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CENSUS BASED INFORMATION SYSTEMS FOR ETHNIC GROUPS: A STUDY OF LEEDS AND BRADFORD

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ABSTRACT

The paper explores the problems involved in using Census data as a guide to the evolving ethnic geography of British cities. The relationship between the concept of ethnicity and Census questions on place of birth is traced. Employing the country of birth statistics for small areas from the 1981 and 1971 Censuses the study attempts to ascertain the influence of technical specifications on the measurement of the residential segregation of ethnic groups in order to distinguish real differences from apparent ones. The attempt is not fully successful but it does provide clear pointers on how to proceed further in research on the ethnic spatial mosaics that our cities now are.

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1. INTRODUCTION

Speaking very broadly, the population of a Western country is differentiated along three social axes, those of class, generation and ethnicity. The major exercise that has gathered information about the population in developed countries for over a century, the Census, has included questions on occupation to measure class, on age and household composition to measure generation and on place of birth to measure ethnicity. Although the latter question is not an ideal measure of ethnicity, it does provide the only comprehensive, country-wide picture of geographical variation in the numbers and concentrations of the various ethnic groups that make up the population. In this paper we examine the residential patterns revealed by the Census country of birth data in two neighbouring northern cities, Leeds and Bradford.

The next section of the paper discusses the questions used to count the numbers of people in ethnic groups, and reviews the extent to which census statistics available at the Small Area scale match our notions of ethnicity. The third section defines the simple pattern measures to be used in the investigation, discusses the likely "operational" influences on those pattern measures and describes the research design of the investigation. The fourth section reports on the extent of those influences and the fifth section attempts to summarize what influence-independent ethnic patterns can be said to characterize Leeds, Bradford and London.

2. ETHNIC ORIGIN AND THE CENSUS

2.1 The concept of ethnicity

"Ethnic" literally means "pertaining to a nation" or "ethnos" (Greek for nation). A person is born into an ethnic group and generally remains a member of that group for the rest of his or her life. Ethnicity is thus an ascriptive characteristic, assumed at birth, and not an achieved attribute such as social class in a mobile society or a regularly changing characteristic such as generation or household membership.

People who migrate from one nation to another are recognized as "ethnic" in the destination country. Ethnicity can also be a function, within one nation, of race or of religion, and often of a combination of national origin, racial membership and relgious affiliation. It is also in part a function of the view that an individual holds about him or herself, and society's opinion of a person. Those who possess some characteristics of two ethnic groups may on occasion be classified with the members of one group, on other occasions with the members of another, reflecting their ambiguous or transitional status.

2.2 Census questions

The question traditionally employed in the British Census to classify persons into ethnic groups has been that of country of birth. For example, in the latest 1981 Census, county, district, ward and enumeration district populations are all classified according to eighteen country of birth groups. It was realized well before the 1971 Census that such a question would fail to include, in the count of members of an ethnic group, the children of immigrants from an overseas country and so an additional question on parents' country of birth was asked (OPCS, Office of Population Censuses and Surveys, 1974) so that the numbers of native born children of overseas born immigrants could be ascertained.

The question on parental birthplace proved, however, a sensitive and unpopular one, and an alternative was sought. Prior to the 1981 Census attempts were made to design a question that asked people to classify themseles according to a list of ethnic origins (Sillitoe 1975, 1977, 1978 and 1981), but the Office of Population Censuses and Surveys came to the conclusion that (OPCS, 1982a, p.1):

> "tests of various questions and consultations with representatives of ethnic minority groups showed that a question on race or ethnic origin would be universally acceptable in the context of the statutory Census nor would it give accurate information."

No question on ethnic origin was included in the 1981 Census on the instructions of the Secretary of State for Social Services. Parenthetically, it should be noted that a report of a House of Commons Select Committee in 1983 suggested that this decision had been a mistake and recommended inclusion of such a question in the next Census.

It proved, however, possible to use the country of birth question in a different way to distinguish the native born children of ethnic households. Tables were prepared classifying the private household

population by country of birth of the head of household and by whether born in the United Kingdom or not. The total number of persons living in households classified by the ethnicity of the head is generally felt to be a substantial improvement on the simple country of birth measure.

2.3 An evaluation

An opportunity was taken in the biennial Labour Force Survey of 1981 (OPCS, 1983) to compare the counts of the "indicator" based on head of household's birthplace with those based on a direct question on ethnic origin. The Office of Population Censuses and Surveys write that

> "approximation to the size of the relevant ethnic group. Thus, results from the 1981 Census may be used to produce more detailed analyses of the socio-economic characteristics of certain ethnic minority groups, for sub-national areas, than are possible from sample surveys" (OPCS, 1983, p.6).

although this is later qualified (p.8)

> "... at least in areas where there are high concentrations of ethnic minority groups ...".

"Good approximation" is, however, a subjective term. Table 1, in which persons in the Labour Force Survey 1981 are cross-classified by country of birth of head of household and by ethnic origin, reveals that, whereas 3.85 per cent of the Great Britain population live in households headed by persons born in India, Bangladesh, the African Commonwealth, Pakistan and the Caribbean Commonwealth only 2.83 per cent have the corresponding ethnic origins, and 0.46 per cent are white. Similarly, of the 3.05 per cent of the Great Britain population with these ethnic origins, only 93 per cent live in households of the same ethnicity.

Nationally, if we accept the head of household indicator as a surrogate for the main NCWP groups, we will overestimate by 17 per cent the main NCWP groups; in the metropolitan counties with higher concentrations of these groups, however, the misclassification is lower at 6 to 9 per cent (Table 2). One of the main sources of misclassification are white households with heads born abroad to parents serving in a diplomatic, commercial, civil service or commercial capacity. Since such households are more likely to live in the affluent suburbs, this error may be important when interpreting the residential patterns revealed by the Census indicators.

2.4 Country of birth tables available in the 1981 Census

Tables classifying the population by country of birth and by country of birth of head are available at national, county, district, ward and enumeration district scales in England and Wales.

In the County Reports Table 10 reports on the "usually resident population by country of birth by sex", and Table 11 on "persons usually resident in private households, whether born inside or outside the United Kingdom by age of residents by birthplace of head of household" (OPCS,

TABLE 1. Population by country of birth of head of household and by ethnic origin: broad groups, Great Britain, 1981
Percentages

Country of birth of head of household	Ethnic origin of persons					
	White	Indian, Pakistani African, Bangladeshi, West Indian or Guyanese	Other inc. Arab, Chinese	Mixed	Not Stated	All Ethnic Origins
UK	90.01	0.12	0.06	0.18	0.50	90.88
India, Bangladesh, African CW, Pakistan and Caribbean CW	0.46	2.83	0.07	0.16	0.06	3.58
Other NCW	0.37	0.03	0.23	0.05	0.01	0.70
Rest of World	3.81	0.05	0.21	0.04	0.06	4.17
Not stated	0.16	0.01	0.002	0.002	0.50	0.67
All birthplaces	94.82	3.05	0.57	0.44	1.13	100.00

Source: OPCS (1983), Table 10, p.6. The figures have been converted into percentages.
NCW = New Commonwealth.

TABLE 2. Population of NCWP origin by birthplace: selected areas, 1981

Area	Population of ethnic origin: West Indian or Guyanese Indian, Pakistani, Bangladeshi & African	Population in households with head born in: India, Pakistan, Bangladesh, Caribbean and African Commonwealth
	As a percentage of all persons in the area	
	(1)	(2)
Great Britain	3.0	3.6
Greater London	10.3	11.3
West Yorkshire*	5.3	5.7
West Midlands*	10.3	11.0
Greater Manchester*	3.3	3.5
Leicester	22.9	24.4

Source: OPCS(1983), Table 13,p.7
NCWP = New Commonwealth and Pakistan
* = Metropolitan county

1982b).

In Table 3 these two sets of statistics are compared for the Bradford and Leeds metropolitan districts. As we go from Table 10 to Table 11 a substantial number of the UK born population (7% in Bradford and 4% in Leeds) is transfered to other ethnic groups. The numbers in these groups according to the birthplace of head definition are greater than the birthplace of person definition for all non-UK groups, and substantially greater in many instances, except for those in East Africa. The explanation for this exception is that many of the East Africa born, being of Asian (generally Indian) descent, live in households headed by persons born in India. This is what makes the Table 11/Table 10 ratio for the Indian origin group greater than that of the Pakistani group, despite the higher fertility rates of the latter (King, 1974 and Policy Unit Bradford, 1982).

The clear message of Table 3 is that, to investigate the residential patterns of ethnic groups in these two West Yorkshire cities, we should employ the birthplace of head indicator.

Unfortunately, the birthplace of head table published in the Census 1981 Small Area Statistics (SAS) is a collapsed version of the County Report table. Instead of nine separate countries of birth only four are reported in the SAS: head of household born in (i) the United Kingdom, (ii) the Irish Republic, (iii) the New Commonwealth or Pakistan or (iv) Elsewhere. By contrast the eighteen country of birth groups of Table 10 of the county reports are used unchanged in SAS Table 4.

The researcher therefore faces a dilemma: should a finely detailed but grossly underenumerated classification of ethnic groups be used (SAS Table 4) or a grossly aggregated and marginally overenumerated specification of ethnic groups (SAS Table 37)?

The ideal solution would be to order special small area tabulations using the classification scheme of County Report Table 11. Prior to the production of such tables, it was decided to concentrate attention on the finer detail of the country of birth of person tables (SAS Table 4).

2.5 An evaluation of the SAS Table 4 statistics

Although the SAS Table 4 statistics are a severe underenumeration of most ethnic groups, it could be argued that the relative spatial patterns revealed are not likely to be severely distorted. The missing United Kingdom born members of the non-English ethnic groups are members of the same households as those born in the various country groups abroad. The only inter-group comparison that is likely to be severely distorted is a comparison with the English born, since, to a small extent, this will be a comparison with members of the same ethnic group.

We can test the proposition that the SAS Table 4 statistics are a good relative approximation to the County Report Table 11 statistics missing at the small area scale by looking at the SAS Table 37 aggregate groups. We define a good relative approximation to be when the proportions of one group defined by one method in the residential areas being studied are very similar to these for the group defined in an

TABLE 3. A comparison of ethnic group definitions for Bradford and Leeds, Census 1981

Country of birth	Country of birth Table 10, County Report		Country of birth of head, Table 11 County Report		Ratio (3)/(1)
	Number (1)	Per Cent (2)	Number (3)	Per Cent (4)	(5)
BRADFORD					
United Kingdom	409,205	90.1	379,882	84.4	0.93
Irish Republic	3,716	0.8	6,116	1.4	1.65
NC East Africa	1,733	0.4	1,442	0.3	0.83
NC Caribbean	1,812	0.4	3,694	0.8	2.04
NC India	6,379	1.4	12,428	2.8	1.95
NC Bangladesh	1,305	0.3	1,807	0.4	1.38
NC Remainder	1,555	0.3	1,648	0.4	1.06
Pakistan	17,668	3.9	29,423	6.5	1.67
Total NCWP	30,452	6.7	50,442	11.2	1.66
Rest of World	10,825	2.4	13,457	3.0	1.24
All birthplaces	454,198	100.0	449,897	100.0	0.99
LEEDS					
United Kingdom	660,239	94.8	634,922	92.2	0.96
Irish Republic	7,563	1.1	12,745	1.9	1.69
NC East Africa	1,816	0.3	1,471	0.2	0.81
NC Caribbean	3,889	0.6	8,193	1.2	2.11
NC India	4,627	0.7	8,639	1.3	1.87
NC Bangladesh	641	0.1	931	0.1	1.45
NC Remainder	3,011	0.4	3,289	0.5	1.09
Pakistan	3,337	0.5	5,284	0.8	1.58
Total NCWP	17,321	2.5	27,807	4.0	1.61
Rest of World	11,591	1.7	13,087	1.9	1.13
All birthplaces	696,714	100.0	688,561	100.0	0.99

Source: Computed from OPCS(1982b), West Yorkshire, p.13-15.
NC = New Commonwealth.

alternative way. In Figure 1 we compare the New Commonwealth and Pakistan (NCWP) born population (the horizontal axis) with that living in private households with heads born in the New Commonwealth and Pakistan for the 33 wards of Leeds Metropolitan District.

The scatter about the average regression line is tight. The correlation coefficient (Table 4) is very high at 0.99 and the index of dissimilarity is very low at 5.1. The slope of the regression line is 1.77, close to the overall Table 11 to Table 10 ratio for the NWCP population for Leeds reported in Table 3 of 1.66. We can thus be confident that the SAS Table 4 measures do give a good relative approximation to the better birthplace of head indicators.

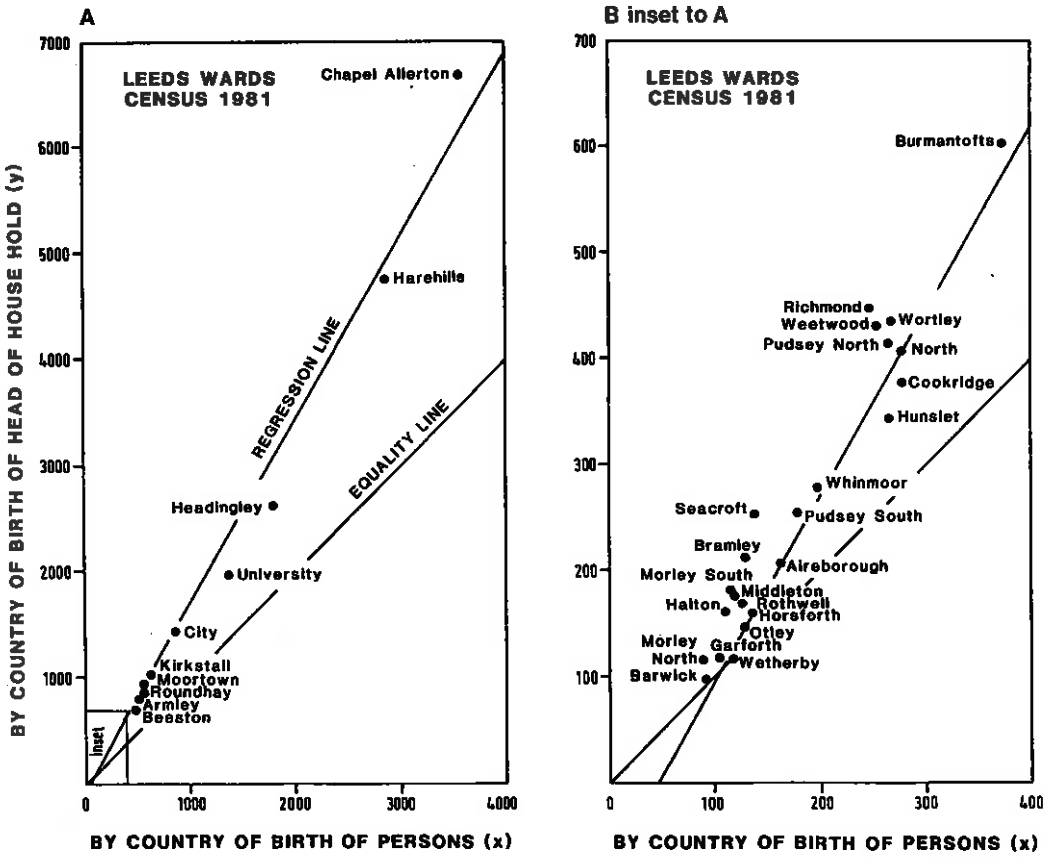
Do they, however, measure the relative distribution of properly defined ethnic groups? Recall that the 1981 Labour Force Survey suggested that almost 1 in 8 residents in households headed by persons born in India, Bangladesh, the African Commonwealth, Pakistan and the Caribbean Commonwealth was white. Does this problem, which the 1981 Labour Force Survey suggests was more prevalent outside the main metropolitan centres, also appear in the suburbs of those centres?

For Bradford, we have available an independent measure of the Indian population based on an analysis of the names on the Register of Electors for October 1981 (Ram, 1983). When we compare Ram's Register count with the SAS Table 4 figures (Table 5), we find 9 wards in which Ram records 11 or fewer Indian electors but in which the Census records many more persons born in India. In Bingley Rural and Ilkley wards Ram's analysis reveals no Indian electors; the Census gives 21 and 29 India-born residents respectively. These are the "white Indians" picked out by the 1981 Labour Force Survey. As a result the index of dissimilarity between Indian electors and the rest of the electoral population is nearly 9 points different on the 0-100 index of dissimilarity scale from the corresponding index value based on the Census SAS country of birth tables (Table 5). However, other comparisons such as Indians versus Other Asians against Indians versus Pakistanis and Other Asians versus the Rest of the Electors against Pakistanis versus the Rest of the Population are much closer.

One step that could be taken to improve our estimates of the numbers in the eighteen ethnic groups of SAS Table 4 would be to multiply the country of birth numbers by the ratios reported earlier for the metropolitan districts (Table 3, column (5)), subject to suitable constraints. However, this effects no change in the relative distribution across wards of the groups, except for the residual group, the rest of the population. The shift in indices of dissimilarity between a group and the rest of the population is small, except for the comparison of the English born versus other groups.

On balance, the decision was taken to proceed with the analysis of the SAS Table 4 definitions of ethnic groups, bearing in mind the caveats revealed by the comparisons reported in this section. This analysis should, however, be superseded in the near future by a fresh analysis based on the above adjustment procedure or on new tabulations of County Report Table 11 at small area scale. Choice of the SAS Table 4 statistics does make comparison with the previous Census, when a braodly comparable table exists, whereas no direct equivalent of the head of household

FIGURE 1. A comparison of country of birth and head of household figures for the New Commonwealth and Pakistan population



indicator is available.

TABLE 4. The statistics of a comparison of SAS Table 4 and SAS Table 37 figures

4.1 Variable definitions

NCWP(SAS Table 4) = usually resident persons born in New Commonwealth or Pakistan (by ward)
NCWP(SAS Table 37) = residents in private households with head born in New Commonwealth or Pakistan (by ward)
RPOP(SAS Table 4) = the usually resident population minus NCWP(SAS Table 4)
RPOP(SAS Table 37) = the population usually resident in private households minus NCWP(SAS Table 37)

4.2 Regression of NCWP(SAS Table 37) against NCWP(SAS Table 4)

Correlation coefficient = 0.9937
Regression slope = 1.7658
Regression intercept = -83.7186
Number of cases (wards) = 33

4.3 Indices of dissimilarity

NCWP(SAS Table 4) vs. RPOP(SAS Table 4) = 48.4
NCWP(SAS Table 37) vs. RPOP(SAS Table 37) = 51.9
NCWP(SAS Table 4) vs. NCWP(SAS Table 37) = 5.1
RPOP(SAS Table 4) vs. RPOP(SAS Table 37) = 1.3

TABLE 5. A comparison of indicators of the Indian population Bradford, 1981

Ward	Count from Register of Electors (Ram, 1983)	Count from SAS Table 4
Baildon	4	22
Bingley	7	18
Bingley Rural	0	21
Idle	11	22
Ilkley	0	29
Keighley North	2	29
Keighley South	10	17
Keighley West	9	40
Worth Valley	1	6

Indices of dissimilarity	Register based	Census based
Indians vs. Rest of Electors	61.8	
Indians vs. Rest of Population		53.2
Indians vs. Other Asians	26.8	
Indians vs. Pakistanis		25.1
Other Asians vs. Rest of Electors	63.5	
Pakistanis vs. Rest of Population		60.6
Indians: Register vs. Census	9.3	

3. PATTERN MEASURES, PROBLEMS OF COMPARISON AND STUDY DESIGN

3.1 The index of dissimilarity

There has been a long running debate about which is the best index to use in comparing the spatial distributions of two phenomena. Recent additions to this debate (Lieberson, 1981; Morgan, 1983) have reminded us that no one index can capture all the subtleties involved in such a comparison, but replacement of the favourite index, the Index of Dissimilarity, was not suggested. This has been in widespread use in many fields since the beginning of the century.

Formally, the index of dissimilarity can be defined as

$$D(e,f) = 100\ (1/2) \sum_{i=1}^{N} \left| (P(i,e)/P(*,e)) - (P(i,f)/P(*,f)) \right|$$

where d(e,f) is the index of dissimilarity between the distribution of group e and group f, P(i,e) is the number of people in zone i of group e, P(i,f) is the number of people in zone i of group f, P(*,e) is the sum of people of group e in all zones and P(*,f) is the sum of people of group f in all zones, P(i,e)/P(*,e) is thus the proportion of people of group e in all zones who live in zone i and P(i,f)/P(*,f) is the corresponding proportion for group f. The absolute value of the difference of these proportions is taken and these values are summed over the N zones in the study area. The sum is multiplied by 100 and one half to scale the index between 0, meaning no dissimilarity between the distributions, and 100, meaning complete dissimilarity between the distributions. To work out the indices of dissimilarity reported in this paper a modified version of the computer program reported in Rees, Brookes and Sellers, 1981 was used: this program computes indices of dissimilarity between zones as well as groups, and prints out statistics for groups and zones such as the location quotient for a group in a zone, LQ(i,e)

$$LQ(i,e) = \{ (P(i,e)/P(i,*))/(P(*,e)/P(*,*)) \}$$

where P(i,*) is the population in a zone of all groups, P(*,e) is the population in a group of all zones and P(*,*) is the total population of all groups in all zones. The location quotient measures the concentration of a group in a zone, with values below 1 indicating less than average concentration and values above 1 indicating more than average concentration.

Sample tables produced in an index of dissimilarity analysis are listed in Table 6. The first sub-table (Table 6.1) shows the indices of dissimilarity between country of birthplace groups for Bradford in 1981. In the last two rows of the sub-table are summary indices comparing each group listed in the table columns with the rest of the population and the whole population.

The second sub-table (Table 6.2) gives zonal statistics for one country of birth group, those born in Pakistan. The location quotient column shows, for example, that Pakistanis are concentrated in University, Toller and Undercliff wards (all location quotients greater than 1), but underrepresented in Thornton, Tong and Wibsey wards. Sub-tables 6.3 and

TABLE 6. Sample table extracts from an index of dissimilarity analysis

6.1 A portion of a table of indices of dissimilarity for pairs of ethnic groups, Bradford, 1981

Country of birth group	...	5 Irish Rep.	6 Old CW	7 NC E. Africa	8 NC R. Africa	9 NC Carib	10 NC India	...
1 England	...	17	15	54	37	44	56	...
2 Scotland	...	19	10	57	38	46	60	...
3 Wales	...	25	10	57	40	52	62	...
4 Rest UK	...	13	19	55	37	45	58	...
5 Irish Rep	...	0	25	48	35	37	49	...
6 Old CW	...	25	0	59	41	50	63	...
.		.	.	.	.	.	.	
.	...	.	.	.	.	.	.	...
.		.	.	.	.	.	.	
Rest of Popn	...	14.6	16.8	50.8	34.1	40.7	53.2	...
Whole Popn	...	14.5	16.8	50.6	34.0	40.5	52.4	...

6.2 A portion of a table of zonal and group percentages and location quotients, Bradford, 1981

Group 15: born in Pakistan

Zone	% in zone of zonal population	% in zone of group population	Location quotient
.	.	.	.
.	.	.	.
.	.	.	.
Thornton	0.12	0.10	0.03
Toller	13.53	12.17	3.46
Tong	0.22	0.20	0.06
Undercliff	5.35	4.57	1.37
University	26.69	28.93	6.86
Wibsey	0.09	0.07	0.02
.	.	.	.
.	.	.	.
.	.	.	.

6.3 A portion of a table of indices of dissimilarity for pairs of wards, Bradford, 1981

Zone ...	10 Great Horton	11 Heaton	12 Idle	13 Ilkley	14 Keighley N	15 Keighley S
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
Bradford Moor	15	10	22	22	13	20
Clayton	7	13	2	3	10	5
Craven	8	14	1	3	10	5
Eccleshill	7	13	2	3	10	5
Great Horton	0	9	8	8	8	6
Heaton	9	0	14	13	5	12
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
Rest of area	2.7	7.4	7.8	6.8	5.5	4.8
Whole popn	2.6	7.1	7.6	6.6	5.3	4.7

6.4 A portion of a table of zonal and group percentages and location quotients, Bradford, 1981

Zone 6: Bradford Moor

Country of birth group	% in group of zonal population	% in zone of group population	Location quotient
.	.	.	.
.	.	.	.
.	.	.	.
NC India	7.13	18.42	5.07
NC Bangladesh	0.41	5.13	1.41
NC Far East	0.25	5.85	1.61
NC Mediterranean	0.05	2.43	0.67
NC Rest	0.05	8.08	2.23
Pakistan	12.43	11.60	3.19

6.4 are the zonal equivalents of the group tables. The indices of dissimilarity in sub-table 6.3 measure how dissimilar are the ethnic population compositions of the listed wards. The zonal statistics in sub-table 6.4 show which groups are concentrated in Bradford Moor - all of the groups listed except for those born in the New Commonwealth Mediterranean countries.

Of course, to use one index number to summarize the relationships between two complex spatial distributions is a somewhat foolhardy enterprise, but it has the clear advantage of making possible a wide set of comparisons. In the remainder of the paper we practise further omissions by concentrating, of necessity, on only one set of indices, those comparing an ethnic group with the rest of the population. We do this in order to provide a reconnaissance map of the ethnic geography of two British cities, before returning in detail to the more detailed materials in future analyses.

3.2 Problems in comparing indices of dissimilarity

Three kinds of comparison of the residential distributions of ethnic groups will be made, using the index of dissimilarity:

(i) the spatial patterns of the ethnic groups will be compared within one city at one point in time;
(ii) the spatial patterns of ethnic groups in one city will be compared with those in another city at one point in time; and
(iii) the spatial patterns of ethnic groups at one point in time will be compared with those at an earlier point in time.

These inter-group, inter-city and inter-temporal comparisons are affected by three well known problems common to many socio- geographic phenomena.

(a) Group size can affect the level of dissimilarity measured, with the index tending to be higher for very small groups.
(b) Zone size and the number of zones can also affect the levels of the indices. The smaller the zone size and the greater the number of zones, the higher the indices of dissimilarity.
(c) The study area chosen can also affect the level of the indices. Whether the inner area or the continuously built up area or the commuting field of a city is chosen will affect the measures of residential dissimilarity.

3.3 The study design

To carry out the three types of comparison outlined above while controlling and allowing for the three problems a careful study design was established (Table 7). For Leeds and for Bradford some seven analyses were planned, four using 1981 Census data and three employing 1971 Census data. For 1981 an analysis was carried out for a partition of the

TABLE 7. The research design for the index of dissimilarity analyses

Analysis number	City	Date of Census data	Study Area	Areal Units (number)
L1	Leeds	1981	Metro District	City,suburbs (2)
L2	Leeds	1981	Metro District	1981 wards (33)
L3	Leeds	1981	"Ethnic area"	1981 wards (16)
L4	Leeds	1981	Metro District	EDs (1565)
L5	Leeds	1971	Metro District	1981 wards (33)
L6	Leeds	1971	"Ethnic area"	1981 wards (16)
L7	Leeds	1971	Metro District	EDs (1625)
B1	Bradford	1981	Metro District	City,suburbs (2)
B2	Bradford	1981	Metro District	1981 wards (30)
B3	Bradford	1981	"Ethnic area"	1981 wards (19)
B4	Bradford	1981	"Ethnic area"	Census tracts (432)
B5	Bradford	1971	Metro District	1981 wards (30)
B6	Bradford	1971	"Ethnic area"	1981 wards (19)
B7	Bradford	1971	"Ethnic area"	Census tracts (432)
GL1	London	1981	GLC area	Boroughs (33)
GL2	London	1971	GLC area	Boroughs (33)

Notes: 1. ED = enumeration district.
2. For definitions of the study areas see Figure 2.
3. GLC= Greater London Council.

Sources:

L1:	L2, L3	B1:	B2
L2:	SAS W Yorks tape from OPCS	B2:	SAS W Yorks tape from OPCS
L3:	L2	B3:	B2
L4:	SASPAC at UMRCC	B4:	SASPAC at UMRCC
L5:	Leeds City Planning Dept.	B5:	SAS tape from SSRC Archive
L6:	L5	B6:	B5
L7:	SAS tape from Leeds City	B7:	SAS tape from SSRC Archive
GL1:	County Report, Census	GL2:	County Report, Census

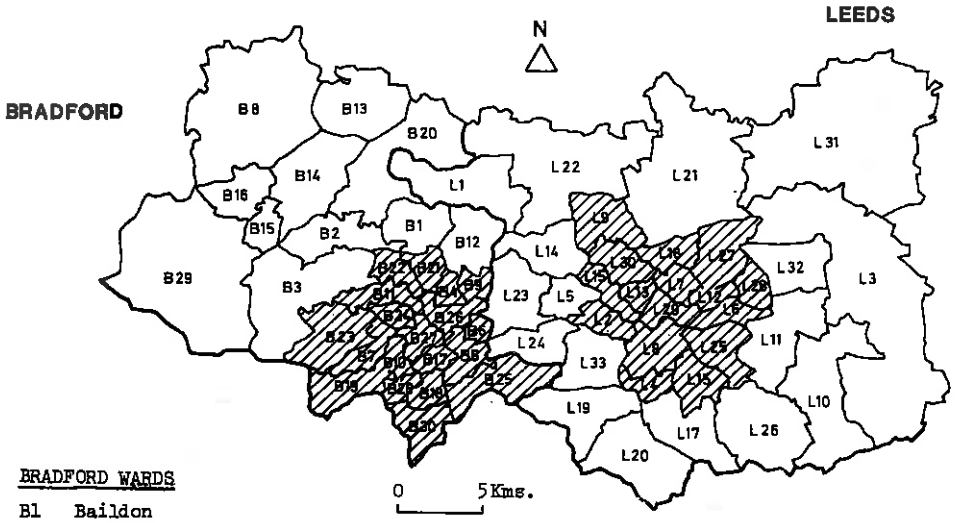
All the statistics are derived from the 1971 and 1981 Censuses but by a variety of routes. Our thanks are due, in assembling these data sets, to: L2,B2 - OPCS, Titchfield, Alan Wilson, Martin Clarke, Margaret Spowage, School of Geography, University of Leeds; L4,B4 - David Rhind, Birkbeck College et al, Sean Dunne, UMRCC; L5,L7 - Peter Shilson, Peter Monaghan, Leeds City Council, Alex Hirschfield, School of Geography; B5,B7 - Nigel Walford, SSRC Data Archive, Essex University. SASPAC is a program for extracting Census 1981 Small Area Statistics from a national data set mounted on computer disks at selected University Computing Centres. UMRCC (1982) gives details of how to access and extract the data from the University of Manchester Regional Computing Centre.

metropolitan districts into two units, the "ethnic" or city area and the suburbs (analyses L1 and B1). For each date, an analysis was carried out for the whole metropolitan district at the ward scale (analyses L2, L5, B2 and B5). Figure 2 gives the ward boundaries. Since the 1971 and 1981 ward boundaries differed considerably, the census statistics were standardized on the 1981 wards; for 1971 this involved aggregation of 1971 enumeration districts to 1981 ward boundaries (analyses L5 and B5).

To gauge the effect of study area choice reduced areas were chosen in which the main country of birth groups are principally concentrated and the analyses carried out at ward scale (analyses L3, L6, B3 and B6). These "ethnic areas" are shown on Figure 2 and comprise the central wards, contiguous and wholly within the 1971 County Borough definitions (though excluding the peripheral parts of them). Sixteen wards are involved in Leeds and nineteen in Bradford.

To examine the role of scale in the measurement of ethnic patterns, studies (analyses L4 and L7) were carried out at enumeration district scale for the whole metropolitan district in Leeds, though the two sets of enumeration districts are not comparable. In Bradford, the analyses (numbers B4 and B7) were carried out using areal units comparable at the 1971 and 1981 Censuses called census tracts for the "ethnic area" of Bradford. Census tracts are lowest common denominator aggregations, defined by OPCS, of 1981 and 1971 enumeration districts. A majority of census tracts consist of one 1981 enumeration district and one 1971 enumeration district. Of the rest most tracts comprise from 2 to 6 enumeration districts from each census, and a very few consist of more than 6.

Finally, two additional analyses (numbers GL1 and GL2) of ethnic groups in Greater London at the Borough scale were carried out to ascertain how far the two West Yorkshire cities depart from those of the national capital, the city of highest concentration of most minority ethnic groups.



BRADFORD WARDS

B1 Baildon
B2 Bingley
B3 Bingley Rural
B4 Bolton
B5 Bowling
B6 Bradford Moor
B7 Clayton
B8 Craven
B9 Eccleshill
B10 Great Horton
B11 Heaton
B12 Idle
B13 Ilkley
B14 Keighley North
B15 Keighley South
B16 Keighley West
B17 Little Horton
B18 Odsal
B19 Queensbury
B20 Rombalds
B21 Shipley East
B22 Shipley West
B23 Thornton
B24 Toller
B25 Tong
B26 Undercliffe
B27 University
B28 Wibsey
B29 Worth Valley
B30 Wyke

METROPOLITAN DISTRICT BOUNDARY

WARD BOUNDARY

ETHNIC AREA

LEEDS WARDS

L1 Aireborough
L2 Armley
L3 Barwick & Kippax
L4 Beeston
L5 Bramley
L6 Burmantofts
L7 Chapel Allerton
L8 City & Holbeck
L9 Cookridge
L10 Garforth & Swillington
L11 Halton
L12 Harehills
L13 Headingley
L14 Horsforth
L15 Hunslet
L16 Kirkstall
L17 Middleton
L18 Moortown
L19 Morley North
L20 Morley South
L21 North
L22 Otley & Wharfedale
L23 Pudsey North
L24 Pudsey South
L25 Richmond Hill
L26 Rothwell
L27 Roundhay
L28 Seacroft
L29 University
L30 Weetwood
L31 Wetherby
L32 Whinmoor
L33 Wortley

Figure 2. The Leeds and Bradford study areas.

4. THE INFLUENCE OF ZONE SIZE, GROUP SIZE AND STUDY AREA ON RESIDENTIAL PATTERN MEASURES

4.1 The Leeds ward pattern, Census 1981

In a previous paper (Birkin and Rees, 1982) the ethnic residential patterns of Leeds were described. Using the index of "residential segregation" (the index of dissimilarity between a group and the rest of the population) and the index of "spatial assimilation" (the index of dissimilarity between a group and the host population) the country of birth groups were ranked and grouped into four ethnic families with similar degrees of spatial concentration. The map patterns of each group were displayed. Table 8 lists the ethnic groups in the order of the Leeds ward analysis and the third column of the table shows the indices of residential segregation. The ordering of the groups appears to reflect the cultural distance between the group and the English. The wide spread of index values and the variety of patterns displayed on the associated maps for groups which are members of the New Commonwealth and Pakistan set showed that, although many of these groups are spatially concentrated in the inner city, their patterns within it are quite different. We will use this Leeds 1981 ward pattern as the standard against which to compare our other results.

4.2 The influence of zone size

The other columns of Table 8 and those of the equivalent Table 9 for Bradford show the effect of the number of zones and their size on the measurement of residential segregation. The more numerous the zones and the smaller the zone size, the larger the index of dissimilarity for the groups. For example, consider persons born in Wales. When we divide the Leeds Metropolitan District into two parts - the inner sixteen wards and the outer seventeen - the Welsh born and the remainder of the population have almost identical distributions (an index of dissimilarity value of 1). At the ward scale this value has climbed to 16, and at the enumeration district level to 37. For Bradford, the two zone index is larger at 12 and only climbs to 14 at the ward scale; when the inner wards only are considered it falls to 11 but climbs to 33 when the 432 Census tracts are used.

It is clear that, if we wish to compare ethnic residential patterns in one city with those in another, we can only do so at the same spatial scale. Very often, however, this is not possible. Can we still compare the ordering of the groups and their relative distance apart on the index of dissimilarity scale even though a comparison of absolute levels would be biased? To answer this question we investigate the degree to which results at one scale can be predicted from another. In Figure 3 are plotted for Bradford and Leeds the indices of residential segregation for wards and the smaller areal units used in each city analysis - census tracts in Bradford, enumeration districts in Leeds.

All index values on the graph are located above the line of equality, and the correlation coefficients are fairly high at 0.83 for Bradford and 0.79 for Leeds. The slope of the regression lines of smaller scale indices against larger scale ones are, at 1.01 and 0.92, fairly close to unity. Thus, the main effect of moving from the ward scale to the census

TABLE 8. Indices of dissimilarity for country of birth groups at various spatial scales, Leeds, 1981

Country of birth	Number in group	Index of dissimilarity versus Rest of the population			
		Metropolitan District			"Ethnic area"
		City, Suburbs (2)	Wards (33)	EDs (1565)	Wards (16)
		L1	L2	L4	L3
	(1)	(2)	(3)	(4)	(5)
HOST GROUP					
England	642,205	23.9	26.9	32.5	24.6
ETHNIC FAMILY I					
Scotland	11,195	7.8	12.5	26.9	9.4
Old Comm.	1,173	3.4	15.8	55.1	15.7
Other EEC	3,303	7.8	15.8	37.1	17.4
Wales	3,315	1.1	16.1	36.8	15.9
Rest of UK	3,527	16.4	17.8	40.1	8.7
ETHNIC FAMILY II					
NC Med.	559	7.1	21.7	75.5	24.6
Irish Republic	7,562	26.8	28.5	36.9	16.2
Rest of Europe	3,073	21.0	33.7	49.4	34.9
Rest of World	4,040	22.4	34.6	49.9	30.8
NC Far East	1,490	28.4	38.9	68.2	40.5
ETHNIC FAMILY III					
NC East Africa	1,818	35.2	43.1	71.3	32.3
NC India	4,632	34.2	44.0	62.1	36.2
NC Rest of NC	181	22.1	44.9	94.2	43.9
NC Rest of Af.	777	33.8	45.1	78.6	42.7
ETHNIC FAMILY IV					
NC Caribbean	3,889	47.2	61.4	71.9	54.0
Pakistan	3,329	46.9	63.0	80.3	43.6
NC Bangladesh	639	50.2	75.7	94.9	61.8

Notes:
1. NC = New Commonwealth = Commonwealth minus Australia, Canada and New Zealand.
2. (33) = number of areal units in analysis.
3. L4 = analysis number (see Table 7 for the full list).
4. (1) to (5) = column number.
5. Correlation coefficients:
   18 groups L1 vs L2 = 0.94; L2 vs L4 = 0.79; L1 vs L4 = 0.61; L2 vs L3 = 0.94
   13 groups L1 vs L2 = 0.96; L2 vs L4 = 0.92; L1 vs L4 = 0.85.

TABLE 9. Indices of dissimilarity for country of birth groups at various spatial scales, Bradford, 1981

Country of birth	Number in group	Index of dissimilarity versus Rest of the population			
		Metropolitan City, Suburbs (2) B1	District Wards (30) B2	"Ethnic area" Wards (19) B3	CTs (16) B4
	(1)	(2)	(3)	(4)	(5)
HOST GROUP					
England	399,837	15.3	34.4	34.8	44.3
ETHNIC FAMILY I					
Scotland	5,523	7.9	11.8	9.1	23.9
Old Comm.	749	11.7	16.8	12.7	47.1
Other EEC	2,625	1.0	15.3	15.0	31.7
Wales	1,870	12.0	14.1	10.5	33.1
Rest of UK	1,972	1.7	15.1	11.4	32.3
ETHNIC FAMILY II					
NC Med.	371	0.1	19.2	18.1	64.1
Irish Republic	3,715	4.1	14.6	11.4	27.4
Rest of Europe	3,593	14.1	24.8	23.3	36.3
Rest of World	3,856	10.7	26.0	23.9	38.2
NC Far East	718	12.9	27.2	28.6	58.8
ETHNIC FAMILY III					
NC East Africa	1,733	26.3	50.8	43.8	61.8
NC India	6,379	30.2	53.2	42.3	57.1
NC Rest of NC	99	8.5	48.3	42.0	86.9
NC Rest of Af.	368	9.0	34.1	38.1	73.9
ETHNIC FAMILY IV					
NC Caribbean	1,810	28.8	40.7	30.7	48.6
Pakistan	17,667	23.8	60.6	54.2	71.2
NC Bangladesh	1,307	2.2	68.8	64.1	86.1

Notes:
1. NC = New Commonwealth
2. (30) = number of areal units.
3. B3 = analysis number (see Table 7 for the full list).
4. (1)-(5) = column numbers.
5. Correlation coefficients:
   16 groups B1 vs B2 = 0.50; B3 vs B4 = 0.83; B2 vs B3 = 0.98
   13 groups B1 vs B2 = 0.89; B3 vs B4 = 0.98.

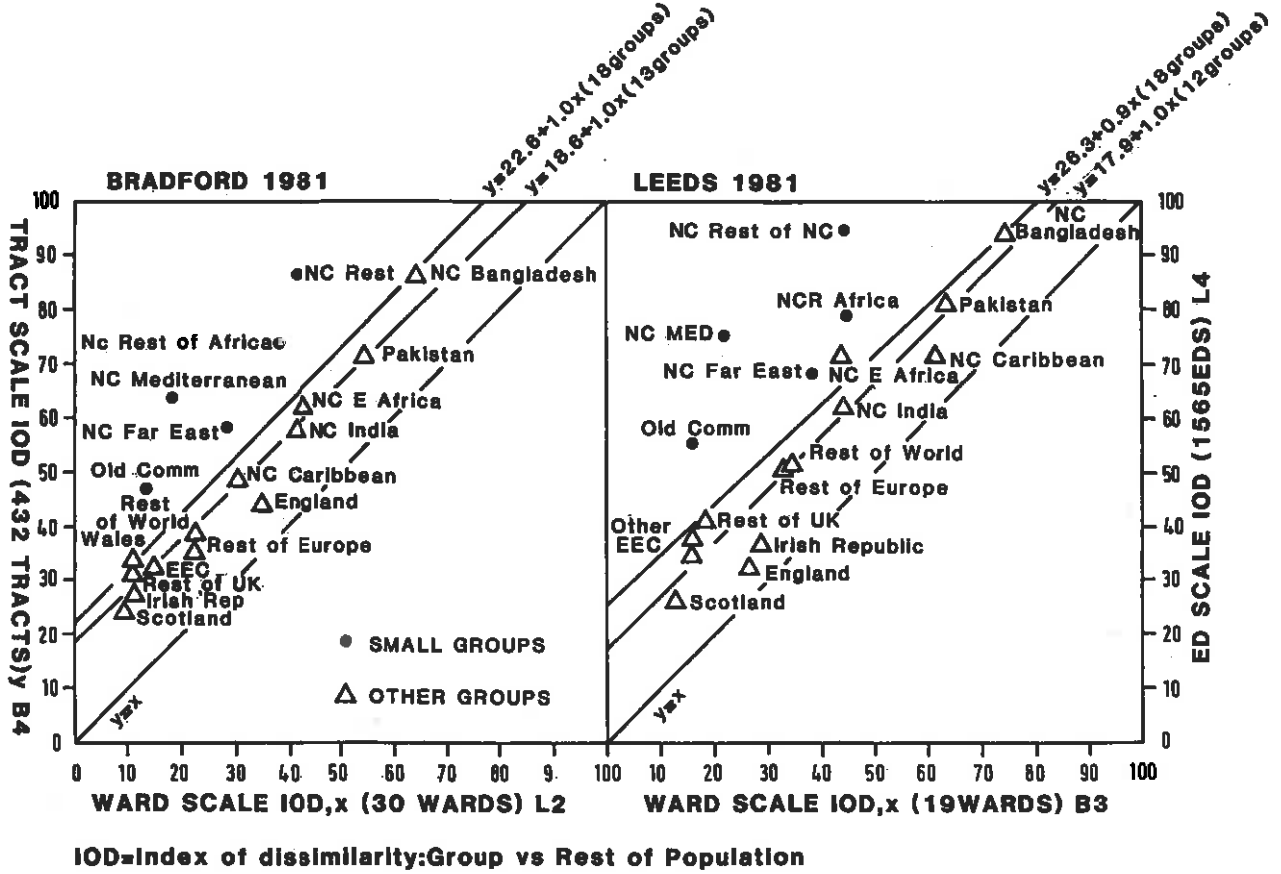


FIGURE 3. The effect of scale on the measurement of residential segregation

tract or enumeration district scale is to add a constant, 23 in Bradford and 26 in Leeds, to the index of dissimilarity values.

4.3 The effect of group size

There are, however, a number of country of birth goups that depart substantially from the average relationship and lie well above the regression line. These are all groups small in number: those born in the Old Commonwealth, NC Mediterranean, NC Far East, NC Rest and NC Rest of Africa. If we abstract the indices for these groups from the calculation of scale effects, the fit improves substantially - from 0.79 to 0.92 in Leeds and from 0.83 to 0.98 in Bradford - and the slope of the line remains near unity.

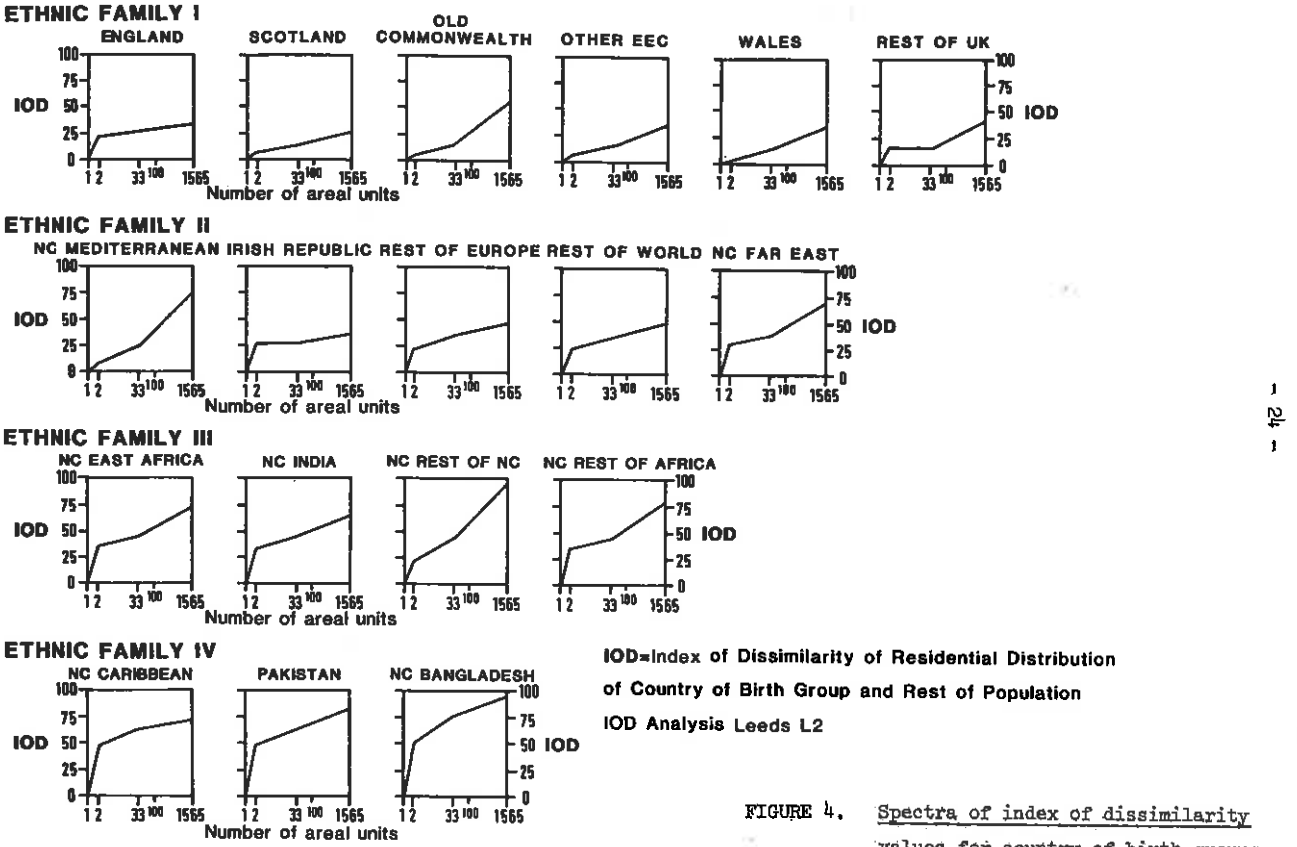
Clearly, we cannot meaningfully measure residential segregation of small ethnic groups using very fine zones, such as Census tracts or enumeration districts. Put very simply, if you have too many zones, small populations cannot be spread evenly across the zones because there are not enough people available. The index of dissimilarity will have a minimum value well above zero. And because people live together in families group sizes in terms of numbers of households are smaller than the numbers listed in column (1) of Tables 8 and 9 suggest. Average household sizes range from about 2.5 to 5.5, depending on the country of birth group. If we assume an average of 4 persons per household then in Leeds the Rest of the New Commonwealth group (the smallest) consists of only 45 households. Even with one household per enumeration district, we will be left with 1565 less 45 or 1520 zones empty of the group. Hence the very high index value of 94 for this group in the fourth column of Table 8.

On this criterion, that there be at least as many households as zones before we can contemplate measurement of residential patterns, only two groups - the English born and the Scots born - can be compared at enumeration district scale. At ward scale all groups can be included, and we can, if we eliminate the smallest group, use a zone system of up to about 100 units without violating this criterion for Leeds. The same arguments apply to census tracts in Bradford, although in this case two groups, NC Rest and NC Mediterranean, would have to be excluded from the analysis. Aggregation of the two groups would not be a feasible solution, since at ward scale they display very different patterns.

4.4 Spectra of indices of dissimilarity

Although we have seen that, eliminating the effect of group size, there is broad agreement between the different scales in the level of residential segregation from the rest of the population of the various ethnic groups, there are nevertheless interesting differences in the scales at which dissimilarity is accumulated. This can be seen clearly if we plot for Leeds the indices against the logarithm of the number of units used in the measurement of the indices (Figure 4).

For some groups the level of segregation at the two zone level is a very high percentage of that at ward level. For the Northern Irish (Rest of UK born), the Southern Irish (Irish Republic born), East African, Indian, West Indian and Pakistani groups the residential segregation at city/suburb scale is 75 per cent or more of that at ward scale. These



IOD=Index of Dissimilarity of Residential Distribution of Country of Birth Group and Rest of Population

IOD Analysis Leeds L2

FIGURE 4. Spectra of index of dissimilarity values for country of birth groups, Leeds 1981

groups are under-represented to a significant degree in the outer wards. By contrast the Welsh and Old Commonwealth population is over-represented in the outer suburbs and relatively little of their residential segregation is shown at the city/suburb scale.

4.5 The effect of study area

When we confine attention to inner wards of Leeds and Bradford, containing 46 and 56 per cent of their metropolitan district populations, we obtain a new set of measures of the residential segregation of country of birth groups (Table 8, column (5); Table 9, column (4)). The results for the whole metropolitan district and those for the "ethnic area" are compared graphically in Figure 5.

On average choosing the inner wards as study area reduces the level of residential segregation measured: the slopes of the regression lines are below unity at 0.9 (Leeds) and 0.8 (Bradford). This is particularly the case for the main New Commonwealth and Pakistan groups: the Bangladeshi, West Indian, Pakistani, Indian and East African in both cities. Thus, the inner wards are characterized by a greater degree of residential mixing of the different ethnic groups, when compared with the metropolitan districts as a whole.

When we later compare the Leeds and Bradford patterns with those of Greater London, we use the "ethnic area" results as this is what Greater London is in relation to the wider London metropolitan region.

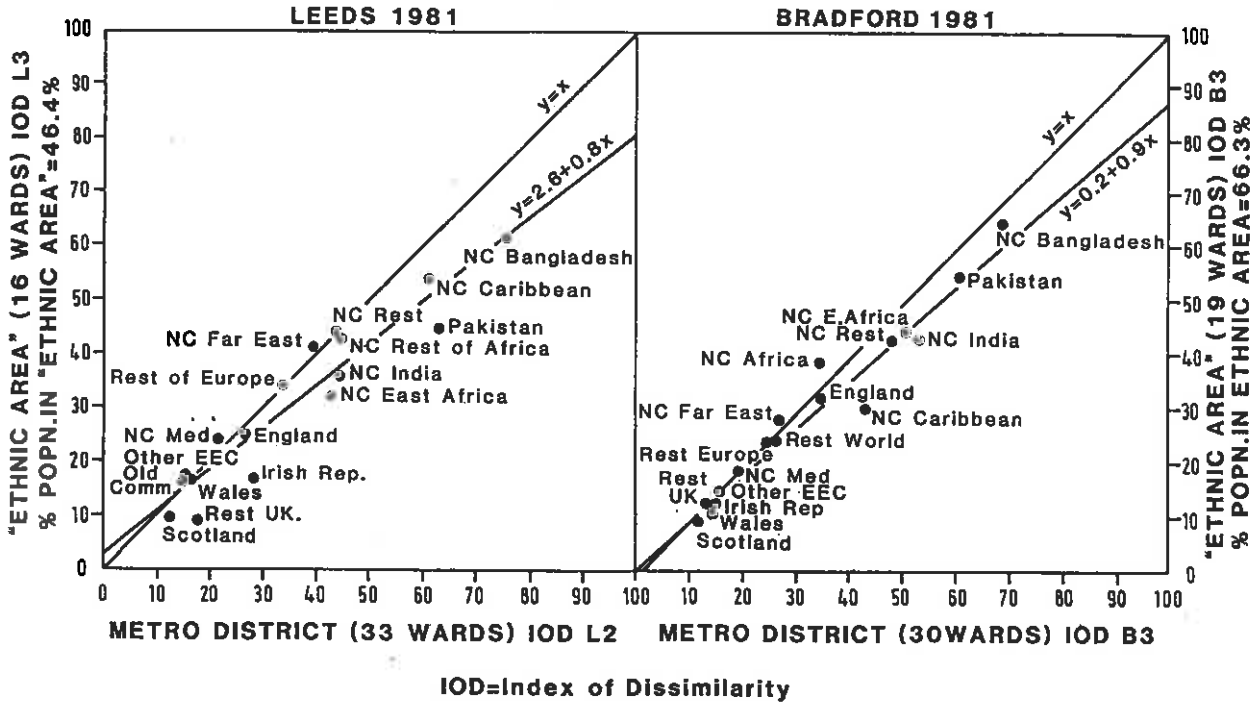


FIGURE 5. The effect of study area on the measurement of residential segregation

5. A COMPARISON OF ETHNIC PATTERNS AT TWO TIME POINTS AND IN THREE CITIES

We are now in a position to compare the levels of ethnic segregation at Census 1981 with those at the previous Census in 1971. We will concentrate attention on the ward level analysis for the inner wards, and the relevant indices of dissimilarity have been assembled in Table 10. The extra difficulty that presents itself in these comparisons is that the definition of country of birth group differs between the two censuses, and, in 1971, between cities. Thus, the number of strictly comparable ethnic groups across all the studies reported in Table 10 is reduced from the eighteen available in the 1981 Census and the fifteen available in the 1971 Census to only eight, although another three have some measure of comparability. We examine the comparable groups in turn.

5.1 The English born

The English born are most segregated in Bradford and least residentially separate in London. Leeds falls in between. The shift over the 1971-81 decade has been to lower levels of residential segregation (Table 11 shows the changes in indices). However, we should treat this result with caution since the discussion of section 2 suggested that this was the group for which SAS Table 4 statistics were most unsatisfactory. It could be that what these decreases merely reflect is the addition of English born children in the residential areas where immigrants live, thus reducing the apparent levels of residential dissimilarity. This process also affects the individual non-English groups, but to a relatively lesser degree.

5.2 The Scots born

On average, the Scots born are the most residentially assimilated of any group in the three cities. They are found in all wards or boroughs but concentrate highly in none. In Leeds and in London the level of residential segregation fell over the 1971-81 decade.

5.3 The Canadian, Australian and New Zealand born

The position of the Old Commonwealth group differs markedly from the two West Yorkshire cities in London. If the analysis had been confined to London, their level of residential segregation would have assigned them to Ethnic Family II (groups with a low moderate level of segregation). In the larger milieu of London these groups probably take on a more "ethnically" distinct identity. The levels of residential segregation for Old Commonwealth born fell in all three cities over the 1971-81 period.

5.4 The Welsh born

The Welsh born exhibit low levels of residential segregation, though consistently higher than the Scots born. An earlier Leeds analysis (Birkin and Rees, 1982, section 6) revealed that this was because they are more concentrated in the more affluent northern suburbs than the Scots. In Leeds and Bradford their segregation increases marginally between 1971 and 1981 - the only group to register an increase in a majority the three cities.

TABLE 10. A comparison of levels of residential segregation in 1971 and 1981

Country of birth 1981 definition	Leeds "Ethnic area" (16 wards)		Bradford "Ethnic area" (19 wards)		London GLC area (33 boroughs)		Country of birth 1971 definition
	1981 L3 (1)	1971 L6 (2)	1981 B3 (3)	1971 B6 (4)	1981 GL1 (5)	1971 GL2 (6)	
HOST GROUP							
England	24.6	28.8	34.8	36.0	23.8	25.7	England
ETHNIC FAMILY I							
Scotland	9.4	10.8	9.1	9.1	10.9	11.6	Scotland
Old Com.	15.7	22.5	12.7	14.2	25.6	28.1	Old Com.
Other EEC	17.4		15.0		24.4		
Wales	15.9	15.8	10.5	9.7	13.1	14.9	Wales
Rest of UK	8.7	13.7	11.4	10.7	13.0	14.5	Rest of UK
ETHNIC FAMILY II							
NC Med.	24.6		18.1		38.3	45.4	NC Med.
Irish Rep.	16.2	19.9	11.4	14.1	22.3	21.6	Irish Rep.
Rest of Eur.	34.9		23.3		33.7	29.6	Europe
						45.1	America
Rest of World	30.8	32.2	23.9	25.3	30.9	27.6	Other
NC Far East	40.5	35.9	28.6	29.6	22.2		NC Far East
ETHNIC FAMILY III							
NC E.Africa	32.3	48.4	43.8	50.1	35.3	28.0	NC Africa
NC India	36.2	50.8	42.3	53.7	31.4	23.2	NC India
NC Rest of NC	43.9	31.3	42.0	22.8	21.9		NC Rest
NC Rest of Af	42.7		38.1		31.7		
ETHNIC FAMILY IV							
NC Caribbean	54.0	61.7	30.7	43.5	37.5	37.7	NC America
Pakistan	43.6	49.6	54.2	59.0	35.3	29.9	NC Pakistan
NC Bangladesh	61.8		64.1		50.3		
		54.0		64.4			NC Ceylon
		32.9		23.6			Not stated

Notes:
1. NC = New Commonwealth.
2. L3 = analysis number (see Table 7 for full list).
3. (1)-(6) = column numbers.

TABLE 11. Changes in levels of residential segregation between 1971 and 1981

Comparable country of group	Change in the index of dissimilarity value: IOD 1981 minus IOD 1971		
	Leeds	Bradford	London
England	-4.2	-1.2	-1.9
Scotland	-1.4	0.0	-0.7
Old Commonwealth	-6.8	-1.5	-2.5
Wales	+0.1	+0.8	-1.8
Rest of UK	-5.0	+0.7	-1.5
Irish Republic	-3.7	-2.7	+0.7
NC India	-14.6	-11.4	+8.2
NC Caribbean	-7.7	-12.8	-0.2
NC East Africa	-16.1	-6.3	+7.3
Pakistan	-6.0	-4.8	+5.4

Source: Computed from Table 10.

5.5 The Northern Irish born

The Northern Irish born exhibit similar levels of residential dissimilarity to the previous two groups with falls over 1971-81 in Leeds and London but not in Bradford. Their closest residential affiliation is with the Southern Irish (Irish Republic born).

5.6 The Southern Irish born

The position of the Eire born differs between the two West Yorkshire cities and London. In Leeds and Bradford their index of dissimilarity with the rest of the population has fallen to a level where the group might be reclassified as a member of Ethnic Family I (low levels of residential segregation). However, in London they have remained more residentially distinct and have marginally increased this distinction.

5.7 The Indian born

The Indian born population belongs to Ethnic Family III (high moderate segregation levels) in all three cities but the changes in Leeds and Bradford have been in an opposite direction to those in London. Between 1971 and 1981 the index of dissimilarity fell nearly 15 points in Leeds and 11 points in Bradford, evidence of considerable residential change and diffusion. In London, on the other hand levels of residential dissimilarity have increased for this group, although the level is lower than in Leeds and Bradford.

5.8 The West Indian born

The London level of residential segregation of the West Indian born has remained static over the 1971-1981 decade, whereas in the two West Yorkshire cities it has declined substantially. It remains substantially higher in Leeds than in the other two cities.

5.9 The East African born

Although no figures were available in the 1971 Census for the East African born it is probable that a majority of the born in Africa group were of Asian origin, born in East Africa. The levels of segregation and their changes are very similar to those of the Indian born, to whom they have close family or cultural ties. Again the trends in Leeds and Bradford are opposite in direction to those in London.

5.10 The Pakistani born

Between the 1971 and 1981 censuses the New Commonwealth country of Pakistan became the non-Commonwealth republic of Pakistan and the Commonwealth state of Bangladesh. Although West Pakistanis made up a majority of the 1971 Pakistani group, we should be cautious in interpreting the patterns of changes (similar again to those for Indians and East African Asians) in the last line of Table 10. They could be merely the result of group partition over the 1971-81 decade.

6. CONCLUSIONS

To study the spatial patterns of ethnic groups in British cities using Census data sounds a relatively straightforward task of geographic analysis. This paper refutes that view. The available statistics pose difficult problems and suggest that better statistics should be sought or should be estimated than those currently available in the small area statistics. There is a need to explore the influence of scale of observation unit on residential pattern measures further and to design new zones, smaller than wards but much larger than census tracts or enumeration districts for the study of ethnic patterns.

Abstracting from all these problems it does appear from our results that the ethnic patterns in the British cities studied are very similar but that Leeds and Bradford appear to be moving in a different direction from that taken by London over the 1971-81 period. Whereas in the West Yorkshire cities the spatial segregation of most ethnic groups is decreasing, in London, for many groups, the residential mosaic is becoming more polarized. The more detailed investigation of such trends using the landmarks defined in this paper is the next research task.

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