Estimating segregation and diversity of ethnic groups over time in England and Wales, 1991-2001

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Abstract

The study of changing residential patterns of ethnic groups is a key area to inform debates of residential segregation and diversity in urban areas. The aim of this paper is twofold. Firstly, it provides empirical evidence of clear declines in residential segregation between 1991 and 2001 in England and Wales using both census data as published and complete mid-year estimates for the same years. For the analysis, we implement segregation and diversity measures (Index of Dissimilarity, Index of Isolation and Index of Diversity) across wards nationally and for sub-national areas. The outcomes highlight marginal changes when complete mid-year estimates are used, which incorporate non-response not included in census output and the harmonisation of the population definition and census geographies. Secondly, we provide an approach to analyse residential segregation of ethnic groups at different life-stages. For this purpose, the paper traces changes in residential segregation of ethnic groups by using 1991 and 2001 data for various cohorts. This approach sheds some light on the similarity of patterns exhibited between ethnic groups over time.

Keywords: segregation; ethnic groups; census; complete mid-year estimates; age cohort comparisons; England and Wales

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1. Introduction

Britain is the only EU member state to ask about ethnicity in censuses, and the inclusion of the ethnic group question in the 1991 Census is considered as a landmark in British social statistics (Coleman and Salt, 1996; Langevin *et al*, 1992). After the 2001 Census of Population, comprehensive data on ethnic groups from national to local areas are available from two consecutive censuses, thus providing a large array of data for various analytical practices and for use in 'new' research about the characteristics and distribution of the population. Within this context, the use of census data has allowed the analysis of the intercensal change in residential segregation by ethnic groups, with many geographers, social statisticians and demographers examining whether residential segregation has increased or decreased over time (Champion, 1996; Peach, 1996a and 1998; Johnston *et al.*, 2002a, 2002b; Parkinson *et al*, 2006; Phillips, 1998; Dorling and Rees, 2003; Simpson, 2004 and 2007a).

Since the landmark publication on the subject by Ernest Burgess (1928) on residential segregation in American cities, the study of separation of groups, contexts and scale has been seen as a key feature of urban landscapes (Kaplan and Holloway, 1998). The study of spatial arrangements of the population, how these vary across areas and what it signifies to the group and to the host society has dominated most of the literature on segregation. Within this context, American scholars have focused on the interplay between residential segregation and the political and social organisation of cities that limit the chances of some groups of the population, particularly those with an African American origin (Massey, Condran and Denton, 1987; Logan, 1978). This conceptual framework is based on the idea that high levels of segregation imply the deterioration of the social and economic well-being of some groups, for example, from employment opportunities (Deskins, 1988; Farley, Danziger and Holzer, 2000), the relegation of their children to schools with 'poor' standards (Farley and Taeuber, 1974; Orfield, 2001) as well as greater environmental health risks (Bullard, 1983; Williams and Collins, 2001).

Similarly, in Britain, the ethnic group dimension of settlement patterns has been one of the main issues on the debate about the consequences of international migration. In fact, instead of recognising cosmopolitan realities with the already-existing mix of origins and cultures in many urban areas, the debate has been predominantly based on the view that some groups living together constitute a problem, for example the concentration of ethnic groups such as the Black and Asian (Greater London Authority, 2005). However, the rise of large urban areas with various ethnic minority populations is not always associated with negative impacts. For example, the result of the new term 'super-diversity' recently coined by Vertovec (2006) has played an important role for the promotion of ethnically diverse cities, which in turn have been used to attract more human and capital resources as well as to organise great public rituals such as the London 2012 Games (Roche, 2000). This clearly represents an example of how statistics and visual representations of the geography of ethnic groups might be used in the political and policy sphere (Phillips, 2007).

Nonetheless, policies tend to be focused on the association between high levels of segregation and high levels of concentration as an indicator of the negative outcome of migrant integration. This is in line with the belief that a negative relationship exists between segregation and integration. This has been criticised from scholars with the view that the social solidarity that is gained in diverse neighbourhoods is a process that has historically preceded and acted as the basis for integration (Peleman, 2002; Rex, 1981). This relationship in Western Europe is expressed by Sako Musterd as follows:

> 'Whereas the segregation-integration debate generally addresses both the social and the ethnic dimensions of the neighbourhood composition (frequently simultaneously), European countries have recently focused much more on the ethnic dimension. That may be a consequence of the large number of immigrants settling in the European Union during the past two decades' (2003: 626).

From this perspective, segregation has become a public debate issue in Europe with outspoken negative connotations, generally associated with the poor black ghetto (Fortuijn *et al.*, 1998). This fear of 'ghettoisation' has been expressed very clearly in the Government report for Community Cohesion in England and Wales (Cantle, 2001) in which it is expressed that 'the depth of polarisation of our towns and cities'

(page 9) and 'the high levels of residential segregation found in many English towns would make it difficult to achieve community cohesion' (page 70). Similarly, in September 2005, the head of the Government's Commission for Racial Equality warned that the UK was 'sleepwalking into segregation' in reference to the creation of racial ghettos similar to those in the US (Phillips, 2005). These are clear examples on how the issue of ethnic segregation in Britain has been a topic of considerable public debate in recent years with the apparent belief of increasing segregation. However this is not consistent with the empirical evidence provided by academic studies using census data (Johnston et al, 2002a; Peach, 1996a; Simpson, 2004; 2007a).

This paper provides an analysis of the level and direction of change of segregation and diversity over time using 1991 and 2001 census data and complete mid-year estimates for the same years in England and Wales and sub-national areas. The implementation of different data sources is used to provide empirical evidence on the impact of enhanced census-based estimates on the indices of segregation and diversity. From this perspective, it highlights the benefits of using consistent census data when segregation and diversity are measured over time.

The paper also provides a general approach to measuring residential segregation of ethnic groups across different life-stages by using information from complete mid-1991 and mid-2001 population estimates. With this alternative methodology the aim to explore the influence of life events on residential segregation. This approach based on the analysis of segregation for different age cohorts constitutes a window to measure differences and similarities in the relationship of age and other aspects of the family life-cycle and work with residential segregation of ethnic groups over time.

This paper offers therefore an updated perspective within which the issue of changing levels of ethnic residential segregation in England and Wales is reviewed by taking into consideration consistent population estimates across time for areas smaller than districts as well as age detail for specific age cohort analyses.

In summary, four questions deserve more investigation following previous investigation:

1) Does analysis that corrects for the census's incompleteness change the value of segregation indices?

2) Does analysis that makes the census boundaries consistent over time alter the interpretation of change in segregation indices?

3) Is segregation greater at some life-stages (represented by age) than at other?

4) Does this life-pattern of segregation differ between ethnic groups?

This paper first describes the measures of segregation and diversity that will be used to investigate the patterns of change in ethnic segregation. It then provides a review of the sources of data available in England and Wales for years 1991 and 2001 in Section 3. It then investigates the change of index values on evenness, exposure and diversity over time nationally and for ethnically diverse urban areas. Finally, Section 5 provides results for specific age cohorts as a way to assess variations in segregation in relation to life-stages.

2. Measures of segregation and diversity

Many measures have been formulated as an attempt to indicate the degree of segregation, with the term 'index wars' reflecting a past debate about the most effective way to measure segregation (Peach, 1996a). In this paper, two distinct measures, the Index of Dissimilarity (*evenness*) and Index of Isolation (*exposure*), often regarded as the more important dimensions in residential segregation are explored. Additionally, the paper shows a measure of *diversity* using the Simpson index.

Index of Dissimilarity (ID). This index has been used on a regular basis since a paper by Duncan and Duncan was published (1955a and 1955b). It is acknowledged simply as the most common index of segregation. *ID* is a common measure of evenness to indicate how evenly one ethnic group is spread out geographically compared to the rest of the population (Massey and Denton, 1988). As such, *ID* is conceived to measure an unequal geographical spread, and it is often interpreted as an indicator of the proportion of one group's population who would have to move to be distributed across areas in the same way as the rest of the population. The formula to calculate *ID* can be expressed as follows:

$$ID = 0.5 * \sum_{i} \left| \frac{N_{gi}}{N_{g\bullet}} - \frac{N_{\bar{g}i}}{N_{\bar{g}\bullet}} \right| \qquad (1)$$

Where N_{gi} refers to the population of group *g* in locality *i*; $\bar{g}$ means the rest of the population; and the summation over an index is represented by the dot symbol. The same formulae can be used to compare the spread of any two groups by superseding the second term in the formulae with the area's proportion of a second group h.

Generally, *ID* is expressed as a percentage with index values between 0 and 100. Values between 0 and 30 indicate low segregation, values between 31 and 60 indicate moderate segregation, and values between 61 and 100 indicate high levels of segregation (Massey and Denton, 1993: 20).

Index of Isolation (P).* This index measures the average local concentration of a group (Lieberson, 1963). Sometimes a high proportion of a particular ethnic group in a locality is termed as an ethnic enclave (Johnston *et al.*, 2002a). Perhaps it is more useful when it is used as an indicator of the likelihood that members of each group will meet members of their own group. The formulae used to calculate the Index of Isolation can be expressed as follows:

$$P^* = \sum_{i} \left(\frac{N_{gi}}{N_{g\bullet}} \right) \left(\frac{N_{gi}}{N_{\bullet i}} \right) \qquad (2)$$

The interpretation of this index is also straightforward as a percentage. If the index is close to 0, it indicates that the average local concentration of the group being studied is very low. On the contrary, if the index values are close to 100, it highlights a high level of concentration, thus meaning that all members of the group are in areas where no other groups live.

It is important to note that whilst *ID* is not affected by the overall population composition (only by its distribution through the areas), *P** is not invariant to the relative size of different ethnic groups in the population (Simpson, 2007a). Considering the demography of immigration, the two indices are expected to change after significant streams of immigration. For ethnic groups in their early years of

immigration, the two indices are expected to increase for a while as the tendency is to live only in the clusters where the influence of the kinship ties is strong. Therefore, the indices of segregation reflect the settlement pattern of international migration around the family, cultural and religious support given by social networks. However, when families begin to move elsewhere the two indices are likely to change in different directions as a result of the movement away from original settlement areas (i.e. dispersal of groups to other areas).

Reciprocal Diversity Index (RDI). Contrarily to the two indices described above, this index is a measure used to capture how mixed is an area. It is commonly known as Simpson's Reciprocal Index as it was introduced by the British statistician Edward Hugh Simpson, and it has been widely used in ecology studies to quantify the biodiversity of a habitat. In social sciences it is used to indicate the existence of equal proportions of different subgroups locally. This means that a more equal distribution of people from different groups locally results in a higher diversity score. Contrarily, if the local area only has one dominant group, then a lower diversity score is found. This measure has been particularly useful to capture the diversity of ethnic groups in a cosmopolitan area (Greater London Authority, 2005). The formulae used to calculate the Reciprocal Diversity Index can be expressed as follows:

$$RDI_i = 1 / \sum_g (N_{gi} / N_{\bullet i})^2 \qquad (3)$$

The index takes values between 1 and the number of groups *g*. For example, when taking eight ethnic groups the resulting diversity score will range between one and eight. Therefore, the value of one would indicate that all the population was in a single group (i.e. no diversity), whereas the value of eight would indicate that there is an equal proportion of each ethnic group in the population (i.e. 12.5 per cent from each group).

3. Sources of data for England and Wales, 1991-2001

The availability of census data online as part of the Census Dissemination Unit has constituted a fundamental step forward for census users, thus enabling the analysis of large and complex census data sets for various geographical units (CASWEB, 2006).

Even though many users of demographic statistics will find census data sufficiently useful to compare the geographical patterns of settlement of ethnic groups over time, such comparisons are subject to four types of bias that make comparisons of populations over time difficult (Simpson *et al.*, 1997; Sabater, 2008; Sabater and Simpson, 2008): (1) the population definition, which defines who is a resident, has changed between the 1991 and 2001 Censuses; (2) the treatment of non-response in the census in 1991 and 2001 was different, and varied between ethnic groups, areas and ages; (3) key classifications changed between 1991 and 2001, including ethnic group and age in standard outputs; and (4) geographical boundaries used for standard census outputs changed, after local government reviews between 1991 and 2001.

It is for this reason that the sources of data used in this paper are both the 1991 and 2001 Census of Population and complete mid-1991 and mid-2001 population estimates for sub-national areas in England and Wales. Since harmonised data for the same years by ethnic group for postcode sectors in Scotland are not available, these sub-national areas have not been included in the analysis.

In order to evaluate the empirical behaviour of the indices of segregation and diversity described above, seven ethnic groups are used to make more suitable comparisons between 1991 and 2001: White, Black Caribbean, Black African, Indian, Pakistani, Bangladeshi and Chinese. The use of this seven-category classification reflects those ethnic groups for whom self-definition is most constant over time (Bosveld *et al*, 2006; Simpson and Akinwale, 2007).

Census output tables for both 1991 and 2001 for the total population of each ethnic group has been obtained through the CASWEB (2006) online interface. Table S06 for 1991 and CAST03 for 2001 are used in this paper to measure segregation and diversity across all standard areas: districts, wards and the smallest census areas in 1991 (Enumeration Districts) and 2001 (Output Areas). Although the 1991 and 2001 Census outputs provide information of ethnic group data for small areas in England and Wales, these census statistics are neither wholly accurate nor comparable over time. The comparison of populations over time and space are subject to four standard but difficult problems of data harmonisation (Sabater and Simpson, 2008).

First, who is included in the definition of population affects the population estimate published. In England and Wales, two differences between practice in the censuses of

1991 and 2001 are significant, the enumeration of students and population date. Since the 2001 Census enumerated the whole population at the address of 'usual residence', including students at their term-time address, and the 1991 Census enumerated students at their vacation address, a transfer of students from their vacation address to their term-time address in 1991 has been necessary to assess the impact of population change appropriately. In addition, because Census day was undertaken in different days in April in 1991 and 2001 and mid-year estimates are usually made for mid-year (30th June), an additional allowance for timing has been included in the complete mid-year estimates to bring them both to the same population date. Although the net effect of timing is small nationally, its impact locally can be significant.

Second, since it is widely accepted that no census will count the whole population measures were adopted to compensate undercount in the 1991 and 2001 Censuses. However, the treatment of non-response was substantially different. In 1991 extra records for people in missed households were included in the census database and published output but a further 2% were estimated as missed from the census output (OPCS, 1993). In 2001 the One Number Census (ONC) integrated a more complete estimate of non-response in the published census counts for all areas, with further non-response limited to about 0.5% (Simpson, 2007b). In both years, the non-response missed from census output was skewed towards young men, urban areas and minority ethnic groups. The complete mid-year estimates include an allowance for this non-response based on evidence from post-enumeration surveys following the 1991 and 2001 Censuses.

Third, changes in recording and coding practices can render censuses incompatible, as happened in England and Wales with ethnic identification and age group categories. Whilst the 2001 Census recorded 16 ethnic group categories, including four mixed categories, the 1991 Census output included 10 ethnic group categories, with no mixed categories. Analyses of ethnic group stability over time using the ONS Longitudinal Study (LS) data showed that reliable comparisons over time can be made for five groups: White, Indian, Pakistani, Bangladeshi and Chinese and less reliable comparisons for the Black Caribbean and Black African groups (Bosveld *et al*, 2006; Simpson and Akinwale, 2007). The residual ('Other') ethnic groups of both 1991 and 2001 exhibit very low stability and, therefore, are not appropriate for comparisons. Although date of birth is captured during census fieldwork, published

output uses age bands which are not compatible between censuses. For example age 85 and over in 1991 and 90 and over in 2001 for electoral ward and further discrepancies for smaller areas.

Fourth, geographical boundaries of most countries' administrative units change over time, in ways that prevent the calculation of consistent measures such as the level of segregation and diversity over time and space when taken directly from census output. In England and Wales, sub-national areas (i.e. small geographical units) have been most affected by geographical boundary changes between 1991 and 2001. The complete mid-1991 population estimates for the smallest census areas have been proportionally converted, using the 2001 Census boundaries for districts, Standard Table (ST) wards and Output Areas as target geographies.

These four problems are general to any country when comparing population estimates over time and space and their impact for England and Wales for the period 1991-2001 is highlighted in the text and in Table 1.

4. Population and index values over time

4.1 Population change

In this section, empirical evidence is provided for England and Wales on how population change by ethnic group can be misleading when census output is used. The introduction of a consistent time series can affect the interpretation of population change, and for some groups, what is seen to be a population growth during the decade according to the 1991 and 2001 Census output is actually a population decrease when using complete mid-1991 and mid-2001 population estimates.

Table 2 illustrates how the key feature of population change in England and Wales between 1991 and 2001 using data from census output and complete estimates is similar for the total population, with an increase by 3-4 percentage points over the decade. Nonetheless, significant differences are found when an ethnic group dimension is considered. Generally, a fast population growth of ethnic minority groups according to the published census output is seen to be a much slower population growth after using the complete population estimates.

Table 1 Enhancements to comparisons between successive censuses. England and Wales, 1991-2001

Enhancement, 1991 and 2001 censuses	*Global impact, England and Wales*	*Examples of extreme impact*
1. *Population definition* a. Students, transferred from vacation address to term-time address (1991 only)	53,975 net addition (213,628 net gain for 103 districts; 159,653 net loss for 273 districts)	14,500 net gain to Oxford. 2,600 net loss from Wirrall.
b. Population date, change from census day to mid-year 1991: April 21 to June 30 2001: April 29 to June 30	43,094 net addition 41,006 net addition	974 net gain to Lambeth, 442 net loss to Brent. 1,081 net gain to East Riding of Yorkshire, 1,746 net loss to Birmingham.
2. *Non-response not estimated within census output* 1991 Census 2001 Census	1.6% addition 0.5% addition	Pakistani addition of 6.7% in 1991, 2.1% in 2001. Manchester addition of 4.0% in 1991, 7.4% in 2001.
3. *Demographic classifications* a. Age, distribute broad age groups to individual ages	No net impact on population	Largest approximations in smallest areas where 5 age groups published for each ethnic group in 1991, 7 in 2001.
b. Ethnic groups 10 in 1991; 6 extra in 2001.	Of those in both censuses, 3.2% changed categories	77% of those recorded as Black Caribbean in 1991 were recorded as Black Caribbean in 2001, while a similar number moved from other groups to Black Caribbean.
4. *Harmonisation of geographical units.* Smallest 1991 areas converted to 2001 Census units	139 of 403 local authority boundaries and 4,398 of 9,527 electoral ward boundaries changed involving more than 1% of their population.	The geography of York involves the 1991 district boundary and parts of Harrogate, Ryedale and Selby in 1991.

Source: Adapted from Sabater and Simpson (2008).

Table 2 Population change by ethnic group with census output and complete estimates. England and Wales, 1991-2001

Group	Census			Complete estimates		
	1991	2001	Change (%)	1991	2001	Change (%)
White	46,938,466	47,520,614	1.2	47,429,019	47,747,355	0.7
Black Caribbean	499,325	563,880	12.9	569,621	572,212	0.5
Black African	209,665	479,691	128.8	255,336	494,668	93.7
Indian	829,966	1,036,674	24.9	891,827	1,053,302	18.1
Pakistani	455,443	714,705	56.9	494,973	727,726	47.0
Bangladeshi	161,626	280,735	73.7	176,912	286,693	62.1
Chinese	146,156	226,640	55.1	173,184	233,346	34.7
Other	649,846	1,217,910	87.4	757,161	1,244,677	64.4
Total	49,890,493	52,040,849	4.3	50,748,033	52,359,979	3.2

Source: census output (Table S06 for 1991 and CAST03 for 2001). Complete estimates are consistent with ONS latest estimates of mid-1991 and mid-2001 populations published in 2004 without an ethnic group dimension, as well as with the mid-2001 populations first published in 2006 with an ethnic group dimension.

Table 3 Population change by ethnic group with census output and complete estimates. England and Wales, 1991-2001

Group *Men aged 20-39 only*	Census			Full estimates		
	1991	2001	Change (%)	1991	2001	Change (%)
White	6,736,427	6,443,463	-4.3	6,881,515	6,565,396	-4.6
Black Caribbean	85,183	87,628	2.9	125,266	92,583	-26.1
Black African	48,873	91,951	88.1	71,734	101,225	41.1
Indian	146,002	178,277	22.1	168,764	189,420	12.2
Pakistani	68,091	122,551	80.0	84,516	130,173	54.0
Bangladeshi	19,730	47,954	143.1	25,906	51,683	99.5
Chinese	31,381	43,907	39.9	44,352	47,453	7.0
Other	112,579	194,759	73.0	153,579	208,942	36.0
Total	7,248,266	7,210,490	-0.5	7,555,632	7,386,875	-2.2

Source: census output (Table S06 for 1991 and CAST03 for 2001). Complete estimates are consistent with ONS latest estimates of mid-1991 and mid-2001 populations published in 2004 without an ethnic group dimension, as well as with the mid-2001 populations first published in 2006 with an ethnic group dimension.

Table 3 shows how these differences between census output and complete estimates are particularly noticeable for young male adults. The assessment of population change for these groups is mostly affected by non-response not included in census output, with the greatest impact among ethnic minority groups, especially for those groups with a recent history of migration to the UK such as the Black African, Bangladeshi and Pakistani. These results are in line with the evidence from ONS (2005) that young male adults and ethnic groups other than White are more likely to be missed by the census (Simpson *et al.*, 1997). For example, young male adults in 1991 from ethnic groups such as the Black Caribbean, the Black African, the Black Other and the Bangladeshi groups experience percentage adjustments of more than 40 per cent nationally. The largest adjustments in 2001 are also found among males in their twenties and early thirties of the same ethnic groups, with an increase over the published census population of about 10 per cent nationally. The impact of non-response is very significant in dense urban areas where characteristics known to be related to census non-response are more likely to be found, such as higher proportions of ethnic minority groups (Sabater and Simpson, 2008).

These results highlight that some comparisons between censuses are misleading if inconsistencies between censuses are not allowed for. Analyses of population change over time and space in England and Wales with complete mid-1991 and mid-2001 population estimates have established the ground to support that the introduction of adjustments is needed (Sabater, 2008). Next this paper evaluates the effect of using complete mid-year estimates on the values of segregation and diversity indices. The review of the marginal changes will provide a clearer picture on the extent to which the analysis of segregation over time is affected by changing definitions, quality of data and changes in geographical units.

4.2 Index values nationally

In this section, a comparison over time of the marginal changes on indices of segregation by using 1991 and 2001 census output directly as published and complete mid-year estimates for the same years is provided. Table 4 displays the values of the selected indices calculated across wards of England and Wales in 1991 and 2001 using these two sources of data.

The first dimension, evenness, which is represented by *ID*, shows how each ethnic group in England and Wales has become more evenly distributed between 1991 and 2001 with both census output and complete mid-year estimates. Although ethnic minority groups only represent 9 per cent of the total population in England and Wales in 2001, their geographical distribution is far from even as observed since 1991 with the release of census data with an ethnic group dimension (Owen, 1992; Peach, 1996a). The higher values of *ID* for non-white groups simply indicate this pattern of distribution with ethnic minority groups more concentrated in particular areas, with the largest values of unevenness among groups whose history of immigration to the UK is most recent such as the Pakistani, Bangladeshi and Black African groups.

A decrease in *ID* is recorded after converting the same census data from 1991 to 2001 wards for all ethnic groups, thus indicating that the harmonisation of boundaries de-emphasise segregation. This would be in line with the reduction in the number of wards between the two years from 9509 to 8850, with an average population size increasing from 5247 to 5880 respectively. According to Simpson (2007a: 11), "this change by a factor of 1.1 is likely to have contributed to the reduction in unevenness during the decade, …, but only marginally and certainly not to account for it all".

Whilst the direction of change in the geographical spread of ethnic groups is similar with both sources of data, the level of change is significantly higher when complete mid-year estimates are used. The results suggest that the average clustering has decreased over the decade by 2-5 percentage points, with the largest percentage changes when complete mid-year estimates are used. This would indicate that overall the introduction of adjustments that take into account changing definitions, quality of data and changes in geographical units have contributed to a reduction of *ID* values for each ethnic group. The decrease on the index values of *ID* using complete estimates suggest that the effect of adding to the minority and to the rest of the population, predominantly as a result of non-response not included in the census output, with the same geographical pattern (more in cities), increases the similarity of each ethnic group with the rest of the population. This effect is discussed in the next section for selected urban areas.

Table 4 Evenness, exposure and diversity across wards in England and Wales, 1991-2001

Index	Group	Census			Complete estimates	
		1991	1991* 2001b	2001	1991	2001
Evenness						
Index of dissimilarity	White	61.4	60.9	58.8	60.5	57.3
	Black Caribbean	68.9	68.6	67.1	68.0	65.7
	Black African	71.1	70.7	70.6	69.6	69.4
	Indian	65.3	64.8	62.1	64.2	60.9
	Pakistani	75.1	74.5	71.8	74.2	69.7
	Bangladeshi	74.2	73.1	71.7	72.7	67.9
	Chinese	42.2	41.0	42.0	42.5	37.5
Exposure						
Index of isolation	White	95.3	95.3	93.5	94.9	93.3
	Black Caribbean	7.6	7.4	7.3	7.9	7.1
	Black African	4.3	4.2	8.2	4.6	8.0
	Indian	15.6	14.7	15.5	15.5	15.2
	Pakistani	13.9	13.4	17.4	14.0	16.8
	Bangladeshi	10.9	10.3	13.7	10.9	13.2
	Chinese	0.8	0.8	1.2	0.9	1.1
Diversity						
Reciprocal Diversity Index		1.1	1.1	1.2	1.1	1.2

* 1991 Census data with 2001 boundaries.

The second dimension, exposure, shows how *P** reflects the national composition of ethnic groups across wards in England and Wales. The values of *P** for both 1991 and 2001 display how the White group is by far the most exposed compared with the rest of the population followed by South Asian minority groups. However, the values of *P** between 1991 and 2001 for the White group illustrate that the index of isolation has decreased over the decade. On the contrary, *P** values show an increase of exposure for those groups such as the Black African, Pakistani and Bangladeshi groups whose population growth is the significant during the decade. Similarly, *P** values for the Chinese group have also increased slightly although these are comparatively from very low levels. On average the values of *P** suggest that the White group lived in areas with fewer white people in 2001 than they did in 1991, a trend that is also observed for the Black Caribbean and the Indian groups. The values of *P** when using complete mid-year estimates serve to extend the evidence to other ethnic groups such as the Indian group, whose likelihood of meeting someone of their

own group across wards in England and Wales has also decreased over the last decade.

The values of *P** for both census output and complete mid-year estimates also give evidence that all ethnic minority groups are living in wards in which they form a small percentage of the ward's population. The results clearly illustrate that none of the ethnic minority groups reaches a value of 20 per cent, thus indicating that the proportion of a given ethnicity living in high local concentrations is generally low. The index values are greatest for the three South Asian groups (Indian, Pakistani and Bangladeshi) with an average local concentration in 2001 that ranges between 13 and 17 per cent, thus implying that on average the groups with most exposure to others live in areas where more than 80 per cent of the population are from other groups. These results highlight that there are differences in the extent to which the local average concentration of ethnic groups is changing. As expected, the fastest growing groups, the Pakistani and Bangladeshi show the largest increase in the index values of exposure between 1991 and 2001.

Finally, as expected, a gain in diversity occurs as minority groups grow in size. The index values of the *RDI* suggests that diversity has increased slightly between 1991 and 2001, an increase that is perceived using both census output and complete mid-year estimates. The overall diversity increase is explained by the effect of non-white young populations with more births than deaths as well as international migration.

4.3 Index values in ethnically diverse urban areas

Since index values can be highly sensitive where the group members are small (Voas and Williamson, 2000), it is generally more important to focus the attention in those areas with large groups and where ethnic minority groups represent a substantial percentage of the total population (Peach, 1996a). This section attempts to review the index values of evenness, exposure and diversity in four ethnically diverse urban areas where non-white groups form a majority or a significant percentage of the total population. For this purpose, two London Boroughs (Newham and Brent) are used to exemplify the changes in residential segregation and diversity over time.

Tables 5 and 6 illustrate the index values for Newham and Brent between 1991 and 2001. Contrary to the results of England and Wales as a whole, these two districts with at least three ethnic groups with 10 per cent or more of the local population

clearly display a more equal geographical spread and a more equal distribution of people from different groups locally.

As seen earlier on, the analysis over time indicates that the use of complete mid-year estimates that correct for the census's incompleteness change the value of segregation indices. For example, in Newham an increase in unvenness for various groups such as the Indian, the Pakistani and the Chinese according to the census data as published is in fact a slight decrease when complete estimates are used. In fact, only the Black African group appears to be less evenly distributed using both census data and complete estimates, mainly as a result of its population growth over the decade as illustrated by the higher index of isolation.

Table 5 Evenness, exposure and diversity across wards in Newham, 1991-2001

Index	Group	Census			Complete estimates	
		1991	1991* 2001b	2001	1991	2001
Evenness						
Index of dissimilarity	White	31.5	28.7	25.2	29.5	24.9
	Black Caribbean	16.8	16.2	13.4	16.1	13.1
	Black African	10.6	10.1	15.4	10.3	15.2
	Indian	39.1	36.0	36.5	38.0	35.9
	Pakistani	29.7	26.3	29.6	29.1	29.1
	Bangladeshi	36.4	35.5	24.1	35.6	23.6
	Chinese	25.5	21.1	27.5	24.2	24.2
Exposure						
Index of isolation	White	63.4	62.6	44.5	61.3	44.4
	Black Caribbean	8.1	8.0	8.0	8.5	7.9
	Black African	5.9	5.8	14.5	6.6	14.4
	Indian	21.9	20.7	19.4	22.1	19.1
	Pakistani	8.5	7.9	11.9	8.6	11.8
	Bangladeshi	6.5	6.2	11.1	6.6	11.0
	Chinese	1.1	1.0	1.5	1.3	1.4
Diversity						
Reciprocal Diversity Index		2.8	2.8	4.2	2.9	4.2

The same pattern of residential segregation is found in Brent for the Black African group as well as for the Indian and Chinese groups, thus indicating a gain of population for these groups in the original settlement areas. Contrarily, the White group shows a more uneven distribution across wards in Brent at the same time its values of the index isolation indicate a lower level of exposure. These results

constitute an example on how ethnic groups can be distributed so that they are overrepresented in some areas and underrepresented in others (Massey and Denton, 1988). As a consequence clusters are likely to remain and rather than expecting a residential melting pot a residential 'mosaic' might be anticipated (Peach, 1996a).

Table 6 Evenness, exposure and diversity across wards in Brent, 1991-2001

Index	Group	Census			Complete estimates	
		1991	1991* 2001b	2001	1991	2001
Evenness						
Index of dissimilarity	White	18.0	14.6	20.1	15.5	20.1
	Black Caribbean	33.0	26.4	21.1	27.7	20.8
	Black African	20.2	15.9	19.1	17.6	18.9
	Indian	31.0	28.6	33.7	30.1	33.5
	Pakistani	18.7	16.6	14.7	19.2	14.2
	Bangladeshi	27.5	20.1	14.2	20.5	10.9
	Chinese	18.2	12.8	18.5	13.9	16.0
Exposure						
Index of isolation	White	57.3	56.9	48.6	55.6	48.8
	Black Caribbean	15.7	14.5	13.1	15.4	12.9
	Black African	5.2	4.9	10.0	5.3	9.9
	Indian	23.1	22.0	25.7	22.8	25.4
	Pakistani	3.7	3.4	4.5	3.7	4.5
	Bangladeshi	0.5	0.4	0.5	0.4	0.5
	Chinese	1.3	1.2	1.3	1.2	1.2
Diversity						
Reciprocal Diversity Index		2.7	2.7	3.4	2.8	3.4

* 1991 Census data with 2001 boundaries.

The analysis of *P** for 1991 and 2001 show how the composition of ethnic groups across wards in these cosmopolitan areas is different compared to the national composition. *P** values are generally greater in these areas than nationally, which suggests that the probability that members of each group will meet members of their own group is obviously higher in Newham and Brent. Finally, the index values of the *RDI* show a much greater diversity compared to England and Wales as a whole, which basically reflects a widespread tendency of population growth of non-white populations. This phenomenon not only applies to already ethnically diverse urban areas such as Newham and Brent but for every region and city in England and Wales (Parkinson *et al*, 2006; Simpson, 2007a).

Table 7 Evenness, exposure and diversity across wards in Newham for those aged 25-34 only, 1991-2001

Index	Group	Census		Complete estimates	
		1991* 2001b	2001	1991	2001
Evenness					
Index of dissimilarity	White	26.4	25.5	26.0	25.5
	Black Caribbean	14.8	16.1	14.8	15.9
	Black African	10.1	14.1	10.4	13.8
	Indian	36.7	34.6	38.9	34.2
	Pakistani	26.8	31.2	28.6	30.9
	Bangladeshi	34.6	18.4	34.0	18.1
	Chinese	26.9	30.2	31.2	28.4
Exposure					
Index of isolation	White	58.0	40.6	55.2	41.0
	Black Caribbean	9.3	7.9	10.8	7.6
	Black African	10.8	17.0	12.4	16.6
	Indian	21.6	17.9	21.9	17.7
	Pakistani	6.5	13.5	6.8	13.6
	Bangladeshi	4.1	10.6	4.2	10.6
	Chinese	1.8	2.1	2.2	2.0
Diversity					
Reciprocal Diversity Index		3.0	4.6	3.3	4.5

* 1991 Census data with 2001 boundaries.

Tables 7 and 8 show the values of selected indices for Newham and Brent for those aged 25-34 only so that the marginal changes between census data and complete estimates can be seen for those groups most affected by high levels of non-response in urban areas. As expected, the impact of non-response contributes to greater exposure of the majority of ethnic groups as a result of adding population to each group and to the rest of the population both in 1991 and 2001. Nonetheless, the index values of *ID* indicate that the impact is more noticeable in 1991, especially for ethnic groups other than White, whose level of evenness is lower after the addition of non-response not estimated within census output. For example, the index values of *ID* decrease by between 2 and 4 percentage points when using complete mid-1991 population estimates for the Indian, Pakistani and Chinese groups in Newham. Similarly, the Black Caribbean, Pakistani, Bangladeshi and Chinese experience a similar decrease in their similarity in Brent when complete mid-1991 estimates are used. *A priori* one

should expect the same impact regarding non-response included in the mid-2001 complete estimates. However an increase in similarity is observed for the majority of groups.

Table 8 Evenness, exposure and diversity across wards in Brent for those aged 25-34 only, 1991-2001

Index	Group	Census		Complete estimates	
		1991* 2001b	2001	1991	2001
Evenness					
Index of dissimilarity	White	18.3	29.6	17.2	29.6
	Black Caribbean	23.0	19.1	24.8	19.1
	Black African	13.2	20.0	13.5	19.8
	Indian	34.9	40.4	35.1	40.1
	Pakistani	16.3	19.4	18.6	19.1
	Bangladeshi	28.1	20.7	29.8	17.7
	Chinese	12.8	17.4	14.1	16.1
Exposure					
Index of isolation	White	55.0	55.7	54.1	56.0
	Black Caribbean	14.0	9.7	15.8	9.4
	Black African	6.2	10.8	6.8	10.6
	Indian	24.2	24.1	23.1	23.8
	Pakistani	2.8	4.8	2.8	4.8
	Bangladeshi	0.4	0.5	0.3	0.5
	Chinese	1.4	1.3	1.4	1.3
Diversity					
Reciprocal Diversity Index		2.9	3.3	3.0	3.3

* 1991 Census data with 2001 boundaries.

The inclusion of small populations in the complete estimates that are more evenly spread than in the census due to the random rounding of 1s and 2 to 0 or 3 (ONS, 2006) is likely to decrease the index values of *ID*. In the complete estimates, 0s and 3s tend to become smoothed to values between 0 and 3. Although this might be a more realistic picture than the lack of 1s and 2s in the census, the truth cannot be known, thus adding approximation to all analysis, particularly for small areas as discussed by Stillwell and Duke-Williams (2007). Overall the comparison of index values for 2001 using census data and complete estimates suggest that a less segregated pattern of residence is obtained when complete estimates are used.

4.4 The impact of geographical boundaries on index values

In this section, analyses of the effect of changing boundaries over time and different geographical scales on the index values of segregation and diversity are provided. For this purpose, a review with the impact of these two issues on the indices' behaviour is given for England and Wales as a whole, and separately for Newham, Brent, Leicester and Birmingham.

In the UK electoral wards are frequently changed in order to ensure electoral equality so that each ward in every district has a broadly equal representation in local elections (i.e. a similar councillor:elector ratio). However, equalising the number of electors is only one of the considerations that the Boundary Committees for England and Wales are required to take into account. The process of delineating wards is also subject to two other factors: reflection of community identity and convenient and effective local government (Boundary Committee, 2008). These two factors are often seen as very subjective and difficult to measure. The main arguments that are generally taken into account to define community identity by the Boundary Committees are mostly related to the location of public facilities (schools, hospitals, libraries, etc.) and an area's history and tradition. However, since communities constantly evolve over time historical considerations can be less important and more subject to other factors such as the settlement of different ethnic groups. Nonetheless, the extent to which ethnicity may be more or less relevant to redraw electoral boundaries in defining community identity is still unclear (Chisholm and Dench, 2005).

Table 9 shows the effect of re-warding over time on the index values of evenness and exposure for each of the selected areas using 1991 Census data with and without 2001 boundaries. Because electoral ward boundaries have changed since 1991 in all the selected areas, 1991 Census ward-level data as published has been converted to the ward boundaries used in the 2001 Census output, which include all boundary reviews agreed by the end of 2003. The results clearly display how the index values are generally lower with the 2001 ward boundaries, thus illustrating that segregation maybe emphasised as a consequence of using different ward geographies. As seen earlier on, this common decrease in the index values of *ID* and *P** is mainly explained by the reduction in the number of electoral wards between 1991 (9509) and 2001 (8850) in England and Wales.

Table 9 Evenness and exposure across wards in England and Wales and selected areas using 1991 Census data

Index	Group	England and Wales		Newham		Brent		Leicester		Birmingham	
		1991	1991* 2001b	1991	1991* 2001b	1991	1991* 2001b	1991	1991* 2001b	1991	1991* 2001b
Evenness											
Index of dissimilarity	White	61.4	60.9	31.5	28.7	18.0	14.6	53.8	47.1	58.4	58.5
	Black Caribbean	68.9	68.6	16.8	16.2	33.0	26.4	28.9	26.5	41.7	41.7
	Black African	71.1	70.7	10.6	10.1	20.2	15.9	30.9	27.7	38.7	38.7
	Indian	65.3	64.8	39.1	36.0	31.0	28.6	54.8	48.4	51.3	51.5
	Pakistani	75.1	74.5	29.7	26.3	18.7	16.6	47.2	45.7	66.3	66.5
	Bangladeshi	74.2	73.1	36.4	35.5	27.5	20.1	73.7	68.5	67.0	67.2
	Chinese	42.2	41.0	25.5	21.1	18.2	12.8	32.8	27.2	29.5	29.6
Exposure											
Index of isolation	White	95.3	95.3	63.4	62.6	57.3	56.9	80.2	78.3	85.1	85.3
	Black Caribbean	7.6	7.4	8.1	8.0	15.7	14.5	2.5	2.1	9.7	9.7
	Black African	4.3	4.2	5.9	5.8	5.2	4.9	0.4	0.4	0.6	0.6
	Indian	15.6	14.7	21.9	20.7	23.1	22.0	43.8	38.4	17.2	17.2
	Pakistani	13.9	13.4	8.5	7.9	3.7	3.4	2.9	2.4	25.0	25.0
	Bangladeshi	10.9	10.3	6.5	6.2	0.5	0.4	2.6	1.9	6.3	6.3
	Chinese	0.8	0.8	1.1	1.0	1.3	1.2	0.6	0.5	0.6	0.6

* 1991 Census data with 2001 boundaries.

Table 10 Evenness and exposure in England and Wales and selected areas across different units of analysis using 2001 complete estimates

Index	Group	England and Wales		Newham		Brent		Leicester		Birmingham	
		Output areas	Wards	Output areas	Wards	Output areas	Wards	Output areas	Wards	Output areas	Wards
Evenness											
Index of dissimilarity	White	60.8	57.3	30.8	24.9	25.8	20.1	55.9	49.6	58.3	53.6
	Black Caribbean	72.6	65.7	20.6	13.1	30.6	20.8	41.0	19.1	44.0	36.8
	Black African	77.0	69.4	24.3	15.2	31.8	18.9	57.8	31.9	64.0	30.6
	Indian	68.8	60.9	42.2	35.9	38.7	33.5	59.2	51.4	54.2	43.9
	Pakistani	78.5	69.7	36.5	29.1	30.1	14.2	55.4	36.9	68.4	61.1
	Bangladeshi	82.3	67.9	33.4	23.6	71.6	10.9	74.4	53.0	70.2	61.0
	Chinese	67.7	37.5	54.9	24.2	48.2	16.0	70.6	28.6	72.5	29.2
Exposure											
Index of isolation	White	93.8	93.3	47.1	44.4	51.0	48.8	77.6	74.9	82.1	81.1
	Black Caribbean	8.9	7.1	9.0	7.9	15.2	12.9	3.6	2.0	12.4	9.4
	Black African	11.0	8.0	16.9	14.4	12.8	9.9	6.8	2.0	2.7	1.0
	Indian	20.0	15.2	22.1	19.1	28.7	25.4	52.9	44.3	21.3	15.4
	Pakistani	25.6	16.8	14.6	11.8	6.3	4.5	5.2	2.7	41.6	29.4
	Bangladeshi	19.9	13.2	14.1	11.0	2.4	0.5	9.2	2.4	13.9	7.4
	Chinese	2.9	1.1	3.8	1.4	2.7	1.2	3.4	0.9	3.8	1.1

The effect of such boundary changes in ethnically diverse urban areas where electoral boundaries have changed since 1991 illustrates that the impact can be particularly misleading in these areas. For example, in Brent the use of 2001 ward boundaries leads to a reduction of the index values of *ID* for the Black Caribbean and Bangladeshi groups by between 6-7 percentage points, a similar decrease to that of the White and Indian groups in Leicester. Therefore, the results reveal that unless a consistent geographical approach with time series is taken (e.g. wards as defined in 2001), it is difficult to know whether changing trends are taking place or whether observed changes are simply an artefact of a boundary change.

Another aspect when analysing the indices' behaviour is the effect of geographical scale. This is widely known as the scale effect, and is part of the more general modifiable area unit problem (MAUP) which is recognised as an endemic problem to all spatially aggregated data such as census data (Openshaw and Taylor, 1979; Fotheringham and Rogerson, 1993).

Table 10 displays the values of measured segregation for 2001 using complete mid-year estimates for different units of analysis (Output Areas and wards) nationally and in the selected ethnically diverse urban areas. As expected, the results confirm that the index values are higher when the unit of analysis is smaller, thus indicating that the level of clustering for each ethnic group is more clearly represented when smaller geographical scales are used. Thus the index of dissimilarity shows greater unevenness and the index of isolation shows a greater average local concentration when measured across Output Areas. These results are of significance and clearly demonstrate that the effect of scale is greater than the effect of changes over time. For example, the index values of *ID* are reduced by between 3 and 61 percentage points, and the index values of *P** decrease by between 1 and 12 percentage points when moving from Output Areas to wards. Although the same patterns are reproduced for each ethnic group some differences are also noticeable which illustrate the extent to which ethnic groups are represented for the varying geographical scales. For example, the Chinese group displays much higher levels of unevenness across Output Areas than for wards compared to other ethnic groups, thus providing further evidence of relatively small localised clusters for some ethnic groups.

5. Index values across life-stages

5.1 Exploring variations by age cohorts

The two common indices of segregation used in the previous analysis have straightforward interpretations. However, these are only crude measures that indicate how evenly one ethnic group is spread out geographically compared to the rest of the population (index of dissimilarity) and the average concentration of a group across localities (index of isolation) at a particular point in time. Although they do not describe the various factors which contribute to local population change such as natural population growth of groups with a recent history of immigration, the interpretation of these two common indices may be improved by incorporating an age dimension. In this second part, an age cohort approach is taken into consideration so that the index values can be related to population movement.

Since age carries with it culturally defined behavioural norms, it has generally been used to trace regularities associated with processes and events across the life-course (Courgeau, 1985). Despite the growing complexity of modern life-courses identified (Hohn, 1987), research does still demonstrate the relationship of age with demographic events. One of the most common approaches exploring this relationship is a model based on age migration schedules (Rogers *et al*, 1978; Rogers and Watkins, 1987) which suggested that constant migration is affected by four peaks of migration during different life-stages (early childhood, early participation in the labour force, retirement and late old age). Research has also linked the life-pattern of migration with particular life transitions motivated by family expansion and the need for domestic space (Warnes, 1992a). The latter can be particularly relevant when the demographic processes expected from recent immigration are placed within a structural context, thus making the application of state policy fundamental. For example, the availability of employment and the 'understanding of this purely demographic pressure on housing is a priority' (Simpson, 2007a: 18).

In the next two sections the index values of *ID* and *P** are analysed for different age cohorts between 1991 and 2001 in England and Wales as a whole and for ethnically diverse urban areas. For this purpose the complete mid-1991 and mid-2001 population estimates are used to identify how ethnic residential segregation varies for eight different age cohorts. Within this context, the age cohort change analysis is used as a

proxy to examine the relationship between segregation and the general social structuring of life-stages by ethnic groups. For example, index values of the resident population aged 0-6 in 1991 are compared with index values for those aged 10-16 in 2001. Similarly, those aged 7-16 in 1991 are compared with the equivalent for those aged 17-26 ten years later. Consequently, the results for these groups will allow us to illustrate changes in the level of segregation for a first age segment focused on preparation and education. Similarly, the index values are analysed by taking into consideration other age segments such as those related to family building and work, and retirement.

Although one can argue that the cohort change is not strictly cohort because it includes mortality and international migration, these two components of change are unlikely to change the interpretations of the results. First, since ethnic minority groups in England and Wales are predominantly young significant differences in mortality levels between ethnic groups are not to be expected. Although there is a growing number of ethnic groups reaching older ages, the absence of evidence from national sources on mortality differentials for these ages means that mortality from mid-1991 to mid-2001 is assumed to be the same for each group. Second, the growth of ethnic minority populations with a relatively young age structure such as the Black Caribbean, Indian, Pakistani, Bangladeshi and Other populations in England and Wales is more through natural growth than immigration between 1991 and 2001 (Finney and Simpson, 2008b).

5.2 Index values nationally

Figures 1 and 2 display the level of evenness and exposure by age cohorts across wards and districts respectively in England and Wales as a whole in 1991 and 2001. The graphs clearly indicate how the level of unevenness for each age cohort in 1991 and ten years later is generally higher among ethnic groups other than White, with the exception of the Chinese group, whose geographical distribution appears to be more widely dispersed than the rest of ethnic groups. The common view is that 'links to restaurants and takeaways catering for the total population would produce such a degree of dispersal of small pockets of population' (Peach, 1996a: 224).

As seen earlier on, the groups with the most recent history of immigration to England and Wales, the Black African, Pakistani and Bangladeshi groups, show the largest

index values of *ID* for every age cohort as a result of their clustering in towns and cities, where old private housing is more readily available.

The change in evenness across wards show a reduction of the index values of *ID* for the majority of age cohorts, thus indicating that all groups and age cohorts have become more evenly distributed between 1991 and 2001. The analysis also reveals a very similar pattern of change in evenness between ethnic groups across age cohorts. Whilst the youngest group (which refers to children living with their parents) and adult ages display similar changes in evenness during the decade, a significant decrease in unevenness is found among young adults.

During the early adulthood phase, represented by the age cohort 7-16 in 1991 and ten years later, it becomes apparent that a shift on the residential distribution between schoolchildren and young adult ages (some of them university students) results in much lower levels of segregation. Since minority groups have a strong urban pattern and ethnic minority students are more likely than others to live at home, these results suggest that student and migration of young adults, predominantly of the White group, to large urban areas (as the places to be at these ages for study and work reasons) may constitute the key factor for greater evenness at this life-stage. Whilst this explanation seems to be applicable to all groups, an exception is found with the Chinese group, whose unevenness has increased from low levels most likely as a consequence of international migration of overseas students to UK universities.

During the middle adulthood phase, represented by the age cohorts 17-26, 27-36, 37-46 in 1991 and ten years later, the change in the index values of *ID* is reduced, with some groups, including the White group, becoming less evenly distributed. The interplay of demand and supply in metropolitan areas -from housing to education to language instruction to efficient public transportation for accessing jobs- would explain the relative differences between groups in the middle aged phase. The decline in the proportion of late middle ages in the total population of big cities would then be defining the dividing line between 'the places to leave and the places to head for' (Dorling and Thomas, 2004: 28). From this perspective, those who can afford will move from big urban concentrations to less urban environments. This would clearly go in line with the extended process of suburbanisation from cities to mixed urban areas (Champion, 1996).

Figure 1 Evenness and exposure by age cohorts across wards in England and Wales, 1991-2001

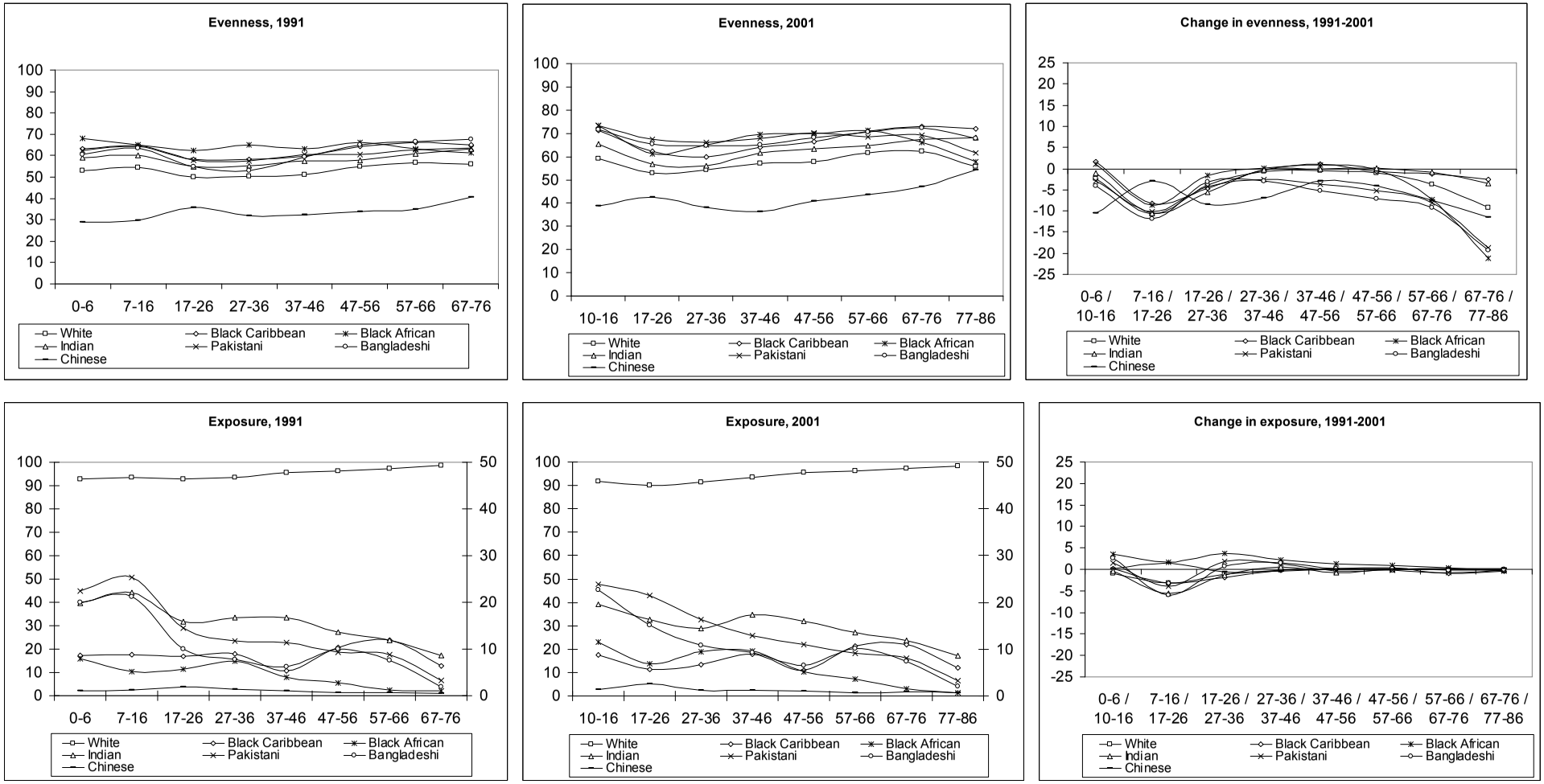
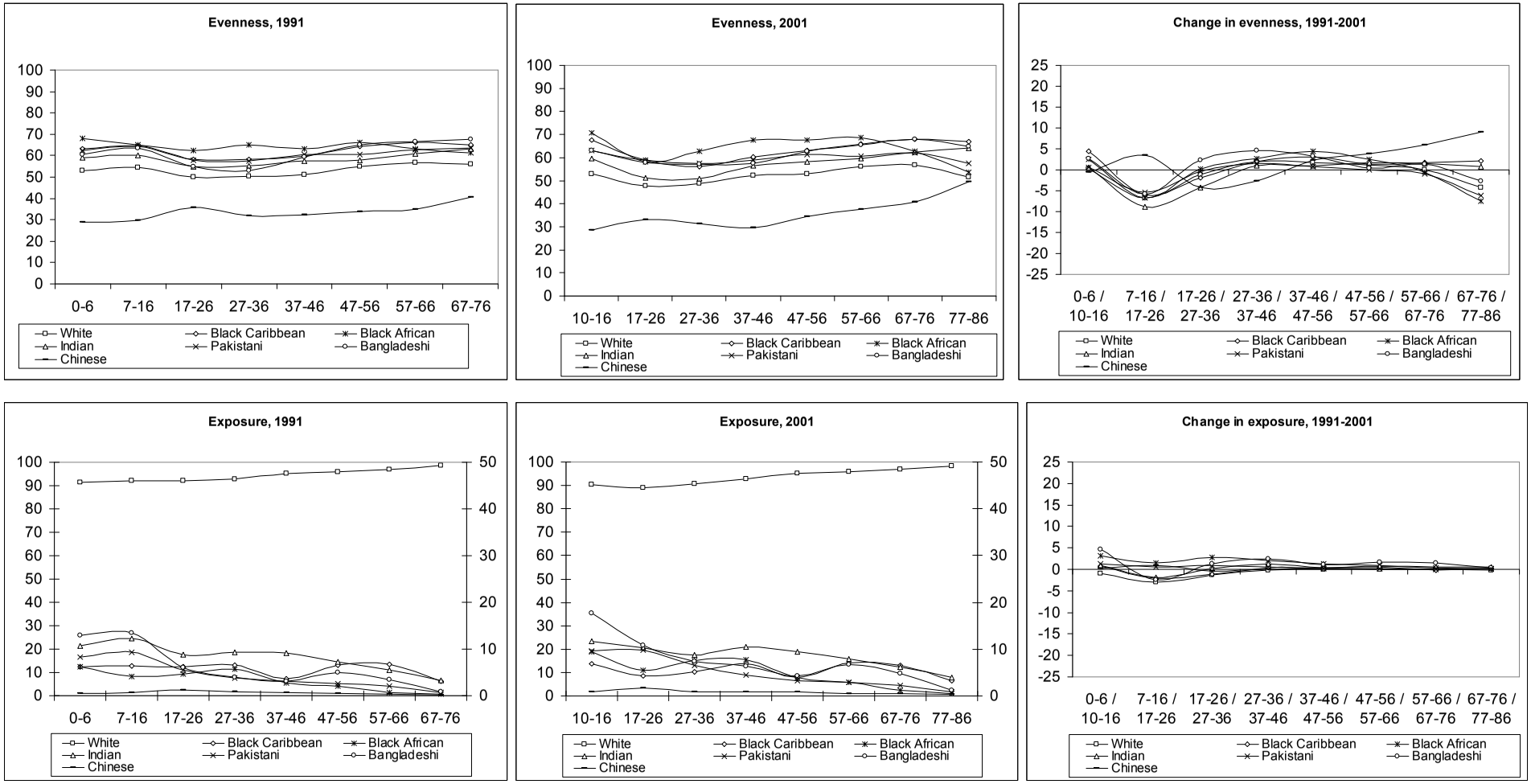


Figure 2 Evenness and exposure by age cohorts across districts in England and Wales, 1991-2001



Finally, during the late adulthood phase and post-retirement age, represented by the age cohorts 47-56, 57-66, 67-76 in 1991 and ten years later, an increase in evenness is found. These results would be in line with the idea that the elderly are more likely to leave than to move to the big cities (Fokkema *et al*, 1996), thus highlighting a possible negative balance of migration of elderly people in dense urban areas which contributes to the suburbanisation process, particularly of the White group. However, not much should be made of the changes from older age cohorts of ethnic minority groups because these are likely to be affected by small numbers, particularly when the calculation of the index values of *ID* is made across wards.

Whilst the pattern of change in evenness for wards and districts in England and Wales as a whole appears to be similar, it is clear that all groups tend to become less evenly distributed when the analysis of change is undertaken across districts, perhaps reflecting the idea that the movement away from original settlement areas is not outside the district but predominantly within districts. This may explain the greater reduction of clustering for all groups across wards.

The picture of exposure of ethnic minority groups is largely explained by the succession of international migration and the logic population growth that follows *in situ*. The widespread population growth of the non-white groups taken as a whole between 1991 and 2001 is highlighted by Sabater (2008), and has occurred in every region and every type of city (Parkinson *et al*, 2006).

Figures 1 and 2 also the level of exposure by age cohorts across wards and districts respectively in England and Wales as a whole in 1991 and 2001. As expected, the results clearly demonstrate how the index values of P^* are dependant of the overall population composition, with the White group being by far the most isolated with index values close to 100 for the majority of age cohorts both across wards and districts. However, as the size of the geographical unit becomes smaller (i.e. from districts to wards), the degree of local average concentration of ethnic minority populations becomes more apparent. For example, the greatest index values of P^* are found among the Indian, Pakistani and Bangladeshi groups for the youngest age cohorts (0-6, 7-16 in 1991 and ten years later) across wards.

The higher values of the index of isolation for young ages are likely to indicate both natural change (i.e. the excess of births over deaths) and continued international

migration. For example, the Black African, Pakistani and Bangladeshi show higher index values of P^* in 2001 for the age cohorts 17-26 and 27-36, thus suggesting a population gain of these groups due to immigration to England and Wales. The analysis of P^* for older ages also exhibits clear cohort effects. For example, the Black Caribbean group shows the greatest exposure for the age cohorts 47-56 and 57-66 in 1991 already, which reflects a process of population ageing of the major migration streams from the West Indies after the Second World War. Within this context, the progressive ageing of other non-white groups is likely to change the picture of exposure, with more demographically mature populations showing the highest index values at older ages. Nonetheless this will also depend on fertility levels, mortality rates and future net migration.

Finally, the graph of change in exposure across wards and districts show how a decrease in the average local concentration has occurred amongst the second youngest age cohort for all ethnic groups, with the exception of the Black African and the Chinese. This repeated pattern of lower levels of P^* for the majority of non-white groups in conjunction with greater evenness for the same ages (as seen earlier on) suggests that a process of dispersal from the settlement areas to other types of area is occurring. Although this process associated with suburbanisation has already been significant for the White group, there is a consensus that non-white groups are also taking part in out-migration to suburban areas, principally from London and major cities (Owen, 1997; Rees and Butt, 2004; Stillwell and Duke Williams, 2005).

5.3 Index values for ethnically diverse urban areas

In this section the index values of evenness and exposure are reviewed for the local authorities of Newham and Birmingham as a way to examine whether the regularities observed nationally are also reproduced in these two major ethnically diverse urban areas. Figures 3 and 4 show the level evenness and exposure by age cohorts across wards in 1991 and 2001 in Newham and Birmingham respectively. The graphs showing the level of evenness for these two ethnically diverse urban areas clearly display a more even distribution of ethnic groups for all ages compared to the results obtained for England and Wales as a whole. These results are particularly noticeable in Newham, where the index values of *ID* vary between 10 and 40. The analysis of the index of dissimilarity between 1991 and 2001 unveils that similar changes in evenness occurred in these two ethnically diverse areas.

Figure 3 Evenness and exposure by age cohorts across wards in Newham, 1991-2001

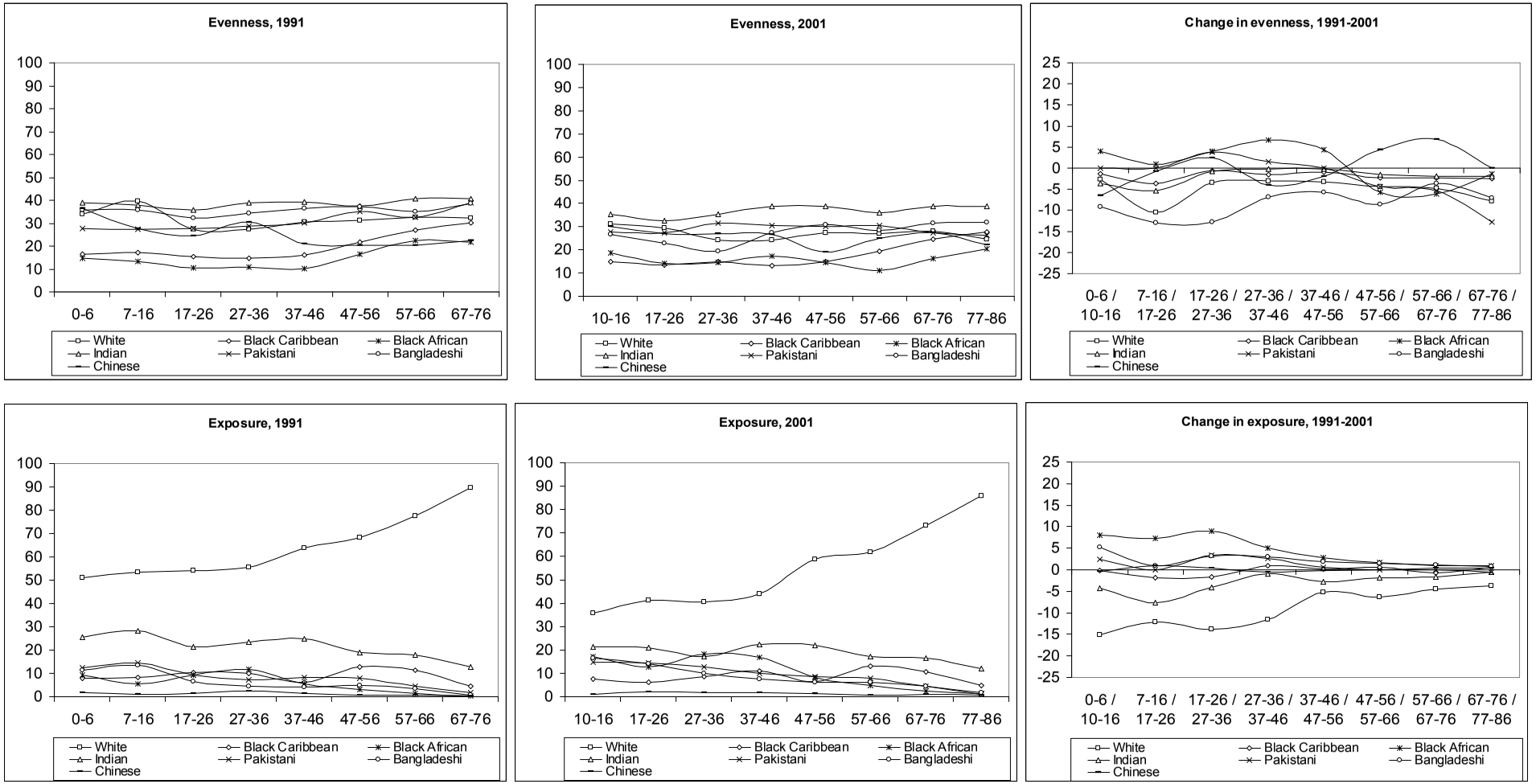
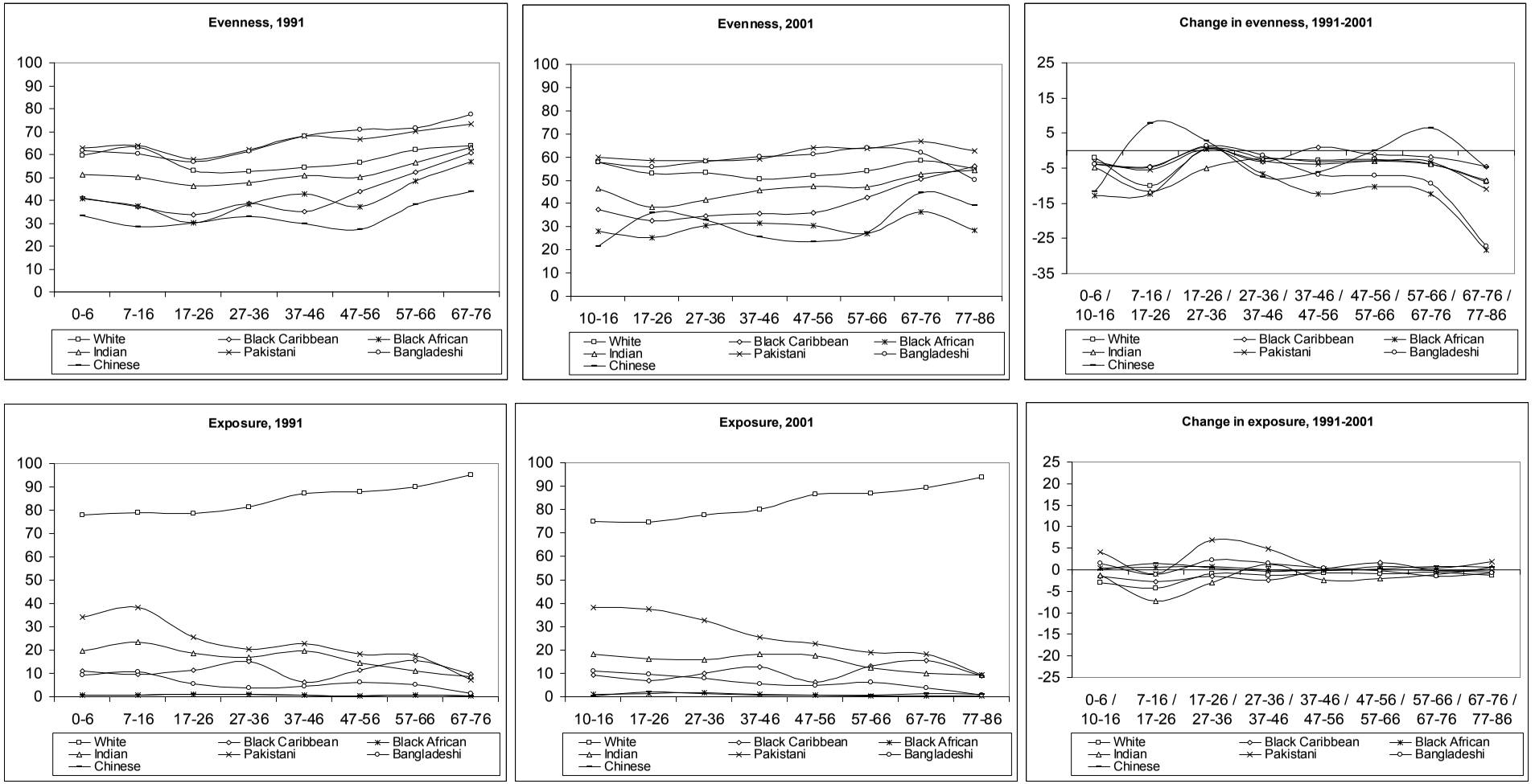


Figure 4 Evenness and exposure by age cohorts across wards in Birmingham, 1991-2001



First, the index values of *ID* for those in the early adulthood phase, represented by the age cohort 7-16 in 1991 and ten years later, replicate the patterns of greater evenness for these ages, hence highlighting again the importance of migration to major urban areas as the places to be at these ages for study and work. This pattern appears to be consistent with the results obtained nationally for England and Wales, including the effect of what is seen as international migration of some groups to the UK, as exemplified by the Chinese group in Birmingham.

Second, the reduction in evenness is less significant for those in the middle adulthood phase, represented by the age cohorts 17-26, 27-36, 37-46 in 1991 and ten years later. The young age structure of ethnic minorities and net migration are expected to generate population growth in already dense ethnically diverse urban areas. Such population dynamic features combined with the geographically specific labour demands and the pressure on the housing market in urban areas are the key explanations for the promotion of clusters (Simpson *et al.*, 2008). For example, some groups such as the Black African and the Pakistani in Newham and the Chinese and Bangladeshi in Birmingham show an increase in unevenness.

Third, the index values of *ID* point out again a tendency to be lower during the late adulthood phase and post-retirement age. As mentioned earlier, these results are likely to hold true for some groups (e.g. White, Black Caribbean and Indian) more than others due to the timing and pace of the population ageing process. One may speculate that the gain in unevenness by the Chinese group in these two areas after the post-retirement ages, particularly for the elderly age groups, is the result of immigration of elderly Chinese who have settled within the frame of family reunification. This process might be accompanied by the characteristic movement of the Chinese group from mixed urban areas to densely populated cities (Finney and Simpson, 2008a).

The analysis of the index of isolation in 1991 and 2001 clearly highlights how despite the importance of ethnic minority groups in the overall population composition of these two ethnically diverse urban areas, the White group is still the most isolated group. For example, in Newham none of the ethnic minority groups' index of isolation across age cohorts reaches 30 per cent in 1991 and 2001, whereas in Birmingham only the Pakistani youngest groups as well as those in the early adulthood phase in 1991 and ten years later obtain similar percentages. The change in exposure between 1991 and 2001 for Newham and Birmingham point out how not

only the White group has experienced a reduction in exposure but other groups such as the Black Caribbean and the Indian groups are also following the same trend, particularly at young ages.

The behaviour of the indices in Newham and Birmingham largely reflect the demographic consequences of natural growth and migration in these two local authorities. Whilst it is at a high level of operation for the Black African, Pakistani and Bangladeshi groups, the growth of the population has become stable for long-established groups such as the Black Caribbean and the Indian. Thus, an increase in exposure in the original settlement areas by recent immigration, which creates a pressure on housing for all local residents, is followed by a decrease in unevenness for the majority of groups across age cohorts. By taking into consideration an age dimension in the analysis of the index values of *ID* and *P** in Newham and Birmingham further evidence is provided of the twin notion of population growth and dispersal from urban areas where co-ethnics live.

6. Conclusion

This paper has provided sufficient evidence that the recurrent fear expressed by politicians, the media and scholars on increasing segregation in England and Wales cannot be supported. The empirical analysis of ethnic segregation over time and age cohorts in England and Wales between 1991 and 2001 has led to clear findings.

First, the analysis that corrects for the census's incompleteness demonstrates that the impact of using complete mid-year estimates is likely to change the value of segregation indices. Although the outcome of less segregation over time has been validated with both the last two censuses and complete mid-1991 and mid-2001 population estimates, the latter has provided evidence of marginal changes when full non-response is not included in census output and the harmonisation of the population definition and census geographies is not taken into account. This finding is especially relevant in urban areas, mostly as a result of non-response not included in the census output. Within this context, the effect of adding to each ethnic minority groups and to the rest of the population in these areas contributes to greater unevenness, particularly

of those groups that are more clustered such as the Bangladeshi and the Pakistani groups.

Second, the analysis that makes the census boundaries consistent over time points out that the interpretation of change in segregation indices can be altered and misleading. The results clearly highlight that an increase in segregation can also be purely artefactual, reflecting ward boundary changes between 1991 and 2001. The results for England and Wales as a whole showed how the index values are reduced when 2001 ward boundaries are used for the mid-1991 and mid-2001 populations. The impact of electoral boundary changes between 1991 and 2001 is particularly significant in ethnically diverse urban areas, where segregation is clearly emphasised.

Third, the results of the analysis across age cohorts suggest that segregation is greater at some life-stages, particularly during the middle adulthood phase, which has been interpreted as a consequence of the concentration of ethnic groups in their middle ages in predominantly urban areas. On the contrary, the index values for younger groups and the post-retirement ages suggest that segregation is much lower for these groups, a result that is seen as a consequence of in-migration to urban areas of young adults and out-migration from urban areas to mixed urban areas and rural areas by the young elderly. This leads to the fourth and last finding, namely that this life-pattern of segregation does not significantly differ between ethnic groups. Despite the differences between individual ethnic groups in the level of segregation, a similar life-pattern of residence is found, which allow us to establish the connection between residential segregation and movement at different life-stages. These results are especially relevant as they clearly display that depending on the life-stage reached, the level of measured segregation can differ greatly regardless of ethnicity. What this suggests is that the residential pattern of ethnic groups measured by the indices of segregation is not simply a consequence but rather an interrelated aspect of different life-stages. Therefore it is assumed that the occurrence of different events which can be related to the family life cycle and work affect the outcomes in the measured segregation, which in turn are influenced by socio-spatial inequalities in education, employment and housing.

The overall analysis is in line with the evidence that the behaviour of the indices of segregation and diversity manifest the demographic consequences of relatively recent and past immigration streams, which leads to population growth and dispersal (Salt

and Rees, 2006; Simpson, 2007a; Finney and Simpson, 2008a). The combination of increased population and increased evenness for all groups would confirm a process of out-migration from dense cities to more suburban areas. This trend is also observable for the fastest growing groups such as the Pakistani and Bangladeshi groups, thus exemplifying that all non-white groups are taking part in the movement away from original settlement areas. As such, this general direction can be easily related in appearance to those following Irish and Jewish immigration to Britain (Peach, 1996b). However, this is clearly a process that is constrained and modified by the specific arrangements in the housing system, employment markets and access to services such as education and health (Musterd, 2003; Simpson, 2004).

As part of a research programme to provide a better understanding of the residential patterns of ethnic groups in England and Wales between 1991 and 2001, one would like to close this paper believing that by making use of social statistics the idea of increasing segregation cannot be supported. Although more inflammatory language and alarming headlines are likely to appear on segregation debates, this study has shown that the paradigm within which segregation indices are analysed in the European context can be perfectly understood by taking into consideration the demographic processes that are anticipated from populations of young adults after immigration.

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- Census data are Crown copyright.
- The complete mid-1991 and mid-2001 population estimates are census-based and have been prepared by members of the University of Manchester (Cathie Marsh Centre for Census and Survey Research). More information is available at www.ccsr.ac.uk/research/PopulationEstimates.htm

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