Urban size, spatial segregation and educational outcomes

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1. Introduction

Despite several swings in the theoretical basis of British urban policy since the late 1960s, one continuing strand (imported from earlier US initiatives) has involved a focus on action in small areas of concentrated deprivation, typically in the inner city, but also in peripheral estates. This was actually the dominant strand from the late 1960s (when poverty was rediscovered) to the mid-1970s, producing an 'alphabet soup' of spatially targeted projects -including EAAs, CDPs, CCPs. Many of these were fairly short-lived, but the Blair government has produced a rather similar array of EAZs, EZs, HAZs et al.[1] - and unlike the 1960s a widely accessible new set of small area ('neighbourhood') statistics to support the targeting and evaluation of such initiatives.

From the start, this small area-based approach has been counterpointed by critical commentary challenging the efficiency of spatial initiatives as a means of targeting individuals exposed to the forms of deprivation with which the programmes were concerned (see e.g. Holterman, 1975). Often this critique went with suspicions that a tight spatial focus was simply a means of limiting financial commitments by addressing only the immediately visible part of an iceberg of poverty and deprivation. Against such criticisms there were and are two lines of defence of a small-area approach to urban social problems. The *first* of these was that some key policies to tackle causes of deprivation were of necessity delivered on a small area basis by schools, field workers or through community centres and that specific interventions were required to make their delivery more responsive to the need of deprived groups, and to ensure that additional funding was actually directed to their needs. The *second*,

[1] These acronyms stand respectively for Education Action Areas, Community Development Projects, Comprehensive Community Programme, Employment Zones, Education Action Zones and Health Action Zones.

more fundamental, response has been that spatial concentrations of deprivation themselves contribute substantially to the reproduction and intensification of the problems experienced by individuals, requiring strategic local interventions to limit the spread of poverty, alienation and social exclusion.

Until recently, curiously little research has actually been undertaken (or commissioned) in the UK to evaluate this second more fundamental rationale for small area initiatives. In the US several important studies had been launched in the 1990s, but these also followed more than 30 years of spatially-focused urban programmes.[2] One reason for a recent growth of work in the field has been the increasing availability of large scale micro-data sets capable of being linked with aggregate small area data in analyses to test the significance of 'neighbourhood effects' on outcomes for individuals when relevant characteristics of their own have been controlled for. An important example is the British Household Panel study, with which Buck (2001) has shown that people's chances of entering poverty are significantly higher and of leaving it significantly lower if they live in an area with concentrations of other deprived people – though the scale of this difference is relatively modest. But it is also possible to look for evidence of such effects within aggregate data sets on their own, through examination of the *form* of key relationships, when suitable micro-data sets are not available. This is the approach followed in the later parts of this paper in relation to school-level educational outcomes.

As well as questions about the general significance of neighbourhood influences, however, there are also important questions to be addressed about the

[2] At a larger spatial scale, in the case of UK regional economic policies, despite more than 50 years of experience there is still no substantial research assessing the actual significance of the negative social and economc impacts of uneven economic development and a spatially uneven economic distribution of unemployment, on which the case for top-down regional policies seems to rest.

geography of residential segregation, which provides the basis for potentially significant variations in neighbourhood effects. One motivating force for such questions is the broader issue of what actually is ‘urban’ about deprivation, alienation and exclusion, and why specifically these are identified with big cities, and hence as providing the target for urban policies of various kinds. The literature suggests a number of different kinds of answer to this issue, from Durkheimian ideas about anomie as a feature of urban ways of life to more contemporary literatures focusing on the effects of de-industrialisation and concentrated job loss in the major cities. Here, however, we focus on a more purely spatial hypothesis about consequences of the differing spatial scales over which segregation occurs in settlements of different sizes, and their relation to the ranges over which ‘neighbourhood effects’ could be expected to operate.

One starting point is the banal observation that in small communities the richest and most respectable necessarily live cheek by jowl with the poorest and least respectable, whereas in larger towns and conurbations they do not need to, instead tending to occupy areas where the lower status and potentially dangerous classes could not afford to live. This was a source of concern to moralising Victorian writers who feared the consequences of a loss of positive role models and social control in one-class urban areas from which the middle-class had departed (Stedman Jones, 1971). There are echoes of this idea in Wilson’s (1987) analysis of the contribution to formation of a ghetto underclass made by the more recent out-migration of middle-class African-Americans.

Against such ideas, it might be objected that space is relative, with people adapting their action spaces so that it scarcely matters whether highly segregated areas are 100 metres across or several kilometres. On the other hand there are some social

institutions, notably the neighbourhood school, which operate at a fairly consistent scale more or less independent of social geography, meaning that in big cities these are much more likely to be socially (and racially) homogeneous than in small or medium sized towns. In these cases at least if there are significant peer-group effects (the educationists' version of the geographers' neighbourhood effect), the outcome could well be much greater variance in educational outcomes in the larger settlements, both as between schools and population groups (or individuals).

Whether or not such effects are really significant, area deprivation indicators based on standardised spatial units (notably in England the IMD2000 set from DETR) are customarily deployed in ways which are very sensitive to differences in the scales over which segregation operates. In particular, local regeneration needs are often assessed in terms of the proportion of wards within an area falling within the worst 5 or 10% of wards in a national ranking on one or other of the deprivation indicators – or (in the conurbations) the proportion of their local authority districts or parliamentary constituencies in an equivalent position on rankings of unemployment rates. If neighbourhood effects *are* really important this could provide salient information about additional risks of social exclusion facing residents of such areas. But as an indicator of the incidence of personal deprivation, it is liable to convey an exaggerated impression of the severity of problems in the larger cities – if (as we expect) larger scale segregation in these cities means that more of their constituent wards, districts or constituencies figure toward the extremes of the national distribution.

In the remainder of this paper, we look at these issues in turn, starting with an examination of the pattern of variation of residential segregation across housing/labour market areas, defined in terms of functional regions (section 2).

Having established that segregation of all kinds does indeed operate across larger geographical sub-units within the more populous city-regions, we then examine the evidence for significant neighbourhood effects in relation to educational outcomes at the level of individual secondary schools within the largest such region, i.e. the London metropolitan region (section 3). The next section returns to analyses across functional regions, looking for evidence that scale and residential segregation affect the aggregate pattern of outcomes at this level – particularly whether segregation produces more unequal educational outcomes (section 4). Finally, we relate these findings to the apparent relationship between inequality and urban size, emphasising how a combination of residential segregation with under-bounding of cities can lead to an exaggerated view of inequalities in the biggest cities (section 5).

2. Urban Size and Scales of Spatial Segregation

There is a vast literature on residential segregation in cities, particularly in the United States, much of it focused on issues of race. But (since the contribution of Morgan, 1975) little of this has been concerned with trying to understand in a systematic way how patterns of segregation are affected by urban scale. In this literature, the largest cities have commonly appeared among lists of the most segregated areas (e.g. in Massey and Denton, 1993). But there is often some ambiguity as to whether 'segregation' represents a set of (invidious) processes constraining individuals' location decisions, or simply unevenness in the pattern of outcomes from these decisions, whatever their cause. Interest naturally tends to be stronger in the former of these, where a relevant question is whether housing market constraints operate more severely, for one reason or another, in some of these major cities. Our focus, however, is really on the latter issue, and the extent to which similar

processes are likely to produce larger scale and/or more intense segregation in bigger cities, simply because they are bigger systems.

In broad terms as an outcome, segregation simply implies the uneven distribution of different population groups within a local or regional housing system. Such unevenness might be primarily tenurial, with differences in the types of accommodation occupied, but our concern here (as in most of the literature) is simply with their spatial manifestations (i.e. with spatial segregation). And, while in some times and places there has been substantial vertical segregation within buildings, the principal concern (as here) has typically been with horizontal segregation, because of its generally stronger implications for the likelihood of some interaction. The chances of direct person-person interaction with different kinds of people, on the street or in the classroom, giving rise to more/less welcome 'message exchanges' and influences on behaviour (particularly of children), has been one of the traditional motives for segregation (Williams, 1981). De facto segregation may emerge for quite other reasons, but its interest as a phenomenon lies in the fact that residential proximity creates a range of externalities, both positive and negative, which people try to make the best of, in part through decisions about where they live.

Within a free, private housing market, standard models of urban land use point to three main factors underlying de facto residential segregation:

(a) variations between groups in their ability to afford access to exogenous attractiveness factors - including environmental attractions, such as higher land, open space and major cultural facilities – and/or longer-distance commutes to places of work;

(b) parallel variations in ability to afford access to areas with population mixes, and associated amenities (including school quality) which are generally seen as attractive by members of the population; and

(c) inter-group variations in the value attached to living close to members of that group, and to the specific amenities which they attract.

This is somewhat over-simplified since groups can also vary in the intensity of their desire to be close to, for example, cultural facilities, while a relative disinterest in some non-place-specific sources of utility (including residential space) can also contribute to segregation. But these three factors are the critical ones, with the second and third – in each of which area attractions are both cause and effect of segregation - serving to intensify patterns of segregation which may have been initiated by the first (and/or by pure chance). On the other hand, in so far as there is a shared need for access to a single centre, the first factor serves to limit the effects of the other two: in particular, members of population groups who would like to be close to each other and away from (some or all) of the rest have to trade this off against access to the centre.

These three factors have some implications for the degree of segregation to be expected in particular housing markets, which should be greater where:

- employment is concentrated in a single centre – or where there is a single centre for each particular kind of job;
- there is a single area of high environmental attraction, and/or a single area with very low environmental quality;
- there are relatively large differences in spending power within the population; and

- differences in preferences in relation to the various accessibility factors are stronger between than within identified population groups.

And, other things being equal, the size (and population) of areas above any particular threshold of homogeneity should be greater where:

- the aggregate population is larger.

Appropriate ways of measuring segregation have been very extensively debated in the literature over the past half century, reflecting both the importance of comparative analyses of segregation in American debates about persisting racial inequalities (as in Massey and Denton's 1993 study) and the fact that researchers have typically been interested in what segregation implied for interaction between groups or accessibility to decentralised employment opportunities. Following Massey and Denton (1988) it has become conventional to recognise five quite distinct and rather independent dimensions of 'segregation': evenness, exposure, concentration, centralization and clustering. Our direct concern in this paper is solely with the first of these, 'evenness', in the sense of the degree of variation between sub-housing market areas in a particular group's share of the local population. We are also interested in clustering, in terms of the likelihood of adjacent areas having similarly high or low proportions of a particular group, but this is addressed here solely in terms of how measures of evenness vary with changes in the level of spatial aggregation.

Evenness is actually the most straightforward of the dimensions to operationalise, with all of the relevant measures used in earlier research proving to be closely correlated (Massey and Denton, 1988; Massey et al., 1996) and one – the dissimilarity index (D) - having clearly established itself as the standard indicator for comparative work. Among its advantages are that it is formally independent of the overall population share of the group concerned, and that it is scaled to vary between

0 and 1 (or 100%) for the range of situations between complete homogeneity and maximum possible segregation. Jargowski (1997) has proposed a variant, the neighbourhood sorting index, which fulfils the same role in relation to characteristics such as income defined in continuous rather than discrete, binary form.

The form of the dissimilarity index is:

$$D_i = \frac{0.5\, MAD_i}{\overline{p}_i \left(1 - \overline{p}_i\right)} \tag{1}$$

where D_i = the dissimilarity index for population sub-group i;

$\overline{p}_i$ = the overall proportion of the population in sub-group i; and

MAD_i = the mean absolute deviation across sub-areas of the population proportions in sub-group i.

In this study we have started from conventional variance-based measures of deviation across areas - rather than mean absolute deviations – and used these as bases for similar segregation indices. A natural idea is simply to replace the MAD measure in the numerator of the index by a standard deviation, yielding an adjusted version of the coefficient of variation (suitable for variables expressed in proportions). However, though the minimum value of this statistic, in the absence of segregation, would be zero, its maximum value is not independent of the overall proportion of the population with the characteristic in question. One alternative, which satisfies that requirement and yields a consistent maximum value of one for the index (and for which the maximum values are independent), involves using the variance rather than standard deviation as the numerator. But clearly it would work as well to keep the standard deviation as numerator and use the geometric mean of the overall population mean and its complement as the denominator:

$$D_i^{SD} = \frac{SD_i}{\sqrt{\overline{p}_i (1 - \overline{p}_i)}} \tag{2}$$

where D_i^{SD} = a standard deviation-based dissimilarity index; and

SD_i = the standard deviation across sub-areas of the population proportions in sub-group i.

Any positive power of this index would also clearly satisfy the formal independence requirement, although between the limiting cases of zero and complete segregation, they would be related in quite different ways to the overall proportion possessing the characteristic. Indeed there is no a priori way of ensuring independence of *any* segregation index from this proportion, inside these limiting cases, since dependence in this range arises not simply logically but from the way actual locational processes operate. In our analyses – where we use the index defined in equation (2) - we control for dependence by including the mean proportion with the characteristic (or an appropriate function of it) among the explanatory variables in the regressions.

The spatial units across which segregation indices are appropriately computed are functional housing and labour market areas, such as the SMSAs for which US residential segregation indices have commonly been computed (e.g. by Massey and Denton, 1993). For our analysis we have adopted a British equivalent to these, namely the set of CURDS functional regions (FRs) defined by Coombes et al. (1982), of which there are 208 within England and Wales, varying in 1991 population between 23 thousand and 7.8 million. These do not represent the most up-to-date effort at defining functional regions, being based originally on 1971 Census travel to work patterns. But for our purposes they have the advantage of internal zonal disaggregation, distinguishing core, ring and rural areas, and allowing a measure of employment centralisation to be derived.

In order to examine how the scale of residential segregation varies between these functional regions, we start by distinguishing three nested sets of sub-areas, representing different spatial levels at which we can derive indices of residential segregation for each functional region. Unlike local authority districts (not used, for this reason) each is of relatively consistent size in terms of resident population:

- Census enumeration districts, with average populations of about 500 ± 125;
- wards with average populations of 5.2 thousand ±3.9 thousand;[3] and
- parliamentary constituencies with average populations of 90,000 ± 12,000.[4]

For each of these spatial scales a set of segregation indices were calculated, covering the following array of socio-demographic variables drawn from the 1991 Census, including indicators of social class, economic activity, health, mobility, age, ethnicity and housing tenure (all expressed as proportions of the relevant population).[5] Simple comparisons of average values of our segregation index for these variables across FRs for the three levels of disaggregation show firstly that there are great differences in degree of segregation between these scales (Table 1). Typically segregation seems to operate about three times as strongly at ward as at constituency level, and about twice as strongly again at enumeration district level. But there are also quite big differences between population characteristics, which may reflect either contrasts in their housing market position or the degree to which their presence affects others' locational preferences (or both). Generally, the highest degrees of segregation

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[3] EDs correspond roughly to the scale of US 'blocks' while English wards correspond broadly to that of US 'tracts'; US 'wards' are several times larger with upwards of 10 thousand population.

[4] Strictly parliamentary constituencies are not nested within the FURS functional regions, an adapted version of which, comprising whole constituencies, was used for the constituency level analysis. Since half of the adjusted functional regions comprised a single constituency, these regions had to be dropped from this particular analysis.

[5] These indicators are: households renting from public authorities; families headed by a lone parent; economically active in social classes 1 and 2 (professionals & mangers); economically active in social classes 4 and 5 (semi- and un-skilled workers); population over retirement age; economically active population; unemployment; population of non-white ethnic origin; households with a move in the previous year; working age population reporting a limiting illness.

tend to be in the distribution of public sector tenants, followed by lone parents and the high and low social class groups. At the other extreme, segregation is least evident in relation to those with limiting illnesses, though it is also quite modest for the elderly, the unemployed, recent movers and – significantly in relation to the US literature – the non-white population taken as a whole (cf. Voas and Williamson, 2000). There are also interesting differences between variables in the degree to which segregation persists as we consider higher levels of spatial aggregation. In particular, this seems to be the case for the higher social class grouping, the unemployed and the non-white population, where segregation remains relatively strong at constituency level, whereas for public renters it seems most significant at ward level, and for lone parents at the scale of enumeration districts.

In order to examine how far the degree and scale of segregation were influenced by differences in regional size, three sets of regression analyses were undertaken, at the three spatial scales, relating our indices of segregation for each functional region to its total population and to a set of control variables including other possible influences on the local intensity of segregation. Among these was a measure of the overall incidence of the characteristic in question as a control for possible substantive (as distinct from formal) dependence of segregation levels on population mix.[6] Another set were essentially spatial, including the proportion of FR employment concentrated in the core, and the overall ratio of employment by workplace to employment by residence in the FR, reflecting its effective independence as a housing market area. In the first case, the hypothesis was that greater concentration of employment would promote segregation. In the second case, there was a hypothesis that workplace ratios in excess of 1 should be associated with

[6] We actually used an adjusted version of this variable, representing the geometric mean of proportions with and without the attribute in question.

lower measured segregation, since the effective housing market area was greater than the functional region. For workplace ratios below 1, there was no clear hypothesis, however, and for this reason the workplace:residence ratio measure was split in two. Since the London functional region was a clear outlier in terms of population size, a dummy variable for this case was included also, to ensure that its peculiarities were not solely responsible for any observed relation between segregation and size. The full set of independent variables in all analyses comprised: total population (logged); London region (dummy); adjusted means of the variable in question for the functional region as a whole (logged); proportions of employment by workplace in the core zone; numbers working in the region as a ratio of workers resident in the area (separately defined for areas with ratios above and below 1); proportion of employment in manufacturing; proportions of the population of non-white ethnic origin; proportions of owner-occupier households; proportions of households renting from public authorities; and an index of the ‘excess’ spatial segregation of public sector housing.

The last of these variables, included in each of the equations except for public sector housing, was calculated as the residual from that regression. It was intended to reflect the potential influence of non-market housing location and allocation policies in particular functional regions - including the effects of housing authority boundaries and local variations in political control – on segregation, over and above influences on locational choice in the private market. In all regressions the dependent variable was logged: hence coefficients on population size and the adjusted mean values represent elasticities.

The full sets of results from these regressions are presented in Tables 2(a), (b) and (c) (for EDs, wards and constituencies respectively). One consistent feature is that

there always seems to be a positive association between the adjusted mean values of a characteristic and measured segregation – usually statistically significant, often very strongly. In other words, although formally independent (for the extreme cases of perfect and zero segregation) this segregation index at least is not substantively independent of population mix, and tends to record higher values as the size of the groups involved approach parity. This tendency seems particularly strong in relation to the unemployed and the non-white population. Among the spatial structure variables, there were indications at ED level that segregation was stronger where employment was more spatially concentrated, but this was not borne out at the two other spatial scales. Contrary to our hypothesis, no association was evident with the workplace ratio for values greater than one, but there was a tendency for strong positive associations among areas with values below one – in other words, areas with substantial net outflows of commuters tended to be significantly less segregated. Except in terms of ethnic segregation itself, there are no signs that segregation is generally more marked in areas with significant ethnic minority populations, and some pointing in the reverse direction. Areas with more industrial employment do seem to show stronger segregation in relation to the upper social classes, the unemployed and the non-white population as a whole. Tenure patterns often seem to have strong effects, usually with similar relations for owner-occupiers and public sector tenants – implying that the scale of private sector renting may be the crucial influence, sometimes positively and sometimes negatively. A very consistent tendency is evident, however, for unexpectedly high or low levels of segregation of public sector tenants to be reflected in all the other measures of segregation. Segregation is not consistently higher or lower where there are more residents in the non-market sector, but the way in which they are distributed spatially (through a

combination of administrative, political and historic influences) seems to have a pervasive effect on the intensity of segregation.

In relation to the central hypothesis – about the influence of scale on segregation – the results are consistent. Measured segregation is always stronger in functional regions with larger populations, usually significantly so, with the strength of this effect increasing as we move up from enumeration districts to wards. The median elasticity at ED level is about 0.05; at ward level it is about 0.085, and at parliamentary constituency level (for multi-constituency regions) about 0.66. Since a separate dummy variable is included for the London case, these estimates actually relate to the regions ranging in size between 24 thousand and 1.4 million. In most cases the London dummies are not significant, but they are preponderantly negative – consistently so at ED and constituency level. In other words, segregation across the London region seems less than would be expected for a functional region of its extreme size (7.8 million population). Indeed, typical values for these dummies imply that it is not much more segregated than functional regions with around 1 million population. The London case suggests that, beyond some point, regional scale may make little or no further difference to degrees of segregation, but it still exemplifies the general point that conurbation-scale regions tend to exhibit substantially higher levels of segregation, especially across units of ward size and above.

How far the tendency for big cities to display stronger segregation patterns actually matters for the life chances of individuals depends on the practical importance of neighbourhood effects, to which we turn in the next section. But, before doing so, we should note that this city size effect certainly matters for the way that area-based indicators of deprivation are commonly presented and used. More or less self-evidently – other things being equal – big cities will have a larger proportion

of their constituent sub-areas amongst the worst x% on national rankings. Such findings are commonly reported, but it is less common to note that the major city-regions also have more than their share of sub-areas among the best x%. The biases in perception arising from the combination of scale factors with use of the official area deprivation indicators to imply something about the intensity of social deprivation within an area can be simply illustrated with functional region data. For this exercise we have undertaken regressions relating the proportion of wards in each FR falling within the top/bottom 5/10% on the IMD2000 national rankings and related this to, on the one hand, an average IMD score for the region – reflecting the overall incidence of deprivation, and, on the other hand, a simple measure of size (the logged population level). An adjusted count has then been produced for each FR, controlling for the effect of differing average deprivation levels. The results reported in Table 3 indicate how distribution of wards by rank position expected in the absence of any overall variations in the incidence of deprivation. What they clearly show is a tendency for substantially larger numbers of wards from the larger city regions to fall in the extreme categories, both among the 'worst' 5 or 10% and even more strikingly among the 'best areas. If deprivation and affluence really are much more strongly experienced by individuals living among similarly placed people in segregated areas, this may not give too misleading an impression of the relative intensity of both of these in larger as compared with smaller centres. If this cannot be assumed, the correlation between size and segregation clearly makes for biased comparisons.

3. Neighbourhood Effects and Educational Outcomes

How far such segregation really matters, however, is not entirely clear. There are actually some simple arguments to be made in favour of spatial concentration offering positive externalities, not only for the advantaged but also for some disadvantaged minority groups, by facilitating mutual support and development of local facilities to meet specialised needs. There might also be wider benefits to social cohesion, or at least social order, if physical separation of affluent from poorer groups inhibited the development of resentment at the scale of inequality, which various authors have suggested to be a contributory factor in generating anti-social behaviour (Kawachi et al., 1999).

More commonly, however, it is argued that spatial concentration only favours advantaged groups and exacerbates the problems of those already experiencing disadvantage as individuals. One possible mechanism for this is through the polarisation of information about worthwhile opportunities, with networks in poor neighbourhoods coming only to provide information about (for example) marginal and insecure types of work. It might also be through the removal of successful role models from these areas, or of people with the resources to offer effective aid to neighbours falling on hard times. Classically, concentration of poverty has also been seen as producing neighbourhoods with depressed property values where (private) property owners are discouraged from investing in maintenance, let alone upgrading the environment, creating downwardly spiralling ‘slum’ areas with cumulatively negative effects on the living conditions of the poor, and of their chances of accumulating any worthwhile material resources. There can also be serious implications for the viability of local service facilities, including small shops and bars.

In the context of African-American ghetto areas where class and race-based segregation compound the scale of problems, Wilson (1987) and Massey and Denton (1993) show how these factors can be exacerbated by growth in family fragmentation and in forms of crime and disorder, whose victims are predominantly the local community – to produce very high levels of isolation in social, cultural and linguistic terms. There are differences in emphasis between these accounts, however, in the role allotted to the racial discrimination experienced by individuals, which for Massey and Denton (if not Wilson) remains fundamental to the very high level of segregation of African Americans in cities of the northern US.

In areas where segregation is less intense, arguments about neighbourhood effects have tended to concentrate mainly on schooling and particularly on the role played by peer group effects on individuals' levels of aspiration and performance. Starting from the premise that residential segregation produces school segregation, the general argument is that concentrations of educationally disadvantaged groups within particular schools tend to lower the performance of all, whereas concentrations of advantaged groups have the reverse effect. The simple prediction then is that more intense residential segregation will be associated with greater inequality in educational outcomes for individuals – though we cannot say whether this would on balance lead to better or worse overall outcomes.

The natural approach to testing this hypothesis is through multi-level analyses using individual level data on educational outcomes and personal/family characteristics in conjunction with aggregated data on the pupil mix in their schools, and other factors potentially affecting school performance. In Britain, Harvey Goldstein and various colleagues have pioneered this approach, using micro-data from within schools and focusing on the role of longitudinal influences and the

interacting factors affecting individuals' achievements (see e.g. Goldstein, 1997). Others, starting with micro-data from panel studies have incorporated contextual variables in conventional regression models to identify peer-group effects. In particular, in the UK Feinstein and Symons (1999) have reported strong peer-group effects which, given a tendency for school-level clustering of advantaged pupils, make this a main route for the passing-on of parental social advantage. It is not currently feasible, however, to extend either of these micro-based approaches to the much larger number of schools necessary to identify the role played by residential segregation of various population groups in contributing to inequalities in outcomes.

A feasible complementary approach to identifying such neighbourhood effects involves looking for non-linearities in the relation between population composition measures and proportions of pupils achieving particular educational outcomes. The logic is simply that where outcomes depend solely on an individual's possession of certain personal or family characteristics – with independent effects on their probability of success – then the proportion of a local (or school) population achieving such success should depend *linearly* on proportions of the cohort with each of the relevant characteristics. Less simply, it can be shown that where these pupil mix variables exert a significant additional effect on chances of success, there will be non-linear relations between success rates and some or all of the mix variables (i.e. the proportions of pupils with particular characteristics)[1].

A little more formally, we posit a (logit) model in which an individual's chances of success depend simply on (a) whether they individually possess an advantageous characteristic and (b) the proportion of the pupil group possessing that characteristic; in linear form:

$$\ln\left(\frac{P(S,i,a)}{1-P(S,i,a)}\right) = \alpha + \beta X_i + \gamma \bar{x}_a \qquad (3)$$

where P(S,i,a) = the probability of exam success for individual i in area a;

X_i = an advantaging personal characteristic possessed by individual i; and

$\bar{x}_a$ = the proportion of pupils in area a with this characteristic; and

α, β, γ are parameters; β, γ >= 0.

When pupil mix is irrelevant (γ is zero) the proportion of pupils achieving success is:

$$p_a = (1 - \bar{x}_a)\Phi + \bar{x}_a \Psi = \Phi + (\Psi - \Phi)\bar{x}_a \qquad (4)$$

where p_a = the average proportion of pupils in area a achieving successes;

$\Phi = \frac{\exp(\alpha)}{1+\exp(\alpha)}$; and

$\Psi = \frac{\exp(\alpha+\beta)}{1+\exp(\alpha+\beta)}$.

With a significant neighbourhood or peer group effect (i.e. $\gamma > 0$), the proportion of pupils achieving success is given by the more complex relationship:

$$p_a = (\exp(\gamma \bar{x}_a))\left[\frac{\exp(\alpha_a)}{1+\exp(\alpha+\gamma \bar{x}_a)} + \bar{x}_a\left(\frac{\exp(\alpha_a+\beta)}{1+\exp(\alpha++\beta+\gamma \bar{x}_a)} - \frac{\exp(\alpha_a)}{1+\exp(\alpha+\gamma \bar{x}_a)}\right)\right] \qquad (5)$$

If we could ignore the terms involving $\bar{x}_a$ in the denominators (e.g. if they were small relative to α and β), the linear relation with this mix variable is now multiplied by some exponential factor of itself. The implication is that overall rates of exam success will be an accelerating (positive) function of the proportion in the population *with* the advantageous characteristic. On the other hand, if the critical population mix factor was one relating to the proportion of pupils with disadvantaging characteristics, failure rates would be an accelerating (positive function) of the proportion *lacking* the positive attribute. Thus the shape of the relationship with a particular population mix

variable is quite unpredictable from this simple general model, but if the mix effects are at all strong, the relationship is very unlikely to appear linear.

For the analyses reported here we started with published data on GCSE results in 1999 for the 779 state-maintained secondary schools[7] of the London metropolitan region (i.e. Greater London and the surrounding Outer Metropolitan Area, an area with some 13 million residents). These results were related, via simple regression analyses (followed up with some spatial econometrics) to, on the one hand, a number of school characteristics – including size, gender composition, selection, and type of control – and, on the other, characteristics of the population in the hinterlands, from which were likely to have been drawn. For this number of schools it was not feasible to focus explicitly on the formal catchment areas of each – and in any case there is no assurance that individual schools' intakes would be representative of pupils resident in their catchment areas. The approach was therefore to start from the residential characteristics of (the 1800 or so) wards in the region, and use the distances of each from the schools concerned to construct weighted average measures for their hinterlands. In fact a series of 6 or 7 alternative measures for each variable was constructed, using exponential distance decay functions of varying degrees of steepness, within plausible ranges for travel to school behaviour. The potential impact of 'creaming' off of more advantaged pupils by selective (or independent) schools within striking distance was similarly approached, by constructing a set of averaged measures of selective (or independent) school density within a hinterland, using a similar set of alternative distance decay functions.

These analyses were undertaken for each of the published GCSE success rates (and also for school absence rates), but here we shall concentrate on results in terms

[7] Excluding special schools for those with particular educational difficulties.

of proportions of pupils achieving 5 or more A-C grades, as the median level of achievement for pupils across the country. Initially a simple linear model was fitted, the preferred version of which, in terms of characteristics identified and distance decay functions used, is reported in Table 4. In addition to strong associations with the school characteristics – and with proximity to selective schools – this shows significant links to various characteristics of hinterland populations, including ethnic and social class mix, unemployment, and the proportion of children with lone parents. Significantly, we found that the strongest relations with indicators of disadvantage (unemployment, lone parents and lower social class) occurred when steep distance decay functions were used,[8] implying that the groups concerned were most likely to attend a very local school, while for two positive influences (higher social class and Asian residents) the strongest effects were found with much flatter distance decay functions, suggesting broader patterns of commuting to school.[9] The 'creaming' effect from relative proximity to selective schools also seemed to operate over a broad hinterland around them, rather than being localised. In the case of schooling therefore the relevant scale of segregation would appear to differ according to the groups concerned, from something close to a ward to something more like a parliamentary constituency. We presume that this difference reflects both variations in the transport costs that can be afforded and differing degrees of knowledge about non-local school opportunities, and how these can be accessed.

These results point to a strong association between school results and population composition in catchment areas, but they provide no evidence as to whether the link simply reflects children from more advantaged backgrounds

[8] Or simply the value for the local ward, in the case of unemployment.

[9] One apparent negative effect, from 'other non-white' population groups also appears stronger with the rather flat decay function used in Table 3. The same one is shown for the black population, simply for consistency, since this variable is never at all significant in these analyses.

individually doing well, or whether peer-group and neighbourhood effects are operating. In order to address this question, a second step was to use the results in Table 4 to construct two summary variables representing school and neighbourhood-based influences respectively, and run a new regression including just this pair of variables together with their squares and product, in order to look for evidence of non-linearity in the relations. Results reported in the first column of Table 5 indicate that all three of the additional variables contributed some improvement to the model fit, but that none of them individually were significant, even at the 5% level. The signs on the extra variables suggested firstly that the 'school' effect is somewhat concave – perhaps because, as other analyses show, the pupil number effect actually peaks some way below the largest schools in the sample. The negative interaction term suggests that neighbourhood characteristics may matter less to the strongest schools – perhaps because they can attract pupils from further afield, selecting those they want. A positive sign on the squared neighbourhood term implies a convex relationship, with bigger differences in performance between the most advantaged and more average neighbourhoods than between these and the least advantaged. If these represented neighbourhood effects, the implication would be that these operated more powerfully in reinforcing advantage than in compounding disadvantage.

However, the squared 'neighbourhood' term while non-trivial is not actually statistically significant. A possible explanation is that the non-linearity only involves some of the factors contributing to this composite variable, and to investigate this a series of exploratory regressions were undertaken introducing squared values of specific neighbourhood characteristics. What these showed was that the non-linearity related solely to the lone parent component. Including the proportion of non-working lone parents as a separate variable, along with its square, pushed the squared

‘neighbourhood’ effect close to zero while yielding significant coefficients, with opposite signs, on both the lone parent variables (columns 2 and 3 of Table 5). The form of the relationship implies that starting from low levels, increasing the proportion of lone parent families markedly reduces average exam success rates (beyond what is plausible as a purely individual effect), but that the decremental effects reduce at higher levels. Further analyses (to be reported in Gordon and Monastiriotis, forthcoming) revealed that a large part of this effect was channelled through rates of absenteeism (both authorised and unauthorised), which are strongly and non-linearly related to exam success and (particularly) failure rates. Absenteeism rates themselves were strongly, but linearly, influenced by the proportion of lone parents (as well as some school characteristics). Of course, the effect attributed to these variables cannot be taken as simply reflecting effects of missing study-time, but may well also be proxying other facets of behaviour and relations in school. It suggests, however, that in relation to educational achievement disciplinary issues may form a substantial element in neighbourhood effects, associated particularly with concentrations of lone parent families.

In one respect at least, then, we have evidence that neighbourhood effects could be significant in relation to school exam performance, and thus that at least one dimension of residential segregation within a functional-region could make a difference to the overall pattern of educational outcomes for individuals living there. If, as the previous section has clearly indicated (both in general and for the specific case of lone parents), segregation at school catchment area scale is likely to be a stronger feature of larger city-regions, we could expect to find greater *inequality* there in terms of educational outcomes. There is also a question as to whether *average* outcomes might be significantly better or worse as a result – with the form of non-

linearity identified in this section suggesting that segregation might actually enhance average outcomes (at the cost of greater inequality).

4. Residential Segregation and Inequality in Educational Outcomes

For this last stage in the empirical analysis, seeking evidence of the effects of residential segregation on aggregate patterns of educational outcomes, we return to the functional region level. The measures of residential segregation explored in section 2 are now used as independent variables in regressions with summary measures of educational outcomes – representing both *average* achievement and the *degree of variation* in this between individuals - as dependent variables.

For the measure of average achievement, we have taken the percentage of pupils in the 1999 cohort (now including independent as well as state schools) who secure at least 5 GCSE A-C grades. Over the country as a whole, this represents a median level of performance nationally. For an indicator of inequality in achievements, however, we cannot rely on GCSE outcomes since published results contain no direct information on success rates at higher levels, for example, the proportion of A and A* grades achieved. Some inferences about these can be drawn from the 'points' score recorded for each school, but this is not a sufficiently reliable indicator. 'A' level exam results are available, but rates of success in these cannot readily be related to the whole cohort of 18 year olds, since the least successful of these have already left school and do not take the exams. For an index of high level performance we have therefore taken an estimate of the percentage of the age cohort entering university in 1997/8 (from HESA data published on the ONS Neighbourhood statistics web site). At the lower end we have taken the proportion of pupils failing to achieve at least 5 GCSE A-G grades. As Table 6 indicates, these two indicators are

less symmetrical than would be desirable – since substantially more people go to university than fail to achieve this basic GCSE standard. A consequence is that there are – both absolutely and proportionately - greater variations in the higher of the two indexes, requiring these to be rescaled to produce an equal variance in their logged values, before summing them to produce a measure of inequality of educational outcomes for each functional region.

The main independent variables employed in the analysis reflected three sets of hypothesised influence on inequality in educational outcomes: existing *social inequalities* in the local population structure; the degree of *residential segregation* of more from less advantaged groups; and additional *institutional sources of school level segregation*. The first of these was represented by two indicators: the proportion of the working age population in social classes 1 and 2 (professionals and managers); and the unemployment rate. For a single measure of relevant forms of residential segregation within each functional region, we started from four dissimilarity indices, of the form used in section 2 (i.e. adjusted coefficients of variation). These were computed across wards, the spatial unit nearest in scale to school catchment areas. These were based respectively on the area unemployment rate, and the proportions of non-white residents, lone parents and working age residents in social classes 1 and 2. One principal component was then extracted from a factor analysis of logged values of each: this loaded strongly and positively on all four variables, though a little less so on the racial segregation measure. Finally, in relation to the schooling system, we included two measures of the role of academic and social selection: the proportion (in 1999) of 15 year old state sector pupils attending selective (i.e. grammar) schools, and of all 15 year old pupils at local independent (i.e. private) schools, as a percentage of all those at school in the functional region. Two additional variables – the logged

population size of the functional region and its proportion of workers in manufacturing – were included as controls for other important respects in which regions actually vary, quite independently of inequalities or social segregation.

Results from the regressions of each of the four measures of educational outcomes on this set of independent variables are presented in Table 7. In terms of the median standard of achievement (5 A-C grades) outcomes are clearly better in functional regions with lower unemployment, more people in the higher social classes and more at selective schools (though not more at independent schools). The effect of residential segregation appears to be positive, but is not statistically significant. In terms of high achievement (university entrance) the social class factor is even stronger, while neither the proportion of selective or independent schools appear to make any difference. The two control variables do, however, appear significant, with higher rates of university entrance achieved from less populous and more industrial functional regions. The effect of residential segregation is strongly positive. In terms of low achievement (failing to secure 5 A-G grades), unemployment is the one clearly significant influence, though absence of higher class residents also appears to be a significant factor. Higher levels of residential segregation seem to be conducive to low levels of achievement, but this relation is not statistically significant. Finally, more unequal outcomes seem to be promoted by unemployment and by residential segregation.

In relation to our central questions then we find that higher levels of residential segregation do seem to encourage more unequal outcomes – but they do so, primarily by boosting performance at the top end, while exerting a mildly positive influence also on achievements at the median level. This would be consistent with evidence in the previous section suggesting that neighbourhood effects on educational

outcomes operate more strongly in already advantaged areas than among the most disadvantaged. Institutional factors, in terms of the representation of selective and independent schools, appear to have no significant effects on the inequality of educational outcomes achieved in particular functional regions.

Finally, we should note that – while residential segregation has been found to be stronger in larger functional regions and to favour less equal outcomes – there does not appear to be any clear-cut relation between population levels in particular FRs and inequality in educational outcomes. When the segregation variable is removed from the inequality regression, the effect of FR population size appears positive but not statistically significant.

5. Conclusions and Implications

As 'any fule kno', cities, especially big cities, have more than their share of social problems, as well as of opportunities for 'getting on'. Why this is so – and whether it really is – are central questions for urban research. A number of specific factors have been held to account for one side or other of this picture in particular situations – for example, the negative effects of urban job losses since the 1970s. The more general explanations offered for cities generating diverse and unequal outcomes include:

- the implications of high order central place roles for their industrial and occupational structures;
- patterns of self-selection among migrants to big cities, which attract both marginal and highly ambitious groups;
- effects of sheer scale in discouraging rootedness and weakening social control; and

- consequences of residential segregation in reinforcing and reproducing individual advantage and disadvantage.

This paper has focused on the last of these lines of explanation, investigating hypotheses about: effects of urban scale on residential segregation; effects of neighbourhood composition on social (educational) outcomes; and the combined effects of both on patterns of inequality in outcomes at the individual level.

What we have found, firstly, is clear evidence that segregation operates more strongly over broader areas in large city-regions. In the case of school-level outcomes we have also found evidence of one significant respect in which (quite localised) neighbourhood effects – specifically those involving concentrations of lone parents – impact on achievement levels. The form of these effects implied that segregation could have stronger (positive) effects in advantaged areas than the (negative) effects experienced by areas with already disadvantaged populations. A third stage of the analysis found significant relations between degrees of segregation and inequality in educational outcomes, though again these were stronger in relation to positive than negative outcomes. Putting these three findings together, we would expect to find a tendency for greater inequality in educational outcomes in larger functional regions. But the evidence for this proved to be weak. In this case, at least, segregation cannot really explain the way in which big cities – properly defined on a functional regional basis – differ from other places, because the differences are much less clear than common knowledge suggests. One reason for this misapprehension is a frequent failure to bring the suburban and exurban fringes fully into the picture. But another is the effect of urban scale on segregation, which (as we have seen) biases area-based comparisons of deprivation (and affluence), exaggerating their degree of concentration in big cities.

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Table 1
Average Values of Segregation Indices across Functional Regions at Enumeration District, ward and Constituency Levels

	ED level	Ward level	Constituency level
Public Renters	0.570	0.319	0.081
Lone Parents	0.507	0.199	0.059
Social Classes 1&2	0.469	0.272	0.092
Social Classes 4&5	0.401	0.182	0.050
Old	0.222	0.109	0.026
Unemployed	0.189	0.114	0.048
Non-White	0.184	0.102	0.057
Movers	0.175	0.081	0.020
Limiting Illness	0.142	0.071	0.020
No of FRs	208	208	108

Source: all basic data are derived from the 1991 Census
Note: the data set relate to the CURD-defined functional regions of England and Wales, restricted in the case of the constituency level analyses to those including multiple constituencies.

Table 2
Regressions of Segregation Indices on Functional Region Characteristics

(a) Enumeration District Level

Independent Variables	Public Renters	Lone Parents	Social Classes 1 & 2	Social Classes 4 & 5	Elderly	Unemp -loyed	Non-white	Movers	Limiting Illness
Constant	-3.174 (5.4)	-1.746 (6.2)	-3.361 (6.0)	-2.848 (9.4)	-1.932 (2.7)	-8.079 (18.2)	-6.737 (7.3)	-5.803 (4.7)	-4.753 (13.5)
Adjusted Mean (logged)	0.380 (3.1)	0.531 (8.5)	0.513 (4.0)	0.449 (6.5)	0.143 (0.9)	1.261 (15.0)	1.151 (25.2)	0.896 (3.9)	0.133 (1.8)
Population (logged)	0.050 (4.7)	0.013 (1.7)	0.025 (3.3)	0.007 (1.1)	0.023 (2.0)	0.091 (6.2)	0.124 (4.1)	0.085 (5.2)	0.049 (4.9)
London (dummy)	-0.074 (0.7)	-0.017 (0.3)	-0.031 (0.4)	-0.004 (0.6)	-0.254 (2.3)	-0.242 (1.9)	-0.622 (2.3)	-0.248 (1.6)	-0.148 (1.6)
Employment in Core (%)	0.129 (3.6)	-0.020 (0.7)	-0.002 (0.1)	-0.001 (0.1)	0.211 (5.1)	0.112 (2.3)	-0.356 (3.3)	0.218 (3.8)	0.111 (3.3)
Commuting balance (ratio<1)	0.040 (0.4)	0.207 (2.9)	0.261 (3.5)	0.153 (2.4)	-0.024 (0.2)	0.717 (5.4)	0.723 (2.5)	0.141 (0.9)	0.098 (1.0)
Commuting balance (ratio>1)	0.066 (0.6)	0.087 (1.1)	0.063 (0.8)	-0.012 (0.2)	-0.033 (0.3)	-0.064 (0.4)	-0.217 (0.7)	0.348 (2.0)	0.169 (1.6)
Industrial employment (%)	0.001 (0.7)	0.000 (0.2)	0.003 (2.7)	-0.003 (3.1)	-0.005 (3.4)	0.010 (6.3)	0.014 (4.3)	0.000 (0.1)	0.000 (0.2)
Non-white population (%)	-0.003 (1.1)	-0.001 (0.7)	-0.002 (1.5)	0.003 (2.3)	-0.002 (0.7)	0.000 (0.1)	..	-0.008 (2.4)	-0.005 (2.4)
Owner-occupiers (%)	0.006 (2.5)	-0.013 (5.3)	-0.001 (0.4)	0.001 (0.7)	-0.004 (1.0)	0.004 (0.8)	-0.000 (0.0)	-0.006 (1.0)	0.015 (4.7)
Public renters (%)	..	-0.015 (6.5)	0.001 (0.5)	0.001 (0.3)	-0.003 (0.8)	-0.003 (0.7)	0.003 (0.3)	-0.006 (1.0)	0.017 (5.4)
Excess segregation of public renters	..	0.170 (3.4)	0.408 (8.0)	0.273 (6.1)	0.029 (0.4)	1.202 (12.5)	1.429 (7.3)	0.334 (3.0)	0.540 (7.9)
R squared (adjusted)	0.249	0.557	0.338	0.395	0.224	0.850	0.851	0.372	0.541
N	208	208	208	208	208	208	208	208	208

Notes: bracketed values are t-statistics; the 'adjusted mean' refers to the geometric average of the proportion in each FR with a characteristic in each FR and its complement (i.e. the proportion without) , with a value of zero where all either share or lack it and a maximum of 0.5, where the population is split 50:50.

(b) Ward Level

Independent Variables	Public Renters	Lone Parents	Social Classes 1 & 2	Social Classes 4 & 5	Elderly	Unemp -loyed	Non-white	Movers	Limiting Illness
Constant	-8.992 (6.2)	-4.327 (5.7)	-5.266 (4.0)	-4.555 (5.9)	-2.265 (1.0)	-8.818 (12.7)	-6.825 (5.3)	-2.227 (1.2)	-7.819 (10.2)
Adjusted Mean (logged)	1.330 (4.4)	0.945 (5.9)	0.789 (2.6)	0.564 (3.4)	0.123 (0.3)	1.906 (15.7)	1.595 (25.1)	0.715 (2.0)	0.531 (3.5)
Population (logged)	0.055 (2.1)	0.049 (2.5)	0.085 (4.7)	0.044 (2.7)	0.010 (0.3)	0.128 (5.7)	0.208 (5.0)	0.181 (6.9)	0.084 (4.0)
London (dummy)	0.160 (0.6)	0.113 (0.6)	-0.063 (0.4)	0.006 (0.0)	0..028 (0.1)	-0.34 (1.7)	-0.918 (2.4)	-0.311 (1.3)	0.008 (0.0)
Employment in Core (%)	0.116 (1.3)	-0.310 (4.4)	0.001 (0.0)	-0.081 (1.4)	0.067 (0.6)	0.028 (0.4)	-0.606 (4.1)	0.353 (3.9)	-0.134 (1.8)
Commuting balance (ratio<1)	1.125 (4.6)	0.441 (2.3)	0.290 (1.6)	0.302 (1.8)	0.578 (1.6)	0.770 (3.6)	0.725 (1.7)	0.058 (0.2)	0.072 (0.3)
Commuting balance (ratio>1)	0.161 (0.6)	-0.019 (0.1)	0.134 (0.7)	0.193) (1.1)	-0.012 (0.0)	-0.183 (0.8)	-0.459 (1.0)	0.155 (0.6)	0.459 (2.0)
Industrial employment (%)	-0.008 (3.0)	-0.001 (0.6)	0.008 (3.3)	-0.001 (0.5)	-0.012 (3.0)	0.012 (5.0)	0.018 (3.9)	-0.001 (0.2)	-0.004 (1.5)
Non-white population (%)	-0.012 (2.2)	-0.001 (0.3)	-0.004 (1.1)	0.004 (1.1)	-0.016 (2.0)	0.013 (2.9)	..	-0.020 (3.6)	-0.016 (3.4)
Owner-occupiers (%)	0.018 (3.1)	-0.014 (2.2)	-0.007 (1.4)	-0.001 (0.2)	-0.006 (0.6)	-0.020 (3.0)	-0.026 (2.0)	-0.054 (5.6)	0.021 (3.1)
Public renters (%)	..	-0.018 (2.9)	-0.006 (1.0)	-0.006 (1.1)	-0.014 (1.2)	-0.032 (4.7)	-0.020 (1.5)	-0.063 (6.5)	0.023 (3.4)
Excess segregation of public renters	..	0.480 (10.6)	0.509 (12.1)	0.487 (12.6)	0.211 (2.5)	0.690 (14.0)	0.310 (3.2)	0.392 (6.5)	0.348 (7.1)
R squared (adjusted)	0.252	0.578	0.529	0.554	0.242	0.809	0.842	0.627	0.402
N	208	208	208	208	208	208	208	208	208

Note: see table 2(a)

(c) Parliamentary Constituency Level

Independent Variables	Public Renters	Lone Parents	Social Classes 1 & 2	Social Classes 4 & 5	Elderly	Unemp -loyed	Non-white	Movers	Limiting Illness
Constant	-29.44 (3.1)	-13.43 (2.4)	-36.41 (3.5)	32.54 (4.1)	-10.00 (1.0)	-26.88 (5.8)	-17.80 (4.3)	-21.09 (1.4)	-41.37 (5.0)
Adjusted Mean (logged)	2.806 (1.5)	2.382 (2.2)	2.121 (0.9)	1.05 (0.6)	0.297 (0.2)	3.189 (4.1)	1.514 (9.1)	2.039 (0.8)	3.5 (2.3)
Population (logged)	0.762 (3.9)	0.833 (5.5)	0.660 (4.6)	0.816 (4.9)	0.562 (3.4)	0.688 (4.6)	0.668 (5.0)	0.624 (2.9)	1.053 (4.7)
London (dummy)	-1.510 (1.3)	-1.940 (2.2)	-1.247 (1.5)	-1.756 (1.8)	-1.299 (1.30	-1.713 (1.9)	-1.781 (2.3)	-2.421 (1.9)	-1.92 (1.4)
Employment in Core (%)	0.634 (1.2)	0.455 (1.0)	-0.106 (0.3)	0.497 (1.0)	0.350 (0.7)	0.113 (0.3)	0.243 (0.6)	1.489 (2.3)	-1.379 (2.1)
Commuting balance (ratio<1)	2.069 (1.2)	1.958 (1.4)	2.861 (2.2)	2.049 (1.3)	-0.803 (0.5)	3.817 (2.8)	3.839 (3.2)	3.430 (1.7)	-1.566 (0.8)
Commuting balance (ratio>1)	2.174 (1.0)	-2.36 (1.4)	2.713 (1.7)	-0.97 (0.5)	-0.759 (0.4)	0.212 (0.1)	-3.454 (2.4)	1.431 (0.6)	2.697 (1.1)
Industrial employment (%)	-0.027 (1.1)	0.018 (1.0)	0.004 (0.2)	-0.016 (0.7)	-0.029 (1.4)	0.002 (0.2)	0.004 (0.3)	-0.051 (1.9)	-0.009 (0.4)
Non-white population (%)	-0.017 (0.6)	0.009 (0.4)	0.017 (0.7)	0.045 (1.7)	0.005 (0.2)	0.027 (1.1)	..	0.011 (0.3)	0.021 (0.5)
Owner-occupiers (%)	0.044 (1.2)	-0.085 (1.9)	0.137 (3.2)	0.161 (3.1)	0.005 (0.1)	0.033 (0.7)	0.023 (0.6)	-0.022 (0.3)	0.137 (2.0)
Public renters (%)	..	-0.108 (2.4)	0.103 (1.7)	0.138 (2.8)	-0.007 (0.1)	-0.005 (0.1)	0.029 (0.8)	-0.011 (0.1)	0.093 (1.37)
Excess segregation of public renters	..	0.304 (3.9)	0.353 (4.7)	0.545 (6.2)	0.122 (1.4)	0.475 (6.0)	0.094 (1.4)	0.289 (2.5)	0.530 (4.5)
R squared (adjusted)	0.240	0.441	0.428	0.482	0.139	0.524	0.708	0.326	0.296
N	108	108	108	108	108	108	108	108	108

Note: see Table 2(a)

Table 3
Functional Region Population Size Effects on Distribution of MDI2000 Scores for Wards After Control For Mean Index Value

FUR population	% of wards by position in national ranking (most to least deprived)				
	0-5%	5-10%	10-20%	90-95%	95-100%
Under 100K	4.0%	5.0%	12.0%	4.0%	1.2%
100-316K	4.0%	5.5%	11.5%	3.6%	4.2%
316-1000K	5.1%	4.3%	8.7%	6.2%	5.1%
Over 1 million	8.8%	5.0%	6.6%	7.4%	10.9%

Table 4
Regressions of School Success Rates at GCSE Exams on School and Neighbourhood Characteristics: Percent gaining 5 A-C grade passes, London region, 1999

Variable	Distance Function (exp -β kms)	Coefficient	T statistic
Constant		-0.496	4.4
School Pupil numbers (logged)		0.195	13.1
Control: directly funded		0.024	2.1
voluntary aided/ CTC		0.159	13.11
Type: comprehensive		-0.453	20.8
secondary modern		-0.527	22.2
Gender: single sex (boys)		0.049	3.2
single sex (girls)		0.163	11.9
Selective schools in surrounding area (proportion of pupils)	0.030	-0.175	2.9
Neighbourhood Proportion of families with non-working lone parent	0.250	-0.365	2.3
Unemployment rate		-0.564	2.9
Ethnic Origin: Asian	0.050	0.320	4.4
Black	0.050	-0.011	0.1
Other non-white	0.050	-1.381	3.6
Social class: professional and managerial	0.050	0.553	5.2
manual	0.250	-0.134	1.7
R-squared (adjusted)		0,704	
N		779	

Sources: GCSE statistics and school characteristics from DFES web-site; other variables from 1991 Census.

Notes: In school characteristics the omitted categories are county/local authority controlled, selective/grammar and co-educational. The dependent variable and all neighbourhood characteristics are expressed as proportions (rather than percentages). Variables with values in column 2 are spatially weighted moving averages of ward values using the indicated exponential distance function with the parameter value shown.

Table 5
Regressions Testing for Non-linear Relations between School Exam Success Rates and Neighbourhood Characteristics: Percent gaining 5 A-C grade GCSE, London region, 1999

	(1)	**(2)**	**(3)**
Constant	-0.697 (6.1)	-0.669 (5.9)	-0.670 (5.9)
School (composite)	1.360 (6.3)	1.385 (6.4)	1.383 (6.4)
School squared	-0.159 (1.6)	-0.171 (1.7)	-0.170 (1.7)
Neighbourhood (composite)	1.527 (5.1)	1.514 (4.9)	1.50 (4.9)
Neighbourhood squared	0.433 (1.2)	-0.130 (0.2)	..
School * Neighbourhood	-0.529 (1.7)	-0.567 (1.9)	-0.565 (1.9)
Non-working lone parents		-0.810 (2.3)	-0.782 (2.4)
Lone parents squared		3.000 (2.1)	3.015 (2.6)
R squared (adjusted)	*0.711*	*0.712*	*0.713*
N	*779*	*779*	*779*

Source and notes: see Table 3.

Table 6
Indicators of Level and Variability of Educational Outcomes at Functional Region Level 1999/200?

	Median Achievement (% gaining at least 5GCSE A-C grades)	**High Achievement (% entering university)**	**Low Achievement (% gaining less than 5 GCSE A-G grades)**	**Inequality in Educational Outcomes**
Average	49.6	26.6	9.3	100
Standard Deviation	8.5	6.1	2.9	41
Highest FR	72.2	50.3	17.3	238
Lowest FR	24.8	14.2	2.4	41

Note: for derivation of the inequality measure see text.

Table 7
Regressions of Educational Outcomes at Functional Region Level on Indicators of Inequality and Segregation

	Median Achievement	High Achievement	Low Achievement	Inequality of Outcomes
Constant	-0.911 (5.1)	2.629 (11.3)	1.600 (3.1)	5.189 (6.4)
% in Social Classes 1 and 2	0.011 (5.7)	0.024 (9.8)	-0.010 (1.9)	0.008 (0.9)
Unemployment Rate	-0.185 (4.1)	0.004 (0.1)	0.394 (3.0)	0.634 (3.1)
Residential Segregation	0.009 (1.2)	0.044 (4.5)	0.030 (1.4)	0.092 (2.7)
% at Selective Schools	0.192 (2.3)	0.077 (0.7)	-0.107 (0.4)	0.094 (0.2)
% at Independent Schools	-0.195 (1.5)	0.106 (0.6)	-0.041 (0.1)	0.040 (0.1)
% manufacturing workers	-0.000 (0.5)	0.003 (2.1)	0.004 (1.1)	0.009 (1.7)
Functional Region Population (logged)	0.014 (1.2)	-0.030 (2.0)	0.002 (0.1)	-0.027 (0.5)
Adjusted R squared	0.676	0.692	0.376	0.160

Note: for definitions of variables see Table 5.

[1] This criterion was originally suggested by Boudon (1963), although his argument is strengthened in the context of logistic models of success/failure.