Primary Schools, Markets and Choice:
studying polarization and the core catchment areas of schools

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In this paper we distinguish polarization from other conceptions of segregation by conceiving the former as a local phenomenon. To this end we argue that evidence for any school-level separation of ethnic groups must be sought and contextualised within the local markets within which schools operate. By determining the ‘core catchment’ areas of primary schools from geographical micro-data reporting where pupils reside and which school they attend within the study region of Birmingham, England, so we estimate where and by how much schools compete with each other across spaces of admission, consider whether the ethnic compositions of those spaces are representative of the actual intakes of schools, and identify evidence of post-residential sorting and ethnic polarization, where locally competing schools draw markedly different student intakes.

KEY WORDS: catchments, choice, ethnicity, PLASC, polarization, schools, segregation

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The geography which matters is the local, not the national or regional, and the scale of analysis should be commensurate with the local markets within which schools (and parents faced with placement decisions) actually operate (Gibson & Asthana, 2000a: 304).

1. Introduction

In October 2005 the Department for Education and Skills (DfES) published a White Paper entitled *Higher Standards, Better Schools for All – More Choice for Parents and Pupils*. It clearly signalled the Government's attention to expand the education market for state-funded schools within England and Wales. The timing of the paper coincided with raised concerns about ethnic division, religious fundamentalism, and debates about multiculturalism and citizenship within the UK. In a speech becoming emblematic of the period, Trevor Phillips, Chair of the (British) Commission for Racial Equality, warned that Britain is

‘sleepwalking to segregation’: “[there are some] white communities so fixated by the belief that their every ill is caused by their Asian neighbours that they withdraw their children wholesale from local schools [...] We really need to worry about whether we are heading for USA-style semi-voluntary segregation in the mainstream system” (Phillips, 2005).

Although there was no clear evidence of segregation having worsened (see Johnston *et al.*, in press), the suggestion that ethnic segregation is nevertheless too great in some parts of British society met a sympathetic audience.

In the academic literature, a longer-standing debate about social segregation, and whether it is exacerbated by schools, markets and choice, now widened to consider ethnic dimensions –

supported by the release of the DfES' Pupil Level Annual Census (PLASC) micro-date for research. Where initially the focus had been on children of low income families and whether they were becoming increasingly segregated from others into poorly performing schools, now ethnic segregation was of particular interest – do children from different ethnic groups choose different schools from each other, even if they live in the same mixed neighbourhood? For example, Johnston *et al.* (2006) apply a classification of ethnic segregation used by Poulsen *et al.* (2001; 2002) to compare the ethnic composition of English schools (their observed ethnicity profile) with the composition of the census zones within which the schools are situated (their expected profile). The results suggest greater segregation in schools than in the residential neighbourhoods – considerably so for primary schools, and more so for the South Asian, Black Caribbean and Black African populations.

There is a flaw in the analysis, however, and identifying it provides both the rationale for this paper and an affirmation of Gibson's and Asthana's (2000b) observation that “in trying to establish whether or not the marketization of education has had a polarizing effect, the unit of analysis must [...] be the local markets within which schools (and parents faced with placement decisions) actually operate” (p. 139). The problem with the existing comparison of schools and neighbourhoods is that census zones and their entire populations (not just those of school age) are taken to represent the pupils expected to attend the schools. In other words, census zones are assumed congruous with the schools' areas of recruitment, and census populations are conflated with school populations. The challenge is to develop a better counter-factual when assessing the (observed) ethnic profiles of schools against what they 'should be'.

Further self-critique clarifies the issue. A model of school allocations developed by Harris *et al.* (in press) assumes two criteria for school selection: first, that parents will prefer to send a child to the nearest school to their home; second, that there is a preference for children to attend schools with what is loosely termed a ‘sufficient presence’ of that pupil’s same ethnic group. These criteria may be in tension and are conditioned on characteristics of the pupils and of schools.

The model focuses on the demand side of the education market, insofar as demand is expressed by the schools pupils attend. What is missing is an explicit consideration of the geography of supply: the proximity of schools to each other and the extent to which they compete with each other for the same spaces of recruitment. Implicit to the Harris *et al.* model is a friction of distance and ‘least cost’ argument: that those pupils who do not attend their nearest school are, in some sense, exhibiting an unusual behaviour. Such an argument is not tenable if school catchment areas overlap substantially and frequently – if they exhibit a geographical patterning that is not incorporated within the model but would likely alter the likelihood of attending a nearest school. Research by Burgess *et al.* (2006) tabulates the proportion of pupils who have three schools within two, five and eight kilometres of their home. Their conclusion is that most pupils do have considerable choice of school.

The aim of this paper is to model the geography of supply: to estimate where and by how much schools compete with each other within spaces of admission; and to consider whether the ethnic compositions of those spaces ('the neighbourhoods') are representative of the actual compositions of schools. This is achieved by determining the ‘core catchment’ areas of schools – here, primary schools within Birmingham, England – using a method that is set out in the third part of the paper. Prior to this, we summarize the debate about whether education markets increase or decrease social segregation, revisiting the exchange of views between Gorard and Fitz (2000), and Gibson and Asthana (2000b). We do so to distinguish polarization from other conceptions of segregation and to reiterate the latter authors' comment that “polarization must be conceived as an essentially local phenomenon” (p. 139).

2. Schools, Markets and Choice: some debates

From the Elementary Education Act of 1870 (signalling a national system of primary schooling) and progressing through the 1944 Education Act (which made secondary education free), a tax-funded system has been established in England, as in other countries, providing compulsory

schooling for an increasing span of the population.¹ A parallel trend had been to cede responsibility for schools to local education authorities (LEAs) that also controlled the schools' budgets, curricula and admissions criteria, commonly (though not exclusively) using catchment-area systems to allocate children to their nearest schools (Gorard *et al.*, 2003). However, the Education Reform Act of 1988 gave LEAs less autonomy: schools are now able to receive funding directly from central government and have greater control over their admissions criteria; and parents can express a preference for their child to attend any state-funded school.² Schools now operate in a quasi-competitive market where 'performance tables' are published; diversity, specialization and innovation are encouraged; and funding is per pupil, so therefore linked to processes of school choice.

The burgeoning education market has received critical attention; whether people should or do have the right to choose a school is a recurring debate. The "orthodox view" described by Noden (2000) (after Gewirtz *et al.*, 1995; Waslander & Thrupp, 1995) "suggests that quasi-markets present further advantages to already advantaged families and that, consequently, such market reforms will lead to increased social segregation in schools" (pp. 371-2). However, alternatives might be worse. For example, a system whereby all pupils are allocated to their nearest school is one where educational choices are realized within the housing market – it risks 'choice by mortgage' with pupils living in disadvantaged areas being forced to attend schools corresponding to those areas (this usually presumed to be harmful to potential attainment).

A 'middle ground' is to argue that *insufficient* choice will create educational inequalities if it happens that certain sub-groups of the population only can select from a limited set of schools whereas others, with more alternatives, are better positioned to avoid unpopular or underperforming schools. If the supply of places always meets or exceeds demand then, in principle, any pupil could attend a school of choice (if we ignore mobility constraints, but see

1 The upper age of compulsory education was 10 in 1880, 14 years in 1918, 16 in 1972 as today, and proposed to be 18 from 2015. In 2006, only 7% of all pupils in England were outside the 'state system' and in fee-charging schools.

2 Parents can also appeal against decisions that do not meet their preferred school placement: there were 59,300 appeals in 2004/5, of which 36% found in the parents' favour.

<http://news.bbc.co.uk/1/hi/education/6409771.stm>). However, if demand for the most popular schools exceeds supply, then admissions criteria will be invoked which usually include a geographical constraint (priority is given to those living nearest to the school). It is then easy to imagine a scenario where 'league tables' are published, the best schools are identified, the demand to be at those schools outstrips supply, the schools are unwilling or unable to expand, and consequently housing around the preferred schools attracts a premium, reintroducing (and perhaps exacerbating) the problems of choice by mortgage.

Because parents have no automatic entitlement to send their children to over-subscribed schools, so some – possibly many – will be disappointed. In 2007, The Daily Telegraph ran a headline estimating that '200,000 will miss out on their first choice [secondary] school' – which, if true, would be about one third of all pupils. The estimate was based on research in places such as Birmingham, "...the biggest urban authority, [where] 33 per cent of children failed to get into their first choice secondary school [and] [a]most one in 10 were turned away from their preferred primary" (<http://www.telegraph.co.uk/news/main.jhtml?xml=/news/2007/02/28/nschool28.xml>).

If the headline was correct and choice is indeed limited then the next question is whether it is also discriminatory – exercised primarily by those with the wealth or social capital to do so? Is the "orthodox view" correct?

In an exchange of papers presented in the journal *Research Papers in Education* (volume 15, number 2), Gibson and Asthana (2000b) contest Gorard's and Fitz's (2000) finding that "overall segregation in terms of poverty and special educational need has declined in England and Wales since 1988 [to 1997], as it has done in most regions and most schools within England and Wales" (p. 116). The basis of Gibson and Asthana's objections is part surprise – "their [Gorard's and Fitz's] analysis has led them to conclusions which are entirely opposed to those drawn by the vast majority of scholars working with other forms of [theoretical and qualitative] evidence" (p. 134) – and part technical: much of their paper questions the use of pupils receiving free school meals as an indicator of poverty over time, the problem being that it is not a 'fixed category' because the numbers

receiving such meals are dependent on the prevailing economic climate.³ However, the real nature of the disagreement fundamentally is geographical: at least tacitly, both set of authors are raising issue of aggregation and scale, asking about the size of the spaces across which educational markets operate? It is because their answers disagree that their understandings of segregation and polarization diverge.

Nevertheless, there is common ground: each pair of authors starts with a notion of unevenness and the idea that evidence of segregation (for Gorard and Fitz) or polarization (for Gibson and Asthana) is departure from an expected norm: when particular schools are found to have more than their 'fair share' of economically deprived (free school meal) pupils. This is explicit in Gorard *et al.* (2003: 34): "the key characteristic of segregation is unevenness. Segregation, here, is a measure of the unevenness in the distribution of individual characteristics between organisational units" – the organisational units being, for example, schools within a LEA. The difference is that Gorard and Fitz look more at the distribution for all the organisational units, whereas Gibson and Asthana look more at departures from the norm for particular sub-groupings.

Consider Figure 1a. This shows a hypothetical LEA (though it could be any other territorial unit) with ten equally sized schools. Since each school contains 10% of all pupils in the LEA, so (*pro rata*) each is expected to contain 10% of all pupils taking free school meals (FSM). However, the observed proportions differ from expectation: half of the schools each contain 13% of all FSM pupils; the remainder each contain 7%. Applying the segregation index used by Gorard and Fitz (see also Gorard *et al.* 2003) determines that the proportion of FSM pupils that would have to exchange schools for there to be an even distribution: 0.15 (15%). The index is calculated as:

³ Gorard and Fitz are aware of this and specifically state that 'equality of poverty' could explain some or more of the measured desegregation: p. 127 of their paper (see also Gorard, 2000).

$$S_k = 0.5 \times \sum |p_{FSM_{jk}} - p_{PUPILS_{jk}}| \quad [1]$$

where p_{FSM} is the proportion of all free school meal pupils in LEA k attending school j , and p_{PUPILS} is the corresponding proportion of all pupils. Equation 1 can be generalised, making clear that the index compares what is observed for a school against a prior expectation:

$$S_k f \sum |p_{OBSERVED} - p_{EXPECTED}| \quad [2]$$

Now look at Figure 1b. The size and number of the schools is the same, as is the scale of the graph. The LEA appears more polarized (because school 10 clearly differs from the rest). But it is also a more even distribution: only 9% of pupils need to exchange schools to create evenness.

[FIGURE 1 ABOUT HERE]

Together Figures 1a and 1b highlight a problem with the segregation index, or rather a potential problem when using it at too coarse scales of aggregation. However, Gorard and Fitz also use segregation ratios to consider the ratio of observed : expected for *specific schools* within the territorial units – that is, to look for evidence that FSM pupils are concentrated within particular schools. Applying the method to Figure 1b would quickly reveal the polarization of school 10 from the others.

Still a problem remains, illustrated by Figure 2. It shows the distribution of FSM pupils at two points in time for a hypothetical LEA of ten equally sized schools. Imagine that an economic downturn has led to an 'equality of poverty' situation between Time 1 (e.g. 1988) and Time 2 (e.g. 1997). The result is a more even distribution of FSM pupils *and* the segregation ratios being closer to unity. Arguably there is also less polarization: for examples, schools 8 and 9 are more evenly

matched than before. Yet, the point is *it is* arguable, the alternative view being from Gibson's and Asthana's interest in the geography of local markets. If it happens that schools 9 and 10 strongly compete for the same spaces of admission (and rarely overlap with schools 1-8) then there is evidence that polarization has *increased* from Time 1 to Time 2 in the context of the local market for these schools. Any such increase would be revealed by calculating change in the segregation indices for relevant sub-groupings of schools.

[FIGURE 2 ABOUT HERE]

Although the analysis presented in this paper is not longitudinal, giving attention to local markets also questions why the share of FSM pupils found within a school is expected to be proportional to the school's share of all pupils (within the territorial unit, e.g. an LEA), as is assumed by the segregation index. This idea of a 'fair share' implies we also expect the FSM pupils to be evenly or randomly distributed across the territory – a notion which conflicts with the clustering of particular cohorts of society into particular places at finer scales (as encapsulated by the term 'postcode poverty' or by deprivation indices for census geographies: ODPM, 2004).

Whether the conflict matters depends on the purpose of the analysis. If the intent is to show segregation exists within LEAs and between schools (or to measure its change on aggregate over time) then the assumption can hold. However, if the desire is to disentangle post-residential sorting from neighbourhood levels of segregation/polarization, then a more realistic expectation is required.

Here, again, we return to the rationale of this paper, which is to model the geography of local

markets, profile their populations and to incorporate both into measures of ethnic polarization.⁴ We now consider how to do so.

3. Modelling Local Markets

To consider the effects of local markets in their study of school-average GCSE attainment, Gibson and Asthana (2000a and b) group the schools into (overlapping) ‘five-school market groups’ – each individual school plus the four schools with which it has greatest catchment overlap. The overlap is determined by using look-up tables to locate the postcode of each pupil into a census ward and then treating the number of wards two schools have in common as the level of interaction between them – their amount of ‘catchment overlap’.⁵

In this paper we also use pupil-level data (in this case, PLASC: see Harland & Stillwell, 2007) to derive *de facto* catchment areas, though here for primary schools (not secondary schools). Spatial patterns of admission occur because schools do not have unlimited capacity, albeit that they no longer have absolute (*de jure*) catchments. In many cases, parental choice is constrained, ultimately by admissions criteria which, for most schools in our study area of Birmingham, are (in descending order of priority): looked after children (in public care); children in the priority catchment areas of three particular schools; whether a sibling attends the school; denominational grounds for some faith schools (voluntary-controlled Church of England schools) and then children who live nearest the school, by straight line distance. Although geography is not paramount, that fact that it appears in the criteria and given that primary schools have a neighbourhood identity, serving a community function, together lead to clustered geographies of recruitment.

Those geographies are revealed by mapping the home address of each pupil attending any

⁴ Following our discussion, polarization can be conceived as more localized instances of unevenness between specific organisation units within a system (e.g. schools within an LEA), whereas segregation is the boarder measure of unevenness across all units within the system. Of course, this is scale dependent: segregation at one scale of aggregation could become polarization at a more coarse scale. Nevertheless, it is helpful to retain an understanding of polarization as something that exists but is localized within, for example, an LEA.

⁵ They show that between 1995 and 1998, those schools initially at the top of their local market subsequently improve more rapidly than those at the bottom.

given school. The task is then to define that pattern. Gibson and Asthana use zones that are exogenous to the data (census wards). Here we adopt an endogenic approach, drawing the geographies out from pupil and school data, and then defining the size of the local market group (i.e. not defining it *a priori* as five). The method adopted is to model the ‘core catchment’ areas of schools – here defined as residential areas containing 50% of the pupils attending any given school – and to assess where and how often those catchment areas overlap. Figure 3 shows the core catchment for one school in our study region of Birmingham, England. Figure 4 shows that the catchment area intersects with the catchments of two other schools.

[FIGURE 3 ABOUT HERE]

[FIGURE 4 ABOUT HERE]

There are, however, many ways of bounding an area; of defining a ‘core catchment’. Even agreeing the 50% criterion, if a school has, say, 200 pupils, then there are $200! \div (100! \times 100!)$ ways of selecting half. What is important, therefore, is to ensure that the method of selection accords with the aims and objectives of the analysis for which the selection is made. Here we are interested in developing a counter-factual: in generating an ethnic profile *expected* for schools and comparing it with an *observed* profile. If the observed and the expected are not in agreement then the discrepancy provides evidence of processes of ethnic separation..

We know, from the PLASC data, the *actual* spaces of recruitment for any of the 322 schools within the study region (or, at least, we know the unit postcodes where the pupils attending any

school live, admitting some migration between where they live now and where they lived at the time of choosing the school). To be inferred from the same data are the *potential* spaces of recruitment. Whilst we want to calibrate the modelled catchment areas with reference to the PLASC data, we do not want them to be over-fitted to a specific set of pupils and their school allocations. To give a simple example: if a postcode is near to and contains a pupil at a given school then it is reasonable to assign that postcode to the school's core catchment area. However, it is also reasonable to assign a neighbouring postcode even if it does not contain a pupil attending the school. Potentially the school could have recruited from that second postcode, too.

To be specific, we are trying to model the potential catchment areas of schools from what is known about past school allocations as they are recorded in the 2002 PLASC data. We do so using an algorithm, the simple form of which is:

1. Position a rectangle of size $l_{p(NS)} \times l_{p(EW)}$ at the (median x , median y) residential grid reference, calculated for the set of all home postcodes of pupils attending any given school: a geographical centroid.
2. To determine $l_{p(NS)}$ and $l_{p(EW)}$, quantiles are generated along the North-South and East-West axes (i.e. separately for the x coordinates and for the y coordinates of all pupils attending the school). The length and width of the rectangle are then determined as the distances required to contain a starting proportion (p_1) of the pupils in each of the two dimensions ($p_1 = 0.2$ was used; the expected proportion of the pupils contained in the initial rectangle is therefore $p_1 \times p_1$).
3. Allow the rectangle to grow in one of the N, E, S, W directions, choosing that which returns the greatest prevalence of pupils attending the school (i.e. maximise n_1 / n_2 where n_1 is the number of pupils in the search area that attend the school and n_2 is all pupils in the search area). When the rectangle grows outwards it does so by quantiles: each time it captures a further p_2 of the pupils in the direction concerned

($p_2 = 0.1$ was used).⁶

4. Repeat stage 3 until 50% of the school's pupils have been included in the catchment.
5. Define the core catchment area as the convex hull containing the point grid references for the 50% of pupils (i.e. the convex polygon of smallest area that completely encloses the set: Smith *et al.*, 2007: 106).
6. Repeat stages 1 – 5 for all schools in the study region.

Two refinements were made to the simple algorithm when modelling the catchments areas referred to in this paper. First, two datasets were considered simultaneously: the first had the original (x, y) coordinate of the pupils' residential postcodes; the second had those coordinates rotated by 45 degrees. The polygon (previously a rectangle) can therefore grow in each of the N, NE, E, SE, S, SW, W, NW and N directions. Second, any postcodes with point location more than $1.5 \times$ the maximum of the four (N-S, E-W, NE-SW, SE-NW) interquartile ranges were excluded from the core catchment areas.

The resulting algorithm generally produces a compact and unbroken catchment area representing the clustered residential geography of half the pupils attending each school in Birmingham. Figure 5 shows the detail of some of these catchments. Whilst there is evidence of edge effects (caused by pupils travelling from outside Birmingham LEA to schools within it), in general the catchment areas avoid open spaces, water, the centre of Birmingham and the University area, and also tend not to cross principal roads and rail routes.⁷ The smallest core catchment area is 0.05km^2 and around a housing estate with residential tower blocks. The school with the largest core catchment area is a voluntary-aided Roman Catholic school: at 17km^2 it is over twenty times larger than the median area of 0.79km^2 . In fact, 76% of faith schools are found to have core catchment areas that are larger than the median average, whereas only 40% of all (LEA-controlled, non-

⁶ But only in that direction: an increase in the EW direction remains bounded by the length of the rectangle in the NS direction, and *vice versa*.

⁷ It would be possible to remove non-residential spaces entirely from the modelled catchments by clipping them against a suitable land boundary file. The result might be visually more appealing but would change none of the analyses presented here, except some of the area measures.

denominational) community schools do.

[FIGURE 5 ABOUT HERE]

4. Identifying Processes of Polarization

From our demarcations of the core catchments of schools, there are two ways that processes of ethnic separation can be identified. Knowing that 93% of the 101,496 pupils included in the study are located within at least one catchment, the first is to adopt a friction of distance or ‘least cost’ perspective and identify any pupils that appear to be travelling further to school than they need to – pupils that live within the core catchment of at least one primary school but attend another school of which they are not in the core catchment. Of course, this may not be a matter of choice: some schools will be over-subscribed and, in any case, the catchments are defined to contain only 50% of the pupils at the school. Nevertheless, if the propensity to attend any one of the ‘near schools’ (any school for which the pupil is within the core catchment) is consistently lower for some ethnic groups than others then this could suggest a process whereby different ethnic groups are separating away from their shared neighbourhoods into different schools.

However, any separation does not necessarily lead to overall segregation. It is entirely possible for a proportion of ethnic group ‘A’ to be lost from the local schools yet be replaced by an equal proportion of the same ethnic group drawn from surrounding neighbourhoods. Under this scenario, group A remains less likely to attend a near school and, whilst there might be considered to be a local process of polarization, the net result will not be one suggesting segregation. What this emphasises is that ‘migratory processes’ (travelling longer distances to school) are not the only ones leading to separation. Local processes may have the same result when two or more schools strongly

overlap in terms of their potential spaces of recruitment.

Imagine, for example, a neighbourhood with equal proportions of ethnic groups 'A' and 'B', where the neighbourhood is within the core catchments of two schools (I and II), and where A tends to I but B tends to II. Both ethnic groups are attending a local (or near) school but, within the context of the local market, polarization occurs. Hence the second way of identifying ethnic separation aims to disentangle migratory and local processes of polarization, using a series of pairwise comparisons to ask whether the (observed) ethnicity profile of schools corresponds to the (expected) profile of their core catchment areas.

4.1 Least cost perspective

Figure 6 adopts the first approach, showing, for each of the largest ethnic groups, the proportion attending *any* near school as a function of how many near schools there are (as defined above). The horizontal trends simply acknowledge that a pupil is more likely to attend a near school as the number of schools near to them (the supply) increases. It is the vertical differences that are interesting: consistently showing the Black Caribbean group as least likely to attend a near school. This is not merely an artefact of the 50% of pupils threshold used to define the core catchments. The trend is true when other proportions are considered; the 25% and 75% catchments are also shown.

Are, then, Black Caribbean pupils (of which there are 5,824 in the study) attending schools within which their ethnic group has higher (than expected) representation? To answer this, the pairwise comparisons are undertaken.

[FIGURE 6 ABOUT HERE]

4.2 Pairwise comparisons

For each school is known the proportion of all pupils living within the modelled catchment area who are of the Black Caribbean group. If school populations are representative of their catchments (their neighbourhoods), then this is the proportion of Black Caribbean pupils *expected* for each school.

Not all of the pupils will attend the school of which they are within the catchment. Also known is the number of Black Caribbean pupils – living in the catchment and attending the school – as a proportion of all pupils living in the catchment and attending the school. This is the *locally observed* proportion of Black Caribbean pupils attending the school. If the school has a local intake representative of its catchment then the locally observed proportion should be equivalent to the expected proportion of Black Caribbean pupils. If not, then it is suggestive of local processes of polarization.

The locally observed proportion is different to the *globally observed*: the number of Black Caribbean pupils as a proportion of all pupils within the school is calculated. Unlike the former, the global measure ignores whether pupils live in the catchment – it is calculated by school but is blind to geography. Looking at the difference between the globally and locally observed proportions of Black Caribbean pupils indicates the effects of migratory processes of ethnic separation over-and-above local processes.

It is also possible to identify locally ‘competing’ schools – that is, ones that overlap in terms of their core catchment areas. Retaining the 50% (of pupils) threshold to determine the size of catchments, the number of schools each is found to compete with ranges from 0 to 19, with a median of 2, mean of 2.9 and an interquartile range from 1 to 4. There are 41 schools (13%) that overlap with no other; for others the percentage of pupils shared with another school is calculated as:

$$\frac{\#(A \cap B)/\#A + \#(A \cap B)/\#B}{2} \times 100 \quad [3]$$

where #A is the number of pupils in the first school's catchment (including those who live in the catchment but do not attend the school), #B is the same for the second school and #(A ∩ B) is the number in both catchments. Where school catchments overlap, the percentage share ranges from 0.18% to 76%, with a median of 10%, a mean of 15% and an interquartile range from 4.1% to 23%. Looking only at the shares between any school and its most overlapping competitor, they are found to range from 0.69% to 76%, with a median of 23%, a mean of 26% and an interquartile range from 11% to 38%.

However, this is to label any school a competitor no matter how few pupils are actually shared – provided there is at least one, it is sufficient. To identify the more dominant pairings and to simplify the graphs that follow, only shares exceeding the median of the greatest competitor values are taken to distinguish a locally competing school (i.e. shares exceeding 23%). The effect of this is to reduce the number of competitors per school: the range is now from 0 to 7, with a median of 0, a mean of 0.70 and an interquartile range from 0 to 1.

Finally, it is not necessary to plot every school on the graphs. Most schools are expected to have less than their 'fair share' of Black Caribbean pupils, this being defined as when the locally expected proportion of all Black Caribbean pupils (in the LEA) that are in the school is equal to the proportion of all pupils (of any ethnic group) that are in the school – when:

$$\frac{P_{EXPECTED_{jk}} \times n_{jk}}{\sum_j P_{EXPECTED_{jk}} \times n_{jk}} = \frac{n_{jk}}{N_k} \quad [4]$$

where p_{jk} is the expected proportion of Black Caribbean pupils in school j , n_{jk} is the total number of pupils in that school, and N_k is all pupils attending schools within LEA k (Birmingham). In fact, 71% of all Black Caribbean pupils are found in the 81 schools (25%) expected to have more than their (locally weighted) fair share.

Figure 7 summarizes the pairwise comparisons. The leftmost plot is of the locally observed percentage of Black Caribbean pupils against the expected percentage for each of the 81 schools. If the schools are recruiting Black Caribbean pupils in proportion to their prevalence within the catchment areas, then the two percentages would be equal and each school would lie on the solid, diagonally fitted line. However, some deviation is to be expected. Also shown (as dot-dashed lines) are the thresholds beyond which the difference between any observed and expected value becomes significant (at a 95% confidence interval, assuming a two-tailed binomial test). On this basis, only 11 of the schools (14%) ‘over-recruit’ Black Caribbean pupils from within their catchments, 36 under-recruit (42%) and 34 (44%) have intakes representative of their catchments. (These schools over- or under-recruit not only in proportional terms but in absolute terms – the counts are higher or lower than expected too).

[FIGURE 7 ABOUT HERE]

Superimposed upon the same (leftmost) graph is a sunflowerplot showing the number of locally competing schools for those schools which either over- or under-recruit Black Caribbean pupils. (No competitor is indicated by an unfilled circle, one by a filled circle, and two or more by the number of ‘petals’ extending out from the point). Where any two schools are found to be locally competing and where both are either over- or under-recruiting Black Caribbean pupils, then they are

shown linked together by the thicker, solid black lines: there is suggestion of some schools over-recruiting at the expense of others that are under-recruiting within the same locally-defined market: note, in particular, school 313, a faith school of Roman Catholic denomination. (There are other pairs that ‘move together’ – both over- or under-recruiting Black Caribbean pupils).

The picture portrayed appears consistent with Figure 6: more schools ‘lose’ Black Caribbean pupils than do gain them, implying that the pupils are travelling beyond near schools to attend ones which are further away. But, now looking at the middle plot of Figure 7, the scene becomes blurred. The x-axis of this graph summarizes the previous: it is the difference between the locally observed and the locally expected values: any school with a higher than expected local intake of Black Caribbean pupils will be to the right of the dotted vertical line. However, the schools’ intakes are not limited to their core catchment areas (by definition, given that each catchment contains only 50% of the pupils attending the school). Whether the final ethnicity profile of the school is representative of its catchment depends both on those who attend locally and those who travel from further away.

The y-axis of the middle plot has the differences between the globally observed and locally observed percentages of Black Caribbean pupils. For the majority of the schools the shift is upwards; only 14 of the 81 schools (17%) have an overall percentage of Black Caribbean pupils that is lower than the local percentage. The net result, shown in the rightmost plot, is to partly reverse the local trend of even or under-recruitment: it is now found that 26 of schools (32%) have a higher than expected percentage of Black Caribbean pupils; 19 have less (23%); and 36 (44%) are adjudged equal. This is not simply a function of the 50% threshold used to define the core catchment areas: using the less conservative 75% threshold gives a similar reversal: locally 24 of 90 schools (27%) are found to over-recruit and 36 to under-recruit (40%); but the net result is of 31 with higher than expected percentages of Black Caribbeans (34%), and 25 with lower than expected percentages (28%).

Figure 7 suggests a selection process whereby parents of Black Caribbean pupils prefer their

children to be schooled with their same ethnic group but also where particular schools are additionally popular. Pupils who attend those more popular schools leave spaces in local schools that can be filled by pupils travelling from further away. It is notable that nine of the eleven schools found to over-recruit Black Caribbean pupils locally are voluntary-aided faith schools (82%, against the 26% of the 81 schools that are of this type) – and six of those are Roman Catholic (55% Vs 21%). In contrast, of the fifteen schools that do not over-recruit locally but still obtain a higher than expected percentage of Black Caribbean pupils, eight are Community schools (53% - but they comprise 63% of the 81 schools), a further three are voluntary-controlled faith schools (20% Vs 10%), the remaining four are voluntary-aided (27% Vs 26%).

4.3 Evidence of polarization?

It is known that 71% of all Black Caribbean pupils attending primary schools in Birmingham LEA can be found in the 25% of schools expected to have more than their ‘fair share’ of this group. This is not due to residential sorting alone: 26 schools have a significantly higher percentage of Black Caribbeans than is expected based on their locality. Those 8% of all schools contain 32% of all Black Caribbean pupils.

By direct analogy to Equations 1 and 2, a segregation index can be derived *for each school* by comparing their observed ethnicity profile with the profile expected from their modelled catchments (at the same time acknowledging that there are other and possibly better indices we could have used: Allen & Vignoles, 2007 but see also Gorard, 2006). The index is calculated as:

$$S_j = 0.5 \times \sum_1^e \left| p_{OBSERVED_j} - p_{EXPECTED_j} \right| \quad [5]$$

where summation is across the ‘e’ number of ethnic groups (of which there are nine) and where it is the globally observed (net) profile which is used.⁸ The index is, however, sensitive to the relative sizes of the various groups; there is not a simple linear relationship between the value of the index and its significance. Therefore each value of S_j is compared against S^*_j , where

$$S^*_j = 0.5 \times \sum_1^e |p_{RANDOM_j} - p_{EXPECTED_j}| \quad [6]$$

Here, p_{RANDOM} is the ethnicity profile obtained for a school if half of its intake is randomly sampled from its core catchment and the other half sampled from outside of it.⁹ By repeating this procedure multiple times (10,000 was used) so measures of statistical significance can be simulated for each S_j given the size of the schools, and given the size and composition of their catchments.

In this way, seven of the 26 schools with higher than expected percentages of Black Caribbean pupils are also found to have significantly high segregation indices (at a 95% confidence level). The profiles of these schools are shown in Table 1, together with the profile of their most strongly competing school where applicable (the school with which they have greatest catchment overlap). Comparing the observed and expected values, what is stark is the separation of Black Caribbean pupils from Pakistani ones. In some cases both the school and its ‘competitor’ attract higher than expected percentages of Black Caribbean pupils (especially true of school 272); in other cases, one gains whilst the other loses Black Caribbean pupils (school 313) – a clear example of ethnic polarization within the local market.

[TABLE 1 ABOUT HERE]

⁸ The groups are Bangladeshi, Black African, Black Caribbean, Black others, Chinese, Indian, Pakistani, White and other.

⁹ It is half because half the population of the school is found within its core catchment area.

5. Conclusion

The paper has demonstrated a method of understanding processes of ethnic segregation and polarization within the context of the local markets within which schools operate. It has done this by modelling the core catchment areas of schools – their spaces of potential recruitment – and then considering the propensity of various ethnic groups to attend near schools, as well as undertaking pairwise comparison of the ethnic composition of ‘neighbourhoods’ (the catchments) with the observed intakes of schools.

Consistent with previous studies (for example, Harris *et al.*, in press, though that study is of secondary schools), Black Caribbean pupils appear more likely to travel further to school than they need do. Moreover, whilst such pupils are non-evenly and non-randomly distributed across the study region but, instead, are clustered into certain residential spaces, still clear evidence of post-residential sorting is also found (supporting the findings of the Johnston *et al.*, 2006, study), as is evidence of polarization where locally competing schools draw markedly different intakes.

This is not to imply, however, that Black Caribbeans are the only ethnic group with a tendency towards segregation from other groups. For example, there are 81 schools (25%) each expected to have more than their fair share of Pakistani pupils and together containing 86% of the group. Of these, 30 have a higher than expected percentage of Pakistani pupils and those 9.3% of all schools have 49% of all Pakistani pupils within the study region. Of the 30, three have significantly high segregation indices; all three are community schools.

It is important to understand what the study does *not* show. First, it is not longitudinal and so there is no evidence that recent school reforms have either worsened or improved ethnic separation. Secondly, it cannot be presumed that segregation and polarization would disappear without a system of school choice. Choice can be exercised or denied in many ways, including through housing and employment markets. Thirdly, it should not be concluded that ethnic groups actively avoid each other. A preference to be schooled with children of the same ethnicity (if that is what we are observing) is not, in itself, a process of avoidance but of seeking ethnic peers. Fourthly, it may not

be ethnicity but other factors that drive the processes of separation – factors that are confounded and concealed by a focus on ethnicity alone. Potential candidates include socio-economic determinants, noting rising levels of inequality (Dorling et al., 2007) and, in particular, Allen's (2007) study of a cohort of pupils in English secondary schools in 2002/3, finding that "of FSM [Free School Meals] pupils, 61 per cent are worse off in terms of their peer group under current sorting, compared with proximity allocation [...] By contrast, half of the pupils not eligible for FSM have a better peer group under current sorting" (pp. 764–5).¹⁰ A model-based approach could explore – and quantify – how changes in (ethnic) segregation are affected by other factors (Goldstein & Noden, 2003; see also Gorard, 2004 and Goldstein & Noden, 2004).

Finally, it is as well to avoid hasty, normative judgments. Whilst this study points to faith schools are being some of the most segregated – in fact, of the 37 of all schools with a significantly higher than expected segregation index, 65% are faith schools (against 26% in the LEA) – the contribution of such schools to education and to society must be placed within a broader discussion. More particularly, whilst supporters of a diverse and mixing society may be uncomfortable to discover processes of segregation and polarization at the point of entry into primary schools, this is still, at least in part, the choice of parents, for their children.

The simple fact is that most pupils in the UK attend schools where their own ethnic group dominates – because most pupils are white. Why other ethnic groups should not experience the same is the trigger for debate.

¹⁰ In terms of educational outcomes, Hamnett et al. (2007) show that although ethnicity accounts for some variation in performance for schools in East London, social background (as measured by a classification of postcodes) is the more determining factor, with the social composition of schools also have an effect upon individual attainment. Looking at the whole of England, Gibbons and Telhaj (2007) highlight wide disparities between peer-group ability in different schools but also show little change over the period 1996-2002 in regard to whether pupils of differing age-11 ability are sorted into different secondary schools.

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Figure 1. Showing the observed proportion of FSM pupils in ten equally sized schools within two hypothetical LEAs. The upper LEA is measured as the more segregated (index = 0.15), though the lower LEA (with index = 0.09) seems the more polarized.

Figure 2. Showing ‘equality of poverty’ but also increased polarization within a local market.

Figure 3. The 'core catchment' area of a primary school in Birmingham, England.

Figure 4. An example of overlapping catchment areas.

The pupil appears to have had the choice of three schools to attend.

(a) Showing how open spaces generally are omitted from the modelled catchment areas

(b) Showing admission spaces falling either side of the motorway and other principle roads

(c) Showing evidence of edge effects caused by pupils travelling from outside Birmingham LEA to schools within it. In this case, the axis of the catchment area mimics the route of roads into Birmingham.

Figure 5. Some of the modelled core catchment areas.

Figure 6. The proportion of pupils attending any near primary school as a function of the number of near schools and by ethnic group. (upper) with the core catchments containing 50% of pupils; (middle) with the core catchments containing 25% of all pupils; (lower) with the core catchments containing 75% of all pupils per school.

Figure 7. Visual summary of the pairwise comparisons for schools expected to have highest percentages of Black Caribbean pupils.

Sch.	index	School type	Expected					Observed					Competitor (observed)						
			Area (km ²)	Bangla- deshi	Black Caribbean	Indian	Pakis- tani	White	Bangla- deshi	Black Caribbean	Indian	Pakis- tani	White	Bangla- deshi	Black Caribbean	Indian	Pakis- tani	White	(share)
313	0.64	Voluntary aided: Roman Catholic	3.32	19.7	11.1	16.0	36.8	5.70	0.00	49.1	8.18	1.82	27.7	15.0	1.87	31.2	44.1	1.09	0.34
277	0.45	Voluntary aided: Roman Catholic	2.28	2.13	20.9	8.37	36.5	15.3	0.00	39.6	3.05	0.00	29.3	0.25	27.0	23.5	12.5	14.0	0.36
275	0.40	Voluntary aided: Roman Catholic	1.32	25.6	20.0	2.38	26.0	11.3	2.26	41.4	2.63	10.2	11.3	-	-	-	-	-	-
272	0.34	Voluntary aided: Roman Catholic	4.11	8.74	10.1	3.39	28.8	23.3	0.65	34.0	3.92	8.50	28.8	3.46	26.0	0.87	7.79	31.6	0.42
305	0.32	Voluntary aided: Roman Catholic	2.08	4.95	6.07	3.28	41.0	25.5	0.00	12.8	9.23	17.9	45.1	0.00	3.11	1.78	0.89	82.7	0.38
251	0.32	Voluntary aided: CoE	1.16	4.58	21.1	18.9	18.2	19.8	2.54	49.7	22.3	6.09	9.14	-	-	-	-	-	-
9	0.29	Community school	2.01	2.82	15.4	12.9	38.1	13.8	0.25	27.0	23.5	12.5	14.0	0.00	39.6	3.05	0.00	29.3	0.36

Table 1. Ethnicity profiles of the seven schools with significantly higher than expected percentages of Black Caribbean pupils and segregation indices. Where applicable, the ethnicity profile of their most competing school is also shown.