RESIDENTIAL DIFFERENTIATION AND DISADVANTAGED URBAN RESIDENTS:

approaches towards the study of socio-spatial environments in the city of Bradford

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Chapter 10

Cluster Analysis as Areal Classification

CLUSTER ANALYSIS AS AREAL CLASSIFICATION

The areal classification of all 632 enumeration districts is undertaken for 37 variables using a dual clustering algorithm. The dual mode is composed of iterative relocation (non-hierarchical) and step-wise fusion (hierarchical) that together retain the largest possible share of original data variance concomitant with the increased level of generalisation.

Iterative relocation assigns ED's to clusters on the optimisation of a specified criterion (e.g. variance maximisation within clusters) so that each cluster is mutually exclusive. In step-wise fusion ED's with the shortest linear distance between them are fused together to form a dendrogram. The step-wise algorithm by minimising the error sum of squares criterion pairs those ED's which result in the least loss of variance. Because the fusion of enumeration units is proportional to their distance apart and their mass the incremental loss of variance rapidly increases as the clusters develop. The fusion is halted if differences between two points is too large and therefore the loss of variance too great. Further details of both techniques are given in Appendix B.

The cluster analysis reuses the 632 non-institutional ED's for the city of Bradford. All data is extracted from the 1971 census library of small area statistics and is therefore subject to the same caveats mentioned

CLUSTER ANALYSIS : DATA CHARACTERISTICS

VARIABLES	MEAN	STANDARD DEVIATION	ENUMERATION DISTRICTS MINIMUM	NO.	MAXIMUM	NO.	COEFFICIENT OF VARIATION
Distance CBD	3149.413	1466.837	University 01	527	Allerton 45	10	0.466
Aged 0-14	2599.824	667.899	Wyke 01	599	Little Horton 45	336	0.257
Aged 15-24	1524.016	397.505	Allerton 19	37	Bolton 37	63	0.261
Aged 25-44	2282.835	515.535	Wyke 19	617	Manningham 41	400	0.226
Aged 45-59	2525.150	627.630	Little Horton 45	336	Bradford Moor 50	126	0.249
Aged 60+	1091.390	579.192	Little Horton 45	336	Allerton 19	37	0.531
Fertility Ratio	3913.463	1009.226	Great Horton 24	189	Laisterdyke 30	305	0.258
Single Persons	4143.598	1614.283	Wyke 18	616	Great Horton 52	216	0.390
Born Outside GB	1193.367	1556.183	Wyke 16	614	University 20	546	1.304
Ireland	150.664	115.233	Wyke 16	614	University 18	544	0.765
Asians	573.589	1243.214	Wyke 49	632	University 20	546	2.167
Other Europeans	161.027	196.274	Wyke 22	620	Wyke 16	614	1.219
Migrants 5 years	3521.609	1709.464	Odsal 39	425	Little Horton 32	325	0.485
Activity Rate	6452.391	688.219	Wyke 16	614	University 10	536	0.107
Unemployed	584.429	591.218	Wibsey 12	582	Wyke 16	614	1.012
Fem. Act. Ratio	4751.266	789.223	Wyke 16	614	University 19	545	0.166
Industry/Const.	4765.504	1434.168	University 10	536	Little Horton 07	344	0.301
Distribution/S	3884.169	1651.057	Wyke 16	614	Thornton 27	443	0.425
Employers/Man.	675.841	725.499	Wyke 31	629	Wibsey 08	578	1.073
Professionals	178.524	344.264	Wyke 32	630	Wyke 16	614	1.928
Intermediate	2247.626	1262.807	Wibsey 08	578	Bolton 26	52	0.561
Skilled Manual	2704.611	1029.219	Wyke 19	617	Wyke 08	606	0.381
Unskilled	4212.156	1757.695	Wyke 19	617	University 10	536	0.417
ONC A Level	555.744	642.503	Wyke 31	629	Little Horton 02	339	1.156
No Car	6503.473	1938.806	Wyke 16	614	Little Horton 17	354	0.298
Bus to Work	3639.012	1362.957	University 19	545	Eccleshill 46	170	0.375
Walk to Work	1563.015	1048.941	Wyke 19	617	University 11	537	0.671
Car to Work	2297.109	1720.296	Wibsey 08	578	Wyke 16	614	0.749
Owner-Occupied	5760.875	3460.563	University 16	542	Wibsey 13	583	0.601
Council Housing	2680.019	3830.562	Wyke 49	632	Little Horton 33	326	1.429
Private Furnish	390.702	1087.942	Wyke 32	630	Bolton 37	63	2.785
One Person Hshlds	2070.475	1041.705	Eccleshill 35	159	University 16	542	0.503
One Pensioner	1330.120	727.521	Wyke 26	624	Little Horton 16	353	0.547
Overcrowded	339.911	503.496	Wyke 49	632	Bolton 36	62	1.481
Shared Dwellings	217.212	739.469	Wyke 49	632	Little Horton 28	321	3.404
No Inside WC	1950.731	2304.245	Wyke 31	629	University 10	536	1.181
No Bath	1330.835	1753.273	Wyke 31	629	University 13	539	1.317

Values Expressed per 10000 Population at risk. Note: Wyke 16 is the anomaly.

Fg. 33

for the factor analysis. Details of the variables used, their means, standard deviations, maximum and minimum areas are given in Figure 33.

The sixfold differentiation could be either increased or decreased depending upon where the cut-off point is drawn. The dendrogram (Fig. 87) for the fusion of clusters in the second stage classification shows that a four-fold division may provide the more optimal solution but this would result in the merging of Group B with Group C. Although spatially contiguous it was considered desirable at this stage to isolate what were really representations of very different housing markets occupied by people in varying stages of the life cycle. The former is characterised by shared, generally substandard rented dwellings, inhabited by a mix of age groups and polar social classes whilst the zone in transition proper is consistently defined by young working class families in substandard accommodation and associated high Asian occupancy who prefer to own their homes.

Conversely a sevenfold division would give the existing six groups with the addition of a splinter cluster characterised by the most affluent areas of the city (cluster 17). This was not considered to add anything of descriptive value particularly since the fusion process between clusters 14 to 18 is confined to a limited range of loss in explained variance. The six-fold solution therefore contributes to a 14% loss in variance from the cluster stage (see Fig. 87).

The share of the total original variance for the six groups is 32.63%.

As with factor loadings there is no objective means for identifying a threshold cluster score. In the table of mean standardised scores for the groups (Fig. 35) all positive values indicate that the variable is of some importance, the higher the score the more important the variable. Full interpretation of the clusters and groups is made by comparing the mean standardised scores with the ratio scores (really location quotients) since the latter indicate an above average incidence in each level of resolution where the score is greater than unity.

As might be expected the two scores correspond closely with negative mean standardised scores having location quotients less than one. The decision to establish a threshold value of one, though arbitrary, is made in the absence of any alternative procedure.

Six groups are distinguished from the dual mode cluster analysis that broadly differentiate between aggregates of ED's in terms of their spatially referenced social dissimilarities. Each of the groups may roughly be described as social areas:

A) associated by their late stage in the life cycle, particularly of retired persons, some of whom occupy inner city local authority housing

B) of skilled manual workers in middle age who generally own their property

C) of peripheral council estates constituted by young couples in the early child rearing stage of the life cycle

D) of bed-sit characteristics such as shared dwellings

and young single adults

E) defining an inner city belt of high Asian occupancy

F) defining the high status outer zone of owner occupiers

FIG. 34

SIZES OF THE GROUPS

GROUP	CLUSTERS	% OF ED's	% OF POPULATION
A	1, 2, 3, 4, 5	28.01	24.00
B	6, 7	13.61	13.64
C	8, 9	12.34	15.89
D	10	3.17	2.54
E	11, 12, 13	15.03	13.53
F	14, 15, 16, 17, 18	27.85	30.39

Group D, the bed-sit area, is significantly smaller than the other groups containing only 2.54% of the city population and 3.17% of the ED's. The largest is group F, with 30.4% of the population and nearly 28% of the ED's. The figures do illustrate the relative imbalance of social classes in Bradford towards groups IV and V (69% of heads of households are thus classified) and of the balance of tenures (26.8% of households rent from the local authority compared with a national average of about 31%). Similarly, the second largest group, group A, reflects the large elderly component in the city (11% of the city population is of retiring age,

CHARACTERISTICS OF THE GROUPS. MEAN STANDARDISED SCORES.

Variables		A	B	C	D	E	F
1.	Distance	0.211	-0.296	0.577	-1.143	-1.122	0.259
2.	Children	-0.715	-0.136	1.165	-0.986	0.679	-0.203
3.	Young Adults	-0.332	0.040	0.434	2.709	0.495	-0.430
4.	Mature Adults	-0.805	-0.106	-0.326	0.683	0.244	0.688
5.	Middle-Aged	0.594	0.345	-0.569	-0.623	-0.782	0.074
6.	Retired	1.136	-0.026	-0.819	-0.530	-0.468	-0.204
7.	Fertility Ratio	-0.164	-0.088	1.267	-0.428	0.595	-0.723
9.	Single Adults	0.141	0.345	0.049	1.002	0.045	-0.396
11.	Born Overseas	-0.356	0.019	-0.363	1.882	1.781	-0.488
12.	Irish	0.022	0.160	0.557	1.247	0.121	-0.540
13.	Asian	-0.339	-0.041	-0.420	1.175	1.886	-0.432
14.	Other European	-0.332	0.164	-0.359	2.405	0.491	-0.043
16.	Five-year Movers	0.077	-0.111	-0.068	0.702	0.350	-0.190
19.	Economically Active	-0.782	0.350	0.645	0.030	-0.041	0.139
20.	Unemployed	-0.050	-0.094	0.542	1.387	0.472	-0.528
21.	Females Employed	-0.455	0.553	0.666	-0.543	-1.029	0.267
23.	Industrial Workers	-0.104	0.193	0.244	-0.218	0.758	-0.452
25.	Distribution Workers	0.031	-0.010	-0.465	-0.288	-0.758	0.585
27.	Employers/Managers	-0.227	-0.221	-0.534	-0.186	-0.508	0.800
28.	Professionals	-0.278	-0.156	-0.377	0.428	-0.465	0.658
29.	Non-manual Workers	-0.275	-0.129	-0.338	-0.430	-1.081	0.969
30.	Skilled Manual	0.120	0.343	0.394	-0.813	-0.242	-0.280
31.	Semi & Unskilled	0.266	-0.003	0.279	0.768	1.237	-0.970
32.	Education	-0.356	-0.136	-0.311	0.315	-0.489	0.696
35.	No Car Households	0.509	0.128	0.653	0.794	0.867	-1.253
37.	Bus Commuters	-0.164	-0.058	0.716	0.584	0.435	-0.461
38.	Pedestrian Commuters	0.082	0.602	0.109	-0.248	0.199	-0.460
39.	Car Commuters	-0.306	-0.404	-0.445	-0.760	-0.830	1.089
40.	Owner Occupiers	-0.435	0.447	-1.392	-0.918	0.266	0.829
41.	Council Tenants	0.376	-0.486	1.605	-0.693	-0.583	-0.601
42.	Tenants - Furnished	-0.232	-0.079	-0.347	5.051	0.384	-0.193
43.	One Person Households	0.843	-0.121	-0.742	2.828	0.247	-0.569
44.	Single Pensioner Hshlds	1.180	-0.073	-0.612	-0.648	-0.103	-0. 79
48.	Overcrowding	-0.291	-0.251	0.043	1.894	1.689	-0.590
51.	Shared Dwellings	-0.180	0.080	-0.284	3.555	0.362	-0.203
52.	No WC.	0.106	0.067	-0.641	1.602	1.491	-0.577
54.	No Bath	0.128	-0.015	-0.679	2.490	1.204	-0.484

Fig 35

36% of all people are aged 45 years or more).

Each of the six typal groups is described in greater detail below. Each description is accompanied by a full table of standardised cluster scores. Tables of location quotients for cross-referencing can be found in Appendix B also with cluster scores as percentages of the total distribution. No attempt is made to describe the nature of clusters in detail; brief summaries are given at the end of each group description. Every cluster is, however, mapped according to its combination with other clusters within groups.

GROUP CHARACTERISTICS

GROUP A - Elderly Stage in the Life Cycle

The main characteristic of this group is its large elderly component. Although there is a large proportion of residents in the 49-59 age category the majority are of retiring age or beyond and many live on their own. There is a relative absence of young adults and children and, as might be expected, the fertility ratio is very low. Council housing figures prominently with one and a half times the city average in the group, as is housing substandardness measured on variables 52 and 54. Occupationally many residents in this group fall into the lower social classes, particularly the unskilled and associated with this is the low incidence of car commuting.

The location of this group appears to be extensive and almost random. No overall spatial pattern can be easily discerned at this level because the clusters that contribute

to this group are united predominantly by their common age characteristics rather than any other distinct group of variables. Disaggregation of the group into its cluster components reveals clearer associations between age and life cycle, social class and housing tenure that otherwise tend to be masked at the more general level. Thus for example cluster one (and to a lesser extent cluster two) is strongly associated with council housing and its distribution picks out the parts of council estates of pensioner flats, maisonettes and bungalows, some of which have central locations. Overall, the distribution is not dissimilar from factor II in the previous chapter. That no ward exists without an elderly component is probably attributable to a combination of the historical growth of the city which left pockets of high density terraced housing in old village cores (much of which is now substandard) and the immobility (socially and spatially) of elderly social groups.

Cluster 1.

High Scores: council tenancies, one person pensioner households, recent (5 yr) migrants, lower social classes

Low Scores: owner occupied, mature adults, car commuters, activity rate.

Cluster 2.

High Scores: council tenancies, one person pensioner households, some Irish born, unemployment rate

STANDARDISED CLUSTER SCORES FOR GROUP A

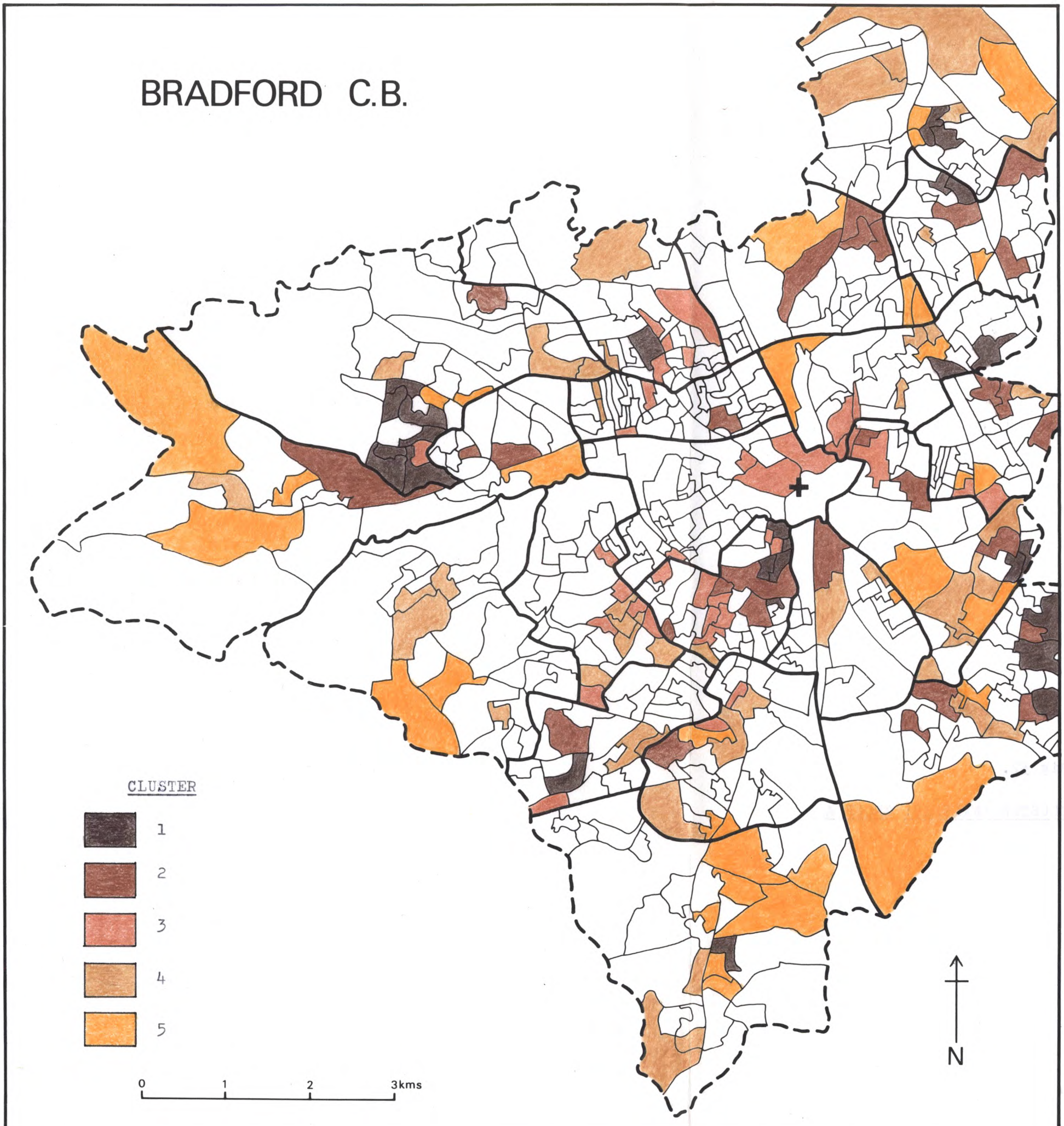
Variables	Cluster				
	1	2	3	4	5
1. Distance	0.361	0.261	-0.862	0.382	0.720
2. Children	-0.416	0.070	-1.509	-1.053	-0.735
3. Young Adults	0.431	-0.289	-0.612	-0.747	-0.292
4. Mature Adults	-0.622	-0.838	-1.223	-0.877	-0.487
5. Middle-Aged	-0.088	0.175	1.152	1.001	0.666
6. Retired	0.720	0.613	2.438	1.383	0.657
7. Fertility Ratio	-0.360	0.695	-0.434	-0.444	-0.346
9. Single Adults	0.244	-0.021	0.563	0.330	-0.363
11. Born Overseas	-0.298	-0.289	-0.107	-0.479	-0.535
12. Irish	0.122	0.785	0.324	-0.561	-0.419
13. Asian	-0.383	-0.341	-0.154	-0.405	-0.374
14. Other European	-0.105	-0.410	0.021	-0.543	-0.483
16. Five-year Movers	1.691	-0.330	0.200	-0.518	-0.254
19. Economically Active	-0.620	-0.592	-1.334	-0.896	-0.521
20. Unemployed	0.055	0.228	0.035	-0.342	-0.150
21. Females Employed	-0.064	-0.343	-0.911	-0.476	-0.504
23. Industrial Workers	-0.187	-0.118	-0.178	-0.442	0.467
25. Distribution Workers	0.145	-0.454	0.096	0.624	-0.338
27. Employers/Managers	-0.408	-0.425	-0.512	0.318	-0.294
28. Professionals	-0.181	-0.365	-0.360	-0.165	-0.341
29. Non-manual Workers	0.144	-0.677	-0.362	-0.133	-0.310
30. Skilled Manual	-0.238	0.070	-0.387	-0.087	1.173
31. Semi & Unskilled	0.229	0.669	0.758	0.032	-0.261
32. Education	-0.044	-0.581	-0.443	-0.301	-0.378
35. No Car Households	0.753	0.833	0.887	0.105	0.128
37. Bus Commuters	0.314	0.058	-0.469	-0.622	0.006
38. Pedestrian Commuters	0.098	0.030	0.182	0.221	-0.132
39. Car Commuters	-0.488	-0.620	-0.772	0.044	0.150
40. Owner Occupiers	-1.499	-1.287	-0.329	0.411	0.274
41. Council Tenants	1.550	1.422	0.172	-0.471	-0.555
42. Tenants -Furnished	-0.335	-0.326	-0.052	-0.229	-0.199
43. One Person Households	0.894	0.421	1.809	0.682	0.639
44. Single Pensioner Hshlds	1.402	0.902	2.113	0.949	0.785
48. Overcrowding	-0.379	-0.205	-0.291	-0.357	-0.227
51. Shared Dwellings	-0.154	-0.275	-0.090	-0.107	-0.267
52. No WC.	-0.791	-0.234	0.701	0.132	0.722
54. No Bath	-0.691	-0.473	0.572	0.174	1.059

Fig. 36

Fig 37.

CLUSTER ANALYSIS: GROUP A

BRADFORD C.B.



Low Scores: owner occupiers, mature adults, car commuters, education

Cluster 3.

High Scores: one person pensioner households, retired persons, middle-aged adults, no car households, housing substandardness

Low Scores: children, mature adults, activity rate, bus commuters

Cluster 5.

High Scores: social class IV, housing substandardness, pensioner households, retired persons

Low Scores: children, mature adults, born overseas, council tenancies.

GROUP B - Skilled Manual Owner Occupiers

There are few marked fluctuations in group scores but those variables with relatively high scores include: owner occupiers, skilled manual workers, pedestrian commuters, female activity rate and shared dwellings. The association of positive scores therefore suggests uniform social spaces of working class families who are owner occupiers mainly. Between the two clusters that comprise this group there are however marked differences. Cluster 6 for example contains a high proportion of overseas born, a higher than average degree of housing substandardness, and more young people (children and young adults). Cluster 7 on the other hand is more typical of the group characteristics with owner occupancy, single adults and a relatively old population

structure. Almost twice as many residents in this cluster walk to work than the city average.

Enumeration districts in this group are distributed in and around the inner city. The most central cluster, 6, is to be found mainly in the east in Undercliffe, the Barkerend Road areas and part-way along Wakefield Road to the south-east. Cluster 7 has a less central location and generally surrounds, particularly in the west, the residential inner city. Together, more than 86% of the ED's in this group are found within a 3km radius of the city centre.

Cluster 6.

High Scores: Irish, females employed, owner occupiers, housing substandardness

Low Scores: distance from CBD, car commuters

Cluster 7.

High Scores: pedestrian commuters, social class IV, single adults, owner occupiers, middle-aged adults

Low Scores: children, overcrowding, bus commuters, unemployed.

GROUP C - Local Authority Housing

Group C is the third largest with 16% of the city population. It is comprised of two clusters that differ mainly by their age and location characteristics. Collectively they form a distinctive council housing social area. A complementary social area, similarly characterised by a high proportion of

STANDARDISED CLUSTER SCORES FOR GROUP B

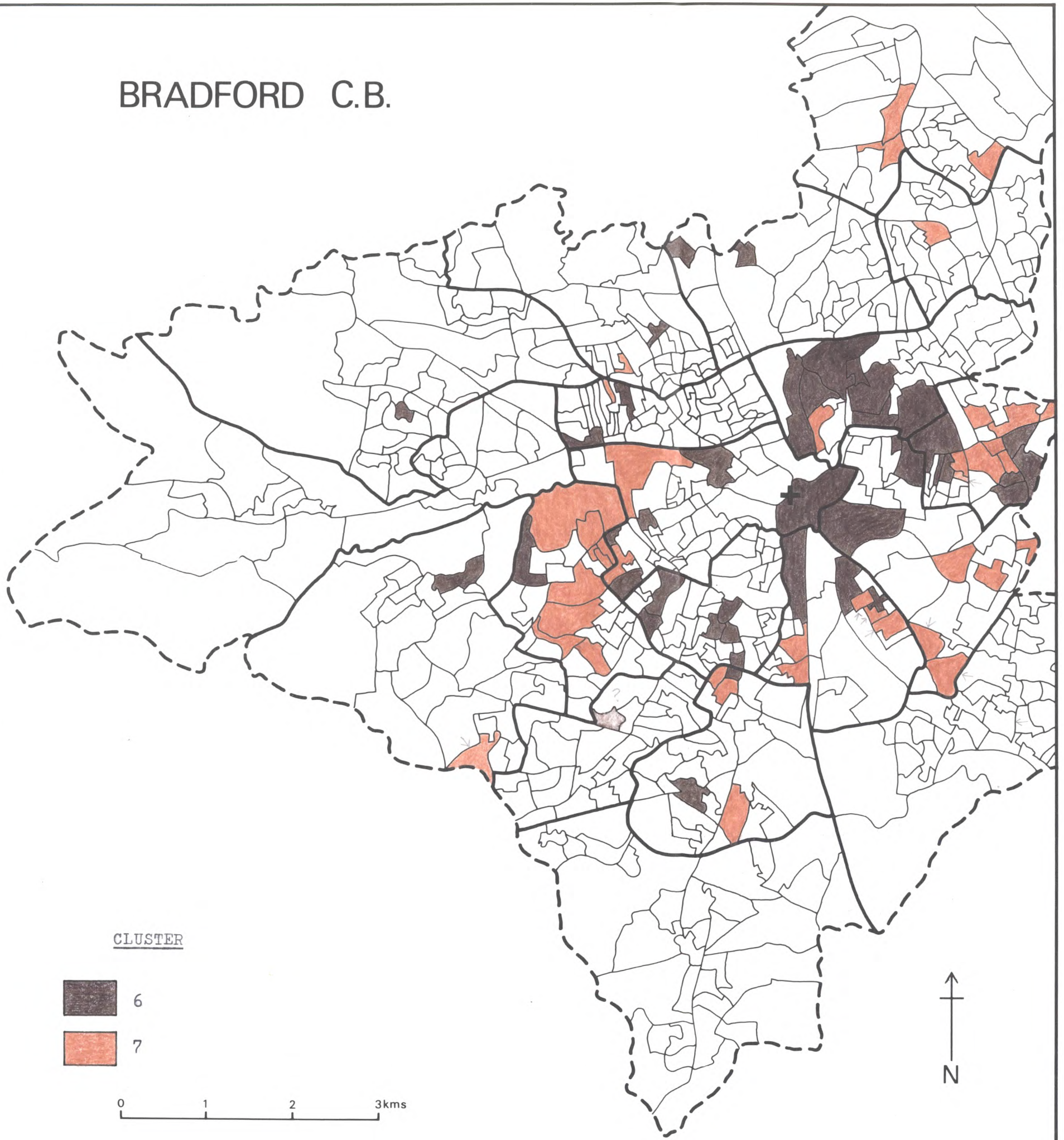
Variables	Cluster	
	6	7
1. Distance	-0.454	-0.127
2. Children	0.073	-0.360
3. Young Adults	0.308	-0.246
4. Mature Adults	-0.096	-0.117
5. Middle-Aged	0.078	0.630
6. Retired	-0.140	0.095
7. Fertility Ratio	0.073	-0.259
9. Single Adults	0.070	0.639
11. Born Overseas	0.331	-0.315
12. Irish	0.627	-0.338
13. Asian	0.225	-0.324
14. Other European	0.343	-0.028
16. Five-year Movers	0.026	-0.256
19. Economically Active	0.385	0.312
20. Unemployed	0.127	-0.330
21. Females Employed	0.559	0.545
23. Industrial Workers	-0.095	0.500
25. Distribution Workers	0.078	-0.103
27. Employers/Managers	-0.223	-0.219
28. Professionals	-0.045	-0.273
29. Non-manual Workers	-0.208	-0.044
30. Skilled Manual	0.104	0.600
31. Semi & Unskilled	0.179	-0.198
32. Education	-0.133	-0.139
35. No Car Households	0.288	-0.043
37. Bus Commuters	0.231	-0.366
38. Pedestrian Commuters	-0.024	1.270
39. Car Commuters	-0.474	-0.329
40. Owner Occupiers	0.351	0.551
41. Council Tenants	-0.453	-0.520
42. Tenants - Furnished	0.084	-0.254
43. One Person Households	-0.013	-0.236
44. Single Pensioner Hshlds.	-0.113	-0.030
48. Overcrowding	-0.071	-0.443
51. Shared Dwellings	0.342	-0.200
52. No WC	0.346	-0.234
54. No Bath	0.189	-0.234

Fig 38

Fig 39.

CLUSTER ANALYSIS: GROUP B

BRADFORD C.B.



STANDARDISED CLUSTER SCORES FOR GROUP C

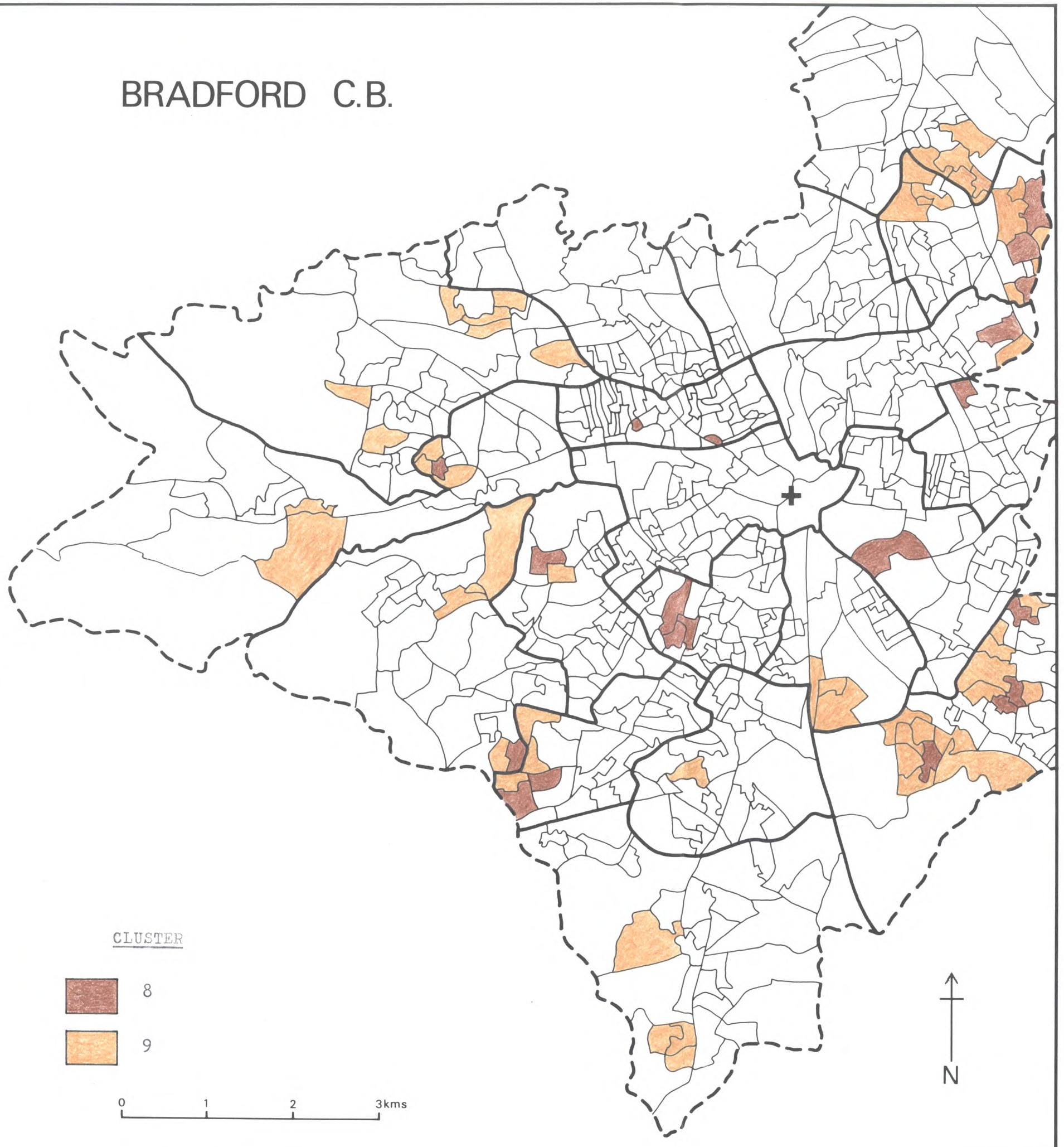
Variables	Clusters	
	8	9
1. Distance	0.283	0.702
2. Children	1.999	0.811
3. Young Adults	0.032	0.604
4. Mature Adults	-0.356	-0.314
5. Middle-Aged	-1.069	-0.356
6. Retired	-0.980	-0.751
7. Fertility Ratio	2.095	0.916
9. Single Adults	0.165	-0.000
11. Born Overseas	-0.032	-0.503
12. Irish	1.241	0.267
13. Asian	-0.367	-0.443
14. Other European	-0.429	-0.329
16. Five-year Movers	-0.140	-0.037
19. Economically Active	0.374	0.760
20. Unemployed	0.813	0.427
21. Females Employed	0.270	0.834
23. Industrial Workers	0.198	0.263
25. Distribution Workers	-0.724	-0.355
27. Employers/Managers	-0.709	-0.460
28. Professionals	-0.470	-0.338
29. Non-manual Workers	-0.341	-0.337
30. Smilled Manual	-0.310	0.693
31. Semi & Unskilled	0.801	0.058
32. Education	-0.490	-0.235
35. No Car Households	0.999	0.507
37. Bus Commuters	0.469	0.821
38. Pedestrian Commuters	0.136	0.097
39. Car Commuters	-0.613	-0.374
40. Owner Occupiers	-1.583	-1.311
41. Council Tenants	1.803	1.521
42. Tenants - Furnished	-0.354	-0.344
43. One Person Households	-0.776	-0.728
44. Single Pensioner Hshlds	-0.652	-0.596
48. Overcrowding	0.553	-0.173
51. Shared Dwellings	-0.268	-0.291
52. No WC	-0.412	-0.738
54. No Bath	-0.706	-0.668

Fig. 40

Fig 41.

CLUSTER ANALYSIS: GROUP C

BRADFORD C.B.



council tenants, is formed by clusters one and two (in group A) but these are differentiated by their elderly age structure. On its own, group C accounts for 52% of all council tenancies.

As well as council tenancies the pattern of group scores indicates high fertility rates, many children, bus commuters and high female and general activity rates (but also some unemployment). Cluster 8 has a particularly high fertility ratio and proportions of children under 14 years. Cluster 9 is very similar but the fertility rate is lower and more of the population is in social class IV. The combinations of variables, particularly those relating to age and household composition indicate young couples in the child bearing stage of the life cycle and a relative absence of elderly people. Some studies, notably Webber's (1976) have suggested that young couples starting families are less able to gain access to public housing vis a vis mature families with school-aged children because of the eligibility criteria which stress dependent children and overcrowding. Although more established families are to be found on all council estates in Bradford, young families appear to have the same chance of securing public sector housing and stage in the life cycle appears not to be a less important factor than personal circumstances.

The social class composition is clearly biased to groups IV and V and accounts for 18% of the city total in each class. Significantly this social area also accounts for 25% of the city's unemployed, the highest rate of any group, and it demonstrates the vulnerability of the lower social

classes. Further work patterns emerge from the commuting measures. Because of the low level of car ownership many residents have to depend on public transport for their journey to work and a higher than average proportion walk to work suggesting local employment.

Cluster 8.

High Scores: fertility ratio, council tenancies, Irish, children, no car

Low Scores: owner occupiers, middle-aged, employers and managers

Cluster 9.

High Scores: council tenancies, fertility ratio, children, bus commuters

Low Scores: owner occupiers, pensioners, one person households, housing substandardness

The distribution of council housing areas in Bradford follows a now routine pattern of essentially peripheral locations for the large post-war estates such as Holme Wood, Eccleshill, Thorpe Edge and Buttershaw, and more central locations such as Canterbury Avenue and White Abbey Road. Figure 24 shows the distribution of the main estates. It should be mentioned that the group map (Fig. 41) does not satisfactorily outline the estates because of the omission of clusters one and two (group A) and because the boundaries between ED's and areas of different tenure are not always coincident. The explanation for the distribution of post-war council estates rests not with the ecological forces of segregation but with the particular

conditions of land ownership in the 19th century city, discussion of which is reserved for Chapter 13.

GROUP D - Bed-Sit Land

The very distinctive Group D is a spatially compact and well defined cluster relating to the bed-sit area of the city. The most diagnostic variables are rented accommodation, shared dwellings, one person households, young adults, housing substandardness and East Europeans. There are sixteen times the city average of private tenancies and thirteen times the proportion of shared dwellings. Whilst it accounts for only 2.5% of the city population, this social area has 38% of all rented accommodation, 33% of shared dwellings and 6% of one person households. The combination of over-represented variables indicates a typical rooming house or bed-sit type of transitional area.

The age structure of the bed-sit area is distinctive for its low proportions of children (the fertility ratio is 11% below the city average) and relatively large groups of young adults, many of whom are probably recent migrants. A large proportion are single and there is a significant correlation with one person households ($r = 0.32$) which would partly explain the low fertility ratio.

This type of area is frequently associated in Britain with the decline of the Victorian merchant classes and the functions of the city change (see Pritchard 1975, Webber 1976). Their former accommodation is always large and spacious allowing for domestic quarters and ample rooms

STANDARDISED CLUSTER SCORES FOR GROUP D

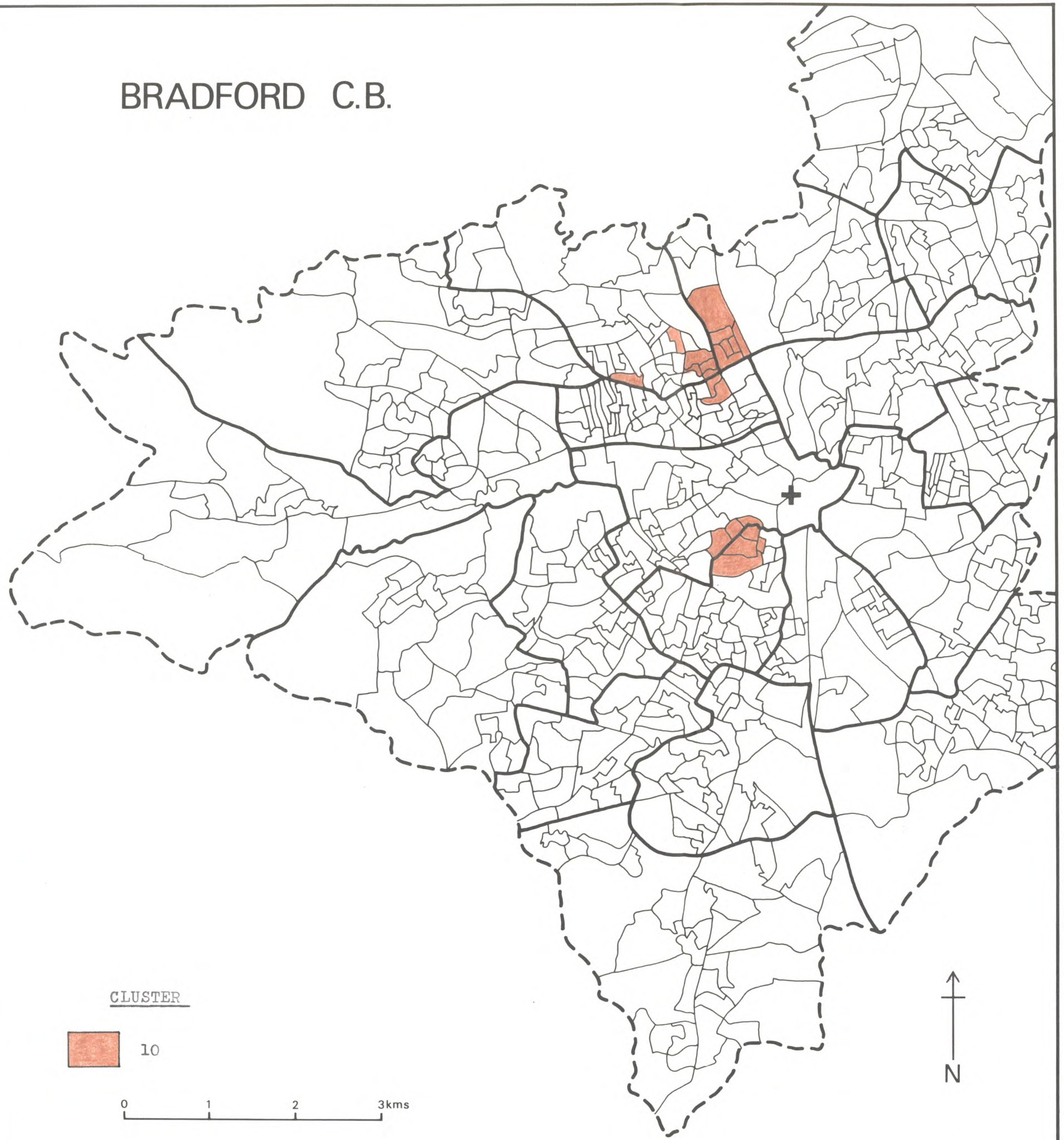
Variables	Cluster
	10
1. Distance	-1.143
2. Children	-0.986
3. Young Adults	2.709
4. Mature Adults	0.683
5. Middle-Aged	-0.623
6. Retired	-0.530
7. Fertility Ratio	-0.428
9. Single Adults	1.002
11. Born Overseas	1.882
12. Irish	1.247
13. Asian	1.175
14. Other European	2.405
16. Five-year Movers	0.702
19. Economically Active	0.030
20. Unemployed	1.387
21. Females Employed	-0.543
23. Industrial Workers	-0.218
25. Distribution Workers	-0.288
27. Employers/Managers	-0.186
28. Professionals	0.428
29. Non-manual Workers	-0.430
30. Skilled Manual	-0.813
31. Semi & Unskilled	0.768
32. Education	0.315
35. No Car Households	0.794
37. Bus Commuters	0.584
38. Pedestrian Commuters	-0.248
39. Car Commuters	-0.760
40. Owner Occupiers	-0.918
41. Council Tenants	-0.693
42. Tenants - Furnished	5.051
43. One Person Households	2.828
44. Single Pensioner Households	-0.648
48. Overcrowding	1.894
51. Shared Dwellings	3.555
52. No WC.	1.602
54. No Bath	2.490

Fig. 42

Fig 43.

CLUSTER ANALYSIS: GROUP D

BRADFORD C.B.



for the family. Today such large properties have found commercial profitability in their subdivision and occupation by several household units, some flats, some bed-sits.

The most typical area is found in Manningham on either side of Manningham Lane and an outlier along Toller Lane. Much of this housing consists of large mid-Victorian detached and semi-detached villas that are today too expensive for single family occupation. Many (if not most) have therefore been subdivided and placed on the renting submarket that tends to attract the poorest, most transient, students, and social deviants. Consequently the age groups are strongly biased towards young adults (15-24 years) who live, often alone, in subdivided rented accommodation. The unemployment and activity rates are respectively high and low, and substandardness commonplace. Significantly there is a polarity of classes II and V, suggesting the mix of well educated, essentially middle class student element and the poorly educated, unskilled manual worker, the immigrant (probably East European or Asian) and the unemployed.

GROUP E - The Inner City Immigrant Belt

This group is composed of three clusters which together make up a large part of the classical zone-in-transition. It accounts for 13.5% of the city population and 15% of enumeration districts, and as such is one of the smaller groups.

There are high proportions of persons born overseas,

STANDARDISED CLUSTER SCORES FOR GROUP E

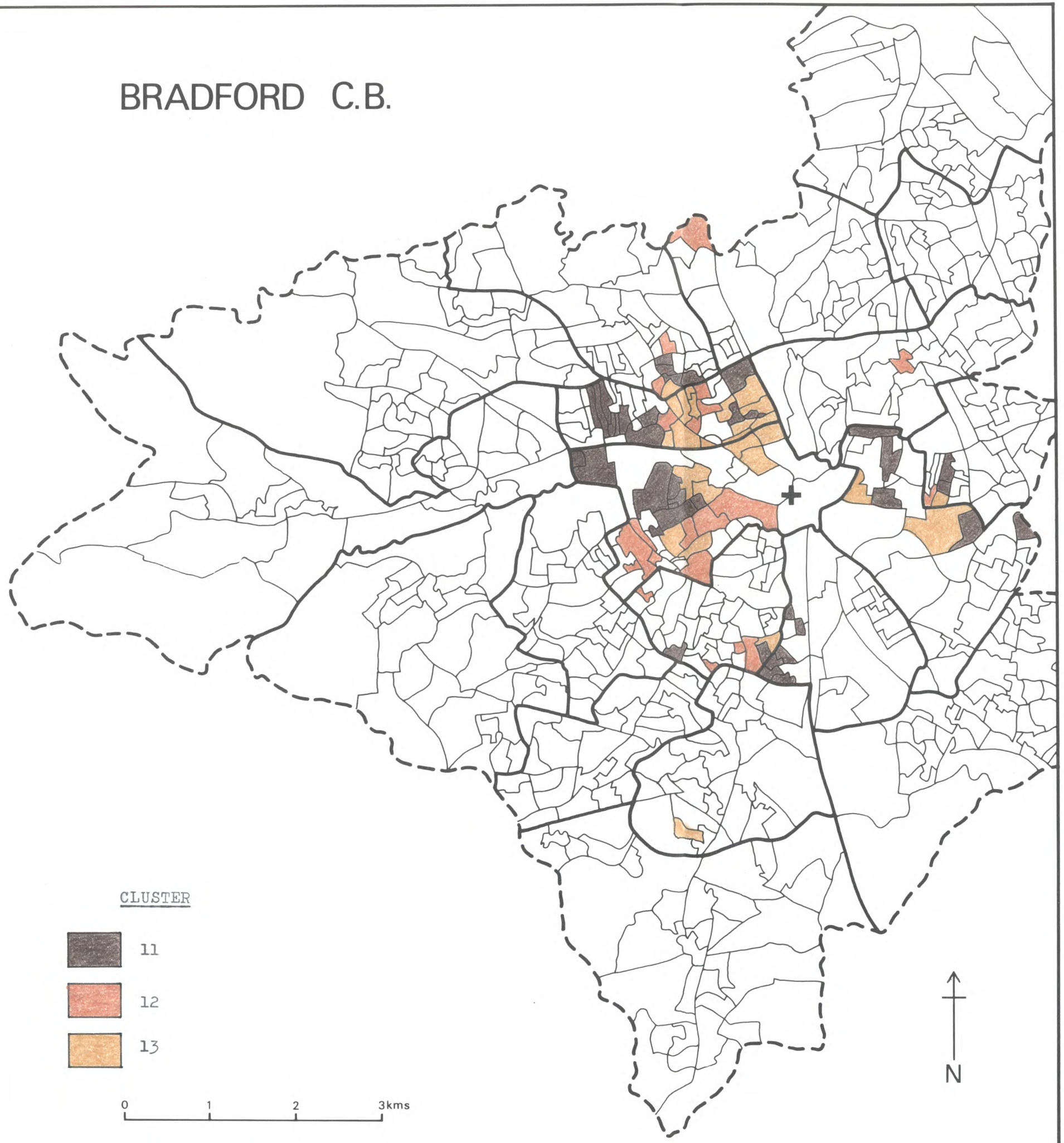
Variables	Clusters		
	11	12	13
1. Distance	-0.889	-1.179	-1.336
2. Children	0.503	0.647	0.901
3. Young Adults	-0.038	0.836	0.817
4. Mature Adults	-0.336	0.156	0.963
5. Middle-Aged	-0.330	-0.852	-1.230
6. Retired	0.053	-0.600	-0.943
7. Fertility Ratio	0.697	0.361	0.670
9. Single Adults	0.360	0.144	-0.385
11. Born Overseas	0.683	1.976	2.849
12. Irish	1.031	-0.541	-0.363
13. Asian	0.748	1.588	3.395
14. Other European	-0.129	1.843	0.100
16. Five-year Movers	0.014	0.115	0.912
19. Economically Active	-0.333	0.192	0.097
20. Unemployed	0.547	0.052	0.725
21. Females Employed	-0.717	-0.233	-2.014
23. Industrial Workers	0.226	1.016	1.146
25. Distribution Workers	-0.402	-0.812	-1.111
27. Employers/Managers	-0.403	-0.561	-0.582
28. Professionals	-0.519	-0.421	-0.440
29. Non-manual Workers	-0.961	-0.863	-1.389
30. Smilled Manual	-0.239	0.331	-0.703
31. Semi & Unskilled	1.102	0.796	1.742
32. Education	-0.792	-0.067	-0.490
35. No Car Households	0.922	0.548	1.060
37. Bus Commuters	-0.157	0.695	0.887
38. Pedestrian Commuters	0.340	0.096	0.124
39. Car Commuters	-0.873	-0.581	-0.982
40. Owner Occupiers	0.084	0.566	0.229
41. Council Tenants	-0.530	-0.578	-0.645
42. Tenants - Furnished	0.026	0.391	0.778
43. One Person Households	0.515	0.024	0.126
44. Single Pensioner Hshlds	0.470	-0.394	-0.510
48. Overcrowding	1.140	0.955	2.888
51. Shared Dwellings	-0.080	0.445	0.788
52. No WC.	1.981	0.330	1.874
54. No Bath	1.917	0.049	1.336

Fig. 44

Fig 45.

CLUSTER ANALYSIS: GROUP E

BRADFORD C.B.



particularly Asians, many residents belong to social class V and there is considerable housing substandardness and overcrowding. For example, there are five times as many Asians in this group as there are in the city and the rates of substandardness are at least twice as high as the city average. Thus 70% of all Asians and almost 50% of the city's overcrowded dwelling stock can be found here.

The age structure with overrepresentations of children, young adults and mature adults, is a reflection of the nature of immigration controls about ten years ago. Since the early influx of male-dominated migrations spouse patriation has enabled family units to be complete again with a concomitant rise in the Asian fertility ratio. The latest evidence suggests that the non-white birth rate for the city is three times the white birth rate although this is expected to fall by the late eighties to about twice the national average (BMDC, 1977). Likewise, the bimodal split of house tenures between owner occupiers and private tenants reflects the preference of Asian families to own their property, particularly the early byelaw terraces built before 1906 which they can best afford. Equally, the nature of chain migrations and the strength of kinship ties created in the late 1960's strong pressures on the migrant rule to rent accommodation in the house of a friend or relative (Dahya 1974). Although such pressures are less today at the time of enumeration (1971) the pattern was well established and probably contributed to the high proportion (28% of the city total) of furnished tenancies, shared dwellings (30% of the city total) and to the single largest concentration of overcrowded dwellings (47% of the city total).

The spatial pattern is most clear in the west, in the wards of Manningham and University but there are three smaller concentrations in the east along Leeds Road. The only ED's not part of the inner belt are Bolton 44 in the north and Undercliffe 26 and Bowling 12 in the east. Apart from these outliers the general pattern is one of a series of wedge-like intrusions with their apex towards the CBD (Tommis 1974).

Cluster 11.

High Scores: Irish, social class V, overcrowding, housing substandardness

Low Scores: education, car commuters, social classes II and III, distance

Cluster 12.

High Scores: Other Europeans, Asians, overcrowding, owner occupiers

Low Scores: Distance from CBD, elderly, council housing

Cluster 13.

High Scores: Asians, overcrowding, housing substandardness, no car, social class V, unemployed

Low Scores: Distance from CBD, social class III, middle-aged, females employed.

GROUP F - High Status Outer Zone

The most distinctive characteristics of this group are its location towards the periphery of the city and its high status as measured by higher social class and the proportion of residents who commute to work by car. The main tenure is owner occupation, there is an overrepresentation of social classes I, II, and to a lesser extent III, and the middle age ranges dominate. Although this group accounts for only 30% of the population it contains 51% of those persons who are classed as employers or managers in the city and 69% of the professionals but only 18% of the unskilled manual workers. Correspondingly there is very little housing sub-standardness, a low level of unemployment, very few foreign born and relatively few elderly persons.

The groups which are most overrepresented in this social area tend to have a good level of education - 55% of all city residents with ONC or 'A' level as a minimum qualification live here - and a similar proportion commute by car to work. The age structure is weighted towards the 25-59 age ranges suggesting established nuclear families. Indeed, much of the housing covered by this group is post-war development of semi-detached and detached housing and the better quality byelaw terraced housing dating from the early 20th century, housing that is most suitable for single family units. The fertility ratio is not particularly high; it is lower than the city average so families tend to be small.

Between-cluster variation reflects their relative status positions. Indexed by those who travel to work by car and

a good education, the most prestigious cluster is number 17. Here there are almost ten times as many residents in social classes I and II as in the city and nearly four times the number with'A'level as minimal qualifications. Cluster 14 of relatively lower status has fewer owner occupiers in social classes I and II but in relation to city averages these variables are still overrepresented.

Spatially the belt of affluence is best developed to the north, west and south. The nature of the eastern boundary does not permit a continuous zone but it is likely the residential areas of Pudsey will exhibit a similar pattern of variables. There is a void in the central area about 2½-3km in radius where the zone-in-transition of classical urban ecology is traditionally located. The gaps in the belt represent either the post-war council estates or concentrations of terraced houses in former village cores, particularly to the south east with Holme Wood and Bierley estates and Tong Street, and beyond on the outer fringe lies the green belt.

Cluster 14.

High Scores: car commuters, social class III, owner occupiers, mature adults

Low Scores: no car, social class V, fertility ratio, council housing

Cluster 15.

High Scores: social class III, workers in distribution, middle aged, owner occupiers

Low Scores: children, fertility ratio, workers in

industry, no car, overcrowding

Cluster 16.

High Scores: mature adults, car commuters, activity rate, owner occupiers, education, social classes I, II and III

Low Scores: middle-aged, elderly, social class V, no car, one person pensioner households, fertility ratio

Cluster 17.

High Scores: social classes I and II, education, workers in distribution, car commuters

Low Scores: no car, social classes IV and V, bus commuters, workers in industry, middle-aged and elderly.

Cluster 18.

An anomalous E.D.

STANDARDISED CLUSTER SCORES FOR GROUP F

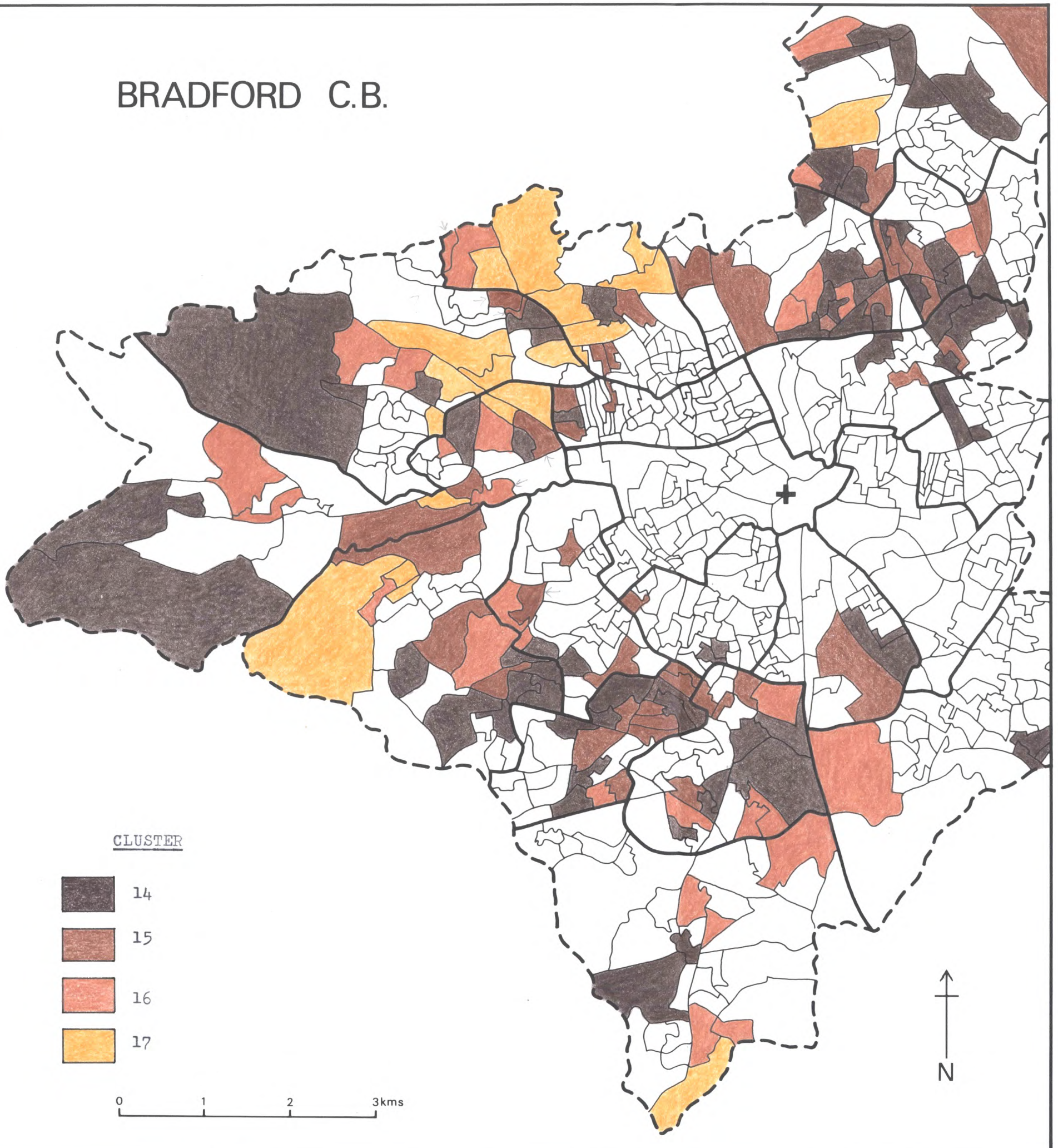
Variables	Clusters				
	14	15	16	17	18
1. Distance	0.327	-0.114	0.610	0.070	1.912
2. Children	-0.154	-0.799	0.500	-0.465	-0.449
3. Young Adults	-0.473	-0.460	-0.343	-0.547	3.902
4. Mature Adults	0.686	-0.231	1.971	0.135	1.385
5. Middle-Aged	0.209	0.747	-1.061	0.447	-2.048
6. Retired	-0.360	0.690	-1.075	0.174	-1.171
7. Fertility Ratio	-0.680	-0.704	-0.802	-0.749	-1.173
9. Single Adults	-0.420	-0.151	-0.939	0.280	-1.718
11. Born Overseas	-0.516	-0.434	-0.511	-0.448	-0.767
12. Irish	-0.585	-0.379	-0.639	-0.497	-1.307
13. Asian	-0.428	-0.445	-0.435	-0.414	-0.461
14. Other European	-0.109	-0.213	-0.010	0.066	11.030
16. Five-year Movers	-0.356	-0.508	0.520	-0.240	-1.758
19. Economically Active	0.431	-0.600	1.028	-0.705	-9.057
20. Unemployed	-0.534	-0.565	-0.634	-0.608	9.431
21. Females Employed	0.505	-0.147	0.856	-0.612	-6.020
23. Industrial Workers	-0.153	-0.798	-0.071	-1.433	-2.765
25. Distribution Workers	0.319	0.845	0.164	1.922	-2.353
27. Employers/Managers	0.450	0.592	0.756	2.659	-0.932
28. Professionals	0.221	0.318	0.668	2.604	9.538
29. Non-manual Workers	0.921	1.106	0.860	1.052	1.266
30. Smilled Manual	0.050	-0.709	0.171	-1.388	-1.133
31. Semi & Unskilled	-0.867	-0.717	-1.177	-1.441	-1.959
32. Education	0.245	0.337	1.047	2.463	-0.865
35. No Car Households	-1.131	-0.766	-1.720	-1.758	-2.986
37. Bus Commuters	-0.293	-0.457	-0.405	-1.160	-1.203
38. Pedestrian Commuters	-0.394	-0.433	-0.610	-0.640	4.230
39. Car Commuters	0.938	0.521	1.587	1.752	4.356
40. Owner Occupiers	0.857	0.668	1.000	0.837	-1.644
41. Council Tenants	-0.601	-0.555	-0.634	-0.630	-0.700
42. Tenants - Furnished	-0.297	-0.015	-0.311	0.007	0.367
43. One Person Households	-0.645	0.067	-1.187	-0.413	-1.709
44. Single Pensioner Hshlds	-0.532	0.188	-1.168	-0.326	-1.732
48. Overcrowding	-0.595	-0.578	-0.594	-0.623	0.181
51. Shared Dwellings	-0.249	-0.205	-0.277	0.097	0.098
52. No WC.	-0.587	-0.486	-0.681	-0.519	-0,816
54. No Bath	-0.502	-0.392	-0.578	-0.419	-0.759

Fig. 46.

Fig 47.

CLUSTER ANALYSIS: GROUP F

BRADFORD C.B.



INTER-GROUP COMPARISONS

The ordination of variables according to the factor analysis suggested that the census data for Bradford could be reduced to a higher order generalisation of three dimensions: 1) Ethnicity-housing substandardness 2) Life cycle 3) Social status. It is an instructive exercise to examine the comparisons between groups according to indicators of each of these principal dimensions. Because of the different nature of cluster analysis it is stressed that the following discussion is based on indicators only; the variables chosen are illustrative of data variation between groups, not representative of them. The indicators chosen are:

Factor One: overcrowding, shared dwellings, no W.C., no bath.

Factor Two: children, young adults, mature adults, retired persons

Factor Three: owner occupiers, council tenants, private renters, social classes I to V.

Where social areas are spatially segregated the efficiency of the clustering algorithm can be measured by its ability to apportion the segregation between clusters and groups. Ideally the variation in group scores should be very large with some groups scoring very highly and others very low. This is unlikely to be the case with so many subareas and in a city demonstrating a poly-nuclear pattern which can juxtapose relatively needy social areas with affluent suburbia.

The distribution of substandard housing indicators is clearly separated into two megagroups. Generally speaking there is underrepresentation in groups A, B, C and F although some variables on some clusters do have scores above the factor mean. For example, overcrowding is slightly overrepresented in group C (council estates) but it is to be found in only one of the two clusters of which it is composed (cluster 8). Similarly, no W.C. and no bath are overrepresented in groups A and B but not C and F, and with A only in clusters 3, 4 and 5, and in B in cluster 6.

Interestingly the overlapping of lines in Figure 48 shows that the indicators of substandard housing do not consistently 'define' the concept of substandardness. In other words housing can be substandard either because it lacks an inside W.C. or a bath or it suffers from overcrowding, or the dwelling is subdivided, or a combination of two of these, but <u>not</u> a combination of all four variables acting simultaneously. Thus, with the exception of group F all groups show a measure of housing substandardness on at least one indicator and occasionally two. These graphs suggest that substandard housing can be found in areas other than the inner city group and that its relations with the social groups affected can be diverse. Simplistic aggregate social indicators are inadequate in this respect because they no not show the relations between variables or groups depending on the scale of analysis.

The second megagroup consists of groups D and E. Unlike the above, all indicators score consistently above the group means showing the coincidence (spatially and structurally) of

STRUCTURE OF HOUSING SUBSTANDARDNESS

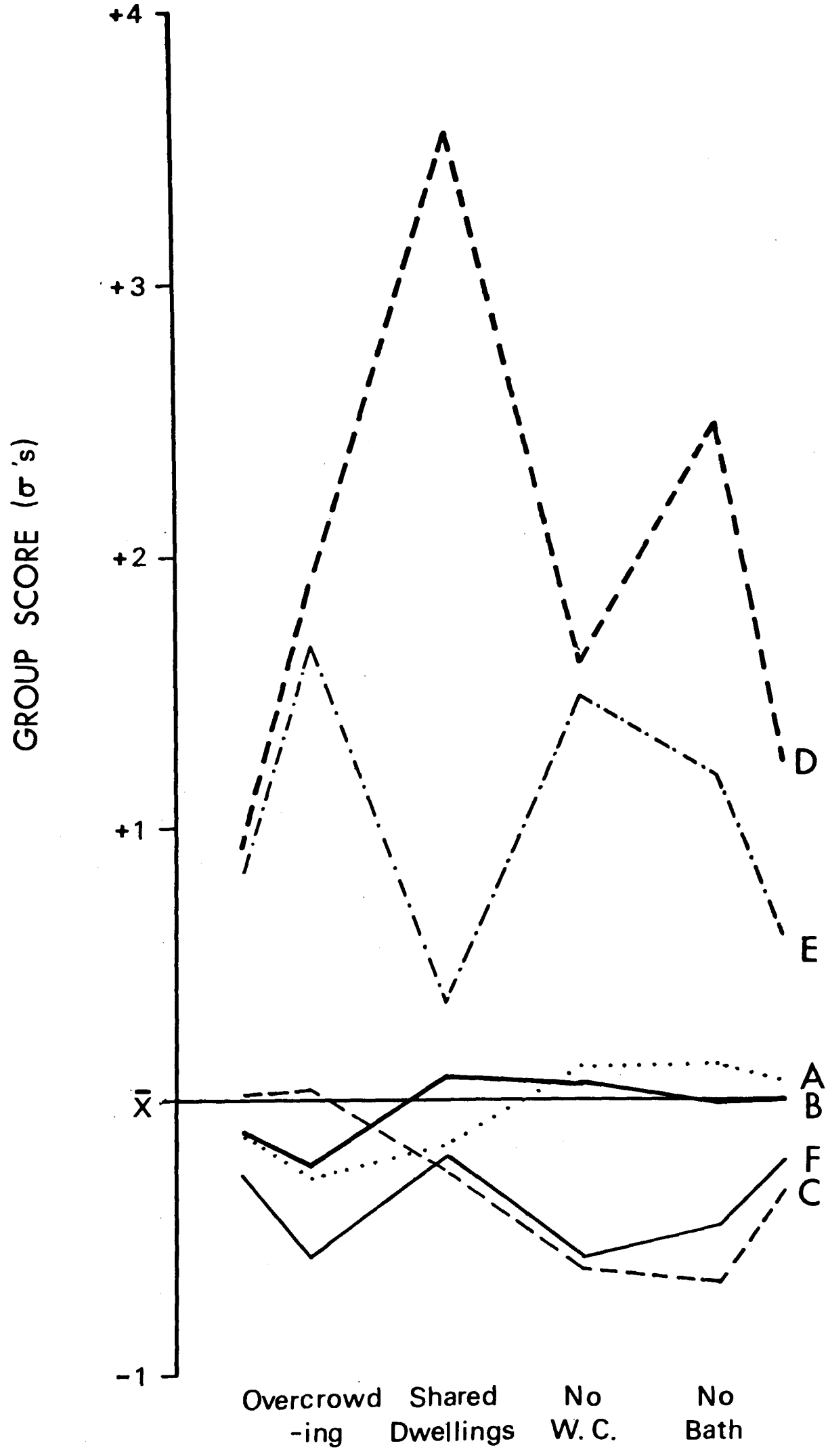


Fig 48

all four measures. The scores however are not uniformly high across all measures; group D representing the bed-sit areas of the city is an exception but it demonstrates the particular combination of variables that account for the distinctiveness of these areas. Group E, the wedge-like intrusions of high Asian occupancy, has high scores on indicators of substandardness but these are not so closely associated, as in the former case, with a particular housing tenure, namely private renting, since most prefer to own their property.

The age structure of each group shows a more complicated pattern (Figure 49) but in most cases there are substantial deviations from the group means suggesting that age factors can be and are spatially segregated. Each group tends to show an age bias. Thus groups C and E are overrepresented by young persons (mainly 0-24 age range), group F by mature adults (25-44 ages); group B shows only slight deviation about the mean but is overrepresented by people in middle age (45-59 ages), and group A is clearly biased towards the elderly (45-60 years). Group D has a very marked age structure with few persons outside of the 25-44 years age category but this is to be expected given the nature of the group.

The groups can be ranked by mean standardised distance from the CBD and inferences made for the spatial form of life cycle processes. The results are: D, E, B, A, F and C. With the important caveats that the age structure variables are only indicators of any life cycle stages and that generalisations are of a high order nature there does

AGE STRUCTURE

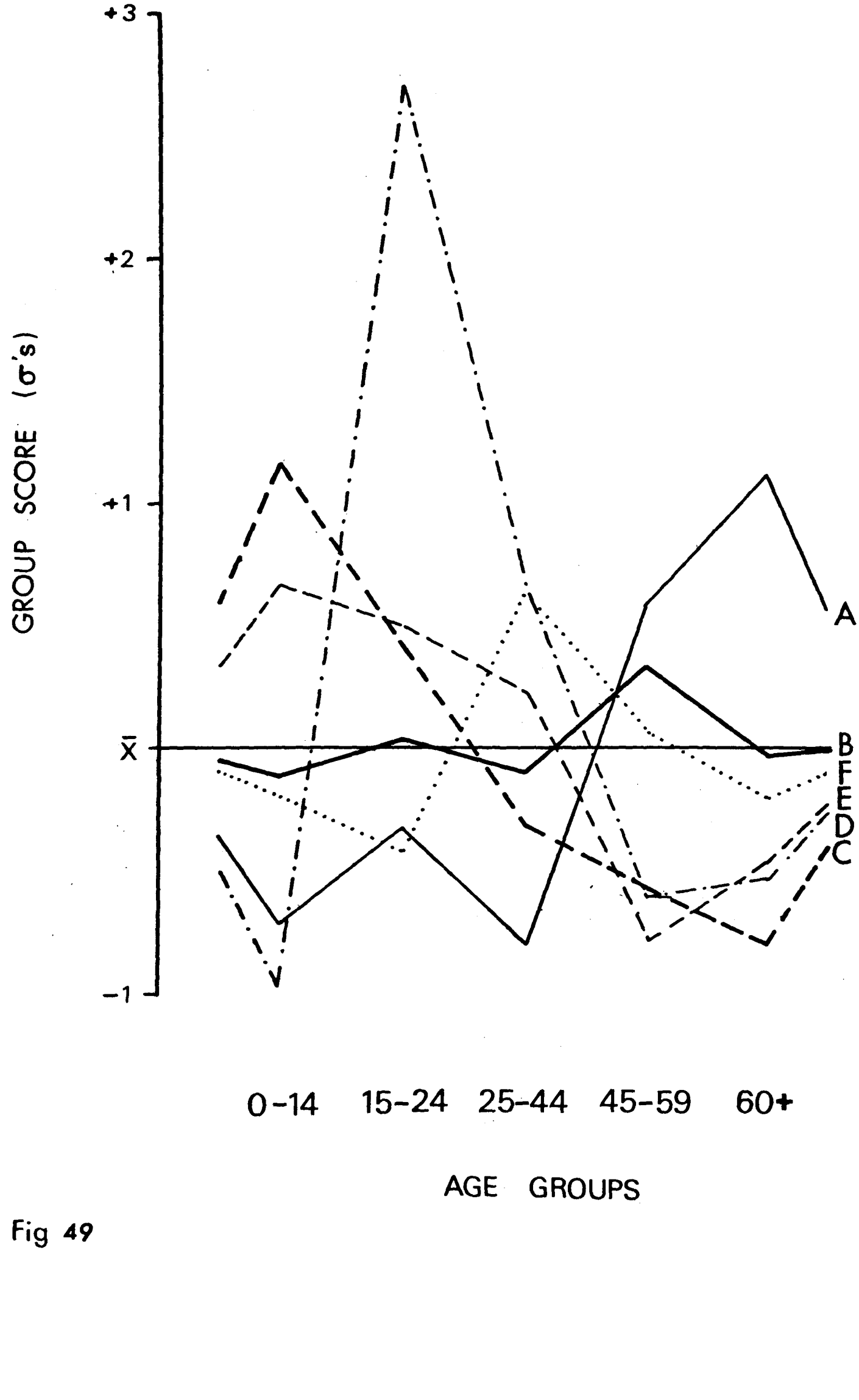


Fig 49

appear to be some spatial patterning. Thus, young adults are overrepresented in the central, bed-sit locations and in the peripheral council estates but in the former case the fertility rate is very low indicating a relative absence of young children. Mature adults are overrepresented in the inner city (group E) and in the outer affluent belt but fertility is again a differentiating factor; in the former case there is high Asian occupancy and since patriation has been allowed ethnic fertility rates have increased rapidly to well above the city average. The fertility rate in suburban areas remains low. The middle-aged and elderly tend to occupy median locations (groups A and B) sandwiched between the inner city proper and the outer suburban belt. The general pattern however is complicated by two factors: the presence of a polynuclear housing morphology reflecting the historical growth of the town and the inner city developments of local authority housing. Clearly, the analysis *per se* cannot explain the importance of these factors; it merely hints at their existence.

There are also marked tenurial differences between groups. All groups, apart from E, are characterised by a single dominant tenure. Group D, the most centrally located, is dominated by the private rented sector as might be expected of bed-sit areas. Groups B and F are overrepresented on owner occupiers; groups A and C on council tenancies. Only group E is overrepresented on both owner occupied and private renting. Therefore, because only one group is bimodal by tenure it can be said that the clustering algorithm is able to identify and amalgamate areas according to the predominant tenure and be differentiated between tenure categories.

There is a certain spatial geometry to the ordering of tenure groups. The most central tenure is private renting (in group D). Group E with bimodal scores is also centrally located and with group D largely defines the private sector residential inner city. Owner occupancy areas are generally found towards the suburbs but they are flanked on the periphery by a discontinuous chain of council estates on all sides of the county borough. In contrast, however, there are some very central public sector areas such as Manchester Road and Jervaux Crescent that intrude into areas that are more typically given over to owner occupiers or private tenancies. In many cases these central public sector areas are also associated with high levels of substandard housing as in, for example, cluster 3, 4 and 5. Relations between measures of substandardness and tenure are discussed later (chapter 11).

The pattern of social classes closely reflects the structure of housing tenures. Most groups are overrepresented by classes IV and V but this is due to the particularly high incidence of these groups in the city. Thus groups A, B, C and E are overrepresented on either or both of these groups. Group D shows a bimodal distribution between social classes II and V and is a function of the heterogeneous class structure of most traditional bed-sit zones. Only group F, the affluent belt, shows a relative absence of the two lowest social classes.

Spatially the higher status groups are not the most peripheral. Conversely group V is not, on its own, the most central. The former is outflanked by the council estates

STRUCTURE OF HOUSING TENURE

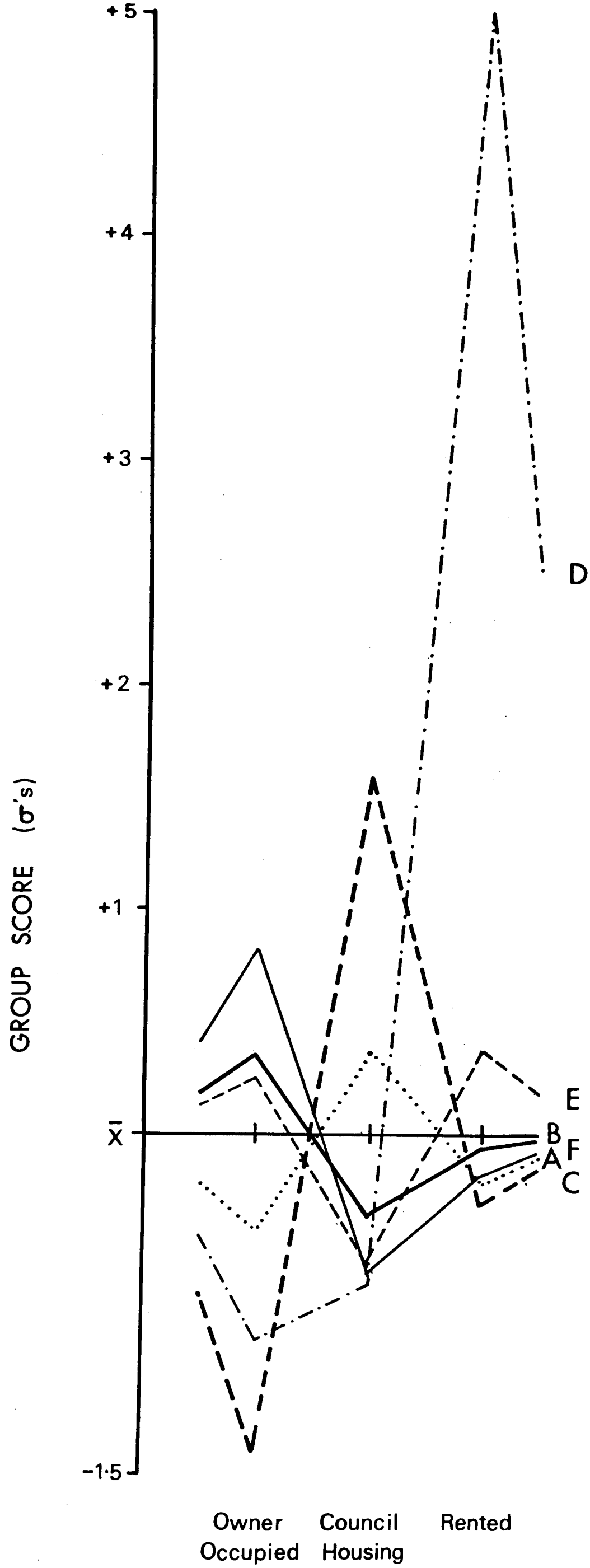


Fig 50 HOUSING TENURE

SOCIAL CLASS STRUCTURE

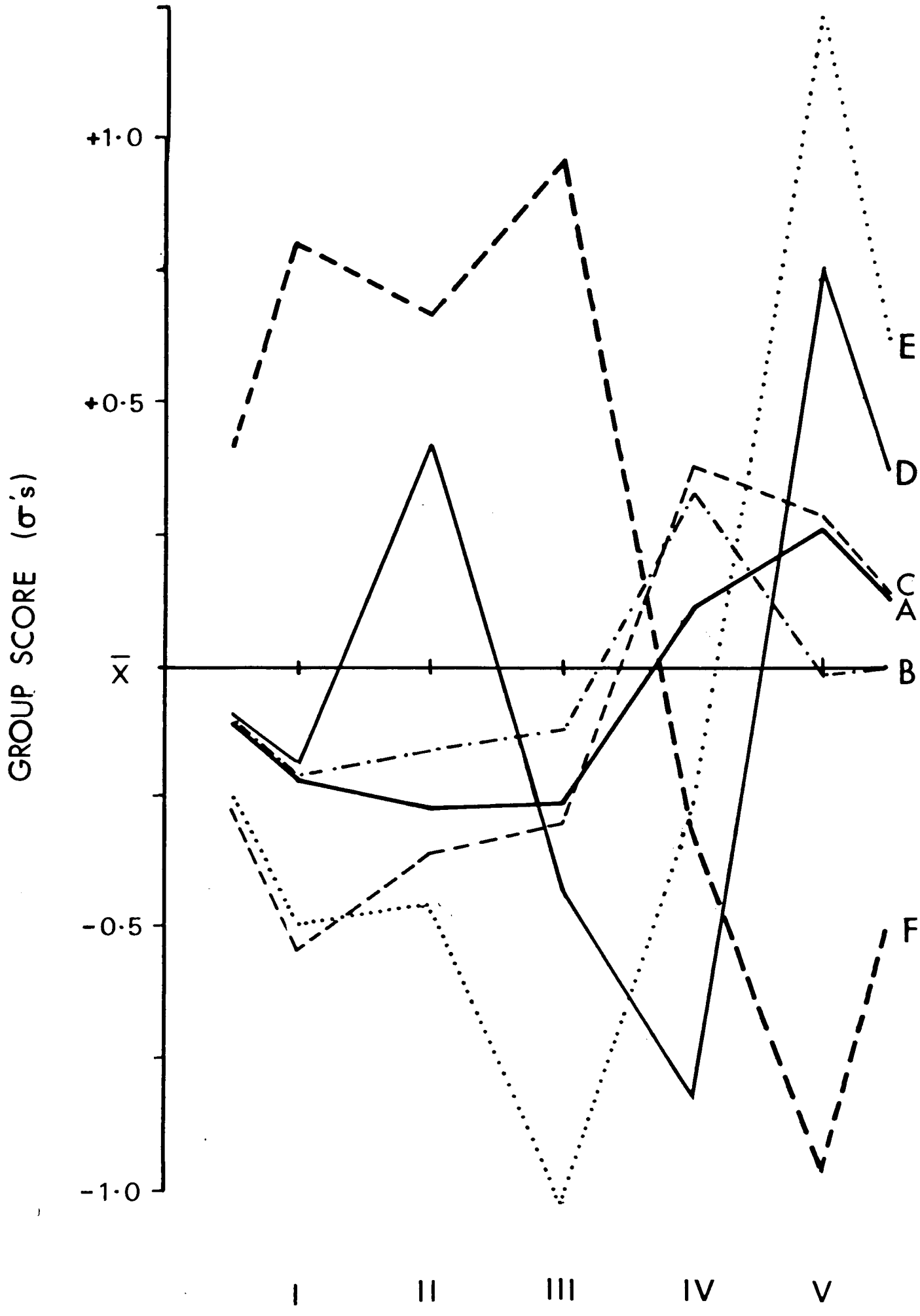


Fig 51

which tend to be overrepresentative on classes IV and V. The latter, group D, also shows a high proportion of professionals.

Chapter 11

An Empirical Typology of Urban Social Areas

AN EMPIRICAL TYPOLOGY OF URBAN SOCIAL AREAS

This short section aims to interpret the ordination and classification analyses in a little more detail by an extension of the two to form an empirical typology of the social areas of the city. It has been demonstrated that uniform social space does exist in terms of a set of attributes - demographic, employment, housing, social class - which describe its population. It is certain combinations of these characteristics that creates the differentiation between social spaces to give typal groups. It is, of course, recognised that each typal group is polythetic (Sokal and Sneath 1973:13) in that all groups share all the features which are used to identify them; their typicality lies in their unique combination of features which creates a commonality between some districts rather than others.

The principal form of methodology rests on a distinction between correlational, functional and causal languages (Galtung 1967, Harvey 1969). All three are ways of organising empirical data starting from a correlation matrix but their implications for social research are very different. The main differences between the languages can be briefly stated. The simple correlation is a statistical measure of association between two variables and not a statement of a process relationship between them. There is a very real difference between explaining how a matrix of correlations arises and explaining the implications between propositions as represented by these variables. Correlation analysis is therefore always

synchronic.

A regression model is appropriate for positivist research situations where a functional relationship is postulated. One (or more) variable(s) is then said to be dependent on one (or several) other(s). In the present context the city is often thought of as the independent variable and the social processes, the dependent variables. Rather more specifically the main dimensions of urban differentiation: social rank, urbanization and ethnicity are usually considered the independent variables in the analyses of residential location with behaviour the dependent variable. This contrasts with correlation analysis which considers only the covariation of variables; dependence is not implied. The emphasis in correlation is therefore on the degree with which the two sets of values vary together around their respective means (in product movement correlation) and on the direction of this covariation.

Both regression and correlation analysis are descriptions of empirical regularities between variables. Broadly speaking they permit the researcher to make probabilistic generalisations about the way in which two variables or sets of variables covary. Thus a strong positive correlation indicates that a high value for one variable will be associated (to a greater or lesser extent) with a high value for the second variable. The association of $C^{+}(X,Y)$ is therefore: high X, high Y or low X, low Y. The relation does not state that an increase in one variable will give rise to an increase in the second nor that the former (independent) variable predicts the latter

(dependent) variable. Thus, correlation and regression give numerical expression to an empirical situation for a given point in time. This is because synchronic correlation cannot say what process is acting between two variables and also because it is tied to specific contextual conditions which may themselves change over time.

'Prediction' on the other hand suggests that there is some mechanism at work by which there is a logical relation between propositions. In other words, given an antecedant condition X, the consequent proposition Y will always follow. The implication therefore is of a causal relationship between the two propositions rather than an associational relationship. Because correlation analysis permits only of associational relationships it is difficult to see how the analyst can proceed to a cause-effect explanation (even in the positivist sense).

Galtung has suggested that it is possible to infer from a correlation to a process when two conditions are met:

> "the correlation holds if the same unit is measured at several points in time (diachronic correlation) and the variables are also correlated with time, so that the finding actually refers to a covariation between time and two other variables."
>
> (Galtung 1967:472)

Whilst such a proposition may suggest necessary conditions for hypothesis formulation of acting process between two variables it need not provide the sufficient conditions. It is quite conceivable that two variables, X and Y, which correlate strongly with each other at several time

points and also with time are the result of an exogenous variable, Z, that is a variable not included in the analysis. Nor can the process by which Z influences the respective size of X and Y be explained by correlation alone. Explanation is a derivative of theory and depends upon a sound knowledge of mechanisms and structural transformations, not on a knowledge of correlations.

It is an instructive exercise however to extend the present analysis into the functional language and to demonstrate the logic of empiricist argument. No further statistical analyses are conducted. Instead these are replaced by a functional typology of urban social areas that is derived from the results of the factor and cluster analyses. In the conventional manner the dimensions from the ordination of variables are held to be the independent (social process) variables, and the classification of districts the dependent (spatial form) variables. The higher-order generalisations from the factor analysis are used with the difference that the factor representing the bed-sit combination of variables is separated out and added to the remaining three because of its highly distinctive character. In the typology these form the main elements of the Y axis (see Fig. 52). Each of the cluster analysis typal groups represent the elements of the X axis. Also included is information on social networks since this relates to important sociological concepts of neighbourhood and community which in certain circumstances have important spatial attributes, and each group is given a location according to its mean standardised score (i.e. its average position on all clusters).

EMPIRICAL TYPOLOGY OF URBAN SOCIAL AREAS

(The inner city is indicated by the thicker line)

CLUSTER ANALYSIS

FACTOR ANALYSIS	BED-SIT TRANSITIONAL	ETHNIC TRANSITIONAL	AGING TRANSITIONAL		STABLE WORKING CLASS	COUNCIL HOUSING	OUTER AFFLUENT BELT
ETHNICITY/ HOUSING SUBSTANDARDNESS	Ethnically mixed High incidence of mult. depriv.	Asians High incidence of mult. depriv.	Very few Some depriv.	Some Irish Very little	Very few Very little	Some Irish Overcrowding only	None Very little
LIFE CYCLE	Single young adults (15-24) Low fertiltiy ratio	Mainly young Mod. high fertility ratio	Pensioners Very low fertility ratio		Middle aged but with some Young couples	Young couples Very high fertility ratio	Mainly 25-59 ages Low fertility ratio
SOCIAL RANK	Classes II & V mainly rented many unemployed	Class V owner occup. & rented	Class IV owner occup.	Class V council tenants	Class IV mainly owner occupiers	Classes IV & V council tenants some unemployed	Classes I, II & III owner occup. & rented
TRANSIENCE/ BED SIT	Recent migrants private renting	Mainly single males but approaching complete family units	Many single pensioners (single or widowed) well established		Established family units	Nuclear family units mainly	Established family units
SOCIAL NETWORKS	Loose-knit	Close-knit	?		Close-knit	?	Loose-knit
LOCATION	Central bed-sit land	Inner city sectors	Old village cores & periphery	Inner city & peripheral estates	Central -median	Peripheral council estates	Suburban estates, particularly in affluent NW
GROUP	D	E	A		B	C	F
CLUSTER	10	11, 12, 13	3, 4, 5	1, 2	6, 7	8, 9	14 to 18

Fig. 52

Methodologically a typology functions in the same way as a classification. Its purpose here is to structure the reality of urban space by grouping areas that show certain affinities across a range of attributes and, more importantly, it is used by positivists to generate hypotheses concerning the functional relations between the major elements of urban differentiation and their spatial form. Particular attention will be paid to the residential inner city as identified by certain direct indicators of low material welfare such as overcrowding and lacking basic amenities.

The success of the typology will depend to some extent on the degree to which it is able to combine similar districts possessing common differentiating features. This can be tested by reproducing dimensional profiles for randomly selected ED's for each of the group or uniform social spaces. An example is provided below for cluster 8, group C - the council housing social space (Fig. 53). The score profile across nine factors indicates a high level of similarity between the three districts. All three have low scores on factors II (old age) and VIII (mobility) and high scores on factor III (council housing). Indices of dissimilarity measure the typicality of the district to the cluster with values approaching zero indicating a good fit. Further profiles illustrate the ability of the typology to classify urban social areas particularly those of the inner city.

Measures of Housing Deprivation

It was stated in chapter 8 on 'Defining the inner city'

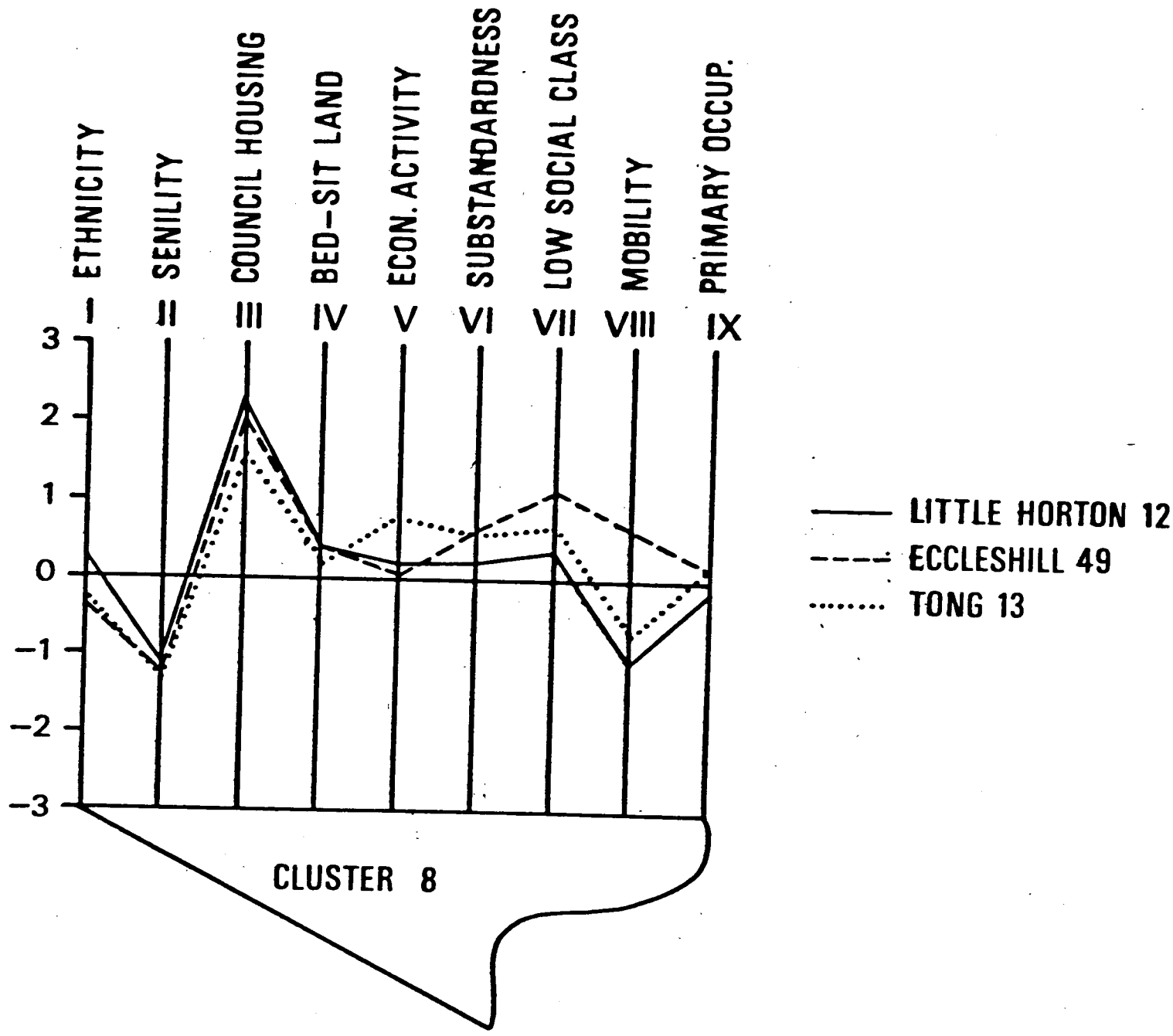

I ETHNICITY
II SENILITY
III COUNCIL HOUSING
IV BED-SIT LAND
V ECON. ACTIVITY
VI SUBSTANDARDNESS
VII LOW SOCIAL CLASS
VIII MOBILITY
IX PRIMARY OCCUP.
3
2
1
0
−1
−2
−3
CLUSTER 8
LITTLE HORTON 12
ECCLESHILL 49
TONG 13

Fig. 53.

that the great strength of territorial social indicators is their ability to provide profiles across a range of indicants for each area and, especially when a Z-score transformation is applied the scores on each indicant can be summed to provide an aggregate housing stress score. They do therefore show the differences in combinations of urban deprivation between areas but they fail in at least one important respect. They are unable to examine the relations of housing deprivation indicants with other groups of variables that might indicate a localisation of deprivation by area, housing tenure or population age group. It is difficult therefore to proceed beyond the stage of indentification of those areas with the severest incidence of material deprivation and the strongest claims for priority allocation of resources.

It is true of course that any index of urban stress, welfare or deprivation will be highly sensitive to the nature and mix of variables used to define the problem. This has already been encountered in the chapter on social indicators when different combinations of variables produced different housing stress areas. It is also similar to the lack of invariant structure in derived factor solutions. But there are less obvious biasses. Webber (1976) for example argues that the choice of certain variables will prejudice some types of areas against others. The bed-sit areas will be favoured by the inclusion of amenity variables and council estates by occupancy variables; indices will also tend to favour urban over rural ED's. Although car ownership can be a powerful indicator of social status it could also be a

measure of low accessibility and poor public transport forcing rural families to allocate a greater proportion of their disposable income on a car.

Each of these qualifications are particularly important in view of the technical nature of so many reports concerned with the identification of problem areas. The view taken here is that there are always some parts of the city that will perform consistently worse no matter what the choice of welfare measures. There will be areas that show different combinations and degrees of 'diswelfare' possibly indicating different processes at work and requiring alternative policy measures for their eradication. The important point, however, is that because deprivation is multi-dimensional these areas will always exhibit some measurable facet of deprivation. It is because no positivist analysis can hope to capture all the dimensions (if only because some, like happiness, are not easily quantified) that there have been moves over the past ten years towards multifactor attempts that at least catch some of the facets in a large variable net.

With these important qualifications in mind attention now focuses on the relations between measures of housing deprivation and the independent variables of factors. Inferences will be drawn from these associations concerning the processes that might be at work within each of the typal social areas. The measures of housing deprivation chosen are: overcrowding (48), sharing or lacking a bath (54), shared dwellings (51) and lacking an inside W.C. (52). Variable 51 is an indicator of housing stress only

in conjunction with one or more of the other measures. They are used in the sense that they are indicative of housing obsolescence and low material welfare.

It is reasonably well established now that measures of deprivation vary between housing tenures. The exact pattern will be different for each town but the private renting sector is nearly always ranked worst on all available measures of deprivation. Overcrowding is frequently associated with council housing. The hypothesis that different aspects of housing needs correspond to different tenure groups is discussed using the correlation matrix (normalised variables) below.

FIG. 54

	48 Over-crowding	52 No inside W.C.	54 Shared Bath	51 Shared Dwelling
40 Owner Occupancy	-0.270	0.132	0.156	-0.058
41 Council Housing	-0.005	-0.322	-0.403	-0.223
42 Renting	0.521	0.463	0.514	0.727
51 Shared dwelling	0.428	0.347	0.366	-

(normalised data)

Overcrowding is mainly associated with private renting; this has already been demonstrated by the cluster matrices of group 10. It also correlates significantly with shared dwellings but the correlation with council housing is very weak. The scale at which the matrix has been compiled conceals a stronger relationship between the two at the cluster scale. Reference to the matrix of values for cluster 8 (appendix B) shows considerable above average levels of overcrowding in this group of council tenancies (LQ=1.82). In contrast, overcrowding covaries negatively with owner

occupation.

The causes of overcrowding in the two tenures is different. The overrepresentation of young adults and the high correlation between council tenancies and fertility (r = 0.41) indicates large, young families. The low fertility ratio of the bed-sit areas suggests that large families are not the cause of overcrowding but small dwelling size and excessive occupancy. The two are not totally separate, however. The Woodview Report already referred to provides much significant information on the functional relationships between variables. It states that 74.4% of households in this area live in dwellings of one or two rooms and of these 6% are of four or more persons. On the conventional measure of overcrowding (more than 1.5 persons per room) 22% of the area's households were thus classified compared with a city average of only 3.4%. As an aside it is worth noting that the rates of overcrowding in areas with many children (such as council estates) may be overstated because of the equal weight with adults given to children in forming the index.

The lack of basic amenities is most strongly associated with private renting but there is a smaller correlation with owner occupancy. The former correlation adds to the syndrome of deprivation in the bed-sit areas of the city and is clearly a product of the subdivision of large houses and subsequent multiple occupancy in a manner incompatible with their intended use. Subdivision of dwellings in itself need not indicate housing deprivation but in the ethos of the inner city they tend to be shabby conversions, hastily done and with disregard for proper

sanitary needs. The correlation with owner occupancy refers mainly to those areas in cluster 6, the inner city late Victorian terraces of high density and low amenity.

It appears that no sector escapes at least some degree of housing deprivation. Inner city owner occupied areas can suffer from a lack of amenities, some parts of council estates can be overcrowded. All private renting areas however are prone to high levels of multiple deprivation.

Besides housing tenure the two factors most responsible for the sorting of residential areas are socio-economic status (as measured by occupation) and stage in the family life cycle (as measured by age structure and fertility ratio). Social status has proved a difficult concept to define but it seems clear that different occupations bring with them differentials of income and prestige. An individual's place in society can determine the type of house available to him, its tenure and its location. Success in the housing market can then be seen as a reinforcement of his own social standing. It would be expected that those groups of high social status will occupy the most expensive housing which, in Bradford, are owners outright or owner-mortgagees in the suburbs, particularly to the north and west. It is less certain which tenures will correlate with the lower social classes.

To test and examine some of these assumptions a matrix of correlations between social class (census defined) and housing tenure is shown below (Fig. 55).

FIG. 55

	Social Class				
	I	II	III	IV	V
41 Council Housing	-0.261	-0.194	-0.183	0.085	0.216
40 Owner Occupancy	0.381	0.243	0.299	-0.026	-0.376
42 Renting	-0.101	-0.009	-0.179	-0.221	0.288

(normalised date)

There is a significant positive correlation between social classes I, II and III and owner occupancy indicating that high status and this tenure tend to occur together, but not exclusively otherwise the correlation would be stronger. A high income gives a potential mortgagee credit worthiness and a larger loan capacity than a similar applicant with a lower income. Since private ownership of property holds prestige in British society it is not surprising that the correlations for the same social classes and alternative tenures are negative. By contrast social classes IV and V correlate negatively with owner occupancy but positively with public and private renting. Lower social status usually (though not inevitably) means lower income and therefore households in this category are less likely to secure a mortgage even if they desire one. Excluded from the private ownership sector these households seek accomm-odation in one of the alternative tenures. It is impossible to say from the above data whether such households actively seek rented tenures because those are the tenures they prefer or whether exclusion from owner occupancy leaves them little choice. In this respect empirical data *per se*

cannot offer any form of explanation.

Information on stage in the family life cycle at an aggregate level provides detail on housing need (mainly regarding the size of house) rather than tenure but interesting correlations do emerge with tenure when the above discussion on social status is borne in mind.

FIG. 56

	Age Structure					
	0-14	15-24	25-44	45-59	60+	Fertility Rate
40 Owner Occupancy	-0.166	-0.257	0.296	0.137	0.024	-0.355
41 Council Housing	0.227	0.043	-0.297	-0.049	-0.012	0.355
42 Renting	-0.061	0.437	0.127	-0.214	-0.102	-0.016

(normalised data)

Young people (aged 0-24) correlate negatively with owner occupancy and similarly with fertility as might be expected but there is a positive correlation with council housing and of council housing with fertility. The implication in this matrix is that many young people are single, possibly at early stages in their careers if middle class, and therefore on relatively low incomes. Loan security requirements would therefore exclude many from a building society loan. Owner occupancy tends to be reserved for those households with an established career (at 25 years of age and beyond). Private renting correlates positively with young adults and weakly but negatively with fertility suggesting characteristics typical of a transient bed-sit area (as in Manningham and University Wards). High fertility rates, young people,

low social class and council housing correlate positively.

Taken together these matrices hint at the possibility of existence of functional relationships between the sets of variables (factors) from the multi-factor analysis and the spatial form of the city but on the basis of correlations alone such postulations must remain speculative. Nevertheless, it is in the nature of positivist analysis to attempt some explanation for the nature of these relationships and in the next sub-section the empirical typology is analysed and discussed in more detail but only for the inner city as the focus of interest.

EMPIRICAL TYPOLOGY OF THE INNER CITY

Type One: Declining Bed-sit Transitional (cluster 10)

The main feature of this area is the changed character of the resident population from that for which the housing was designed. It has already been stated that traditionally these two subareas of the city were given over to the residences of the merchant classes of last century particularly in Manningham with its grandiose villas. Each house was intended as a single family dwelling for large Victorian families with additional accommodation for domestic staff in some of the larger properties.

In more recent times the investment costs have necessitated the subdivision of these houses to create several dwellings in one structure to provide a much reduced average floor space per family or occupant. There are no statistics readily available on multi-occupancy so it is difficult to state the ratios between bed-sits and flats but if the figures from the Woodview Report are typical the former can be expected to predominate.

The class structure of this area is bi-modal with above average proportions of professionals and unskilled manual workers. The relative cheapness of accommodation attracts two main social groups: a youthful population of university and college students and the transient single, working class adult who cannot afford to live elsewhere. In both cases the population turnover is high and the nature of migrants mitigates against stable family units being established in

any great numbers. It is often said that the transitional bed-sit land fulfils an important role in the housing market for those groups of the population who are prepared to rent rooms because they value the anonymity and impersonal market relationship with a landlord. It also offers accommodation for those who cannot find an alternative. Rex and Moore believe that in taking on the necessary role of pariah groups, landlords become the scapegoats for critics of overcrowding, high rents, deviant groups, noise and vice commonly found in these types of area (Rex and Moore 1967:38-41).

What does emerge is that combinations of multi-occupancy, disinterested tenants and absentee landlordism prevent investment for alterations or improvement of the existing housing stock so that physical decay soon exacerbates the problem of poor conversions.

Fig. 57 shows factor score profiles for three typical ED's and the close correspondence between them.

Type Two: Ethnic Transitional (clusters 11, 12, 13)

In many ways this typal area is the classic zone-in-transition with its mixture of land uses, high immigrant concentrations and substantial housing deprivation. There are some interesting differences between the clusters that make up this group and two score profiles (Fig. 58) illustrate some of these, but the differences hide many of the processes common to them all.

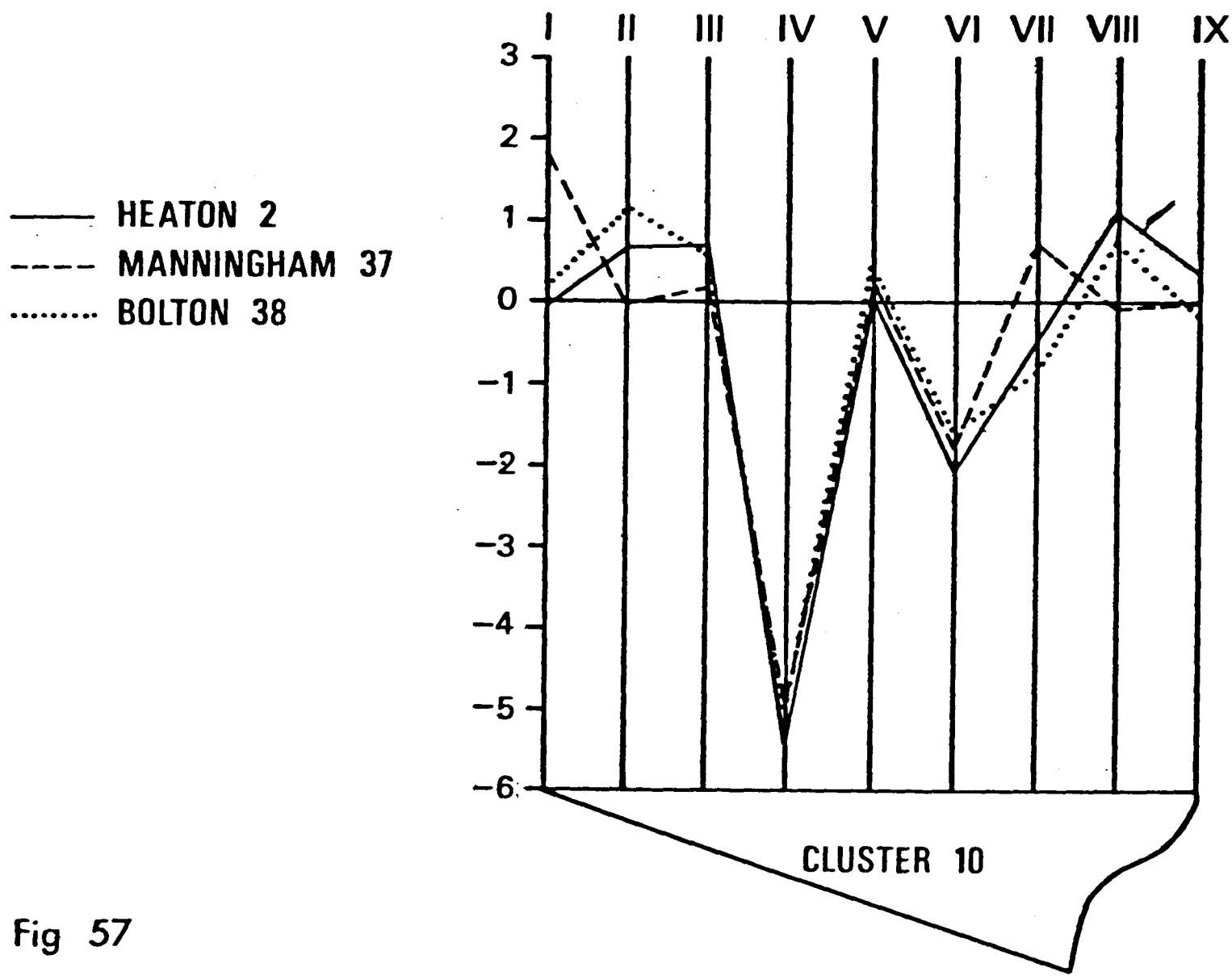

HEATON 2
MANNINGHAM 37
BOLTON 38
I
II
III
IV
V
VI
VII
VIII
IX
3
2
1
0
−1
−2
−3
−4
−5
−6
CLUSTER 10

Fig 57

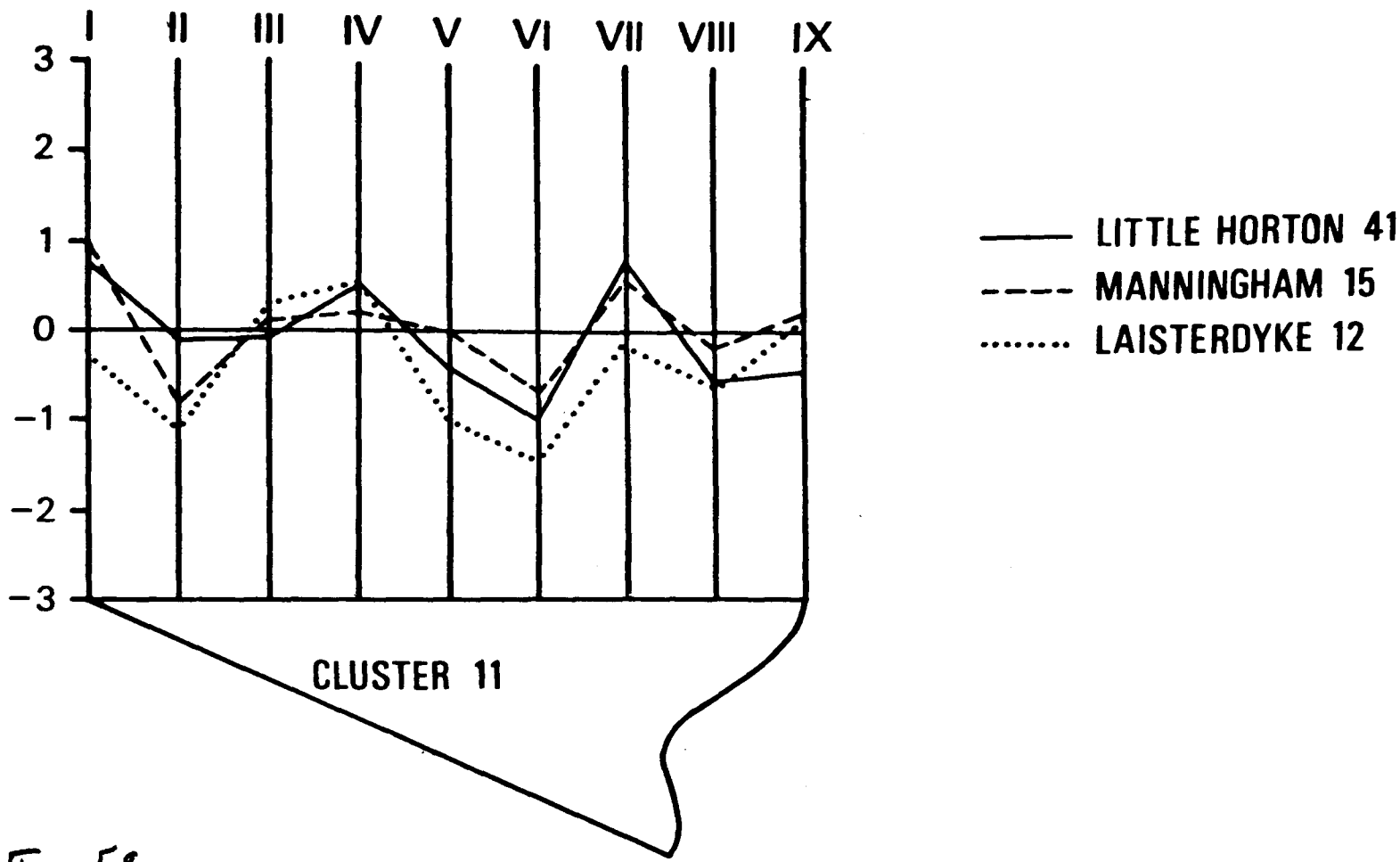

I
II
III
IV
V
VI
VII
VIII
IX
3
2
1
0
−1
−2
−3
CLUSTER 11
LITTLE HORTON 41
MANNINGHAM 15
LAISTERDYKE 12

Fig 58

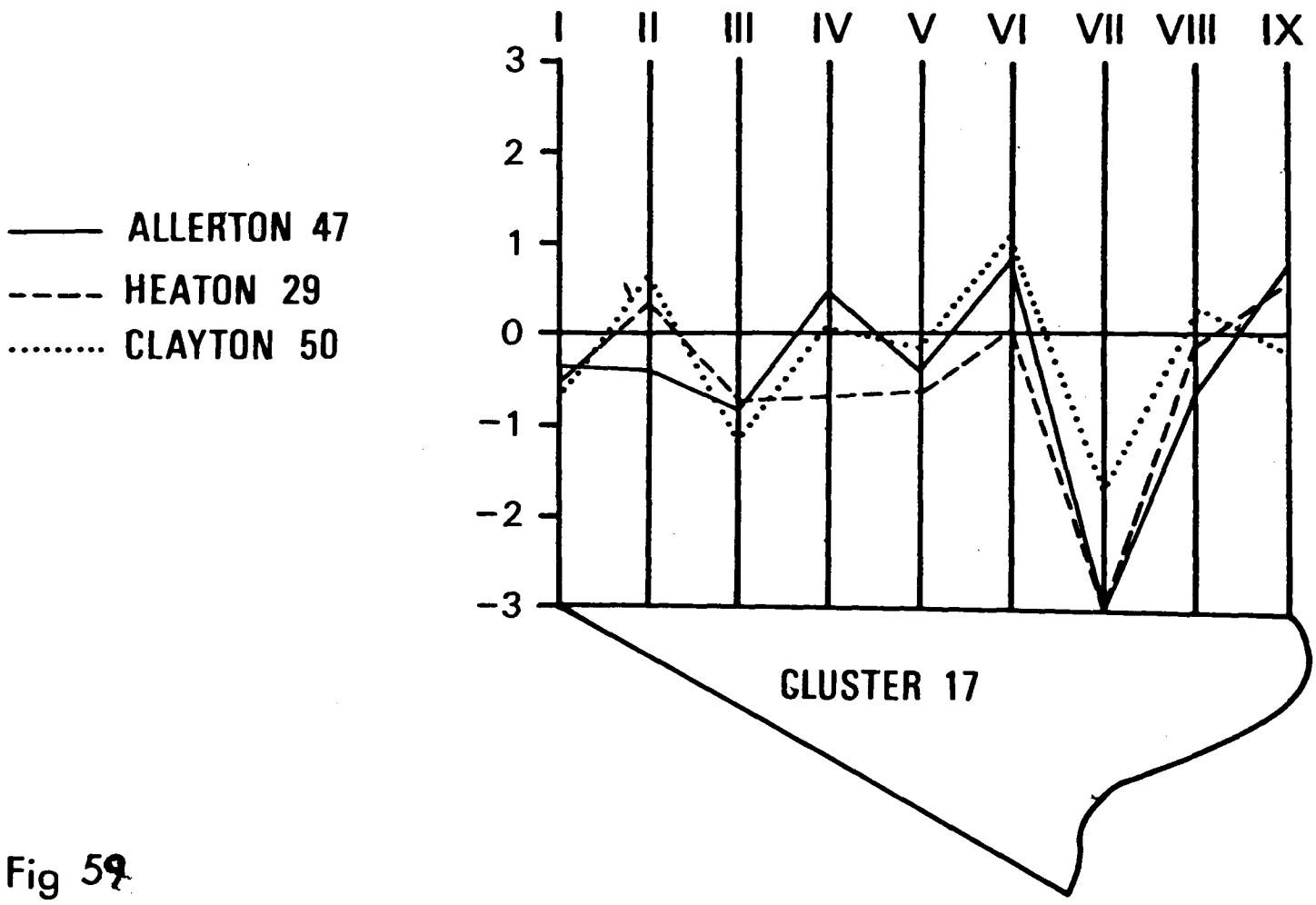

I
II
III
IV
V
VI
VII
VIII
IX
3
2
1
0
−1
−2
−3
GLUSTER 17
ALLERTON 47
HEATON 29
CLAYTON 50

Fig 59

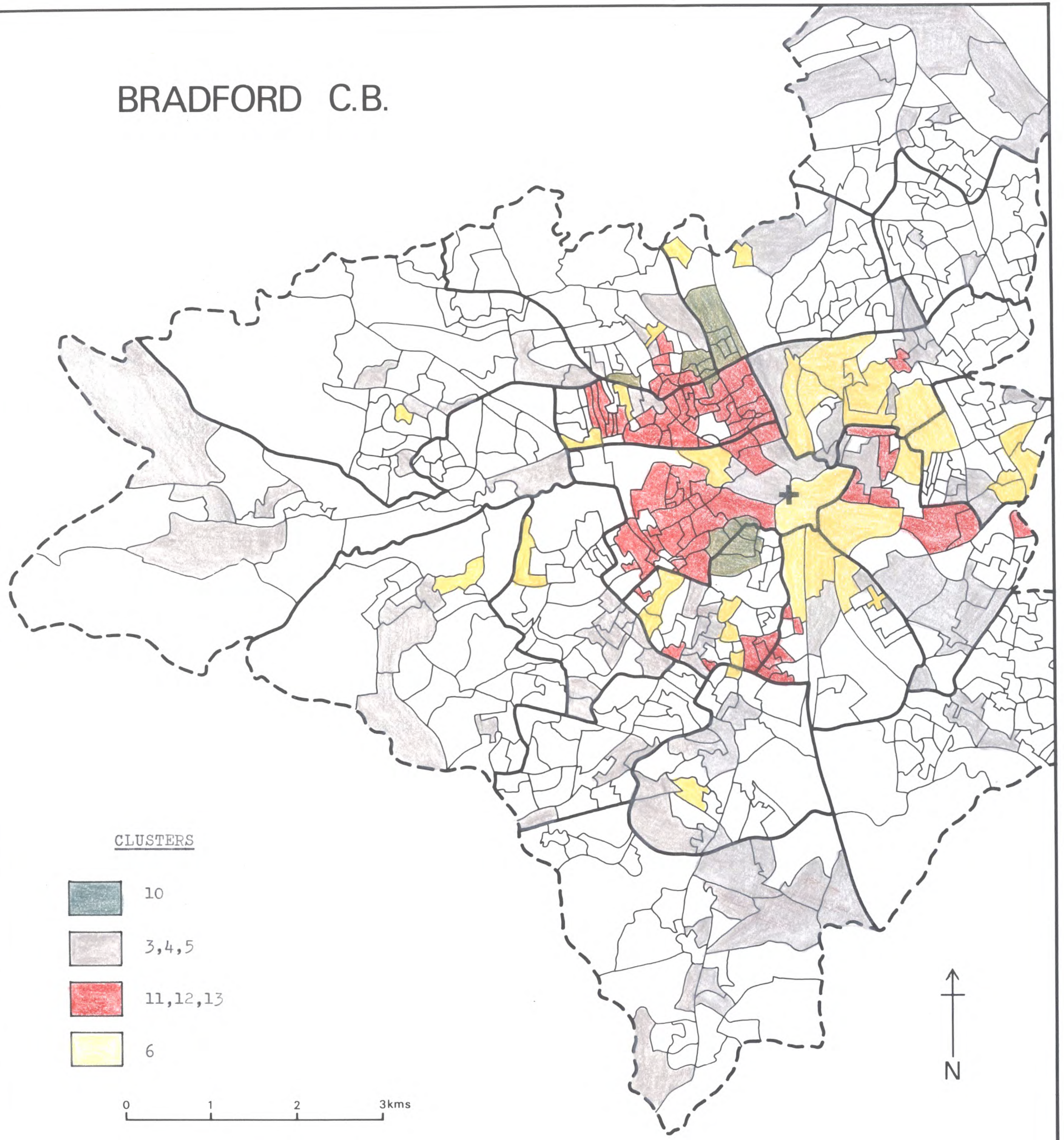
A recurring feature of this typal area is the prevalence of early century terraced housing built originally for artisans and back-to-back cottages for the mill workers. It is the distribution of these 1860's byelaw back-to-backs and the 1873 terraces that define today's inner city as comparisons with maps of the built-up area at the turn of the century clearly reveal (see Mortimore 1970:111). Thus the main spatial patterns of the residential inner city were established as early as 1873. The houses are in the main sufficient in size for a single family of average size and today they are occupied by working class white and Asian families. Throughout the area the housing stock has reached and in many cases passed its obligatory one hundred years' life and so not surprisingly there is considerable structural obsolescence. The terraces are in varying states of deterioration but their poor condition has meant cheap housing for the migrant groups of the late 1950's and 1960's and it was to the inner zones that Asians in particular were attracted.

Therefore this is an area in which the indigenous population has long since moved away and the remaining aged cohort died leaving a housing vacuum that has been quickly filled by the Asian replacement immigrations. The multi-racial character of this area is now its main feature and substantially overlays the broader forces of urban differentiation. Occupationally the immigrants were attracted to the lowest paid jobs the white residents had vacated long ago, yet owner occupancy is the dominant tenure in Asian families. A SHARE report in 1973 on part of the Manningham areas (Southfield Square) showed that 35 out of 36 interviewed

Fig 60.

DISTRIBUTION OF SOCIAL AREA
DEPRIVATION TYPOLOGY

BRADFORD C.B.



heads of households were owner occupiers and that property ownership was a common aspiration. The family structure statistics revealed that a little over 69% of households were nuclear families, the remainder living with other single males. About 53% were living as joint families which, in the extended family system can include brothers and their families, uncles, aunts, nephews and cousins. This type of family structure of course creates a persistent demand for the larger terraced house but inflation and clearance by the local authority is placing this type of housing in limited supply.

Type Three: Ageing Transitional (cluster 3, 4, 5)

The main characteristic of this typal area is the ageing of the population and the housing fabric. The rate of population turnover is low (measured by 5-year migrants) so that the population becomes progressively older and the single family units begin to disintegrate. Physical deprivation sets in due to the progressive ageing of the housing but also the ageing population means a fall in disposable income with the result that the occupant cannot afford to stop the decay that has started. Tenurially this area is a mixture with council housing slightly dominant. In terms of location the spatial pattern both intermixes with the inner city and picks out the village cores of former townships.

This type of area must shortly experience rapid change, socially and possibly physically, as the resident population dies. Replacement might take several forms: (a) owner-

occupation by young couples in early married life where the housing is small and terraced because this offers a way into the owner occupied sector; (b) multiple occupation if the housing is sufficiently large for subdivision, or (c) wholesale redevelopment by the local authority or the designation of subareas as G.I.A.'s (as in Barkerend Road).

It was asserted earlier that the success of any typology must lie in its ability to discriminate between the variables in any data matrix so that inter-variance distances are maximised. The table below indicates the measure of success achieved by this typology in delimiting the spatial extent of Bradford's inner city.

FIG. 61

	Cluster 10 Bed-sit	Clusters 11,12,13 Ethnic Transit-ional	Clusters 3,4,5 Ageing Transit-ional	% of Total Category Distribution
No bath	10.9	35.0	25.7	71.6
No W.C.	7.3	37.4	23.0	67.7
Overcrowding	9.7	47.4	8.3	65.4
Shared Dwelling	33.3	30.3	7.0	70.6
Unemployment	6.1	19.9	12.1	38.1
Retired	1.8	10.1	25.9	37.8
Asians	9.0	68.9	4.3	82.2
Social Class V	3.4	20.6	15.5	39.5
Private Renting	38.3	28.0	7.7	74.0
Owner Occupiers	1.1	15.7	16.1	32.9
Council Tenants	0.0	2.3	7.9	10.2
% of ED's	3.2	15.0	18.5	36.7
% of city Population	2.5	13.5	14.7	30.7

SECTION D

A THEORETICAL SOCIAL GEOGRAPHY OF THE CITY

"Geographers who have become rapidly disillusioned with much of the modern geographical writing continue to look for the presentation of detailed, critical perspectives."

D. Slater 1975

Chapter 12

Towards a Theoretical Social Geography: a reformulation

"Confronted with anomaly or with crisis, scientists take a different attitude towards existing paradigms, and the nature of their research changes accordingly. The proliferation of competing articulations, the willingness to try anything, the expression of explicit discontent, the recourse to philosophy and to debate over fundamentals, all these are symptoms of a transition from normal to extraordinary research. It is upon their existence more than upon that of revolutions that the notion of normal science depends."

Thomas Kuhn 1970

TOWARDS A THEORETICAL SOCIAL GEOGRAPHY OF THE CITY

Marxian analysis is a structuralist analysis based upon the concept of the capitalist social relations of production and with its philosophical basis rooted in historical materialism. It is an attempt

> "to approach the totality of social existence by providing a set of concepts through which societal processes may be grasped as a whole rather than as a loosely linked set of social, economic and political factors (as in systems analysis)".
>
> (Lee 1979:54)

The economy is viewed as the starting point for analysis and it contains the key elements of the production of wants for any society which stand in a specific relation to each other within any particular historical context. The economic relations of production (particularly between capital and labour) provide the basic structural requirements for man's subsistence whilst also largely determining the superstructural organisation of political, legal and administrative institutions in society (Althusserian interpretations allow for relative autonomy at this level, but this is a contentious point).

Marx's analysis of the formation of social relations rests on the labour theory of value which he develops to reveal the real sources of profit and capital accumulation within the socio-economic system. It is this more than anything else which allows a structuralist theory of socio-spatial relations to be developed. The major obstacle to uncovering the relationships between social structure and spatial form

arises from the fact that Marx was never interested in this particular conjuncture. Consequently much of the work in this field rests in inference and interpretation from Marx's agricultural examples and footnotes of what he would (or might) have said had his interest been more specifically 'urban'. Much of the following discussion derives primarily, apart from readings of Marx (1974 Edition), upon the works of his interpreters - notably Althusser (1969), Castells (1969 & 1977), Lamarche (1972), Poulantzas (1973), Harvey (1972 & 1975) and Mandel (1968).

Lukács (1947) has stated that the materialist-dialectical conception of reality "means first of all the concrete unity of interacting contradictions", so any analysis that seeks to examine the relationships between social process and spatial form must begin with the 'interacting' and 'contradictory' forces that shape class configurations in advanced capitalist societies or, to use the nomenclature of Giddens (1973), the forces of class structuration. Harvey (1975:356) recognises two sets of internally contradictory forces - primary and secondary - that gain their contingent meaning within a specific historical context. The distinction between the two is, however, an abstraction for the purposes of the analysis; they possess no functional autonomy or independence of each other, or from the wider structures of which they are an integral part.

Two assumptions are central to the structuralist interpretation. The first is that in western society capitalism is the dominant mode of production in that commodities are prod-

uced, exchanged and consumed within a competitive system called the market. The second is that the nature of market relations is a constantly changing one. The fact that relationships are neither static nor absolute gives to Marxian analysis a vocabulary of explanation which is consequently both dynamic and contingent, and thus overcomes two of the main weaknesses of the functionalist paradigm.

Theoretical Analysis on the Formation of Social Relations

The market, then, is the medium permitting exchange for and the nexus between the production and consumption of commodities that are deemed to be of value by a society divided into two classes: employers and employed. A free and competitive market is the expression of the most basic and fundamental power relation in capitalism - that between capital and labour as this is revealed by the differential power relation between the owners of the means of production, capitalists, and the owners of saleable skills, labour. These are referred to as the social relations of production.

The key theoretical link between this primary force of class structuration and spatial form is made with the help of Lamarche's (1972) exposition on the concept of the circulation of capital. It is therefore necessary to understand not only the nature of the relations of production but also the nature of the circulation and means for promoting capital accumulation. Both are best explained by reference to Marx's 'money circuit of industrial capital' (Marx 1974 Book II,

chapter 1:25-64). [1]

Commodities are produced by the owners of the means of production, the employers or capitalists, whose prime motive for production is the accumulation and acquisition of wealth through greater profits. The human contribution to production comes from the sale of skills on the part of labour. Thus the fact that labour must sell its productive ability (skill) in a market situation means that labour-power assumes a commodity character. The reward for skill, or the sale of labour power, is the wage paid by the capitalist to the labourer. The power of labour lies in its prerogative to withdraw its labour power from the market when it wishes. Power, however, is also found in the hand of the capitalist but this power is double-edged in that the capitalist has firstly, ownership and control of the means of production, and secondly, he relies on the fact that labour must work to subsist and reproduce. In relation to the last point, Marx stated:

> "In the social production which men carry on they enter into definite relations that are indispensable and independent of their will; these

---

1

'Industrial capital' in the strict Marxian sense is an umbrella term for all capital circulating within industry run on a capitalist basis and which takes on the specific form of money capital, productive capital or commodity capital during the act of production. Lamarche's use of 'industrial capital' is more specific, relating to Marx's productive capital only and his use of it results from the fraction of capital.

> relations of production correspond to a definite stage of development of their material forces of production. The sum total of these relations of production consistutes the economic structure of society - the real foundation, on which rises a legal and political superstructure and to which correspond definite forms of social consciousness. The mode of production in material life determines the social, political and intellectual life processes in general. It is not the consciousness of men that determines their being but, on the contrary, their social being that determines their consciousness."
>
> (from the preface of 'A Contribution to the Critique of Political Economy').

It is the contradictory and essentially irreconcilable interests of capital and labour that generates a necessarily dichotomous model of class structure, though as Harvey clearly states (1976:357) the model is an abstract analytic construct aimed at revealing the exploitive character of capitalist production rather than a description of an actual class state.

The whole range of transference and exchange procedures from initial capital investment to the production and sale of a finished product was called by Marx the '<u>circular movement of</u> capital'. It takes place in three stages: M — C — M'.

<u>Stage 1</u>: the capitalist acts as buyer on the labour and commodity (i.e. instruments of production) markets. Money - capital (M) changes hands for commodities of the same use-value that will enable the capitalist to set up the means for production.

<u>Stage 2</u>: the capitalist acts as consumer of the purchased commodities of the means of production, commodity capital (C), in their transformation by production to new commodities for sale.

Stage 3: the capitalist returns to the market as seller of the finished product; these are transformed back into money - capital increased by surplus value (M').

Under capitalist conditions, then, the act of production involves the capitalist in transforming his money-capital into commodity capital and finally its metamorphosis back into money-capital by an amount equivalent to the original money-capital (M) plus surplus value ('). In Vol. II of 'Capital':48, Marx expands this general formula into:

$$M \text{ ——— } C < \begin{matrix} L \\ MP \end{matrix} \text{ ..... } P \text{ ..... } C' \ (C+c) \text{ ___ } M' \ (M+m)$$

The dots indicate the places where the process of circulation is interrupted and C' and M' designate C and M increased by an amount equal to surplus value.

M-C is the first stage in the conversion of money-capital (literally a sum of money) into commodity capital of an equivalent exchange value. These commodities are composed of the means of production (MP) and labour-power (L), hence the designation $C < \begin{matrix} L \\ MP \end{matrix}$, and the quantitative balance between the two is such that the combined capacity (i.e. the act of production) is at optimum where there is no underutilization of labour or the means of production. If the combination were below full capacity e.g. if MP were insufficient, the quantity of excess labour required to produce maximum surplus value (i.e. surplus labour) would be underutilized and therefore the value of surplus value would be sub-optimal.

When the transformation from M-C has been completed the capitalist possesses "a greater quantity of labour than is

necessary for the replacement of the value of his labour-power, and he has at the same time the means of production requisite for the realization or materialization of this quantity of labour" (Marx 1974 Ed.:27). In other words the capitalist has now transformed commodity-capital into productive capital (P) which has the propensity to create value (the money equivalent of the total value represented by labour time expended by the labourer and the value of the means of production) and generate surplus value (that value above and beyond the value required to reproduce the productive means). At this stage, however, surplus value is not realized, hence the value of P=L+MP. Therefore M=C=P in value terms; they differ only in their mode of existence at this stage.

It is in the appropriation of commodity-capital for money-capital (M-C) that the first metamorphosis of capital occurs. Taking the case, as does Marx, of M-L, the purchase of labour-power by the capitalist also involves the sale of labour-power by the labourer who owns it, in the form of a wage. This he needs to subsist and reproduce. Therefore, what is a transformation from M-C for the buyer (capitalist) is concomitantly C-M (or, more specifically, L-M) for the seller (labour). The transformation M-L is the hallmark of the circuit of capital reproduction because it "is the essential condition for the real transformation of value advanced in the form of money into capital, into a value producing surplus value." (Marx 1974 Ed.:29). On its own, the transformation from M-MP is not capable of producing value; the realization of productive-capital must await the harnessing of labour-power and its subsequent sale. Consequently it is the market relations

between the buyer of labour and the seller of labour-power that conditions the power-relation between the capitalist and the labourer because surplus value can only be realized when harnessed with the means of production. The owners of labour-power and the means of production are therefore distinctly separate.

The historical nature of the political economy of urbanism is perforce the study of the historical development of the reproduction of this basic social relationship. It is evident therefore that because the full circuit of capital reproduction presupposes this dichotomous class model on a wide scale, it applies only to the situation of already well established social relations of production. It presupposes a developed capitalist system of production.

The second stage concerns the entry into and functioning of productive-capital and its potential for transformation into surplus value. Capital accumulation is possible only through the production of surplus value(s), because without its production, money-capital merely exchanges hands - it is a simple transfer of values from one person to another, not the creation of fresh (surplus) values. Capital accumulation needs to be examined. The labour theory of value states that the total value (in money-capital form) produced by a labourer is greater than the value (again in money-capital form) of the wage paid to the labourer for his effort. As Mandel (1968:132) states:

> "The employer does not buy labour power (solely) in order to keep it alive; he buys it as he buys any other commodity, in order to realize its use-value. And the use value of labour-power, from the capitalist's stand-point, is precisely its capacity to create surplus value, to provide surplus labour

> over and above the labour needed to produce the equivalent of the wage paid for it. In order to be hired by an employer, a worker must work longer than is needed to produce his equivalent. In doing this he will create new value for which he will be paid nothing."

Labour-power reproduces the equivalent of its own value (the wage) and also produces an excess or surplus value; it is therefore known as variable capital (V). The means of production (machinery, plant, etc.), because they do not undergo any alteration of value are known as constant capital (C). (The depreciation costs associated with machinery are transferred to each commodity in the final realization). The value of surplus value is therefore dependent solely on variable capital acting in association with constant capital. The ratio of surplus value (S) to the value of labour-power (S/V) is known as the rate of exploitation since it indicates the degree to which the labourers are exploited; the larger the ratio, the greater is the share of new value created by labour which is taken by the employer. It is therefore the factor which governs the rate of capital accumulation.

The rate of exploitation can, however, be expressed in modified form as surplus labour/necessary labour (Marx 1974 Book 2 chapter 9). Necessary labour is (in value terms) the amount of labour required to create new value that sufficiently replaces the variable capital advanced; it is the amount of value created by labour that 'justifies' an equivalent return payment (i.e. exchange of value) in the form of wages. Surplus labour is that labour which creates surplus value which is then appropriated by the capitalist as part of his profit.

Therefore: $\frac{\text{surplus value}}{\text{variable capital}} = \frac{\text{surplus labour}}{\text{necessary labour}} = \text{rate of exploitation}$

It follows that the rate of surplus value produced can be increased in one or a combination of ways - a) by a fall in the numerical value of the denominator (necessary labour), i.e. by a fall in the exchange value (real wages) of labour; b) by an increase in surplus value without employing extra labour. This is achieved either by increasing the value produced per unit of labour power (i.e. increased productivity) or by an increase in the working day.

By the third and final stage of the circuit, productive capital is transformed into a form of commodity capital (C') again that incorporates the element of surplus value. It is in this way that the material base of the CMP is reconstituted and, more importantly, it demonstrates how and why social relations are continuously reproduced.

Increased labour productivity is usually brought about by moves towards greater efficiency and rationalization through mechanization. (Machinery takes on an increasingly competitive role with human labour and eventually comes to supersede it; unemployment therefore becomes a permanent institution). This, however, produces a contradictory tendency. Whilst the ratio S/V will be of interest primarily to the employed, the employer is more concerned with the profitability of all his capital outlay, (constant and variable). We have seen that the total value embodied in the commodities manufactured is made up of three component parts: the value of labour-power (V), the value of the means of production (C), and surplus value (S). As more

machinery is employed the ratio of constant capital to variable capital increases or, in the words of Marx, "there is an increase in the organic composition of capital." The more advanced an enterprise, the higher is the organic composition of capital, i.e. the larger is the share of total capital spent on machinery, raw materials etc. But it has been stated that surplus value is created only by labour-power (variable capital) acting in conjunction with the other means of production. Therefore, constant increases in machinery inputs do not increase the amount (or value) of surplus value. It is inevitable then for the rate of profit, defined by S/C + V, to fall as the value of new production inputs (C + V) increases. - the falling tendency of the rate of profit. It follows that the higher the organic composition of capital, the lower will be the rate of profit (since only variable capital can produce surplus value).

A further feature of the function of productive-capital is that capital value is taken out of circulation at this stage and transferred to the sphere of production. This is because in the transformation of money-capital (M) to productive-capital (P), capital value loses its money form and becomes embodied in machinery, plant, etc. which must enter into productive consumption rather than circulation. In many ways, therefore, production and circulation, though part of a continuous and necessary reproduction process are analytically quite distinct. Moreover, since surplus value accrues only from the labour embodied in it in the act of production, it follows that the circulation of capital is an unproductive activity in that it adds no further value. Capital in its productive form is, by definition, productive, since this is the stage at which

capital can be expanded through productive labour. "The means of production do not become the material forms of productive capital ... until labour-power, the personal form of the existence of productive capital, is capable of being embodied in them" (Marx 1974 Book II:37). It is a logical consequence therefore that capital involved in circulation is capital lost to the process of capital accumulation.

With this necessarily extended discussion on the formation of social relations the importance of space has been re-established for, as Castells says

> "there is no theory of space that is not an integral part of a general social theory"
>
> (Castells 1977:115)

His prospectus goes

> "beyond the description of mechanisms of interaction between locations and activities, in order to discover the structural laws of the production and functioning of the spatial forms studied"
>
> (1977:124)

In a similar vein Lamarche has stated that

> "if the city is considered to start with as a market where labour power, capital and products are exchanged, it must be equally accepted that the geographical configuration of this market is not the result of chance; it is governed by the laws of capital accumulation ... the urban question is first and foremost the product of the capitalist mode of production, which requires a spatial organisation to facilitate the circulation of capital, commodities, information etc."
>
> (Lamarche 1972:86)

Lamarche argues that there <u>are</u> certain problems which are specific to the city e.g. poor housing, high rents, etc.,

but these are not the product of a "specifically urban logic" or a "specifically urban structure"; they are the local consequences of capital accumulation. Within this theoretical perspective the city is not only the projection of society on space, but space is also an integral explanatory variable in the total urban structure.

This is why it is necessary to introduce Marx's "money circuit of industrial capital". There are two points relevant in this for a theory of space:

a) that surplus value results only in the production stage
b) that the circulation of capital from M-C or C'-M' (i.e. exchanges of either commodities or money) not only does not create surplus value but is also unproductive (i.e. create costs), especially in a temporal and spatial environment.

For example, the longer it takes for M' to be realized (i.e. the sale of commodities) the slower will be the rate of capital accumulation. It is to the advantage of the capitalist, therefore, to reduce to a minimum the period of time and costs involved in circulation and this is best achieved by the division of capital (like the division of labour) and the creation of specialised capitals, each with a specific function. Space also gives rise to costs of circulation since the less concentrated the spatial organisation between economic agents, the greater will be the costs of circulation (transport, communications, information etc.) and the more will they detract from overall surplus values. For this reason the administrative sector depends in part on the proximity of certain service establishments such as banks, credit institutions and of

information networks to produce spatial entities such as Wall Street, The City and Rue Saint-Jacques.

The nature of capital accumulation, then, always necessitates the search for ways of reducing the amount of capital engaged in circulation at any one time (i.e. in terms of time and space circulation costs). The fractions of capital therefore permit

a) industrial capital to concentrate on the process of production

b) commercial capital to convert commodities into money form (i.e. helps to realise their value); this requires the setting up of merchants, who, by acting as intermediaries, purchase the commodities produced by industrialists and offer the goods on the market themselves. For the capitalist/industrialist, the circulation of his capital is shortened and thereby lets him return to the factory quicker than he would otherwise.

c) financial capital to control the amount of money in circulation at any one time that is not engaged in industrial or commercial operations - a role fulfilled by banks, building societies, insurance companies, etc.

The particular function of the fraction of capital is to plan and equip space in order to increase the efficiency of commercial, financial and administrative activities by reducing their indirect or unproductive costs. It is able to do this in three ways:

First, the specialisation of functions minimizes the time taken for any form of capital to complete the circuit. Thus, wholesalers as intermediate merchants are able to inject capital

back into the industrialist's circuit of capital so that he can realise surplus value sooner (though the intermediate merchant must then wait to realise the full circulation of his capital). Second, if capital circulates within the economy at a reasonably fast rate its cost to the owners of production is kept low because, for instance, interest payments on capital loans are reduced. Finally the financial institutions bolster the amount of capital available in the economy (as does the State) by their lending policies whilst at the same time minimising the amount of non-productive capital in circulation: both factors facilitate the reproduction of social relations in the capital market.

It is for these reasons that Marxists see the city as a product of capitalism. For them, the city is the form of spatial organisation/concentration of the means of production, exchange and distribution, and consumption. (Consumption, an element not discussed at length by Marx, must be introduced because it is the means whereby surplus value is realised in the sale of commodities). When they talk of urbanization or urban development, Marxists are referring to the emergence of spatial concentrations - to minimise the circulation of non-productive capital - which have a necessary function in capitalist social formations. The city must be seen as the logical product of capitalism, and therefore social relations (though operating in an 'urban environment') are not the result of specifically 'urban' processes but of the historical development and increasing rationalization of capitalism itself.

Moreover, space is now integrated with a general social theory. The circulation of capital is a statement of the basic relation

between society and space and it replaces the need, conventional to geographic practice, of looking at spatial form as though society operated on a blank page to reflect a given spatial configuration. As Castells says "society cannot be reflected in space since it is not external to it." Space is seen, therefore, not simply as the projection of society, but as a concrete element with explanatory significance that is capable of being related to a broader social theory; in fact the significance of space can be understood only in relation to the social theory - its meaning is contingent.

Housing and Social Segregation at the Intra-City Scale

The spatial distribution of social groups within a city follows the general laws of the distribution of commodities according to the circulation of capital and necessarily brings about regrouping according to the market capacity (ability) of households (i.e. according to income, age groups etc.) to gain access to the housing stock of the city. Put simply, urban segregation is explained through the production, exchange and consumption of housing.

Housing, besides being an essential element in the social reproduction of labour power, is also produced like any commodity and is therefore a vehicle for the realization of capital accumulation. There are, however, at least four obstacles to the direct translation of Marx's circuit of industrial capital to the housing system that result from unspecified details about housing in Marx's own writings and from features that are particular to housing as a commodity. First, housing requires land as an input, some of the qualities

of which cannot be reproduced in the capitalist system because of its scarcity. Land as a consequence has an exchange value dependent upon various forms of ground rent (differential rents I and II and absolute rent) but these need not concern us here. Second, housing has a long period of rotation of industrial capital. This is partly a result of the long period of production (from C to C') and, more significantly, there is a long period for the full realization of the sale. Third, because housing is an expensive commodity for many people, private appropriation is not possible and alternative (or additional) mechanisms have evolved which make housing available for those who cannot afford to own outright. Traditionally these mechanisms have included state intervention in the housing market through the provision of public housing and indirectly through the Housing Corporation, renting privately from a landlord, and purchase through loan finance. The role of state intervention in the allocation of housing has become ofmajor research interest (Lambert, Paris and Blackaby 1978, Schifferes 1976, Gray 1976) because of its direct influence through housing provision and statutory controls of standards, and indirectly through mandatory regulations by which other tenure categories are allowed to operate. The role of the state in housing therefore requires further discussion.

Finally, it is because housing costs form such a large outlay for most households that it is <u>rarely</u> purchased outright. Credit has to be introduced into the conventional circuit and a new sub-circuit of loan capital (or circulation capital) develops. Mandel (1968) has defined "circulation credit as the realization in advance of the value of commodities already produced." Therefore credit in the form of a loan must be

injected as a premature means for the realization of the surplus value and thus permit industrial capital to pass rapidly back into general circulation and production. A need emerges, therefore, for financial institutions (the financial intermediaries) to lend capital to the purchasers of housing. The financing of the private housing sector therefore develops as a secondary circuit with an extended period of rotation - the circuit of loan (credit) capital - which in the case of owner occupation is usually 20-25 years.

It is possible to represent these primary and secondary circuits of capital flows schematically for different tenurial groups in the manner of true structuralist models. For example, in the private purchase of property most people seek mortgage facilities from one of the established financial institutions (usually a building society). Subject to conditions a loan is financed and weighted for an additional return on interest as a payment for the services of the lending institution.

Thus:

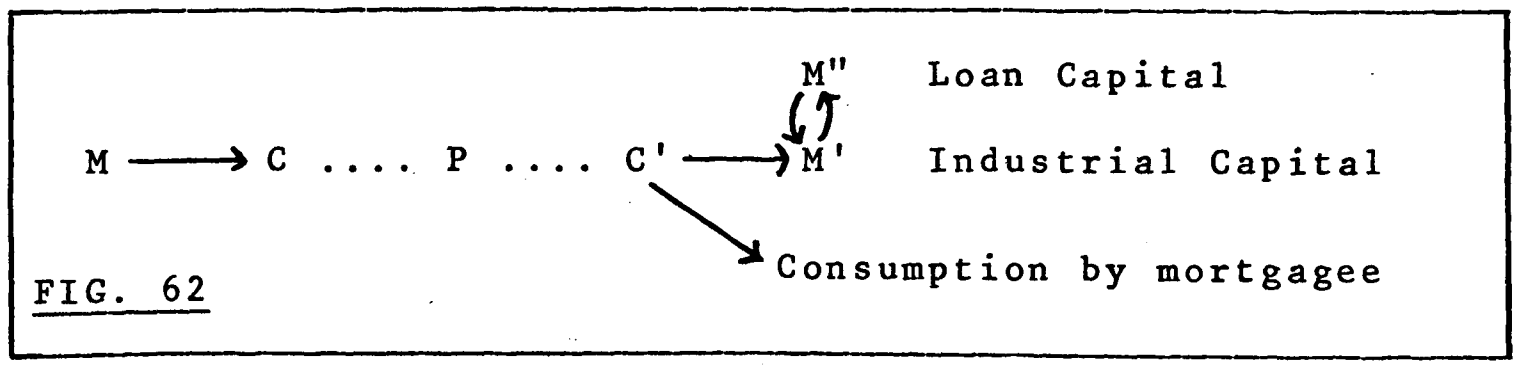


FIG. 62

In this way the purchaser is able to 'consume' his property and the builder realizes his profits and completes his circuit of industrial capital.

In a similar manner the circuits for private renting can be illustrated:

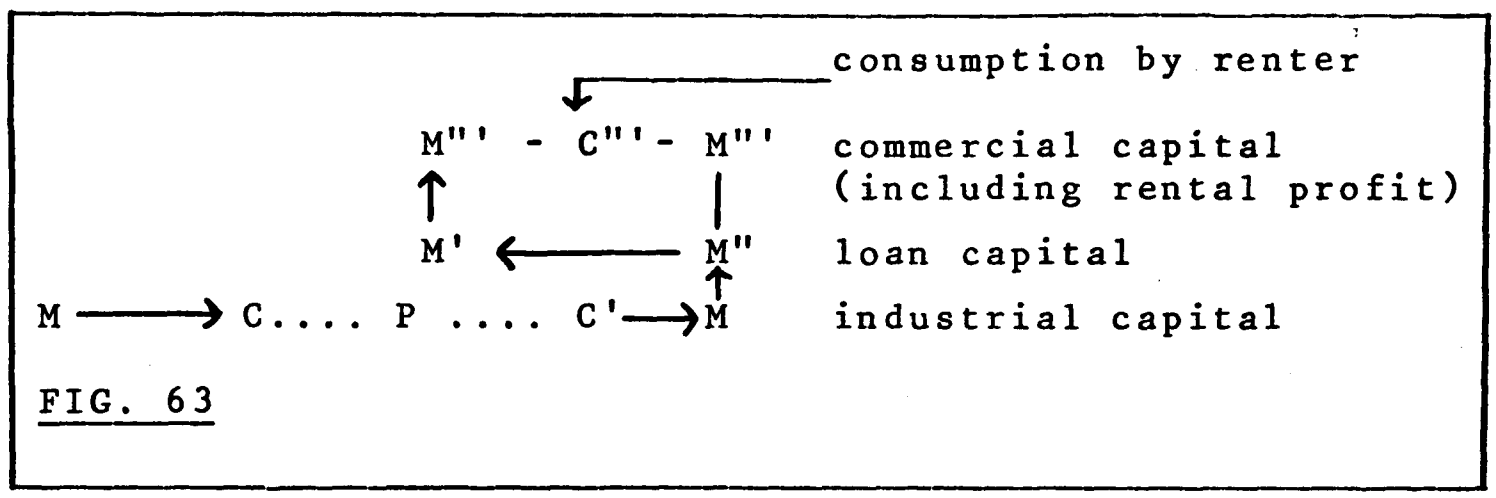


FIG. 63

A landlord would possibly raise commercial capital from the bank at current interest rates to purchase his property which he would then let at a rental charge which would cover his loan, interest payments on the loan, and make a profit for himself. In reality of course each source of capital will be represented by its own system of primary, secondary (and maybe tertiary) circuits of capital so the <u>total</u> picture for any one property transaction can become very complicated. Boddy (1980) has recently devised similar models.

The circuit of loan capital takes on great importance in the maintenance of capital accumulation in the housing market and in this respect echoes the emphasis placed by Harvey on the importance of financial institutions (and the government) in the management of urban systems (Harvey 1974). Harvey appears to support Lefebvre's assertion (Lefebvre 1970) that industrial capital's share of the realisation of surplus value is falling relative to that of finance capital with the latter extending its control over the processes of production, realisation <u>and</u> consumption. It may be that the recent credit explosion is a response to the changing nature of late twentieth century

capitalism and a partial answer to the problem of underconsumption. Baran and Sweezey (1966) have argued that vast economic surpluses have been produced since the 1950's as the momentum for intra-firm rationalisation increased but that effective demand has not kept pace. The real problem now is not so much the production of surplus values but its realisation in the form of profit. Strategies for absorbing the surplus are threefold. First, there is increasing state intervention in the form of massive expenditure on collective goods (such as motorways, industrial estates, housing). Second, a massive sales effort through modern advertising stimulates latent demand by encouraging material wants and mass consumption (akin to Marcuse's "One Dimensional Man", 1964). Thirdly, these 'needs' are realised in a materialist society by credit facilities on an increasingly large scale. The primary circuit of capital may then be a legacy of late 19th and early 20th century capitalism and is therefore considerably less important in the welfare capitalist era, although all circuits of capital must necessarily be closely related.

It is because of the importance attached to secondary circuits that Harvey has stressed so strongly the importance of public and private financial institutions in the allocation of loans and investments to different housing submarkets (Harvey 1974) and the consequent shaping of housing space (Harvey 1975). For example, his analysis of finance capital and the Baltimore housing market showed that different financial institutions were responsible for loan advancement in different price ranges and serviced different areas of the city. Significantly it was noted that most institutions operated a 'minimum lending policy' in the inner city where there is a high risk

of deterioration in property values. Cash payments dominated inner city housing transactions. Spatially this policy (or outcome) has seen controversial parallels in Britain with the redlining practices of building societies (in chapter 14 some empirical evidence is available to support this) and, certainly in the U.S., Federal Housing Agency programmes had to be introduced in the 1970's to stem social unrest caused by bad housing. Through the operations of the finance institutions Harvey was able to identify thirteen housing submarkets in the residential mosaic of Baltimore, each with distinctive patterns of tenure, house prices, income levels, and ethnic patterns.

The price of housing as such is not central to the present argument although it does of course determine which social groups are allowed access to it in the owner occupied sector and presumably it must have some bearing on the determination of rent and rates in the rented sector. Basically the final price of a house is made up of four components: a) a land rent payment, usually termed ground rent; b) interest repayment on the loan either to a building society in the form of a mortgage or to the local authority as a loan advance; c) a capital repayment to cover the cost of materials, labour and builder's profit; d) the current state of demand for and supply of the housing stock. The exact nature and importance of these components has been the subject of intense debate amongst academics particularly concerning the nature of housing rent and its further subdivision into differential, absolute and monopoly rents (see Harvey 1974, Breugel 1975, Byrne and Beirne 1975, Clarke and Ginsberg 1975, Edel 1976). The debate is far from resolved and will not be entered into here although this is a crucial aspect of housing production. We shall take the

price of housing as given and instead examine the effects these prices have on the nature of exchange and consumption for it is in their relationship with social groups in the sale of housing that spatial differentiation is clearest.

In a sense the introduction of secondary circuits of finance capital must require a modification to the strictly Marxian analysis of capital accumulation. According to Marxist theory surplus value is only created in the production process of the circuit of industrial capital but the presence of secondary circuits means that some of this is appropriated by commercial and loan capital in the form of rent and interest payments. Moreover the realization of surplus value in the housing market reflects the original costs of production only in the case of new property. Since most housing transactions are dominated by second-hand homes the finance capital required reflects current replacement costs rather than original production costs. The realization of surplus value in the housing market situation therefore becomes divorced from the production side of the equation as the transaction involves property of greater age.

The relations expressed in the circuits of fractions of capital represents the most basic and fundamental workings of the private sector of the economy and represent the essential elements to an understanding of the private sector housing market. It is necessary at this stage however to develop the argument on the relations between the analysis of social formations and its expression in the residential kaleidoscope at the intra city level. The analyses of this problem by Harvey do not explain the precise way in which one social group, say the manual working classes, is located towards

the edge of the inner city as in Bradford. It is necessary to clarify the way in which our analysis of social formations, through the web of the circulation of different capitals determines who should benefit from the services of the housing institutions concerned, how they do it, and where they should be found in the city. An analysis of the circulation of capitals per se does not offer this.

Drawing on the analyses of Althusser (1969), Poulantzas (1973) and Castells (1977) it is possible to recognise structures within any socio-political system. This is necessary because a Marxist interpretation requires the analysis to go

> "beyond the description of mechanisms of interaction between locations and activities in order to discover the structural laws of the production and functioning of the spatial forms studied" and therefore "there can be no specific theory but ..... a deployment and specification of the theory of spatial structure in order to account for the characteristics of the particular social form, space, and of its articulation with other ..... forms and processes"
>
> (Castells 1977:124)

Castells identifies three 'levels' that shape social structure: the economic, the political/juridical, and the ideological; they are mutually interdependent and causally related with the economic level 'determinant in the last instance', although he does believe that each level possesses a degree of relative autonomy. These levels are

1) economic level - this refers to the organisation in space of the relations between capital and labour
2) political/juridical level - this refers to the politico-institutional organisation of space particularly by the state at different levels (national to local)
3) ideological level - this refers to the symbolic organ-

> isation of space in that some residential areas are regarded as working class by a 'network of signs' such as monotonous rows of terraces, high density living, absence of gardens, and so on, whilst others clearly indicate a different class membership.

A thorough understanding of the housing market would require detailed discussion of each of these levels and of the causal relations between them but for the moment attention must be directed towards a clearer specification of the economic level since it is suggested by the analysis so far that this is the most important axis of residential differentiation.

For the realization of surplus value within any of the circuits of capital identified the transference of capital forms must pass through three analytically discernable stages: production, exchange and distribution, and consumption. For example in the housing market there must be a bringing together of activities to produce the commodity in the form of building materials, labour and finance capital. Equally the realization of surplus value depends upon the consumption of the commodity either by the individual household or collectively by society (eg. housing). Necessarily the commodity in question has to be exchanged between the stages of P and C but also exchanges must take place <u>within</u> P and <u>within</u> C (hence the complexity of circuits) and in this respect intermediary agencies interject to speed the flow of capital (eg. estate agents, solicitors, building societies, in the housing market). The concept of exchange can take two forms: a service to speed up the rotation or the physical transportation of capital usually in commodity form across space.

The notion of 'housing classes' first discussed by Rex (1967) has come under a lot of criticism in that in true Weberian style it diverts attention away from the basic structural relations between labour and capital and that each class posits a common value system expressed through individual choice and preference. Clarke and Ginsberg (1975) for example argue that "in a formal sense class and tenure do not overlap" so that housing struggles should not be regarded in purely tenurial terms. The argument developed here takes a similar stance and is based on the following assumption. Housing is a commodity and therefore subject to the same power relations between labour and capital as any other commodity and subject also therefore to the consequences of capital accumulation. Furthermore it is argued that just as there are unequal rewards in the production of value there must also be inequalities of distribution (as in different wage rates between occupations) and an unequal consumption of value. Therefore, although orthodox Marxian analysis defines class in terms of its relation to the process of production it seems inevitable that there must also be (social) groupings which can be distinguished by their consumption of material goods (in this case housing).

In the context of housing there is very clear empirical evidence to confirm the differential rewards to different consumption groups. Despite limitations of definition (especially their inconsistency with theoretical concepts such as social class) there are often considerable divisions between tenants and owners and between non-manual and manual occupations (see Fig. 64). For example 85% of all professionals own their property; only 8% rent from any sector.

SOCIO-ECONOMIC GROUP OF HEAD OF HOUSEHOLD BY TENURE : GREAT BRITAIN 1971

Socio-Economic Group

	Employers and Managerial	Professional	Intermediate & Non-manual	Skilled & Semi-Skilled Manual	Unskilled Manual	All Heads of Household
Sample Number	1699	453	2297	6104	764	11664
	%	%	%	%	%	%
TENURE						
Owner Occupied	74	85	59	38	21	49
Rented from local authority	10	3	20	41	56	31
Privately Furnished	1	2	5	2	3	3
Privately Unfurnished	7	2	11	13	18	12
Other	8	6	6	6	3	5

(Source: General Household Survey: Introductory Report 1973 Table 518:109)

FIG. 64

By contrast 56% of all unskilled manual workers rent from a local authority and a further 21% rent from the private sector.

Therefore it is fair to say that 'classes' are created based on consumption as well as production but that the causal structure of consumption groupings is determined ultimately in the economic level. [1]

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1. This argument does not mean to imply that there is a one-to-one correspondence between social class and consumption grouping though one would expect some correlation. It is quite conceivable that any one particular social category could be found in a range of tenures, qualities and types but on a macro scale of analysis this might be expected to be small.

The use of the term 'class' has a very specific meaning in Marxian analysis and therefore it would seem better to use the term 'grouping'. Therefore within any economic system a differential system of rewards must logically lead to differential access to the material goods and services on offer whether these be cars, washing machines, televisions or houses. Differential access in the housing market will vary between tenures because the rules of housing allocation tend to be specific to each form of tenure. (This is why tenure is an important taxonomic criterion). Thus owner occupation in Britain is largely determined by the requirements of the circuit of finance capital in building societies (and more recently of the commercial banks) and of the constraints these requirements impost on their lending policy. (see Ball 1976). The position of a consumption group in the housing market will therefore depend on several factors: its ideological commitment to a certain type of property, the state of the housing stock (a combination of both private and public supply) and its eligibility to enter the market at the level desired (Ball and Kirwan 1977).

It is the distribution of housing in social space according to the criteria of capital accumulation that produces the mosaic of residential areas.

> "The distribution of residential locations follows the general laws of the distribution of products and .... brings about regrouping according to the social capacity of the subjects ..... according to their income, professional status, educational level, ethnic group, age, etc."
>
> (Castells 1977:169)

Thus the circuits of loan capital are most secure from the

building society's point of view when the capital is invested in property of a suitably long life and in a mortgagee who is unlikely to default on payments. The circuits therefore define and equip space by segregating consumption groupings in such a manner that the rotation and realization of surplus value is completed in the quickest time at the least cost to the owners of that capital. It is thus possible to speak of the friction of political space economy.

The formation of social relations, based as they are on the internal contradictions of the economic structure, means that the housing market (as part of the structure of social relations) acts as an arena for their working out. Conflicts between the interests of capital and labour will be seen in the fractions of capital discussed earlier and, perhaps more clearly, in their agents. Institutional agencies pursue their own interests towards capital accumulation and these can often be contradictory. The accumulation of industrial capital is helped by low land prices, high house prices and a steady supply of low interest loans to maintain a buoyant market. Landowners however benefit from high land prices and high interest rates because this determines the return they can expect from leasing their land. Consequently

> "the contradictory nature of the system means that individual capitalists, in pursuing their own specific interests, create situations that threaten the reproduction of capital as a whole".
>
> (Bassett and Short 1980:179)

The state intervenes in the housing market to regulate the contradictory forces at work and to maintain the relative stability of the system. It may intervene at different

levels: structurally, through the process of direct housing provision (i.e. housing production) as in council housing or through its housing associations funded from a central coffer; and superstructurally, through, for example, statutory regulation of the financial institutions (setting of MLR, tax concessions on mortgage interest repayments, rent controls, etc.) Although the theoretical position on state intervention is not clear (see Jessop 1977) it does seem that the state pursues its economic operations in a manner entirely compatible with the private individuals and institutions. It might be expected therefore that the consequences of this for the allocation of housing amongst concumption groups might be similar to those of the private sector whilst at the same time trying to reconcile the need for housing the urban poor. In the absence of necessary data only some of these ideas are examined in the following chapter when empirical evidence is made available but without entering the polemical debate on the functions of the state (but see Marcuse 1977).

Chapter 13

The Historical Socio-Spatial Structure of the Nineteenth Century City

"The present without the past has no meaning."

anon.

RESIDENTIAL DIFFERENTIATION: SOME HISTORICAL PERSPECTIVES

The historical geography of nineteenth century Bradford provides many insights into the material processes that influence the differentiation of social groups spatially and temporally and is suggestive of the historical forces that at least in part shape the present day spatial geometry. The nineteenth century is particularly instructive because of the rapid rate of industrial growth and the accompanying development of the social relations of production.

Drawing on a typology of residential areas for 1850 and 1880 with data extracted from trade directories, census returns and supplemented by local archival evidence this section attempts to unravel the complicated network of historical factors that help to explain the social and spatial character of the city today. The explanation is sought at the level of structural changes taking place in the local economy and of the way this influenced the contemporary geometry of socio-spatial environments. The social geography of nineteenth century Bradford reflects an amalgam of forces that shaped its character and laid the foundations for the built environment that have a profound influence on the social topography of today. The massive population increase from 13,264 in 1801 to 228,628 in 1901 was itself highly significant but it was also accompanied by massive immigrations of polar social groups from Ireland (unskilled labourers) and Germany (industrialists). The structure of the economy changed from a small home-based textile industry to a highly concentrated (in terms of both capital and space) factory-based system that had fundamental repercussions on the allocation of residential space for the

labouring classes. The incorporation of the Borough of Bradford in 1847-8 meant, among other things, the passing of byelaws to regulate and control the less acceptable face of urban housing development. Also in 1882 the Corporation took the first steps at introducing a municipal tramway system which, by providing low cost transport, began to make the villages and hamlets on the higher slopes of Bradford Dale more accessible and this initiated the earliest form of sub-urbanization (though there had been a steady centrifugal movement since 1800). The appearance of terminating and building societies towards the middle of the century and the formation of land societies provided organised financial backing of greatest benefit to the middle classes and contributed in a substantial way to their increased segregation from the central areas of poverty, crime, and substandard housing of the labouring classes. The scale and pattern of landownership, and the predominance of freehold tenures, strongly influenced the direction of growth for the town throughout the century and of the differentiation of land within it. Each of these factors, singularly and severally, had an impact on socio-spatial differentiation in the built environment at the time but also gave rise to the inertia of building form in that the extent of residential areas in 1880 broadly defines the inner city of today.

The population of Bradford in 1780 has been estimated at 4,200 (Turner 1884) and the settlements of which it was composed were clustered alongside the banks of Bradford Beck. Most of the population was occupied in the small cottage industry of cloth-making but some remained in coal mining from shallow pits throughout the Dale. By 1801 the recorded

population was 13,264 and increased to 103,778 in 1851, a mean annual rate of increase of about 5%. By 1881 the population reaches 183,032 and by 1901 was 228,628. A peak of 298,692 was reached in 1931 and ever since the population total has steadily fallen. Despite three substantial boundary changes in this period 1801 to 1901 the city grew at an unprecedented rate as a result of rapid and large scale industrialization .

POPULATION GROWTH OF BRADFORD 1801 - 1971.

Year	Area acres	Population	Mean annual change (percentage)	Areas included
1801	6,590	13,264	2.1	(a) Bradford Borough as constituted in 1847 including the townships of Bradford, Bowling, Horton and Manningham
1811		16,012	6.5	
1821		26,309	6.6	
1831		43,527	5.3	
1841		66,715	5.6	
1851		103,778		
1864		118,098	1.1	(b) Bradford Borough as defined in (a) plus Bolton
1871	7,326	147,101		
1881	10,802	183,032		(c) Bradford Borough as defined in (b) plus Allerton, Heaton, Tyersal townships
1891		216,495	1.8	
1901		228,628	0.6	
1911	22,881	288,458		(d) Bradford Borough as defined in (c) plus Thornton, Tong, N.Bierley, Idle
1921		285,961	0.1	
1931		298,692	0.5	
1941		No Census		
1951	25,529	292,405		(e) Bradford Borough as defined in (d) plus Clayton
1961		295,922	0.1	
1971		294,177	0.1	

FIG. 65

From the figures available it appears that natural increase accounted for only 1% per annum of the increase over the first half of the century and diminished thereafter. Crude birth and death rates fell by about the same rate over the period (8.5 per 1000) although infant mortality showed fluctuations. In marked contrast immigration must have contributed 80% to the annual rate of growth. That is, migration accounted for a 4% annual growth rate out of a total 5%. The facts of the migration are less important than the nature of the migrants themselves for it was their social composition into remarkably polar social groups that played a considerable part in the shaping of the residential structure of the city throughout the 19th century.

The period 1800 to 1850 was one in which Bradford experienced a rapid transformation from a small market town to a large industrial city. The basis for this economic development lay with local deposits of coking coal and iron that had been worked since the 16th century but which by 1866 were producing 976,000 tons from 48 collieries and 4,390 tons of pig iron respectively (Richardson 1976, Chapter 5). It was against the setting of these heavy industries that the real economic base of the city emerged and grew to give the region an apt title - "worstedopolis". Cloth making is a trade with a long history in Bradford Dale and dates back to at least 1540 but by the 18th century worsted making as the principal cloth manufacture was established in several townships around Bradford including Bowling, Eccleshill, Idle, Wibsey and Wyke. At this time the economic and spatial organisation of the industry was cottage-based which created a dispersed distribution based on the home location of the producer but the concentrations of the popu-

lation in small townships laid the basis for the city's subsequent polynuclear pattern. By about 1830 the worsted trade had begun to concentrate along the watercourses (Bradford Beck, Horton Beck, Low Beck) and later along the railway sidings, and throughout this transitional period the cottage organisation of production persisted in the warrens of narrow back-to-back streets, courts and alleys. However by 1834 there were 34 mills in full operation and at this time a new style of building to house the workers had begun to appear in tight clusters close by the textile mills, foundaries and dyehouses in the valley bottoms. Conditions at this time were not good and it was common to find housing developments without surfaced streets, no provision for drainage, and no street lighting.

The census of 1841 recorded a massive 53% growth in the population since the previous returns and moves began to petition for a charter of incorporation as a county borough which actually saw fruition in 1848. It was with the advent of byelaws from 1854 and the regulation of the built environment that some ameliorating influences were felt on the urban fabric. By this time the urban area had spread out, partly as ribbon development, to include the industrial cores of several villages: Manningham, Great Horton, Little Horton and Bowling (see Fig. 66). The year 1850 provides a useful point at which to assess the residential structure of the city, partly because it marks the watershed in rapid population growth but more particularly because of the beginnings of the regulation of urban development by the newly incorporated borough. The vast increases in population experienced at the beginning of the 19th century brought about a new type of

THE GROWTH OF BRADFORD, 1800 - 1873

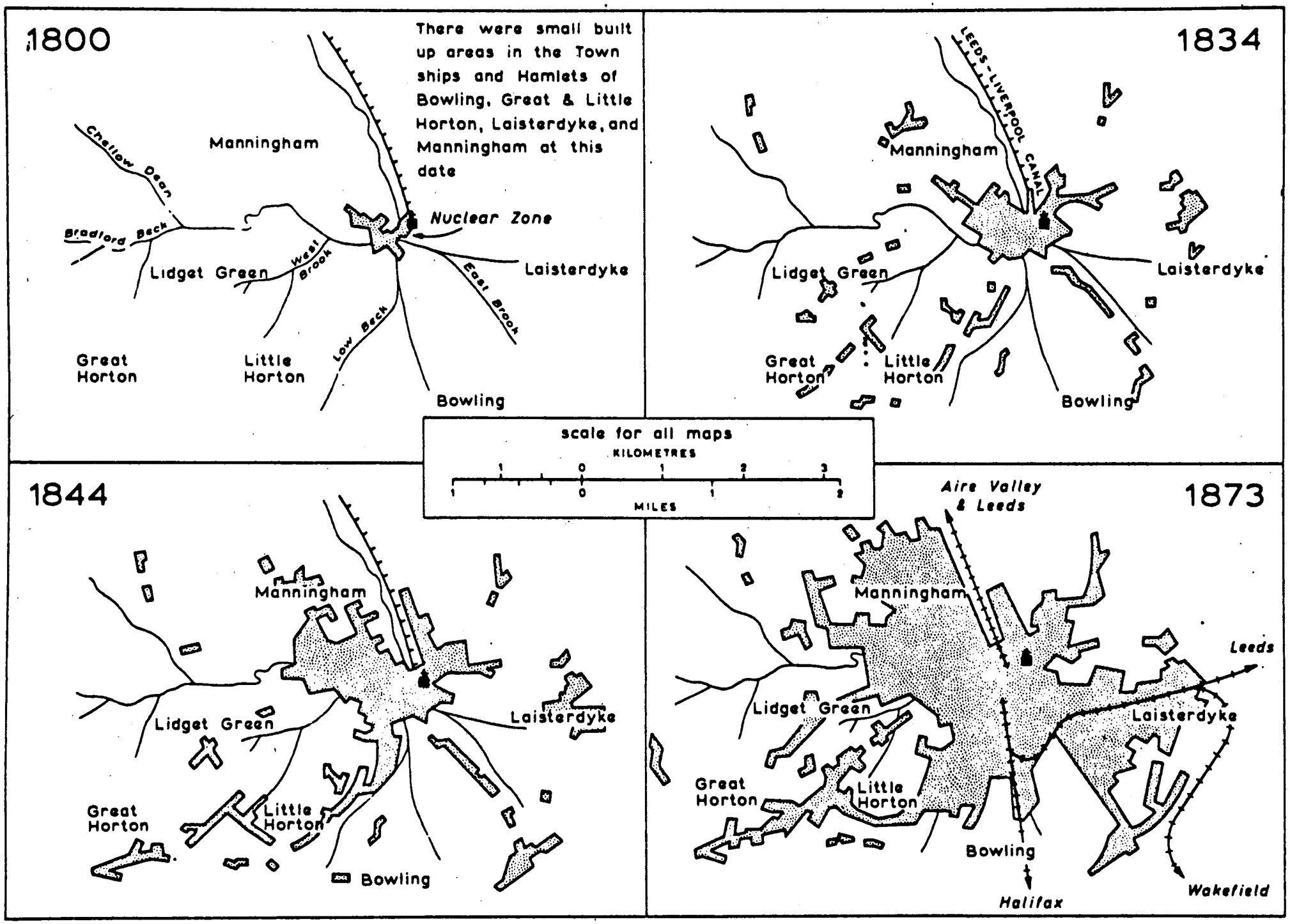


Fig. 66

urban development - house building in polyglots but over large areas, for prior to this, extensions to the built up area had been ad hoc and small scale. The pace of expansion not only required a new approach to the building of property but it also ushered in the jerry-builder of working class homes. It is necessary therefore to establish for this point in time the pattern of residential areas in the city when the 'raw' forces of industrialization were at their clearest and most potent.

Social Areas and Residential Differentiation in 1850

It was considered instructive to impose some form of classification so that different residential areas could be distinguished. With the archival evidence available it was decided to use two main parameters without recourse to multivariate techniques: social class and housing type. Marxian definitions of social class are not amenable to statistical analysis in the strictest sense so the surrogate 'income' was adopted since this type of information was available from the 1851 census returns. The enumerators' returns from 1841 onwards provide a rich source of data for historical geographers since, for the first time, "all the principal occupations in the country are recorded and the whole population is brought directly into the tables of enumeration" (Booth 1886:315). Beresford (1963) and Armstrong (1968, 1969) have discussed their utility. House types were gleaned from the conditions set by local byelaw regulations but also from available cartographic evidence, using Dixon's map of 1847 (Fig. 67) and the 1852 edition of the first 6" to 1 mile O.S. map (surveyed in 1847-48) available in Bradford Central

The section of T. Dixon's map of Bradford showing the central part of Bradford surveyed 1844-46

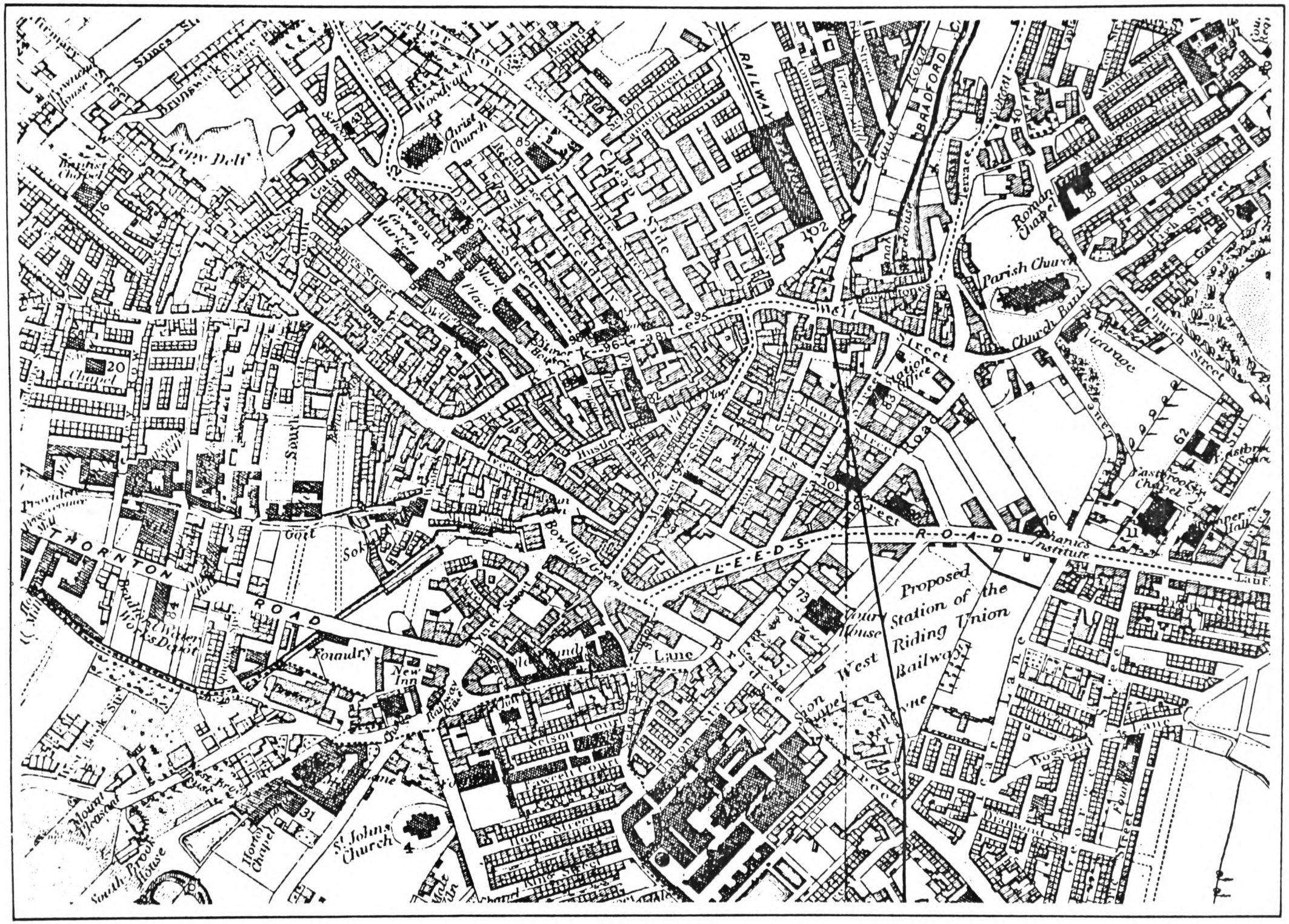


Fig. 67

Library. The classification of incomes is somewhat arbitrary but attempts to reflect the distribution of occupations in the borough at this time which, as Fig. 68 shows, was weighted towards the labouring (i.e. unskilled) classes, particularly the Irish.

THE OCCUPATIONAL STRUCTURE OF THE BRADFORD BOROUGH AND OF BRADFORD IRISH IN 1851

Occupation	Bradford Borough		Bradford Irish		Irish as percent of Bradford
	No.	%	No.	%	
Total	103,778	100.00	8,687	100.0	8
Teachers	240	0.2	19	0.2	8
Servants, Nurses and Midwives	2,108	2.2	268	3.1	12
Charwomen, washer-women	894	0.7	199	2.3	25
Tailors	816	0.1	143	1.7	18
Other needle trades	2,078	2.9	222	2.6	11
Boot, Shoe Footwear	1,069	1.0	52	0.6	5
House proprietors					
Bankers, Agents etc.	200	0.2	-	-	-
Food and other shopkeepers	2,347	2.3	66	0.8	3
Hawkers & pedlars	413	0.4	334	3.9	81
Agriculture and Horticulture	1,020	1.0	73	0.8	7
Machine-making					
Millwrights etc.	1,113	1.1	4	0.1	0.0
Building crafts	2,628	2.6	72	0.8	3
Dyers Bleachers	539	0.5	18	0.2	3
Stuff, Woollen Worsted Mfr.	33,142	32.0	3,377	38.9	10
Woolstaplers	136	0.1	1	0.0	1
Other textiles	1,520	1.2	30	0.3	2
Coal mining	1,049	1.1	10	0.1	1
Iron mining	76	0.1	1	0.0	1
Railway Labourers	139	0.1	60	0.7	43
Other Labourers	997	1.0	584	6.7	62
Iron manufactures	870	0.8	17	0.2	3
Boiler manufactures	101	0.2	3	0.0	3
Other metal	761	0.7	20	0.2	3
Other occupations	5,473	5.0	172	2.0	3
Children etc.	44,349	42.7	2,942	33.8	7

FIG. 68

Source: Richardson 1976:100

Consequently three categories of income were established:

1) income category A - 7/- to 19/11 per week ⟶ labouring classes

2) income category B - £1 to £2 per week ⟶ skilled manual classes

3) income category C - over £2 per week ⟶ professional classes

The category 'professional classes' also includes the merchant capitalists with incomes far in excess of this figure but they were included because of their relatively small numbers but enormous impact on creating social segregation. Housing types were classified in the following manner:

1. cottage terraced property predating 1840 built within or near to the old city core of Bradford Dale
2. back-to-back terraced housing with no yard, a common yard or individual yards
3. through terraced housing with a backyard and occasionally a small front garden
4. villa-type semi- and detached housing but also including some large terraces.

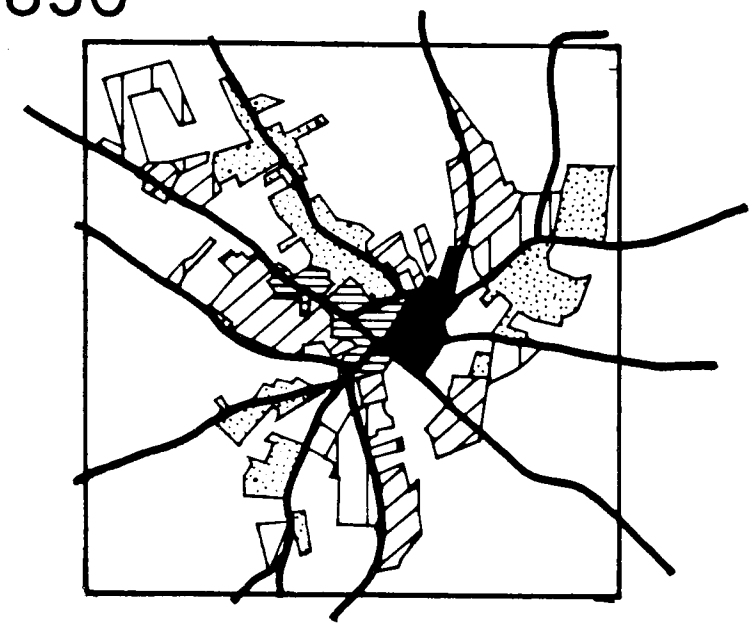
This classification summaries the main types of housing available in the city at the time. By cross-tabulating the two sets of parameters it has been possible to identify a number of distinctive social areas that account for the residential topography of the rapidly growing 19th century city (see Fig. 69).

Social Area One: Labouring classes in Courtyard Property

This residential area is represented by the lowest income groups in a variety of low status occupations such as building workers, labourers, and hawkers. The house type is typically of the

RESIDENTIAL AREAS IN BRADFORD

1850



Old city core

Labouring classes in pre-1850 (courtyard) property

Labouring classes in early terraced cottages

Skilled manual workers & some labourers in back-to-back property

Professional classes in detached & semi-detached villas

0 ·5

km.

Pre-byelaw working class housing

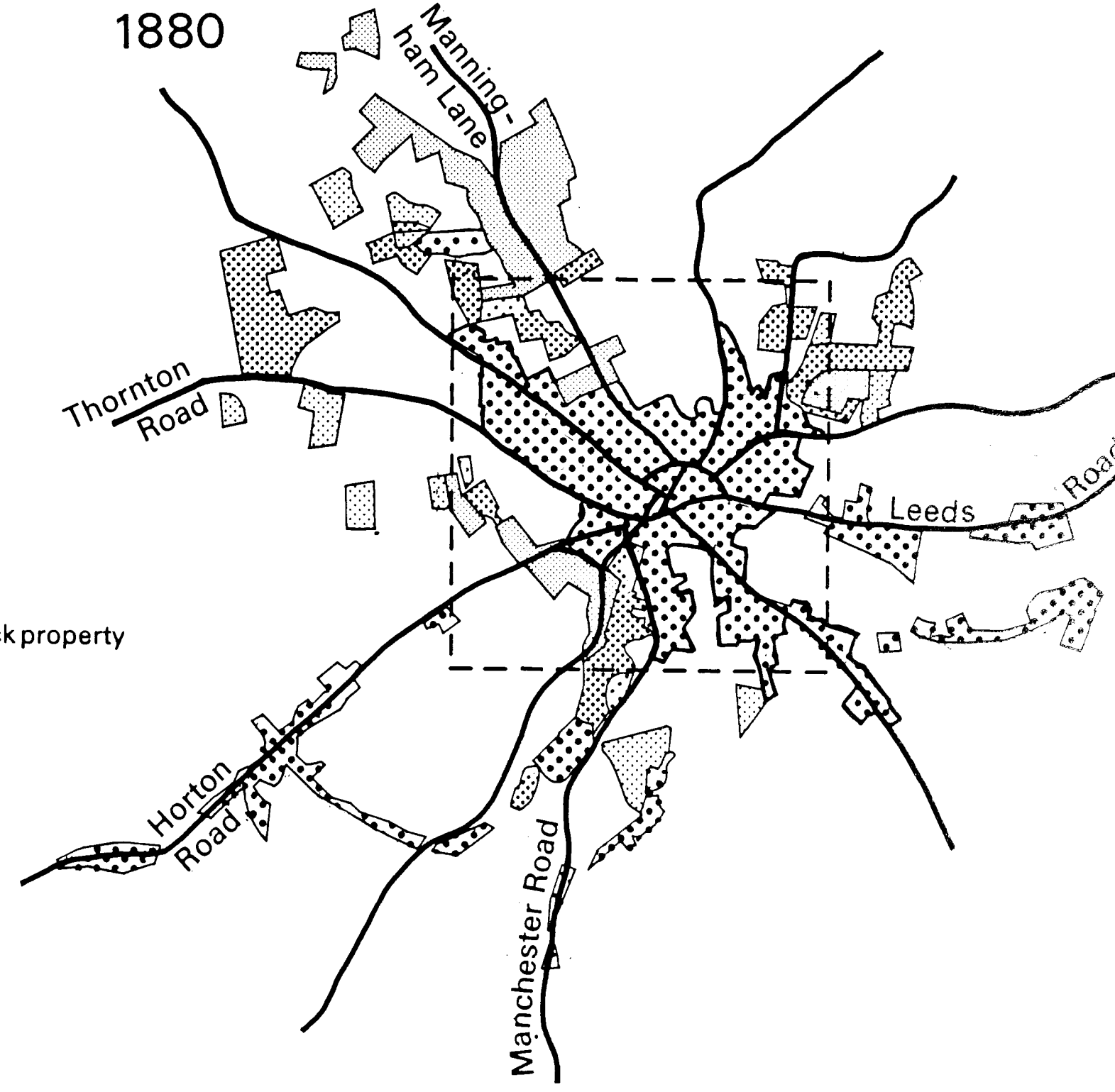
Lower middle social classes

Byelaw back-to-back working class areas

Middle & upper class suburbs

Fig 69

1880



courtyard nature (sometimes called 'cellar dwellings'). These were small dwellings closely packed around a courtyard that provided common access, often for as many as thirty houses. These developments were completed in piecemeal fashion on a small scale without reference to adjoining buildings so street frontages were often irregular and discontinuous. Conveniences for residents were minimal: light and fresh air was limited, privacy in the houses fronting the courtyard was non-existent, and frequently privies or ash pits were never built (although if present they were often situated within a few feet of the houses). A report in the Bradford Observer of 1845 referring to the area known as Millbank stated:

> "It is filthy in the extreme and the street is narrow, drainage bad, stagnant water allowed to accumulate and most offensive smells continually emitted from the refuse which lies about in all directions."

Housing densities of 65 per acre were not uncommon and although the Borough surveys of this time vividly described the conditions of "no means of ventilation beyond what could be obtained at one side of the house" and the "emanations from a cluster of privies immediately before the door" (Bradford Borough Council Report of the Surveyor 1862), the local byelaws prior to 1873 were weak and brought only marginal improvements to the housing since stronger measures would have worked against the interests of landowners and builders.

The location of this social area was to the west of the old city core where there was still sufficient flat land on which construction could cheaply continue. The major occupants were the peasant Irish who, with their family size, Catholic religion and cultural identity came to form several Irish quarters which

Richardson (1971) has likened to ethnic ghettos. Certainly their living densities were high; the highest concentrations were to be found in Goit Side with an excess of 800 persons per acre and Nelson Court with 509 persons per acre (Richardson 1976:97).

Social Area Two: Labouring Classes in Industrial Terraced Cottages

Social area two represents the embryonic residential areas that were a product of the growth of textile manufacturing and the concentration of mills on the accessible flat land in the valley bottoms. Concomitant with the localisation of manufacturing within the city was the emergence of residential areas specifically to house the workers. It was not uncommon for the industrialist to buy a plot of land freehold and then instruct a builder to erect as many houses as possible; conversely by the 1850's the initiative had been taken by the builders themselves and speculative building became very common.

This social area shows little difference from the first in terms of income; 83% of these people suffered incomes of less than £1 per week. The main difference lies in the type of housing, its location and the prevailing occupation. The changing technology of worsted manufacturing throughout the early part of the 19th century is significant for the effects it has had on influencing the spatial location and extent of residential areas around the factory walls. Worsted manufacturing was not a monolithic process but consisted of eight consecutive stages and since it was necessary to increase

THE SEQUENCE OF PROCESSES IN WORSTED MANUFACTURING TECHNIQUE AND THE PHASING OF THEIR MECHANISATION DURING THE NINETEENTH CENTURY

Process	Description of the operation	The development of mechanisation
Sorting	A hand operation involving the separation of the various parts of the fleece into categories for the wool industry.	
Combing	The wool is first washed in soap and hot water and then wrung out to dry. Initially a hand process. In the hand combing, the cleaned wool was oiled and then combed, using one- two or three- pitched combs, a) to separate the long from the short strands and b) to align them ready for later processing, prior to spinning. This stage required warm combs and a warm atmosphere and the stock in trade of the hand comber was the comb, the pot and the brazier.	Arkwright invented a mechanical comb in 1792, and a combing machine was installed in a horse mill in Bradford in 1794. Platt and Collier patented a combing machine in 1827, but the main development was the Lister–Donnisthorpe combing machine, with modifications to prevent snarling (1842–1849). These were 'pretty extensively used in 1842–44'. Crabtree produced an improved combing machine in 1854.
Carding	The separation and aligning of the wool fibres for spinning. Was used in both wool and worsted fibre preparation.	Carding machine for use in worsted yarn preparation was used in Idle in 1820. An improved machine was invented by G. Anderton of Cleckheaton in 1829.
Drawing	The preparation of the fibres prior to making the sliver ready for the spinners, it involves the placing of the fibres in line, so that they overlap, the fibres being stretched, laid straight and cleared of knots.	Machines appear to have been invented contemporaneously with the combing machine.
Roving	A further stage, in which the threads are given a slight twist to fit them for spinning.	
Spinning	The rovings are twisted and drawn into yarn ready for weaving.	In worsted manufacture the spinning machine was known as a throstle. Wyatt invented a machine in 1741, Highs later, but Arkwright took up the idea and patented a spinning machine, the first being used in Preston in 1768. Hargreaves' 'Spinning Jenny' appears in 1780, and was 'early applied to worsted manufacture'. The Arkwright machine was used locally (Halifax) in 1757. Hargreaves machine was driven by water, hence his 'Water frame'. Bradford mills were using mechanical spinners c 1801.
Weaving	This remained a hand operation, hand looms being used into the late 1830's. There were 10,000 hand-weavers in 1838, by which time they were reduced to a state of near pauperdom.	Wool power looms were introduced into the Bradford area c 1822 (James Warbrick of Shipley, and Messrs. Horsfall Bradford 1825. Introduction of cotton warps in 1836 must be treated as major weaving innovation.
Dyeing	Involves the dyeing of either yarn or finished cloth. Worsted is made with coloured yarn. The fibres have to be treated chemically before immersion in the dyevats. The industrial group includes scourers and bleachers.	Bradford stuff was formerly dyed in Wakefield or Leeds, but was doing its own by 1797 when there were two dyehouses in the town (Bowling Dyeworks and Peel's of Thornton Road). Bradford Dyers established c 1843. By 1871 this industry employed 1,829.

Fig. 70
Source: Richardson, 1976

productivity within and between stages the organic composition of capital was increased in the form of mechanization. But the increase was not uniform. Some stages such as spinning increased their organic composition much earlier than others. Fig. 70 sequences the processes and the phasing of their mechanization (after Richardson 1976). At any one time there co-existed hand operational stages in some processes and machine working in others. Whilst the localization of the machine processes within the factory reduced the costs of circulation of industrial capital the hand operational stages required large injections of labour. Consequently as long as the two modes of production co-existed the houses of workers became 'natural' extensions of the mills in the act of production and the laws of capital accumulation necessitated close spatial proximity. Residential spatial location was therefore both a result and cause of this pattern of industrial production.

Richardson quotes the example of Thompson's Mill and the neighbouring buildings for housing the workers, particularly the hand woolcombers prior to any technological innovation in this process. In 1832 their role in the production process was vital and they enjoyed the status of good pay - about 16sh. per week but as mechanization took over this fell to 7sh. (Richardson 1976:83). A report of 1844 stated that for Thompson's Buildings that

> "the streets were narrow and filthy and the general arrangement of the dwellings unfavourable to health. In twelve cases taken by rotation the figures showed that the dwellings inhabited by 95 persons having only 23 apartments for all purposes and 24 beds making an average of 4 individuals to each bed or eight to one bedroom, the average size of which is 17'x13'."

Significantly, perhaps, even the acknowledged benefactors of this industrial age such as Titus Salt built his model village close to his factory and at an average density of 40 houses per acre. (Saltaire).

Given this brief outline it is not surprising that most of the property is of the earliest style of terraced back-to-backs sometimes in parallel rows but frequently paying little attention to street alignment. The main areas are spatially discontinuous to reflect the distribution of mills, particularly along some of the main arterial roads from the city centre and therefore towards the edge of the existing built-up area. The cottages were an urban adaption of the original single back 'salt-pie' cottages of the surrounding rural areas and represented the building response for high density urban housing. They were usually comprised of three rooms: bedroom, living room and cellar, and either directly fronted the street or a communal yard at the back.

A council survey in 1864 for 51 of this type of house in Summer and Hayworth Streets reported an average ground area for each dwelling of 55.5 sq.yards (only 26 sq.yards actually occupied by the house, the remainder being taken up by the street and yard) and the provision of only 2 privies and 2 ashpits. These figures would suggest a housing density of about 65 houses per acre (similar to area one). The resultant overcrowding was felt most by the poorest families, especially the Irish. It was not uncommon for two or three Irish families to be found under one roof whilst the indigenous population enjoyed the relative comfort of only 5 or 6 persons per house. Because rents frequently accounted for 50% of total income

many families resorted to the sub-letting of cellars but this of course only exacerbated the initial problem.

Social Area Three: Skilled Manual Workers

Social area three represents residential locations that for the first time were less tied to mill locations, at least initially, but as the century progressed the areas were surrounded by further industrial development and invaded by the mill workers. The house type was still the back-to-back terrace but the location was 'up slope' away from the mills and slums of the centre and the quality of housing better. Partly the improvement can be attributed to the advent of byelaws which allowed the building of back-to-backs subject to certain minimum conditions being met and the coordination of street schemes. This gave rise to the distinctive back-to-back which survives today in so many parts of the inner city and in the hearts of the former villages. Officially the minimum distance separating houses had to be 10 feet, approached by a passage 6'6" wide and 8ft. high, each dwelling having its own privy in a communal rear yard. As the 1864 Corporation Survey shows there were parts of the city (notably Ashley and Lumby Streets; see Fig. 71) in which only 6 privies and 4 ashpits served 27 houses; the average area of ground occupied per house was 57 sq.yards (31 sq.yards of house) and the average rent was 3/2d. per week. These figures suggest an average housing density of about 45 houses per acre in contrast to the 65 per acre of pre-byelaw back-to-backs.

Given the better quality of housing and the higher rents income category (1) is less common; most streets are occupied

TYPICAL BACK-TO-BACK HOUSE BUILT BEFORE 1868

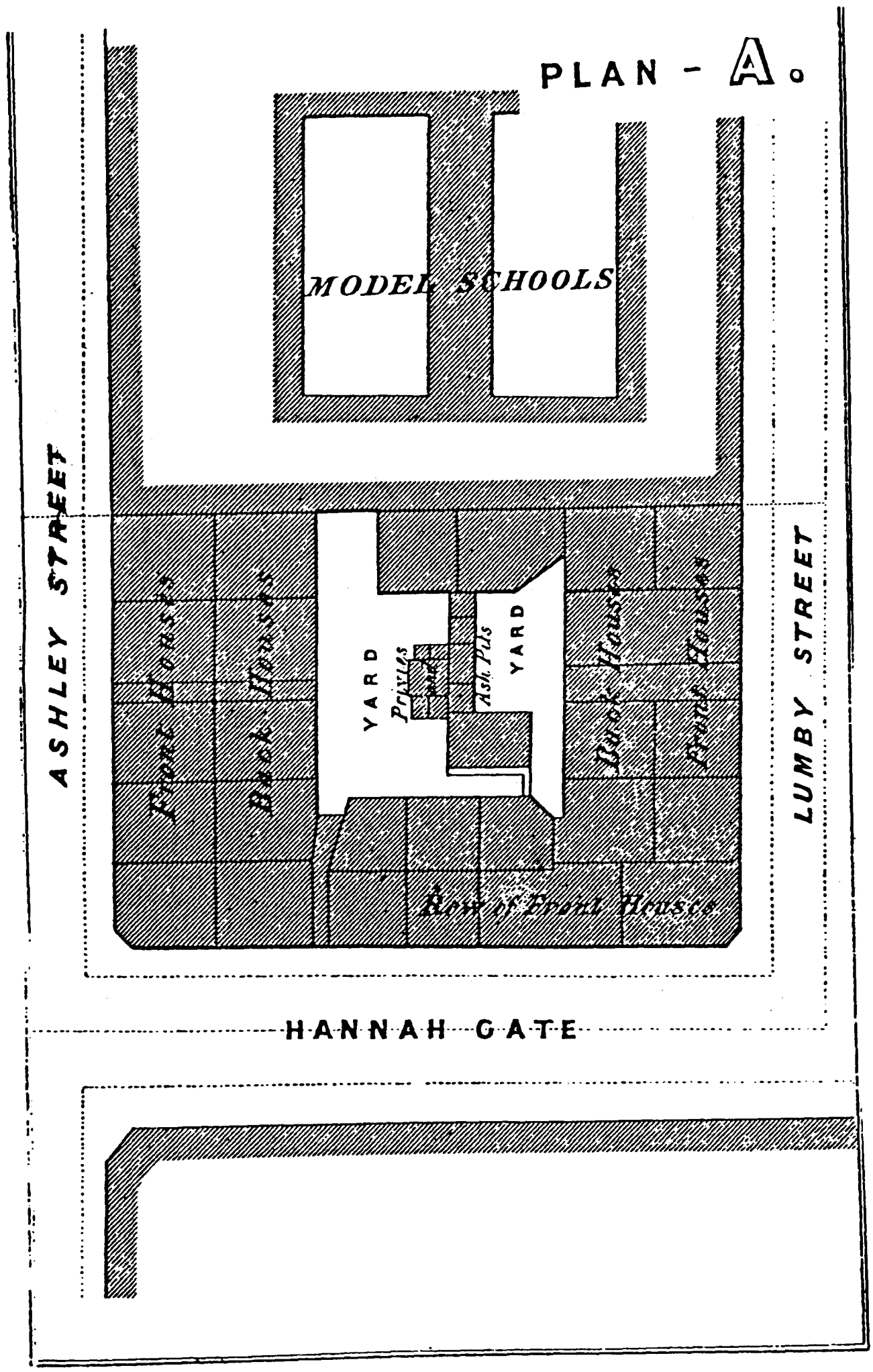


Fig. 71

by residents in category (2) with occupations in the skilled trades of iron manufacturing, machine making, and such like. For example, Green Lane (to the north west) was composed entirely of income category (2) occupants and maps of the time show a housing type that fulfilled the requirements of the 1860's byelaws (separate yards, privies, etc.) Significantly these properties are associated with the emergence in the middle 19th century of terminating and building societies (Naylor 1908) which acted as non-profit making cooperatives to which members paid an annual subscription and as soon as sufficient funds were available an advance was made to a member whose priority was usually decided by ballot. Most commonly the loan was made on a collective basis so that members, by building whole streets, could secure economies on land and building costs. The workings of the building societies in the early stages were different from those of today and are less easy to explain in terms of the circuit of loan capital. It is clear however that the only groups able to benefit from such an institution were whose who could afford to subscribe and since the quality of housing was the best available for skilled working classes their investment was secure. The consequences of institutionalized loan capital therefore, particularly the exclusion of some social groups, are not very different from those of today.

Social Area Four: Professional Classes

Social area four is probably the most distinctive of all residential areas in the 1850's in that it is occupied solely by professionals, industrialists, merchants and gentry, many with weekly incomes far in excess of £2. The merchant classes of the city were dominated by German migrants who numbered

244 in 1851 and they quickly became part of the Bradford establishment as mayors (Charles Simon in 1864, Jacob Moser in 1910), deputy lieutenants of the county, or as merchants who amassed fortunes (Behrens for example made £40m by the time of his death in 1889).

The German merchant classes settled initially in Bermondsey (near present day Forster Square) but by 1850 had moved to the outskirts of the town away from the grime and poverty of the centre and into two particular residential locations: in Little Horton (at Ash Grove, Claremont and Trinity Terrace) and the more extensive area of Manningham (Manningham Lane and St. Paul's Road). A third affluent area between the Leeds and Barkerend Roads was the preserve of the professional classes such as bankers, teachers and shopkeepers. Apart from being situated on direct routes to the city all the disadvantages of dirt, noise, smog and smell

> "could be alleviated by physically removing oneself and family from the town, especially in an upward direction and those with economic resources did this".
>
> (Cudworth 1887:26)

The house types of these classes were distinguished. At worst they were grand three storey stone terraces in elegant squares; at best they were Italianate detached and semi-detached villas of vast size that can be found today along Manningham Lane and form part of bed-sit land.

SOCIAL AREAS IN 1880

A similar analysis was conducted for 1880 when the regulation of urban development by the local authority had become established and before a public transport system enabled suburban-

THE DENSITY OF POPULATION IN BRADFORD AND IN EACH OF ITS MUNICIPAL WARDS IN 1884

Ward	Persons per acre
North	39.7
South	40.4
East	37.6
West	100.9
Listerhills	59.1
Great Horton	10.7
Little Horton	39.8
East Bowling	31.1
West Bowling	13.7
Exchange	47.1
Bradford Moor	20.7
Manningham	48.3
Bolton	7.2
Heaton	15.3
Allerton	2.7
Borough Average	19.4

Source Geldart 1975

For example the affluent north west of the city enjoyed densities of between 2.7 and 15.3 persons per acre, partly as a result of restrictive covenants that prevented the sale of land for building purposes. On the other hand several inner wards have underenumerated values because of the same fact; the density gradient between centre and periphery was therefore greater than might appear from the table.

On the basis of housing type and trade directory evidence it has been possible to distinguish (admittedly arbitrarily) the following social areas (see Fig. 69).

Social Area One: Pre-Byelaw Working Class Housing which included most of the already working class areas with more recent additions along the arterial roads. None of the

occupants were of sufficient status to be listed in the trade directory. It is significant to note that this social area has absorbed social areas one, two and much of three from the previous analysis. With the movement of a socially mobile middle class to more salubrious locales the zones of pre-byelaw housing which they vacated filtered down to the labouring classes. Consequently by 1880 much of the built-up area of 1850 was given over to housing the labouring classes.

Social Area Two: Byelaw Back-to-Back Working Class Housing. The quality of housing gradually improved but not without opposition from local builders. Attempts to set a minimum standard for the construction of housing began in 1850 but persistent complaints of breaches of standard led to the banning of back-to-backs in the 1858 Public Health Act. The 1860 byelaws aimed to strengthen statute law but immediately met with opposition from the building trade with the argument that the local building regulations were stifling the "free growth of the town". A building trough at the time lent strength to the claim and the authority reluctantly allowed the building of back-to-backs to recommence, but still subject to certain minimum standards.

Housing became more regimented as long streets of development, frequently without respect to topography, spread up the Dale. Most were built in regular units of four dwellings, two facing the street directly and two facing communal yards which contained privies and ash pits. The occupants were still working class, most employed in the unskilled tasks of the textile trade at the local mill. It is not surprising therefore that very few of the residents were listed in the trade directory.

Social Area Three: Lower Middle Class Areas.

In this social area at least 66% of residents had to be listed in the trade directory indicating middle income groups. Some of the housing was of the back-to-back type but most was post 1873 byelaw terraces. It was typical of these houses to have gardens at front and rear and a private privy and ashpit. This increased garden space reduced the average housing density to about 27 houses per acre. It is significant looking at the two maps of residential areas in the two periods that the middle classes had, with perhaps the exception of Lower Manchester Road, moved out of the central area by 1880 and up-slope. The effects of the byelaws appear to have been at least twofold. First they strengthened the contrast both socially and spatially between the labouring and lower middle classes: note, for example, how many of the middle class areas are segregated from the poorest pre-byelaw working class houses. Second, the establishment of the 1873 byelaw introduced a type of property (the 'through terrace') which came to be acceptable for loan security to the building societies. Within thirty years the byelaw back-to-backs had become less acceptable as an investment for the building societies and the withdrawal of cash from this housing type served to quicked the rate of downward filtering to the labouring classes. The appearance of a middle class stratum enabled these people to find the 20% or 25% deposit and their regular employment meant they could undertake repayments over a 20 year term. The effects of the building societies and byelaws were therefore to increase the housing supply most for those who could afford it.

Social Area Four: Upper Class Districts.

The affluent areas had maintained their positions in 1880. The

area north of Barkerend Road had become engulfed by middle class suburbia. Little Horton had preserved its exclusiveness and its proximity to the centre gave it added attraction to the merchant classes who were able to retire to the countryside at weekends and holidays. The area around Bermondsey was invaded by warehouses and railways sidings in the second half of the century and because of the release of certain covenants on land the merchant classes were able to extend their residential area along Manningham Lane towards Oak Lane and Wilmer Road. Evidence from the trade directories indicates that many of the houses along Manningham Lane, even at this time, had been subdivided into lodgings and 'invaded' by the lower middle class since the costs of buying or maintaining much of the property was beyond the means of most. The coincidence of boundaries between this exclusive area in 1880 and the bedsit land of 1980 is quite marked.

It is perhaps significant to an explanation of the segregation of social groups in the 19th century city that the capitalist system of production itself produced a middle class income group within the urban system that possessed a degree of self-sufficiency which gave them some choice about where they should or could live. This development was the result of an increase in the skilled and clerical sectors which serviced the basic relations between capital and labour and which commanded higher remuneration and a regular employment contract. The emergent middle classes however would not have been able to take advantage of their new found wealth were it not for the support of certain institutions with similar interests. Foremost amongst these were the building societies and the legal structure of land ownership. The latter will be discussed

briefly.

The structure and pattern of land ownership in Bradford has been documented by Mortimore (1970) following from work by Ward (1962) for Leeds (see also Dyos 1961), and his findings are partially adapted and related to the development of residential areas in the 19th century. Urban growth in Bradford before 1900 took place mainly by high density development on a large number of smallholdings since the pattern of land ownership dated from the Enclosures and has remained remarkably stable despite subsequent changes of ownership. Where there were large land holdings as with the Bowling Iron Company to the south east of the centre substantial barriers to development were raised because of the difficulty of land transfers and subdivision. Each factor was mutually reinforcing: the large estates reduced the amount of land available for building at a time when demand for housing the mill workers was rapidly increasing, land values rose disproportionally making high density development an inevitability. Likewise, the increase in smallholding values served to increase the value of the estates, especially when their locations were central. Cudworth (1887) cites examples of land that was withheld from the market (both voluntarily and because of anachronistic land law) until the price was high enough to gain maximum absolute rents (see also CDP 1976 for similar examples in Saltley, Birmingham). For the most part, however, 19th century development took place through the sale of land-holdings of less than 6ha. The following table illustrates this.

THE LOCATION OF BUILDING DEVELOPMENT IN RELATION TO SIZE OF HOLDINGS

Township	Total number of separate holdings	Holdings of 6ha. or less % total holdings	Holdings of over 6ha. % total holdings
Central Townships:			
Bradford	135	81	19
Bowling	63	80	20
Horton	217	87	13
Manningham	147	83	17
Peripheral Townships in 1880:			
Allerton	117	72	28
Bierley	133	69	31
Bolton	35	71	29
Clayton	105	72	28
Eccleshill	182	92	8
Heaton	42	66	34
Idle	242	92	8
Thornton	228	85	15
Tong	59	62	38
Wyke	87	82	18
City Totals	1792	77	23

FIG. 72

Source: adapted from Mortimore 1970 Table III

Of all building development within the city 77% has taken place on holdings of small size and it is perhaps significant that smallholdings were disproportionately represented in the central townships where housing densities were at their greatest. (Within the West Riding 85% of landholdings were of 6ha. or less). This in itself would not give rise to high density development and must be considered in relation to the circuit of industrial capital. By 1851, 129 out of a total of 153 mills were to be found in the central townships (James 1857:606-609); the requirements of the circuit of capital required distance minimisation to increase surplus value. This would explain why Eccleshill and Idle, despite large proportions of small holdings did not suffer from the same degree of overcrowding. The availability of small holdings, albeit in large numbers, merely exacerbated the tendency towards overcrowding. James in 1841 was to say

> "The consequent demand for habitations has caused building speculations to prevail here to an extraordinary extent; and all the legerdemain of modern builders has been employed - fragile walls, hastily and loosely constructed, or rather "run up", with ill-attempered lime .....; roofs of unseasoned worthless deal, and of strength hardly sufficient for a hen-cote - pervious to all the elements; are the characteristics of whole masses of modern houses in the town. It may of them truly be observed ..... they are formed for sale, not for use."
>
> (James 1841:185)

The predominance of smallholdings on a freehold basis suited the availability of building capital at the time. Speculative building was circumscribed by two factors. Despite the need for housing the demand for land was unpredictable and therefore capital investment in large estates (even if they had been available) would have been a risky venture

since the realization of surplus value would be long delayed whilst all dwelling units were sold. Smaller parcels of land therefore reduced the risk. Also, most builders preferred short term leasehold property since this reduced their capital investment. The greater proportion of land in Bradford was freehold so the higher costs of land encouraged high density development and reinforced the exchange of smallholdings. The spread of the built up area to 1906 followed very closely the distribution of smallholdings. For example, a Report on the Sanitary Condition of Populous Towns in 1844 stated that

> "an individual ..... will purchase a plot of land, perhaps an acre or half an acre; then he will ..... place as many houses on this area of land as he possibly can without reference to drainage or anything, except that which will pay him a good percentage on his money. That is how the principle part of the suburbs of Bradford have sprung up."

Consequently, where smallholdings were most numerous as in Bradford, Manningham and Horton townships, 19th century housing developments took place extremely rapidly and laid the foundations for the assymetrical nature of today's inner city. Landholdings to the east were generally greater in size and as the pace of activity increased it became possible to coordinate and impose uniformity of development over larger areas. It is for these reasons that the cluster analysis reveals a discontinuous belt of high material deprivation around the centre but with a greater spatial extent in the west - a legacy of industrial production and the peculiar nature of land law.

At the other end of the social scale patterns of land tenure have had a great effect on upper class housing development. For example a great deal of land to the north and west of

the town (particularly in Heaton) was owned by Lady Rosse. Parts of the estate in Manningham were offered for sale on 999 year leases for villa development in parcels of land larger than usual. Most of the Heaton estate was sold freehold in 1911 but under restrictive covenants which ensured that all subsequent development in the area would be of 'middle class character'. The boundary of the Rosse estate clearly demarcates the core belt of affluence in Heaton today and parts of Allerton. By contrast the intervention of the state in the provision of 20th century housing required large holdings which were still intact towards the edge of the town; between 1918 and 1960 no less than 51 landholdings not less than 6ha. in size were involved in transactions.

This brief discussion of some of the historical factors involved in the segregation of social groups, although based on only partial evidence, does lend support to the view that society determines the character of the city, the environment in which people live and the factors forcing people into particular housing areas and situations. The outcome of 19th century social relations of production was a localized structuring of housing areas around the main centres of employment (at least for the labouring classes) in order to maintain and optimise the circuit(s) of industrial capital. At the superstructural level the legal, financial and state institutions reinforced the tendencies already observed. Each of the structural levels operated in parallel to emphasise the contrasts, spatially and environmentally, between the labouring classes and the middle and merchant classes. These forces may not have been exclusive but they were pervasive.

Chapter 14

Housing and Housing Finance as Key Variables: some empirical evidence

"We must confess that the conspiracy of silence within the academy concerning Marx and Marxism is perhaps the greatest scandal of North American scholarship."

Wilbur Zelinsky 1975

HOUSING AND HOUSING FINANCE AS KEY VARIABLES

Fundamentally there are two schools of thought concerning the nature of and reasons for the residential inner city. On the one hand it is thought that people live there through choice, since the area provides a comforting social and spatial milieu especially for the young, single, transitory person, and this school emphasises the advantages - access-ability of the city centre, well developed internal social networks, community spirit, of the central location. (see Gray 1975). On the other hand the opposing school would contend that people live in the inner city largely through their inability to live elsewhere. To some extent these people are 'forced' to live in a blighted environment because their access to housing in suburban areas is in most cases limited, and for many, non-existent. This school emphasises the collective situation of the poor. (see Harloe et al. 1974).

The theoretical and policy implications on following either would be substantially different. Obviously the 'choice/ preference' emphasis and the 'constraints' emphasis are polar types and we can expect the real situation to be an amalgam of both - but no study has yet come up with suggestions for locating this balance. An uncontested observation from the Inner Area Studies reports - that there is a fundamental lack of fit between the kinds of dwellings and the types of households found in them - would suggest that these people who live in the inner city suffer a housing condition because of an inability to exercise a housing choice elsewhere.

Additionally the objectives of most Housing Panels in local authorities and, indeed, of the Inner Area Studies generally, emphasise the production (i.e. supply) of housing and the improvement of existing housing at the aggregate level. For example, the K.I.T. Housing Report, (1976) stated 3 principal policy objectives. First "to ensure that each household which desires a separate dwelling can achieve this - i.e. to ensure that the housing stock is sufficient in numerical terms to provide for a balance between the number of households and the number of dwellings". Secondly "to ensure that the housing stock is adequate in terms of condition (the target used is that of all dwellings being brought up to the intermediate grant standard)." Thirdly "to identify, clearly, the housing needs of special groups." (K.I.T. 1976: 3-4)

The emphasis seems always to be on the achievement of a balance between the number of households requiring a dwelling an/ the total number of dwellings available in a suitable condition - an emphasis then on supply (especially the increased availability of council houses, new building and sales) and policies of municipalisation of under-occupied or empty properties - and on the attainment and maintenance of a minimum standard of housing (declaration of General Improvement Areas and Housing Action Areas and discretionary grants available for improvement).

So, local and central government are, in effect, recognising in inner cities, the difference between on the one hand housing need - "the extent to which the quantity and quality of existing accommodation falls short of that required to

provide each household with the accommodation which equals its requirements in terms of price, quality, tenure and location" (K.I.T. 1976) - a very difficult concept to express in concrete terms - and on the other housing demand - "accommodation for which people are able and willing to pay. It takes no account of social or personal aspirations which cannot be fulfilled for lack of money". (K.I.T. 1976)

To ignore housing aspirations, however, (almost a third level) may turn out to be an important omission. For those households who are able and are willing to pay, their preference for a particular housing stock and location will usually be realized. There is here, to a large extent, a fulfilment of housing aspirations.

Within inner areas, however, the gap between ability to pay and housing preference can be (and usually is), very wide. It is because households vary in their ability to pay for housing that the problem of differential access arises. Choice and preference for a particular dwelling or location can only be realized for those who can afford to exercise that choice; the majority of people, particularly in the inner city, are constrained by factors such as income, age, stage in the life cycle, in their ability to command access to scarce urban resources such as housing. For this reason, it is considered to be a fruitful exercise to focus attention towards the accessibility structures of the different housing tenures and between them.

Such a study would have to examine two related elements:

a) the institutional procedures of housing finance and

finance allocation;

b) the consequences this has for the populations who are differentially placed in their ability to create housing demand.

This is not to suggest that policy decision-making (about numerical increases of the housing stock or its condition) is either mis-directed or unimportant. Indeed, the structure of housing finance is but one element in the housing system of which these traditional areas of concern are critical. Rather, it is suggested that the provision of more and better housing, although important, is of limited utility unless the disadvantaged groups being planned for are allowed to exercise some choice, to satisfy some of their housing preferences, with regard to this housing (especially along tenurial divisions).

Although figures from surveys on housing preferences should always be treated with some caution, the recent national Housing Consumer Survey by the B.M.R.B. (1977) concludes that: 69% of interviewees described owner occupation as their ideal tenure in two years time; disaggregating by age, the 25-44 group showed an 80% preference. Also, 40% of council tenants and 36% of private tenants expressed a preference for owner occupation (only 3% of owner occupiers wanted to rent, privately or publicly).

If these preferences could be realized it would mean a dramatic change in Britain's tenure structure (and of Bradford's):

	Present Tenure (%)		Potential Tenure (%)	
	National	Bradford	National	Bradford
Owner Occupied	53	58	69	75
Council Tenants	31	26	21	18
Private Tenants	16	16	8	8

Whilst there are problems in disaggregating national figures for analysis at the town level, it cannot be denied that owner occupation gives the individual household a greater choice in both type of dwelling and, more importantly for the geographer, its location.

Housing Finance and the Private Sector

Of the total housing stock of the city approximately 58% is owner occupied, a figure slightly above the national average for Great Britain of 53%. And of this figure for Bradford the majority of residents have not purchased their property outright but are in the process of achieving sole ownership with the aid of a loan from one of the main financial institutions. Figures at the city scale are not available but the majority of intending purchasers in Great Britain are funded from building societies with smaller, but rapidly growing, contributions coming from insurance companies and commercial banks. The figures below indicate the major sources of loan finance in this country for house purchase:

	Building Society	Local Authority	Insurance Companies	Banks	TOTAL
£m	3447	406	261	290	4404
%	78	9	6	7	100

Source: D.O.E. 1977 (House Policy Technical Volume)

In combination a vast number of secondary circuits of loan capital are set up to finance home ownership. In recent years the banks have declared a more definite interest in the housing finance stakes and though their interest charges are higher they appear to offer serious competition to the traditional source, building societies. The most recent figures (August 1981) indicate that the banks are making loans at a rate of £250m a month compared with £600m a month by the building societies. Furthermore the National Savings movement, by offering inflation-linked investment (eg. 'granny bonds') is more attractive for investors in times of high inflation rates and so deposits are being switched quickly away from the building societies. All this means that building societies are losing their share of the market as investors funds search out the most profitable sectors of the money market. Fig. 73 shows that in recent years the relationship between the inflow of funds to building societies follows closely the relative interest rates offered elsewhere so that when building societies have a competitive advantage over other sectors there is an almost simultaneous increase in net receipts and vice versa.

In times of severe competition the reduction in net funds means that there will be a reduction in loans either in the form of fewer new mortgages as happened in 1973-74 (from 549,000 to 433,000 mortgages) or by placing a ceiling on the amount each applicant is allowed as in 1977-78. This reduction in loan finance will of course affect lowest income groups most since marginal applications either in terms of applicant (a low income) or property (an inner city location), or both, will be less likely to be successful. Similarly the availability of new housing will at least in part be determined by the amount

RELATIONSHIP BETWEEN MORTGAGE AVAILABILITY AND PRIVATE SECTOR HOUSING STARTS.

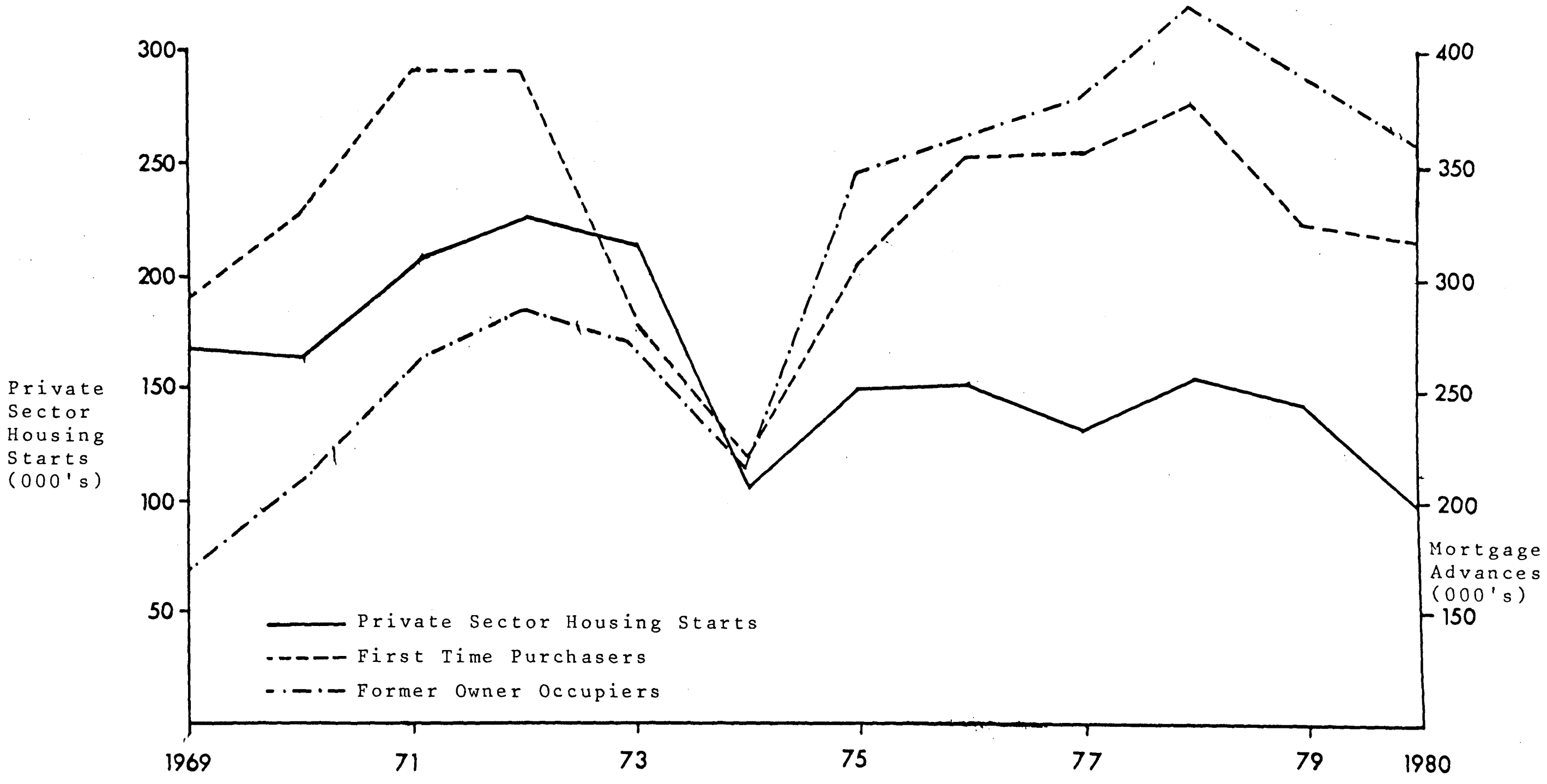


FIG. 73.

Source: Building Society Association Bulletin 1981.

of finance capital available for purchase (CDP 1976). Government subsidies and wage rates apart both the price of housing and the number of housing starts in the private sector is best explained by the explosion of credit or loan capital which in turn determines the level of effective demand, especially since the Competition and Credit Control Policy Bill, 1971. The collapse of the property market in 1973-74 was a reflection of the contraction in loan capital as interest rates increased and investors withdrew their money from building societies which then ran short of funds resulting in a dramatic fall in housing starts as builders' profits were squeezed. (Fig. 73). It would appear therefore that any contraction in loan capital will have a severe effect on the housing market both in respect of the housing stock (reduction in numbers) and the vulnerability of those consumption groups at the margin of loan security, but any change in the availability of loan capital is itself the product of the general workings of the finance and capital markets in their search for alternative sources of capital accumulation (Ball 1978).

Given this very general picture of the operations of housing finance it is necessary to narrow the focus of attention to the operations of the various institutions at the city scale to show the consequences these will have on the consumption patterns and their locations of those social groups most eligible and, necessarily, of those left out. With regard to the private sector, the operations of a particular building society in Bradford will be analysed using data that has been aggregated to avoid any breach of confidentiality. Also, because of the need for state intervention some implications of local authority finance and placing policy are investigated,

though not in the same detail because access was not permitted to all the relevant data required to conduct a rigorous analysis. Most of the building society data was randomly selected from successful mortgage applications for the 1977-78 financial year.

Building Society Loan Capital and the Segregation of Social Groups

The building society, like any other business in industry, must ensure the circulation of its capital in the manner already described. Although building societies maintain a non-profit making stance their obligation to their investors to maintain high interest rates and to their influence on housing markets any break in circulation would affect this standing. The risk for the building society however is compounded in that it borrows capital short term and lends longer than most financial institutions (i.e. the circuit is extended as a result of the house price: wage ratio of about 4:1 in this country.) Additionally, their importance in the national economy (total assets in 1977 were £31 bn) requires a continued stability. Whilst the precise rules by which building societies allocate their funds cannot be discussed in detail (but see Building Societies Handbook 1973), it may be said that their policies aim to maintain the level of aggregate (and effective) housing demand, maximise the likelihood of mortgage repayments being met, and to maintain the value of property. It is the purpose of this section to demonstrate that this conservative, low-risk oriented housing policy will inevitably determine the character of the property, the borrower, and the areas receiving funds from building societies.

The nature of property ultimately determines whether the property will be able to maintain its value and therefore provide sufficient security on a loan made in the event of foreclosure and the subsequent sale of the property to recover the outstanding debt. The nature of property will vary between towns and regions; the north for example has a much higher proportion of terraced property than the south. The pattern of housing types can be seen from the following table:

Types of Housing Stock - some comparisons (%)

Dwelling Type	Bradford	Yorkshire and Humberside	Great Britain
Terrace	47	37	28
Flat/maisonette (purpose built)	9	6	14
Semi-detached	37	39	35
Detached	5	12	18
Other	2	6	5

Source: Area Profile 1977, Bradford Metropolitan Council

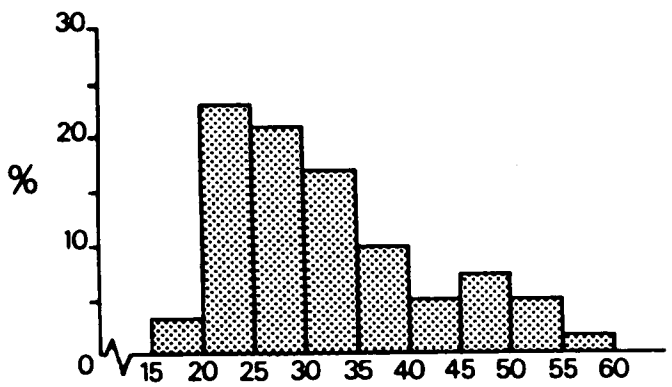
The city has a greater proportion of its housing stock as terraces compared with the national average, and fewer detached. This is mainly a reflection of the historical nature of the housing market at the period of rapid industrialization in the 19th century.

Probably the two most important surrogates for loan security on the nature of property are its type and age. The older the property the less likely is it to be standing for 25 years to 30 years during the repayment of the average debt, although turn-of-the-century terraced property is not generally disfavoured because of its solid building structure. Fig. 74

FIG. 74.

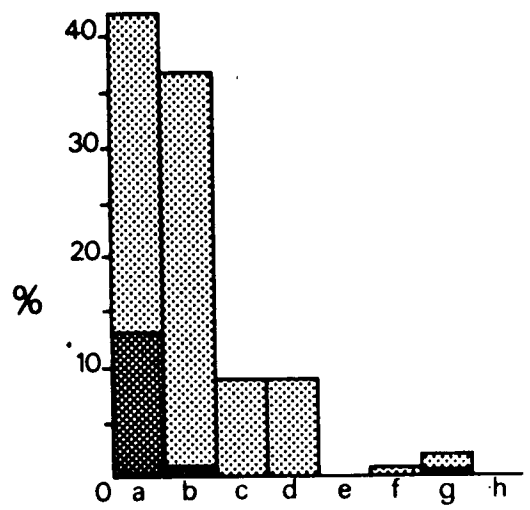
The Structure of Building Society Mortgages in Bradford

AGE OF MORTGAGEES



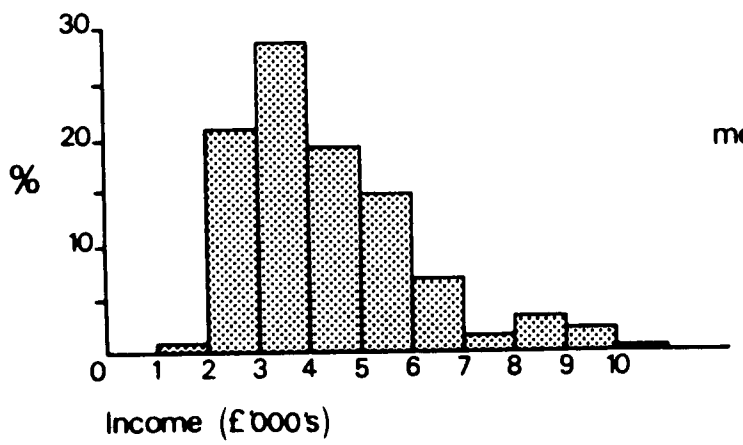
$\bar{x}$ = 28 yrs
S.E.$\bar{x}$ = 1 yr
s.d. = 10 yrs
median = 25 yrs
n = 112
χ^2 = 33·89
d.f. = 8
p < 0·001

TYPE OF MORTGAGED PROPERTY



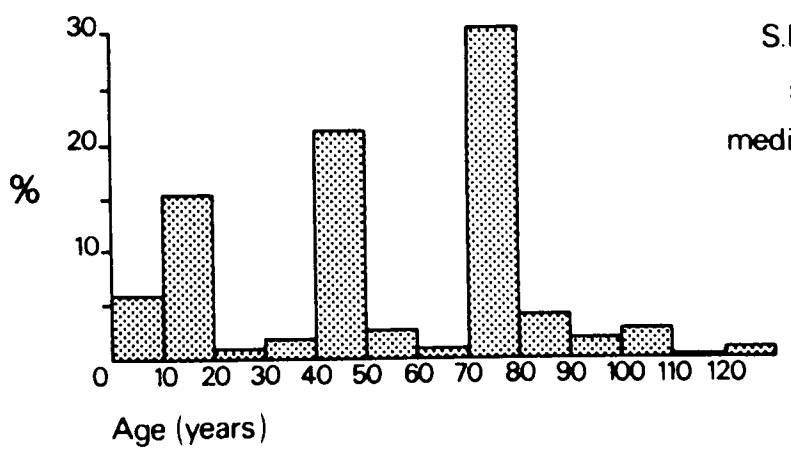
a through terrace
b semi detached
c detached
d bungalow
e flat/maisonette
f town house
g cottage
h back-to-back terrace
Local Authority nominations

INCOME OF MORTGAGEES



$\bar{x}$ = £3873
S.E.$\bar{x}$ = £163
s.d. = £1739
median = £3481
n = 114
χ^2 = 44·23
d.f. = 9
p < 0·00005

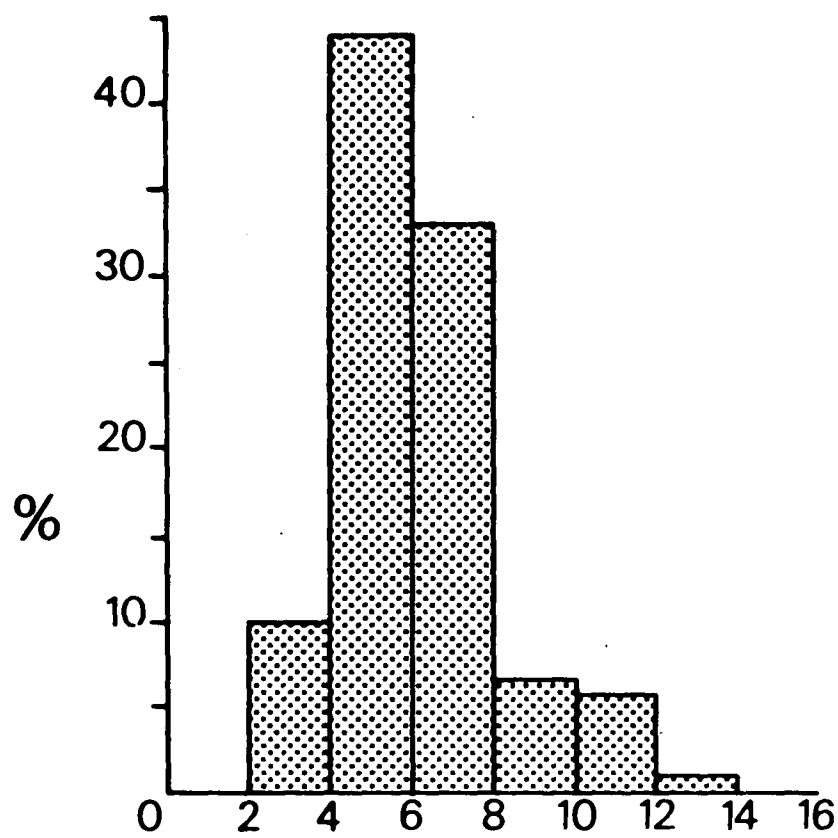
AGE OF MORTGAGED PROPERTY



$\bar{x}$ 42 yrs
S.E.$\bar{x}$ 3 yrs
s.d. 31 yrs
median 42 yrs
n 120
χ^2 169·22
d.f. 12
p < 0·001

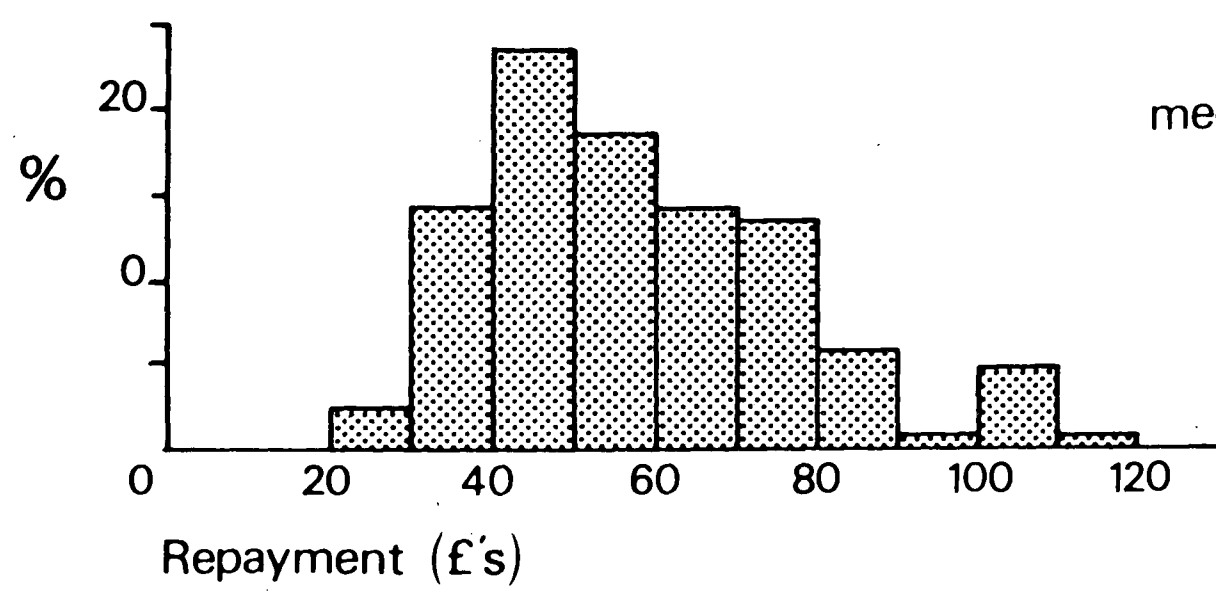
Building Society Mortgages Contd.

MORTGAGE ADVANCES



$\bar{x}$ = £5141
S.E.$_{\bar{x}}$ = £185
s.d. = £2030
median = £4849
n = 21
χ^2 = 20·5
d.f. = 7
p < 0·01

MORTGAGE REPAYMENTS



$\bar{x}$ = £53
S.E.$_{\bar{x}}$ = £2
s.d. = £20
median = £50
n = 118
χ^2 = 29·53
d.f. = 10
p < 0·01

FIG. 74 continued

illustrates some of the findings with regard to the type of property. Note the dominance of through terraces and semi-detached dwellings (together they account for 78% of mortgage advances) and the relatively small proportion of detached dwellings and bungalows. Local authority nominations, a scheme set up in March 1975 whereby the D.O.E. allocated £100m. to building societies for housing public mortgagees in the light of local government spending cuts, formed a significant proportion of successful applications on terraced property. The implication in these bar charts is that the most successful mortgage applications are for recent properties (i.e. interwar and later) and these would tend to be more expensive than the standard through terrace, thus imposing constraints on those consumption groups unable to afford a substantial deposit. Local authority nominations therefore partially redress the balance of mortgage allocations against byelaw terraces and go some way to providing access to owner occupation for some social groups who might otherwise miss out. From the sample, no advances were made on freehold flats or maisonettes because of the legal complications of responsibility for structural maintenance nor on back-to-backs by virtue of their age, condition, and inner city location.

Statistical tests regarding property age are relatively meaningless given the nature of the distribution but it can be said that it does correspond closely with property type. For example, the modal group 70-80 years corresponds to byelaw terraces, the interwar property to semi-detached development, and the recent age groups to further semi-detached and detached property particularly towards the

city periphery. The preference for more recent semi-detached and detached property can be seen as a reflection of the belief that this property will (at worst) maintain its value and that there will be few problems in the event of a foreclosure of realizing the original purchase price.

Since loan security is always the overriding criterion of building society advances the manager must attempt to assess the financial status of the borrower and his potential for maintaining repayments. It would seem that the critical considerations are absolute income levels, stability of income and credit worthiness. Most societies therefore quote a ratio of advance to gross income of 2.5:1, though the overall ratio may be increased with the addition of a spouse's income.

The social class (as defined by occupational groups) distribution of the city is not random, reflecting as it does the historical importance of Bradford in the growth of the textile trade and its labour intensive nature (see Fig. 75). The higher social classes (particularly the managers and employers category) are under-represented in relation to the rest of the country by nearly 50% and there are nearly one-third more unskilled manual workers in the city than there are in the country. In a reasonably 'fair' allocation of mortgages one would expect each group to receive the same proportion of overall mortgages as its share of the social class structure. In reality the requirements of loan capital do not permit this.

Fig. 74 shows the emphasis on younger age groups ($\bar{x}$=28 years); nearly 50% of mortgagees were below 30 years of age. As far

SOCIAL CLASS DISTRIBUTION OF HEADS OF HOUSEHOLDS IN BRADFORD (%)

Social Class	Bradford	Great Britain	Location Quotient
I	9.9	14.1	.70
II	2.5	4.8	.52
III	14.9	17.3	.86
IV	37.7	37.2	1.01
V	35.1	26.6	1.32

Social Class

I - Employers and Managerial
II - Professional
III - Intermediate and Non-manual
IV - Skilled Manual
V - Unskilled Manual and 'Others'

Source: 1971 Census: Economic Activity Tables

FIG. 75

as the repayment of a standard (i.e. 90%) mortgage is concerned it is necessary that the payment be completed before the retirement of the purchaser. Given a 25 year repayment period (the national average) the maximum mortgageable age would be 40 years (assuming retirement at 65). With recent high interest rates the building societies have extended the period of loans to 30 years to prevent foreclosure for those whose mortgage repayments became too much; this of course has the effect of reducing the maximum mortgageable age still further. Of those aged 45 years and older the mortgage was below the average advance of £5,141 and appeared to be required as a small 'topping up' for the retirement home so it involved a capital sum that could conveniently be repaid over the remaining working life of the mortgagee.

The average annual income of mortgagees was £3,873 but the positive skew to the distribution shows that more incomes occurred above rather than below this mean figure. On their own, income levels indicate very little, except that not many manual workers in the city could boast an annual income of nearly £4,000 in 1977 which would limit their chances of gaining access to this sector of the market. By comparison, for the same period, 74.2% of former owner occupiers and 63.5% of first time buyers declared incomes greater than £4,000 p.a. in Great Britain for mortgage assessment. These figures are best seen in relation to the success with which occupational groups gain access to this form of tenure.

It has already been shown that the occupational-social class structure of Bradford is bottom heavy. Using the building

society data the occupations of successful applicants were classified in the standard Office of Population Censuses and Surveys (OPCS) manner and a ratio calculated for each group according to their proportions in the city (a location quotient). Comparisons with additional data are tabulated in Fig. 76. Information published from a 5% sample of all building societies indicates the relatively easier access to owner occupation for social classes I, II and III, and the lack of success for groups IV and V at the national scale. There would appear, however, to be marked regional variations in this pattern because the data for Bradford and Huddersfield (after Duncan 1976) indicates a bias against the unskilled manual worker. There were fewer successful applications for the employers and managerial groups (L.Q.= 0.55) but this group is under-represented in the city anyway. The professions (social class II) are over-represented by 1000% and the intermediate and non-manual over 300%. Even though it is conceivable that manual workers achieve reasonably high incomes they do not succeed in gaining access to mortgages probably because of lack of job security and an income structure that may not follow any progression with years of service (cf. Barbolet 1969). Boddy (1976) and Duncan (1976) have found similar results. These results bear testimony to the exclusion of the lower social groups from ever owning their property even though 70% of those currently not owning would wish to do so if they could gain access.

The reality of the situation is appreciated by the lower social classes. The average monthly repayment from the sample was £53 per month with a range from £20 to well over £100 per month. This figure bears comparison with the Mann-

THE ALLOCATION OF BUILDING SOCIETY MORTGAGES BY SOCIAL CLASS (%)

Social Class	Great Britain [1]	L.Q.	Bradford [2]	L.Q.
I	17.7	1.26	5.4	.55
II	12.3	2.56	26.1	10.44
III	23.1	1.34	49.6	3.33
IV	24.2	.65	17.1	.45
V	22.9	.86	1.8	.05

Social Class	Huddersfield [3]	L.Q.
I	14.9	1.51
II	14.4	3.43
III	21.1	1.46
IV	42.3	.96
V	6.3	.23

Sources:
1. Nationwide Building Society, 1974 (p.124)
2. Sample from 1976-77 mortgage acceptances
3. Adapted from Duncan, 1976, 311.

FIG. 76

ingham District Plan survey results in which 86% of respondents (non-owner occupiers) felt that they could afford no more than £50 per month to own property. According to the estimated repayment that people might be able to afford, the mean figure of £53 would be too high for at least three-quarters of inner city residents in Bradford. (The Survey results are assumed to be representative of inner-city responses.)

The empirical evidence, both 'hard' and perceived, would suggest that even an average mortgage repayment represents a sum beyond the poorests' willingness and ability to pay.

Local Authority Loan Capital and Owner Occupation

Over the past decade the local authority has increasingly intervened in the local housing market by injecting its own circuit of loan capital into the system. The ideological importance attached to owner occupation and the growing waiting list for council housing in the city made it apparent that something had to be done to provide housing for those who could least afford it. Accordingly a modest sum of £50,000 was released by the city finance committee in 1970 to act as a mortgage pool for applicants who were marginal for building society consideration. The amounts allocated are tabulated below:

1970	-	50,000
1970-71	-	40,525
1971-72	-	344,371
1972-73	-	699,506
1973-74	-	2,163,000 (creation of Metropolitan District)

1974-75	-	6,660,000
1975-76	-	3,330,000
1976-77	-	2,774,000 (cut by 15% subsequently)
1978-79	-	2,814,000 (including a building society support scheme of £1.94m)

In subsequent financial years the amount has steadily increased to (just) keep pace with inflation, though what is of interest in the present discussion is the allocation of these funds amongst different social groups.

Precise empirical evidence is not available because access to the necessary data was denied for fear of breaking confidentiality. What follows therefore is a brief account of the answers given at an interview with one of the city's principal housing officers and supplemented by some numerical data obtained from within the local authority planning department.

The lending policy of the local authority is not dissimilar from that of the building society in that loan security is an overriding factor, though the defaulting rate on local authority loans is higher than that of the building societies. The rate of interest charged over the period 1976-1977 was ¼% above the current local authority borrowing rate which effectively meant a repayment rate 1% below that charged by the building societies (1976: 11¼-12¼%; 1977: 8½-9½%). By the late 1970's public expenditure cuts had virtually eliminated public sector lending. According to a D.O.E. circular dated 20.1.76 potential borrowers had to fall into one of four priority categories: (1) existing tenants of the authority who are high on the waiting list or people displaced by slum clearance or renovation whom an

REHOUSING REQUIREMENTS BY MORTGAGE REPAYMENTS

Occupation Group	Estimated Average Gross monthly earnings (£)	Estimated monthly mortgage repayment likely to be able to afford (£)	Number of respondents indicating the amount they estimate they could afford per month. £30-40	£40-50	£50	Unknown
Professional	246	66	2	3	0	0
Employers	-	-	-	-	-	-
Skilled manual	236	59	36	9	1	4
Non-manual	180	45	4	1	1	0
Semi-skilled	200	50	95	29	4	17
Unskilled	212	53	70	15	1	8
Forces	-	-	-	-	-	-
Unemployed	-	-	34	4	0	8
Retired	-	-	4	1	2	2
Unknown	-	-	4	1	1	3
			249	63	10	42

REHOUSING REQUIREMENTS BY CAPITAL COST

Occupation Group	House Price Range: £3000 25 year repayment £21.85 per month	£3000-5000 25 years £36.45 per month	£5000-8000 25 years £58.30 per month	£8000-10000 25 years £72.90 per month
Professional	3	2	1	0
Employers	0	0	1	0
Skilled Manual	7	22	20	0
Non-manual	3	1	3	2
Semi-skilled	17	58	50	0
Unskilled	17	51	26	2
Forces	0	0	0	1
Unemployed	13	26	13	0
Retired	0	3	9	0
Unknown	1	4	4	0
TOTAL	61	167	127	5

Source: Manningham District Plan 1977

FIG. 77

authority would otherwise have been obliged to rehouse; (2) applicants who are homeless or threatened with homelessness, or living in conditions that are overcrowded or otherwise detrimental to health; (3) applicants who wish to buy larger property for only partial occupation by themselves, in areas where conditions of overcrowding seem liable to develop; (4) applicants who wish to buy older property suitable for single family occupation; and more particularly persons who wish to acquire a house with a view to subsequently improving it for their own occupation with the help of grants payable under the provisions of the Housing Act 1974. (Authorities should give special attention within this category to pre-1919 properties, and to properties the purchase of which would further the objectives of a housing action area, general improvement area or priority neighbourhood).

The circular is therefore directing limited funds not only at those most in need of housing but also to the improvement of run-down housing stock (improvement is cheaper than rebuilding) and to potential landlords in overcrowded sections of the city. On this evidence alone it might be expected that the available monies were not entirely being directed to the most needy. Further rules of allocation included a valuation on the property that could not exceed £6000 nor fall below £3000 and the borrower has to occupy the property for a minimum of five years.

The average advance was £3750 which at the prevailing interest rate would involve a pretax monthly repayment of about £36 (assuming a 25 year repayment period); both figures are significantly below comparable statistics for building societies. The majority of loans were made on through terraces and back-

to-backs and about 50% of all loans went to Asians; unfortunately precise data, particularly concerning locations of these properties, was not available. It was possible, however, to collect information on the occupations of 155 applicants for council mortgages during the first quarter of the financial year 1976-1977:

STATE INTERVENTION AND HOUSING FINANCE BY SOCIAL CLASS

Local Authority Mortgage Acceptances (%)

Social Class	Bradford	L.Q.
I	0	0
II	2.6	1.04
III	28.4	1.91
IV	25.2	.67
V	43.9	1.22

Source: adapted from Manningham District Plan 1977

FIG. 78

The quotients indicate the proportionate allocation of loan capital. Social classes II and III are again over-represented but to a far smaller degree than with the building society. Significantly, the lowest group, social class V, was better represented which would indicate that some of the funds were getting through to the most disadvantaged residents of the city. It is still the case however that the requirements of loan capital necessitate a borrowing policy of the lending institution which will as far as possible secure the loan and though the nature of property is less important in public mortgages,

the occupational standing of the applicant is just as important. A state concern for partial redistribution of the private housing sector is mitigated against by the logic of the circuit of loan capital and capital accumulation.

Building Society Spatial Lending Preferences

Because the quality of property is non-randomly distributed (the inertial factor of older building usually being located towards the inner city), because those households who can, will exercise a preference over certain types of property, and because of the requirements of the circuit of loan capital, it is inevitable that a specific spatial distribution of mortgage finance will occur according to position in the social class hierarchy.

This major hypothesis was tested in the following manner. Each successful mortgage applicant for a large building society was allocated to one of the five standard occupational groups (as defined by OPCS) and the location of the property to be bought was plotted; the procedure was repeated for all 114 applicants in the random sample. The sampling design meant that some applicants were applying for mortgages on property beyond the old county borough boundary (but within the Metropolitan District) and since these were part of the usual business of the building society it was decided to include them in the analysis. Superimposed on to this distribution was the inner city as defined from the cluster analysis according to the three main distinguishing characteristics: lodging areas, old age areas, substandard areas. Added to this were the following General Improvement Areas

(GIA's) incorporated within the county borough boundary:

GIA	Date of Declaration	Number of Properties
Barkerend	2.12.70	2137
Pollard Park	15. 3.72	568
Lidget Green	16. 2.72	2288
Low Moor	1.11.71	129
West Bowling	21. 3.73	1502
Girlington	23. 2.76	2087
Victor Road	23. 2.76	645
	Total	9356

The statistical methodology for designating the inner city of Bradford has been discussed in chapter 10 and need not be repeated here. These areas designate the most deprived districts of the city as the following statistics indicate. The inner city, as defined, accounts for 53% of all households with no bath; 66% of all shared dwellings, 60% of overcrowded dwellings, and 81% of Asian households. And in terms of tenure there is also a marked pattern. About 7% of all council tenancies are accounted for as are 17% of all owner occupiers, but 70% of those households privately renting accommodation can be found here. The implications of this tenurial imbalance will be discussed shortly.

With very few exceptions loan capital in the form of mortgages is not found in the inner city and is suggestive of a redlining policy (Karn 1976, Lambert 1976, Williams 1978) though it is difficult to say whether this is a result of discriminatory policies or a passive consequence of the circuit of loan capital. The majority of loans in this sample were allocated to properties generally beyond a 2½km. radius of the centre in locations which were stable in terms

of housing quality and turnover (usually good quality through terraces) and suburban semi- and detached properties (they formed at least one quarter of acceptances). The overall pattern of social class distribution is difficult to see because of the large number of divisions between categories so to reduce the analysis to its simplest form it is possible to generalise the distribution. This was done by measuring the linear distance from the property location to the city centre, repeating for all properties in each social stratum and then dividing by the number of entries to give an average locational radius for each social class. The pattern that emerges for the city is a textbook example of declining social status in central locations and the highest social classes in the most peripheral locations (see Fig. 79). The average radial values are:

	Radius from City Centre	
Social class I	9.10	
Social class II	7.48	
Social class III	5.13	
Social class IV	4.97	
Social class V	4.50	(units are irrelevant because all measures are relative)

In its simplest form then the pattern of mortgage finance conforms to zones in a manner consistent with the model of Burgess (1925) although these are not necessarily of uniform width and on a more detailed level of analysis can be modified into sectoral arrangements.

Fig. 79 illustrates the inner city vacuum and the complete avoidance of the statistically defined areas of severe material

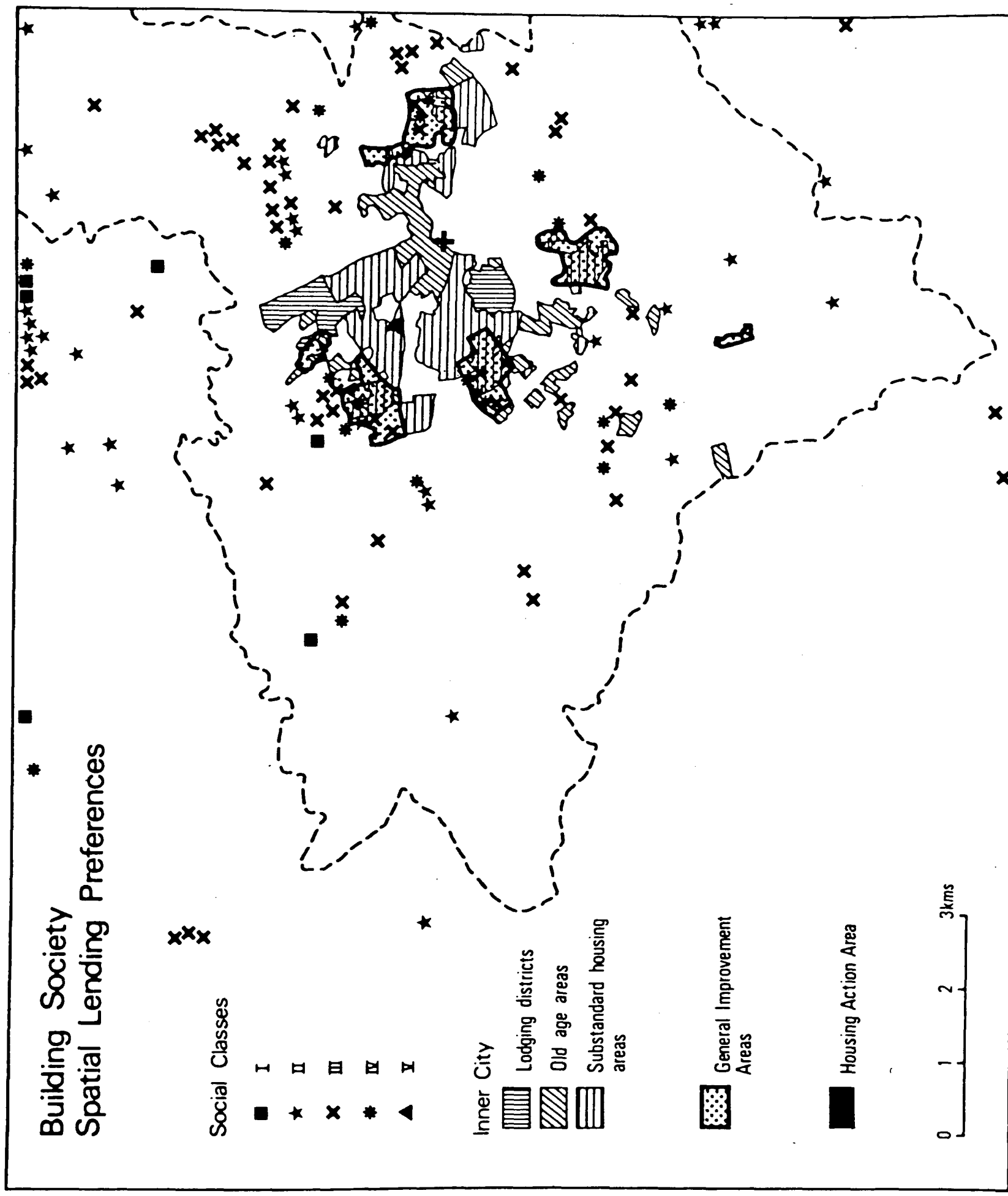

Building Society
Spatial Lending Preferences
Social Classes
I
II
III
IV
V
Inner City
Lodging districts
Old age areas
Substandard housing areas
General Improvement Areas
Housing Action Area
0
1
2
3kms

FIG. 79.

deprivation. It is significant to note that the only exceptions to avoidance of the inner city involves those mortgages allocated to properties in the designated GIA's, especially Barkerend Road, Girlington and Lidget Green. GIA's were set up as a result of the 1969 Housing Act to reflect a change in planning philosophy towards inner city rehabilitation as a quicker and cheaper way of improving housing conditions. The emphasis moved away from wholesale redevelopment towards improvements concentrated in designated areas, but a government circular (65/69) advised councils to choose those areas most likely to succeed, suggesting that success of government policy was more important than the eradication of Britain's poorest inner areas. Councils were given powers for house improvement through a grants procedure (up to 75%) which would give all houses a minimum 30 year life; they were also empowered to undertake environmental improvements such as closing some streets to through traffic, creating small open spaces, planting trees and providing grassed areas. Bradford council was quicker than many to respond to the new directives and declared its first GIA at Barkerend Road in December 1970 and instituted a rolling programme of six further areas within the borough boundary.

The circular also suggested that councils give preference to an area if "the people in it are more likely to welcome and co-operate in a scheme of improvement" but such areas do not necessarily represent the most deprived and those most in need of government help. The effect of imposing GIA status on these areas of Bradford's inner city has been to improve the environment but it has to be asked whether the areas so

designated were the areas most requiring improvement. It would appear that as with the declarations (CDP 1975) the majority of improvements have gone to owner occupiers in areas peripheral to the main concentration of deprivation so that the policy (at least in Bradford) has worked to the advantage of the relatively better-off leaving the poorest members of society at a marked disadvantage. The 1974 Housing Act introduced the housing action area for those parts of cities with chronic housing stress but up to 1978 only one had been declared in Bradford since the council had already begun to implement in 1971 an 'ongoing' clearance programme for the next decade and with minor exceptions a HAA designation could not be seen as a direct alternative since the housing was of such bad condition (mainly byelaw back-to-backs).

The declaration of GIA status, which guarantees a 30 year life on property, has meant that building society managers are now prepared to make loans in these areas. Life expectancy on these houses is now sufficiently long enough to realise the repayment and therefore satisfy the requirements of loan capital circulation. More particularly, properties in GIA's have substantially increased in value which has had the effect of widening the gap of material affluence between inner inner city residents and outer inner city residents.

The conclusions to be drawn from this brief analysis centre on the role and consequences of finance capital. The building society, as an intermediary in the circuit, has to ensure capital accumulation for its investors and maintain the circulation of housing as a commodity by adopting a

conservative lending policy aimed at minimizing risk. Suburban properties and middle to high income applicants satisfy these criteria. The consequence spatially is to make a remarkably clear differentiation between the urban core to which private funds are not directed, and suburbia which can enjoy the status of low risk assessment. In the owner occupied sector therefore building societies have in large part the power and control of structuring the space economy in such a way that some districts are differentiated from others primarily because of the local residents' ability (or not) to gain access to the housing stock to which they aspire. Personal choice is therefore constrained by income and age primarily, a reflection of the nature of accessibility structures imposed by the circuit of loan capital and therefore it must act as one of the primary forces of class and space structuration. Space is both a cause and effect, an integral part, of the housing system.

Housing Associations and Disadvantaged Residents

One of the offshoots of the 1974 Housing Act was a major new role for housing provision by housing associations as the new "third arm" between owner occupation and council renting, and involvement was particularly encouraged in H.A.A.'s.The main source of finance for housing associations since 1964 has been the Housing Corporation and provided the rules of registration have been implemented any association can benefit from financial assistance (a housing association grant). It has been argued that housing associations provide a flexible alternative to owner occupation and public renting tenures. For example, many specialist

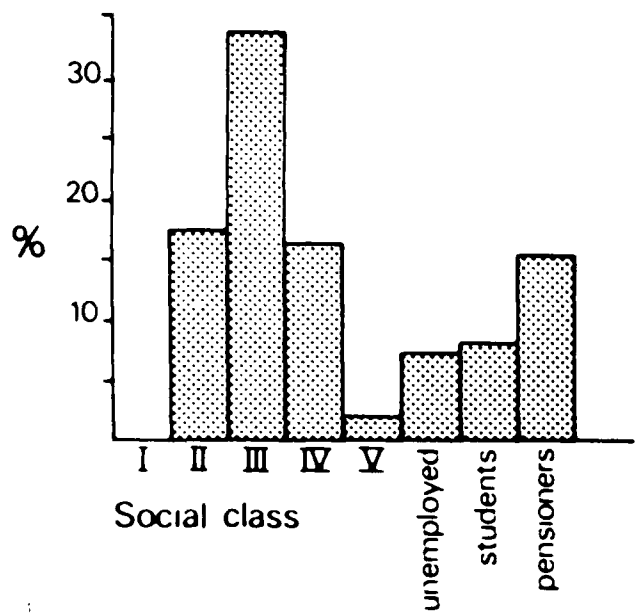
associations have developed to cater for the needs of groups such as the elderly (e.g. Anchor), their allocation policies are less rigid than the points system in council housing, and they can also provide different forms of tenure (co-ownership, furnished and unfurnished tenancies, etc.) to suit local needs. Housing projects in the city have taken many forms from the building of large-scale blocks of flats to the renovation of inner city properties where they are structurally sound and not within the local authority clearance areas. Whatever their particular emphasis, all housing associations are supposed to fulfil the particular needs of those social groups who, for one reason or another, are unable to gain access to alternative housing sectors. It might be expected therefore that because the laws governing the circuit of loan capital do not strictly apply the accessibility structures would be less stringent and therefore be of greater benefit to disadvantaged groups.

It was decided to test some of these ideas using the confidential files of applicants to a nonspecialist (and large) housing association in the city to see which social groups were able to benefit most. The results with their statistical tests of significance are illustrated in Fig. 80. The sample was randomly designed but because of some omissions on application forms the numbers sampled on specific questions varies from 95 to 106. This sample size represents approximately 65% of annual applications for this particular housing association.

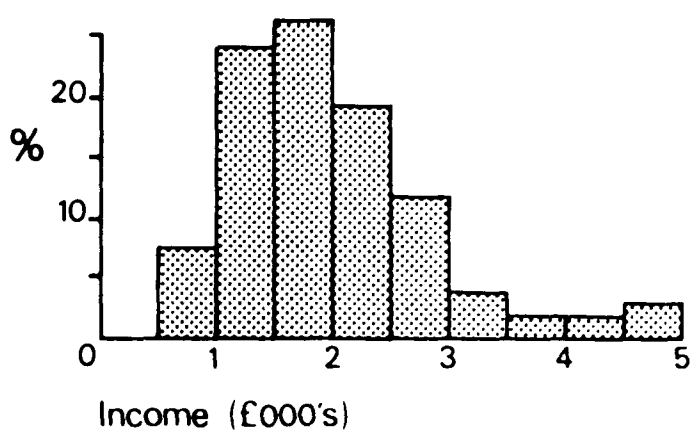
The average rent charged was £7.83 per week, an amount very similar to the average rent for a council tenancy in the city

FIG. 80.

TENANTS BY SOCIAL CLASS

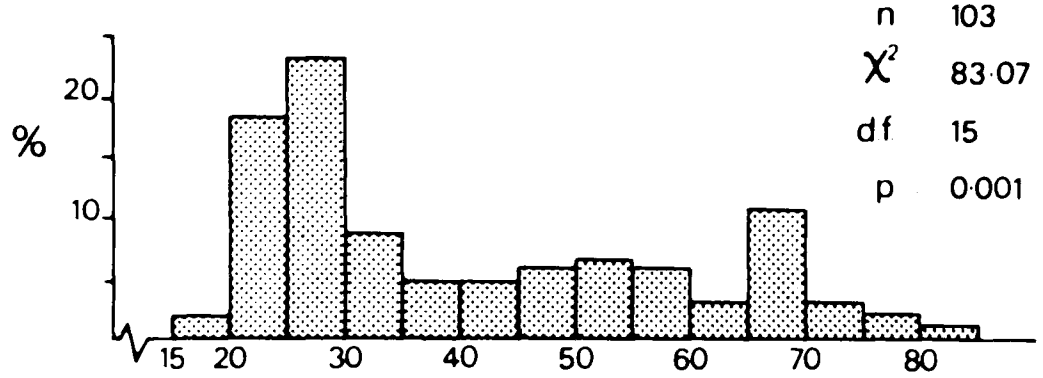


INCOME OF TENANTS



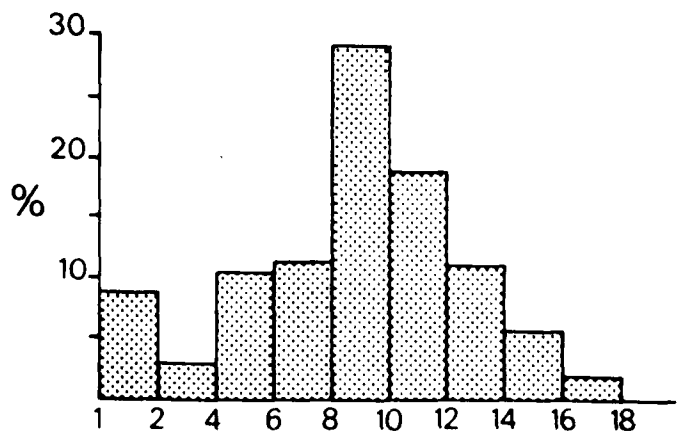
$\bar{x}$	£1768
$SE_{\bar{x}}$	£93
sd	£910
median	£1610
n	95
χ^2	44·36
df	7
p	0·00002

AGE OF TENANTS



$\bar{x}$	38yrs
$SE_{\bar{x}}$	2 yrs
sd	18yrs
median	31 yrs
n	103
χ^2	83·07
df	15
p	0·001

RENT



$\bar{x}$	£7·83
$SE_{\bar{x}}$	£0·37
sd	£3·81
median	£8·19
n	106
χ^2	23·48
df	8
p	0·07

(excluding rebates). The standard deviation was quite large (amounting to 50% of the mean) indicating the broad range of rents that could be charged as a result of the diversity of housing types (from inner city conversions to purpose-built maisonettes.[1] As a proportion of average income this level of rent was quite considerable - 23% - a figure which is comparable with the average proportion of income taken up by initial mortgage payments in the same year. It may be the case, of course, that higher rents are paid only by higher income groups but the histograms do suggest that housing association rents form a large proportion of gross income. Significantly income is well below that of the average mortgage applicant as might be expected and the upper limit on income is less than half; about 50% of tenants had average incomes of between £1000-£2000. The age distribution is also broader since most housing associations cater for fixed income social groups (e.g. the unemployed and pensioners). Consequently the average age of tenants is 38 years though the bimodal distribution shows peaks at 27 years and 67 years. Social class structures display a great diversity than owner occupiers, though the majority of tenancies go to social class III (31%) and only 2% to social class V (unskilled manual workers). See the location quotients below:

Housing Association Tenancies (%)

Social Class	Bradford	Location Quotient
I	0	0
II	17.2	6.88
III	33.5	2.25
IV	16.1	.43
V	33.4	.93

---

1. Housing association rents tend to be set according to the nature of the occupied property rather than the personal circumstances of the applicant, unlike council tenancies.

By grouping pensioners, students and the unemployed with social class V the allocation of tenancies almost approached their proportional shares (L.Q.= 0.93) but the table also shows marked over-representations of applicants in social classes II and III. Clearly, although there is some attempt to provide housing for those on fixed incomes and who are precluded from other housing sectors the evidence does suggest marked biases between social classes.

The table below indicates the previous tenure of housing association tenants and, despite the large 'unknown' category the combined rented sector accounts for 51.5% of all tenures.

Previous Tenure	% in Housing Association Property	
Owner occupation	10.3	
Private renting	30.8	
Public renting	10.3	
Lodger	10.3	
Homeless	1.9	
Student Hall	0.9	
Other	0.9	
Unknown	34.6	
Total	100.0	(n = 106)

Previous owner occupiers tended to be of retiring age (or near) and with a limited income that prevented them from trading-up their existing property for the retirement home. A surprisingly small proportion were previously homeless considering the priority this category would receive on the council waiting list but it could be argued that its success in that sector precluded any need to seek access to this sector. The evidence presented hints at a lack of mobility between tenures so that once a household starts to rent it may be circumscribed in its actions from filtering up into owner occupancy for

reasons of high risk and poor loan security in the capital market.

The importance of housing associations in the residential differentiation of the city should not be overstressed for their tenancies account for only 6% of the total housing stock and since their proportion of dwellings completed in the decade of the 1970's accounted for only 14.2% compared with 65% for private completions their share is not likely to appreciably increase (Housing and Construction Statistics 1980). It would be expected however that if housing associations are to function as the 'third arm' of housing, those groups which are most disadvantaged should be the ones to receive help but the cursory evidence presented here indicates that the least privileged still 'miss out'. The argument that housing associations do add significantly to the local authority's housing improvement policy therefore fails to ask "who benefits most?" and, of course, there is a danger that any blame for inadequacy of housing provision in local areas will shift away from councils as their share of the housing market declines.

A Comparison of Real Housing Costs between Owner Occupiers and Tenants

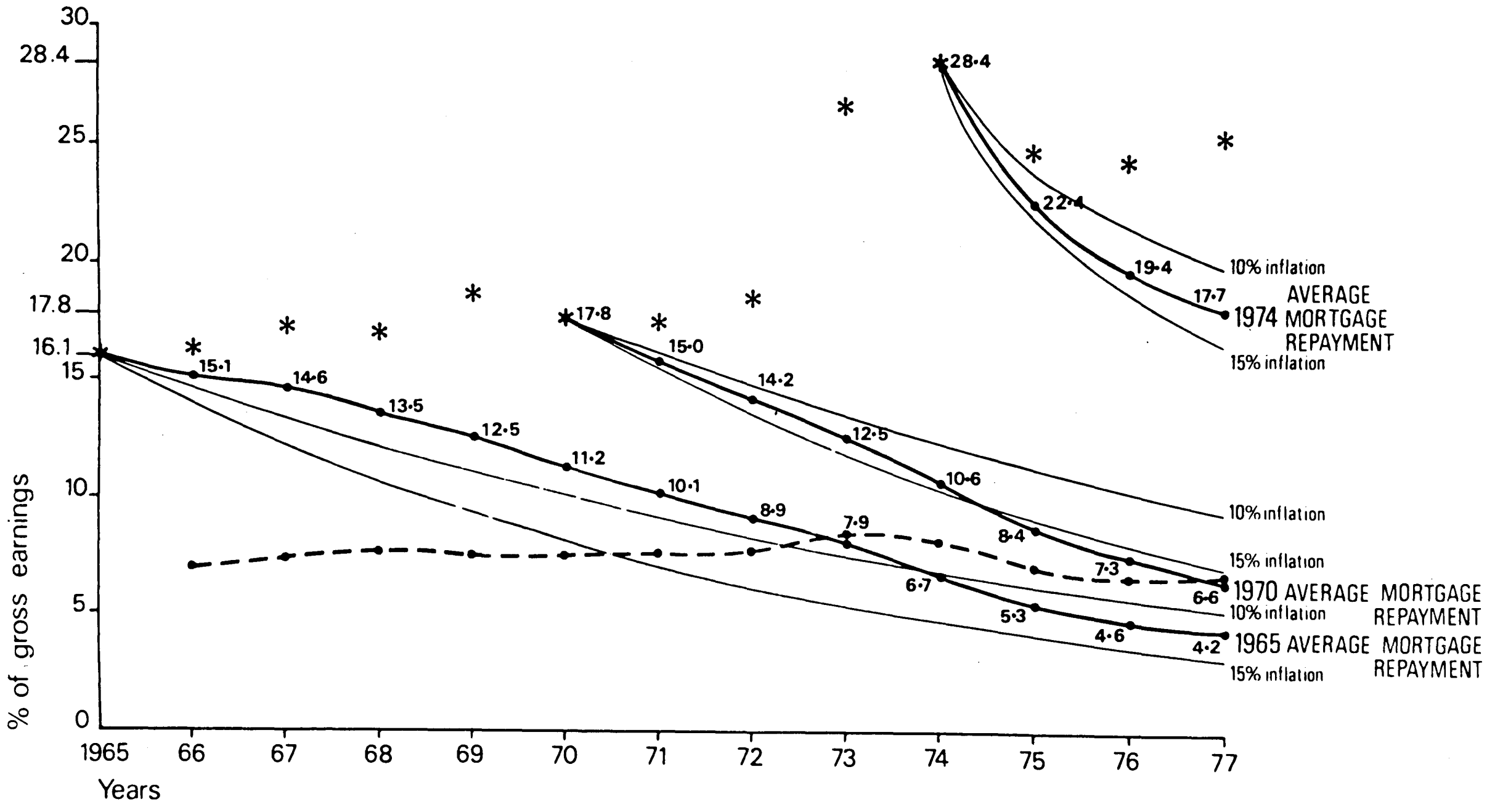
The empirical evidence on housing finance and its consequences suggests that different social groups benefit most between tenures but in almost all cases the lower social classes fare badly in the allocation of private urban housing because they cannot meet the rigid loan security criteria. As a final comment on the difference between the private and public

housing sectors data has been collected and plotted to show that not only is there inequality of access to housing but this inequality persists in terms of real housing costs particularly in the long term. The data was collected from the Building Society Association Bulletins of national data concerning average annual income, average house prices (regional variations are ignored), average council rent, and the inflation rate (from the retail price index). Average incomes were standardized for each year for tax relief on mortgage interest at a rate of 30% and a mortgage rate of 11% per annum. Interest repayments and council rents were then calculated as a proportion of averaged gross incomes.

The results (Fig. 81) show the diminishing real housing costs for owner occupiers over time. For an applicant taking out an average mortgage in 1965 about 16% of his gross earnings would be accounted for in mortgage repayments but in subsequent years this would gradually diminish so that by 1974 mortgage repayments would take up less than 7% of earnings (assuming no further topping-up loans). Similar calculations were made for applicants starting mortgages in 1970 and 1974 with actual inflation rates and averaged rates of 10% and 15% plotted over the years shown. The feature of diminishing real housing costs for owner occupiers only holds if incomes increase with inflation and this in fact is what has happened. Despite a roller-coaster pattern, <u>initial</u> mortgage repayments as proportions of income have steadily increased since 1965 particularly during periods of rapid house inflation as in 1972-1974. The ownership of property is becoming more costly even though incomes keep pace with inflation and therefore one might natually expect more households to be denied access

FIG. 81.

Real Housing Costs of Owner Occupiers and Council Tenants 1965–1977 (averaged figures)



to this sector on grounds of cost as well as inability to fulfil the loan security requirements. Additionally, inflation benefits owner occupiers in the long term to a greater extent than council tenants; in fact the greater is the rate of inflation the greater will be the fall-off in real housing costs of owner occupiers (see the cost curve for 1974-1977 when inflation was high). In marked contrast the average council tenant has found that his cost of housing has remained remarkably constant, forming about 7%-8% of his income (excluding rebates). Combining the cost curves for the two sectors suggests that after a period of about 7 years council tenants' real relative housing costs are greater and continue to be greater in subsequent years. Basically, council rents in the long term are regressive. Given the nature of housing costs, especially the crossing of cost curves after about 7 years it is tempting to suggest that this could be an indication that non owner occupiers could afford to own property in the longer term if only they could gain initial access and meet the early repayments. One final point - the tax relief system offers an incentive to higher income groups to take out as large a mortgage as the loan institution will allow (subject to status) since their tax relief, up to a maximum of £25,000 currently, will be much higher.

By way of summary in this section the evidence clearly shows a bias in the housing market towards those who can afford to pay and away from the inner city poor. Private institutional loans favour relatively recent properties in the established suburban locations where any risk on loans is minimised. These middle class neighbourhoods will typically house the

professional classes and 'stable' working class families. In the poor areas of the city the absence of mortgage lending implies housing transactions on a cash basis but given the nature of both housing and the social groups that occupy them, the amounts changing hands are quite small (e.g. a small terraced house in 1977 in the transition zone would be valued at about £1000). The operations of private institutions can therefore be seen as a form of discrimination, although the wider framework of the capital market within which such institutions operate necessitates such selectivity and therefore discrimination should best be seen as an inevitable consequence of the desire to safeguard capital accumulation through the circuits of loans. Public and semi-public financial institutions adopt the same (or similar) policy though the welfare commitment of central and local authorities acts as a palliative for the harsher reality in enabling some relatively poor households to enjoy owner occupation. In both public and private sectors, however, it can be seen from the empirical evidence available that some social groups persistently fall below the requirements of institutional credibility and therefore always fail to gain access to owner occupation. Whilst there are some who would prefer to rent (publicly or privately) for a variety of reasons it does seem clear that there must be substantial numbers who would own if they could gain access to that sector and certainly it makes economic sense to own property given the present state of tax incentives and inflation. Problem of access is a key feature. Additionally, discrimination in the lending market can be seen as a major factor in accentuating the demise and environmental decline of inner cities where there is an

absence of private capital, and the designation of GIA's would seem only to sharpen the contrast between inner suburbia and inner city. Note, for example, the distribution of many of the city's materially deprived ED's and their proximity to GIA's in the west.

Wherever there has been an inability on the part of the private sector to produce housing for everybody it has been the response of government to intercede either directly through the provision of public housing by local authorities or housing associations or indirectly through planning regulations, byelaws and loan finance. The precise allocation mechanisms within the council housing sector could not be studied here because access to the necessary data was denied, although the characteristics of council estates and the social groups occupying them can be examined from the results of the cluster analysis in Chapter 10. Further comment on this housing sector would therefore be speculative in the present context. The role of the local authority as loan financer however is clearer. Although the funds available for public mortgages have declined in absolute and real terms in recent years the operations of local authorities are similar to those of building societies since in the last analysis public monies always have to be accounted for. Consequently the main beneficiaries for home ownership are those social groups just on the margin for normal building society consideration. Housing associations have also acted primarily in the interests of professional and 'intermediate' category households. Social classes IV and V remain at a disadvantage.

The combined nature of this evidence supports the assertion

that tenures are a crucial element of any discussion on residential segregation. The laws of housing finance are such that the exchange and consumption of housing are clearly differentiated along tenurial divisions because tenures permit of quick and 'safe' circuits of loan (or rent) capital for different social groups. 'Tenure' helps to define consumption groupings according to the structures of accessibility (income, age, property, etc.) though tenures often cut across class (in the Marxian sense) divisions, and consumption is a reciprocal element of production and capital accumulation. Increasingly, the aspirations of households for home ownership are attainable only if backed up with sufficient income to meet repayments and a mortgageable (and suburban) location for the property. Access to this tenure for the urban poor is denied not just because of <u>who</u> they are but also because <u>where</u> they could afford to live falls below the bottom line on the institutional ledger, and because public institutions operate in similar ways, they do, in effect, legitimate housing inequalities (with all the spatial implications this raises).

SUMMARY

Geographical understanding does not begin with geography lessons .....

H.M.I. 1978.

SUMMARY

Since most of the analytical chapters were written in 1977-78 there has been considerable research interest in the subject of housing and political economy and the weight of empirical evidence has grown enormously (see Bourne 1981). Fortunately the nature of this evidence lends credence to the ideas advanced here and in this respect the empirical findings for Bradford can be seen as part of a pattern rather than anomaly that is beginning to emerge in the 1980's. These empirical findings are extremely important and most conventional theses would attempt at this stage to summarise the ways in which the analysis complements and extends these contemporary results. This is not the objective of this summary. Instead it is essential to relate the chapters to each other and to discuss the implications of empirical results for a restructured theory of socio-spatial relations in the city. It has been a central theme throughout that a true understanding of the built environment will emerge only when social scientists adopt a structuralist concept of science in their attempts at causal explanations (rather than low level descriptive analyses). Empirical studies (but not empiricism) will always remain essential aspects of a structuralist critique but empirical data will only gain its meaning within a sequence of theoretical propositions from which derive, as inevitable consequences, observable phenomena. Empirical data must not only be consistent with theory it must also therefore be an expectation from it.

The appeal of the arguments developed here will depend very

much on the background and domain assumptions of the reader and whether they predispose him to favour or accept the logic of structuralism (if not Marxism). It has been suggested by some philosophers that the social sciences face a crisis of plausability, partly because the possibilities of internal development of the extant system have exhausted themselves (as in comparative empirical analysis) and partly because the realities apprehended by the orthodox system appear incompatible with orthodox thought (as in the persistence of inner city problems, poverty, inflation). Although the term 'crisis' is much over used today it does serve to focus attention on the plight of contemporary academic analysis and its inability to adequately explain (however defined) its objects of study. The polemic surrounding interpretations of social reality has often floundered because either one side or the other has failed to recognise the fundamentally different epistemological bases on which positivism and structuralism rest. As Harloe states

> "if the very conception of theory itself differs, discussions which refer to differences between specific theories but which do not take explicit account of this are apt to be conducted in terms which combine considerations relating to these two levels in ways which are illegitimate."
>
> (Harloe 1977:10)

Consequently a very broad perspective is required that can weld together considerations of substantive theory with problems of method since the two are essential complements in the pursuit of knowledge. Only in an empiricist philosophy does theory become divorced from practice (method); in structuralism it is difficult even to establish the difference.

A prime objective of the argument has been the clarification of the assumptions upon which positivist urban geographic analysis is based and of the consequences for developing higher levels of explanation. Two central themes recur and form the basis of the problematic. First, most social scientists have uncritically accepted the methodology of positivism as the absolute rationale of scientific practice. Although it may produce high standards of precision and a certain formal logic the ontological commitment to the observational language does not appear to allow the investigator to extend his analysis beyond the observation of associative occurrences and regularities. Whilst the search for categories and patterns in a complex world is a means whereby a measure of understanding is made possible such a procedure does not allow the investigation to extend beyond description and generalization. On the other hand structuralism also resolves the problem of order by a simplification of the phenomenal world but through a logic that is very different from that of positivism. The constitution of a structuralist explanation rests upon a collapsed causal sequence of statements (analytically discernable on different 'levels') that are derived from some overall theoretical component and related by structural transformations. The observation language is therefore important not as a direct means for the testing of theories but as the logical consequence of theoretical deduction. Empiricism and empirical studies are not symmetrical.

Furthermore the standards against which to measure the legitimacy of theory are far from resolved amongst philosophers of science. Broadly speaking there are two camps:

the rationalists who believe in rational standards of scientificity and the conventionalists who argue for theory legitimacy via behavioural codes of practice. Kuhn, for example, has argued for a community paradigm in which formalization, quantification, social behaviouralism, ethical neutrality and the discouragement of philosophical controversy are encouraged because they maximise scientific community values. It is less clear whether he is offering a statement on the pattern of scientific development or a prescription of the direction in which he feels scientific development should go; whichever interpretation one places on his writing it can be said that his analysis is of convergent development, a situation he considers to be inevitable in the post- period of revolutionary science. It is on this aspect that Kuhn parts company from Feyerabend since the latter argues for the 'proliferation' thesis, not only as a more accurate description of scientific progress but also as a more desirable state for the liberty of man. Whatever their differences both reject the possibility of absolute standards and stress the social or behavioural infusion of beliefs, attitudes, and clarify the position of social knowledge being socially produced (and reproduced). To argue for a value free commitment to one theory or another is therefore not only a myth but a contradiction.

In this respect the penetrating critique of orthodox sociology by Gouldner permits us to at least begin to understand the relations between the investigator as scientist and the investigator as a member of society with values, purposes and prejudices like anyone else. Ideology defines reality for any individual or group of scientists by

making meaningful sense perceptions of the phenomenal world, and not infrequently by imposing order. Some understanding of the concept of ideology is essential if one rejects the possibility of schizophrenic science - a science which is able to stand apart from (and above) everyday life.

Any discussion of ideology must (almost) inevitably lead to the Marxian thesis since it is here that an exegesis has been most clearly worked out (though much remains to be done). It has become fashionable in recent years to take the political economy perspective, particularly in housing studies but the literature, however replete with empirical evidence, is still lacking in philosophical debate and a deeper understanding of the methodological issues at the heart of this 'new' perspective. Given the criticism of positivism, the advocacy of structuralism and ideology, and a concern for the disadvantaged in urban society, the convergence towards Marxism is entirely logical but the Marxian element in the analysis is a result of a fundamental concensus between structuralism and Marxist method. The two are extrinsically compatible and it is the methodology of Marx which led on to the adoption of his political economy thesis. Logically, of course, the acceptance of structuralism as an adequate (however defined) methodology of a reconstituted urban geography need not accept also the Marxian thesis, though it has to be said that alternative theses are not very forthcoming. The converse is not true. Since the theoretical content of the present analysis has been taken from Marxist interpretations the success of the enterprise cannot be judged on the logic of method alone, although the latter lies at the kernel of the problem.

Marxist analysis also represents a marked shift in the theoretical object of study. Traditional urban study can be seen to have developed from a confused lineage, the result of the conceptual separation of the urban component of society from society itself. Two urban theoretical objects appear to have been central to this traditional emphasis: 'urbanism' as a cultural thesis, and 'urbanization' which views society as statistical accounts of increasing spatial concentrations of people. In both there is the belief in complete urban autonomy, that a specific spatial and cultural form has an independent effect on human behaviour (as in, for example, the segregation of groups in cities). It is therefore possible to speak of an urban as well as 'space fetishism'. Since the structural correspondences between elements in this perspective have not been made the development of theory on socio-spatial relations is retarded and may even be impossible in the structuralist sense. The analyses in chapters seven to eleven attempt to exemplify this tradition. A Marxian analysis on the other hand locates the problematic not only in the nature of methodology but also in the basic socio-economic relations of production. Urban society is now to be seen as a specific form of the underlying contradictions between capital and labour (at least in the last instance). Thus the understanding of inner city problems and the plight of disadvantaged residents is to be seen not as a peculiarly urban phenomenon but as the result of contradictions in the basic relations of production, particularly concerning the nature of capital circulation now and in the past to preserve the process of capital accumulation. It would be misleading to imply that capital

circuits are the sole cause of segregation; it seems plausible (though this requires further testing) that some degree of autonomy be given to the urban realm. For example, social networks at the intra city scale will largely be determined by the nature of the neighbourhood (loosely defined) unit and will reinforce particular class consciousness. It may be that the recognition of structural 'levels' is of great importance in this respect and perhaps further consideration of the role and relations of the ideological level (the symbolic differentiation within the city) can particularly help to establish reasons for the behaviour and segregation of social groups.

It is understandable that the geographic perspective should place such a strong emphasis on spatial organisation and interaction, and seek to impute a spatial cause where this is deemed appropriate, as in the distance decay effect. It has therefore become commonplace to talk about spatial inequalities of welfare, but the implication in such phrases is that the cause of inequality is a poor distribution of rewards with some areas having better distributive mechanisms than others. It is possible therefore for Chisholm and Manners to talk of

> "spatial versus social inequalities" whereby
> "the dilemma of the two nations has shifted
> from being a class ..... to a spatial problem"
>
> (Chisholm and Manners 1971, Ch.1)

Social and physical space are conceptually separated as though they act out their dramas on different stages even though they are part of the same play. From the geographer's perspective the interaction between the two is never

theoretically clear but the empirical evidence provided by, for example, indices of dissimilarity, leads us to be convinced that some pattern in the relationship must exist.

Geographers may have been mistaken in thinking that the conceptual link had to be made between social process and spatial form since this involves merely a technical consideration of adopting single variables from each side of the equation and assuming that both are necessary and sufficient papameters in accounting for any observed relation. Any geographical perspective is essentially seen as the result of prior social processes acting on a blank surface to give at a point in time a certain spatial pattern or geometry. Thus the Duncans' conclusion that "residential segregation is greater for those occupational groups with clearly defined status than for those ..... whose status is ambiguous", demonstrated that a relationship between space and (some aspects of) society does exist (reference the U-shape pattern of indices of dissimilarity), but how this pattern has been produced cannot be explained by empirical generalization. Whenever a link of this order is observed, it should be the starting point for research rather than an explanatory argument per se. It must be said in their favour, though, that at least these studies demonstrate that space can exist as a variable of causal status and this is an advance on the methodology of factor analysis which proceeds by the opposition or similarity of correlations. Fundamental to a structural analysis however is the relations between space and other 'variables' within the theoretical system of interest. Positivist analyses separate space as a theoretical category and reify its

importance - the fetishism of space. Thus relations between social groups are seen as relations between areas; many social problems (such as housing and welfare provision) are therefore also seen as having spatial solutions. On the intra city scale this has been apparent in the Housing Acts of the past twenty years and changes in planning philosophy. The declaration of GIA's, HAA's, CCP's and the like to improve the physical fabric of inner city environments through policies of positive discrimination are good examples. They rest on the belief that social problems occur through a maldistribution of resources and opportunities; therefore a reallocation of resources through discriminatory policies will solve the problem. Such approaches, particularly on an official government level have clearly not produced the solutions intended and, as chapter 14 demonstrates, GIA's can actually work against the interests of the most disadvantaged groups. A structuralist analysis should redirect attention on to the main reasons for this.

In the first place 'spatial form' is less important than 'spatial process'; spatial distributions and patterns are static concepts and imply a place in the explanatory chain towards the end, as a product of other, prior social processes. Secondly, space cannot be seen as an isolated variable; it can only be given meaning in its relation to the social processes with which it interacts now and has interacted historically. Therefore it may be seen that the conceptual problems of relating social processes and spatial form have resulted from the widespread adoption of a positivist method which not only separates theory from methodology but variables from other related variables for the

purposes of analysis.

The view of space and territory adopted here and derived from the previous theoretical and empirical analysis is similar to that advocated by Mingione (1974). A structuralist perspective suggests that space be considered as a map (sic) of the social relations of production, exchange and consumption which underlies them, is shaped by them and influences them. In the context of residential segregation the analysis must focus on the production, exchange and consumption of housing. Space and territory are understood in terms of the uneven development of production relations, the social divisions of space that follow, the locational inertia of physical and social structures and the consequent inqualities of consumption.

Space is both a means of production and one of its consequences. As the former it enters into the social relations with capital and labour. Thus territory can be used directly as in agriculture and indirectly as land on which to build urban systems - but in both cases land acts as a commodity produced by and given meaning within the social relations of capitalism. Thus the growth of cities represents the need for greater concentrations of factors to facilitate exchange and circulation; similarly the geometry of social groups in the city is not the result of chance decisions made by households in the market place but is

> "governed by the laws of capital accumulation .... a product of the capitalist mode of production which requires a spatial organisation to

> facilitate the circulation of capital, commodities and information".
>
> (Lamarche 1972:86)

It may well be of course that in reality the circuits will behave sub-optimally in that the rate of capital accumulation may not be as great as it could be under ideal, frictionless circumstances. For example, the historical growth of the city will provide a building stock and urban fabric that mitigates against a smooth circulation; space will always exert a frictional effect in terms of the time, effort and cost required to cross it (though the genesis of the city might be seen as an attempt to overcome this effect to some extent). Thus, residential areas are in large part the local consequences of capital accumulation, particularly in those urban spaces where private capital most actively operates (as in suburbia).

Seen in this context the spatial organisation of the city is not the product of a specifically urban logic nor a specifically urban culture but a consequence of localised capital circulations which involve space as an integral factor for operation. Within this theoretical perspective the city is more than the projection of society on a blank surface; space and society are essential inter related ingredients to the theory. The theoretical object is no longer the city but capital and its relations with labour. Space can no longer be seen as an independent variable aside from theory, the form of which may reflect or accentuate certain systems of behaviour. Space is now an integral part of a broader

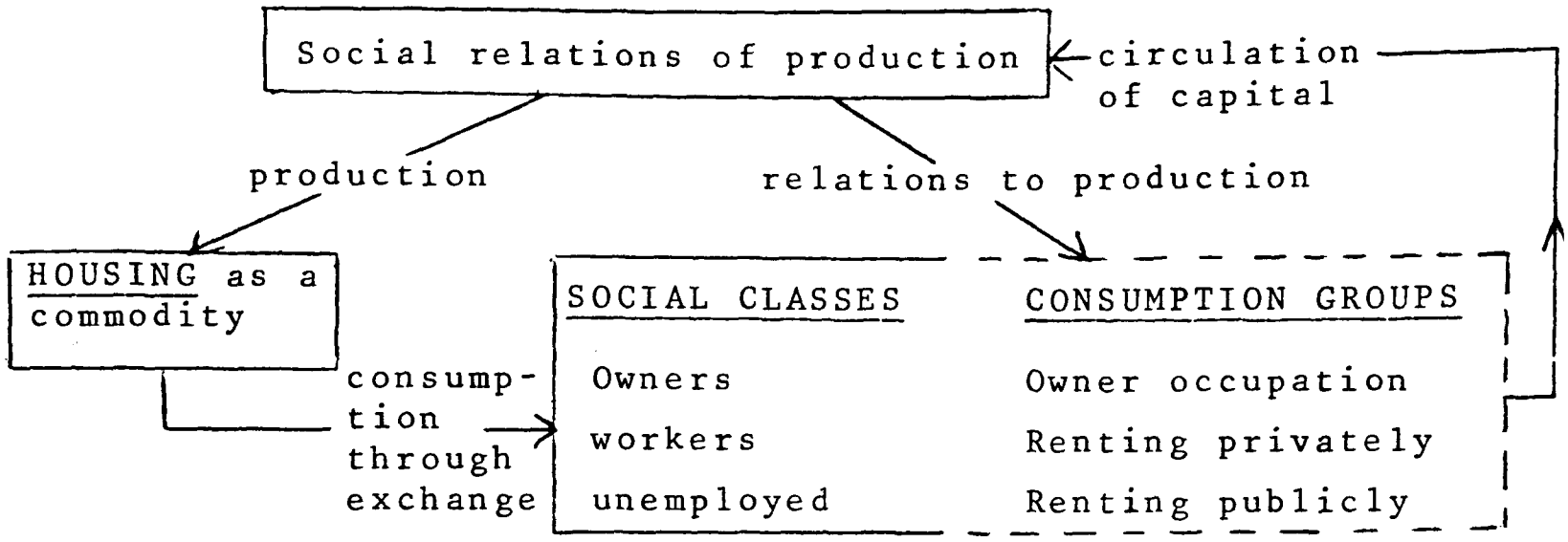
social theory of economic relations (though determinism is not implied). Not only is it possible to speak of the relations between social process and spatial form but also social and spatial processes in which space plays both an active (causal) and passive (resultant) role.

Two rather obvious criticisms may be levelled at this synthesis. The first concerns the autonomy of the urban realm or the degree to which urbanity can, of itself, influence socio-spatial organisation. It would be fatuous to argue that the economic relations of production determined the nature of urban systems in all instances. Clearly there are levels at which the nature of the built environment will influence say the behaviour of individuals. Social network analysis traditionally provides evidence of dense patterns of primary associations in working class neighbourhoods where high living densities and close proximity are experienced. Similarly the distribution of substandard housing in inner cities is a common feature and caused in part by the growth of the city and its own obsolescence. In this respect the 'urban' component of geography, sociology and other social sciences continues to make sense and the reality of an urban object of study can be demonstrated to exist. This is the level at which most urban research with a 'theoretical' bent has operated. It seems almost inevitable that in adopting a structuralist explanation a researcher also adopts Marxism as a thesis which, given the above may not be flexible enough to allow for the existence of phenomena whose genesis can hardly be located in the economic relations of production at all times.

Secondly the emphasis in a structuralist explanation shifts away from the individual and (in the context of residential segregation) household residential location decision making towards decision making at the institutional level. This does not reflect a simple shift of emphasis as some authors have implied (see Johnston 1978, 1980) but it locates the sources of power in shaping the urban space economy and particularly those who manipulate capital for gain. On its own, behaviouralism seems doomed to platitudes since it assumes that decisions are made by individuals operating in a totally unconstructed environment. Preferences are therefore exercised through choice. The evidence on owner occupation however clearly demonstrates that 'choice' is a relatively meaningless term for the most disadvantaged; not only are they unable to gain access to the private ownership sector but their 'choice' of council house or tenement is determined by what happened to be available at the time. Attempts at measuring decision making in this sort of situation become little more than technical exercises of numeracy. 'Choice' becomes theoretically meaningful when it can be exercised, as with middle class owner occupiers. In this situation the constraints imposed by the capital market are less severe and factors such as the quality of neighbourhood and access to the golf club become real decisions. There can be little doubt that some social groups do exercise choice and preference for residential neighbourhoods in urban space but even at this level decisions are constrained by housing availability, the progress of developers, planning regulations, all of which operate on an economic level. Perception studies in vacuo

can therefore have very limited meaning because they assume that man's actions are never circumscribed by the environment in which he lives. The precise relations between the theoretical levels of causality: economic, political and ideological, remain to be worked out but, at least intuitively it seems plausible that they must each have a measure of relative autonomy from the structural relations of capital and labour.

The role of consumption in Marxist theory is an integral part of the polemic for it is often confused with class concepts which gain meaning only in relation to production. It is argued in chapter 12 that groups can be defined by their consumption characteristics (in housing) which to some extent depend on competition with others in the market place. Although this has strong Weberian overtones and approximates to Rex's 'housing classes' there is a danger of lapsing into pluralistic conceptions which are incompatible with the main corpus of theory. Since a Marxist definition of class centres on a group's relationship to the means of production the notion of consumption class must, it is argued, be non-Marxian. The argument adopted here is that consumption is an essential part of production in that without consumption the process of reproduction of class relations would not be possible. Within the housing market consumption groupings are therefore produced to allow commodity capital to be realised in the form of money capital and to hasten the speed by which reproduction of social relations is made possible. The following model attempts to illustrate this in a decontextualized way:



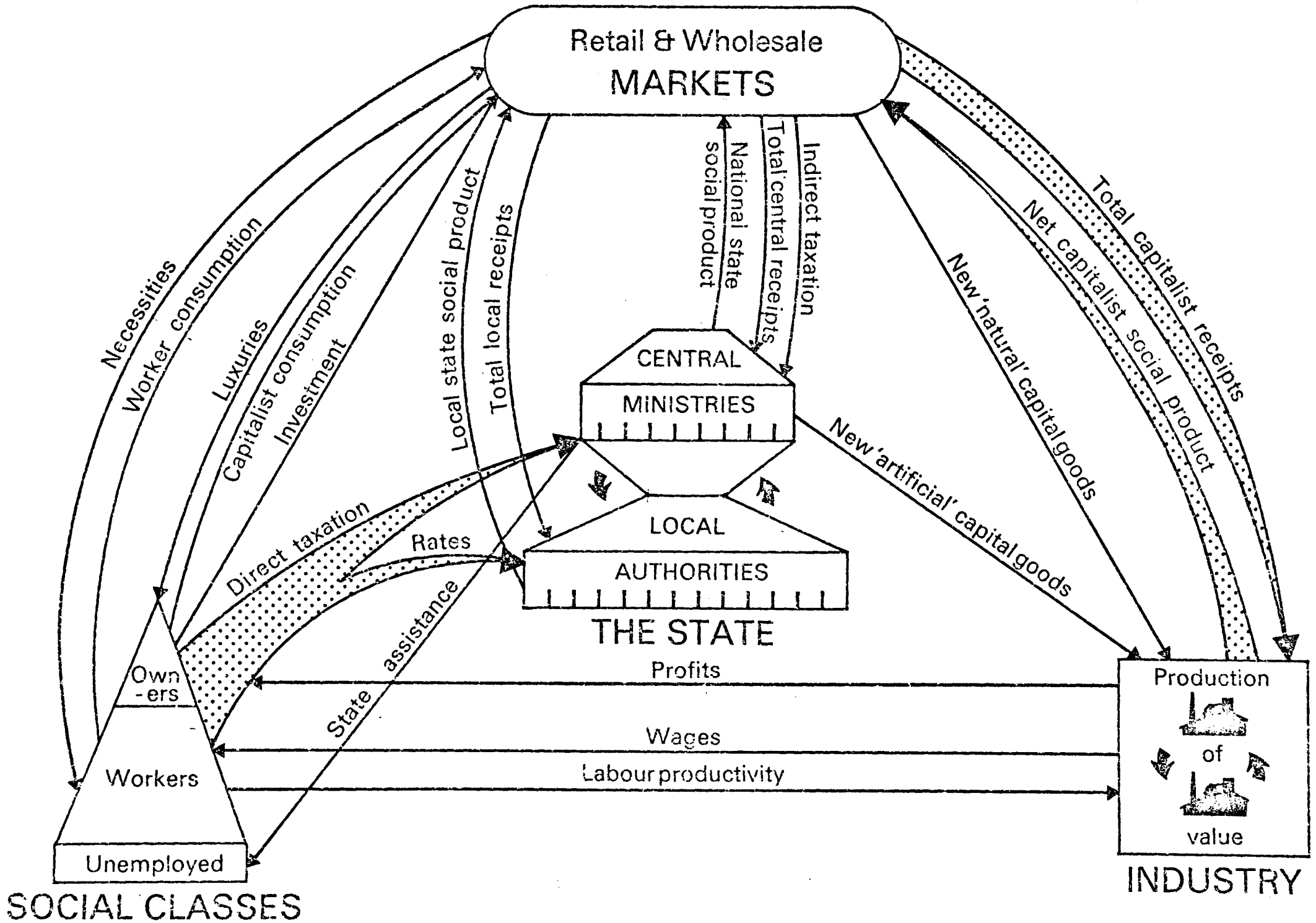
Housing is produced as a commodity for the realisation of surplus value; social classes are defined by their relations to the means of production, fundamentally as owners or workers. Social classes are then subdivided into consumption groups according to tenure as part of the residential segregation process. Tenures therefore define consumption groups; different tenures exist to speed the rotation of capital within different groupings. Since consumption of housing varies along a tenurial division it is possible to think of tenure as the form of consumption. Tenure is not an abstraction (as in Rex's 'housing classes') but related to the production of value through the possibility of its realisation. In any situation where the rewards for production are differentiated through an earnings capacity it is inevitable that there will be inequalities of consumption in all material wants. The act of production therefore creates a social stratification and a restructuring of space in such a way that unproductive capital circulates with all speed (akin to reducing the friction of space) in such a way that social stratification and spatial territories are mutually reinforcing.

Within any specific set of social relations spatial territoriality provides the conditions for reproduction of the relations of production. Space allows existing social relations to continue to be profitable. Thus the private rented sector is seen as an inertial tenurial form from the last century though it catches those consumption groups unable to escape and high absolute rents can still be charged. Suburban (and private) developments in housing are aided by fiscal legislation and institutional credit control and provide levels of aspiration for the middle classes. This analysis may have lapsed into formalism whereby the theoretical concepts outlined in a Marxist exegesis are reduced to abstract constructs in the attempt to give them empirical creditability. Thus social class becomes an 'occupation' category. Even so it is possible to see the development of the residential mosaic in which social groups are segregated according to class, age and ethnicity but these are seen as the dimensions which facilitate the social relations of production, either directly or through an extended circuit of loan capital. Estate agents, solicitors, and the like facilitate exchange and thus aid circulation.

The role of the state in housing is a contentious issue amongst theoreticians, not least for the problem of definition. Taken in a rather narrow sense 'the state' includes central government, administration and local authorities (not the military, judiciary, police, etc.) and conventionally they are seen not as free agents in the production and implementation of policy but as constrained with a structural framework which bounds their

FIG. 82.

THE CIRCULAR FLOW OF INCOME IN A MIXED ECONOMY.



possible actions. Although the argument developed by Engels and Marx that the state and other superstructural elements are a direct product of the economic base has been discredited as being too mechanistic (see Miliband 1969), Althusser and Poulantzas regard the state as having relative autonomy from the economic level yet still dialectically related in the last instance. Thus Miliband states

> "mitigation of dysfunction of capitalism is one of the state's most important attributes - an intrinsic and dialectical part of its role as the guardian of the social order".
>
> (Miliband 1969:242)

In the housing market Harvey (1978) views the state as an agent of private capital intervening in conflicts over the built environment between labour (as the appropriators of rent) and the construction faction. Thus the need for

> "capital to dominate labour not simply in the work process but ..... in the consumption sphere".
>
> (Harvey 1978:14)

is reflected in the role of the state in encouraging home ownership, rationalising consumption patterns and legitimating suburbanization.

Although it is not possible to discuss the implications of this perspective in depth it is desirable to relate, briefly, these ideas to the empirical evidence presented earlier. Fig. 82 synthesises the main ideas on the state as a medium for the realisation of surplus value and the maintenance of economic stability. The state is seen as an integral part of welfare capitalism both in the production of (artificial) capital goods and as a consumer of

social products.

The importance of local byelaws to the building fabric of the nineteenth century city was discussed in chapter 13. Without some form of intervention by the state the quality of industrial housing would have rapidly deteriorated to an unacceptable level. The nature of land tenure, the emergence of terminating societies and anachronistic land law served not only to shape the urban nature of a rapidly industrialising city but also to legitimate those forces operating at the structural level. More recently the state can also be seen to possess an 'accumulative' role (Marcuse 1977) in that consumption of the private sector is encouraged wherever possible, even though loan subsidies to the building societies, tax relief on mortgages and the levying of an historical 'economic rent' work to the disadvantage of the tenant compared with the owner occupier. Public policy in housing appears to work then in a supportive capacity to the needs of capital production and reproduction and therefore maintains the position of the disadvantaged.

In conclusion the success of the geographical enterprise will depend entirely upon its ability to increase its theoretical content in the next few years. To do this it will be necessary to cast off the shackles of positivism and adopt a structuralist perspective. At the moment the Marxist thesis offers a powerful alternative though there is a danger that geographers may, to adopt the phrase of Heilbroner, reject thraldom to technique in their adoption of thraldom to a thesis. Increasingly it is my belief that the pleas for geographers to be taken seriously in their analyses of

the social problems besetting contemporary society will be realised only when we are seen to produce solutions. Ironically, perhaps, the theoretical geography of the future will be judged by the success of its pragmatism.

APPENDIX A.

THE STATISTICAL RATIONALE OF FACTOR ANALYSIS

THE FACTOR MODEL

Too few geographers realise that the term 'factor analysis' is a generic term embracing a large corpus of related techniques (Davies 1973). In this study terminology is used sensu stricto; a clear distinction is made between principal components and principal axes factors analyses. It is generally believed that the two serve different purposes. By its reduction of a variable matrix to a factor matrix, principal components analysis is thought to be more appropriate to the descriptive classificatory role ascribed to it by Rummell (1970) whereas Lawley and Maxwell (1972) suggest that common factors analysis implies some hypothesis testing as to the number and nature of common factors. They argue that since the data is fitted to a specific model the technique is less descriptive and more concerned with hypothesis confirmation or refutation. What tends to have happened is that the hypotheses have been set up to test assumptions made of the technique rather than the theory the technique is supposed to be testing. Consequently, possibly more than in any other area of urban analysis, factor studies are replete with a vast number of auxiliary hypotheses.

Harman (1967) has defined factor analysis as

> "..... the resolution of a set of variables linearly in terms of a small number of categories or factors, ... a satisfactory solution yielding factors which convey all the essential information of the original set of variables."

Similarly,

> "in sciences beset with highly multiple determination of events,"
>
> Cattell (1965:429) has observed that,
>
> "factorial studies are designed to linearly resolve an n (attributes) x N (observations) data matrix into a nx F factor matrix in which F, the number of factors extracted, is smaller than n, the number of variables."

Excluding factor designs such as the centroid technique (Burt 1917., Thurston 1947), MINRES (Harman and Jones 1966) and other multiple grouping techniques (Harman 1967:233-246) the two basic factor models may be differentiated.

Firstly, the Principal Axes Factor (Open) Model acknowledges the fact that the total variance of a data set cannot be accounted for by a small matrix of common factors. Rather some variance will be unique to the variable(s) concerned. Consequently in the principal axes factor model, unique variation is set aside and patterns are sought within the common variation amongst a set of attributes. The standard formula (after Harman 1967) is

$$Zji = \sum_{p=1}^{m} ajp\ Fpi + dj\ Uji \qquad \ldots\ldots\ldots\ (1)$$

$$\left[\begin{array}{l} i = 1, 2, 3, \ldots N \\ j = 1, 2, 3, \ldots n \end{array}\right]$$

In this expression Fpi is the value of the common factor p for an individual i and each of the m terms ajpFpi represent the contribution of each successive factor to the linear composite, while djUji is the 'residual domain' of the observed measurement Zji.

The residual element is usually termed the unique variance since the common factors fail to account for its value. Its constituent parts include (Child 1970:33) (a) specific variance: within a given data set some variance will be specific to a particular variable; this can be reduced by adding more variables (b) error variance (unreliability) is a random component resulting from imperfections in variable measurement.

Given the decomposition of unique variance into the two types discussed above, the linear model can now be expressed in the following form where specific and error variance are explicitly acknowledged:

$$Zji = \sum_{p=1}^{m} ajpFpi + bjSji + Cjeji \qquad \ldots\ldots\ldots (2)$$

$$\begin{bmatrix} i = 1, 2, 3, \ldots\ldots N \\ j = 1, 2, 3, \ldots\ldots n \end{bmatrix}$$

In the case of orthogonal factors the proportion of the variance of a variable which is accounted for by the factor is indicated by the square of the factor loading. Taking the factor matrix, the sum of squares of loadings in each column gives the amount of variance explained by that factor and is known as the eigen value. The sum of squared factor loadings in a row of the factor matrix indicates the variance accounted for by the common factors for the variable Zj and is known as the communality (hj^2) of that variable and is expressed as:

$$\sum_{p=1}^{m} ajp^2 = hj^2 \qquad \ldots\ldots\ldots (3)$$

Since total variance must have a value of unity

$$1 - h_j^2 = \text{unique variance } (d_j^2) = sj^2 + e_j^2$$

Harman (1967:19) summarizes the composition of variance of a variable Zj by:

Total variance	(1)	$= h_j^2 + s_j^2 + e_j^2 = (h_j^2 - d_j^2)$
Reliability	(rjJ)	$= h_j^2 + s_j^2 = (1 - e_j^2)$
Communality	(h_j^2)	$= 1 - d_j^2$
Uniqueness	(d_j^2)	$= s_j^2 + e_j^2 = (1 - h_j^2)$
Specificity	(s_j^2)	$= d_j^2 - e_j^2$
Error variance	(e_j^2)	$= 1 - rjJ$

When unique variance (d_j^2) is specifically accounted for, the effect in direct solutions (unrotated) is to produce 'purer' dimensions of covariation, accompanied by necessarily lower levels of explained (total) variance though the explanation is attributable to common variance only.

In the Principal Components (Closed) Model (Pearson 1901, Hotelling 1933) no account is taken of the unique variance of the data set. Hence:

$$Zji = \sum_{p=1}^{m} ajpFpi \qquad \ldots\ldots\ldots\ldots (3)$$

$$\left[\begin{array}{l} i = 1, 2, 3, \ldots\ldots N \\ j = 1, 2, 3, \ldots\ldots n \end{array}\right]$$

By placing unities in the diagonal of the similarity matrix common and unique variance merge to produce 'hybrid' components, each containing a proportion of unique variance.

It follows that the components which emerge will produce higher levels of explained (total) variance though their structure will be contaminated by specific- and error-produced loadings. Mathematically simpler than the principal axes technique, Principal Components also produces factor loadings which restore the unreduced correlation matrix (Catell 1965:193-196). It will additionally provide component scores which exactly reproduce the values of the original variables whereas in principal axes factor analysis this is replaced by an estimate.

Of the two factor designs geographers have made particular use of the principal components version but the present study utilizes principal axes. Using Kaiser's criterion for factor extraction a PCA on raw percentage values produced 14 dimensions accounting for 66.92% of the total variance (cf. Norman's 1969 study of London). There were seven 'hybrid' dimensions as a result of the distribution of unique and error variance between all components and this made interpretation very difficult. The PA results, however, produced fewer dimensions (between 7 & 10 depending on the criterion) that were more easily interpretable.

Moreover, it has now passed into conventional wisdom that the two designs perform different functions. There can be many strategies for using factoring techniques (see Goddard & Kirby 1976:33 for examples) in geographical analysis but most reports stress the data reduction role of PCA in contrast to a previously hypothesised pattern to PAFA. This is because PCA is, mathematically, a simpler technique - it makes no prior assumptions concerning the

relationships between variables to be analysed. Its function is the parsimonious reduction of a variable matrix into a component matrix that represents the essential variance of all the original variables. PAFA on the other hand produces factors that represent only the common variance of the original variables and this introduces a large number of additional decisions regarding the techniques that the analyst must make. Because of this, PCA is best used in 'closed systems' (Cattell 1965) where all aspects of interest can be accounted for, say in a country's internal migration pattern (Winchester 1975), but there is less justification in urban research.

Input Variables

Early applications of factor analytic techniques to the spatial structure of the city took their data from the rigid Shevky-Bell seven variable typology (Shevky & Bell 1955) but subsequent empirical accounts (e.g. Anderson & Bean 1961) have extended the number and range of variables. Setting aside specific intra-urban factor studies such as those based on political behaviour (Allardt 1964), Crime (Schmid 1961) and delinquency (Timms 1965) considerable criticism has recently been voiced at the prevailing ad hoc selection of input variables (see Palm & Caruso 1972). Brian Berry (1971) for example has aptly described this as bringing the GIGO principle - garbage in, garbage out - into operation. It would appear that Janson's plea that "no variable should be included except for special theoretical or technical reasons" (Janson 1969:3-7) has not always been heeded.

A limited selection of variables must, clearly, restrict the factor structure; too many will introduce the problem of redundancy. It is usually argued that the former approach does not allow for other dimensions beyond the Shevky-Bell typology to emerge if they exist. On the other hand a large batch of variables could create a nesting effect of those which are related to give double counting and the appearance of spurious factors (usually called artifactors). This problem is particularly prone to emerge with data in ratio form and since the majority of geographic studies has used proportional data it is a problem that often passes unacknowledged (Janson 1969:316-321). There are also a number of other problems concerning input variables and these are briefly discussed below:

(a)
Closed Number Systems

One problem relates to confounding in dichotomous variables. Most factor analyses have included multiple categories of the same initial variable in the numerator (e.g. age sub-groups). Where there is a simple dichotomy (e.g. proportion born outside G.B.) the correlation between these measures will be perfect and negative which often forces a bi-polar factor in the solution. Brown & Horton (1971:274), for example, identified as "Ethnic Status" factor for Chicago on which % negro, % white, % foreign born, and % native born loaded alternatively positive and negative. In such dichotomous situations it should be understood that one need not make comparisons of both categories. Where, however, there are several subgroups the problem of orthogonality between variables becomes more acute. Dent and Sakoda

(1973:42) suggest that

> "the most appropriate procedure is for each category to be eliminated successively from the denominator after being used as the numerator"

as in the following table:

TABLE

	Denominator	Numerator	Measure
1.	Total Population	age 0- 9	Children
2.	age 10 years +	age 10-19	Adolescents
3.	age 20 years +	age 20-39	Young adults
4.	age 30 years +	age 30-39	Mid adults
5.	age 40 years +	age 40-49	Mature adults
6.	age 50 years +	age 50-59	Middle aged

An important caveat is added that the resulting measure must still be meaningful. So if age group 60-69 were deflated by age 60+, the resulting measure would not relate aged persons to a reasonably sized sub-set of the sub-population. A variable must measure what it purports to measure.

(b)
Distortion of Component Scores

Furthermore, Daultrey (1973) has offered empirical evidence to suggest that the inclusion of redundant variables has a distorting effect on component scores. Since component scores are calculated by multiplying the standard score

for each variable in the E.D. by its component loading and the products summed for each component to zero mean and unit variance standardization, the presence of duplicating loadings on trivial variables will give misleadingly high component scores. Checking standard scores against the raw data could guard against misinterpretation. It would seem though that the careful elimination of redundant variables at an earlier stage in the analysis is required. This should be carried out with reference first to the correlation matrix where weak associations will be evident (Meyer, 1971 has convincingly demonstrated the need for continual reference to the initial similarity matrix when descriptive statements beyond factor-level are required), and secondly to the communality estimates. Low communalities in a common factor solution can result either because

(a) too few factors have been extracted so that potentially diagnostic variables have not been allowed to influence the common factor structure;

(b) the variable is either intrinsically unimportant or is a product of a large sampling error so that it is contributing more towards specific and error variance.

Moreover, distortion of factor scores can occur where the factor solution does not approach simple structure because any score value can be the result of numerous combinations of high and low values for individual variables. Joshi (1972) for example attributed the lack of fit between scores and his working knowledge of the social areas of Katmandu to a group of small loadings which had not been used to interpret the component structure but which were nevertheless influencing the pattern of scores. Horn's (1973) re-analysis

of King's (1969) data came to similar conclusions.

Variable Grouping

A further problem arises from the nature of the variables and their grouping. Davies and Lewis (1973/74) have recently criticised the absence of explicit grouping of the initial data into a broad range of categories each containing equal numbers of variables. Citing the studies of Rees (1970) and Janson (1971) they show that variable dominance filters into factor dominance (another case of artifactors). To overcome this in their study a sixfold grouping into (i) demographic (ii) migration (iii) economic (iv) social-occupational (v) commuting - cars, and (vi) household, ensured an equable distribution of variable types.

In this analysis 54 variables were grouped into seven categories each containing roughly the same number of entrants: (i) demographic (ii) ethnicity and migration (iii) employment (iv) social and occupational (v) commuting (vi) tenure and housing composition and (vii) housing characteristics and occupancy. All data was extracted from the 1971 Small Ward library statistics for the old Bradford County Borough and translated into ratio form. The full list of variables is presented in Table 1 below; the numbers allocated to each variable are used consistently throughout the thesis.

The nature of the variables themselves was dictated at this stage less by theoretical considerations than by input variables to previous empirical work. Major British studies

DESCRIPTION OF THE CENSUS VARIABLES SELECTED FOR BRADFORD, 1971

VARIABLES	NORMALISED DATA				LOCATION QUOTIENTS		
	Trans-[1] formation	Mean	Skewness	Commun-[2] ality	Mean	Skewness	Commun-[2] ality
1. Distance	—	30.42	0.37	57	30.42	0.37	45
DEMOGRAPHIC							
2. Children	—	24.98	0.02	98	0.98	0.02	86
3. Young adults	Lg 10	1.17	-0.03	44	0.72	1.29	54
4. Mature adults	Lg 10	1.34	-0.64	55	0.97	0.78	60
5. Middle-aged	—	25.88	0.37	66	1.59	0.38	60
6. Retired	√	3.29	0.13	92	0.73	1.01	91
7. Fertility ratio	√	6.14	-1.08	54	0.99	0.38	62
8. Married females	—	31.98	-1.17	71	0.68	-1.17	73
9. Single adults	Lg 10	1.59	-0.10	33	1.29	0.96	18
10. Sex ratio	Lg 10	-0.01	3.55	19	1.43	14.44	04
MIGRATION ETHNICITY							
11. Born overseas	Lg 10	0.81	0.37	87	0.85	1.96	93
12. Irish	Lg 10	0.10	-0.18	26	1.03	2.05	29
13. Asian	Lg 10	0.28	0.78	83	1.09	2.67	93
14. Other European	Lg 10	0.07	0.17	35	1.04	4.02	36
15. One-year movers	Lg 10	0.71	-0.20	22	1.04	1.63	24
16. Five-year movers	√	5.74	-0.32	56	1.35	0.75	59
17. New migrants	Lg 10	0.31	1.04	24	1.06	2.87	22
18. New Commonwealth	Lg 10	0.33	0.56	82	1.10	2.52	94
EMPLOYMENT							
19. Economically active	—	63.93	-1.94	85	1.00	-1.94	78
20. Unemployed persons	Lg 10	0.65	-0.24	58	0.57	4.62	45
21. Females employed	√	6.81	-2.70	70	0.99	-0.83	76
22. Primary workers	Lg 10	0.06	4.43	14	1.49	8.96	38
23. Industrial workers	√	6.75	-1.22	47	0.94	-0.08	42
24. Transport workers	Lg 10	0.67	-0.41	05	0.95	1.45	11
25. Distribution workers	√	6.06	-0.10	42	1.02	4.02	30
26. Government workers	Lg 10	0.37	0.60	11	1.00	3.57	07
SOCIAL & OCCUPATIONAL							
27. Employers/managers	Lg 10	0.62	-0.05	41	1.03	1.91	43
28. Professional workers	Lg 10	0.21	1.41	36	1.04	3.26	47
29. Non-manual workers	—	21.76	0.54	57	0.96	0.54	53
30. Skilled manual	—	26.65	0.51	53	0.99	0.51	42
31. Semi & unskilled	—	43.16	0.17	76	1.03	0.17	72
32. Education	Lg 10	0.51	0.20	35	1.70	1.85	35
33. Occupational mobility	Lg 10	0.59	-0.18	10	1.74	2.58	09
34. Retired males	Lg 10	0.69	-0.44	21	1.83	2.40	19
COMMUTING							
35. No-car households	—	66.23	-0.77	94	1.01	-0.77	94
36. Two-car households	Lg 10	0.43	0.37	61	0.83	3.84	50
37. Bus-commuters	—	35.71	0.33	48	1.02	0.33	35
38. Pedestrian commuters	√	3.67	-0.32	36	1.08	1.25	30
39. Car commuters	√	4.21	-0.22	68	1.07	0.97	73
TENURE							
40. Owner occupiers	—	57.52	-0.55	86	0.99	-0.55	81
41. Council tenants	Lg 10	0.67	0.58	76	0.95	1.16	84
42. Tenants - furnished	Lg 10	0.26	1.58	82	1.09	4.38	89
43. One person households	√	4.57	0.04	81	1.01	0.97	85
44. Single pensioner households	√	3.61	-0.32	77	1.00	0.93	76
45. Two person households	—	6.35	0.67	33	1.01	0.67	32
46. Two pensioner households	√	2.75	0.01	57	1.02	4.08	43
HOUSING CHARACTERISTICS & OCCUPANCY							
47. Persons per room	Lg 10	-0.18	3.61	12	1.79	11.47	08
48. Overcrowding	Lg 10	0.34	0.69	75	1.14	2.39	78
49. Rooms per dwelling	√	0.62	-2.11	20	1.09	24.43	14
50. Substandard houses	Lg 10	0.18	2.21	84	1.02	4.60	92
51. Shared dwellings	Lg 10	0.16	2.41	63	1.11	5.7	54
52. No W.C.	Lg 10	0.96	-0.33	83	1.12	1.08	83
53. No hot water	Lg 10	0.63	0.22	92	1.14	2.00	86
54. No bath	Lg 10	0.80	-0.02	94	1.11	1.40	94

[1] The transformation factors refer only to the fully normalised data set.

[2] The communalities relate to a principal axes nine-factor extraction rotated according to the varimax criterion for the normalised data and the direct quartimin criterion for location quotients. The decimal point has been omitted in both cases.

Table 1

were reviewed including: Giggs 1969, Herbert 1968, Thomas 1968, Gittus 1964, Robson 1969, Timms 1965, Norman 1969, Wilkinson, Davidson and Francis 1971, Warnes 1973, Davies and Lewis 1973, Ball and Kirwan 1975, Giggs and Mather 1975, Webber 1974, Manchester Planning Department 1975, Cullingford, Flynn and Webber 1975, Davies 1975, Winchester 1975, Webber 1976, and the variables that loaded most significantly on each factor were noted. The aim was to achieve some comparability of data sets with other studies, particularly the equally large analysis of London, Leicester, Bristol and Liverpool.

Since most factor studies have rarely employed more than 42 census variables some scope was allowed for a theoretically-based variable content (discussed below) - though a long-term objective was to extend variable selection over as wide a spectrum of available data as possible in the hope that no potentially diagnostic variable would be omitted. The result has been to create a broader base for the social class and employment groups and a new category, commuting, has been introduced.

(e)

Areal Units and Scale Effects

King (1969:154) and Janson (1969:331) have reported that the areal base in correlation and regression analyses can be modified in several ways to vary the estimates of the coefficients under study. Firstly, a problem arises in defining the urban setting. Should the formal or the functional city be used? The majority of British cases have taken data based on the administrative boundaries with

consequent underbounding. Many studies (e.g. Sweetser 1965, Hadden & Borgatta 1965, Janson 1974) have found considerable variations in the strengths of metropolitan- and city-based factors though some invariance was evident in their structure. It might be expected though that where the boundaries are widely defined factor distortion arises through an over-emphasis on the central area and the exclusion of the affluent urban fringe populations (Davies & Lewis 1973:74, Evans 1973:89). The second fault has been admitted in several British studies (Norman 1968, Herbert 1969), though it is probably common to many more. Where the complete urban system (ultimately impossible to define) can be identified few problems arise since adjacent E.D.'s need simply be added. In the case of Bradford however, the urban subsystems of Bingley, Shipley, Keighley, Otley, Ilkley, Silsden, Spenborough and Pudsey and the regional system of nearby Leeds complicate the picture. Though the city's urban field has been defined on several criteria (Richardson 1968, 1970, 1976) a thorough analysis would entail the inclusion of over 2,000 E.D.'s. For this study limitation had to be placed on the 632 non-institutional enumeration districts for Bradford County Borough as it existed prior to local government reorganisation in 1974.

A further problem relates to the size of the E.D. itself. Though the evidence is conflicting Gelkhe & Biehl (1934) first pointed out that the correlation between attributes increases with the degree of homogeneity and size of units (measured in number of observations). Thus, ward-based analyses might be expected to produce weaker correlation bonds. Duncan, Cuzzort & Duncan (1961) partially support

this view but Thomas & Anderson (1965) and, more recently (though in a slightly different context), Woods (1976) suggest that the positive relationship between no. of observation units and coefficient size is by no means stable and regular. The only valid conclusion that can presently be made is that estimates of the regression and correlation coefficients have no absolute validity independently of the areal units but are relative to them (King 1969:154).

Lacking suitable alternatives, the choice fell to enumeration districts Small Ward statistics on the premise that E.D.'s are more homogeneous than wards and thus a more appropriate level of analysis.

Openshaw (1973) has recently demonstrated how sensitive spatial data can be to scale effects. Because scale and aggregational variability are specific to each variable, an increase in scale being associated with approaches for skewness and kurtosis towards a normal distribution, a change in either will affect statistical measures dependent upon the nature of relationships (e.g. factor analysis, canonical correlation, discriminant analysis). Comparative analyses between E.D.'s in urban space and between cities in national space must suffer until an optimal size of areal unit is available in which relationships between attributes are accurate and assumptions of normality are not violated (Mather and Openshaw 1974:286).

The paucity of research in this area necessitates the use of predetermined areal units. This fact forced Barrow (1972:52) to use census tracts in three Prairie cities that

contained as many as 10,000 people and in one case more than 30,500! Though defined for the convenience of administration and data collection, enumeration districts are the smallest areal data bases currently available (OPCS 1971) in which some measure of population homogeneity can be expected to exist (Myers 1954).

Distributional

The classic factor model makes no assumption of multivariate normality in the data set (Harman 1967) though transformation can be employed as a useful option in analyses where data is highly skewed and as a necessity when significance tests are to be applied when inferring from a sample to a population.

Since most spatial data is characterised by a marked positive skewness few investigations have employed anything more rigorous than a blanket logarithmic transformation (Clark 1973). Exceptions include Murdie (1969), Morrill and Pitts (1967), Taylor (1971), Warnes (1973), Janson (1974) and Robinson (1977). Although blanket logarithmic transformations usually account for a higher explained variance there is no evidence to suggest that a single transformation factor is suitable for all variables. In a preliminary log. transformation of the Bradford data some variables became highly negatively skewed and for this reason it was decided to transform each variable individually to improve the goodness of fit. Twelve variables remained as before; thirty were logarithmically transformed and twelve were transformed by square roots.

On a seven factor, varimax solution there was a marginal increase in the level of explained variance from 46.6% to 51.5%. This small increase is due in large part to the fact that any transformation procedure normalizes only the univariate and not the multivariate distribution. Furthermore, factor scores became more difficult to interpret. This results from new symmetrical distributions which produce fewer extreme-valued factor scores (Britton 1972:89).

To a great extent many of the problems of data normalization were avoided by adopting location quotients as input variables. Not only did this produce factor structures very similar to those of normalized data, it also overcame the problem of factor score interpretation.

Variable Weighting

The standard procedure in geographic studies (though not in allied disciplines) has been to reduce all elements of the data set to ratio form relative to a population factor for the E.D. This has the effect of standardising the relationship of all measures within an E.D. to a common base but of exacerbating relationships between E.D.'s with widely fluctuating absolute values. Thus, two E.D.'s may have 60% of their total population Asian though one can be the product of $^{6}/_{10}$ and the other by $^{372}/_{620}$. By calculating percentages, equal weighting is given to all variables between E.D.'s when the difference in sizes does not warrant it.

As far as the present author is aware only Britton's (1972) Q-mode component analysis of the occupational structure of

central Canadian cities has made an effort to overcome this problem (though Rees' (1968) thesis included 13 location quotients in the 57 variable set). By taking percentaged data (variables standardised within an E.D.) initially, Britton calculated location quotients (variables weighted between E.D.'s) and repeated the analysis. Using percentaged data the first component accounted for 83% of the explained variance; using location quotients it fell to only 21%. Since the aim of most (if not all) urban geographic studies is the areal differentiation of social groups within the city, indices that clearly emphasise variations must intuitively be preferred.

Thus, all 54 variables in every E.D. were transformed according to the following formula:

$$LQ\ ij = \frac{\frac{gij}{m}}{\sum_{j=1} gij} \Big/ \frac{\frac{Pj}{m}}{\sum_{j=1} Pj}$$

Where gij = the population of group i in area j

$\sum_{j=1}^{m} gij$ = the total population of group i in the city

Pj = the total population in area j

$\sum_{j=1}^{m} pi$ = the total population of the city

The effect of using location quotients as input variables is most clearly expressed on factor scores. Fig. 83a shows the

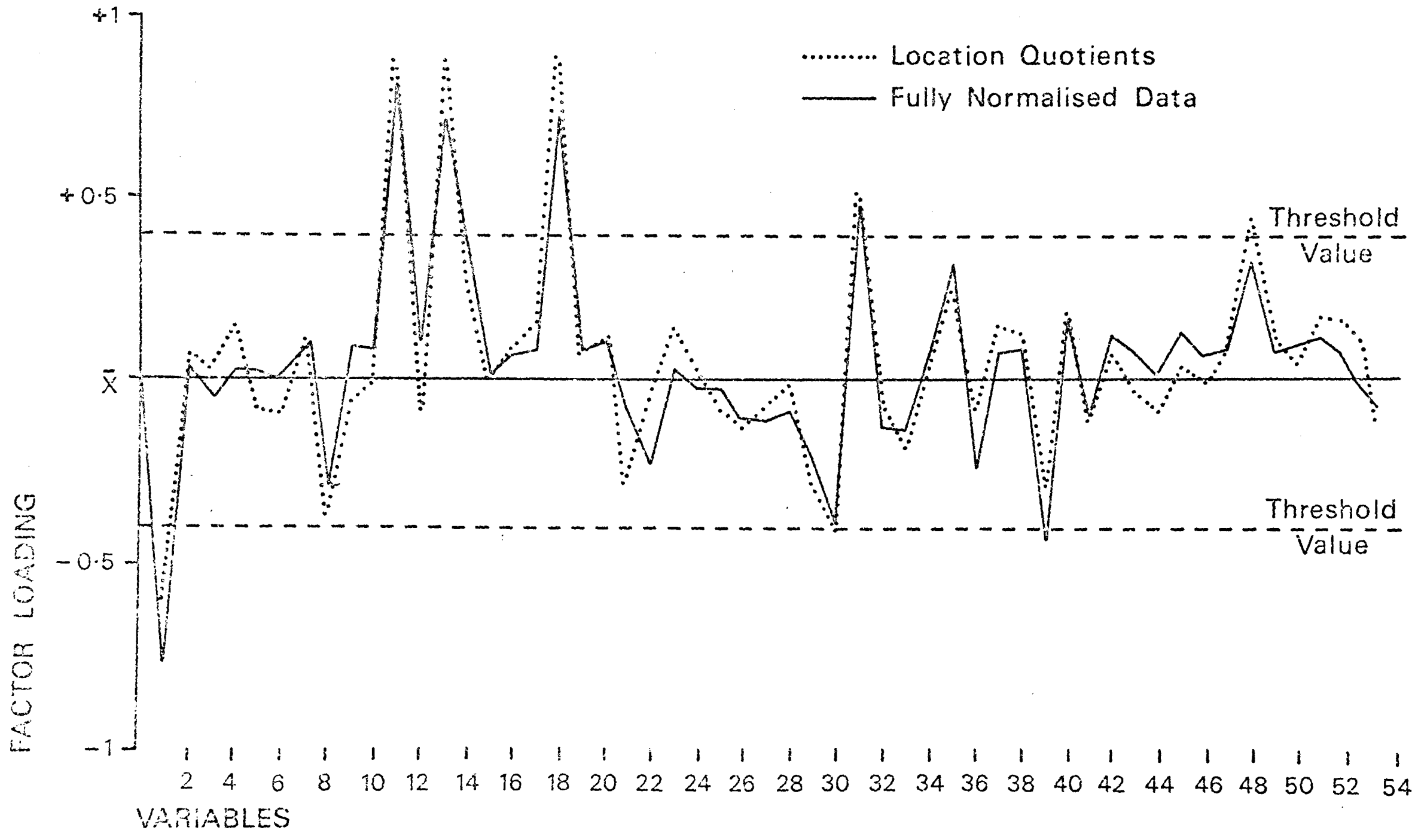
SELECTED EXAMPLES OF CHANGES IN THE PATTERN OF FACTOR SCORES L.Q. & NORMALISED DATA

E.D. Name and Number	Factor I Ethnicity Social Class L.Q.	Factor I Ethnicity Social Class Normalised	Factor IV Rooming House L.Q.	Factor IV Rooming House Normalised
Bolton 36			-4.729	-3.250
37			-5.400	-4.309
38			-5.088	-3.778
39			-5.566	-4.436
40			-5.449	-4.042
41			-2.594	-3.227
42			-0.796	-1.987
43			-0.491	-1.296
44			-2.207	-2.64
Manningham 18	0.741	1.404		
19	0.180	1.047		
20	2.062	1.991		
21	0.916	1.429		
22	1.127	1.494		
23	0.511	1.206		
24	2.166	1.675		
25	2.784	1.716		
26	3.696	2.514		
27	1.733	2.159		
28	3.426	1.995		
29	0.871	1.809		
30	3.686	2.119		
31	2.815	1.727		
32	2.716	2.097		

Table 2

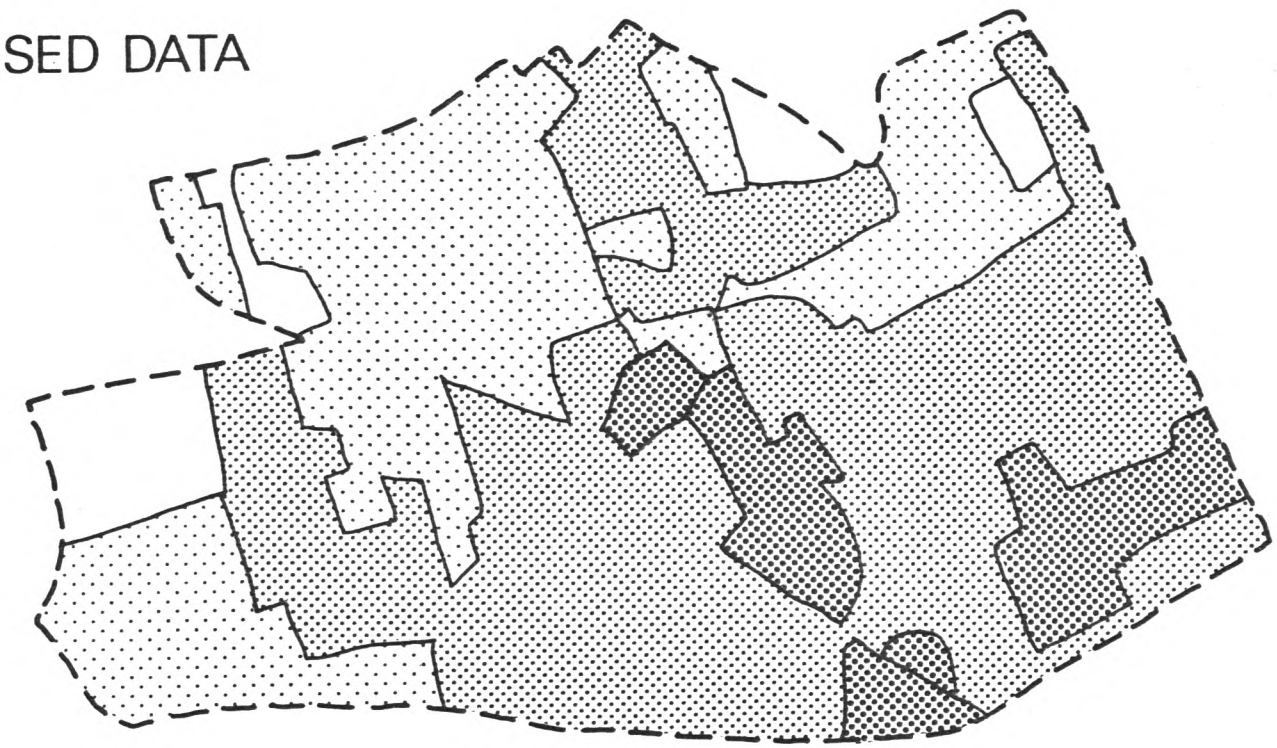
FIG. 83.

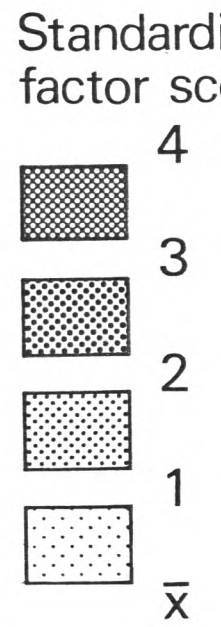
A COMPARISON OF FACTOR STRUCTURE WITH MODIFIED DATA BASES

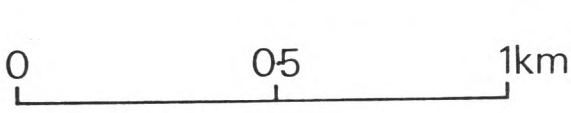


SPATIAL PATTERNS OF FACTOR 1 (Ethnicity) WITH DIFFERENT DATA BASES — Manningham District

FULLY NORMALISED DATA







LOCATION QUOTIENTS

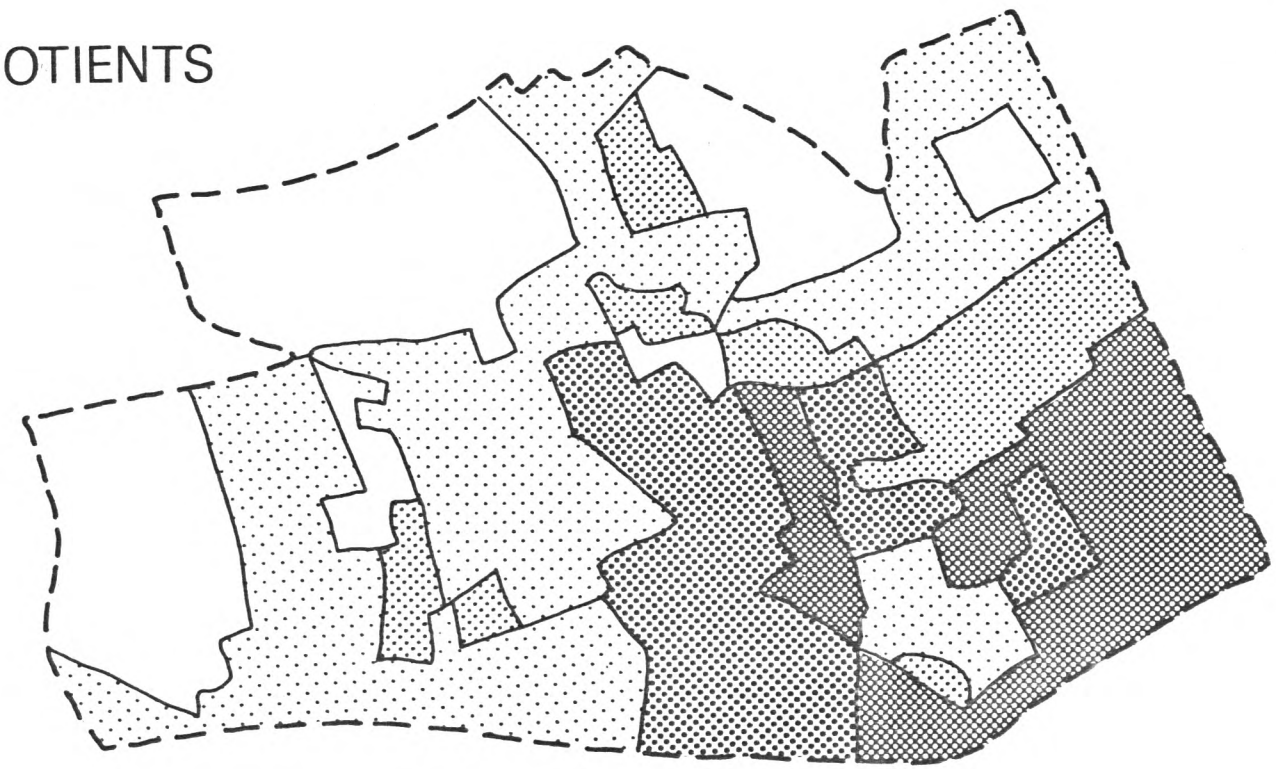


Fig 83a.

spatial pattern that results from mapping the scores referring to the same factor for two data bases, normalised and location quotients. Table 2 shows an extract of E.D.'s from the Manningham District. The pattern produced by fully normalised data is more homogeneous with a maximum value for any E.D. not exceeding Z=+0.3. Location quotients, however, are better at discriminating between E.D.'s as shown by the greater range of standardised scores.

The greater discriminating power of location quotients is also reflected in the distribution and range of factor loadings. Diagram 83 illustrates the range of loadings for two data bases for the same factor (ethnicity). It shows that transforming data into location quotients does not affect interpretation of factor structure: if anything it makes it clearer. It also justifies the use of location quotients.

It is worth noting in passing that the spatial pattern across the whole city using normalised data is of two near-concentric bands around the CBD. The pattern produced by location quotients is of 'wedges' along Manningham Lane, Leeds Road and around the University, and it is a pattern that accords well with previous work undertaken by the author (Tommis 1974). Further work is required on the effects of modified data bases on producing different spatial patterns.

Communality Estimation

Since common variance of large data sets cannot be extracted by principal components the problem arises of estimating values to be placed in the diagonal of the similarity matrix in principal axes techniques. Maxima and minima guidelines have been offered by Guttman (1956) and reiterated by Cattell (1965). The self correlation of a variable, assuming total accountability in the variable distribution, would produce values of unity in the principal diagonal - the component model - and give an upper bound in terms of the amount of explainable variance. A lower limit, however, results when only the common variances (h_j^2) between variables are correlated; this may be computed by calculating the linear multiple correlation (R) of each variable with each of the other variables x_j ..... x_n, in the data set. The square of this value, the coefficient of multiple determination (R^2) indicates how much of the variation can be explained in the dependent variable by all the independent variables acting simultaneously. It is therefore a useful surrogate for communality estimation.

Though the components model has been preferred by the majority of geographers, due mainly to its simplicity, completeness and maximization of explainable variance, Catell suggests that

> "it perpetuates a hoax for actually it really drags in all the specific (S_j^2) and error variance (e_j^2) to inflate specious, incorrect common factors .... It has thus included in the common factor space much variance about which we know nothing more than is known about specific factors."
>
> (Cattell 1965:201)

Its completeness results from the fact that factor scores are obtainable which exactly reproduce the test performance scores, whereas in the principal axes model this is reduced to an estimation procedure because the specific variance (S_j^2) is not known.

The choice of communality estimates however cannot be made in isolation since they are closely dependent upon the number of factors extracted. Most programmes today provide an iterative subroutine which initially 'best guesses' the communalities, factorizes the R matrix with these inserted, to produce a new convergent set of values. Factoring continues until the change in communalities between successive runs is negligable. The BMD programme Nx72 (Dixon 1974:255) offers a complete range of estimating procedures. Initial communality estimates may be maximum absolute row values of the similarity matrix, squared multiple correlations when a correlation matrix is input, variances due to regression in the covariance case, unaltered diagonal elements, or diagonal elements can be supplied by the user.

In all of the principal axes analyses undertaken a decision was made to use squared multiple correlations as initial communality estimates because these would provide the minimum conditions for 'explaining' common variance. A possible maximum of 50 iterations was allowed for and in all the analyses that follow the maximum absolute deviation of the final communality never exceeds 0.0082%.

Factor Extraction

As with communality estimation a wide variety of threshold levels exist for the number of factors to be extracted and no standardized procedure yet exists (Rummel 1970) though several are available for the principal axes method (Bartlett 1950, Anderson & Rubin 1956, Harman 1970). Fewer are available for the component models.

One of the most common standards (Kaiser's) adopted by geographers has been to stop factoring when the eigenvalues (the latent root or sum of squared factor loadings) reach unity (after Guttman, adapted by Kaiser 1960). This means that no factor can account for more variance than does a single variable. Barrow (1972:33) contends though that this may lead to the exclusion of potentially significant factors with 5% of data variance being excluded in a twenty-variable analysis, but only 1% in a one hundred-variable set.

Davies (1972) has suggested that the effect of increased factor estimation in principal axes techniques would be to raise communality values. At an arbitrary cut-off point (say 0.5) extraction could be terminated. This was tested using location quotient data and the results for some variables are illustrated below (Table 3). Six, eight, and ten factor solutions were made and for comparison an eight factor principal components solution is also shown.

SELECTED FINAL COMMUNALITY ESTIMATES -

PRINCIPAL AXES SOLUTION

Variable	Number of Factors Extracted			
			PCA	
	6	8	8	10
1	562	563	649	568
6	912	927	881	923
9	201	239	495	334
12	238	267	512	264
15	085	199	557	218
17	145	228	501	243
20	551	578	581	577
24	031	048	466	051
30	297	373	682	529
33	066	094	533	100
37	188	288	636	476
45	317	314	589	328
49	163	164	651	197
53	875	914	885	921

All decimal points have been omitted.

Table 3

The table shows that by increased factoring the communality value also increases for each variable, some considerably (e.g. vars. 15, 37), others less so. Similarly, the inflation of "specious, incorrect common factors" typical of PCA is well illustrated in variables 17, 33 and 49. Moreover this is not peculiar to the few variables shown but affects 31.5% of all variables with less than 40% of their variance explained in the total data set of 54 variables. And in the ten-factor solution only 59% of all variables had 50% or more of their variance explained (i.e. communality = 0.5). To reach the threshold communality value would require a solution of 17 factors. This method was consequently rejected as being impractical.

A further option is provided by the scree test. Cattell

(1966) has suggested that by plotting the number of factors by the proportion of explained variance (eigenvalue) a curve is produced that will level off when the random specific and error factors are reached. By contrast, Rummel (1970) has noted that the same curve is often discontinuous but that a change of shape can be observed when the last significant factor has been extracted. In both cases the main problem is deciding exactly where the main break of shape occurs.

Fig.84 plots the scree slope for up to twelve factors. Kaiser's criterion suggests that factoring be terminated after the eighth factor. Rummel's discontinuity threshold appears to occur after the ninth factor whereas the conventional scree test suggests a termination point after the sixth factor. It is conceivable that the conservative scree test may force the nesting of smaller factors within larger ones (particularly in PCA) whilst a more liberal criterion may induce specific factors. As a result it was decided that the discontinuity threshold would be the starting point for factor extraction but that subsequent factors would be extracted until no primary loadings (for a definition see below) could be observed. This would help mitigate against specific factors. It turned out that the discontinuity threshold proved to be a remarkably accurate indicator in that nine-factors offered an optimal solution.

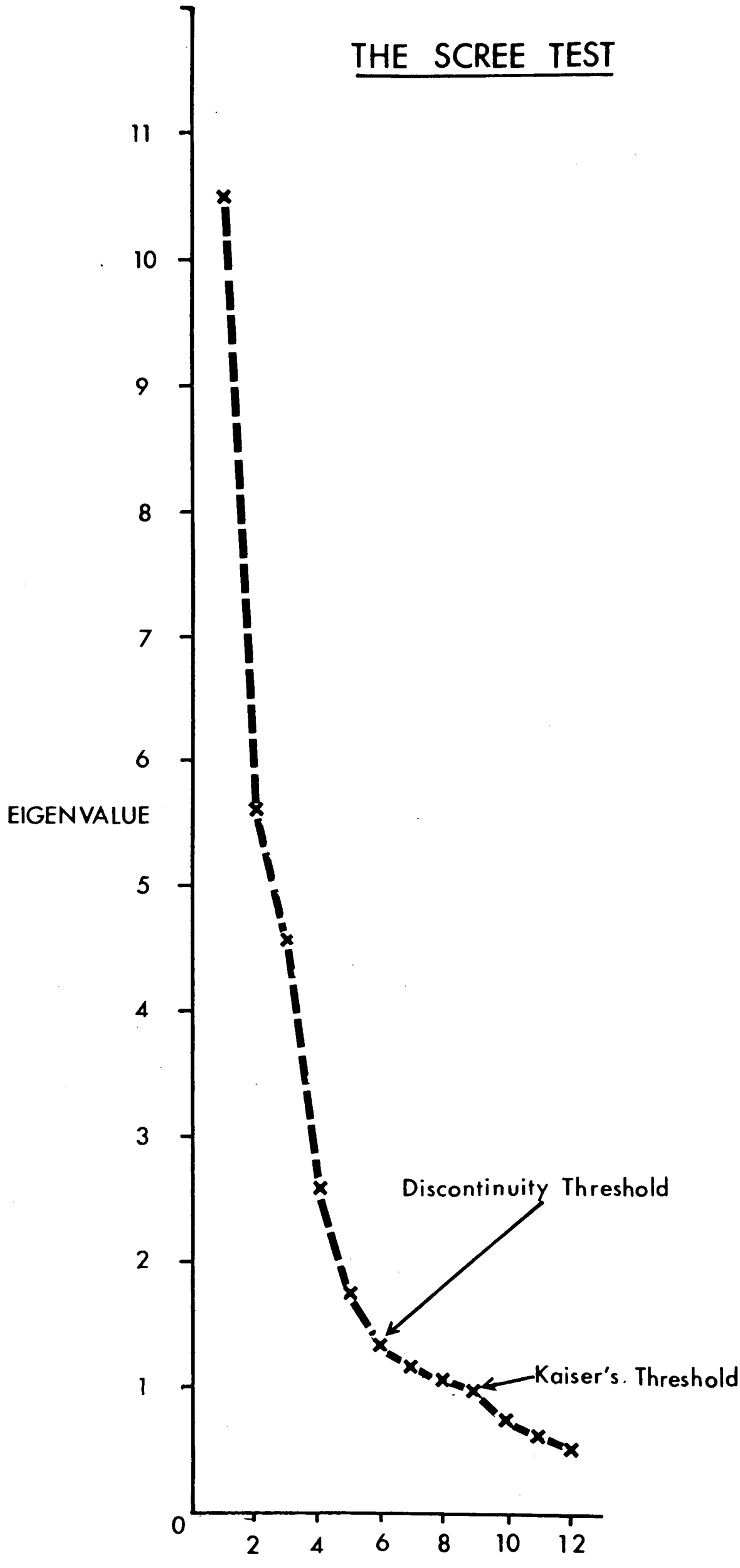

THE SCREE TEST
11
10
9
8
7
6
EIGENVALUE
5
4
3
2
1
0
2
4
6
8
10
12
Discontinuity Threshold
Kaiser's. Threshold
FACTORS

Fig 84

Factor Loadings

The literature is equally vague on the significance of factor loadings. No consistent value has been adopted with most studies tending to use between +/- 0.4 and +/-0.3 as threshold values. Sweetser (1965) compromised at +/- 0.35 in his studies of Boston and Helsinki. Since factor loadings measure the degree of involvement of variables in the factor pattern they can be interpreted like correlation coefficients (the interpretation is only approximate in PA techniques however) and recourse made to significance tables.

Where the d.f. are very large as in the present study (d.f.:630), the critical value will be correspondingly small and therefore of little use in factor interpretation because nearly all the loadings will be statistically significant.

The Burt-Banks formula (1947, 1952) argues that the significance of factor loadings should be increased with each factor extracted to mitigate against the intrusion of unique variance in later dimensions. This criterion is, however, of no use here because of its applicability only to the component model.

Not surprisingly the subjectivity of factor labelling has been called into question recently. Palm and Caruso contend that

> "dimensions have too often been labelled on the basis of a few key variables, with little attention paid to other significant regularities. Too much emphasis has been

> given to a factor taxonomy based on the observation of predictably related variables, not enough to the further development of process explanation."
>
> (Palm & Caruso 1972:122)

Some researchers have taken the highest 'x' most'significant' loadings on a factor (for example, Winchester 1975) but this method begs the definition of 'significant' and it could lend more credence to the Palm & Caruso criticism by omitting potentially diagnostic variables where many variables load highly on specific factors. In PCA the location of the common axes is governed by the equal weighting of clusters of variables. The result is that a component axis can be strongly associated with a variable almost by chance since that location is governed more by the relative positioning of other variables along the axis. As Tarrant suggests:

> "to take account only of the high correlations is the equivalent of drawing a regression line through a scatter diagram, removing all the points which do not fall near to this regression line and taking that line to 'represent' the remaining points, or vice versa."
>
> (Tarrant 1974:32-3)

This problem does not arise in PA techniques because each variable located near to the principal axis is weighted by its communality (SMC in this case). The result is that interpretation is made easier because the axes better fit the distribution of intercorrelated variables.

The lack of a clear procedure necessitated the use of an arbitrary cut-off point of $\pm$ 0.4 in the final interpretation of factor structures. This proved to offer the

clearest interpretation of each factor independent of the many trial solutions. Subsequently, any loading above $\pm$/0.4 is known as a 'primary loading'.

FACTOR ROTATION

The Non-Uniqueness Problem in Derived Solutions

A further problem hindering the development of comparative procedures in factorial studies has been the adoption by researchers of different rotational solutions (Davies 1972a). Moreover, the problem of non-uniqueness in factor structures itself results from the fact that

> "Any factor matrix can be linearly transformed (i.e. rotated) into any one of an infinite series of equally 'accidental', mathematically equivalent factor matrices with the same number of factors"
>
> (Cattell 1965:205)

though,

> "the meaning of the factors themselves - as deduced from what variables they correlate with and affect - will change with every rotation."
>
> (Cattell 1965:207)

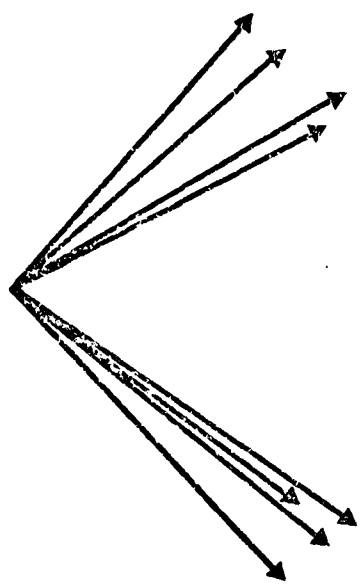
Though resolutions based on matrix transformation are infinitely variable the need for derived (rotated) solutions is based entirely on practical grounds. In principal components analysis the first vector is fitted to the data to account for the maximum possible total variance (that is, it delineates the largest pattern of relationships) and each successive vector is fitted to maximise the residual variance. This commonly results in the first component being located midway between independent clusters of interrelated variables - thus at least 23 of the 54 variables load on the first unrotated factor in all the normalized

solutions - so that loadings are monopolar and uniformly high (Fig.8S, (b)). General factors such as this are useful only if the researcher is aiming at the "widest net of variable linkage" (Rummel 1967, Davies 1971, Mather 1971). Where rotation is applied "factor interpretation shifts from unrotated factors delineating the most comprehensive data patterns to factors delineating the distinct groups of interrelated data" (Rummel 1967: 474). This is known as simple structure.

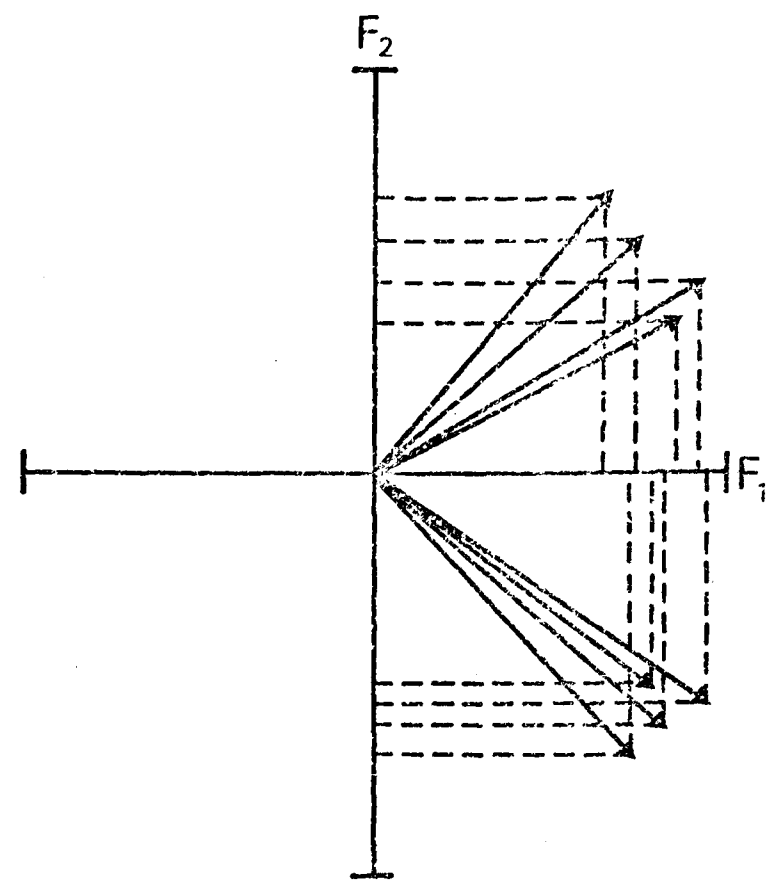
In vainly trying to compute invariant solutions Thurstone (1947) offered five criteria for obtaining simple structure based on the idea that the best and simplest explanations must involve only a few variables. These requirements were: (a) that each row of the rotated factor matrix should contain at least one zero; (b) if there are 'm' common factors each column of the factor matrix should contain at least 'm' zero loadings; (c) for every pair of factors there should be several variables with zero loadings on one factor column whilst simultaneously having significant loadings on the others; (d) for every pair of factors a large proportion of loadings should have zero values in both factors where there are four or more factors; (e) for every pair of factors there should only be a small proportion of loadings with significant values in both factors. The effect is to maximise overall parsimony, resolve the general primary and subsequent bi-polar factors into simpler dimensions, and identify each factor with the minimum number of variables needed to maximise its variance.

Two fundamental rotations to simple structure are possible

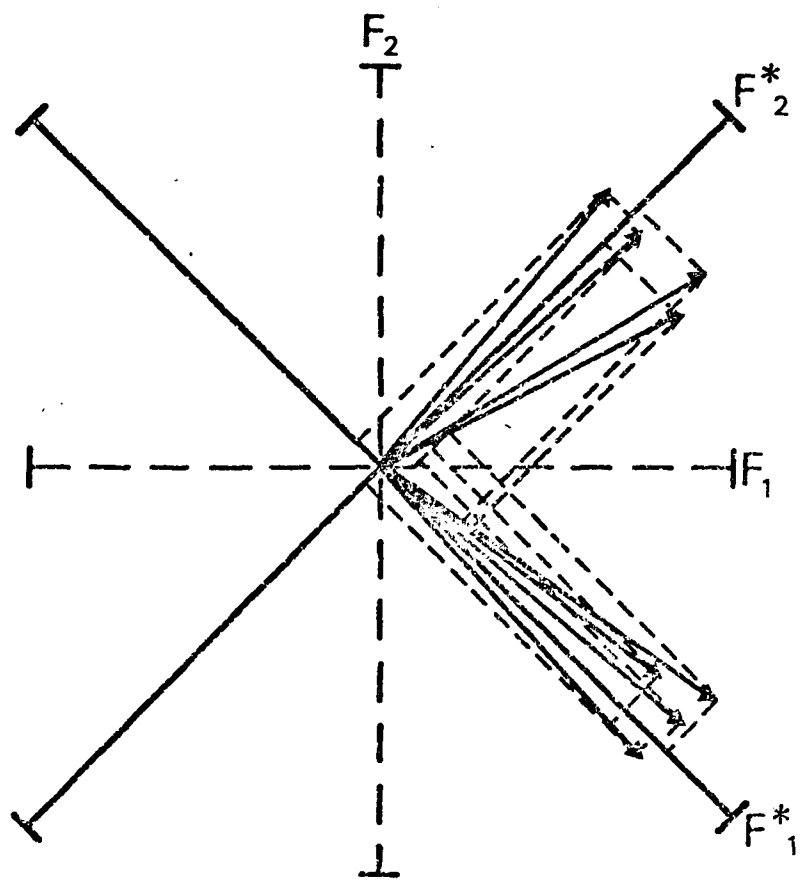
FACTOR ROTATION (After Rummel 1970)



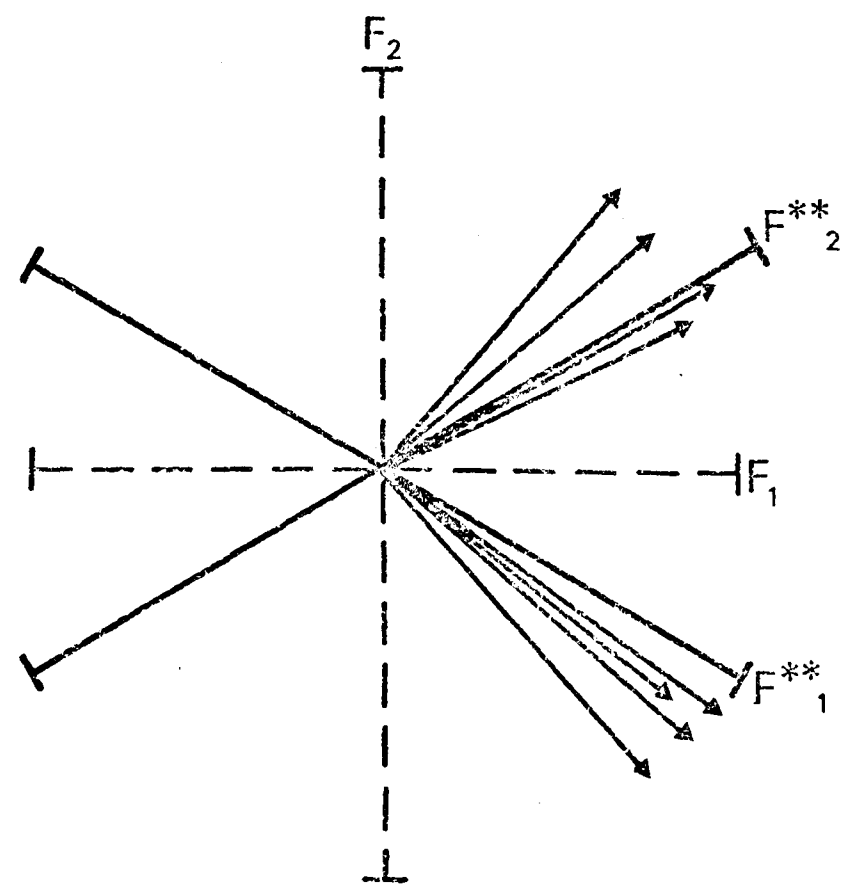
a. Eight variables in two clusters
Variable vectors shown



b. Location of the first factor (F_1) between the clusters and the second (F_2) added orthogonal to the first



c. A simple structure rotation of axes to an orthogonal (independent) solution



d. Oblique simple structure solution

FIG. 85.

Firstly in the orthogonal simple structure, the full set of axes is rotated about the origin maintaining the right-angle (orthogonal) property between them until the axes maximally align with the separate clusters of variables (Fig.55, (c)). Where the clusters are uncorrelated with each other the orthogonal simple structure will be maximised. Clearly, orthogonality can be viewed as an extreme case of the oblique solution so that the stronger the correlation between variable clusters the less efficient will be the orthogonal rotation in identifying distinct patterns of interrelated variables.

Some of the more important properties of orthogonal transformations include: (a) communality values do not change with orthogonal rotations; (b) in the orthogonal factor matrix so significance is attached to factor order; (c) the factors are merely uncorrelated though some authors extend this to independence (see Johnston 1971:); (d) factor loadings can be interpreted in the same manner as correlation coefficients; (e) orthogonal factor scores are amenable to subsequent mathematical treatment e.g. as inputs to clustering algorithms (Spence 1968) and in regression analyses (King 1969:183-4).

Because bundles of variables are rarely uncorrelated in the real world, oblique simple structure seeks the best definition of correlated cluster patterns of interrelated variables by allowing each axis to rotate individually about the origin. This flexibility means that each component axis will more efficiently describe the variable cluster through which it passes (Fig.55, (d)). Consequently the advantages of this type of rotation include: (a) a more

TABLE 10.

A VARIMAX SIMPLE STRUCTURE MATRIX.

Variables	Unrotated Factors		Simple Structure	
	F_1	F_2	F_1	F_2
43	51	63	-35	66
44	13	82	-16	79
45	-16	47	02	43
46	-21	68	-03	62
47	24	-12	-06	-15
48	82	-20	-41	-28
49	-30	-15	22	-10
50	58	-15	-26	-03
51	53	-19	-24	-09
52	62	28	-85	15
53	68	23	-88	11
54	60	26	-92	12

Decimal point has been omitted.

TABLE 11.

AN OBLIQUE SIMPLE STRUCTURE MATRIX.

Variables	Unrotated Factors			Rotated Factors		
	F_1	F_2	F_3	F_1	F_2	F_3
34	-03	34	-07	06	38	04
35	75	43	42	23	23	55
36	-46	-25	-41	-05	-05	-25
37	26	-15	32	10	-19	17
38	15	13	13	03	03	11
39	-66	-36	-35	-23	-17	-40
40	-35	-23	-50	18	-10	-86
41	01	21	70	-19	03	87
42	59	-22	-47	01	-06	-02
43	50	57	-41	01	64	07
44	06	84	-10	-02	37	-06
45	-22	45	02	-07	37	-06
46	-22	57	-14	-00	56	-10

Decimal point has been omitted

precise definition of clusters and therefore a closer approximation to reality; (b) loadings cannot be strictly interpreted as correlations though they often are; (c) the factor loadings or the matrix of factor cosines (usually the latter) can be used in second order analysis in which the factors are themselves factor analyzed to determine the basic latent dimensions of large data sets. On a priori grounds oblique solutions are to be preferred.

Two coordinate systems are available for oblique solutions in defining factor loadings (Fig. 4)

(i) the primary axes are those axes rotated to the best oblique fit to the distribution of the bundles of variables (PA_1 and PA_2)

(ii) the reference axes are those axes perpendicular to each of the primary axes (RA_1 and RA_2) and tend to better define the distribution of variable clusters than do primary axes.

FIG. 4.

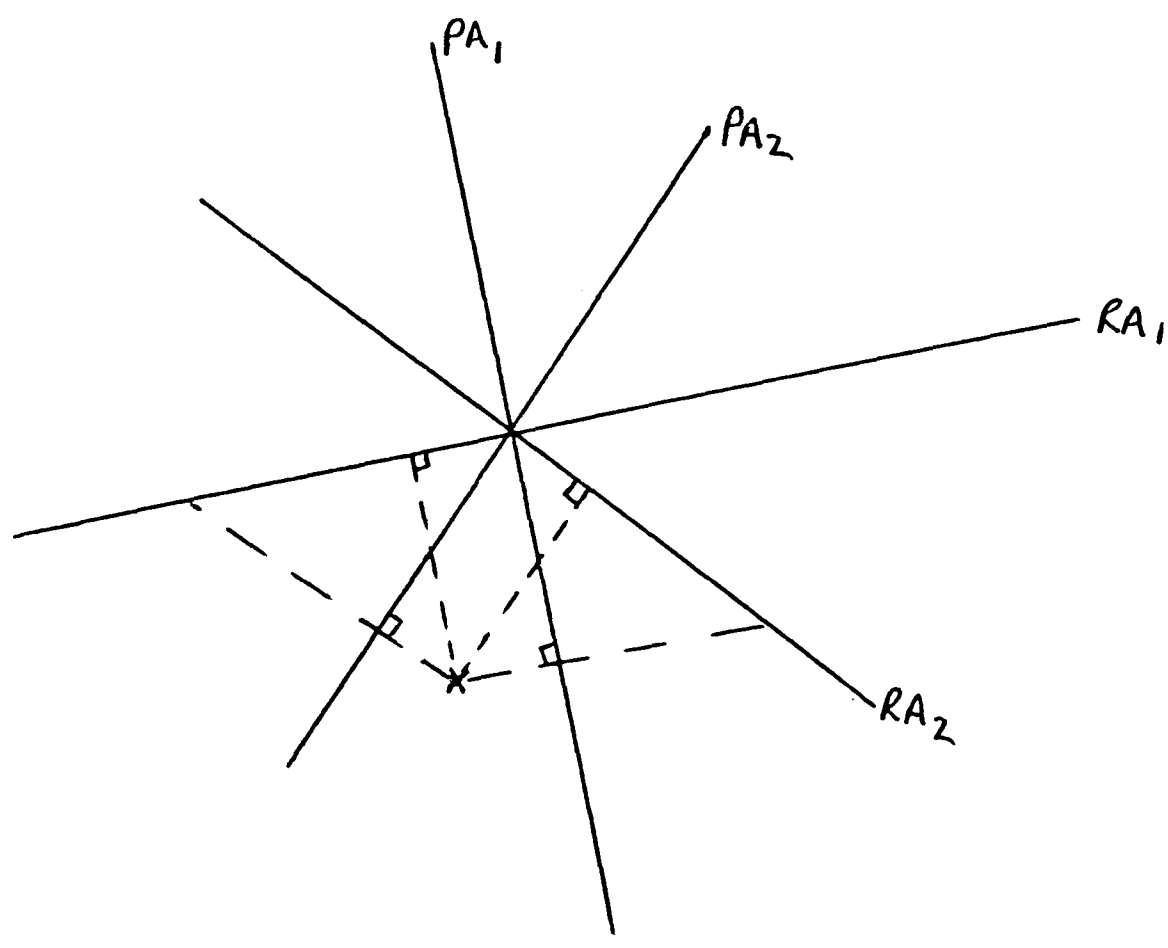


TABLE 12

IMPORTANT DIFFERENCES AMONG ROTATED FACTOR MATRICES

Characteristics of Loadings	Primary Axes			Reference Axes	
	Orthogonal	Pattern	Structure	Pattern	Structure
Loadings distinguish clusters of interrelated variables	yes	yes	no	no	yes
Loadings measure correlation between cluster and variable	yes	no	yes	yes	no

Source: Rummel 1967:468

On the basis of usage, two main types of oblique rotation can be distinguished though an almost infinite number are available - Direct Oblimin and Oblimin. The former obtains directly from the primary pattern matrix; oblimin rotations are generally obtained from the reference structure matrix though a simplified pattern matrix can be used.

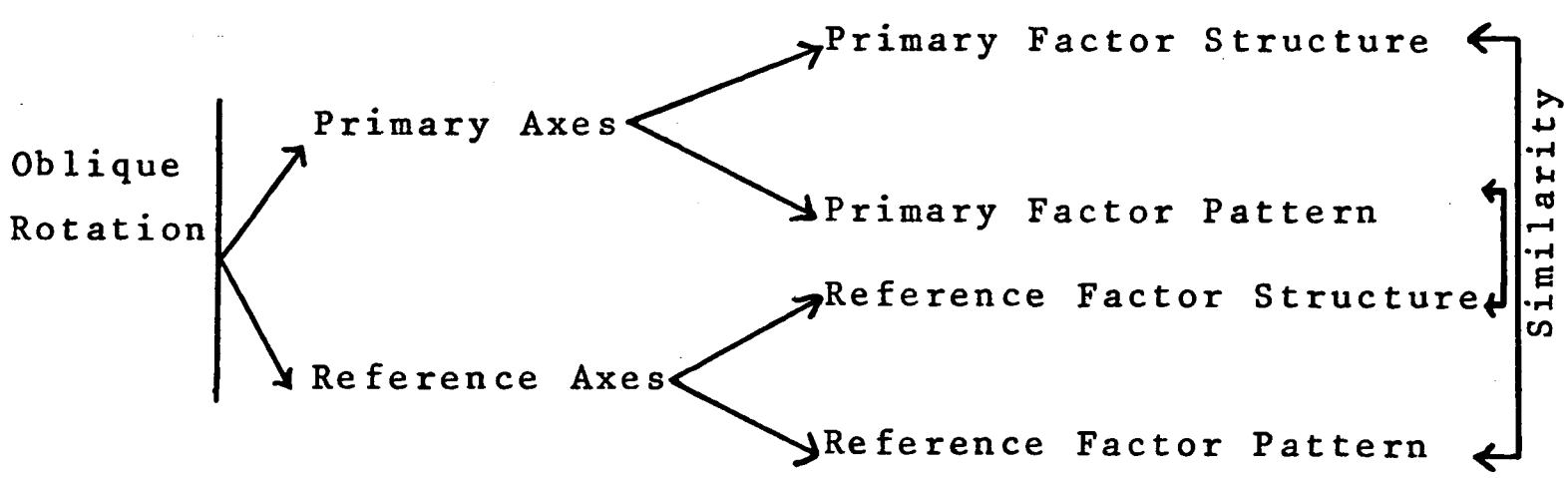
Within each class considerable scope is left to the researcher in choosing the value of the parameter, γ, which determines the angle between the axes and thus their degree of obliquity. In the SPSS manual, Nie, Bent and Hill (1970) summarise the effects in tabular form for the direct oblimin solution:

TABLE 13

Suggested Values of Constant	Effect on Solution
Any positive value	Extremely oblique (correlated) solution
0.0	Fairly oblique solution
-0.5 to -5.0	Less oblique solution
Greater than -5.0	Increasingly orthogonal (uncorrelated) solution

For each set of axes there are two projections of the factor matrices which effect the nature of loadings - factor structure and factor pattern. Thus, the loadings of the primary axes can be derived from either the primary factor pattern or the primary factor structure projection. The factor pattern of the reference axes produces similar results to the factor structure of the primary axes, and equally, the factor pattern of the primary axes mirror the structure of the reference axes. These relationships can be summarized as follows:

FIG. 5.



Simplifying the complex nature of these projections, the structure loadings on the primary axes (pattern loadings on the reference axes) are the Pearson correlations between the variables and the oblique axis. The pattern loadings of the primary axes (structure loadings of the reference axes) are always interpreted as measures of the unique contribution each factor makes to the variance of the variables. In this case, however, factor loadings cannot be interpreted as correlation coefficients since the upper bound of unity can be exceeded (known as loading saturation). This is particularly noticeable the more the axes are correlated with each other. Consequently the squared factor loading

is only an approximate guide to the contribution the variable makes to the factor pattern. In summary, (see Fig. 5), primary pattern matrices illustrate the distinctive patterns where they occur in data sets because they

> "best show what variables are highly involved in what clusters"
>
> (Rummel 1967:468)

whereas primary structure matrices aim to illustrate the correlation between variable and factor.

Few geographers have made use of direct oblimin solutions with different parameter values in the oblimin series to test for factor stability (Haynes 1971, Barrow 1972, Hughes & Carey 1972, Davies & Lewis 1973, Davies 1975). Equally, the variations that can be produced for the oblimin series with different γ values have been summarized by the BMD package (Dixon 1973:262). Amongst the most commonly used are:

(a) covarimin ($\gamma = 1.0$) was developed by Kaiser (1958) and produces 'biased' factor axes towards the orthogonal

(b) bi-quartimin ($\gamma = 0.5$). Carroll (1957) suggested this parameter value as a compromise which produced a generally satisfactory simple structure solution

(c) quartimin ($\gamma = 0.0$). Carroll (1953) considered this rotation produced equally biased factor axes in the opposite direction to covarimin, that is, towards axes which are too highly correlated, too oblique.

TABLE 14.

DISTRIBUTION OF PRIMARY LOADINGS

ROTATION	FACTORS						
	I	II	III	IV	V	VI	VII
No rotation	22	11	10	1	1	2	0
A. Orthogonal							
Quartimax (0.0)	19	9	11	5	5	2	2
Varimax (1.0)	5	9	15	5	9	2	3
B. Oblique							
Direct Oblimin: Direct quartimin (0.0)	5	8	9	5	3	2	3
Oblimin: covarimin (1.0)	15	9	15	12	10	18	9
bi-quartimin (0.5)	3	7	4	5	5	2	3
quartimin (0.0)	24	11	5	1	1	1	1

Notes:

1) because only seven factors are extracted the pattern of primary loadings does not conform to the final nine-factor solution
2) maximum of 50 iterations allowed for communality estimation.

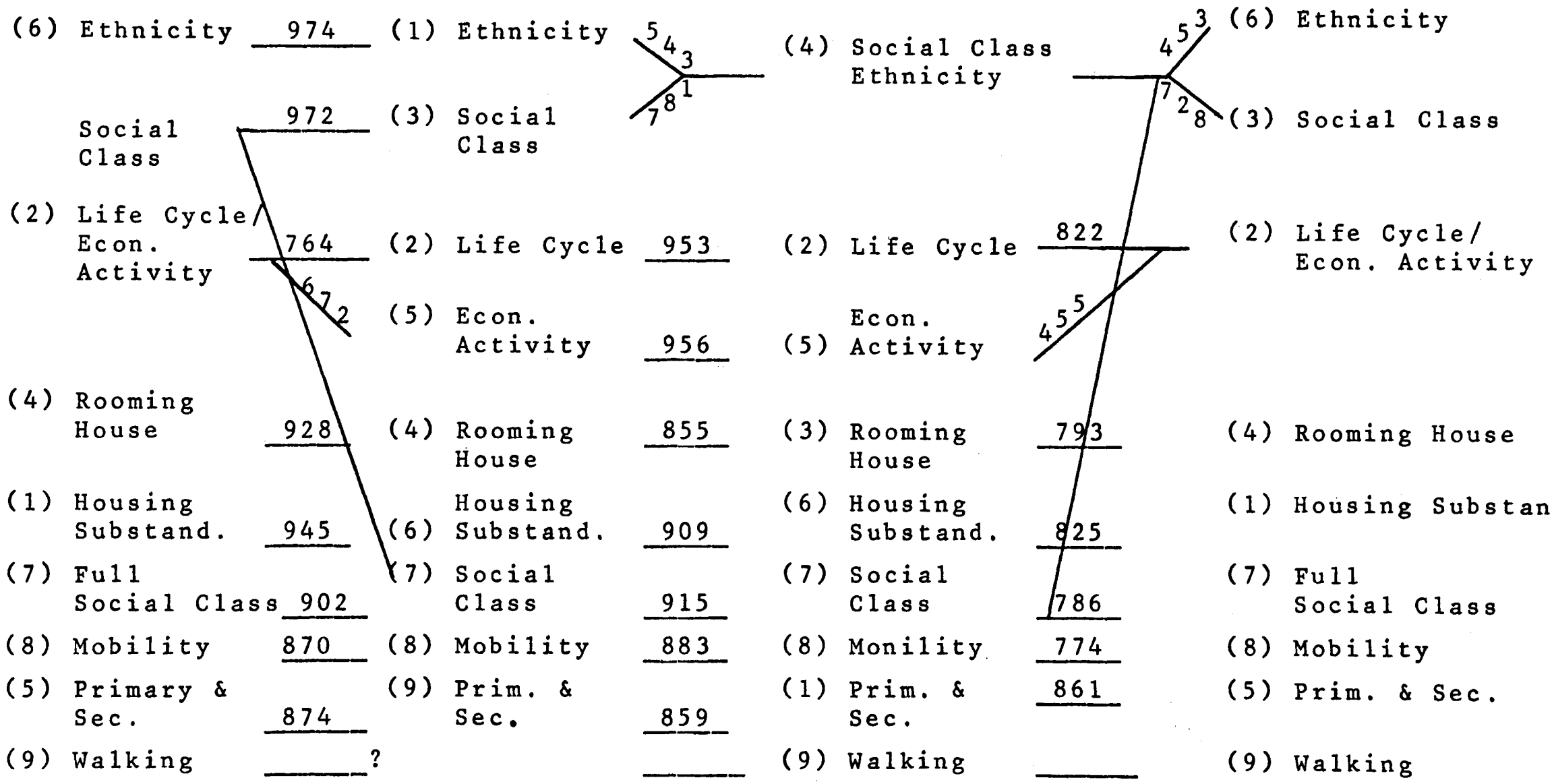
Table 14 above shows the distribution of primary factor loadings on each of the seven mathematically equivalent solutions adopted in the present study. Three broad patterns are recognizable. Firstly, the unrotated, quartimin and quartimax rotations produce similar distributions of monopolar first dimensions which is quickly reduced after the third factor, though the quartimax solution does have its fourth and fifth factors with equal numbers of loadings. This is perhaps significant since the value of γ is one in both the orthogonal quartimax and the simple reference structure quartimin cases. A highly

complex loading distribution is offered by the reference structure covarimin case with a variable often loading on more than two factors; this is an entirely unsatisfactory rotation. Thirdly, the orthogonal varimax, and direct quartimin and bi-quartimin oblique solutions yield a distribution of loadings which, though not maximised on a small number of factors, produces few variables that "double count", the major exception being var.8, married females. These solutions are much the easiest to interpret.

Since the trial runs have produced three 'similar' possibilities the final solution rested on two considerations. Firstly, a number of recent investigations (particularly by Davies 1975) have suggested that because of the complexity of urban social differentiation first order analyses yield insufficient results to generalise about the fundamental dimensions of large data sets. In such cases a table of factor cosines obtainable from oblique solutions only can be used as input for further analysis of second order generalisations. Secondly, of the remaining two oblique rotations, direct quartimin exhibited the maximum number of primary loadings on the minimum number of factors. To show, however, that the three solutions were not radically dissimilar, coefficients of congruence were computed between similarly paired factors across all three solutions. These are illustrated below.

P.A.F.A. - L.Q. DATA BASE

COEFFICIENTS OF CONGRUENCE



The figures in parenthesis refer to factor order.

APPENDIX B.

THE CLUSTERING ALGORITHM

THE CLUSTERING ALGORITHM

The programme for the cluster analysis was similar to the one used by Webber for his census deprivation analyses of Liverpool (Webber 1975, 1976, 1977). Because the core space requirement was extremely large for the computation of a $(632)^2$ matrix the programme was run at the University of London Computing Centre on the IBM machine.

The Needs of the Study

The needs of the study were twofold. First, there was the need to retain the largest possible share of original data variance - the principle of variance maximisation. It is based on the belief that clusters should exhibit a maximum internal homogeneity that can easily be quantified and that each cluster can be separated from all others by maximising the between group variance. Since this was not an exercise in regionalization a contiguity constraint was not imposed.

Second, it was necessary for the classification to be operationally valuable in that the structure imposed upon the data had not simply to be one of mathematical equivalence but that the social areas thus formed would have meaning in terms of spatially differentiating social groups. Moreover, it was intended that the patterning should also produce groupings that could be of value in themselves and as the starting points for further research. Thus, it was necessary that for each cluster the influence of all important variables should be clearly evident in terms of their absolute contribution and in deviations from the city and

cluster means. The latter is the real differentiating characteristic between clusters. This required the original percentage values to be preserved and so no data transformations were undertaken.

If the principle of variance maximisation is achieved the algorithm will provide the degree of within homogeneity required for each cluster to be used as a spatial framework for advanced sampling at the micro scale. Both micro and macro levels of understanding are desirable in the development of spatial taxonomies and necessary in the operationalizing of planning practice.

The needs of the study therefore dictated a balance between a broad brush framework (i.e. a small number of clusters that would broadly summarise the nature of differentiation between areally based social characteristics) with a detailed taxonomy that would provide meaningful social areas that (if required) would form the input to further analysis. These conflicting levels of requirements were best met by a dual system clustering algorithm:

1) optimization - partitioning in which every e.d. is assigned to a group on the optimization of a specified criterion (variance minimization within clusters in this case), each group being mutually exclusive. The variable, p, space is therefore partitioned into a set of discrete entities, called clusters.

2) hierarchical step-wise fusion (Ward 1963) in which at each stage observations (e.ds) are fused with their most similar (variably defined) neighbour. The process is repeated for each level to form a dendro-

gram.

The present research design utilizes both methods in the following way. First, every one of the 632 e.ds is assigned to a cluster on the basis of iterative relocation to form 18 clusters. Each cluster is then assigned to a group using the fusion method. The former is a non-hierarchical technique in which the p-variable vector space is partitioned into a number of discrete, mutually exclusive clusters. Ward's method results in a cluster being nested at each fusion level within a higher-order cluster - represented by a dendrogram - but stopped at some optimal point (at six groups in this case).

Iterative Relocation

Iterative relocation is a non-hierarchical partitioning clustering technique in which initially poor solutions can be improved upon by relocating observations that optimise some objective function (in this case, internal variance maximization).

The raw percentage data was first expressed as a value per 10000 population at risk. To define the coordinate axes of p variable space all the variables in the data are standardized to zero mean and unit variance so that each has equal weighting and the axial origin coincides with the zero mean value. Thus:

$$Zij = \frac{xij - \bar{x}j}{\sigma} \qquad \ldots\ldots\ldots\ldots\ldots (1)$$

Each of the 632 standardized E.D.'s are therefore allocated a position in 37 variable space. The next step is to allocate each E.D. to a cluster. This is achieved by first specifying the number of clusters required (in this case 18), each cluster then acting as the initial approximate centroid about which the nearest E.D.'s can be grouped. The choice of the number and nature (i.e. value) of the initial cluster centroids can involve an element of subjectivity. The centres can be obtained by the analyst from a visual inspection of the data matrix but this is an onerous task, or they can be randomly generated controlling for the range of observed values on each variable. The latter method was adopted with an important modification. When data has been converted into ratio form there is a need to weight by a population factor otherwise those E.D.'s with small populations (often semi-rural areas) will be under-represented in relation to larger E.D.'s. If population differentials are not controlled the fusion of a large number of E.D.'s with small populations with very little loss of variance will take place leaving a small number of large clusters with only a few E.D.'s allocated to them yet incorporating disproportionately large shares of the city population and internal cluster error.

Having selected the initial cluster centroids each E.D. x -632 is allocated to its nearest approximate centre based on the minimization of the Euclidean distance similarity metric (see Sparks 1973):

$$dij = \left[\sum_{k=1}^{37} (xik - xjk)^2 \right]^{\frac{1}{2}} \qquad \text{.....(2)}$$

Each observation is scanned, its 37 dimensional distance from each of the approximate cluster centroids computed and allocated to the nearest. The use of equation (2) implies orthogonality between all 37 variables used in the analysis because a Euclidean metric is used. As this is clearly not the case many studies have transformed the data into uncorrelated dimensions using scores from an orthogonally (usually varimax) rotated principal components analysis (Berry 1966, 1967). Since composite indices (like component scores) are not desired in this part of the analysis the distance metric, dij, was modified by controlling for the correlation (rij) between every value in accordance with the properties of affine geometry. The original, standardised variables can now be used weighted by their population and correlation values in the following manner:

$$dij = \left[\sum_{k=1}^{p} \sum_{k=1}^{p} (xik-xjk)\,(xil-xjl)\,rkl \right]^{\frac{1}{2}} \quad \ldots\ldots (3)$$

This compensates for an overestimation in the values of dij when the variables i and j are positively correlated or an underestimation when negatively correlated.

When all observations have been allocated to one of 18 possible clusters a search is made for wrongly allocated observations in an attempt to optimise the variance criterion. This is done by redefining (i.e. relocating) the initial cluster centres as the centroids of the p variable points thus:

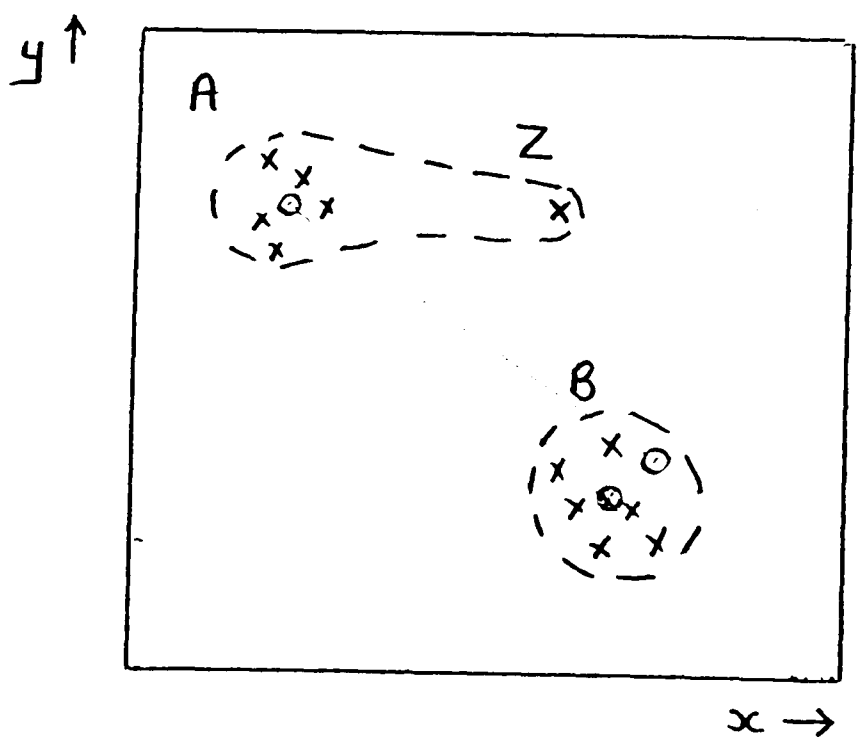
$$ykj = {}^{1}/_{nk} \sum_{i=1}^{k} xij \qquad (j = 1,2 \ldots\ldots p) \quad (k = 1,2 \ldots\ldots \text{max.}) \ldots\ldots (4)$$

An observation is then reallocated to the nearest recalculated cluster centroid if the distance metric on the first allocation is not minimised. This reallocation must take into account not only the repositioning of each observation in 37 variable space but also the new positions of the cluster centroids. Therefore, observation, q, is relocated from cluster k to cluster j if:

$$\frac{nk}{nk+1} \sum_{m=1}^{p} (xqm-ykm)^2 < \frac{nj}{nj-1} \sum_{m=1}^{p} (xqm-yjm)^2 \qquad \ldots\ldots (5)$$

The full set of observation points are repeatedly scanned until no further move takes place (i.e. so that the internal cluster homogeneity is maximised) by retracing the computation back to formula (4).

The principles discussed above can be illustrated hypothetically:



The points ⊙ are randomly generated to fit within the range of initial data. Cluster A has probably reached an optimal solution. The centroid of the points in B however clearly do not coincide with ⊙; iteration therefore produces a new centroid ⊗ in which the Euclidean distance metric is minimized. Point Z is equidistant to ⊙ and ⊙, the initial centroids, yet with the centroid relocation in B, it becomes closer to A and is therefore allocated to it, though A will have a lower internal variance (homogeneity) because the standardized mean square distance of points from the centre will be greater.

Table 15 illustrates the structure of the final clustering procedure. The success of the objective function, internal variance maximisation, can be judged by the average distance values, the lower the value the lower the internal variance. Only one cluster, number 10, has a variance greater than one and most are below 0.65. Cluster 18 consisting of only one E.D. is an anomaly and has been discounted in all further analysis.

The distribution of E.D.'s between clusters is relatively even. Cluster 14 is the largest with nearly 11% of all city E.D.'s; cluster 10 is the smallest with about 3%. The distribution of the city population reflects the distribution of E.D.'s: clusters 9 and 14 therefore make up between them about 23.5% of the whole population.

TABLE 15

CLUSTER CHARACTERISTICS

Cluster Number	Enumeration Districts Number	Enumeration Districts %	Average Distance	% of City Population
1	27	4.27	0.540	4.149
2	33	5.22	0.375	5.153
3	35	5.54	0.614	4.022
4	45	7.12	0.466	5.923
5	37	5.85	0.444	4.757
6	43	6.80	0.526	7.041
7	43	6.80	0.382	6.598
8	23	3.64	0.424	4.735
9	55	8.70	0.397	11.159
10	20	3.17	1.127	2.542
11	38	6.01	0.477	5.176
12	24	3.80	0.574	3.719
13	33	5.22	0.631	4.639
14	67	10.60	0.309	12.453
15	49	7.75	0.411	7.505
16	35	5.54	0.381	6.833
17	24	3.80	0.613	3.467
18	1	0.16	0.000	0.134

The final output gives a) the cluster membership, b) the individual squared distance of the observation points from the cluster centroid (dissimilarity index) and c) the aggregate mean squared distances (average distance) as defined by:

$$d_{ik}^2 = \sum_{j=1}^{p} (xij - ykj)^2 / p \quad \ldots\ldots\ (6)$$

d) the amount of variance accounted by the clusters for each variable (calculated by measuring the distance of each cluster from the axial origin and weighting by population size) and e) the importance of each variable as a percentage of the total distribution per cluster.

Step-Wise Fusion

The hierarchical technique used in this analysis was written by Ward (1963) but the library of similar routines is large and diverse (Everitt 1975). Like iterative relocation Ward's method is based on the need to retain the largest possible variance of the cluster set. The similarity measure is again the Euclidean metric of formula (3). Then pair-wise bonding takes place between those two clusters that results in a minimum increase in the total error sum of squares function:

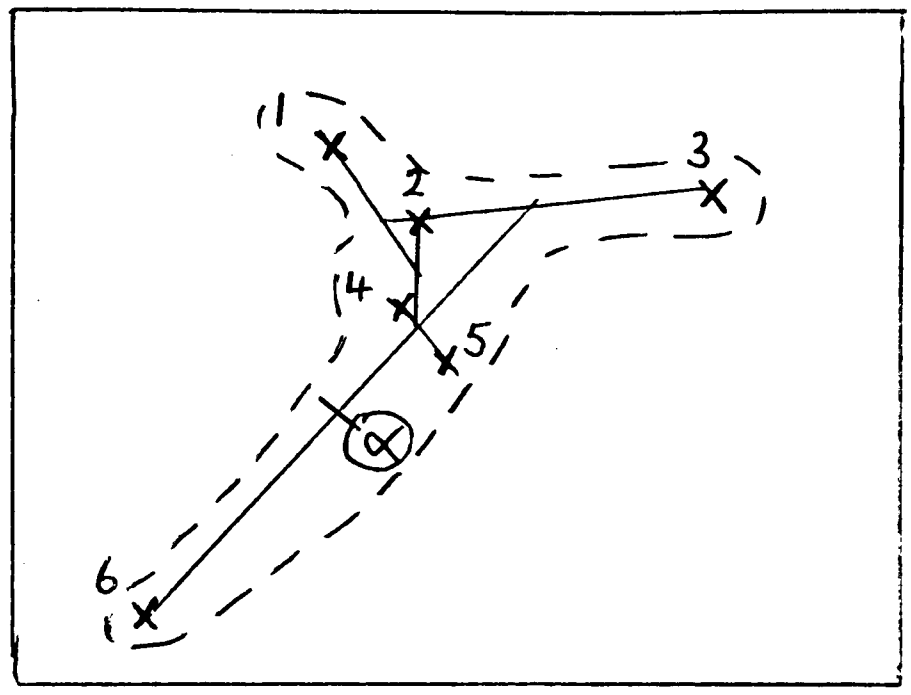
$$E.S.S. = \sum_{i=1}^{n} xi^2 - {}^1/_n \left(\sum xi\right)^2$$

Where xi is the score on the ith cluster ..... (7)

Euclidean distances are calculated for every available pairing between clusters and the minimum distance which results in the least loss of variance accounts for the first fusion; the mid-point of that line then becomes the centroid for the subsequent step. The process continues until all clusters are merged into one universal group or one complete spatial system. By these means the within-group sum of squares for a group at each level of fusion is minimised to give maximum internal homogeneity.

The principle can be demonstrated with a hypothetical example. In step-wise fusion the points with the smallest linear distance fuse. In the diagram this would fuse points 4 and 5; their mid-point becomes the new centroid to join with the next nearest point, 2; point 2 then joins with point 1, 1 with 3 and 3 with 6 to complete the cluster, the

centroid of which is marked (⊗) . Note also the influence of extreme values as in point 6.

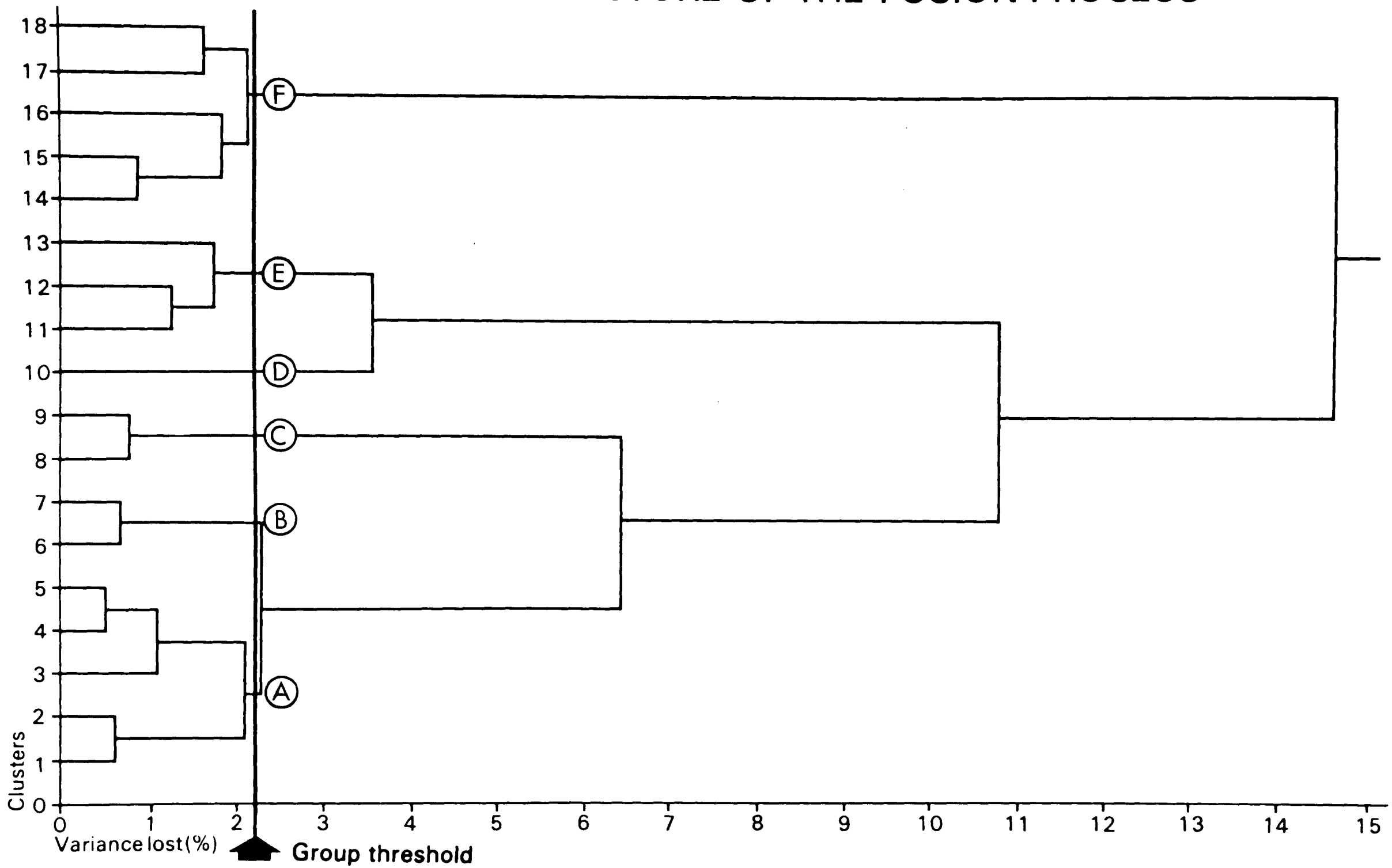


The patterning of variance loss is similar to the iterative relocation case. The early stages of the fusion process contribute only small additions to the cumulative loss, and because the fusion is based on both mass (i.e. population) and distance the incremental variance loss will increase as a positive function of cluster size. At the stage in the fusion process where the change is disproportionately large, a satisfactory solution may be seen to be achieved. Table following and Fig above illustrate the structure of the fusion process.

The column labelled 'loss of variance' indicates that a suitable terminating point would be at stage 13 where the incremental loss of variance shows the first 'big' jump. This is also illustrated in the dendrogram (Fig. 87). Termination at this point however would have fused a total of seven clusters into one group making interpretation extremely difficult. Therefore the dendrogram was traced back to the point at which that group would be first split: this occurs immediately prior to stage 13. The cut-off point chosen is

FIG. 87

CLUSTER ANALYSIS: STRUCTURE OF THE FUSION PROCESS



STRUCTURE OF THE FUSION PROCESS

STAGE	FUSING CLUSTERS		LOSS OF VARIANCE	CUMULATIVE LOSS %	DISCRIMINATING VARIABLE	DIFFERENCE
1	4	5	0.54	0.54	Skilled Manual	-1.260
2	1	2	0.59	1.13	Migrants 5 Years	2.021
3	6	7	0.70	1.84	Walk to Work	-1.294
4	8	9	0.79	2.62	Aged 0-14	1.188
5	14	15	0.93	3.55	Aged 60+	-1.050
6	3	4	1.12	4.67	Distance CBD	-1.394
7	11	12	1.30	5.97	Other Europeans	-1.972
8	17	18	1.73	7.70	Other Europeans	-10.964
9	11	13	1.86	9.56	Asians	-2.295
10	14	16	1.91	11.47	Aged 25-44	-1.630
11	1	3	2.12	13.59	Council Housing	1.801
12	14	17	2.18	15.77	Professionals	-2.500
13	1	6	2.44	18.21	One Pensioner	1.252
14	10	11	3.61	21.82	Private Furnish	4.667
15	1	8	6.42	28.24	Aged 0-14	-1.671
16	1	10	10.84	39.08	Asians	-2.061
17	1	14	14.70	53.78	No Car	1.800

FIG. 88.

thus nearly the optimal solution where the cumulative variance loss is 15.77%.

The particular advantages of the iterative relocation method are threefold. First, since it is a non-hierarchical technique there is no need to substantiate the dubious hypothesis that e.d.'s exhibit phylogenetic relationships. More realistic is a nucleated, non-overlapping distribution of groups that form higher density areas in multi-dimensional space (Pocock and Wishart 1970). Second, this technique requires less core space of the computer. McGammon (1968) has illustrated the exponential growth in core requirements when hierarchical clustering methods are adopted: for 500 observations more than 200 million comparisons are needed to find the minimum distance (dij) at each iteration. Finally all optimization techniques (of which iterative relocation is only one) will, for any specified level of clustering, extract a higher proportion of the original variance than will any hierarchical technique (Barker 1971).

The major disadvantage of optimization techniques is that despite the overall aim of variance maximisation, the global optimum solution is rarely found, being usually replaced by a series of local optima. This is because partitions of the data are rearranged only on the grounds of local criteria (so called 'hill-climbing' algorithms) and there is no reason to believe that the amalgamation of several local optima will likewise produce a global optimum. Moreover, as Everitt states,

> "there is no way of knowing if the criterion value obtained is the true optimum or only a local optimum."
>
> (Everitt 1975:63)

There are, however, a number of procedural guidelines which indicate the existence of a possible sub-optimal solution. The procedures of the technique lead to the valid assumption that the internal variance (homogeneity) of each cluster will be minimized. A checklist of the homogeneity for each cluster is provided on each run; where the average distance for one cluster is above average for the total set of clusters it may be indicative of a sub-optimal solution. This cluster can then be split and iteration allowed to continue until internal stability has been achieved.

A similar check on the step-wise fusion method can be made by reference to the 'loss of variance' column. Again, at each stage in the fusion process the incremental loss of variance should be minimised if the algorithm is working efficiently. Having said this though, where the increment of one fusion level (q) is of the same magnitude as the previous level (q-1) there is every justification for combining these two clusters. This particular feature was evident in the first run. The structure of the fusion was (partly) as follows:

Stage	Fusing Clusters		Loss of Variance
1	13	14	0.21
2	9	10	0.22
3	12	13	0.47
4	1	2	0.50

The very small increases in the early stages and the same changes at stages 9, 10, and 11, 12, suggested that too many clusters had been estimated (in this case 22). This largely accounts for the choice of 18 clusters in the final analysis.

The Data

Considering the lack of sound theoretical synthesis in factorial studies (Johnston 1971 & Timms 1971 are the only exceptions) it is not surprising that few, if any, British approaches have selected variables according to explicitly formulated theoretical criteria. Most have depended upon a single data source, the census, and reflect a preponderance of housing variables such as occupancy, tenure and substandardness (Gittus 1964). Consequently the result has been to stress the importance of housing at the expense of other possibly relevant variables. The need for balance, however, has tended to produce only larger data sets with only marginal consideration given to the likely effects.

Extending the data base however is likely to increase the risk of variable redundancy and a number of investigations have successfully attempted to test factor invariance with 'objectively' reduced data sets (Schmid & Tagashira 1964; Janson 1965, Sweetser 1965, Barrow 1972). Invariance over parallel sets of variables with size of set constant has also been studied (Sweetser 1965, Riihinen 1965, Janson 1960, 1965) and considerable invariance found.

The clustering programme could take a maximum of 40 variables and therefore at least 14 had to be rejected so that only the most 'diagnostic' remained that would contribute to a relatively invariant matrix of correlations.

Probably the most rigorous testing of factor invariance has been undertaken by Jolliffe (1972, 1973). On both artificial

and real data three basic rejection methods, multiple correlation, PCA and cluster analysis, were tested and shown to discard precisely those variables known to be redundant in the majority of data sets.

Of particular interest to geographers is the reanalysis Jolliffe performed on the data set compiled by Moser and Scott (1961). For 157 towns and 57 variables from the 1951 census they performed a PCA, and a cluster analysis on the scores of the first four components classified British towns into one of 16 clusters. Using method C_1, selection of one variable from a single-linkage cluster analysis, Jolliffe produced a similar classification based on only 26 variables.

The initial method of discarding variables was based on the squared multiple correlation because this coefficient

> "indicates the proportion of total variance 'explained' by the multiple regression."
>
> (King 1969:141)

This method, however, eliminated some variables that were considered to be theoretically valuable such as variables 3, 7 and 21 (probably because of the large sampling error associated with the 10% census) and it ignored a degree of overlap between some others (e.g. the Asian and New Commonwealth variables) in which a large degree of redundancy could be expected.

In the final analysis variables were excluded either because their R^2 values was less than 0.4 (an arbitrary decision) or because they were 'represented' by other

variables that were retained. A total of 17 variables were discarded. Of the 37 remaining variables Table below gives the coefficients of determination for both cluster (18) and group (6) levels. Apart from the differences mentioned above all data were taken from the 1971 ward library census for Bradford at the enumeration district scale. No transformations were undertaken since this obscured the actual values that were needed at the aggregate level.

% VARIANCE ACCOUNTED FOR BY THE SIX GROUPS AND EIGHTEEN CLUSTERS

	Variable	Group	Cluster
1.	Distance	29.95	39.98
2.	Children	44.07	62.87
3.	Young Adults	33.24	44.17
4.	Mature Adults	33.82	58.07
5.	Middle-aged	24.66	48.00
6.	Retired	46.59	71.96
7.	Fertility Ratio	47.43	57.68
9.	Single Adults	9.49	18.70
11.	Born overseas	64.31	78.72
12.	Irish	18.30	38.34
13.	Asian	62.93	81.74
14.	Other European	23.08	50.98
16.	Five-year Movers	4.38	26.17
19.	Economically Active	23.59	51.13
20	Unemployed	21.23	37.87
21.	Females Employed	33.40	55.71
23.	Industrial Workers	15.81	28.78
25	Distribution Workers	21.84	37.63
27.	Employers/Managers	29.47	46.47
28.	Professionals	21.02	48.44
29.	Non-Manual Workers	48.71	51.49
30.	Skilled Manual	9.27	31.26
31.	Semi & Unskilled	53.75	63.33
32.	Education	23.05	40.62
35.	No car households	72.71	82.21
37	Bus Commuters	18.74	28.48
38.	Pedestrian Commuters	12.41	21.96
39.	Car Commuters	54.45	65.65

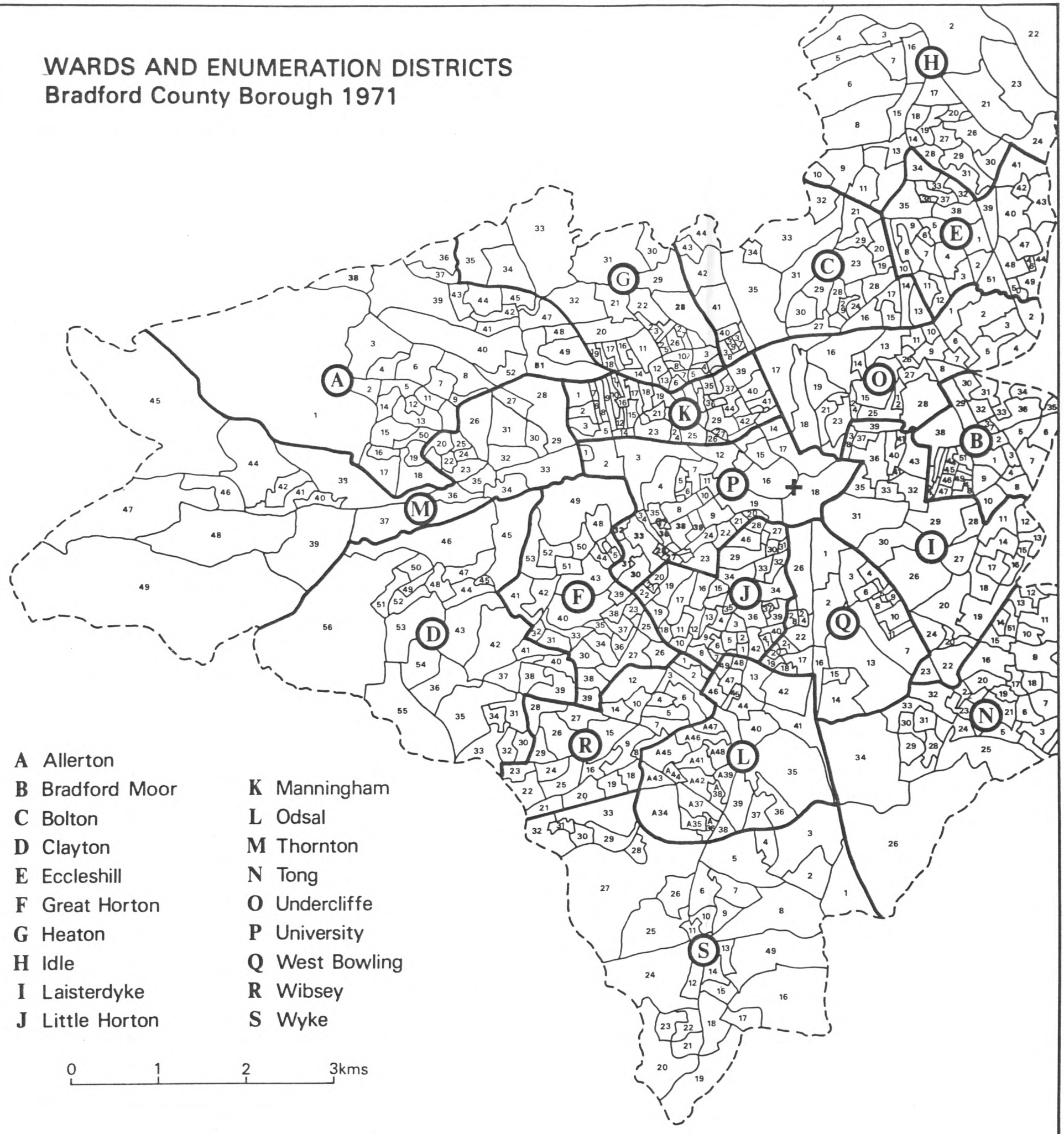
	Variable	Group	Cluster
40.	Owner Occupiers	62.07	79.30
41.	Council Tenants	64.33	84.57
42.	Tenants - Furnished	71.27	73.91
43.	One Person households	57.01	68.82
44.	Single Pensioner Households	47.62	62.51
48.	Overcrowding	61.23	73.88
51.	Shared Dwellings	37.29	40.70
52.	No W.C.	53.57	69.34
54.	No bath	50.23	68.25

It can be seen that the most diagnostic variables, that is the variables accounting for the larger proportion of variance, refer to the broad groups of housing tenure (vars. 40-42) and substandardness (vars. 48-54), ethnicity (vars. 11-14), surrogates for social class (vars. 27-31) and family structure (vars. 2,6,43). Other variables increase substantially in importance at the cluster level, particularly those that are age-related. Again it seems likely that the variables extracted from the 10% census are underenumerated because of the sampling error that always accompanies this library.

APPENDIX C.

WARD AND ENUMERATION DISTRICT REFERENCE MAP

WARDS AND ENUMERATION DISTRICTS
Bradford County Borough 1971



A Allerton
B Bradford Moor
C Bolton
D Clayton
E Eccleshill
F Great Horton
G Heaton
H Idle
I Laisterdyke
J Little Horton
K Manningham
L Odsal
M Thornton
N Tong
O Undercliffe
P University
Q West Bowling
R Wibsey
S Wyke

APPENDIX D.

THE DATA

DESCRIPTION OF THE CENSUS VARIABLES SELECTED FOR BRADFORD, 1971

VARIABLES		NORMALISED DATA			LOCATION QUOTIENTS		
	Trans-formation	Mean	Skewness	Commun-ality	Mean	Skewness	Commun-ality
1. Distance	—	30.42	0.37	57	30.42	0.37	45
DEMOGRAPHIC							
2. Children	—	24.98	0.02	98	0.98	0.02	86
3. Young adults	Lg 10	1.17	-0.03	44	0.72	1.29	54
4. Mature adults	Lg 10	1.34	-0.64	55	0.97	0.78	60
5. Middle-aged	—	25.88	0.37	66	1.59	0.38	60
6. Retired	√	3.29	0.13	92	0.73	1.01	91
7. Fertility ratio	√	6.14	-1.08	54	0.99	0.38	62
8. Married females	—	31.98	-1.17	71	0.68	-1.17	73
9. Single adults	Lg 10	1.59	-0.10	33	1.29	0.96	18
10. Sex ratio	Lg 10	-0.01	3.55	19	1.43	14.44	04
MIGRATION ETHNICITY							
11. Born overseas	Lg 10	0.81	0.37	87	0.85	1.96	93
12. Irish	Lg 10	0.10	-0.18	26	1.03	2.05	29
13. Asian	Lg 10	0.28	0.78	83	1.09	2.67	93
14. Other European	Lg 10	0.07	0.17	35	1.04	4.02	36
15. One-year movers	Lg 10	0.71	-0.20	22	1.04	1.63	24
16. Five-year movers	√	5.74	-0.32	56	1.35	0.75	59
17. New migrants	Lg 10	0.31	1.04	24	1.06	2.87	22
18. New Commonwealth	Lg 10	0.33	0.56	82	1.10	2.52	94
EMPLOYMENT							
19. Economically active	—	63.93	-1.94	85	1.00	-1.94	78
20. Unemployed persons	Lg 10	0.65	-0.24	58	0.57	4.62	45
21. Females employed	√	6.81	-2.70	70	0.99	-0.83	76
22. Primary workers	Lg 10	0.06	4.43	14	1.49	8.96	38
23. Industrial workers	√	6.75	-1.22	47	0.94	-0.08	42
24. Transport workers	Lg 10	0.67	-0.41	05	0.95	1.45	11
25. Distribution workers	√	6.06	-0.10	42	1.02	4.02	30
26. Government workers	Lg 10	0.37	0.60	11	1.00	3.57	07
SOCIAL & OCCUPATIONAL							
27. Employers/managers	Lg 10	0.62	-0.05	41	1.03	1.91	43
28. Professional workers	Lg 10	0.21	1.41	36	1.04	3.26	47
29. Non-manual workers	—	21.76	0.54	57	0.96	0.54	53
30. Skilled manual	—	26.65	0.51	53	0.99	0.51	42
31. Semi & unskilled	—	43.16	0.17	76	1.03	0.17	72
32. Education	Lg 10	0.51	0.20	35	1.70	1.85	35
33. Occupational mobility	Lg 10	0.59	-0.18	10	1.74	2.58	09
34. Retired males	Lg 10	0.69	-0.44	21	1.83	2.40	19
COMMUTING							
35. No-car households	—	66.23	-0.77	94	1.01	-0.77	94
36. Two-car households	Lg 10	0.43	0.37	61	0.83	3.84	50
37. Bus-commuters	—	35.71	0.33	48	1.02	0.33	35
38. Pedestrian commuters	√	3.67	-0.32	36	1.08	1.25	30
39. Car commuters	√	4.21	-0.22	68	1.07	0.97	73
TENURE							
40. Owner occupiers	—	57.52	-0.55	86	0.99	-0.55	81
41. Council tenants	Lg 10	0.67	0.58	76	0.95	1.16	84
42. Tenants - furnished	Lg 10	0.26	1.58	82	1.09	4.38	89
43. One person households	√	4.57	0.04	81	1.01	0.97	85
44. Single pensioner households	√	3.61	-0.32	77	1.00	0.93	76
45. Two person households	—	6.35	0.67	33	1.01	0.67	32
46. Two pensioner households	√	2.75	0.01	57	1.02	4.08	43
HOUSING CHARACTERISTICS & OCCUPANCY							
47. Persons per room	Lg 10	-0.18	3.61	12	1.79	11.47	08
48. Overcrowding	Lg 10	0.34	0.69	75	1.14	2.39	78
49. Rooms per dwelling	√	0.62	-2.11	20	1.09	24.43	14
50. Substandard houses	Lg 10	0.18	2.21	84	1.02	4.60	92
51. Shared dwellings	Lg 10	0.16	2.41	63	1.11	5.7	54
52. No W.C.	Lg 10	0.96	-0.33	83	1.12	1.08	83
53. No hot water	Lg 10	0.63	0.22	92	1.14	2.00	86
54. No bath	Lg 10	0.80	-0.02	94	1.11	1.40	94

[1] The transformation factors refer only to the fully normalised data set.

[2] The communalities relate to a principal axes nine-factor extraction rotated according to the varimax criterion for the normalised data and the direct quartimin criterion for location quotients. The decimal point has been omitted in both cases.

APPENDIX E.

ONE HUNDRED MOST DEPRIVATE E.D.'s -

RANK ORDER.

RANKED SCORES FOR THE WORST HUNDRED ENUMERATION DISTRICTS 1971

Rank Order	Enumeration District		Ranked E.D. Score
1	University	06	574
2	University	20	501
3	Manningham	25	496
4	University	05	407
5	Heaton	05	395
6	University	25	389
7	Manningham	44	384
8	Manningham	45	364
9	Manningham	40	352
10	Little Horton	28	351
11	Laisterdyke	35	348
12	University	42	331
13	Bolton	36	331
14	Manningham	33	331
15	Little Horton	46	325
16	Manningham	42	324
17	Heaton	06	316
18	Manningham	31	306
19	Manningham	26	302
20	University	21	296
21	Laisterdyke	34	294
22	Manningham	13	280
23	Manningham	32	277
24	Manningham	37	268
25	Little Horton	29	264
26	Bolton	41	262
27	Bradford Moor	47	257
28	Heaton	08	256
29	Little Horton	40	252
30	Bolton	40	250
31	University	07	246
32	Manningham	12	237
33	University	24	232
34	University	08	229
35	Manningham	24	227
36	Manningham	41	222
37	University	19	215
38	Heaton	07	214
39	Heaton	04	211
40	Bowling	24	210
41	University	12	208
42	Manningham	09	206
43	University	13	205
44	Heaton	01	203
45	Laisterdyke	33	202
46	University	43	199
47	Laisterdyke	42	196
48	Little Horton	12	196
49	Bolton	38	194
50	Little Horton	18	191

/ Continued .....

Rank Order	Enumeration District		Ranked E.D. Score
51	University	15	191
52	Manningham	10	190
53	Laisterdyke	30	189
54	Manningham	21	189
55	University	10	184
56	Manningham	35	184
57	Heaton	13	181
58	Bradford Moor	46	177
59	Manningham	36	177
60	Heaton	03	175
61	Laisterdyke	31	173
62	Manningham	38	173
63	Little Horton	10	171
64	Laisterdyke	44	169
65	Heaton	02	168
66	Bradford Moor	45	166
67	Manningham	23	164
68	Manningham	08	164
69	Heaton	10	163
70	Little Horton	11	162
71	University	38	159
72	Bowling	01	159
73	Heaton	25	155
74	Bradford Moor	42	154
75	Manningham	29	150
76	Bolton	37	145
77	Bowling	19	144
78	Idle	18	144
79	Laisterdyke	32	142
80	Great Horton	23	142
81	Bowling	21	137
82	University	39	136
83	Bowling	09	135
84	Tong	22	134
85	Odsal	47	133
86	Laisterdyke	12	132
87	Little Horton	42	130
88	Undercliffe	15	127
89	Manningham	15	123
90	Bradford Moor	05	121
91	Manningham	20	119
92	Little Horton	21	119
93	Manningham	39	117
94	Bolton	44	113
95	University	28	109
96	University	44	108
97	University	22	108
98	Heaton	09	105
99	University	26	105
100	University	27	105

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