THE UNIVERSITY OF HULL

Residential Patterns in the Nineteenth Century City: Kingston Upon Hull, 1851

being a Thesis submitted for the Degree of

Doctor of Philosophy

in the University of Hull

by

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May, 1973

"Most if not all cultural changes in society will be correlated with changes in its territorial organisation, and every change in the territorial and occupational distribution of the population will affect changes in the existing culture."

Park, "Human Communities", 1952, p. 231

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ACKNOWLEDGEMENTS

The present work is the result of the fusion of an interest in the nineteenth century urban situation with an interest in the definition of urban residential areas. Both were originally fostered while an undergraduate in the Geography Department at the University of Liverpool, and I am also grateful to Professor H. R. Wilkinson at the University of Hull who originally prompted the merger of these two interests. Kingston Upon Hull City Libraries were very helpful in providing extended access to microfilmed copies of the 1851 census enumerators' books, and both they and Hull University Library deserve my gratitude for providing references and other material. My thanks should also go to the computer at Hull University, and my particular thanks to Dr. R. N. Davidson, whose invaluable supervision has been offered with both tact and integrity.

Summary of Thesis submitted for Ph.D. degree

by Paul Arthur Tansey

on

Residential Patterns in the Nineteenth Century City:

Kingston Upon Hull, 1851

Studies of residential patterns have tended to concentrate on cities in modern societies at a similar stage of advanced industrial development. Those studies which have been carried out in less advanced societies, however, suggest that the forces behind residential differentiation vary with the nature of society itself. The three factors of social rank, family status and migrant status have been identified as major dimensions of differentiation within cities, but at a less advanced stage of development these factors are often measured in terms of different criteria, and show differing degrees of interdependence, particularly between the social rank and family status axes.

Nineteenth century Britain presents an interesting example of a society in the transition stage from a pre-industrial to a modern form of organisation. Available evidence suggests the importance of a social rank criterion based on subjective rather than purely economic definitions of social status, and the differing economic circumstances between strata suggest possible links between family

status and social rank. Using Hull as a case study, and the 1851 census enumerators' books as a source of data, factor analysis techniques have been used to try to define this pattern of differentiation more precisely.

The main dimensions of residential differentiation are shown to be consistent with the patterns found elsewhere, although the composition of these factors contrasts markedly with the twentieth century situation, due to the specific conditions of the period. Social rank, in particular, illustrates the dichotomy within society between employers and the employed, and migrant status reflects the specific situation of Irish immigrants. An oblique solution supports the idea that social rank and family status show a marked degree of interdependence in this context. The results have clear implications for the study of nineteenth century society, and also contribute to a general theory of urban residential patterns.

The Scope of Work on Residential Patterns

Chapter One

Theory and Methodology of Residential Areas

"The city", writes Louis Wirth, "... tends to resemble a mosaic of social worlds, in which the transition from one to another is abrupt" (Wirth, 1938, p. 15). People with like characteristics, Wirth argues, will tend to congregate to form distinctive residential sub-areas within the city. Such areas have long been recognised in urban research, but only within the last fifty years have attempts been made to identify such areas on an objective, scientific basis. Wirth defines heterogeneity, together with size and density, as the characteristic features of urban life, and argues that, in the absence of any other kind of social cohesion in the form of kinship or community groups, spatial segregation of individuals should be according to such criteria as colour, ethnic heritage and social status (Wirth, 1938, p. 11). This view is in some ways an oversimplification - Wirth, for example, underestimates the importance of kinship and primary groups in ethnic communities - but relatively homogeneous areas have certainly been found to exist whenever the spatial distribution of urban populations has been studied.

The search for social theory applicable to urban areas is really a development of the present century,[1] and began in earnest under the leadership of Robert Park in the Chicago Sociology Department of the

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1. The background to studies of residential differentiation is well covered by several recent publications, for example Robson (1969), Timms (1971) and Johnston (1971). Faris (1967) gives a history of the Chicago Movement in particular.

1920s and 1930s. Of the many followers of this "Chicago School" of urban ecologists, Wirth is perhaps the least bound by ecological theory, and many of his ideas have survived the discontent with this method of study which began to be felt towards the end of the Chicago era. In Britain the detailed research carried out by Booth (1902-3)[1], Rowntree's York surveys (1901, 1941), and Mayhew's observations in mid-century London (1861), all concentrated on description rather than attempts to construct general urban theory. Both Booth and Rowntree's work was motivated by the poverty apparent in the nineteenth century city, and their main preoccupation was in recording the numbers and conditions of the poor. Certainly both these workers made valid theoretical statements, and Rowntree's 'poverty cycle' concept is only one example of their application of theory in explanation. The fact remains, however, that the frame of reference these nineteenth century workers adopted did not allow for the study of the city itself, but rather of the economic effects of city life. Observations were made on the structure of cities (Pfautz, 1967), but a general theory of urban structure was outside the range of interests of these nineteenth century workers attempting to make more or less scientific studies of the city.

The larger part of theoretically orientated studies of city life have been carried out in the United States, and the impetus given to urban studies by Robert Park in Chicago must largely be responsible for this. Even after Alihan's attack on the ecological method of

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1. Future references to individual volumes in the final edition of Booth's "Life and Labour of the People in London" (Booth, 1902-3) are given according to the series within the work and the volume number within that series.

study (Alihan, 1938), and other well-reasoned criticisms of ecological principles (Hatt, 1946; Firey, 1945, 1947; Gettys, 1940), interests in the city as a field of study remained. Reissman has suggested that:

> "The ecological period in the history of urban sociology was as valuable as it was necessary. Its value derived from the quantity of information gained about the city. It was necessary because, as in the development of any science, the more apparent clues have to be investigated and evaluated before more complex abstractions are possible."
>
> (Reissman, 1964, p. 120)

Certainly the Chicago ecological movement was valuable, but the basic criticisms of its theoretical base are valid ones. Chicago sociology explored the apparent analogy between human and plant communities, but this analogy was found to be deficient as an explanation of city structure. Since the 1940s researchers have turned to much more empirical methods of approaching the problem, and the emphasis has changed from trying to validate existing theory to attempting to set up laws after empirical investigation. The bulk of research is still carried out in the United States, however, and the result has been a bias in urban theory towards explaining the western industrial city, and consequently the danger has arisen of this theory being erroneously applied to cities as a whole. Those studies which have focused attention on cities at a less advanced stage of industrial development suggest that major changes occur in the factors affecting residential differentiation parallel with changes in the structure of society as a whole. As yet there is little which can be presented as a concrete theory of this aspect of social change, but the more empirical approach to studies of urban differentiation is gradually building up

a body of information from which the basic trends of this development are beginning to emerge.

The number of studies of cities in the Third World - those contemporary cities at a less advanced stage of development - is few enough, but objective studies of cities directly invoking the time perspective are even scarcer. In the United States several of the ecological workers used time series data in their work, and more recently Murdie (1969) and Goheen (1970) have also attempted comparisons through time. On the whole, however, this aspect of the work has been neglected, although available evidence hints at the value of such studies for urban theory. The nineteenth century is hardly represented in such studies, and in Britain the valuable census enumeration book data for the period has hardly been tapped as a source of data for urban studies, let alone for studies of urban differentiation. Lawton (1955) used the 1851 census material in a study of seventeen selected areas in Liverpool and, although the selection of these areas was subjective, the work remains an interesting study in the use of the census enumeration books. Armstrong (1966, 1967, 1968) used data for York from the 1841 and 1851 censuses to illustrate the overall social structure of the town, and similar work is also in progress or has been carried out elsewhere (Dyos and Baker, 1968; Brown, 1970; Tillott and Stevenson, 1970; Fletcher, 1971), but the potential of this enumeration book material for urban studies has been far from exploited to the full.

In essence the present study aims at filling a gap in our state of knowledge about residential differentiation in urban areas. The

heavy bias towards the modern industrial city in studies of residential location begs more work to be carried out in cities of a different type, and certainly the nineteenth century city presents a contrasting picture. In Britain the mid-century was in many ways the heyday of the Victorian period, following as it did the economic hardships of the 1840s and coming before the more troubled economic atmosphere of the later decades of the century. As well as being the year in which Britain felt confident enough to display her manufactures to the World in the Great Exhibition, 1851 also provides perhaps the best available census enumeration book data for urban research. In order to preserve confidentiality the Registrar General only allows access to the enumeration book material after the lapse of a hundred years, and so far the census books for the middle years of the century, from 1841 to 1871, have been made available in this way. The demographic and birthplace information collected in 1851 is much more detailed than in earlier censuses and the 1851 material, as well as being the earliest of these very comprehensive mid nineteenth century censuses, is also the most complete. The 1861 census enumerators' books are often in very poor physical condition, but the mid century census seems to have fared better in this respect. This combination of circumstances - the availability of data and the need for research of this kind - originally suggested the value of a study of this kind, and the present study of Hull makes an attempt to utilize the available census information for the city in the mid nineteenth century in the search for general urban theory.

Residential Segregation: Cause and Effect

Primarily the cause of the development of residential sub-areas lies in the decisions of families and individuals regarding their choice of residential location. This development depends, therefore, on the evaluation of residential locations by their inhabitants, and migration to ensure that, on the whole, this evaluation is favourable. An urban economist would argue that this evaluation is purely in economic terms, and is based on the pattern of the urban land market. Basically the price (or rent) of urban land is an inverse function of distance from the city centre, and therefore reflects demand for and accessibility to city centre facilities. The demand for central land will be most intense because of locational advantages and economies of scale for urban industries, and the angle of the slope of land value will tend to decline as distance from the city centre increases. Various models of urban residential structure have been developed based on this accessibility relationship by, for example, Wingo (1961), Kain (1962) and Alonso (1960, 1964) amongst others. Behind them all lies the basic assumption that journey to work costs form all but a small percentage of total journey costs, and that this adds up to a significantly large proportion of total income. The models also take into account a household's demands for residential space, and argue that residential location is a function of income, space preference and the price of residential space (Kain, 1962, p. 140).

Stegman (1969) writes of such models that they claim "qualities of generality and applicability that far exceed their actual capacities" (p. 25), and Richardson (1969) points out that in attempts to introduce

more realism into the model "elegance, simplicity and internal consistency may be lost" (p. 145). Both writers hold valid opinions. Quite clearly the basic model is a logical one and can be seen to be valid, but other variables are also important and need to be given more attention in this kind of study. Kain, for example, proves the value of his model on data for Detroit, but fails to take up other factors which influence the residential decision and cause deviations from his model. He argues that "Racial discrimination represents a major imperfection which distorts the spatial demand for residential space by both whites and non-whites" (Kain, 1962, p. 158) but does not suggest trying to incorporate this feature into his model, nor apparantly realize that similar factors may be at work in the residential decisions of different social groups within the white population.

Very little work has so far been carried out in an attempt to evaluate the accessibility models, but relevant research suggests that the basic model should not be regarded as explaining a major part of the residential decision. In a study of households' inclinations towards mobility Rossi (1955) found that the most mobile group were those who rented accommodation and wished to become owner-occupiers, followed by those who wished to change their residence due to alterations in housing needs. Considerations of journey to work were only twelfth in rank order of importance when respondants were asked to list complaints about their residential location (p. 82). Stegman (1969) interviewed 841 families changing residence between 1960 and 1966, and found that less than six per cent of these moves were for reasons

of locating closer to work. The most frequent reasons given related to the demand for household space and considerations of the character of the neighbourhood. Asked to choose between a good neighbourhood with poor accessibility and a less desirable neighbourhood with good access some seventy per cent of interviewees chose the former (ibid., p. 26). With regard to the accessibility models Stegman suggests that:

> "The theoretical principle involved more accurately reflects the existing pattern of residential development than the process by which housing consumers move about within that fixed pattern.... Such models tend to confuse the behaviour of the urban land market with that of the urban land consumer, even though the two are quite distinct."
>
> (Stegman, 1969, p. 25)

This does seem to be a valid criticism of the accessibility models. There is, clearly, a causal relationship between accessibility, land value and land use, but this relationship is not strong enough to dictate the location of residence to individuals and households. It must influence this decision, but the range of locations available to a household is, under normal circumstances, great enough to allow a large margin of choice based on other criteria. Stegman (1969) found that twenty-seven per cent of his sample movers moved within the same neighbourhood, and a proportion of these were negroes whose choice of residential location was limited by factors of discrimination. Some seventy-five per cent of movers, therefore, were free to choose their new location at some distance from the old, and the reasons given for moving suggest that economic considerations were not of prime importance in this decision. It is not clear how great an influence economic restraints exercise on the residential decision, but it appears that

households do not attach an overall importance to these factors when considering residential location. It seems reasonable to assume, therefore, that a household has a relatively free choice of location on economic grounds, and that this choice is primarily made on the basis of other factors.

Recent work by sociologists on the residential location decision has tended to stress human behaviour rather than economic restraint. Social needs and aspirations have been seen as of prime importance in evaluating a residential location, and the fulfillment of these needs and aspirations determine the decision of whether or not to change residence. Any residential location has a relative status in the mind of the potential resident on the basis of both its physical and social environment. These two environments are not exclusive, and a location with a high physical environment status will usually also have a high status based on social factors. This social environment is a direct result of the social status of the inhabitants of a residential area, and the location of an individual's residence has often been used as one of the measures of his position in local prestige hierarchies.(Warner et. al., 1960). In addition to this marginal advantage for an individual of being associated with a particular residential area, location within this area also increases the probability of contact with its inhabitants. "The location of a residence", writes Rossi, "has a prestige and is, to some degree, a determinant of personal contact potentials" (Rossi, 1955, p. 179).

Status-conscious families - those moving up the "Social ladder" -

are likely to be most sensitive to this aspect of residential location, and "use residential mobility to bring their residences into line with their prestige needs" (Rossi, 1955, p. 179). All individuals, however, find a need to identify with persons they see as being similar to themselves, and this idea of a reference group for the evaluation of an individual's behaviour is an important one in forming residential clusters[1]. Those persons who wish to interact - namely those with similar social characteristics - are likely to live in close proximity. In this way both the convenience and the likelihood of interaction are increased. It follows that, if residential location is a way of increasing social interaction, those who do not wish to interact are likely to find themselves living far apart. Spatial separation must clearly place limitations on the probability of contact. Timms (1971) sees this relationship between social status and location of residences in terms of social distance and spatial distance, and writes that they "may both be seen as symbols of class standing, and as means of maintaining the existing distinction between ranks" (Timms, 1971, p. 100).

This idea that residential location leads to a correlation between social distance and spatial distance is supported by practical research. Feldman and Tilly (1960), for example, correlate employed males in different occupational categories with those in each other category using 1950 census tract data for Hartford, Connecticut. The expected pattern, with higher correlations between categories of more similar occupational status, well illustrates the grouping of individuals by this criterion. In other words, an individual's residence is located

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1. For details of reference groups see Sherif and Sherif (1964) and Merton (1968).

close to the residences of other individuals with similar occupational (and therefore social) status, with all the social advantages which follow from this. Timms duplicates these findings for Brisbane, using indices of residential dissimilarity on 1951 census collectors' district data (Timms, 1971, p. 101-103).

Ethnic status is associated with socio-economic status as a criterion in the residential decision. Segregation on both counts is concerned with maximizing desired contacts and reference to persons with similar social characteristics. Timms suggests that:

> "The extent to which they (socio-economic status and ethnic identity) serve as independant or as joint influences varies according to the degree of prejudice with which ethnic minorities are treated and the similarity between the socio-economic composition of the ethnic population and that of the core society."
> (Timms, 1971, p. 104)

A study of assimilation of non-Australian born migrants in Queensland illustrates this well. Timms (1969) studied the distribution of the eight major non-Australian migrant groups in the state, and clearly identifies the degree of residential segregation as reflecting assimilation. The importance of the socio-economic status of migrants as a factor of differentiation increases as assimilation progresses, and the importance attached to ethnic status decreases accordingly.

The physical environment of a residential area has an influence on the residential decision in its own right, with regard to its suitability for different styles of life. After type of household tenure Rossi (1955) identifies the major distinguishing features of families with no moving intentions and potentially mobile families

as differences in household composition, in terms of the age of the household head and the size of the household. The younger the head of the household, the higher his inclination towards mobility, and the larger the household the more mobile. This is explained by reference to the family life cycle, and it is argued that household size creates more or less crowded conditions within the home which determine the need to change residence. For Rossi:

> "Residential mobility as an urban phenomenon is to be viewed as the process whereby families bring their housing into line with their needs. Needs change as the family goes through its life cycle and housing varies considerably in its ability to satisfy the changing family needs."
>
> (Rossi, 1955, p. 122)

Rossi's concern is primarily with the adequacy of the housing unit, although wider environmental issues like the amount of open space around the house and street noise had been amongst the frequent complaints of householders interviewed in the study (Rossi, 1955, p. 82). Rodwin (1950) suggests that in locating residence:

> "Among the diverse conditions sought are adequate access to employment centres for the principle and secondary wage earners; convenient access to schools and shopping centres; and improved physical layouts providing adequate and attractive housing, open space, traffic safety and recreation areas."
>
> (Rodwin, 1950, p. 313)

The demands of large families with children and small households with only one or two individuals will clearly differ with respect to these criteria. In modern western cities the suburbs best fulfill the demands of large households in terms of open space, traffic safety, convenient and attractive housing, and often in terms of schooling and shopping

facilities. The move to the suburbs is primarily motivated by the demands of family life. Bell (1956) conducted interviews in two suburbs of the Chicago Metropolitan Region and found that thirty-one per cent of the respondants' move to the suburbs had been motivated purely by these considerations, and that in all but seventeen per cent of cases they contributed to this decision. Other reasons, including pure aestheticism, may be part of the cause of the move to the suburbs, but in the majority of cases "The search for suburbia seems to focus on the good life, for the family" (Dobriner, 1963, p. 65).

This suburban-urban dichotomy, based largely on household space requirements, ~~together with~~ and the desire for proximity to persons of similar social and ethnic status, have been identified as the ~~second of these~~ major factors determining satisfaction with residential locations. The demands on these two scores are not always fulfilled for a variety of reasons. Information about prospective locations and mental conceptions of these areas both tend to be heavily biased, and locations do not always add up to expectations. Economic factors, although not a complete explanation of residential location in themselves, clearly influence the residential decision. Wolpert (1966) argues that the decision to migrate may often be associated with stress imposed by the "noxious" environmental influences of the residential location, which causes an element of irrationality to enter into the residential decision. All these deny the possibility of achieving complete satisfaction with residential location for any given population, but on the whole some kind of equilibrium between aspirations and achievements is maintained. Family type and socio-economic status

have been identified as the two most basic types of homogeneity within urban residential areas in many studies of western societies (Morris and Mogey, 1965; Gans, 1962; Petersen, 1967), but the importance of these factors will certainly vary in different types of society and at different time periods in the same society.

A Methodology for the Identification of Residential Areas

The disillusionment with ecological methods of describing residential areas within cities led to something of a crisis in urban sociology, and the behaviourist-orientated theory of residential differentiation outlined above is in many ways the result of a re-examination of the problem on the part of researchers in the field. The theory of urban ecology had also provided a way of identifying residential areas, based for the most part on the distribution of variables thought to be ecologically significant and the concept of the "natural area" (Zorbaugh, 1926; Hatt, 1946). More recent approaches to the problem have been much less bound by theory although the earliest of these, the technique of "social area analysis", also has serious flaws in its theoretical backing.

Social area analysis first appeared as a definitive method of identifying residential sub-areas in the work of Shevky and Williams (1949), and was restated with greater theoretical backing by Shevky and Bell (1955). The method uses data for census tracts (small areas exhibiting a high degree of homogeneity for which data is made available by the United States census authorities), and relies on the effectiveness of three social area indices of "Social Rank" (an index based on

occupation, education and rental data), "Urbanisation" or "Family Status" (combining a fertility ratio with data on the proportions of women in the labour force and single family dwelling units), and "Segregation" or "Ethnic Status" (an index of 'racial and national groups in relative isolation'). When arbitrary divisions are made between the values obtained, the pattern of high and low scores on the three indices produces a limited number of social areas to which any census tract is allocated (Shevky and Bell, 1955).

As a methodology social area analysis in its original form was described by one reviewer as "A spurious and pseudo-precise procedure" (Ericksen, 1949), and defended as "A new urban referential frame" and "A long awaited advance on the urban natural area framework" (Greenwood, 1950). Several attempts have been made to support the validity of the three constructs by demonstrating the grouping of the measures by factor analysis (Bell, 1955; Anderson and Bean, 1961), but with only partial success, and several workers have supported the method with their own work (Van Arsdol et. al., 1957, 1958a, 1958b; Gagnon, 1960). Other workers using the method found alterations necessary to the overall formula due to the availability of data or the alignment of the measures to the three constructs. McElrath (1967), working with data for Rome, found a marked positive relationship between social rank and family status, and Herbert (1967), using ten per cent sample data for Newcastle under Lyme from the 1961 census of Great Britain, also had only a limited success with the method. McElrath (1968) proposes a revision of the constructs in the light of such results, and puts forward a model with four constructs of social rank, family

status, ethnic status and migrant status. Van Arsdol, Camilleri and Schmid, early exponents of the scheme, joined the critics with a later article (1961) suggesting that:

> "Although the construction of the urban typology offers no empirical advantages over a simple linear combination of the census tract measures, the Shevky indices and social area types do account for a fair proportion of the variance of the measures they were used to explain."
>
> (Van Arsdol et. al., 1961, p. 31)

This general pattern of adjustment and reconsideration of the total method has been followed by most researchers using the Shevky-Bell technique, and early criticisms have to a large extent been borne out by these results.

The number of studies using this technique has declined as the theoretical arguments against the method have been elaborated and as more sophisticated techniques of analysis gained a wider currency[1]. Abu-Lughod (1969a) describes the method as:

> "A crude and approximate solution to a problem for which a superior methodology already existed, even though the latter had not yet been applied in urban ecology. This alternative was factor analysis....which was only called in to buttress the validity of the social area approach."
>
> (Abu-Lughod, 1969a, p. 200)

It is, indeed, difficult to explain this neglect. Tryon (1955) had used cluster analysis (a related method) in an attempt to define urban residential areas, while as early as 1941 Hagood had suggested that factor analysis offered "A method appropriate for synthesizing data

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1. Timms (1971, p. 150-151) gives a summary list of studies using the Shevky-Bell technique or areas defined by the technique as units for further study.

on characteristics with respect to which delineated subregions are to be homogeneous" (Hagood et. al., 1941, p. 216).

Multivariate analysis techniques, primarily factor analysis and principal components analysis, have now become the most frequently used methods of identifying residential areas. Applied to the study of urban sub-areas the statistical population is usually composed of census tracts or enumeration districts, but could be applied to any areal division of an urban area. The choice of variables - demographic, social and economic - aims at the inclusion of those characteristics known to vary within the city area. Kendall (1957) sees these methods as attempts to reduce the dimension of the problem of understanding the relationship between the variables, and appropriate when the researcher "has an embarrassing profusion of variates" and his object is to make the number of important variables as small as he can (Kendall, 1957, p. 6).

The changing emphasis to multivariate analysis techniques as a means of identifying residential areas marks a further departure from a theoretically based methodology. Whilst the work of the human ecologists was too much bound by theory, at the cost of statistical validity and objectivity, the introduction of factor analysis and principal components analysis has brought about an almost complete reversal of this pattern. This is essentially an empirical approach to the problem which, as Hawley and Duncan have suggested:

> "Seems to rest on the one assumption that 'social areas' are there....and accordingly the task of the researcher is merely that of locating and identifying them.... It has yet to be

> demonstrated that a convincing theory of areal differentiation can be generated by such purely empirical procedures."
>
> (Hawley and Duncan, 1957, p. 340-341)

Whilst there is validity in these comments, Hawley and Duncan were surely reactionary in denying that any general theory could emerge from this empirical method of research. It is true that studies concerned with 'locating and identifying' residential areas have been far too common in sociological research, but a body of theory regarding residential differentiation is beginning to emerge from such work, and these more empirical methods of analysis are beginning to shed light on the factors influencing this differentiation and its form in different types of society.

Chapter Two

Residential Differentiation and Social Change

It has long been rumoured that students outside America are more familiar with modern Chicago than with cities in their own countries, and indeed the bulk of sociological work on urban areas has been confined to studies of America and other western industrial societies. Those studies which have focused attention on cities in different types of society or different time periods suggest, however, that changes are apparent in patterns of residential differentiation and that these changes parallel those in the society as a whole. "Social change" is a term which has been presented with many different emphases, but is best taken at its face value as change in the nature of society. The connection between social change and residential areas was first expressed by Shevky and Bell in their monograph on the technique of social area analysis (Shevky and Bell, 1955). They reasonably assert that:

> "We conceive of the city as a product of the complex whole of modern society; thus the social forces of urban life are to be understood within the context of the changing character of the longer continuing society."
>
> (Shevky and Bell, 1955, p. 3)

In using social change as a theoretical basis for their choice of indices, however, Shevky and Bell tended to pose more questions than they answered, but initiated an examination of the nature of this connection.

The basis of Shevky and Bell's rationalization for their method

lies in the concept of societal "scale". "Increasing scale" of a society denotes an increase in the number of interdependent individuals and in the intensity of these interdependent relations (Wilson and Wilson, 1945). Differences in scale are regarded as the fundamental distinction between societies. Shevky and Bell trace the cause of increase in scale in American society to changes in the structure of productive activity, and argue that increase in scale is reflected in "Changes in the distribution of skills, changes in the structure of productive activity, and changes in the composition of the population" (Shevky and Bell, 1955, p. 9). These three trends are reflected in the constructs of social rank, family status and ethnic status respectively.

In the Shevky-Bell model the stages which link the basic postulates of increasing scale and the residential differentiation constructs are not always direct, and the links themselves are often tenuous. Timms points out that:

> "The prime mover is seen as changes in the economy, changes which are themselves the results of technological innovation. To a large extent the model may be seen as one of economic determinism. Little play is given to differences in value orientation, to power conflicts, or even to organizational matters, other than as they are seen as the necessary corollary of changes in the structure of productive activity."
>
> (Timms, 1971, p. 127)

McElrath (1968) remedies these defects to a large extent in a broader based revision of the model. Industrialization and urbanization are seen as twin mainsprings of increase in scale. Changes in industrial organization are responsible for changes in the distribution and reward

of skills (measured by a social rank index) and in the structure of productive activity (reflected in family status). Migrant status and ethnic status measure urbanization in the form of concentration of the population and the degree of co-ordination within it (McElrath, 1968, p. 35).

McElrath presents a much more cogent argument than Shevky and Bell for this link between modernization and social differentiation. The latter is seen as the prime factor behind residential differentiation, and "important social differentia result in residential clusterings of like populations" (McElrath, 1968, p. 40). The connection of these residential clusterings with characteristics of the society as a whole is made by the argument that:

> "Change in the organization of developing societies is accompanied by changes in the dimensions of social differentiation - those categories into which people are divided, and in whose terms they receive differential treatment by others."
>
> (McElrath, 1968, p. 33)

Hence changes in the bases of social differentiation will be reflected in patterns of residential differentiation.

This line of argument has to some extent been tested by empirical research. Work on cities in modern societies has confirmed the importance of Shevky and Bell's original constructs of differentiation. Both McElrath (1968) and Timms (1971) broaden the original three constructs to four - defining them as social rank, family status, migrant status and ethnic status - and work on North American cities has supported these four dimensions of differentiation as the most important in the modern city. Rather than being independent of one

another, however, the measures show differing degrees of interdependence, negligible between social rank and family status, but often pronounced where the other constructs are concerned.[1] This, Timms suggests, reflects differences in population composition and general socio-cultural values, but:

> "The pattern is sufficiently pronounced to conclude that the ecological structure of the modern city may best be summarized in terms of the four basic constructs which the social area model has identified."
>
> (Timms, 1971, p. 152)

Very few studies of urban differentiation have been carried out in cities other than those of the modern industrial type. In his study of Accra, McElrath (1968) uses the four constructs of his redefinition of the Shevky-Bell methodology, and finds an absence of an independent family status factor, but three independent forms of differentiation in social rank, migration status and ethnic status, with migration status being the most important axis. Timms (1971, p. 170) supports this view by the use of factor analysis, though a rather different combination of variables forms the constructs when this method is used. McElrath also presents data on the same constructs for Kingston, Jamaica, for which all the predicted correlations hold, although their magnitude is not as great as anticipated and inter-item coefficients higher than predicted. Clignet and Sween (1969) produce similar results for Accra (Ghana) and Abidjan (Ivory Coast). They conclude that: "Social rank and life-style have lower discriminating

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1. For comparative lists of research using multivariate analysis and the major constructs found in each study see Murdie, 1969, p. 32-38, and Timms, 1971, p. 56-58.

power and independence in Accra and Abidjan than in Rome and San Francisco", and "That migrant and ethnic status plays a more significant role in the former than in the latter cities" (Clignet and Sween, 1969, p. 320). Abu-Lughod (1969a, 1969b) presents a factor analysis of Cairo and interprets the factors (in order of importance) as "style of life" (combining aspects of socio-economic status and family life), "male domination" (migration) and "social disorganisation". In the Cook Islands Timms (1971) again fails to identify independent factors of social rank and family status, and labels the first three factors "modernization", "traditional way of life" and "migration" respectively. In Calcutta (Berry and Rees, 1969) the major features of differentiation are associated with the caste system and different styles of life, reflecting the importance of the specific socio-cultural time and place.

The interdependence of family status and social status seems to be one of the most constant factors of residential differentiation in pre-modern cities, and at the same time forms the most apparant contrast between residential differentiation in western and non-western cities. With this in mind Abu-Lughod, in her study of Cairo, observes that:

> "The dissociation between social rank and familism variables found in contemporary western cities can be attributed to the reinforcing and cumulative effects of several conditions that 'define' the nature of urban organization in such cities:
> (1) residential segregation according to modern ranking systems,
> (2) relatively low correlations between social rank and differences in fertility and family styles,
> (3) high differentiation of residential sub-areas by housing types,
> (4) mobility, and

(5) predominance of independent households.

To the extent that these conditions are not perfectly fulfilled, the vectors will not be totally disassociated."

(Abu-Lughod, 1969a, p. 209)

This is clearly the case in Cairo, and in many cities which have not yet reached the same stage of industrialization as those in Western Europe and North America. The reasons given by Abu-Lughod are in many ways interdependent. The relatively low correlations between social rank and differences in fertility and family styles has a causal relationship with the lack of differentiation according to modern ranking systems and the dominance of other forms of household rather than the independent nuclear family unit.

These contrasts between cities in developing and modern industrial societies suggest some kind of evolutionary change associated with the development of modern industrial society. This process of modernization certainly includes the concept of increasing scale and the breakdown of old social and economic organisations to be replaced by new patterns of society and behaviour. Eisenstadt (1966) defines modernization at the societal level as the breaking down of old social, economic and psychological links and their replacement by the more highly differentiated and specialized social structure of modern societies. With the growth of modernization and occupational differentiation, recruitment to social categories will be increasingly on the basis of achievement rather than birth or kinship. This has the effect of breaking down the previous coalescence between different forms of social differentiation - an individual's kinship no longer provides a valid prediction of his social rank, place of residence or ethnicity.

Eisenstadt writes that:

> "Perhaps the most important aspects of this differentiation and specialization of roles in all the major institutional spheres is the separation between the different roles held by the individual - especially among the occupational and political roles, and between them and the family and kinship roles."
>
> (Eisenstadt, 1966, p. 3)

The basic social area model of Shevky and Bell refers to the axes of differentiation in the modern city, but, as social differentiation will increase with modernization, it is clearly not applicable to cities in which this process is relatively underdeveloped. Timms points out that:

> "Only in the modern city possessing a diversified residential fabric and a well differentiated social structure, may it be anticipated that each construct will emerge in the manner postulated by the basic social area model."
>
> (Timms, 1971, p. 145)

Both theoretical arguments of the nature of modernization and the empirical studies already cited suggest that different models may be appropriate for cities at different stages of development. Timms (1971) suggests a series of six such models, using the Shevky-Bell constructs as a base from which to work backwards to pre-modern cities, and sees the relationship between social rank and family status as the major field of change with industrialization and modernization. An increasing separation of these two factors is visualized, from a single dimension in the feudal city to complete separation in modern industrial cities. During this stage of industrialization the three models involved suggest a degree of interdependence in the pre-industrial and industrializing

The Pre-Industrial City

Construct:

Social rank - Family status (Ethnicity - Migration status)

?

Indicants:

Occupation	Fertility	(Culturally	(Native migrants
Education	Working women	visible	Age-sex imbalance
Income	Marriage	minorities)	Mobility)

The Industrializing City

Construct:

Social rank Family status (Ethnicity) ? (Migration status)

Indicants: ? ?

Occupation	Fertility	(Culturally	(Native migrants
Education	Working women	visible	Age-sex imbalance
Income	Marriage	minorities)	Mobility)

The Modern City

Construct:

Social rank	Family status	Ethnicity	Migration status
Indicants:			
Occupation	Fertility	Culturally	Native migrants
Education	Working women	visible	Age-sex imbalance
Income	Marriage	minorities	Mobility

Table 1: Major lines of social differentiation in three types of city. (Source: Timms, 1971, p. 146)

stages, although there is no attempt made to theoretically derive the exact nature of this relationship (Table 1).

In order to elaborate on this theory of increasing social and urban differentiation with modernization Abu-Lughod (1969a) suggests

that, as necessary preliminaries, researchers should try to work within certain specific limits. She particularly stresses the importance of:

> "Working with the three variables of
> (1) degree of residential segregation by 'modern' criteria of social rank,
> (2) the degree of correlation between rank and family variables with relation to the demographic, and
> (3) the extent of residential and family type specialization, as related to housing/land use on the one hand and the isolation of discrete stages on the other."
>
> (Abu-Lughod, 1969a, p. 210)

These three points draw attention to the difficulties encountered in trying to apply the Shevky-Bell model to cities at a less advanced stage of development, but any conclusive theory of the relationship between the development of residential differentiation and modernization is still for the future. Studies of different cities in different societies are contributing to such a theory and although, at the moment, we have only very general ideas of the important changes brought about by modernization, these ideas are beginning to be examined as part of a general theoretical framework of social differentiation.

The Nineteenth Century Scene

Chapter Three

Social Class and the Victorians

According to Shevky and Bell differences of social rank form the most important basis for the development of distinctive urban social areas (Shevky and Bell, 1955), and later studies using factor analysis and principal components analysis have confirmed this view for western industrial cities. The vast majority of studies carried out on cities in North America and Western Europe have identified a social rank construct as explaining the largest single proportion of variation within the data used[1]. Robson, for example, uses principal components analysis on thirty variables for Sunderland and identifies the first component, accounting for thirty per cent of the total variation, as being positively associated with high social class (Robson, 1969, p. 161-163). Similarly, in an analysis of Hull data from the 1966 census, 23.3 per cent of total variance is accounted for by the first component which is positively associated with low social class and overcrowding (Wilkinson et. al., 1970). Studies on cities in other areas of the world show wider deviations from this pattern, but in the majority of cases some component of social rank is found to be a very strong differentiating feature. In Cairo, for example, Abu-Lughod identifies the first construct produced by factor analysis as "style of life", incorporating social class and family life variables (Abu-Lughod, 1969a, 1969b). In Calcutta the

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1. Gittus (1964a, 1964b) represents a notable exception. Using data from the 1961 census for Merseyside, it was decided to exclude the 10% sample data on occupation, employment, education and household structure. Consequently the first four components are largely concerned with demographic and housing characteristics and only reflect social rank indirectly.

importance of Bengali and non-Bengali castes is emphasized by the second and third components (Berry and Rees, 1969). Even in non-western cities, therefore, social rank is a major feature distinguishing one residential area from another.

In carrying out a study on a nineteenth century urban area there seems no reason to doubt that some aspects of social rank will be important in accounting for a large proportion of the distinctiveness of residential areas. Work carried out during the nineteenth century, in particular Charles Booth's studies, suggest this will be the most important characteristic differentiating one area from another. Without readily apparent distinctions based on economic status in the nineteenth century city there would have been no studies of poverty like Booth's, and this alone must emphasize the importance of social class as a dimension of social differentiation. It is clear that Booth thought of class as involving a definite "style of life", and as being much more tangible than a mere classification device. His continual references to class, descriptions of streets (and larger areas) based on class distinctions, and his maps of poverty show both the importance he attached to this aspect of social differentiation and his awareness of the spatial aspects of this phenomenon. Before looking at the topic of social stratification in detail, however, it is important to clarify the issue by examining exactly what is implied by the various terms used to describe this form of differentiation.

"Social class", "status", "stratification", "rank" and similar terms appear to be used almost at random in publications on the subject of

social differentiation, with little real attempt to systematize their application and often a tendency to regard all such labels as interchangeable. One of the easiest ways to simplify the situation is to classify different social class groupings, and this has been effectively carried out by Ossowski (1963). In this scheme two major ways of interpreting class structure are identified, namely methods based on ordering relations and methods based on relations of dependence. In the former class is used to describe groups defined on the basis of their relative standing with regard to the social and economic variables used in defining the hierarchy, and these are therefore termed schemes of gradation. Schemes based on relations of dependence, however, define a class according to differing attributes: ownership or non-ownership of property, for example. In this study the numbered occupational categories (1 to 6) and the terms "upper class", "middle class" and "working class" are schemes based on gradations of occupation and related social prestige. In the nineteenth century context, however, schemes of dependence are also important, in particular the Marxist view of an economic dichotomy within society involving one-sided dependence of one class on another, and schemes of mutual dependence between classes.

These three types of scheme have one thing in common: they all try to impose order on the stratification within society. All societies have inequalities based on social criteria, and a group having a particular characteristic forms a distinctive strata within a society. Social classes as defined above usually contain several strata, but according to the criteria used in defining the classes the

variation between the classes is greater than that within them.

Schemes of gradation tend to involve fewer difficulties in application than those based on dependence. Max Weber (1946) defined three fundamental forms of social stratification according to the criteria of class (economic situation), status (prestige) and power. Social rank, as used in studies of social differentiation, implies an amalgam of these factors with an emphasis on the economic standing and prestige of a residential area. There is a strong case for arguing that Weber did not, in fact, regard these three dimensions as separate lines of social stratification in any practical sense. Reissman suggests that, for Weber, "whatever its form, stratification was a manifestation of the unequal distribution of power (Reissman, 1959, p.58). Runciman (1968) has demonstrated that the three are conceptually and empirically distinct but discovers the difficulties of trying to evaluate them as separate hierarchies. Whereas class can be measured by economic indices such as occupation and income, status creates greater difficulties by its subjective nature, and power cannot be measured "without experimental evidence". It seems valid to argue, with Runciman, that for most areas of research a single socio-economic index such as occupation reflects these measures of stratification with sufficient accuracy.

To be valid schemes of dependence must be convincingly schemes of interdependence or one-sided dependence. This creates difficulties in trying to establish a scheme, as an interdependent class structure can usually also be visualized as a structure of one-sided dependence and vice versa. To be convincingly a scheme of one-sided dependence,

for example, Marx's scheme relies heavily on the concept of class consciousness: "An awareness on the individual's part of the interests of his class generally" (Dahrendorf, 1959, p, 17). Marx argues, in fact, that the term "class" is only valid if applied to a group possessing consciousness of itself as one of several classes "related to each other in such a way that their interplay is determined by a structurally conditioned conflict of interests" (Dahrendorf, 1959, p. 134). This class conflict "may assume the form of civil war, or of parliamentary debate, of a strike, or of a well-regulated wage negotiation" (Dahrendorf, 1959, p. 135). In the nineteenth century the question of the degree of interdependence or class conflict between classes is a particularly important one.

Stratification in Nineteenth Century Society

Surprisingly little detailed work has been carried out on social stratification in nineteenth century Britain, and most surveys of the period seem to be content with glib generalizations about the Victorian poor and the middle classes. It is only recently that researchers have begun to carry out detailed work comparable with twentieth century studies of stratification, but anything approaching a comprehensive account of the subject is still lacking. The most valuable overall views are still those of contemporaries who identified the great range of economic and social status and the consequent gulf between the upper and lower classes as the most important features of nineteenth century social structure. Broadly society falls into two groupings: an upper class of landowners, property owners, industrialists and entrepreneurs,

and a lower class of factory workers, agricultural workers and the under and unemployed. The lack of a large middle class was particularly effective in keeping these two groupings distinct. Contemporaries, including Disraeli, saw this situation in "Two Nations" terms:

> "In most large cities there may be said to be two nations, understanding as little of one another, having as little intercourse, as if they lived in different lands.... This estrangement of men from men, of class from class, is one of the saddest features of a great city."
> (W. E. Channing, "A discourse on the life and character of the Reverand Joseph Tuckerman", Boston, 1841: Quoted in Briggs and Saville, 1960, p. 7-8)

This does not imply, however, that these two groups were homogeneous, nor that passage from one group to the other was impossible. Indeed, "self-help" in an attempt to raise one's position on the social ladder was considered a great virtue by the Victorian middle class (Smiles, 1859).

Charles Booth's work on London provides some of the most detailed contemporary evidence of the nineteenth century social hierarchy, and in defining this hierarchy he uses two basic social class groupings of the simple gradation type. The first of these, reflecting economic status, is largely confined to the "Poverty" and "Industry" series of the work. The eight groups, as befits their purpose, concentrate on differentiating between the various strata of the working class, and in parts of the work are grouped to form as few as three classes: Lower classes, central classes and upper classes (Table 2). The second scheme is concerned with social status and is primarily used in the "Religious influences" series. Here the eight categories are also

Hierarchy	Description
1	A Lowest classes: semi-criminals
	B Casual earnings: very poor
	C Intermittent earnings: the poor
	D Regular small earnings
	E Regular standard earnings
	F Higher class labour
	G Lower middle class
	H Upper middle class and above
2	AB Very poor
	CD The poor
	EF Comfortable class
	G Lower middle class
	H Upper and middle class
3	ABCD Lower classes
	EFG Central classes
	H Upper classes

1: Poverty Series, I, p. 33
2: Industry Series, II, p. 15
3: Industry Series, I, p. 13

Table 2: Booth's conception of the economic class hierarchy. (Source: Pfautz, 1967, p. 130 - Pfautz lists seven different variations of this hierarchy.)

grouped to form a smaller number where necessary (Table 3). The two systems are clearly not exclusive, however, and the same basic pattern is reflected in both.

In the final analysis Booth's classification can be seen as involving much more than a simple gradation of individuals on the basis of a single criterion of income or status. The systems are based on considerations of "the standard of life", which incorporates income, status and other criteria in its definition. On grounds of income alone the letter classes C and D could be grouped together as "the poor", but:

"....as a rule there is a great difference between the ways

Hierarchy	Description
1	Professional class Middle class Working class
2	Wealth (with fashion) Upper middle class (without fashion) Lower middle class Regular wage earners The poor
3	The oldest English families - those of rank and station. Those who fill the principal places in the Civil Service, officer the army and Navy, plead in our courts of law, supply the Church of England with many of her clergy. The borders of this class have been extended by the increase of wealth. Legal and other professional men, some civil servants, men of business, wholesale traders and large retailers. Those of inferior rank in the same professions, men of business in both wholesale and retail trade, with "lower division" civil servants, and an enormous variety of salaried people. "The new middle class". Lower middle class - clerks. Upper working class - foremen and skilled artisans. Working class. The poor.

1: Poverty Series, III, p. 260
2: Religious Influences, VII, p. 44
3: Religious Influences, VII, p. 396-399

Table 3: Booth's conception of the social status hierarchy. (Source: Pfautz, 1967, p. 131)

> of life in class C, where work though fairly well paid is irregular, and uncertain, and the habits of class D, where the wages, though not high, are the same....all the year round.... The people of class C, though on the whole worse off than those in class D, have in a certain sense a higher standard. For this class demands and aims at more than it can achieve, except when times are good."
>
> (Booth, Industry Series, V, p. 327)

This concept of standard of life was basic to Booth's methodology, and

the use of numbers per room and numbers of servants as sole indicators of class only justified as they formed "an almost absolute test of the style of life" (Industry Series, I, p. 14).

Booth must, of course, have been familiar with the ideas of Karl Marx on nineteenth century social structure. It is equally clear that he did not subscribe to these views. He saw class differences in the period as part of a functional whole rather than a dichotomy of interests. According to Booth each of the three major classes had a distinct economic function within society:

> "The settled rich are the holders and trustees of wealth, but, as with the working classes, their true function is to spend wisely rather than to save... With the working classes the object is to render irregularity of income equal to the calls of a regular expenditure; with the rich it is reversed, and the aim is rather to make a comparatively fixed income meet the claims of varying expenditure... It is on the class between that the real task of accumulation devolves. Excluding a section of the professional men whose savings (like those of the working classes) are mainly a matter of insurance, the main object of the lives of members of this class is money making, and in doing so, even when they are narrowly self-seeking and indifferent to the welfare of others they must, to a great extent, serve the public."
>
> (Final volume, p. 94-95)

As a functional unit, the question of conflict between classes did not arise for Booth, and he could write that:

> "The popular and superficial view of the industrial world into camps of employers and employed is not infrequently accompanied by the assumption that the occupants of each camp represent forces united by the presence of a common enemy. But it would appear that this view is not only superficial but harmful, since the

> analysis of almost any trade shows us the number and variety of its divergent interests; while a broader view reveals the strength of the forces that, in spite of conspicuous forms of conflict and unrest, make for solidarity among all sections concerned."
>
> (Industry Series, V, p. 140)

Booth cites social mobility as one of the major factors preventing conflict between classes, but whether this was really as effective in preventing social conflict as he suggests is debatable. Thernstrom (1964) has shown that in practice social mobility was very limited in the United States of the period, and it seems likely that contempories also tended to over-rate the possibilities of social advancement on this side of the Atlantic. Nevertheless "The great fabric", Booth concludes, "holds together albeit with some thin places" (Industry Series, V, p. 141).

Ossowski (1963) would classify Booth's view as a functional scheme of social differentiation - one based on mutual dependence - and in many ways it is the foil to Karl Marx's view of nineteenth century British society. Marx, in his basic model, presents a dichotomy with two groups having opposite attributes - a scheme of one-sided dependence. As Ossowski has pointed out, however, this ideal pattern has never existed in the real world. In his interpretation of historical events Marx was forced to introduce a large number of social classes to explain situations but, because of its militant programme, Marxist philosophy adopted a scheme emphasizing the sharpness of class divisions and the extremes of inequality between social strata. This scheme was that of two diametrically opposed economic groups, one exploiting and the other exploited, popularised in the "Communist Manifesto" (Ossowski,

1963). Marx's basic thesis rests on the idea that economic inequality within society leads to a parallel development of class consciousness and the realization that changes could be made in the relationship between classes, which finds its expression in class conflict. Before looking at this in more detail, however, it seems wise to look at nineteenth century social structure more closely to see how united class interests were and assess the relative strength of the parties involved.

Within the upper strata of society three main groups can be identified: the old landowning aristocracy, the owners of capital and employers of labour on a large scale, and the growing group of professional workers. Of the first group very little need be said with reference to the present work, as their position as a social group in a nineteenth century industrial town was very limited. Their actual number, however, perhaps masks their true importance. Kitson-Clark (1962) has argued that in nineteenth century government "The control was in hands which had not won it, but received it by prescription and inheritence", and that, even after the 1832 reform:

> "The prejudices, ways of thought and limitations of the old property classes still lay heavy on politics, as it seems also to have been normally members of these classes whose hands still held most of the winning cards."
>
> (Kitson-Clark, 1962, p. 209-214)

Although their influence in a local, urban framework may have been limited, the importance of the old aristocracy in the national context should not be under-rated[1].

---

1. Laslett (1971) describes the landowning aristocracy in pre-industrial England. Although the position of the landed gentry in the mid nineteenth century was being challenged by the newer upper class groups, Laslett gives a good indication of the prevailing attitudes amongst this group at an earlier date.

The newer group within the higher classes - the owners of capital and employers of labour on a large scale - were much more important in an urban environment. Their economic power in the form of ownership of the means of production was more clearly apparant than the power of the aristocracy, although their numbers were not particularly large. The clear dichotomy between this group and the working class has done much to foster the development of theories of class conflict. Cole (1955) has emphasised the distinctiveness of the group, writing that:

> "This new higher class, except at the very top, did not yet mingle much in private social relations with the gentry. A large part of it held itself consciously aloof, repelling as well as being repelled. It was predominantly nonconformist, hostile to the landed interest, proud of having made its own way in the World and of not tracing its ancestry back beyond a grandparent at most."
>
> (Cole, 1955, p. 63-64)

As Booth's hierarchy suggests the contrast is partly one of fashion, and together with the differences of property and birthright this clearly constitutes a rationale for considering the two groups separately.

The professional classes include members at two ends of a spectrum, although exactly where the break into upper and lower professionals occurs is difficult to determine. Certainly, as Reader has shown, the three well established and relatively exclusive professions of the Church, the Law and Medicine, together with officers of the armed forces, form the upper layer of the hierarchy, while the lesser professions change their relative position as the century progresses (Reader, 1967). The 1841 census occupational grouping lists "other

educated persons" , including school teachers, actors, musicians and bankers, immediately after the "professional" occupations, and this device was also followed in 1851. By far the largest group of "educated persons", the schoolmasters, teachers and professors, would hardly constitute part of the upper professionals, and of the other groups the majority of their members would not be considered by contemporaries as on an equal footing with, for example, a successful London doctor (Reader, 1967). In practice, therefore, the core of the upper professional group was still the Church, Law and Medicine, although inroads were being made into this elite by new professions of growing importance such as architecture, civil engineering and the highest grades of clerical work. The reasons for this high status of the "learned professions" Reader describes as "a tissue of impalpability shot through with a solid respect for wealth" (Reader, 1967, p. 152).

Numerically the small size of this upper class group should be stressed. Dudley Baxter, estimating the size of the different strata of society he defined on the basis of income, found that 5,562 thousands out of a total population of about 24,152 thousands belonged to the upper and middle classes. This figure of nearly twenty-five per cent, however, embraces a very wide definition of "middle class", and the true figure much have been much lower (Baxter, 1868). A more accurate picture is gained from modern work using census enumerators' books. Table 4 shows occupation data for household heads in York (10% sample, Armstrong, 1966) from the 1851 census, and Camberwell from the 1871 census (2% sample, Dyos and Baker, 1968) grouped according to the five-fold classification used in modern census analysis. The proportions

Occupational Group		York		Camberwell	
I	Capitalists, manufacturers, professional classes, etc.	59	7.83%	12	1.97%
II	Small shopkeepers, lower professionals, etc.	107	14.20%	83	13.62%
III	Skilled labourers (and shopkeepers who do not employ others)	386	51.26%	398	65.37%
IV	Semi-skilled labourers	103	13.67%	72	11.82%
V	Unskilled labourers	98	13.01%	44	7.22%

Table 4: Occupations of household heads in York (1851) and Camberwell (1871).
(Source: Armstrong, 1966: Dyos and Baker, 1968)

in the upper classes are almost certainly closer to reality than Baxter's estimates, and work in rural areas has produced similar results (Fletcher, 1971: Tillott and Stevenson, 1970: Brown, 1970).

Turning to the working class, one of the most readily apparant disharmonies within the group is the distance separating the skilled and unskilled worker. Booth's hierarchy refers to "higher class labour", and the distinction is perhaps more of an economic one than a reflection of subjective status. Cole quotes the example of skilled engineers and engineering labourers whose typical weekly earnings in large provincial centres in the 1860s were 30s. and 15 or 16s. respectively, whereas by 1914 this gap had narrowed by about fifty per cent (Cole, 1955). Hobsbawm (1964) has defined the interesting concept of a labour aristocracy, which leads to a much easier appreciation of the reasons for this gap in earnings. Inclusion in the aristocracy is defined as depending upon:

(1) the level and regularity of a worker's earnings,

(2) his prospects of social security,

(3) his conditions of work, including employer-employee relations,

(4) his relations with the strata above and below him,

(5) his general conditions of living, and

(6) his prospects of future advancement and those of his children. (Hobsbawm, 1964, p. 273). Although the labour aristocracy shades into white-collar and other non-manual occupations on one side, and into the better-off labourers and ordinary skilled workers on the other, its position as a clearly defined strata of the working class is an important one. Hobsbawm places the origin of the gap in earnings which the labour aristocracy represents in the development of nineteenth century capitalism, where a reserve of unemployed and underemployed workers kept the wages of this kind of labour, that which is most easily expanded, relatively low compared to the wages of the skilled labourer. The aristocracy also had the power to restrict entry into their trade, and thus make their labour artificially scarce. Hence, he concludes:

> "In Victorian Britain there were always some groups of workers who lived virtually always under conditions of full employment, while a much larger mass lived virtually always in what was for employers a wonderful buyer's market."
>
> (Hobsbawm, 1964, p. 290-291)

The size of different groups within the working class is an important feature of nineteenth century social differentiation, Baxter's figures (1868) show that the skilled workers numbered about 1,123 thousands of the economically active population, with 4,695 thousands

semi-skilled, and a further 2,842 thousands in unskilled occupations or engaged as agricultural labourers. The figures for numbers in social class groups in York and Camberwell (Table 4) do not reflect this pattern exactly, partly due to the exclusively urban character of the study areas whereas Baxter's figures generalise the pattern for the whole country, but mainly due to the fact that Baxter estimates numbers of the total economically active where the York and Camberwell figures deal only with the occupation of the household head. The data for Hull[1] (Table 5) illustrates the great difference this distinction makes, and shows that Baxter's gradation from unskilled to skilled workers is a reasonably accurate one. As an industrial town, however, Hull tends to have a higher proportion of workers in skilled occupations than England and Wales as a whole. In Hull some indication of the relative size of the various strata of the working class is also given, for 1839, by data concerning housing conditions collected by the

Occupational Group	Total		Household heads	
1 Manufacturers, upper professionals, etc.	189	2.80%	156	4.59%
2 Lower professionals, small employers of labour	584	8.65%	423	12.48%
3 Skilled non-manual workers	786	11.64%	484	14.27%
4 Skilled manual workers	2333	34.56%	1141	33.64%
5 Semi-skilled workers	1895	28.07%	594	17.51%
6 Unskilled workers	962	14.25%	594	17.51%

Table 5: Occupations of total economically active and economically active household heads in Hull, 1851.
(Source: Census enumerators' books, 1851 census, 20% sample)

1. Details of the sampling procedure for this data from the 1851 census enumerators' books are given in chapter 6, p. 116-128.

	Houses	Rooms	Cellars	Total
Amply furnished	493	91	-	616
Tolerably furnished	1896	123	-	2837
Ill furnished	489	941	14	1407
Not ascertained	552	444	1	997
Total	3430	2412	15	5857

Table 6: Standards of furnishing in homes of the working class, Hull, 1839.
(Source: Manchester Statistical Society, 1842)

Manchester Statistical Society. The information concerning the standards of furnishing gives a particularly good idea of the well off and less well off sections of this group (Table 6).

Unskilled workers must have formed the largest component of the urban poor in the nineteenth century town. Booth, writing about his London work of 1888, stresses the intermittent earnings of many unskilled workers, and arrives at the conclusion that about thirty-five per cent of the population in East London were living below the poverty line (Industry Series, V). Ten years later Seabohm Rowntree found that twenty-eight per cent of the population of York were in the same condition, proving the validity of Booth's figures (Rowntree, 1901). Average wages for unskilled workers were, according to Baxter, 12s and 20s per week (Baxter, 1868), and combined with seasonal unemployment in many industries (including building and dock work) economic hardship must have been a very real feature of life for this strata of the working class. The Manchester Statistical Society report on Hull

suggests that " a seaport affords....not very regular or constant occupation for adult males", but suggests that "there are but few cases in which the labour of adult males is not sufficient for the support of the family" (Manchester Statistical Society, 1842, p. 213). The Society does not, however, elaborate on its concept of "supporting" a family.

The small middle class, though clearly stratified, shows a certain cohesion due to its position with regard to the upper and working classes and the characteristics of the middle class itself. The group contains three main strata: the lower professionals, white-collar workers and small employers of labour. Of professional workers, even including here those excluded from the upper professional group on the grounds that most of their members would not be acceptable there, persons engaged in teaching are by far the largest group. Lockwood (1958) has divided nineteenth century clerical workers into two grades: the more prosperous engaged in banking, insurance, the civil service and similar fields of employment who could maintain "a fairly respectable middle-class way of life without undue strain", and the majority of clerks whose wages were barely more than those of the artisan, but were always striving socially to identify themselves with the middle class (Lockwood, 1958, p. 24). Charles Booth gives wage figures for this lower grade of clerk as between 30s and 60s per week at the end of the century (Quoted in Lockwood, 1958, p. 28). Finally the small producers, retailers and tradesmen, the "petit bourgeois", form part of this class, and basically consist of own account workers and small employers (Ossowski, 1963, p. 77).

This intermediate class can be seen as being composed of persons who are connected with each of the two major classes, but in different respects, and can thus be seen as having divided interests vis-ā-vis these two groups. Due to the white-collar workers' middle class aspirations, for example, Lockwood (1958) visualizes them as "Canute-like, ...standing out against the irresistible tide of 'proletarian-ization'" (Lockwood, 1958, p. 14). The lower professionals and petit bourgeois, however, are less frequently seen in this light. Collectively they have been described as the "uneasy class", undergoing continuous replacement, from which the bulk of radical activity is forthcoming as a result of the frustration this class experiences in its efforts at social climbing (Neale, 1968; Lenski, 1954). The nineteenth century middle class seems to bear this out very well. The interests of small masters have also been seen as being divided, and as being more closely aligned on certain issues with their employees' interests than those of their more successful counterparts, especially with regard to the setting up of large scale mechanized industry (Thompson, 1963, p. 552).

It must be borne in mind that in addition to these divided class interests on the part of the middle class, they lacked both the numeric strength of the working class and the power and privilege of the upper class. The precise numbers are difficult to determine, but some indication of the size of this group has already been given by the figures for occupational groups in York, Camberwell and Hull. Dudley Baxter's estimate has been shown to be inaccurate, mainly because of the income basis of his grouping which proves insufficient as a definition of middle class (Baxter, 1868). Some idea can be

gained from figures for individual occupations in the published census returns. In 1851, for example, the largest lower professional group - teachers - contained only 106,344 individuals of whom 94,518 were female and only 11,826 male and therefore likely heads of families. The number of commercial clerks, probably the most significant occupation in the group, totaled only 37,529 in England and Wales as a whole (Census 1851, II, vol 1).

This overview of nineteenth century society strongly suggests the possibility of class conflict. Hobsbawm (1964) argues that:

> "Under nineteenth century and early twentieth century conditions the normal process of industrial development tends to produce explosive situations, i.e. accumulations of inflammable material which only ignite periodically, as it were under compression."
>
> (Hobsbawm, 1964, p. 139)

Rostow (1948) has illustrated the high correlation between economic factors and social unrest by a "social tension chart" based on the amount of cyclical unemployment, technological unemployment and fluctuations in domestic harvests. Clearly there is evidence to support the relationship between economic conditions and social unrest, and it can be said that class conflict is most likely to occur when the differences between the classes can be most easily perceived. This perception of class differences depends not only on economic circumstances, however, but also on the degree of class consciousness in a primitive or organised form.

In the middle years of the nineteenth century class conflict did occur in many localities and in several different forms. Hobsbawm has written that:

> "At no other time in modern British history have the common people been so persistently, profoundly and often desperately dissatisfied. At no other period since the seventeenth century can we speak of large masses of them as revolutionary, or discern at least one moment of political crisis (between 1830 and the Reform Act of 1832) when something like a revolutionary situation might actually have developed."
>
> (Hobsbawm, 1968, p. 73).

This growing feeling of discontent found its greatest expression in the Chartist movement and its major precursors, agitation for parliamentary reform, agitation for better conditions and shorter hours in factories, and the Anti-Poor Law campaign.

Certainly in both urban and rural areas inequalities of socio-economic class and social status were very great, but from locality to locality the real and perceived range of these inequalities must have altered greatly. Foster (1968a, 1968b) has demonstrated the different degrees of class feeling in three different towns at the beginning of the century, ranging from the intense class conflict and successes of industrial Oldham, through conflict diverted at the old aristocracy and the establishment by the garret-masters and small employers of Northampton, to the poorly developed class consciousness of South Shields. Foster stresses the importance of the trade cycle, with depressions (to which Oldham was subject) increasing the likelihood of class conflict, and the type and location of the town elite - whether it was a privilege elite or self-made, and whether it lived in the town or outside. Other studies have, like Foster's work, illustrated the local aspects of the growth of class consciousness and the demand for increased social equality (Thompson, 1963; Temple-Patterson, 1954).

Local studies of social stratification as such are rare, however, and tend to pay very little regard to aspects like class consciousness and class conflict, although these are very important features of the class structure and the way in which it manifests itself.

Social Space, Physical Space and Victorian Hull

Modern studies of urban differentiation have shown that there is a direct relationship between social distance and spatial distance measured in terms of residential location. Using the census enumerators' book data for Hull, it is possible to illustrate this relationship by indices of residential dissimilarity. The index has been calculated on the basis of occupational groups, which could be termed "classes" in that they represent a scheme of gradation based on the groups' relative standing with regard to socio-economic status and related social prestige (Ossowski, 1963). The index may be interpreted as a measure of net displacement, showing the percentage of one population which would have to move in order to reproduce the percentage distribution of the other population. It is calculated from data giving, for both populations, the percentage living in each areal sub-unit. The index is then one half the sum of the absolute differences between the two populations, taken area by area.[1] In the present case the indices were calculated on the basis of the 74 sub-areas within the town used elsewhere in the study,[2] and have been calculated for both the number

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1. Timms (1971), Duncan and Duncan (1955a, 1955b) and Taeuber and Taeuber (1965) are examples of the use of this index in studies of residential distributions. The numeric value of the index varies depending on the size of the areas used, generally becoming larger as smaller units are used in its calculation (Duncan, Cuzzort and Duncan, 1961).

2. For details of these areal units see chapter 6, p. 129-133.

Occupational Group	1	2	3	4	5	6
1 Manufacturers, upper professionals, etc.	-	37.88	47.17	50.89	52.17	58.77
2 Lower professionals, small employers of labour	36.72	-	26.51	32.05	35.78	42.95
3 Skilled non-manual workers	42.38	21.87	-	25.19	30.63	35.17
4 Skilled manual workers	48.96	28.46	24.91	-	21.94	24.74
5 Semi-skilled workers	43.63	24.85	24.16	20.68	-	26.93
6 Unskilled workers	58.47	40.33	37.43	24.63	29.02	-

Above the diagonal - for household heads in occupational groups.
Below the diagonal - for total economically active in occupational groups.

Table 7: Indices of residential dissimilarity for six occupational groups, Hull, 1851.
(Source: Census enumerators' books, 1851 census, 20% sample)

of individuals in each occupational group and the number of household heads in each group (Table 7). The pattern of indices for the whole economically active population tends to be distorted by the presence of domestic servants, who are included in the semi-skilled occupational group and residentially associated with the servant employing population, and the indices calculated on the basis of the occupation of household heads give the more accurate reflection of social distance.

The values of the indices clearly reflect the pattern expected on the basis of previous use of the technique (Feldman and Tilly, 1960; Timms, 1971). There is a clear correspondance between the ordering of occupational categories in terms of their general social standing and

that produced by indices of their residential dissimilarity, and the degree of residential separation is directly associated with social distance. In only one case does the observed pattern go against the expected pattern, apart from the predictable inconsistencies caused by domestic servants when the economically active population is taken as the basis of calculation. This inconsistency shows that residential segregation between skilled and unskilled workers is not as great as expected or, alternatively, that segregation between semi-skilled and unskilled workers is greater than expected. Perhaps the latter interpretation is the more accurate, and associated with the very low social status of the urban poor in the nineteenth century town. The index between those in skilled and semi-skilled occupations is the smallest which-ever set of data is considered, and the values of the indices as a whole show that these groups in particular, and to a lesser extent unskilled workers, were less segregated from each other residentially than the other occupational groups. At the other end of the hierarchy there is much less of a correspondence between adjacent groups, with a relatively high degree of residential segregation between the two uppermost groups, but a fairly low value between lower professionals and skilled non-manual workers.

Evidence for Hull, therefore, suggests quite a similar pattern of social stratification on grounds of occupation to that in the country as a whole. The data suggests quite a strong desire for residential segregation between groups at the upper end of the hierarchy, and this desire seems to be less strongly felt between adjacent categories at the opposite end of the hierarchy. When mapped the distribution of the

highest and lowest occupational groups reflects the high degree of residential segregation between them, showing an almost direct inverse relationship. From high-grade residences in the new suburbs to the west of the town and in older suburban areas, the predominent residential areas of persons in occupational groups gradually changes until the unskilled worker predominantly lives either in selected areas in the core of the Old Town or industrial areas along the River Hull. This residential segregation and the social distance between groups reflects the gulf between different strata of society in the nineteenth century town (Figures 1, 2 and 3).

In Hull the indices of residential dissimilarity do not suggest a strong feeling of class unity between the different strata of the upper classes, although tend to show that social distance is least between the different strata of the working class. There is very little evidence of class conflict in the town in the mid nineteenth century, and although Chartism and other movements (like the predominantly middle class Anti-Corn Law League) had their followers in the town, "few of the national political agitations of the 1830s and 1840s appear to have made a serious impact on local opinion" (Victoria County History, 1969, p. 242). A better indication of the strength of class feeling is given by religious affiliations. Hobsbawm (1964, 1959) has drawn attention to the influence of Wesleyan Methodism among the working class, and in particular the close connections between Primitive Methodism and trade unionism. Primitive Methodism has been described as "the most purely 'proletarian' of the major sects" (Hobsbawm, 1964, p. 26), and its influence on the formation of a common ideology must

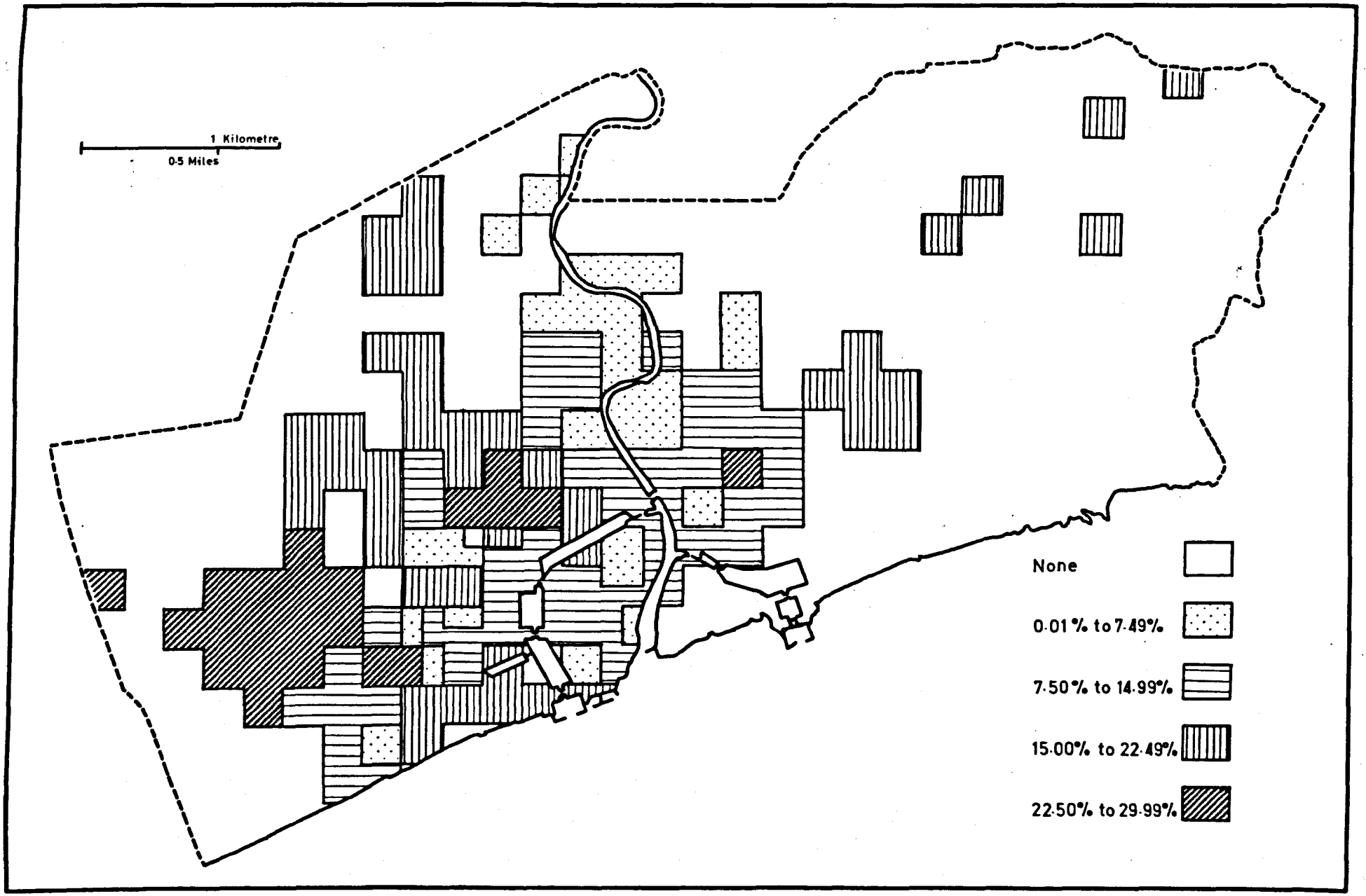

Figure 1: Percentage of the economically active in professional and managerial occupations, Hull, 1851.

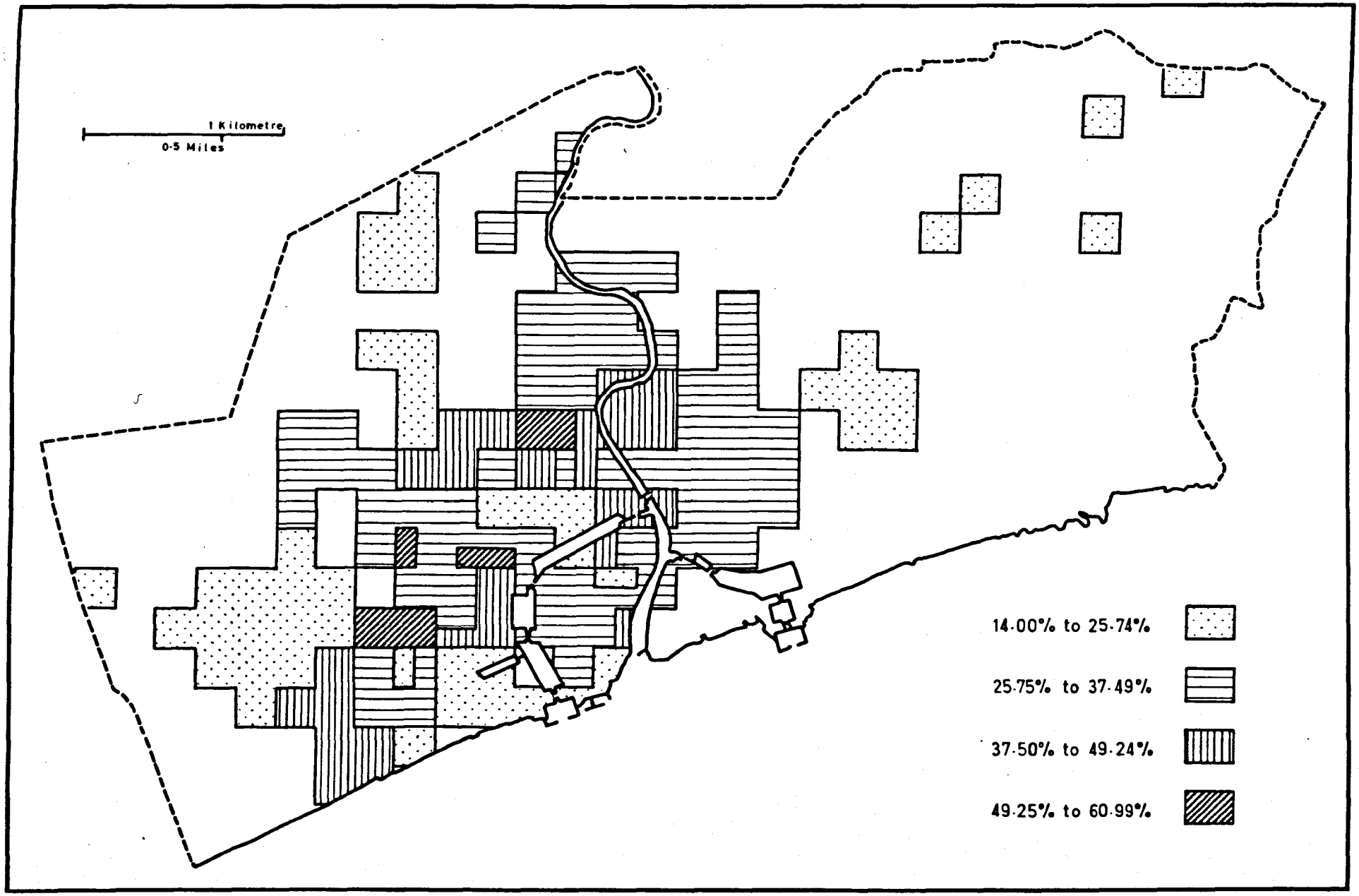

Figure 2: Percentage of the economically active in skilled manual occupations, Hull, 1851.

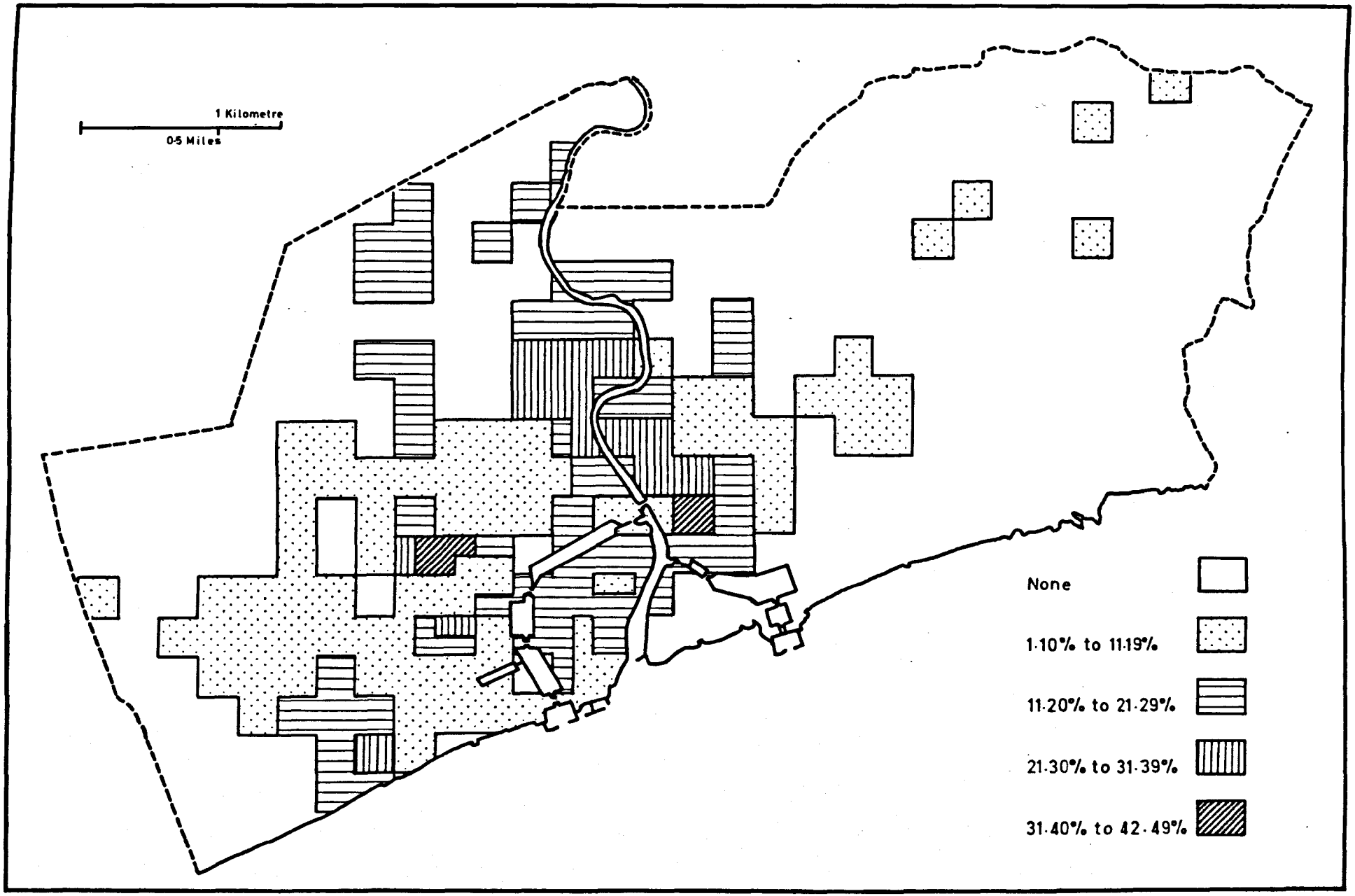

Figure 3: Percentage of the economically active in unskilled occupations, Hull, 1851.

Denomination	Attendants at public worship, March 30, 1851 Morning	Afternoon	Evening	Total
HULL				
Church of England	4,463	811	3,344	8,618
Primitive Methodists	1,526	-	1,480	3,006
Other Wesleyans	2,680	-	2,593	5,273
SCULCOATES				
Church of England	4,245	1,632	2,218	8,095
Primitive Methodists	1,270	271	1,889	3,430
Other Wesleyans	2,915	653	3,903	7,471
YORKSHIRE				
Church of England	170,248	124,430	55,186	349,864
Primitive Methodists	17,925	28,015	40,387	86,363
Other Wesleyans	113,422	99,684	128,237	341,307

Table 8: Relative strength of religions in Hull and Yorkshire. (Source: 1851 Census, Religious Worship)

have been considerable. Figures from the 1851 Census of Religious Worship show Primitive Methodism to have been particularly strong in the area, and especially in the more industrialized and predominantly working class areas of Sculcoates registration district (Table 8).

Although occupation has been found to be a most valuable index of social status in modern societies, Booth and Rowntree, working at the end of the nineteenth century, did not place such a great emphasis on this aspect of social differentiation. For both these workers the most valuable single measures of status were the employment of domestic servants, which identified the upper classes, and secondly the degree of overcrowding amongst the lower classes. In an experimental design which gave equal weight to all these factors - occupation, employment of servants, overcrowding and other indicants of social status - it

might be expected that those factors which proved the most important indicants of social rank would reflect the prevailing hierarchy at the time and place of the study. The available evidence suggests a number of possible lines of social stratification which might be important for residential differentiation in the nineteenth century town, but in this context the evidence is in many ways inconclusive, and an empirical approach is needed to define the importance of these features more precisely.

Chapter Four

Family Status and the Poverty Cycle

The development of family status and social rank as independent lines of demarcation between urban residential areas seems, for cities of the North American industrial type, to be almost inevitable. Although different labels are applied in different cases - "Family life" (Tryon, 1955), "Stage in the life cycle" (Rees, 1970), "Urbanism" (Sweetser, 1965), "Housing conditions" (Robson, 1969) - studies of urban sub-areas have almost invariably identified an index reflecting the style of life and residential preferences of family groups, together with an index of social rank, as the major differentiating factors between residential areas. In pre-modern cities, however, family status seems to be connected in greater or lesser degree with social rank, and suggests the gradual development of independence in the two measures with increasing modernization. Clignet and Sween (1969) compare correlations between variables used to define social rank and family status in cities at different stages of industrial development (Table 9). The picture they give is consistent with the theory that increased modernization leads to increasing independence in these two dimensions. The correlation between individuals with high education and those engaged in non-manual occupations (social rank indices) is much closer in modern cities, reflecting education rather than birth as a criterion of social rank. Infertility rates and women in the labour force (family status variables) are less closely correlated in Accra and Abidjan than elsewhere. Clignet and Sween suggest that this is probably due to

	r12	r12.3	r12.4	r34	r34.1	r34.2
San Francisco	.760	.765	.789	.692	.717	.675
Rome	.789	.587	.662	.685	.445	.453
Accra	.354	.422	.485	-.318	-.250	-.175
Abidjan	.474	.392	.500	.098	.162	.057

Variables used in correlation matrix above:

(1) Proportion of individuals with high education
(2) Proportion of individuals engaged in non-manual occupations
(3) Infertility rates
(4) Proportion of women engaged in labour force.

Table 9: Correlations between indices of social rank and family status in four cities.
(Source: Clignet and Sween, 1969)

the persistance of small-scale trading in these cities, which is not necessarily incompatible with high fertility (Clignet and Sween, 1969, p. 318). Partial correlations between variables in these two groups illustrate the greater dependence of these factors on one another in Accra and Abidjan than in Rome and San Francisco. It would be expected that, if the two variables are components of the same dimension of social differentiation, their association would remain high even with the intervention of other factors. Thus social rank clearly has greater independence in San Francisco and Accra, and family status much greater independence in San Francisco than in the other cities.

Nineteenth century England presents its own problems regarding possible links between social rank and family status. In general it seems reasonable to assume that those factors involved in the modernization process elsewhere may be equally important in this context.

It can be expected that, for example, the separate occupational, social and family roles of the individual will be less clearly differentiated than they are in modern English society. In the nineteenth century, however, a cursory glance at the literature suggests that this relationship is tangibly based on a direct link between variables associated with family type, demographic features and socio-economic factors. It is such information that can furnish a more detailed understanding of this relationship in the nineteenth century context.

Births and Deaths

Data for a study of the demography of the nineteenth century town is not easily forthcoming, and this is as true of birth and death rates as it is of other demographic factors. The Registrar'General's annual reports of births, deaths and marriages fail to give these rates for individual towns consistently, and the mid-years of the century are particularly deficient in this respect. Wrigley (1966a,1968) has drawn attention to the possibility of using parish registers to obtain this data, but this is itself a major research project and its value depends on the completeness of the registers. For nineteenth century Hull there is no readily available data on variations in birth and death rates in different areas of the town and, coupled with the general lack of data on variations between persons of different social rank, it is necessary to look at this question using indirect evidence for the most part.

Available statistics for the middle of the century basically show

	Live births per 1000	Deaths per 1000	Infant mortality -1 year per 1000	Mean family size
Poorest class	39.83	27.78	247	4.14
Middle class	40.32	20.71	184	4.65
Highest class	29.00	13.49	173	3.96
(Servant-keeping class)	?	?	94	?
York	30.00	18.50	176	?

Table 10: Vital statistics for York, 1898.
(Source: Rowntree, 1901)

that both birth and death rates were higher than those in twentieth century England (34.3 and 22.0 per thousand respectively in 1851 against 17.2 and 11.5 per thousand in 1960), and that infant mortality was phenomenally greater (153 per thousand infants during the first year of life, against 22 in 1960 - Mitchell and Deane, 1962). Seabohm Rowntree's work in York in the 1890s, however, gives the equivalent of these figures for three divisions of the working class population on the basis of residential area: The poorest, middle and highest income groups (Table 10). The message behind these figures is quite clear. Death rates amongst those at the lower end of the economic spectrum were far greater than the average, whilst those areas whose inhabitants received larger incomes experienced a much smaller death rate. Similarly infant mortality was much greater in these areas, and more than compensated for the higher birthrate differential. Amongst the poorest class, in fact, where infant mortality was highest, the mean size of family is significantly less than amongst the middle income group. The forces behind these rates are readily apparant: clearly poor

housing and economic hardship led to higher death rates. Higher birth rates can be attributed to what Banks (1954) terms greater "moral restraint" on the part of the more affluent population, and perhaps to a later mean age of marriage amongst this group. The mean age of married male heads in each occupational group for the Hull sample data (Table 11) gives some support to this idea. The lowest mean age of married heads is for those in the skilled manual occupational group (group 4), with much larger mean ages for the higher occupational groups, and marginally larger figures for heads in the semi-skilled and unskilled categories. These figures are obviously only an indirect indication of mean age of marriage, however, and are subject to distortion by external factors.

In Hull the outbreak of cholera in 1849 provides specific evidence of death rates in different areas of the town. Although this information relates to a specific cause of death rather than overall death rates, it merits inclusion due to the support given to the Rowntree data. The epidemic began in earnest in the summer of 1849, and reached its peak in the first three weeks of September, when the "Hull Advertiser" began to publish comparable week-by-week statistics of deaths in the different wards of the town (Table 12). The total number of deaths

Occupational group:	1	2	3	4	5	6
Age	48.15	42.72	41.50	39.05	39.11	39.39

Table 11: Mean age of married male heads by occupational group. (Source: Census enumerators' books, 1851 census, 20% sample)

Ward	Week ending 6 Sept	13 Sept	20 Sept	27 Sept	4 Oct	11 Oct	Total
Myton	182	209	105	49	23	15	583
Humber	64	56	37	28	9	2	196
St Mary's	29	49	37	19	21	1	156
East Sculcoates	38	52	33	8	12	4	147
West Sculcoates	31	36	23	22	9	3	124
Sutton	27	33	21	17	8	-	106
Drypool	8	14	18	55	3	-	48
Total	376	449	274	148	85	25	1360

Table 12: Weekly deaths from Cholera, Hull, 1849.
(Source: Forster, 1972, from the "Hull Advertiser")

was 1,834; a rate of 24.1 per thousand. Forster (1972) attributes the contrast between areas to poor sanitary conditions and to poor housing standards in general - both in overcrowded and decaying property in the older parts of the town (Humber and St. Mary's wards) and housing in Myton ward built during the 1830s and 1840s "as slums from the outset" (Forster, 1972, p. 16). Certainly overcrowding was widespread in Hull at this time and sub-divided dwellings common. In 1851 11,325 families were living in 9,733 houses in Hull registration district (population 50,670) and 2,641 families in 2,279 houses in the East Sculcoates sub-district of Sculcoates registration district (population 11,414; Census 1851, I, Vol 1, p. xcviii). Cooper (1853) analyses the 1849 cholera deaths on the basis of occupation (Table 13), and this lends strong support to the argument that housing conditions and economic factors influencing these dramatically affected the distribution of deaths. Certainly the pattern of cholera deaths according to occupation highlights greater susceptability to the disease amongst the working classes, and this ties in very well with the pattern of

Labouring classes		
Paupers and prisoners	27	
Out-door labourers	237	
Cabmen and police	22	
Sedentary labourers (not specified)	120	406
Joiners	61	
Blacksmiths and engineers	56	
Tailors and shoemakers	74	
Painters	15	206
Sailors	110	110
Wives, widows, and children of the same class	734	
Spinsters of the same class	153	
Unclassified, chiefly children of same	129	1016
Well-to-do classes		
Clerks	16	
Tradesmen	60	
Retired, pensioners, etc.	18	
Professional (2 medical)	6	
Gentry	22	122
		1860

Table 13: Analysis of cholera deaths according to occupation, Hull, 1849. (Source; Cooper, 1853)

death rates by ward. It is possible to say on the basis of the evidence from Hull and York, in fact, that differences in socio-economic standing and the style of life associated with this were closely paralleled by differences in birth and death rates in the mid nineteenth century town.

Family and Household Composition

Family structure is in large part dependent on demographic factors, whereas household composition is affected more directly by social considerations and economic necessity or capability. In York at the

Occupational Group	York	Nottingham	Radford
I Capitalists, manufacturers, professional classes, etc. II Small shopkeepers, lower pro professionals, etc.	1.54	1.69	1.96
III Skilled labourers (including shopkeepers who do not employ others)	1.93	1.84	2.42
IV Semi-skilled labourers V Unskilled labourers	1.73	1.84	2.08

Table 14: Mean children per family in York, Nottingham and Radford, 1851.
(Source: Armstrong, 1968)

end of the nineteenth century family size differed according to the economic circumstances of the group (Table 10), and this feature is also reflected in work using census enumerators' book data. Armstrong (1968) gives figures for the mean number of children per family for groupings of occupations based on the Registrar General's social class hierarchy used in present day British censuses (Table 14), and these reflect the same pattern, as do figures given for a rural area in North West Lindsey by Tillott and Stevenson (1970). The Hull data, using six occupational groups, shows a slightly less consistent picture but the overall trend of figures for mean family size and mean children per family is the same (Table 15).

Household structure tends to be a more complicated phenomenon than family structure. The size of households in the Hull sample varies from one to twenty-five persons, with 26.64 per cent of households comprising only one or two persons and 25.35 per cent comprising

Occupation Group:	1	2	3	4	5	6
Number of heads	156	423	484	1141	594	594
Mean: wives	0.53	0.63	0.64	0.83	0.85	0.68
Mean: children	1.35	1.80	1.62	1.89	1.77	1.78
Mean: family size	2.86	3.40	3.26	3.73	3.62	3.47
Mean: relatives	0.37	0.36	0.34	0.20	0.21	0.18
Mean: servants	0.97	0.70	0.24	0.06	0.05	0.03
Mean: lodgers	0.15	0.31	0.46	0.18	0.21	0.35
Mean: household size	4.35	4.78	4.30	4.17	4.15	4.08

Table 15: Variations in household composition, Hull, 1851
(Source: Census enumerators' books, 1851 census, 20% sample)

six or more persons. Armstrong (1968) found the proportions in the same groups in York in 1851 to be 20.00 per cent and 48.25 per cent respectively, but Armstrong's practice of regarding all persons at one address in the census schedules as belonging to a single household almost certainly overemphasises the importance of large households in this study. This bias is also evident in figures of mean household size. Armstrong gives a mean of 4.70 persons per household for York in 1851, and 4.56 in 1841 (Armstrong, 1968), whereas the Hull mean for 1851 is 4.17 persons.

Household size, like family size, varies with socio-economic status. Laslett (1971), writing of the seventeenth century, suggests that:

> "Poor people....lived in small households and rich people in big ones, though some members of rich households, the servants, came from poor homes and might themselves die in poverty. The general principal....runs as follows: the higher the status of the household or family, the larger it was, and the humbler

> people were, the smaller the households they lived in. The majority of the households were the small, poorer ones, and the minority the large, richer ones, even though more people in total lived in them than in the smaller ones."
>
> (Laslett, 1971, p. 48)

This relationship seems to be at least partly valid for the mid nineteenth century. In Nottingham and Radford mean household size shows a consistent downward trend from the highest to the lowest social groups (R. J. Smith, quoted in Armstrong, 1968). In York Armstrong (1968) gives mean household size in 1851 as 5.31 for the highest social classes (occupational groups I and II), falling to 4.66 amongst skilled workers, and rising again to 4.84 amongst semi-skilled workers. These figures suggest that in a nineteenth century urban environment the pattern identified by Laslett is retained, but may be distorted by larger households at the lower end of the social scale. Armstrong's definition of a household must, in fact, have distorted the figures here again. The Hull figures show a more consistent pattern, with the largest households in the two professional and managerial categories (Groups 1 and 2), and mean household size falling through skilled and semi-skilled workers to the smallest mean amongst households with heads in the unskilled category (Table 15).

The relationship between socio-economic status and household size contrasts strongly with that between status and family size. Families amongst skilled workmen, for example, tend to be the largest, but households in this group are comparatively small. Additions to the household from outside the immediate family must be the cause of these contrasting patterns, and in particular the two numerically

most important groups of domestic servants and lodgers. In Hull figures (Table 15) clearly illustrate the concentration of domestic servants in the two highest occupational groups, with mean numbers of domestic servants per household standing at 0.97 and 0.70 respectively. This pattern agrees with that found in mid nineteenth century York by Armstrong (1968), where the mean number of servants in households with upper class heads (groups I and II) was 1.15, falling to 0.05 in households with heads in the semi-skilled and unskilled categories. In York the mean number of lodgers showed the opposite trend to the mean of servants, but in Hull two clear concentrations of lodgers occur: amongst skilled non-manual households and unskilled households. In many ways the presence of lodgers in a household singles out those households at the lower end of the social scale in much the same way as the presence of servants is indicative of high social status, but the example of Hull also draws attention to lodgers in relatively affluent households, and particularly amongst those with heads in white-collar occupations.

A third group which, from modern studies (Young and Willmott, 1957), might be expected to contribute to the size of households are members of the head's extended family living with his immediate nuclear family. Armstrong's figures suggest, however, that this picture does not hold for the nineteenth century. There seems, in fact, to be some concentration of this type of family structure amongst upper class households, but the evidence for this is not particularly strong. The Hull data yields similar inconclusive results. Laslett (1971) suggests that seventeenth century England

was characterised by the predominance of the nuclear family, due to the necessity of setting up a new economic unit with marriage and, because of shorter life expectation, fewer married couples having in-laws to live with or live with them. In Preston in 1851 Anderson (1972) has shown that between 88 and 100 per cent of persons over 65 having a child alive on census day were, in fact, living with that child, but the actual numbers involved must have been quite small. In Hull 6.46 per cent of the 1851 sample population (999 individuals) were living as relatives in extended families, which figure suggests that similar factors may have been at work to limit this development in the nineteenth century. Almost certainly lower life expectation must have had an influence on this, coupled with the large immigrant population (47 per cent of the population had been born outside Hull in 1851), and possibly economic restraints on household size. It seems that the extended family, far from being destroyed by the industrial revolution, may in some ways have been a creation of it. Clearly longitudinal studies of family structure during the nineteenth century, provided comparable data is available, would help to throw light on this question.

Poverty

On the basis of his observations in York Rowntree, at the end of the nineteenth century, discovered that:

> "Whenever a worker having three children dependant on him, and receiving not more that 21s 8d per week, indulges in any expenditure beyond that required for the barest physical needs,

> he can do so only at the cost of his own physical efficiency, or of that of some members of his family."
>
> (Rowntree, 1901, p. 168)

In other words, an income of 21s 8d was sufficient to keep a family of two adults and three children at subsistence level, and did not allow for any extra expenditure above this. Developing these ideas further Rowntree goes on to suggest that:

> "The life of a labourer is marked by five alternating periods of want and comparative plenty,"

and that a labourer is

> "In poverty, and therefore underfed
> (a) In childhood - when his constitution is being built up,
> (b) In early middle life - when he should be in his prime, and
> (c) In old age."
>
> (Rowntree, 1901, p. 171)

During the first period of poverty the labourer is one of several children all being maintained on the wage of the father which, unless he is a skilled worker, will be insufficient to provide for a number of children adequately. In the second period the roles are reversed, and the labourer takes the place of the bread-earner trying to maintain a family on an insufficient wage. In old age, with his children married, the labourer again experiences poverty as he becomes too old for work and exhausts any savings he may have been able to make during his working life. Largely on this basis Rowntree estimates that 28 per cent of the population of York in 1899 were living in conditions of poverty, and places the root cause of poverty in 1) low wages, 2) largeness of family, 3) irregularity of work, 4) unemployment of the chief wage earner and 5) illness or 6) death

of the chief wage earner. These six factors are closely interwoven, and both rely on and contribute to the poverty cycle concept.

Although wage data of the same accuracy as that used by Rowntree is lacking for the mid nineteenth century, it is possible to make some estimate of the magnitude of the poverty problem during this period. Armstrong (1967) has revised the value of Rowntree's "subsistence wage" on the basis of changes in the cost of food, rent and sundries, and estimates that a family of two adults and three children in 1850-1851 would have needed a minimum income of 22s 8d. Using national wage data he argues that 52 per cent of the population of York in 1851 were in a vulnerable position, and likely to fall into poverty due to inadequacy of wages combined with size of family. Using Dudley Baxter's 1868 estimates of the size of different classes based on income Hobsbawm (1964) has shown that 3.3 million workers were earning less that 20s a week, or about 40 per cent of the working class (Hobsbawm, 1964, p. 280). Although the value of wage data for this period is variable, these figures do give some idea of the proportion of the population at risk of poverty. Rowntree (1901) estimates that low wages were the cause of poverty affecting 52 per cent of the population living below the poverty line, with largeness of family accounting for 22 per cent of poverty. Booth (1889) attributed 55 per cent of "great poverty" to "questions of employment" including casual work, low pay and irregularity of work, and 27 per cent to "questions of circumstance", including largeness of family, illness or infirmity, and combinations of these with irregular work and low pay. Certainly these proportions were no smaller in 1851, and may well have been larger.

Irregularity of work, unemployment and illness of the chief wage earner, in cases where income was at or near subsistende level, would seriously have aggravated the poverty situation. In Leeds in 1838 painters, plasterers, woodsawyers and bricklayers could expect to work for only nine months of the year, shoemakers, masons and wheelwrights for ten months, and coopers, tailors, joiners, saddlers and curriers for eleven months (Hobsbawm, 1964, p. 81). In Hull many other occupations were of a very seasonal or irregular nature, partly because much of the port trade was at this time carried out with the Baltic and therefore dormant during the winter months. Dock workers and seamen were subject to periods of unemployment, as were trades such as timber working which relied on the Baltic for much of their raw material. In the Hull 20 per cent sample data for 1851 18.5 per cent of the economically active male population were engaged in transport and communication industries, of which the majority were sailors and dock workers, and large percentages in other irregular employment such as the building trades (5.7 per cent) and unskilled labour not specifically associated with any industry (8.3 per cent). Some indication of the extent of insufficient wages is given by figures for poor law relief in Hull and Sculcoates[1]. During the half year ending Lady Day 1851, 839 persons were given indoor relief but a total of 4,697 outdoor relief, and this in a period of relative economic well-being following the depression of the 1840s (Returns of Paupers Receiving Relief, 1852).

According to Rowntree irregularity of work and unemployment

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1. For the limitations of figures concerning Poor Law relief see Rose, 1972.

accounted for 5.1 per cent of the population living in poverty in York. Illness or old age of the chief wage earner, forcing him to abandon working, accounted for a further 5.1 per cent. After low wages and large families, however, Rowntree identified death of the chief wage earner as accounting for the largest remaining proportion of poverty: 15.13 per cent of the population living below the poverty line (Rowntree, 1901). This last factor clearly highlights the difficulties for women in the Victorian labour market. The two main occupations of women in this group are, according to Rowntree, charwomen and washerwomen. In the Hull sample 462 widows are economically active (66.5 per cent of total widows) of which 111 (24 per cent) were engaged in unskilled work of this nature. In the sample 519 widowed females described themselves as head of the family (74.6 per cent of all widows), and a large proportion of these must have been trying to support children. In St Mary's ward there were 330 widowed females in 1851, of whom 211 had children (Census 1851, I, Vol 1).

This relationship between poverty, employment and family size which Rowntree's poverty cycle helps to clarify is an important one. Family size is clearly vital in any consideration of poverty, and is usually the deciding factor in trying to balance the household economics of this large section of the population. The implications of this for residential location decisions are easy to appreciate. In York in 1899 28 per cent of the population were living in poverty (Rowntree, 1901), and therefore not economically free to choose any but the cheapest available accommodation. In the middle of the

nineteenth century these factors exerted the same influence. The residential decision in this period was far more dependent on economic factors than it is in modern cities in America and Western Europe, and for a large section of the population the development of a family would be more likely to promote a change of residence on economic grounds than considerations of the suitability of a neighbourhood for family life.

The Relationship between Family Status and Social Rank

One of the reasons Abu-Lughod (1969a) gives for the appearance of family status and social rank as separate dimensions of social differentiation in modern cities is the relatively low correlation between social rank and differences in fertility and family styles. Nineteenth century evidence shows that this was not the case in towns of this period. Both fertility and morbidity are influenced by socio-economic status, and family size and household size and composition also reflect the economics of nineteenth century social stratification. Family size, in fact, is much less likely to lead to the development of a separate dimension based on preferred life-style as this was often a major factor contributing to poverty and the exercise of severe restraints on household expenditure. In Hull at least the distribution of children is not readily explainable in terms of the suitability of an area for family life. Residential areas characterised by young children (Figure 4) show a tendency towards the suburban locations found in modern cities, although this relationship is not as distinct as might be expected. Older children tend to be concentrated

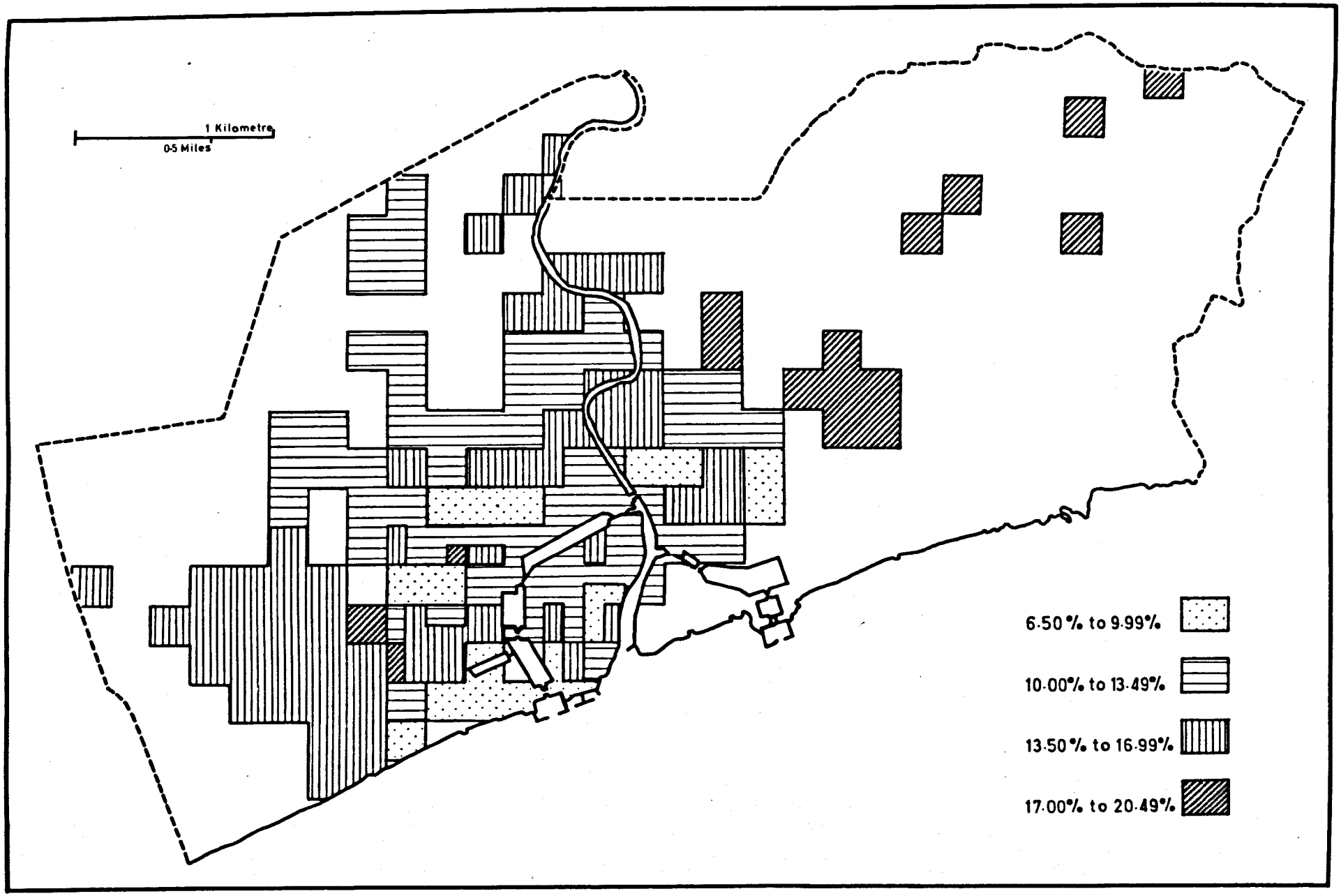

Figure 4: Percentage of the population aged under 5, Hull, 1851.

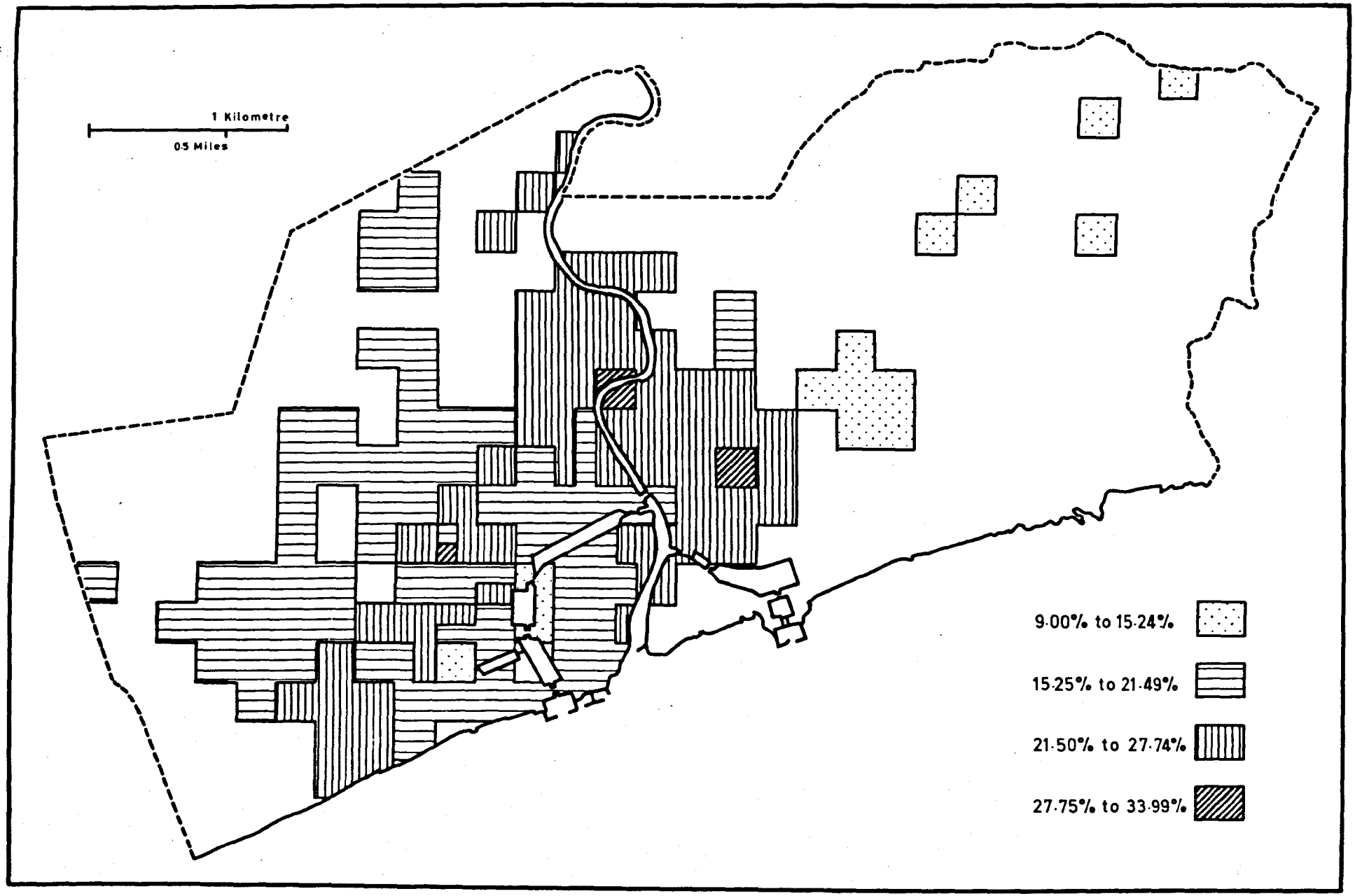

Figure 5: Percentage of the population aged 5 to 14, Hull, 1851.

in those areas already identified as predominantly working class, and this pattern adds weight to the fact that family life was most in evidence amongst this section of the community.

The degree of economic interdependance between social rank and family status suggested by nineteenth century evidence is not difficult to place on the continuum of urban differentiation suggested by Timms (Table 1). Eisenstadt (1966) argues that the separation of roles characteristic of modernisation "has taken place first, and perhaps most dramatically, between family and occupational roles during the industrial revolution"(Eisenstadt, 1966, p. 3). The stage of urban development from pre-industrial city to modern industrial city is essentially a stage of transition - the industrializing city - and as such would be expected to reflect features of both societies. The example of the nineteenth century illustrates this well, with social rank still retaining strong elements of its pre-industrial form, and family status linked to social rank due to direct economic restraints on the choice of residential location and the indirect economic effect on birth and death rates and household structure in general. During the same century, however, Dyos (1961) identifies the move to the suburbs in Camberwell as being directly associated with the desire for single family dwellings, and Booth could write that this move:

> "...depends not so much on class or on amount of income - over a certain minimum - as on the constitution of the family. The father of young children finds it best to establish their home as far from the crowded parts of London as he can afford to travel to and from his work....but later on, when employment

is sought by the younger generation, or better oppurtunities of education for them, or of pleasure for all, the balance may turn in favour of more central quarters."

(Final Volume, p. 205)

Chapter Five

Migrants in Nineteenth Century Towns

The presence of large numbers of migrants in the nineteenth century industrial town must have added greatly to the diversity of the population and the possible lines of demarcation within that population. A special enquiry into the "Influx of population" in Booth's London survey (Poverty Series, III) identifies migrants to the city as a distinctive element of certain residential areas. The study divides immigrants into two groups - provincial migrants to the city and foreign migrants - the latter living in the city centre and the former in the less densely populated outlying areas. Although no clear explanation is given for this distinction between the two groups, it seems probable that it has its origins in differences of social rank, both with regard to economic status and subjective aspects of prestige. Most of the foreign immigrant groups tended to be segregated from one another and the host population, and elsewhere in the work a study of the Jewish community in London is used to illustrate this tendency (Poverty Series, II).

Residential Segregation and Assimilation

"Ethnic status", or more often in the nineteenth century context, "Birthplace status", has been shown to be associated with socio-economic status as affecting the relative desirability of a particular residential location. An individual prefers to live amongst those of similar social standing hence increasing the possibility of

interaction with persons of similar income, work status and interests, while at the same time helping to defend the social hierarchy of which he is a part. Similarly ethnic status, as it affects the social desirability of an individual as a neighbour, works in the same way to promote residential segregation. Timms (1969, 1971) has illustrated this relationship in the twentieth century using Queensland, Australia, as a case study. Measures of residential, occupational and religious dissimilarity between Australian-born and migrant populations, and of the Australians' perceived dissimilarity between themselves and these groups, all varied in the same direction: occupational dissimilarity and perceived dissimilarity varied in the same direction and to much the same degree as residential dissimilarity. Similarly measures of assimilation such as marriage rates between the populations showed a direct relationship with the other measures.

The extent to which birthplace and socio-economic status serve as independent influences on residential segregation depends partly on the degree of prejudice with which the minorities are treated by the host population (or the host population by the immigrants), and partly on the degree of similarity between the socio-economic composition of the two groups. Timms (1971) suggests that where the members of an ethnic minority are overwhelmingly concentrated in a narrow range of the socio-economic status hierarchy there may be no effective discrimination between ethnic identity and socio-economic status. On the other hand prejudice against the minority population may be so great as to lead to social distance being

maintained regardless of the minority's socio-economic status, leading to the development of a separate social status hierarchy paralleling that of the host population within the minority's residential area (Schnore, 1965).

It is difficult to define precisely what is meant by the degree of "assimilation" between the host population and migrant populations, but assimilation has been defined as "A function of the degree of dissimilarity which exists between the members of migrant populations and those of the receiving society" (Timms, 1969, p. 363). This definition, however, suggests that any differences between the two populations indicates lack of assimilation. Differences in religion or type of industry in which the two groups were working, for example, could be taken as indicating lack of assimilation in an otherwise completely assimilated population. It is wise, therefore, not to regard this definition as sacrosanct, but as an imperfect description of a difficult sociological concept. Duncan and Lieberson (1959) regard assimilation as adjustment into the social system of the host society, and define four processes by which the immigrant lessens the difference between the two groups. Naturalization (the acquisition of legal citizenship) and acculturation, involving the decline of old cultural values and customs in favour of those of the host society, are both important but difficult to identify and apply to all migrant groups. Absorption into the economic activities of the society and assimilation into the social system are, however, measured to some extent by socio-economic status, which thus provides a readily available and direct measure of adjustment (Duncan and Lieberson, 1959, p. 370).

The presence of segregation between two groups is, therefore, largely the result of lack of adaption both by the incoming group to the new social and economic structure of the host society, and by the host society to the real or perceived social acceptability of the new group. Lieberson (1963) suggests that residential segregation develops under two sets of circumstances: either the ethnic group is of undesirable status and is involuntarily segregated by the host population, or, if proximity to members of the same group facilitates adjustment for new migrants, residential proximity is desirable and segregation voluntary.(Lieberson, 1963, p. 4-5). In practice both these factors must be at work in the majority of cases, and whichever predominates the results are generally similar.

Studies of segregation in modern societies necessarily concentrate on those ethnic and national groups whose segregation from the native populations is most in evidence in that society. The position of the American negro, for example, has been studied in detail (Duncan and Duncan, 1957; Myrdal, 1964), and other immigrant groups with racial and national distinctiveness from the host population, such as the Puerto Rican in the United States (Handlin, 1959b) and West Indian and Asian immigrants in Britain (Patterson, 1963; Rose, 1969) have been identified as the major population suffering segregation and studied in this light. In nineteenth century Britain, however, immigrant groups were of a slightly different order. The majority of immigrants came from elsewhere in the British Isles - rural areas, small towns, Scotland and Ireland (Redford, 1964; Saville, 1957). Consequently those immigrant groups which did find a place in

nineteenth century urban society were, relatively speaking, of similar background to the host population. This does not imply, however, that immigrants to the nineteenth century town were not involved in problems of assimilation. In a not dissimilar case of a rapidly industrializing country, Ghana, McElrath (1968) identifies "migrant status" (A construct made up of data on the area of birth and proportion of males aged 15-44) as the clearest form of urban differentiation in Accra (McElrath, 1968, p. 43). The birthplace of migrants is clearly important in this situation.

Evidence on the relative segregation of different immigrant groups in the nineteenth century is sparse. Segregation, however, clearly occurred between the Irish immigrants and the host population, and there is some evidence to suggest that segregation occurred between immigrants to nineteenth century towns from other areas of England. Ashworth (1954) quotes the example of immigrants to Merthyr Tydfil who "lived together clannishly, the Pembrokeshire men in one quarter, the Carmarthenshire men in another, and so on" (Ashworth, 1954, p. 28-29). In Hull the 1851 census reveals that the trawling industry, which was largely a development of the 1840s employing 313 men and boys, was largely in the hands of immigrants from Brixham and Ramsgate whose residences were concentrated in the Old Town and especially in Humber Street (Victoria County History, 1969, p. 225). Similarly textile workers, mostly new immigrants from Lancashire and Cheshire, show a marked concentration near the two cotton mills by the River Hull opened in 1836 and 1845 (Victoria County History, 1969, p. 223).

Birthplace	1	2	3	4	5	6	7	Number
1 Hull	-	14.71	18.53	19.14	52.13	25.49	48.48	8208
2 East Riding	14.71	-	19.17	21.87	55.79	26.32	50.36	1810
3 Lindsey	18.53	19.17	-	20.90	57.64	25.70	53.28	1073
4 West Riding	19.14	21.87	20.90	-	74.29	29.84	50.23	998
5 Ireland	52.13	55.79	57.64	74.29	-	77.84	59.80	470
6 North Riding	25.49	26.32	25.70	29.84	77.84	-	57.44	285
7 Lancashire	48.48	50.36	53.28	50.23	59.80	57.44	-	284

Table 16: Indices of residential dissimilarity for major birthplaces of Hull residents, 1851.
(Source: Census enumerators' books, 1851 census, 20% sample)

Using the sample data for birthplaces collected from the census enumerators' books it is possible to measure the degree of segregation between groups by indices of residential dissimilarity[1]. Table 16 gives indices of dissimilarity, calculated on the basis of the seventy four areal units used elsewhere in this study, for the seven most common birthplaces of Hull residents from the 1851 census sample. Quite clearly the most segregated of these populations are the Irish born, who show not only a high degree of segregation from the host population, but also from other immigrant populations. Persons born in numerically more important birthplaces (Lindsey and the East and West Ridings of Yorkshire) are much less segregated from the host population and from each other, and of the smaller birth place groups those born in the North Riding show an intermediate level of segregation and those from Lancashire a relatively high level. The segregation of the Irish population is certainly the greatest, however, and in view

1. See chapter 3 for details of compütation proceedures for this index.

of this it is important to examine the situation in more detail. At the same time an examination of Irish segregation will help to clarify the bases of segregation according to birthplace, and also throw light on the position of other newcomers to the nineteenth century town.

The Irish: A Case Study

Although immigrants from Ireland were an important feature of English life throughout the first half of the nineteenth century, it was not until the 1840s that the influx of Irish took on the character of an urban segregated population. From the turn of the century the Irish visited England as seasonal immigrants in search of labouring work, usually in agriculture (Kerr, 1942). The situation of Irish agriculture in many areas necessitated such means of gaining supplementary income, and many of these seasonal migrants stayed in England so that by 1841 there were over 291 thousand Irish-born living in the country (Freeman, 1957). With the potato famine from 1845 onwards emigration from Ireland rose phenomenally. The number of Irish in England and Wales rose by 79 per cent between the census years of 1841 and 1851 to give a total of some 520 thousand in the latter year. The Irish also became a predominantly urban population during this period. Over 83 thousand Irish were living in Liverpool in 1851, making up over 20 per cent of the population (Lawton, 1959). In Hull the numbers of Irish-born increased from 1,044 in 1841 to 2,983 in 1851, and the distribution of the population shows a marked concentration to the west of Queen's Dock, in an area of very high

population density, and less pronounced concentrations in industrial areas around Queen's Dock and the River Hull. The Irish show the typical age structure of an immigrant group, with few very young or very old persons and a disproportionate percentage of the population in the young adult age groups (Figure 6).

The volume of Irish immigration during the middle years of the century must have contributed to alienating the native population against them, but on the whole the Englishman's dislike of the Irish was based on more deep-seated prejudices. Curtis (1968) identifies three major forms of prejudice against the Irish, based on race, class and religious differences. He argues convincingly that the Angle-Saxon middle and upper classes regarded the Irish as representative of the Celtic race, who displayed all the characteristics most despised by the former. The Irishman was "childish, emotionally unstable, ignorant, indolent, superstitious, primitive or semi-civilised, dirty, vengeful and violent" (Curtis, 1968, p. 52). Secondly class prejudice stemmed from the Victorian sensitivity to class distinctions and the habit of looking at the Irish as peasants and not just as Celts. The low social and occupational status of the majority of Irish immigrants enhanced this reputation of inferiority, and presented a threat to those native Englishmen who stood to lose work or status as they competed with the Irish in the unskilled labour market. Thirdly, Curtis argues that religious prejudice was widespread, and the words "Irish" and "Catholic" inseparable in English minds. Similar considerations were at work in cities in the United States, and the position of the Irish in

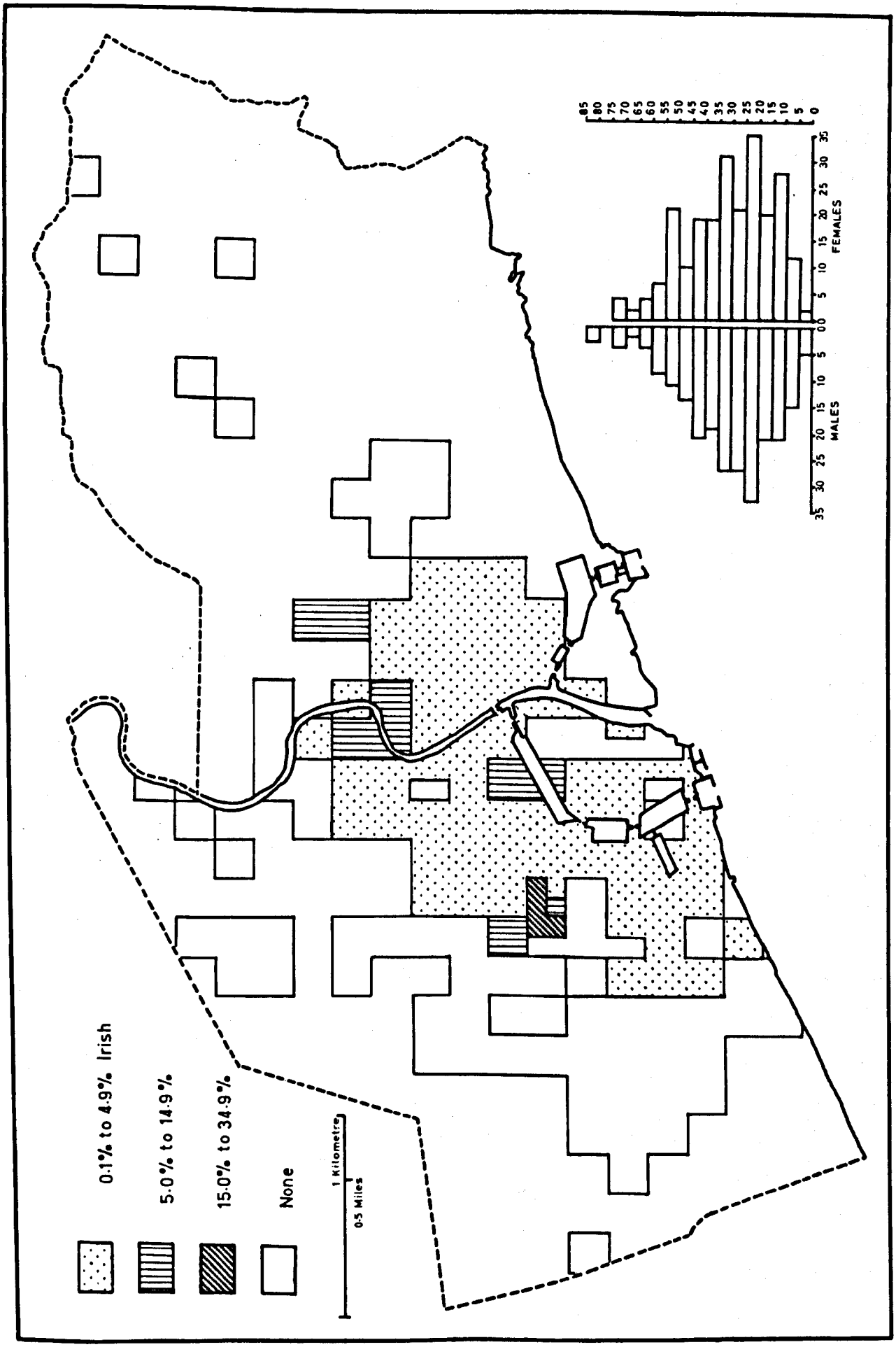

Figure 6: The Irish-born population, Hull, 1851.

society was much the same in the two countries (Handlin, 1959a).

It is certainly true that the Irish were stereotyped as an immigrant group. Engels unsympathetically sums up this attitude to the urban Irish, and writes that:

> "The worst accommodation is good enough for them: they take no trouble with regard to their clothes which hang in tatters: they go barefoot. They live solely on potatoes and any money they have left over from the purchase of potatoes goes on drink. The slums of all the big towns swarm with Irish. One may depend upon seeing many Celtic faces, if ever one penetrates into a district which is particularly noted for its filth and decay. These faces are quite different from those of the Anglo-Saxon population, and are easily recognisable. The Irish, of course, can also be identified by their accent, for the true Irishman seldom loses the sing-song, lilting brogue of his native country."
>
> (Henderson and Chaloner, 1958, p. 105)

Engels view was coloured by the fact that he blamed the Irish for keeping wages low in the unskilled labour market, and indirectly causing unnecessary hardship to the English worker. The Irish were certainly at the bottom of the socio-economic ladder in the Victorian town, and their appearance as a source of unskilled labour caused resentment on the part of the native English who "Distrusted them as Catholics and hated them as underminers of their wages" (Hobsbawm, 1968, p. 310).

The Irish themselves must have found it difficult to adjust to the English way of life. Hobsbawm (1968) writes that:

> "Apart from their language (if they happened no longer to

> be Irish-speaking), they brought nothing with them which would have enabled them to make more sense of nineteenth century England and Scotland than of China. They came as members of a pauperized, degraded peasantry whose own native society had been crushed by some centuries of English oppression into fragments of old custom, mutual aid and kinship solidarity, held together by a generically Irish 'Way of life' (Wakes, songs, and so on), by a hatred of England and by a Catholic priesthood of peasants' sons and brothers."
>
> (Hobsbawm, 1968, p. 310)

Irish problems of adjustment to the nineteenth century town were clearly severe, and it would not be surprising to find Irish immigrants voluntarily segregating themselves from the native population to facilitate this adjustment. Combined with the English prejudices against them, it is understandable that the Irish were the most segregated of immigrant groups during the period.

Lees (1969) has suggested that the Irish responded to the new conditions and facilitated their adjustment to them by quickly reorganising themselves into family units. Using sample data for five London parishes from the 1851 census schedules Lees points out that some 79 per cent of the Irish lived in households headed by Irish nuclear families, and that less than 3 per cent had moved into English households (Lees, 1969, p. 377-378). The emphasis on the importance of the nuclear family unit is probably misplaced, but Irish households certainly did expand to take in those who had crossed over to England alone. Richardson (1968) found that over a quarter of the Irish population in Bradford in 1851 were lodgers, and the Hull sample data gives a figure of 27 per cent of the Irish living as

lodgers, of whom 75.6 per cent (96 individuals) were in households headed by a person of Irish birth. A further 7.7 per cent of the sample Irish population were living as members of the head's extended family, and described themselves as a relative in the census schedules. Irish lodging houses must have been a common feature of urban life at this time, catering for temporary lodgers intending to emigrate overseas and for single immigrants. Mayhew (1861) suggests that these houses were of two kinds - "clean and dirty" (Mayhew, 1861, Vol 1, p. 111). The general pattern of the development of separate Irish households seems to have been that a successful immigrant would send home remittances to bring over another member of the family, and by degrees the whole family would be reunited (ibid., p. 109).

The details of Irish segregation in the nineteenth century are perhaps easiest to appreciate if approached from the angle of occupational segregation. Jackson (1963) writes that the Irish:

> "Showed a remarkable ability to adapt to the labour situation to which they had come. In construction, building, dock labour, and all kinds of heavy work the Irish clearly filled a necessary role in the immense industrial expansion. The labour market needed, and found in the immigrant Irish, a large reserve of casual, cheap and often highly mobile labour."
>
> (Jackson, 1963, p. 93)

Sample occupation data from the London study (Lees, 1969) identifies 26.3 per cent of the total Irish immigrants as unskilled labourers or hawkers, which represents almost exactly one half of the economically active population. In Liverpool the sample data extracted by Lawton (1959) similarly identifies a disproportionately high

percentage of the Irish population in unskilled trades. 34.4 per cent of the economically active sample Irish population and 24.8 per cent were engaged in labouring and domestic service respectively. Some Irish were engaged in high status occupations - in Liverpool 36 individuals in the sample (2.9 per cent) were engaged in commercial occupations, but the Irish were certainly over-represented in the lower occupational grades. The Hull data (Table 17) shows a similar pattern. When grouped according to the type of industry 50 of the sample Irish (19 per cent of the economically active) were engaged in textiles, 29 (10.9 per cent) in transport industries, 24 (9.1 per cent) in distributive trades and 75((28.4 per cent) in the indefinite industry group, most of whom were merely listed as "labourer" in the census schedules. Relatively large numbers of Irish in the textile trades have been identified elsewhere. Richardson (1968) found that 38.9 per cent of the economically active Irish in Bradford in 1851 were so employed, but that over one third of these (some 1,295 individuals) were engaged in the obsolescent hand wool-combing

Occupational Group	Irish		Rest of population	
1. Manufacturers, upper professionals, etc.	6	2.27%	183	2.82%
2. Lower professionals, small employers of labour.	10	3.79%	574	8.85%
3. Skilled non-manual workers.	20	7.58%	766	11.82%
4. Skilled manual workers.	62	23.49%	2271	35.01%
5. Semi-skilled workers.	61	23.10%	1834	28.29%
6. Unskilled workers.	105	39.77%	857	13.21%

Chi squared = 62.7. Significant at the 0.1% level.

Table 17: Occupations of the economically active Irish and Non-Irish populations, Hull, 1851.
(Source: Census enumerators' books, 1851 census, 20% sample)

division and the majority of the remainder in low-skilled work.

The living conditions of the Irish were the other main feature which differentiated them from the rest of the urban population in Victorian England. Jackson (1963) suggests that the conditions the Irish experienced were "in greater or lesser degree those which were the common lot of a large majority of the working class of the country for much of the nineteenth century" (Jackson, 1963, p. 42). Contemporaries held the view that the Irish were responsible for the worst living conditions in Victorian towns. Engels, for example, writes that the Irishman:

> "Empties all their filth and garbage out of the front door, and thus causes filthy puddles and heaps of garbage to accumulate and so a whole district is rapidly polluted. The Irishmen have brought with them the habit of building pigsties immediately adjacent to their houses. If this is not possible, he allows the pig to share his own sleeping quarters. This new, abnormal method of rearing livestock in the large towns is entirely of Irish origin."
>
> (Henderson and Chaloner, 1958, p. 106)

Charles Booth's findings similarly suggest that the worst areas were those inhabited by the Irish. His description of Shelton Street, for example (Fried and Elman, 1971, p. 108-124), one of the streets in a London slum area, contains many allusions to the Irish origins of the inhabitants.

There does, certainly, seem to be a strong relationship between overcrowding and numbers of Irish immigrants. Richardson (1968) notes this association in Bradford, and data for the seventy-four areas used in the Hull study gives a correlation coefficient of

+ 0.498 between density of the population and the percentage born outside England and Wales (approximately 50 per cent of whom were of Irish birth). Dyos (1967), however, using enumerators' book data, quotes the example of Sultan Street, in a London district descending into a slum area, and notes that between 1871 and 1901 when this process was in action, the percentage of provincial and Irish born actually declined. This strongly suggests that the slums were mostly occupied by second or later generation Londoners, and that "the slums of Victorian London are more properly thought of as settlement tanks for submerged Londoners than as settlement areas for provincial immigrants to the city" (Dyos, 1967, p. 29-30). It is difficult to determine the exact relationship between Irish immigrants (or, for that matter, immigrants as a whole) and poor housing conditions, but the evidence to hand suggests that, with their lowly economic position, the Irish lived of necessity in some of the worst housing the nineteenth century city had to offer. The views of contempories that this was invariably the case and that the Irish were instrumental in degrading residential areas should, however, be treated with caution.

The Place of Migrants in a General Scheme of Social Differentiation

Clearly the Irish, as the most segregated population in the Victorian town, are the most easily recognised as a segregated group. Both occupational and residential data reflect this segregation, and contempories stress its importance. When considering segregation between other groups it is less easy to identify voluntary and

involuntary segregation, or to identify segregation when the data available is ambiguous. As Lieberson has pointed out, differences between an immigrant population and the native component are not necessarily due to deviations of the incoming population from the general social patterns of the city. He cites the example of parents' residence influencing the location of their childrens' residences after the latter reach the stage of establishing their own families. This would tend to maintain residential segregation in a population which in all other respects might be completely assimilated.(Lieberson, 1968, p. 11).

In Hull the example of the recently established fishing population poses a difficult question of segregation. Although this new immigrant group shows considerable concentration in the Old Town there is no noticable difference in socio-economic status between it and the host population. At the same time over 35 per cent of this population is engaged in the fishing industry. Similarly those born in Lancashire show quite a high degree of segregation on the basis of indices of residential dissimilarity (Table 16), and again show a concentration in a particular industry (40.9 per cent of the economically active being engaged in the textile industry against 6.7 per cent in the population as a whole), but no marked dissimilarity in socio-economic status is discernable. It is open to doubt if such a concentration in a particular industry is legitimate evidence of lack of integration into the host community. Other factors are involved, including considerations of journey to work and housing supply, and the fact that immigrant groups are likely to

come to a town with certain specialized skills in common. It seems reasonable to assume, however, that residential segregation in an otherwise assimilated new immigrant population is partly due to the ease of adjustment which residential proximity to old acquaintances and people in the same circumstances promotes, and the high indices of residential dissimilarity for the Lancashire-born almost certainly reflects this. Festinger, Schachter and Back (1950) have illustrated the importance of residential proximity in friendship formation, and this relationship also holds good for friendship retention.

The case of the Irish focuses attention on less tangible aspects of the desire to be segregated from a population. The Englishman's prejudiced opinion of the Irishman attributed him with a notoriety he did not deserve, and it might reasonably be expected that similar value-judgments were made about other immigrants. An immigrant from a rural area would face problems of adjustment to a new type of economic system, and probably feel himself looked down upon for him lack of expertise in dealing with this system. Regional accents in nineteenth century England would also pose problems of adjustment, and add to the prejudice against a new immigrant. Residential segregation certainly existed in the nineteenth century between groups which apparantly have no other dissimilarities of any magnitude, and the fact that this segregation occurred was an important feature of social life. In Hull, however, the only group which can be readily identified as a segregated population are the Irish and, on available evidence, Irish segregation seems to be the only major contribution to the overall pattern of urban differentiation made

by immigrant groups to the town at this time.

The nineteenth century certainly draws attention to the similarities to be found in cities at parallel stages of industrial development, but also stresses the importance of the specific time and place in studies of residential differentiation. Using Timms' model of differentiation in the industrializing city as a base, it is possible to suggest a model which more specifically reflects the conditions of nineteenth century Britain (Table 18). The model's basic assumption is that the nineteenth century British city was in a transitional stage from a pre-industrial form of organisation to an industrial one. Abu-Lughod (1969a) and Timms (1971) identify five major societal changes which determine the degree to which this transition has been affected. Increasing freedom of marriage choice and style of life from social rank leads to the crystallization of social rank and family status as separate dimensions of differentiation. Changes in the distribution of social rewards, advances in medical knowledge, and changes in the structure of production and the role of women also tend to loosen these links between social rank and family characteristics. Finally the development of a preference for independent family units also lends support to this development. These factors have all been considered in the revision of Timms' model for the specific nineteenth century situation.

Social rank, which in the nineteenth century shows a greater polarity of individuals at either end of the social scale than in modern industrial societies, is almost certainly the strongest line of demarcation in the nineteenth century context. Goheen (1970)

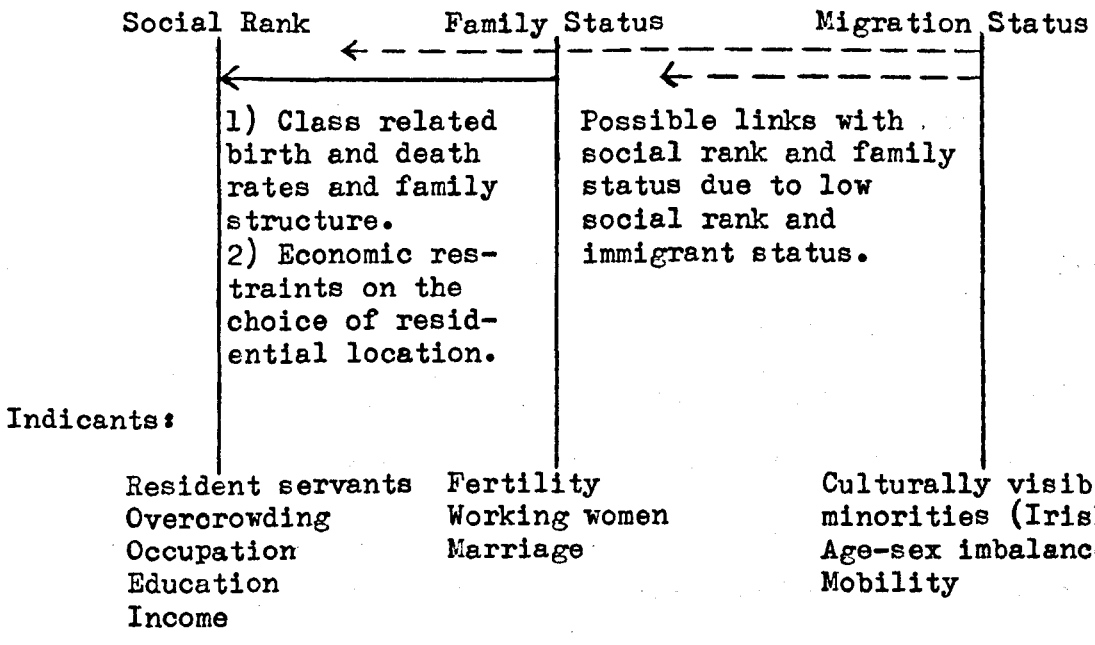

Table 18: Major lines of social differentiation in the nineteenth century British city.

has shown that in mid nineteenth century Toronto the basic social rank division was largely in economic terms, and that differentiation was most clear at the extremes of wealth and poverty. Between these two extremes the social boundaries were much less clearly perceived than later in the century. Certainly in nineteenth century Britain a polarity of social rank would be expected, although it is not yet clear whether the division would be based purely on wealth or include considerations of relationship to the means of production. This polarity and the social division which it implies would be sufficient to place social rank in first position in the model, but it is also maintained here by the dependence of other lines of differentiation on the socio-economic aspects of social rank. In the nineteenth

century this link tends to be based on economic criteria, in particular the differing birth and death rates associated with socio-economic groups, the differing household structure between these groups, and economic restraints on working class families limiting their choice of residential location.

The exact position of ethnic status and migrant status is less clear. On the relatively broad scale which studies of urban differentiation assume, however, it seems that status as an immigrant from Ireland should be easily identifiable as a basis for social distinctiveness. Immigrants from within England and Wales were much less segregated compared to the Irish, and although there was some segregation, it was at a purely residential level rather than the socio-economic and status level which Irish segregation assumed. In many ways the segregation of the Irish reflects both their ethnic status and migrant status, and in these roles might be expected to have links with social rank and family status respectively.

There seems little reason to doubt that the indicants of these three bases of social differentiation will be more or less the same in the nineteenth century as the twentieth. Contemporaries suggest, however, that social rank might be reflected by indices other than occupational groupings. In particular Booth's social rank classification used in the "Industry Series" based on overcrowding and number of servants (Industry Series, I, p. 10), and the importance attached by Rowntree to the family life-cycle as an indication of poverty (Rowntree, 1901), suggest that measures based on these criteria may be more apt indicators for the nineteenth century.

The groups involved in segregation according to migrant and ethnic status will obviously vary greatly with time and place, and in the present context Irish immigrants seem to be the strongest indicator of migration status. Even in other nineteenth century British towns, however, different or additional groups might be important.

The probability that somewhat different indices will be relevant in the nineteenth century context of urban differentiation draws attention to the tentative (because untested) nature of the model. Working backwards from the Shevky-Bell model of differentiation in the modern city Timms assumes that the same features used to construct these indices for modern cities will be relevant for other societies, but it appears that this may not necessarily be the case. This deductive model stretches the available evidence of nineteenth century social structure to the limits of its credibility, but in the process the model has generated a number of interesting hypotheses about the nature of this structure. In trying to prove or disprove these hypotheses it is necessary to turn to other nineteenth century material and other methods of study. By far the most wide-ranging and comprehensive coverage of social data for the period is to be found in the census enumerators' books - transcriptions of the original householders schedules used in compiling the printed census returns. These records lend themselves to analysis along the lines of modern census data, by factor analysis or principal components analysis, and the results obtained possess their own valid validity for or against the projected model of nineteenth century society. Patterns of social differentiation in pre-modern societies

are still only very generally understood, and the use of this approach is therefore a valuable one.

Data and Method

Chapter Six

The Use of Census Data and the Case of the 1851 Census

Modern studies of urban differentiation have, in the main, utilized data collected by government census bureaux and made available to researchers in the form of data sets for small areal units within urban areas. Since 1910 the United States Bureau of Census has made available such data for "Census tracts", urban sub-divisions bearing some resemblance to the urban ecologists' concept of the natural area (Schmid, 1938). Census tracts were originally delimited for eight major urban areas, which number has grown with each successive census, with tracts being defined for 180 urban areas in 1960. The average tract contains about four thousand people, and the boundaries are laid out "with attention to achieving some uniformity of population characteristics, economic status and living conditions" (Robson, 1969, p. 42). Small area data for British censuses first became generally available in 1961, although there are isolated cases of data being made available prior to this (Jones, 1960).

In the nineteenth century the smallest areal units for which census data is readily available are quite inadequate for any detailed work on social differentiation. For the censuses from 1841 to 1871, however, the Registrar General has made available the enumerators' original copies of the census schedules, which give data for individuals arranged in enumeration districts - the original units of data collection. The 1851 enumerators' books are in many ways the most satisfactory of these, partly because it was the earliest

census to ask detailed questions on such topics ~~and~~ age and birthplace, and partly because the physical condition of the 1851 records is particularly good. In the past this data has been neglected to a large extent, but is capable of being used in research in much the same way as modern census material.

Census data has obvious limitations in terms of content and availability, but economies of both time and money necessitate this use of data not specifically collected for urban research. For nineteenth century Britain, of course, there is no alternative but to use second-hand data, and the census forms the most comprehensive source of social and economic data comparable with that used in modern studies of urban differentiation. It is important, however, to carefully judge the value of the data being used, and to bear in mind that the form and content of this data sets quite stringent limitations on the type of research to which it can be applied. Robson (1969) has written that:

> "Given the size and given the intricate system of inter-dependent elements which the city represents, it is obvious that the type, the detail and the accuracy of the material which is used to describe the city largely condition the ideas and the theories which must emerge from any empirical approach to analysis."
>
> (Robson, 1969, p. 39)

The use of mid nineteenth century censuses presents a special case of utilizing data prepared for a purpose other than urban research, and it is pertinent here to assess the value of the 1851 census data and detail the methods used to bring the enumeration book material into a form capable of analysis by multivariate techniques.

The Scope and Machinery of the 1851 Census[1]

Nineteenth century censuses, from 1851 onwards, mark a considerable departure from those earlier censuses where the machinery of data collection was less efficient and the questions asked severely limited. In 1851 in particular the scope of the enquiry was greatly extended. The separate householders schedule, which had been introduced in the previous census, was retained, and details of name, sex, and profession were required as before. The birthplace question was extended from the requirement introduced in 1841 to state whether born in the same county or whether born in Scotland, Ireland or Foreign Parts, to that of giving the county and town or parish if born in England, and the country and nationality if born elsewhere. The census authorities also required, for the first time, a statement of relationship to the head of the household, marital condition, and age at last birthday (in previous censuses age had only been required, if at all, to the nearest quinquennial age group). In addition two important enquiries into religion and education were made in association with the 1851 census. These were carried out on a voluntary basis, as objections were raised to the penalties which were proposed for persons with-holding this information. Despite this the returns were completed for the most part, and there seems no reason to doubt the validity of the data collected. In both cases forms were left with the head of the institution in question, and similar information regarding, amongst other things, the type of establishment, date of

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1. For a detailed summary of the various census enumerations between 1801 and 1931 see the Interdepartmental Committee on Social and Economic Research, 1951, from which much of this general information is taken. Also of use in this respect is Taylor, 1951, and Tillott, 1972. For 1851 in particular Cheshire, 1854, is of interest, and the census 1851 "Forms and Instructions....", and the introductions to Census 1851, I, Vol 1 and II, Vol 2 are of great value.

foundation, number of persons attending and financial aspects of the undertaking were required.

The 1851 census also made innovations in another important field - that of the boundaries used in dividing the country into areas suitable for enumeration and analysis. The census authorities commented on the difficulty of summing the information collected for a number of different types of area, and considerably simplified the process by using the 624 registration districts established under the 1836 "Act for the Registration of Births, Marriages and Deaths in England" as the largest level of organisation below the national one (Freeman, 1968). The boundaries of the districts correspond in the majority of cases with those of the Poor Law Unions. These districts were grouped to form "registration counties" whose boundaries seldom coincide with those of the administrative counties, although some provision was made for comparison with earlier censuses based on the latter. Each registration district was further divided into sub-districts, and it was on the basis of registration counties, districts or sub-districts that the majority of the information was published, although data was also published for the major towns.

As in 1841 it was the responsibility of the registrar in charge of a registration district both to appoint the enumerators and define enumeration districts under the guiding lines circulated by the authorities in London. These districts were to be of a size that the enumerator could comfortably deal with in a day, and the registrar was asked in particular to:

"Bear in mind that the population of Parishes or townships,

> Ecclesiastical Districts, and Parliamentary or incorporate boroughs is hereafter to be separately obtained from the Enumerators Returns; and that therefore it is of the utmost consequence that Enumeration Districts should be so constructed as to correspond, as far as possible, with the boundaries of such divisions."
>
> (Census 1851, Forms and Instructions...., p. 3)

In towns and cities the enumeration districts were to correspond with wards or other sub-divisions where these existed. Detached parts of parishes were included in the parish they were located in (Census 1851, Forms and Instructions....). Although these regulations do seem to have been followed in the main, some slight readjustments and realignments of boundaries have come to light in the present study. One major problem inherent in the division of areas into registration sub-districts and enumeration districts is that of contiguity. In the majority of cases the areas defined by the registrar as enumeration districts were contiguous, but in the case of Hull many inconsistencies occur in North and South Myton sub-districts which detract from the enumeration districts as suitable units for areal analysis.

Hull itself falls into two registration districts. Hull district (Number 520) includes the core of the "Old Town" bounded by Humber Dock, Prince's Dock, Queen's Dock and the rivers Hull and Humber (Humber and St. Mary's wards), and the area to the west of the Humber and Princes's Docks and the south of Prospect Street and Spring Bank to the borough boundary (North and South Myton wards). The remainder of the Borough forms part of Sculcoates District (Number 519), and of this Drypool, East Sculcoates, West Sculcoates and part of Sutton

	Hull Borough	2 Districts	7 sub-Districts	16 Parishes
Population	X	X	X	X
Males and females	X	X	X	X
Houses inhabited, uninhabited and building.	X	X	X	X
Ages of males and females in quinquennial periods.	X	X		
Civil condition	X	X		
Occupations of males and females over 20.		X		
Occupations of males and females over and under 20.	X			
Birth by county	X	X		
Blind, deaf and dumb.		X		
Inmates of workhouses, etc.		X		

Table 19: Published data for Hull, 1851 Census.

sub-district fall within the borough boundary (Figure 7), In all Hull was covered in 110 enumeration districts, and a selection of data published for the Borough, Hull and Soulcoates registration districts, sub-districts and parishes (Table 19).

The householders schedule itself consisted of eight columns headed respectively name and surname; relation to head of family; condition; sex; age last birthday; rank, profession or occupation; where born; and whether blind, deaf or dumb. On the reverse instructions were given regarding the proper method of filling in the form, including examples of this and detailed information regarding the completion of the occupation column. The address of the householder was also included here[1]. The enumerators' instructions

1. For a facsimile of the form used see Interdepartmental Committee on Social and Economic Research, 1951.

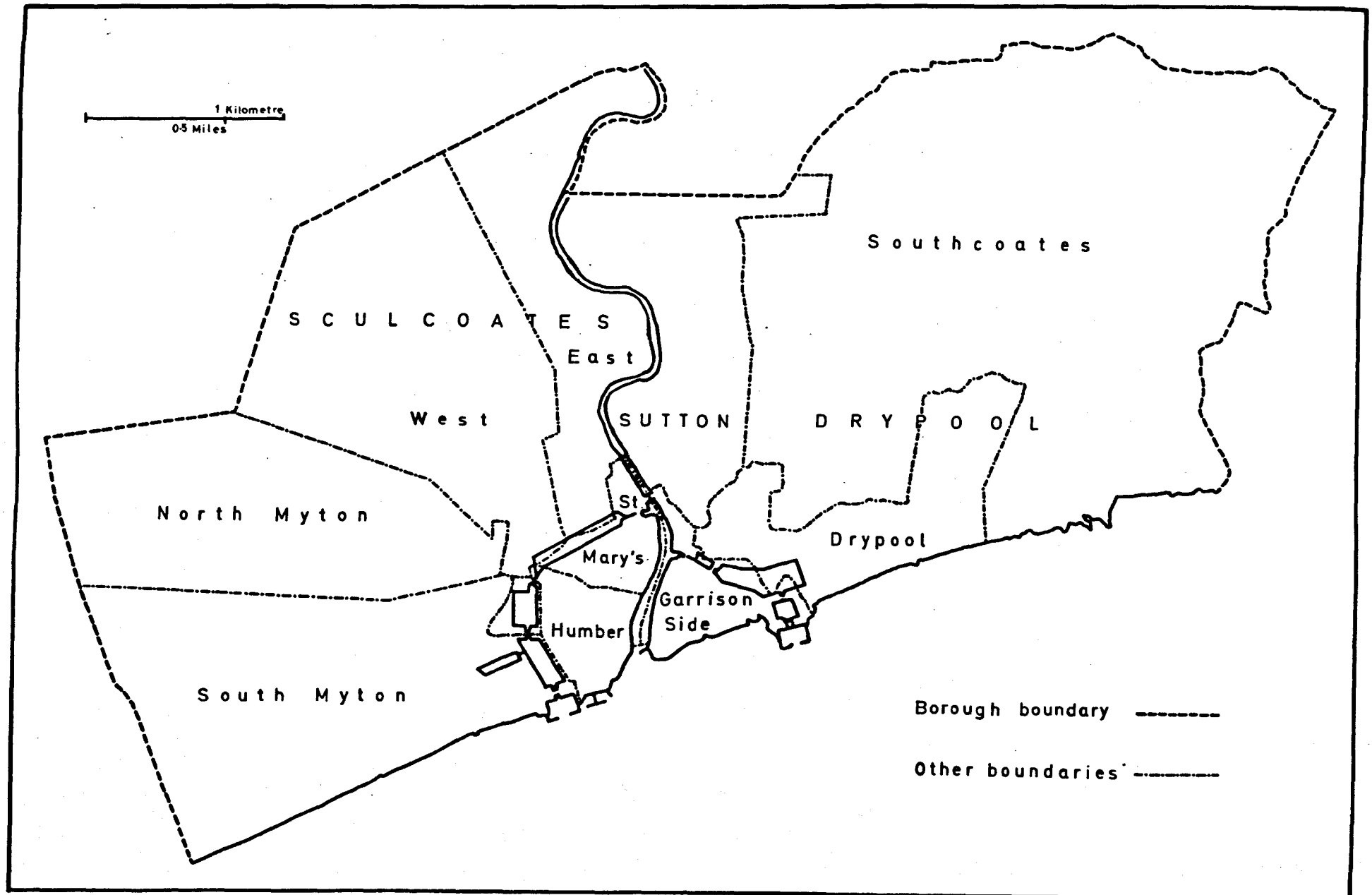

Figure 7: Administrative divisions within Hull, 1851.

were at least as complicated as those given to the registrars. They were instructed to inquire:

> "At every house....whether the same is inhabited by one occupier only, or by more than one; and if the latter be the case, he must leave a separate schedule with each occupier:- understanding by 'occupier' either the resident owner or any person who pays rent, whether (as a tenant) for the whole house or (as a lodger) for any distinct floor or apartment."
>
> (Census 1851, Forms and Instructions...., p. 33)

Where the household exceeded 15 in number, a double schedule or two schedules were to be left. Arrangements were also made for the delivery of the separate forms relating to education and public worship. On collecting a schedule the enumerator was required to read it through to see if all the particulars were correctly entered, paying particular attention to the occupation column, and fill in the location of the household on the reverse. Should the returned form be uncompleted the enumerator was to ask the questions and fill in the answers, the informant being then asked to endorse the information by signing the form.

Having collected all the schedules the enumerator transcribed these into his schedule book. The particulars and description of the enumeration district were entered first, and all the returns relating to one administrative district (parish, township, hamlet, ward) were to be entered together. On prepared pages the number and street in which the dwelling was situated was entered in the first two columns, followed by the information contained in the householders schedule with some standardisation of terms being introduced and the replacement of the separate sex and age columns by two columns

headed "ages of males" and "ages of females" respectively (Figure,8). The transcript of each household schedule was separated from the following household by a ruled line running the length of the first four columns in the case of a household in a different house (defined as "all space within the external and party walls of a building"), or a line running from a little to the left hand side of the third column as far as the fifth column to separate two households living in the same house. All the schedules for one house were recorded together. The original returns were eventually destroyed, leaving the enumerators' books as the only extant record of this data.

There must, obviously, have been some errors introduced during transcription. Tillott (1972) gives a detailed description of the data collection process, and the several stages at which the material might be subject to amendment and alteration. The simplicity, however, of recording such information as marital condition and relationship to the head of household, and the variety still to be found in the occupation and birthplace columns, would suggest that for the most part the information was copied with very few alterations. The basic data even before transcription must have contained some degree of error, but it is difficult to estimate this. Several researchers have worked on errors of age in censuses. Dunlop, for example, working on the 1911 census data, has shown that the statement of the ages of young children is often suspect, and in particular that infants under one year were often enumerated as having reached that age, despite the request to give the ages of such children in months (Dunlop, 1916). Other errors of a similar

2

Parish ~~or Township~~ of Holy Trinity	~~Ecclesiastical District of~~	~~City or~~ Borough of Kingston upon Hull	~~Town of~~	Village of

No. of Householder's Schedule	Name of Street, Place, or Road, and Name or No. of House	Name and Surname of each Person who abode in the house, on the Night of the 30th March, 1851	Relation to Head of Family	Condition	Age of Males	Age of Females	Rank, Profession, or Occupation	Where Born	Whether Blind, or Deaf-and-Dumb
4	53 Humber Street	John Meadley	Head	Mar	48		Tailor Draper	Lancashire Liverpool	
		Mary do	Wife	do		50		Musterton Yorkshire	
		Ann do	Daur	U		20	Dressmaker	Yorkshire Hull	
		John do	Son	do	15		Tailor	do do	
		William do	Son	do	13		Scholar	do do	
		Joseph do	Uncle	Mar	50		Waiter	do do	
5	54 Humber Street	William Bradley	Head	Mar	42		Medical Practitioner	Lancashire Garston	
		Jane do	Wife	do		40	~~Medical Practitioner~~	Yorkshire Rawcliffe	
		Thomas do	Son	U	2		Scholar	do do	
		John S. do	do	U	2			St Oswego New York	
6	55 Humber Street	Charles Wren	Head	Mar	33		Master Baker	Surrey Tooting	
		Susanah do	Wife	do		38		Lincolnshire Kirton	
		Mary Ann do	Daur	U		9	Scholar	Surrey Wandsworth	
		Charles do	Son	U	4			do Clapham	
7	56 Humber Street	William Sidden	Head	Mar	47		Master Mariner	Kent Cliffe	
		Matilda do	Wife	do		47		Yorkshire Hull	
Total of Houses I 3 U B				Total of Persons	10	6			

3 B—Eng

Figure 8: 1851 Census – A page from the enumerators' books.

nature are discussed in the report to the census of 1901 (Census 1901, Preliminary Report), and the 1851 census authorities recognised a tendency to round figures to the nearest '0', due to problems of recall and illiteracy, and suspected a disproportionate number of women as giving their age as between 20 and 25 and fewer than expected between 30 and 35 (Census 1851, II, Vol 1, p. xxxiii-xxiv).

An anonymous article in Household Words (1854) doubts the validity of the occupation data, pointing out, amongst other details, that:

> "There were only three ballad-singers and sellers. This must surely be an understatement. We can hear four bawling lustily in the street as we write."
>
> (Household Words, 1854, p. 228)

Dyos and Baker (1968) suggest that the description of occupation in some instances may be designed to inflate the individual's status in the eyes of the enumerator. Errors in the description of occupations certainly did occur, but there is no way of checking this. The small space allowed for occupation on the census form produced in most instances a single word answer, and there must be errors caused by this need for conciseness. In most cases, however, there seems no reason to doubt the description, although a fuller one would have been of greater value. There are probably also some errors with regard to birthplace, but one would imagine the degree of error to be quite small, especially after the passing of the "Births, marriages and deaths Act" in 1836 which, by compelling the registration of births, would work in favour of knowledge and accuracy of birthplace. The description of relationship to the head of the household may also have been misinterpreted in some cases. Dyos and Baker (1968), for

example, suggest that many step-children were probably described as children of the household head. As with many of these problems of accuracy, however, care can be taken in interpreting the returns to minimize their effect. In particular, when grouping data from enumeration books, it is possible to group with suspected errors in mind and thereby eliminate them to a large extent.

The printed census volumes are only abstracts of the enumerators' books, and the information they give is really inadequate for a detailed study of social differentiation. One of the reasons for this has already been mentioned: the lack of published data for small sub-divisions within urban areas (Table 19). To study residential differentiation it is really desirable to begin with a fine spatial coverage of information, and work towards an understanding of overall patterns by comparison and aggregation. In addition, by returning to the enumerators' books, it is possible to construct a wide variety of indices to test for validity as factors differentiating one residential area from another, which the printed census returns do not allow for. The published volumes, for example, give marital status and age for a particular area, but there is no way of knowing the data for such standard indices as a fertility ratio. Similarly the printed returns give no indication of household structure or shared accommodation although the enumerators books can furnish data on both these points. In addition new classifications can be introduced to replace, for example, the original classification of occupations based on type of industry and nature of the raw material. The publication of the 1851 census

results, in fact, left something to be desired, but a return to the enumeration book material more than makes up for the census authorities' shortcomings.

Data Extraction: Problems and Solutions

The extraction of data from the census enumerators' books is certainly not without its own problems, not least of which is the sheer mass of data to be dealt with. This creates difficulties both of extraction and analysis, and for large scale work using the data the problem has invariably been brought within more reasonable limits by the use of sampling techniques and punch card or computer analysis. Armstrong , in his study of York, used a ten per cent sampling fraction for a city of about 30,00 persons in 1841 and 40,000 in 1851, on the assumption that such a sample would contain 7 to 800 households and 3 to 4,000 persons (Armstrong, 1966). Dyos and Baker are using a ten per cent sample for 1851 and 1861 (with the number of households in the sample being 1,091 and 1,338 respectively), and a 1 in 50 sample for the years 1871 to 1901[1] (with the number of households increasing over the four censuses from 631 to 1,139, Dyos and Baker, 1968). For the present work a much denser areal spread of observations was required and it was decided to carry out a 20 per cent sample to give data on approximately 3,800 households and 17,000 individuals. This data would then be sufficient for the analysis of quite small sub-areas within the town, as well as being

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1. Dyos and Baker were given access to the material for these years with all means of personal identification obscured to preserve confidentiality.

more than adequate for any analysis which might be carried out on a broader scale.

In the work carried out by Armstrong, and again in Dyos and Baker's work, a systematic sample of households was taken as they appeared in the enumerators' books. This policy has been followed in the present study for several reasons, but primarily because a random sample based on householders schedules would have been difficult to construct and apply with precision. Systematic sampling offers an easier method of drawing a sample and is often more easily and accurately executed. The method also offers considerable savings in time against the high preparation and extraction time needed for random sampling, and is more likely to given an even spread of observations over the population which, for the present purpose, is preferable in order that the sample might accurately reflect areal distributions (Cochrane, 1963). The sample finally drawn by this method comprised 15,470 individuals and 3,739 households. The number of individuals was smaller than originally expected due to the exclusion of various institutional and other special populations during the extraction and analysis of the sample. With the aim of avoiding any bias in the results by retaining those populations whose residential decision was not a free one institutional populations[1] and persons on board ship in Hull at the time of the census

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1. The institutional populations extracted during sampling were as follows: Hull Workhouse, Sculcoates Workhouse, Trinity House Hospital, Hull Gaol, Hull Asylum, Hull Infirmary, Hull Citadel, Lister's Hospital, Trinity Almshouses, Trinity House, North Side Almhouses, Merchant Seamen's Almhouses, Ferries Hospital, Victoria Hospital, and Ellis's Hospital. Many of the smaller almshouses and hospitals were administered by Trinity House (Victoria County History, 1969).

were extracted, and also those 453 individuals described as "visitor" in the relationship to the head of household column, whose place of residence was clearly not their place of enumeration. The Victoria County History (1969) gives a list of Hull almshouses which was used to ascertain the exact nature of some of the institutions before excluding them from the sample.

In the present study, as in Armstrong's and Dyos and Baker's work, the household has been taken as the basic unit of extraction. This has obvious advantages over the individual as the household is the most important economic unit within the data, and also allows for some appreciation of household structure during analysis. In common with Dyos and Baker (1968) a household has been taken as being represented by the householders schedule, and commences with the first person described as "head" of a household. In some cases the first person in a household may be listed as "wife" and a return of "husband away" in the occupation column, but the person who has the status of head of the household is usually easily identified on the basis of the numbering of the household schedules and the practice of ruling off between each household at a given address. The latter practice was not always followed consistently, but the division between households can usually be discerned without difficulty. Armstrong took the first person at a given address to be the head of the household, and treated all other residents not described as relatives, servants or visitors as lodgers (Armstrong, 1967), but this seems to be reading too much into the returns. Assuming that the first person listed collects rent from the others would affect,

amongst other things, the count of lodgers and the status of the households in question. In this study the household has been taken as a clearly recognisable unit in the enumerators' books, which we know to have a high degree of economic interdependance, whereas a count based on Armstrong's assumptions would introduce a major element of uncertainty into the definition.

In recording the schedule book data for analysis several rules have had to be adopted to ensure that a standard method was used throughout. Step-children, for example, have been included with the head's children, mainly because there were probably many more of them than are recorded as such, and many parents must have listed them simply as children of the head (Dyos and Baker, 1968). Lodgers present a difficult case of classification in their own right. It has already been explained that it was not thought sufficient evidence of lodger status that a household shared a dwelling with another household listed at the same address. The second problem, as Dyos and Baker pose it, is "when is a lodger not a lodger?". "Presumably", they continue, "the acid test is whether the occupant in question takes meals with a given household and pays for the accommodation provided. Naturally this cannot be discovered from the enumerators' books, and there is the probability that some lodgers will have been entered as heads and vice-versa" (Dyos and Baker, 1968, p. 102). As in Dyos and Baker's work, the entries have here been interpreted literally, and this probably leads to a slight under-estimate of their number, though far from sufficient to invalidate the data. Apprentices and shop assistants, often described as "servants" in the

relationship to head of the household column, have also been classed as lodgers in this study. Any members of a servant's family living within the servant's employer's household have also been given lodger status unless there was an indication that they were also acting as servants in the household. In most cases it is clear that any such children are too young to be working in this capacity, and an occupation is often given for older children which rules out this possibility. In all other cases relationship to the head of the household has been interpreted literally.

With regard to occupation and birthplace the opportunity has been taken to introduce some type of classification during the data extraction process. The Hull sample data gave some six hundred different descriptions of occupation, and therefore some degree of grouping is clearly necessary. The census authorities in 1851 relied on a classification of occupations into seventeen groups based on the type of industry and the nature of the raw material (Census 1851, II, Vol 1), but for the present purpose this would have failed to reflect any socio-economic status distinction between workers. It was decided to adopt a system of socio-economic groupings based on occupation and type of work as a basis for classification, but supplement this by a further coding giving the type of industry in which the individual was employed. For the latter - the industrial classification - Armstrong (1967) used six industrial groups, but found this general grouping too vague and of little value in understanding social structure. In a new classification (Armstrong, 1972) based on Charles Booth's allocations (Booth, 1886), he suggests

eleven major headings with sub-headings amounting to 83 groups in all. The latter has not been tested for use on this data, although it was designed for this type of work, but one can imagine that the application would be a very arduous task and the numbers involved in some of the groups quite small. Dyos and Baker (1968) used a twelve group classification, but in this study the "standard industrial classification" used in present day censuses and other statistical work has been adopted (Central Statistical Office, 1968a, 1968b). Some minor adjustments have been necessary. Several industrial groups not important or non-existent at the time have been re-allocated or removed. Some additional classes have been introduced to include domestic servants and those relying on private or other unearned income, and agriculture and fishing have been separated to form two groups (Table 20). The alterations have been determined to a large extent by Booth's classification (1886), and the above systems have also been taken into account. Bellamy (1952), in an attempt to compare occupational statistics in British censuses, also suggests an allocation based on similar criteria. The twenty three groups arrived at are designed to overcome the problem of too much or too little detail, while at the same time allowing some comparability with the published census returns.

More important for the present work, however, is the classification by socio-economic group, and the classification was designed on the assumption that occupation was an index of social status. In the past researchers working with enumeration book material have stressed this aspect of occupation, arguing that it implies an

Industrial Group		Individuals in sample
1	Extractive industries	
A	Agriculture, mining and quarrying	108
B	Fishing	57
		165
2	Production industries	
A	Food, drink and tobacco	251
B	Chemicals and allied trades	34
C	Metal manufacture and heavy engineering	192
D	Light engineering and other metal goods	82
E	Textiles	453
F	Leather, leather goods and furs	46
G	Clothing and footwear	788
H	Bricks, pottery and glass	33
I	Timber and furniture	385
J	Shipbuilding and marine engineering	108
K	Paper, printing and publishing	55
L	Other manufacturing industries	54
		2481
3	Service industries	
A	Construction	259
B	Transport and communication	852
C	Distributive trades	712
D	Insurance, banking and finance	15
E	Professional	215
F	Public administration and defence	93
G	Domestic service	1034
H	Other services, including gas, water etc.	240
I	Property owning and independant	248
		3668
4	Indefinite	
A	No industry stated or industry not relavant	9156

Table 20: Grouping of occupations from census enumerators' books according to type of industry.
(See appendix A for details of the allocation to groups)

economic stratification for which the more direct data of wage rates and standard of living is lacking for the middle years of the century (Armstrong, 1967, 1968). Runciman (1968) gives strong support to occupation as an index of social status:

> "The analysis of social atratification in terms of occupation is equally justifiable whether it is the causes or the consequences of the nature and distribution of occupations which are to be assessed. To explain the distribution of occupations is largely to explain the social inequalities found in industrial societies, and to explain its consequences is to explain how it is that these are modified or preserved. Occupations are the mechanism by which the influences of natural endowment, upbringing and education are translated into differences of wealth, power and prestige, and the most significant moves which the individual can make in all three dimensions will be by means of a change from one occupation to another."
>
> (Runciman, 1968, p. 55)

Although an indirect index, occupation has, therefore, been considered in this study as a very valuable one, and one which gives an easily comprehensible picture of an individual's social status.

Dyos and Baker (1968) have used an occupational classification based on twenty-one groups[1], many of which have found their way into the categories used in this study. Several alterations have been made with the assistance of a classification devised by Tillott (Tillott and Stevenson, 1970). The final socio-economic grouping of occupations gives 28 categories, with provision for further grouping

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1. Managerial: professional: subprofessional: submanagerial: petty entrepreneurial: clerical: Agricultural self-employed: agricultural labourer: skilled labourer: semi-skilled labourer: unskilled labourer: private income recipient: rentier income recipient: retired: annuitant: unemployed: domestic: scholar: apprentice: undeclared: small child.

into seven (Table 21). Armstrong (1967) grouped occupations into six categories, and Dyos and Baker (1968) suggest several alterations to this grouping. In this study the Armstrong system has been largely adopted, based on the Registrar General's social class groups, the one major departure being the provision of an additional category to distinguish between skilled manual and skilled non-manual workers. Although there has been some debate regarding the relavance of a twentieth century scheme of classification for the nineteenth, past work has certainly proved these groupings valid for occupations of the period, and without detailed information on the Victorian perception of social status there is really no alternative system available.

The occupations given in the census enumerators' books have been interpreted literally, although there are probably isolated cases of the occupational description not reflecting social status. Dyos and Baker (1968), for example, suggest that:

> "One head of a household may describe himself as a carpenter and joiner, live in one of the better parts of Camberwell, and keep a servant or two; another, identically described, may live in the worst of slums with a large family in one or two rooms. It is clear that the two do not belong to the same social class, though in order to be consistent we must take the entries in the census books at their face value and must therefore enter both as skilled 'labourers'."
>
> (Dyos and Baker, 1968, p. 103-104)

Armstrong (1967) used the General Register Office "Classification of occupations" for the 1951 census to group occupations, and in this study the classification from the 1966 census has been used

Occupational Group	Individuals in sample
1 Manufacturers, upper professionals, etc.	
A Professional	63
B Managerial, employing 25 persons or more	8
C Private income	17
D Property owners	101
	189
2 Lower professionals, small employers of labour	
A Sub-professional	142
B Sub-managerial: managers in industry employing less than 25 persons, and administrative and supervisory workers	149
C Agricultural self-employed and managers	12
D Shopkeepers, traders, service workers employing less than 25 persons, and innkeepers with servants	148
E Annuitants	133
	584
3 Skilled non-manual workers	
A Clerical and skilled non-manual workers	234
B Small shopkeepers without employees, innkeepers without servants, shop assistants etc.	552
	786
4 Skilled manual workers	
A Skilled agricultural and supervisory agricultural workers	1
B Skilled industrial craftsmen	272
C Other skilled craftsmen and service workers	1982
D Upper servants	78
	2333
5 Semi-skilled workers	
A Semi-skilled agricultural workers	94
B Mariners, fishermen, etc.	339
C Semi-skilled workers, including service workers	683
D General domestic servants	779
	1895
6 Unskilled workers	
A Labourers and unskilled workers	775
B Lower servants and service workers	187
	962
7 Residual occupations	
A Undeclared	596
B Retired	138
C Paupers, almswomen etc.	50
D Unemployed	5
E Housewives, domestic	2862
F Scholar	2317
G Children under 15 at home	2738
	8705

Table 21: Grouping of occupations from census enumerators' books according to socio-economic status.
(See appendix A for details of the allocation to groups)

(General Register Office,1966), together with nineteenth century studies, notably Booth (Industry Series), to check the status of many occupations. The exact status of occupations in the mid nineteenth century is still unclear, and it was thought best to rely as far as possible on a standard system of classification which, from Armstrong's study, can be seen to have relevance for this period. In addition to stating their occupation, those who employed labour were asked to state the number of their employees, and this information has also been used to help group individuals. Notably, small employers of labour have been grouped in the second large occupational group, and large employers in the first. Although there is doubt as to the completeness of this data (Census 1851, II, Vol 1, p. xxviii) it was thought wise to make use of the information where provided. In many cases the description of occupation is such that the number of employees does not alter the allocation to a particular group.

The birthplace data presents a difficult problem of classification, and as in previous studies the data was extracted by county of birth excepting, in this case, the need for a more detailed description than "Yorkshire" and "Lincolnshire". In Armstrong's study birthplaces within the United Kingdom were grouped to form seven geographic areas - York, East and North Ridings, West Riding, Northern Counties, Rest of England and Wales, Scotland and Ireland (Armstrong, 1967). Dyos and Baker (1968) use thirty-six possible birthplace codes, most of which are areas of London and the Home Counties. In the present study a grouping was originally devised

which reflected that of Armstrong to a large degree, based on numbers of people involved (from the published census returns), proximity, and the migration characteristics of the birthplace county itself (Friedlander and Roshier, 1965). On preliminary analysis of the data, however, there seemed no rational reason for maintaining this grouping. The nature of the area of birth was not clearly reflected in the characteristics of migrants from these areas, and with this there seemed no reason for maintaining the groups. Of the original seven categories - Hull, The East Riding of Yorkshire and Lindsey in Lincolnshire,[1] Northern Industrial counties, Northern agricultural counties, the remainder of England and Wales, and Outside England and Wales - only the first two and the last group have been retained. The method of coding allowed for the extraction of the majority of birthplaces by county rather than group, and this facility was used to check the validity of the original grouping but did not suggest any more logical scheme of classification.

With the three classification systems and the other rules defined for dealing with the data, it was possible to code information from the enumerators' books directly onto coding sheets ready for transfer to punch cards. Armstrong (1966) and Dyos and Baker (1968) both use one data record for each household, which in Armstrong's work takes up eighty columns of a computer card and in the Camberwell study five standard cards (400 columns). The requirements of

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1. This grouping necessitated allocating county birthplaces to Ridings in Yorkshire and to the Parts of Lincolnshire. Contemporary directories were used to achieve this, in particular White's Lincolnshire (White, 1856) and Baines's Yorkshire (Baines, 1822), and the census "Index of places...." (Census 1851, I, Vol 2).

the present study would have necessitated records approaching the length of those used in Camberwell, and it was decided to record the data by individual rather than by household. This avoids problems of grouping and summing data which would have occurred had the household been used as the basic data record, and is most appropriate for the form of data output required. Coding resulted in the data for each individual occupying 22 columns of a single computer card (Table 22).

Analysis of the data has been carried out on the ICL 1905E computer at the University of Hull. In view of the type of data extracted from the census books and the form of output information required it was decided to use an ICL package, namely the Survey Analysis package XDSB, to analyse the material. The package has considerable advantages for a study of this kind as it is sufficiently flexible to allow for a minimum of data coding at the input stage

Column	1 punch card
1 to 6	Household code - area
7 to 8	Household code - number of house in area
9 to 10	Number of person in household
11	Relation to head of household
12	Marital condition
13	Sex
14 to 15	Age
16 to 17	Occupation - Socio-economic classification
18 to 19	Occupation - Industry classification
20 to 21	Birthplace
22	Single or multiple occupation of dwelling

Table 22: Coding of enumeration book data for computer analysis

and a great deal of data grouping during tabulation. It has therefore been possible to tabulate different groupings of the data and select the most valuable, whereas a less flexible survey analysis package would have been more restrictive in this respect. The package also allows for a certain amount of data transformation by addition, subtraction, multiplication and division, and this facility has also been used in analysing the enumeration book data.

Small Areas and Spatial Analysis

The problem of obtaining data for suitable sub-areas within towns has been a very serious one for studies of social differentiation. In preparing the Hull data for analysis the original enumeration districts might have been used as the basic small areal units of the study but in this case, however, these units were far from satisfactory because of their lack of contiguity and varying population size. The problem of areas not being contiguous would have necessitated at least a regrouping of parts of districts to to give contiguous units, and population size, ranging from 195 to 1,740, would also have forced regrouping of as many as 25 per cent of the areas to form larger units. To overcome these problems new sub-areas have been defined on a grid square basis, which have a much tighter range of values, and have the additional advantage of contiguity. Only three areas have sample populations of below 150, and it has not been necessary to omit any of these areas from the analysis (Table 23). The use of grid squares also adds to the value of the results in that they can be compared more easily with other

	Mean	lowest value	L.Q.	median	U.Q.	highest value
Enumeration districts (110) (Full coverage)	747	195	574	737	855	1740
Grid units (74) (20% sample coverage)	209	104	178	206	242	293

Table 23: Enumeration districts and grid units: comparative population size, Hull, 1851.

research (Forster's work, for example, on house-types in Hull using a grid square basis - Forster, 1969, 1972).

The task of allocating addresses from the enumerators' books to grid squares would have been impossible without adequate contemporary maps, and Hull is fortunate in that a survey of the town on a scale of 1 to 1,056 (5 ft. to one mile) was carried out during the years 1852 and 1853 and subsequently published by the Ordnance Survey. The built up area of Hull is covered in 16 sheets, and only 30 addresses in the sample were found to be outside this area. A pattern of grid squares based on the national grid was thrown over these maps and each household given a unique code relating to its position on the grid. Local directories were used to achieve this, notably White's directory of 1851 which, in addition to listing the inhabitants of each street, with the number of each house, also gives the location of streets relative to their intersection with other streets by house number.

The basic grid used was a 200 metre one but, as the population in these squares ranged from 1 to 723, it was necessary to group some

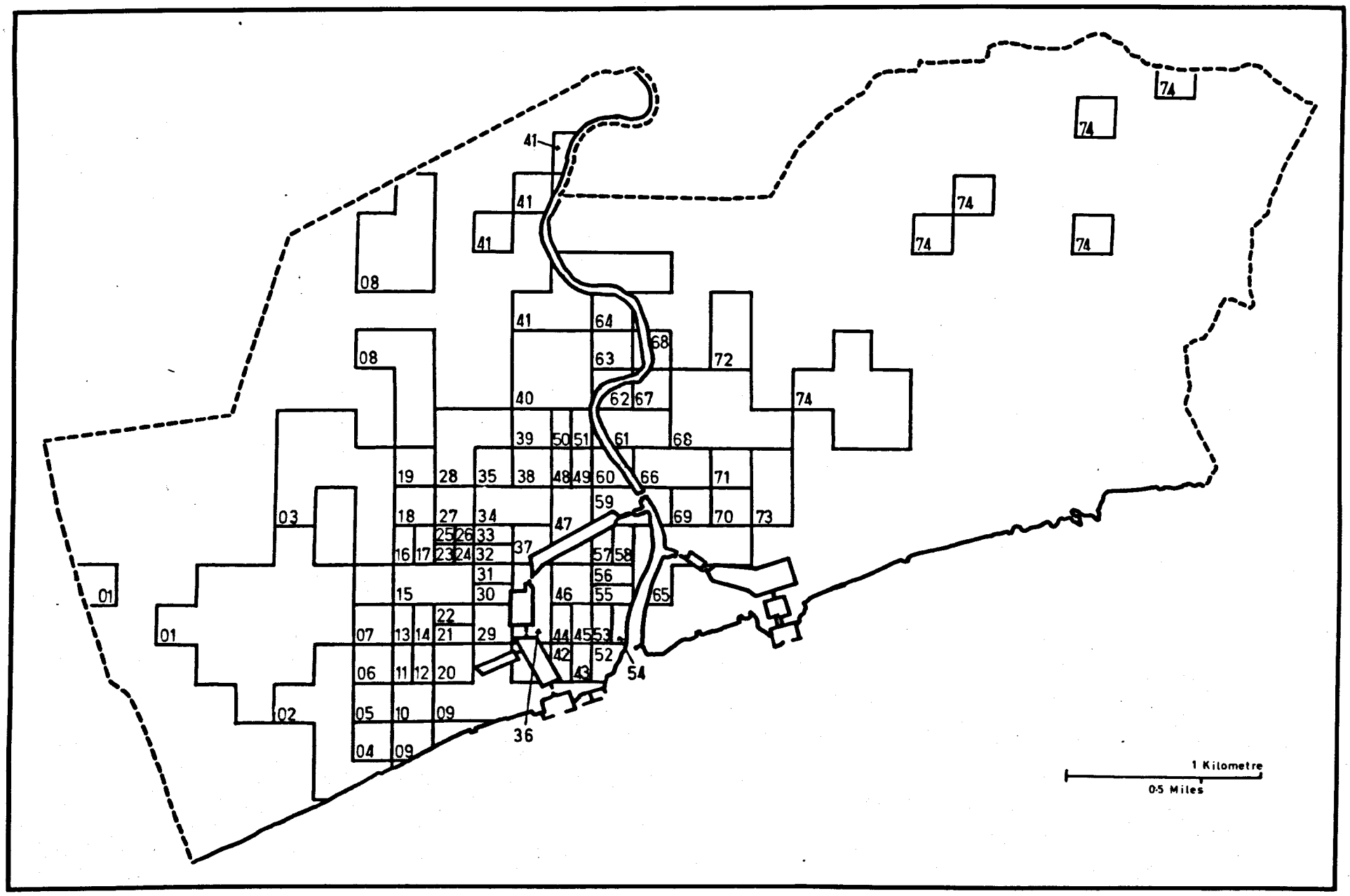

Figure 9: Areas defined on a grid-square basis, Hull, 1851.

and divide others in order to even out the range of populations. Provisions were made during the coding process to divide 200 metre squares into four 100 metre squares, and a total of 13 squares were divided into areas of two 100 metre squares, and another square divided into four 100 metre grid squares. Other squares with populations of less than 150 were grouped together on the basis of proximity and population size. It was decided to avoid grouping these areas with the nearest squares regardless of size in order not to mask the low population densities which these small populations reflect. Eventually a division into 74 areas ranging in area from 1 hectare to 59.59 hectares was decided upon, which effectively overcomes the drawbacks of the original enumeration districts (Figure 9).

Reliance on the census as a source of data for urban social research has, in the past, placed severe limitations on the spatial aspects of this work. The researcher has been restricted to the smallest units for which census authorities have been willing to make information available. In the United States this has been the census tract which, on average, has a population of some 4000 individuals. In Britain, after a brief flirtation with the idea of tracts (Oxford Census Tract Committee, 1957), the census office decided to make data available for enumeration districts whenever it was especially asked for. These areas, used as the basic unit of data collection, usually have a population of less than 1000 individuals. Research carried out in the United States (Form et. al., 1954) and Britain tends to suggest that the smaller area is

preferable, and gains over the census tract on the basis of homogeneity and flexibility (Robson, 1969). The question of homogeneity within these small areas has frequently been put forward in attempts to draw attention to the limitations of such data. It has been argued that in delimiting these areas there should be an attempt to minimize internal variance and maximize variance between areas. Heterogeneity may, of course, be a characteristic of an area and Timms (1971) has argued that:

> "The existence of differences within a census tract or any other small area is only prejudicial to the use of the area in ecological analysis if the differences relate to the proportions of the population possessing specific traits in major divisions of the area."
>
> (Timms, 1971, p. 42)

Clearly, however, if the units are small enough the information will effectively reflect the desired degree of minimization of internal variance and maximization of between area variance. The grid areas used in this study, by their size, should have the effect of minimizing internal variance to a degree consistent with maintaining the validity of the sample census data.

Chapter Seven

Multivariate Techniques in the Study of Urban Differentiation

Data and technique must be at the root of any attempt to analyse the nature of social differentiation in urban areas, and this is particularly so now that the social sciences have turned to a greater reliance on statistics and mathematical techniques in the search for explanation. The nature and validity of data is obviously of prime importance, and the techniques applied have a direct bearing on the theories which are likely to emerge from research. Although technique can never be a substitute for theory, certain techniques are clearly more likely to lead to support for theory than others, and will tend to generate more positive theoretical statements.

The urban population is differentiated in terms of many varied characteristics. Timms (1971) writes that;

> "The social worlds of the city may be distinguished by the occupations, incomes, levels of education, political preferences, types of social participation, and housing characteristics of their populations. They may also be differentiated in terms of age and sex distributions, fertility rates, rates of marriage, separation, divorce and widowhood, size of family, kinship activities, and in the proportions of their women employed outside the home. On top of this, yet further differentiation may be made in terms of birthplace and ethnic identity, mobility, religion, and of a wide variety of other indicants relating to characteristics of the population and the frequency of various types of desirable or undesirable behaviour."
>
> (Timms, 1971, p. 84)

In view of the complexity of urban social differentiation and the number of possible lines of demarcation within urban populations, it is understandable that urban sociologists and others with interests in the urban social scene should have turned to multivariate analysis techniques as a means of study. This is a logical and inevitable development in the analysis of such data, and such methods are becoming increasingly used in many different fields of research.

The different methods of multivariate analysis, of which principal components analysis and factor analysis are the two most frequently applied in urban research, have according to Kendall (1957) two main features in common. Firstly the concern is with a set of individuals each of which bears values on n different variables. The multivariate character of the problem lies in the multiplicity of the n variables rather than in the size of the set of individuals. Secondly the variables cannot be split from the others and considered by themselves - they are dependent amongst themselves. Principal components and factor analysis are concerned with this relationship of a set of variables among themselves, and produce mathematical constructs, based on the original variables, which explain as much as possible of the variation within the original set of variables. In this way the methods reduce the dimensions of a set of variables by summarizing the majority of the variation in a smaller number of constructs, at the same time identifying the fundamental relationships within the set. Both these methods can be summarized, in fact, as revealing the groups of closely related variables contained within the data, and conveying all the essential information of the original set

of variables. Thus, "the chief aim is to achieve scientific parsimony or economy of description" (Harman, 1967).

Factor Analysis and Principal Components Analysis

Although in many respects similar, factor analysis and principal components analysis are distinctly different methods of dealing with a complex of variables. Cattell (1965) points out that:

> "....much confusion and disputation confounding means with aims would be avoided if the mathematical purpose of component analysis were semantically distinguished from the experimental aim of factor analysis."
>
> (Cattell, 1965, p. 411)

Kendall (1957) also emphasises this distinction, writing that:

> "In components analysis we begin with observations and look for the components in the hope that we may be able to reduce the dimensions of variation and also that our components may, in some cases, be given a physical meaning. In factor analysis we work the other way round; that is to say, we begin with a model and require to see whether it agrees with the data and, if so, to estimate its parameters."
>
> (Kendall, 1957, p. 37)

This difference amounts to working with theory (in the case of factor analysis) and working without theory (in principal components analysis - Harvey, 1969, p.343). In fact, as Kendall later suggests, this distinction is often blurred in practice because, at different stages in the development of a problem, both these processes are likely to be operative (Kendall, 1957).

In several respects, however, this distinction between the two

methods is a mistaken one. Factor analysis is a mathematical procedure which requires less prior theory in its application than statements like the above would suggest. Harman (1967), in what has fast become one of the standard texts on the method, identifies ten major forms of factor analysis. Of these different methods nine require either prior estimates of communality (the degree of variance of each variable in common with other variables) or of the number of common factors, and only one of the methods requires prior estimates of both these measures. Principal components analysis is alone in not requiring estimates of either. The degree of prior theory needed to apply factor analysis to a given set of data is, however, clearly limited and the two methods not as disparate as is often suggested.

The question of the place of theory in applying factor analysis and principal components analysis is, however, an important one. A common criticism is the basically empirical nature of many studies using the techniques (Williams, 1971). Armstrong and Soelberg (1968) have shown that many exponents of these methods have failed to provide valid a priori assumptions about the nature of their expected results, and found that without such assumptions a researcher would almost certainly be able to produce a valid a posteriori justification and interpretation of the resulting components or factors. This is not to decry empirical research, but no research is ever completely "blind", and a sound theoretical basis helps to confirm the reliability of the resulting factor structure. The choice of variables for analysis and the general context of the work must invariably produce some prior assumptions about the nature of the results and,

even if the principal components solution is preferred, there seems no reason why the researcher should not provide some theoretical arguments to at least partly predict and certainly supplement the results of the analysis.

The results obtained by factor analysis and principal components analysis have important differences which rule out the possibility of direct comparison between studies using the two methods, although there is clearly a close correspondence between such results. Whereas principal components analysis transforms the original variables into an equal number of components, only a small number of which may be needed to summarize the largest part of the total variation, factor analysis starts from a different premise, namely that, given a set of n variables, the meaningful variation can be expressed in terms of a smaller number of factors plus residual error elements. Principal components analysis is therefore orientated towards redistributing total variance, whereas factor analysis is orientated towards extracting the covariance or correlation within a set of data.

Harman (1967) defines this distinction between the objectives of the two methods as extracting the maximum variance (in the case of principal components analysis), and "best reproducing" the observed correlations (in the classical factor analysis model). The principal components technique was first proposed by Pearson at the turn of the century, but its general use has followed the further development of the method by Hotelling (1933). The model for

component analysis is simply:

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jn}F_n \quad (j = 1,2,\ldots,n)$$

Each of the n observed variables is described in terms of n new uncorrelated components F_1, F_2,..., F_n. An important property of the method is that each component in turn will account for a maximum proportion of the total variance. In practice only a small number of components may be retained for inspection in a study, but all the components are required to reproduce the correlations between the variables. The basic factor analysis model, on the other hand, may be expressed as:

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jm}F_m + d_jU_j \quad (j = 1,2,.,n)$$

Here each of the n observed variables is described in terms of m common factors and a unique factor, with the number of common factors usually being much smaller than the original number of variables. The common factors account for the correlations among the variables, while each unique factor accounts for the remaining variance of that variable (Harman, 1967, Chapter 2).

The basic factor analysis and principal components analysis models include unknown constants (a_{j1}, a_{j2},...,a_{jn} in the above equations) representing the degree of association of each variable with each factor. These constants are termed "loadings", and it is the values of these loadings which the two methods seek to identify. The loadings represent the portion of the variance of a variable

ascribable to respective factors. When summed, the squares of the factor loadings of all variables on one factor gives a measure of the total variance accounted for by that factor or component. Dividing these eigenvalues by the number of variables and multiplying by 100 gives a percentage figure for the amount of total variance within the original set of data accounted for by the factors or components, or dividing by the sum of the eigenvalues of the common factors and multiplying by 100 gives the percentage of common variance accounted for by each factor. The sum of the squared loadings for a particular variable over all common factors, multiplied by 100, gives the percentage of the variance of that variable which is included in the common factors, and is called the communality of that variable. Subtracting this percentage of variation in common from 100 gives a measure of the uniqueness of a variable. The communality, therefore, indicates to what degree a variable is related to or independent of the others - to what degree the data on a variable can or cannot be predicted from the data on the other variables.

These two concepts - that of the communality of a variable and its uniqueness - are very important ones in principal components analysis and factor analysis. All variables subjected to analysis by these methods are likely to contain both common variance and unique variance, and the difference between the two methods lies in their treatment of these two types of variance. In factor analysis some account is taken of the presence of unique variance, whereas in component analysis the intrusion of unique variance is ignored. In a component analysis the unique variance appears to some degree

even in the common factors, but not to a great enough extent to distort the overall picture obtained by the analysis. Factor analysis, on the other hand, describes the n common factors in fewer than n common factors. This is usually achieved by reducing the rank of the correlation matrix, which forms the starting point for both methods, by inserting communalities in the diagonal which, in the principal components model, contains self-correlations (unity). The number of common factors extracted is then equal to the rank of the reduced correlation matrix. By employing communalities in the diagonal factor analysis, therefore, attempts to eliminate unique variance, and extract a more precise pattern of covariance within the data. At the same time the number of common factors is reduced, and some degree of prior knowledge of the factor structure is assumed.

The need for communalities in the initial stages of factor analysis has led to a major problem - there is no a priori knowledge of the values of the communalities. Either the rank of the reduced correlation matrix or its diagonal values (the communalities) must be known, or approximated, to obtain a factor solution. Several solutions make approximations of the number of common factors, (and therefore the rank of the reduced correlation matrix). The principal factor method and the centroid method (which is intended to approximate the results of the former with considerable savings of labour) both require prior estimates of communalities, and also tend to be the most widely used methods of obtaining an initial factor solution.

The increasingly available electronic computer, which has

greatly advanced the use of the otherwise laborious principal factor method of analysis, has also simplified the problem of estimating communalities. Deciding beforehand on the number of desired common factors, it is possible to estimate the communalities by a process of refactoring. The routine is initiated with unities, communality estimates or any other values in the principal diagonal, and involves the calculation of a principal factor solution (which is the method most readily adaptable to the computer) the communalities of which are inserted in the diagonal of the correlation matrix as new estimates of communalities. Another principal factor solution is then calculated, and this process continued until the values of the communalities converge (do not differ) to within a pre-determined amount between successive analyses. Clearly fewer iterations by refactoring will be required if some estimate of the communality is inserted at the outset, and squared multiple correlations of the variable with the remaining variables have been found to be the most satisfactory initial estimates when carrying out the iterative process by computer (Harman, 1967).

It is possible, as a final step in both factor analysis and principal components analysis, to generate factor scores for each individual in the original population on each of the common factors. Here principal components analysis gains over factor analysis in that scores can be arrived at directly, as linear combinations of the variables, due to the fact that total variance has been analysed in a number of components equal to the original number of variables. In the classical factor analysis model, however, the number of factors

exceeds the number of variables in the original matrix by m common factors. The factor analysis model, in an expanded form, becomes:

$$z_1 = a_{11}F_1 + a_{12}F_2 + \cdots a_{1m}F_m + d_1U_1$$

$$z_2 = a_{21}F_1 + a_{22}F_2 + \cdots a_{2m}F_m + d_2U_2$$

$$\cdot \quad \cdot \quad \cdot \quad \cdot$$

$$z_n = a_{n1}F_1 + a_{n2}F_2 + \cdots a_{nm}F_m + d_nU_n$$

Here a direct method of calculation is not possible, as the matrix cannot be inverted, although factor scores can be estimated by a regression procedure.

The idea that a principal components analysis or a factor analysis might provide only an initial solution to a problem of . . analysis has already been suggested. These solutions can be conceived of as final products in their own right, or can be viewed as initial products satisfying the fundamental requirements of the models but requiring further manipulation to a final form. The initial solutions define the common-factor space, but within that space there are an infinite number of different positions for the factor axes. Different solutions can be obtained by rotation of the axes about the origin until a preferred solution has been reached. Initial solutions are often rotated by the Varimax method to fulfill the concept of simple structure proposed by Thurstone (1947), which has the effect of maximizing the number of loadings having negligable values whilst leaving a small number of very large loadings. This obviously makes the task of interpreting a factor very much easier than in the case

of an initial solution comprising, in the main, moderately sized loadings.

The Varimax criterion, together with several other methods of rotating initial factor solutions and the basic factor and principal components analysis models, produces uncorrelated (orthogonal) factors, but there is no reason why this principle should be retained. Some direct solutions, in fact, have been designed to produce oblique (correlated) factors, and other direct solutions can be rotated to give oblique factors. In the early development of factor analysis solutions in terms of uncorrelated factors were generally assumed to be the only permissible type, but an oblique solution is clearly justified when dealing with a set of inter-related variables. If such variables can be related in distinct clusters, then these clusters themselves can also be related. In an oblique rotation each factor is rotated independently of the other factors, and the relationship between factors reflects the relationship between the clusters of variables involved in each factor. If these clusters of variables were, in fact, uncorrelated, an oblique rotation to simple structure would result in uncorrelated factors. The difference between orthogonal and oblique rotation is not, therefore, in discriminating uncorrelated or correlated factors, but determining whether this distinction is empirical or imposed on the data by the model. An oblique solution clearly generates additional information about the data, and more closely approximates to reality.

One important limitation applies to both principal component

and factor analysis models, and consequently also to the rotated solutions. One of the basic assumptions of the techniques is that the relationship between variables is a linear one. Although models for non-linear factor analysis have been developed, the subject is as yet in the early stages of development (Harman, 1967). It is wise, perhaps, to heed Kendall (1957) when he writes of the linear components analysis model that:

> "There is no reason why more complicated types should not be considered, but the theory would become difficult. In practice, when the variation is obviously non-linear, it is best to try to transform to linear variation before embarking on the analysis."
>
> (Kendall, 1957, p. 10)

In fact, the transformation of non-linear data would involve a large degree of knowledge about the relationships between variables prior to analysis, and this state of knowledge is often lacking in studies where the techniques are applied. In studies of urban differentiation land economists would argue the importance of the negative exponential relationship between the price (or rent) of urban land and distance from the city centre. Murdie (1969) includes distance from the peak land value intersection in his analysis of Toronto, as a means of testing the concentric distribution of family status, but this is not common practice in urban studies using multivariate techniques. Present knowledge of social differentiation in urban areas is not really sufficient to allow for the transformation of non-linear data, which would also add to the complexity of the resulting factors or components and the problems of their interpretation.

The Choice of Indices

A study of data by the principal components or factor analysis techniques clearly relies for its results on the value of the original data. The choice of indices subjected to analysis by these techniques is of prime importance, and in this study has been guided in many respects by the selection of indices used in modern studies of urban residential areas using these techniques. The latter have tended to consider between ten and sixty variables in analyses of this type, but most often a number somewhere in the middle of this range has been thought satisfactory. The indices used cover a wide range of social attributes which can generally be summarized under the three headings of "demographic", "socio-economic" and "housing" variables. Demographic variables include measures of migration as well as age, sex, and marital data. The socio-economic group is largely concerned with occupational groupings (as indices of social status) and employment data, whilst the housing variables summarize information on household composition, overcrowding, household amenities and household tenure. Despite the wide range of measures which have been used in different studies to describe these features of urban social structure, the frequency with which comparable results are obtained suggests that the indices themselves are not as important as the balance between them. Although, clearly, an index must be a valid measure of the phenomenon it seeks to describe, the results are more distorted by an incorrect balance of variables. The components or factors rely on the nature of the input variables so that if, for example, housing measures predominate the resulting factors or components

will over-emphasize the importance of housing as a basis for differentiation between urban areas at the expense or demographic and socio-economic factors[1].

In preparing the Hull nineteenth century census data for analysis by multivariate techniques both these factors have had to be taken into account. The only major deficiency in the enumeration book data lies in the field of housing variables, where the returns yield less detail than could be wished for. This is not necessarily detrimental to the balance of variables, however, and neglected factors like household amenities would not be so relevant in the nineteenth century context. One could wish for information on household tenure but this is by no means essential. In ordering the Hull data into measures suitable for analysis many ideas have been tested for their validity as indices, and the final set of variables used in analysis tries to include all the relavant information from the enumerators' books without causing imbalance due to repetition of data or the neglect of available data (Table 24). In view of the time and place of the study an explanation of the absence or inclusion of possible measures will help to clarify their relavance in the nineteenth century context.

The first group of variables, demographic factors, account for 10 of the 28 variables. Those concerned directly with age, sex and

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1. Gittus (1964a, 1964b) is a good example of this sort of imbalance between variables of different types: The danger in analyses of this type is not in interpreting the results as valid, but in not realizing the limitations of their validity.

Demographic variables		
1	Population under 5	as percentage of total population
2	Population aged 5 to 14	as percentage of total population
3	Population aged 60 and over	as percentage of total population
4	Population under 5	to 1000 females aged 15 to 44
5	Males	to 1000 females
6	Single population aged 15 and over	as % of total population aged 15+
7	Single females aged 15 and over	as % of total females aged 15+
8	Population born in Hull	as percentage of total population
9	Population born in Lindsey and the East Riding of Yorkshire	as percentage of total population
10	Population born outside England and Wales	as percentage of total population
Housing variables		
11	Population in shared dwellings	as percentage of total population
12	Gross population density per hectare	
13	Households with 3 or more children aged 12 or under	as percentage of total households
14	Households with 1 or 2 persons	as percentage of total households
15	Households with 5 or more persons	as percentage of total households
16	Resident domestic servants	as percentage of total population
17	Lodgers	as percentage of total population
Socio-economic variables		
18	Professional and managerial	as % of total economically active
19	Skilled non-manual workers	as % of total economically active
20	Skilled manual workers	as % of total economically active
21	Semi-skilled workers	as % of total economically active
22	Unskilled workers	as % of total economically active
23	Semi-skilled household heads	as % economically active heads
24	Economically active aged 15 and over	as % of total population aged 15+
25	Economically active females aged 15 and over	as % of total females aged 15+
26	Males in service industry	as % of males in service and production industries
27	Females in service industry	as % of females in service and production industries
28	Children aged 5 to 12 at school	as % of total children aged 5 to 12

Table 24: Variables used in analysis, Hull, 1851

marital status are for the most part standard measures of these features, and their relevance in the nineteenth century not in doubt. They are directly comparable with variables used in many modern studies, and reflect the possible variations in populations along these lines. These indices have been found to be important in social work in modern cities, and their inclusion here adds to the possibilities of comparing the nineteenth century situation with these later studies. The pattern of the age and sex distribution of the population gives some idea of the numbers used in computing these indices (Figure 10).

Migration indices must clearly be more specifically related to their context, as the importance of different migrant groups will vary greatly from place to place and with time. In many studies birthplace is the only reliable indication of migrant status, and this gives a measure of total migration rather than migration during a specific time period. The birthplace data from the 1851 census has been used to calculate indices of the percentage of the population born in Hull, Lindsey (North Lincolnshire) and the East Riding of Yorkshire, and the percentage born outside England and Wales. Lindsey and the East Riding have been grouped together on the basis of their geographical position with regard to Hull and because of the relatively low degree of residential segregation between persons born in these two areas. The group comprising persons born outside England and Wales shows a high degree of segregation from persons born in Hull and in the East Riding and Lindsey group (indices of residential dissimilarity are 39.42 and 42.80 respectively), and the largest

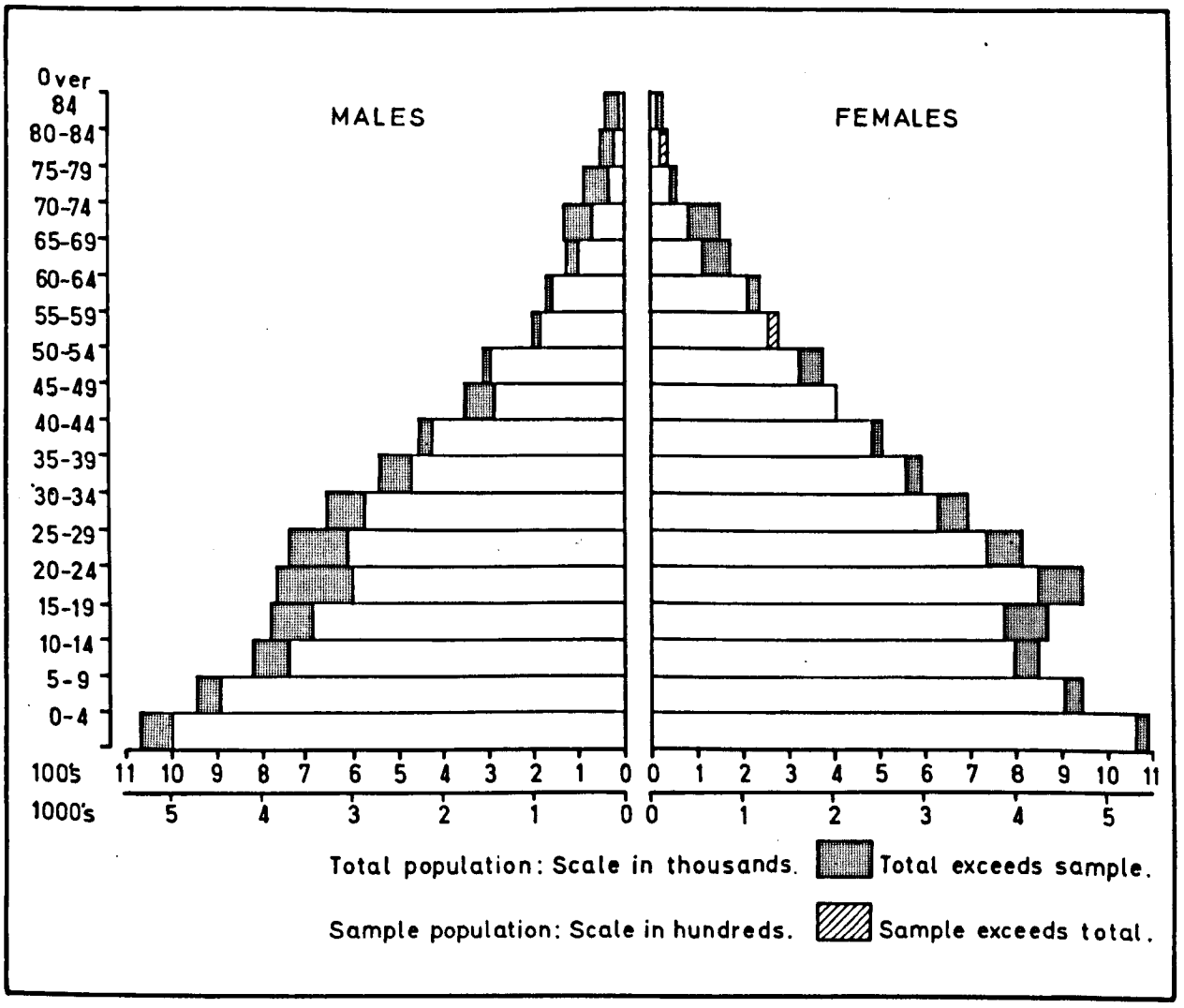

Figure 10: Age and sex patterns, Hull, 1851.

single component of the group are the Irish-born. Although it would have been preferable, due to the position of the Irish as a segregated population, to have included a separate index of Irish-born the numbers in this group (470) were not really sufficient to comprise a valid index. Due to the difficulty of grouping other numerically less important birthplaces, and the lack of evidence of residential segregation between these groups, no other migration indices have been included although, of course, total migration is reflected in the scores on the index giving the percentage of the population born in Hull.

In the second group of indices, those concerned with housing, overcrowding and density of occupation are reflected in two indices. The first gives the proportion of the total population living in sub-divided dwellings, and is derived from the addresses of households and the method used to rule off households in the enumerators' books. The index, therefore, gives the proportion of persons living in houses which are occupied by two or more households, as opposed to those living in single family dwelling units. The index also reflects, to some degree, the proportion of persons renting accommodation, although this is obviously a very imperfect reflection. The second of these indices is a measure of gross population density, computed on the basis of the numbers of persons in an areal unit and its land area in hectares. These two measures give an indication of the degree of overcrowding, although this is obviously inferior to the number of persons per room data used by Booth (Industry Series, Vol 1), which was not collected in the British census until 1891.

The indices concerned with household composition are in many ways self-explanatory. The first of these is a measure of the number of households having three or more children under twelve in the head's immediate family (three or more sons or daughters of the head), and has clearly been motivated by Rowntree's poverty cycle ideas. The index does, however, give a general measure of "family life). The upper age limit has been fixed with regard to the fact that after the age of twelve the number of schoolchildren is exceeded by the number of children at work and at home (Figure 11). No separate index identifying extended family relationships has been included, due to the rather dubious value of the extended family concept in the nineteenth century, and the fact that the members of the extended family seem to be distributed on the basis of population rather than any other criterion. The closest correlation of an index giving the proportion of the population living as members of the extended family by area with the variables chosen for analysis was 0.28 with the numbers of the economically active population in professional and managerial occupations (significant at the 5 per cent level). As Armstrong found in York, however, this relationship is inconclusive. An index measuring the proportion of the population who are resident domestic servants has been included, in view of the importance attached to this measure by contemporaries like Booth and Rowntree. This index could be seen as compensating for the lack of information on household amenities - the domestic servant being the basic household amenity of the nineteenth century. In addition an index of the proportion of the population living as lodgers has been included.

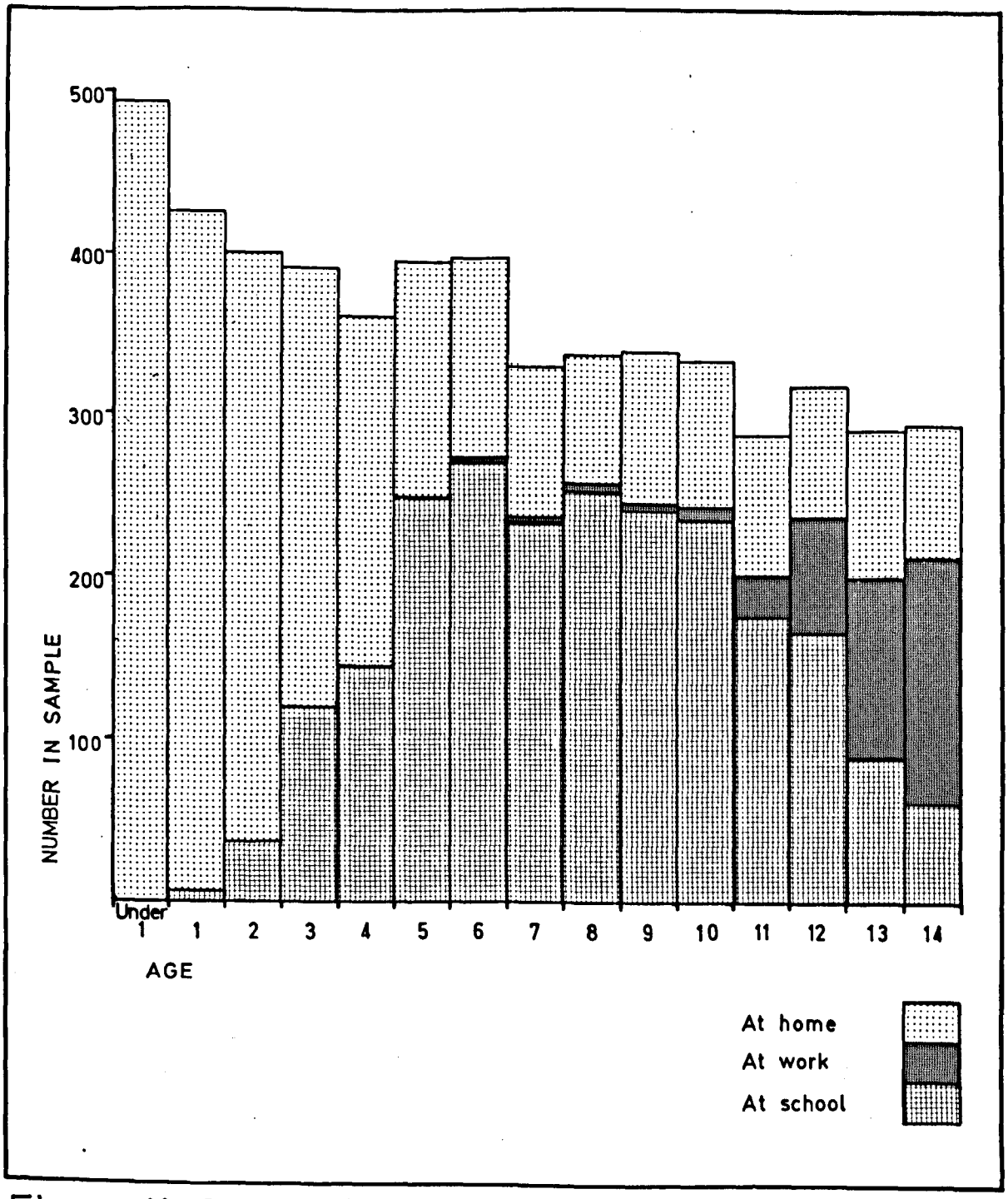

Figure 11: Occupations of children, Hull, 1851.

Presumably the presence of lodgers in a household was, in the majority of cases, as much of an index of social status as the presence of servants, highlighting groups at the opposite end of the social scale.

The socio-economic group of indices rely heavily on the grouping of occupations as an index of social status. Five of the measures in this group give direct proportions of the population in five occupational categories. On the basis of the size of groups it was thought advisable to consider the first two occupational strata as one in order to give a valid number of observations for analysis. Armstrong, in his work on York, also found this practice necessary (Armstrong 1966, 1967, 1968). On the same grounds the percentage of the total economically active has been chosen rather than the proportion of economically active household heads. When the proportion of heads and total population in each group are correlated the coefficients are very high (ranging from 0.84 to 0.93) except for the coefficient between the semi-skilled population and semi-skilled household heads (0.58). This is obviously due to the inclusion of domestic servants in this group, and to counter this a separate index of the number of economically active household heads in semi-skilled occupations has also been included.

The remainder of these measures are concerned with groupings of the population according to socio-economic criteria other than occupation. Two of these give the proportion of the total population and the proportion of females aged 15 and over who are economically

active, and the latter has been found particularly valuable in previous work on social differentiation. Two further indices measure the proportion of males and females in different types of industry - service and production - and a final index the proportion of children at school. Theoretically this index is particularly valuable as, with the lack of compulsory education at the time, it might be expected to reflect socio-economic status and the aspirations of households in different areas. Information on terminal age of education would, of course, have been more valuable in this respect but is not available. The age range for this index was fixed at children between the ages of 5 and 12. Children of 1 year old described as "scholars" are found in the returns, but this age range includes those goups in which the number of children so described exceeded the number at home and at work (Figure 11).

The majority of the variables chosen for analysis have a certain degree of theoretical backing for their inclusion in that they have been shown to be important measures of social structure and areal differentiation in previous research. In other cases the specific conditions of the nineteenth century town, as presented in contemporary sociological work, are more important and indices have been evaluated from this standpoint. On the whole the variables chosen for analysis use all the available data from the 1851 census schedules which might be expected to be relavant for social differentiation, and tries to strike a sensible balance between different lines of differentiation. The pattern of correlations (Table 25) shows the variables to be very

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	1.000	.028	-.296	-.921	.187	-.556	-.439	.023	-.054	.029	-.248	.152	.305	-.119	.066	-.420	-.061	-.055	-.228	.298	-.157	.018	.011	-.412	-.363	-.253	-.224	.173
2	.028	1.000	-.271	.282	.312	-.421	-.520	.208	-.250	.133	-.064	.163	.519	-.190	.262	-.589	-.149	-.361	-.273	.363	-.309	.352	.036	-.147	-.297	-.326	-.327	.190
3	-.296	-.271	1.000	-.168	-.007	.231	.116	-.082	.117	.041	.401	-.058	-.341	.333	-.293	.147	.072	.013	.232	-.358	.130	.099	-.013	.035	.058	.340	.283	.010
4	.921	.282	-.168	1.000	.232	-.636	-.559	.081	-.090	.079	-.222	.150	.422	-.109	.085	-.547	-.116	-.125	-.253	.275	-.205	.154	.057	-.480	-.455	-.246	-.240	.241
5	.187	.312	-.008	.232	1.000	-.427	-.633	-.105	-.389	.377	.247	.403	.047	-.014	.142	-.482	.283	-.457	-.157	.084	-.067	.407	.276	-.272	-.502	-.233	-.132	-.205
6	-.558	-.421	.231	-.636	-.427	1.000	.888	-.176	.245	-.062	.096	-.291	-.259	-.164	.112	.734	.182	.405	.322	-.466	.393	-.390	-.174	.700	.739	.339	.342	-.088
7	-.439	-.520	.116	-.559	-.633	.888	1.000	-.111	.370	-.247	-.055	-.439	-.221	-.160	.005	.822	-.019	.494	.233	-.410	.422	-.492	-.175	.657	.799	.333	.295	-.010
8	.023	.208	-.082	.081	-.105	-.176	-.111	1.000	-.009	-.431	-.012	.014	.271	.213	-.233	-.176	-.592	.075	-.059	.358	-.349	-.047	-.209	-.181	-.174	.020	.008	.140
9	-.054	-.250	.117	-.090	-.389	.245	.370	-.009	1.000	-.443	-.280	-.394	.021	-.066	-.075	.485	-.367	.480	.303	-.212	-.011	-.299	-.327	.066	.211	.337	.431	.048
10	.029	.133	.041	.079	.377	-.062	-.247	-.431	-.443	1.000	.402	.498	-.176	.073	.064	-.250	.644	-.290	-.152	-.141	-.164	.604	-.052	-.027	-.095	-.037	-.085	-.151
11	-.248	-.064	.401	-.222	.247	.096	-.055	-.012	-.280	.402	1.000	.412	-.299	.434	-.174	-.132	.356	-.309	.072	-.016	-.154	.356	-.052	.036	.036	.143	.032	-.305
12	.152	.163	-.058	.150	.403	-.291	-.439	.014	-.394	.498	.412	1.000	-.186	.250	-.064	-.457	.452	-.373	-.059	.285	-.389	.399	.036	-.166	-.267	.051	-.146	-.339
13	.305	.519	-.341	.422	.047	-.259	-.221	.271	.212	-.176	-.299	-.186	1.000	-.387	.436	-.235	-.333	-.040	-.299	.315	-.054	-.073	.037	-.204	-.234	-.397	-.103	.229
14	-.119	-.190	.333	-.109	-.014	-.164	-.160	.213	-.066	.073	.434	.250	-.387	1.000	-.707	-.185	-.044	-.079	.168	.131	-.426	.248	-.168	-.111	-.071	.244	.055	-.185
15	.066	.262	-.293	.085	.142	.112	.005	-.233	-.075	.064	-.174	-.064	.436	-.707	1.000	-.031	.243	-.154	-.131	.003	.345	-.151	.278	.094	-.018	-.325	-.178	.047
16	-.420	-.589	.147	-.547	-.482	.734	.822	-.176	.485	-.250	-.132	-.457	-.235	-.185	-.031	1.000	-.091	.628	.343	-.546	.471	-.562	-.203	.436	.573	.453	.580	-.026
17	-.061	-.149	.072	-.116	.283	.182	-.019	-.592	-.367	.644	.356	.452	-.333	-.044	.243	-.091	1.000	-.300	.020	-.179	.137	.260	.165	.284	.180	-.055	-.165	-.403
18	-.055	-.361	.013	-.125	-.457	.405	.494	.075	.480	-.290	-.309	-.373	-.040	-.079	-.154	.628	-.300	1.000	.323	-.385	.014	-.545	-.360	.158	.334	.452	.597	.123
19	-.228	-.273	.232	-.253	-.157	.322	.233	-.059	.303	-.152	.072	-.059	-.299	.168	-.131	.343	.020	.323	1.000	-.343	-.110	-.340	-.290	.106	.138	.572	.509	-.150
20	.298	.363	-.358	.275	.084	-.466	-.410	.358	-.212	-.141	-.016	.285	.315	.131	.003	-.546	-.179	-.385	-.343	1.000	-.527	-.027	-.092	-.209	-.251	-.492	-.560	.067
21	-.157	-.309	.130	-.205	-.067	.393	.422	-.349	-.011	-.164	-.154	-.389	-.054	-.426	.345	.471	.137	.014	-.110	-.527	1.000	-.388	.583	.306	.285	-.021	.059	.017
22	.018	.352	.099	.154	.407	-.390	-.492	-.047	-.299	.604	.356	.399	-.073	.248	-.151	-.562	.260	-.545	-.340	-.027	-.388	1.000	-.046	-.263	-.348	-.134	-.214	-.093
23	.011	.036	-.013	.057	.276	-.174	-.175	-.209	-.327	-.052	-.052	.036	.037	-.168	.278	-.203	.165	-.360	-.290	-.092	.583	-.046	1.000	-.154	-.246	-.176	-.261	-.113
24	-.412	-.147	.035	-.480	-.272	.700	.657	-.181	.066	-.027	.086	-.166	-.204	-.111	.094	.436	.284	.158	.106	-.209	.306	-.263	-.154	1.000	.911	-.014	-.063	-.158
25	-.363	-.297	.058	-.455	-.502	.739	.799	-.174	.211	-.095	.036	-.267	-.234	-.071	-.018	.573	.180	.334	.138	-.251	.285	-.348	-.246	.911	1.000	.123	.007	-.101
26	-.253	-.326	.340	-.246	-.233	.339	.333	.020	.337	-.037	.143	.051	-.397	.244	-.325	.453	-.055	.452	.572	-.492	-.021	-.134	-.176	-.014	.123	1.000	.701	-.093
27	-.224	-.327	.283	-.240	-.132	.342	.295	.008	.431	-.085	.032	-.146	-.103	.055	-.178	.580	-.165	.597	.509	-.560	.059	-.214	-.261	-.063	.007	.701	1.000	-.143
28	.173	.190	.010	.241	-.205	-.088	-.010	.140	.048	-.151	-.305	-.339	.229	-.185	.047	-.026	-.403	.123	-.150	.067	.017	-.093	-.113	-.158	-.101	-.093	-.143	1.000
Correlations significant at the 0.1% level:	5	4	1	7	9	12	14	2	7	7	4	10	4	4	2	16	4	10	2	7	8	8	1	6	6	6	6	1

A correlation of ± .37 is significant at the 0.1% level,
± .29 at the 1% level,
and ± .23 at the 5% level.

Table 25: Product-moment correlation matrix for 28 variables, Hull, 1851.

closely inter-related, and a fairly general spread of significant coefficients is found throughout the matrix. The three variables with the largest number of significant correlations (correlations significant at the 0.1% level are underlined in table 25) are clearly closely related, being concerned with the unmarried population and domestic servants. Resident domestic servants are obviously an important feature in nineteenth century residential differentiation, and can be expected to emerge as the distinguishing feature of certain residential areas. Other variables tend to correlate as expected, one interesting group being the percentage of persons in the different occupational groups (Variables 18 to 23). Two variables prove dissappointing in their patterns of correlation, the index giving the percentage of the population aged 60 and over and that giving the percentage of children at school. Clearly the relationship between children attending school and socio-economic status must be quite a complicated one, and this relationship has not been uncovered by the linear correlation model.

The Indeterminacy of Factor Solutions

Factors or components, once defined, must be interpreted, and this process demands both intuition and knowledge of the relavant theoretical framework. Factors are mathematical constructs. They are theoretical terms, and are not observable in the real world. Harman (1967) quotes the suggestion that:

> "Every set of phenomena can be interpreted consistently in various ways, in fact, in infinitely many ways. It is our

> privilege to choose among the possible interpretations the ones that appear to us most satisfactory, whatever may be the reasons for our choice. If scientists would remember that various equally consistent interpretations of every set of observational data can be made, they would be much less dogmatic that they often are, and their beliefs in a possible ultimate finality of scientific theories would vanish."
>
> (Harman, 1967, After Moulton, F.R., 1949, "The velocity of light", Scientific Monthly 48, p. 481-484)

Any factor solution is indeterminate in that, given the correlations between a set of variables, the coefficients of a factor pattern are not uniquely determined. Systems of factors may be chosen, consistent with the observed correlations, in an infinity of different ways. In factor analysis one form of indeterminacy lies in the fact that the computational methods do not yield unique values for the factor loadings, an exception being the principal factor solution. Secondly the solution does not determine an exact position for the factor axes, and may be transformed or "rotated" to another solution (fitting the data equally well) which may have greater meaning for a particular investigation. Finally the interpretation of a factor is itself indeterminate, in that different researchers might interpret the same factors in different ways, depending on their theoretical knowledge and ideological standpoint.

Factor analysis and principal components analysis are, however, useful methods of confirming and generating theoretical statements. A factor solution may be one of any number of possible solutions, but any solution reflects the constitution of the original data matrix.

The multivariate technique demonstrated in factor analysis and principal components analysis is not, as Timms (1971) makes clear:

> "A technique which can somehow lead the investigator directly to 'underlying verities', to the 'real principles' at work in nature. It is no more and no less than an expeditious and efficient tool for examining the relationship between observed indicants and certain underlying hypothetical constructs which happen to fit the data. As in all research which attempts to leap the chasm between empirical data and theoretical constructs (its use) demands intuition as well as logic."
>
> (Timms, 1971, p. 54)

Patterns of Dependence and Independence

Chapter Eight

Factor Analysis: The Orthogonal Approach

According to Harman (1967) the Principal Factor solution is probably the most widely used technique in modern factor analysis. This was not always so, as the method requires considerable calculations and without the availability of high-speed electronic computers would be extremely time consuming. The Centroid Factor solution, which approximates the results obtained by the principal factor method, was formerly more widely preferred because of the considerable savings of time achieved. The foundations of the principal factor method were laid at the turn of the century by Karl Pearson, but it was not until the 1930s that the basic method was developed by Hotelling (1933), and the first applications of computers to this problem of factor analysis were made in the 1950s.

As its name suggests, the principal factor solution applies the basic premises of principal component analysis to the classic factor analysis model. Components analysis first of all identifies an axis in the multi-dimensional space of the original variables along which the variance is a maximum; then a second axis, uncorrelated with the first, which accounts for as much of the remaining variance as possible; a third axis, uncorrelated with the first two, etc. The method therefore involves the rotation of axes to a new frame of reference in the total variance space, forming an orthogonal transformation where each of the original variables is describable in

terms of an equal number of new principal components. An important feature of the new variables is that they account, in turn, for a maximum amount of the total variance of the variables.

The important distinction between the two methods is that the basic components analysis model is, in principal factor analysis, replaced by the classic factor analysis model. The principal factor solution follows essentially the same procedures as principal components analysis, but operates on the reduced correlation matrix, with estimates of communalities in the diagonal. All the variance is analysed in terms of the principal components while, in principal factor analysis, only the common variance is analysed in terms of the common factors. The distinction, therefore, is in the amount of variance analysed and in the basic model applied. For principal factor analysis the relevant portion of the factor analysis model is that dealing with common variance:

$$z_j = a_{j1}F_1 + a_{j2}F_2 + \cdots + a_{jm}F_m \quad (j = 1,2,\ldots,n)$$

The common variance of the n variables is explained in m common factors, where m is less than n. Following the components solution, the first principal factor accounts for the maximum possible variance; the second factor for a maximum in the variable space when the influence of the first factor has been removed; and so on. An important distinction between principal components and principal factors is that the components are immediately expressible in terms of the observed variables, and hence component scores can be calculated

directly, while factor measurements can only be arrived at indirectly, using (most frequently) a regression method of complete estimation.

Using the twenty eight selected variables drawn from the 1851 census data for Hull, and the 74 urban sub-areas defined on a grid square basis,as the basic unit of analysis, the principal factor method has been used to provide an initial factor solution capable of being rotated to more valuable solutions. The analysis and subsequent rotations were carried out using the SALY survey and statistical analysis programs developed at the University of Essex, on the ICL 1905E computer at the University of Hull. Squared multiple correlations were used as initial communality estimates, and the iterative process of refactoring was used to gain more accurate estimates. The convergence criterion for successive communality estimates was set at 0.005, and the number of desired common factors at seven. Various criteria have been proposed for defining the number of significant common factors, but by far the simplest and most widely used is Kaiser's criterion. Only those factors having latent roots greater than one, when unities are inserted in the diagonal of the correlation matrix, are considered meaningful common factors (Kaiser, 1960). A principal components solution (unities in the diagonal) previously computed using the ICL XDS3 statistical analysis program, produced seven components which fulfilled this criterion[1]. With these values specified the initial communalities needed only a single iteration for convergence, and the final factors

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1. See Appendix B for the results of principal components analysis on this data.

Variable	Factors 1	2	3	4	5	6	7	Communality
1	-.434	.064	-.216	.146	-.163	.225	-.388	.489
2	-.586	-.056	-.139	-.215	-.241	-.251	.377	.675
3	.181	.180	.338	.120	.190	-.136	.134	.267
4	.181	.178	.047	.049	.060	.355	.061	.203
5	-.217	.268	.066	-.199	.027	-.168	.137	.210
6	.840	-.256	.089	-.238	-.039	-.154	.130	.877
7	.884	-.182	-.109	-.233	.057	-.144	-.071	.909
8	-.172	.507	-.317	-.256	.207	-.243	.103	.564
9	.474	.431	-.370	.075	-.009	-.044	-.020	.556
10	-.277	-.321	.608	.039	-.448	.013	-.150	.774
11	-.049	.079	.666	-.128	.125	-.144	.152	.528
12	.001	-.047	.058	-.060	.034	.168	.200	.079
13	-.395	-.082	-.606	-.073	-.269	-.140	.112	.640
14	-.050	.580	.505	-.140	.294	.055	-.090	.711
15	-.109	-.595	-.319	.099	-.257	.061	.321	.651
16	.863	-.083	-.128	.060	-.019	-.023	-.158	.797
17	.007	-.536	.609	.065	-.178	.226	.001	.746
18	.672	.285	-.314	.060	-.263	-.012	-.177	.735
19	.471	.399	.191	.143	-.150	.386	.533	.894
20	-.620	.163	-.253	-.497	.156	.266	-.038	.819
21	.418	-.660	-.161	.384	.369	-.064	.004	.924
22	-.553	.032	.552	-.032	-.140	-.412	-.153	.823
23	-.228	-.429	-.026	.477	.482	-.105	.087	.716
24	.566	-.414	.114	-.584	.016	-.013	.054	.848
25	.701	-.299	.062	-.542	.009	-.020	-.109	.892
26	.570	.444	.229	.341	-.102	-.145	.115	.735
27	.589	.433	.065	.299	-.324	-.165	-.048	.763
28	.143	.149	.173	-.196	.059	.314	-.069	.219
Eigenvalue:	6.472	3.342	3.006	1.898	1.271	1.071	0.983	
Percentage of total common variance accounted for by each factor:	30.73	15.87	14.28	9.01	6.04	5.09	4.67	85.69

The ten highest associations with each factor are underlined

Table 26: Principal factor solution for 28 variables, Hull, 1851.

accounted for 85.69 per cent of total common variance (Table 26).

The Varimax Solution

The rotation of the axes of an initial factor solution may be viewed as an attempt to reduce the complexity of the factors, and is usually carried out in an attempt to simplify the interpretation of a factor structure. Thurstone (1947) clearly defined the conditions of simple structure, and the various methods of rotation aim at approximating this structure. The varimax criterion places the emphasis on simplifying the columns of the factor matrix - the factors - in an attempt to achieve simple structure, whereas some other methods, such as quartimax rotation, place more emphasis on simplifying the rows of the factor matrix. The rotated factor loadings tend to show a wider range of values, with a concentration of loadings near to zero and a small number of very significant loadings. Davies (1971) sees the distinction between an initial solution and a derived varimax solution in terms of the specific and the general. The initial solution measures the extent of overall similarity, whereas the varimax solution in some respects destroys the generality in favour of a number of specific effects. The choice is, he continues, of "emphasizing the description of the similarities or differences between areas.(Davies, 1971, p. 117). The principal factor solution obtained for Hull in 1851 has been rotated by the varimax method, to give an orthogonal factor solution of seven factors (Table 27). The factor matrix was normalized prior to rotation and, with a convergence value of .0000001, the rotation converged in twenty three major cycles.

Variable	Factors 1	2	3	4	5	6	7	Communality
1	-.477	-.155	.048	-.145	-.336	.205	.205	.489
2	-.235	-.335	-.016	-.223	-.108	-.666	.042	.675
3	.035	.201	.001	.110	.453	.008	.089	.267
4	-.019	.106	-.046	-.047	.029	.305	.304	.203
5	-.107	-.112	-.166	-.240	.239	-.209	-.000	.210
6	.856	.343	.054	.100	.039	.004	.115	.877
7	.850	.347	-.137	.119	-.060	.167	-.037	.909
8	-.119	-.098	-.649	-.251	.150	-.170	-.074	.564
9	.129	.488	-.506	-.086	-.105	.160	.027	.556
10	-.118	-.069	.827	-.172	.098	-.115	-.134	.774
11	.056	-.070	.280	-.080	.647	-.098	.081	.528
12	.034	-.091	.043	.005	.017	-.003	.259	.079
13	-.208	-.182	-.241	-.117	-.547	-.423	-.107	.640
14	-.161	-.015	-.107	-.239	.708	.294	.040	.711
15	.071	-.138	.222	.270	-.566	-.378	.202	.651
16	.603	.532	-.089	.174	-.139	.302	-.031	.797
17	.135	-.113	.814	.135	.097	.067	.142	.746
18	.309	.643	-.272	-.165	-.257	.236	-.057	.735
19	.049	.508	-.037	-.148	.164	.123	.754	.894
20	-.259	-.709	-.291	-.388	-.109	.038	.040	.819
21	.356	.075	.082	.857	-.203	.089	-.029	.924
22	-.320	-.188	.405	-.204	.456	-.332	-.405	.823
23	-.223	-.217	.054	.777	.422	-.086	-.052	.716
24	.896	-.118	.135	-.057	-.005	.034	.094	.848
25	.920	.028	.055	-.092	-.021	.180	-.014	.892
26	.067	.770	-.079	-.001	.327	.036	.129	.735
27	.092	.843	-.071	-.145	.092	.088	-.024	.763
28	.109	-.049	.027	-.206	.126	.336	.180	.219
Eigenvalue:	4.374	3.636	2.652	2.147	2.494	1.593	1.147	
Percentage of total common variance accounted for by each factor:	20.77	17.28	12.59	10.20	11.84	7.56	5.45	85.69

The ten highest associations with each factor are underlined

Table 27: Rotated orthogonal solution (Varimax criterion) for 28 variables, Hull, 1851.

The varimax solution quite clearly displays a greater range of values for the factor loadings than the initial principal factor solution, and it is evident that the percentage of variance explained by the factors is much more evenly distributed. In particular the very great percentage of common variance accounted for by the first factor has been redistributed. In the varimax solution the first and second factors account for 20.77 and 17.28 per cent of common variance respectively, and can be seen as being largely composed of the variation summarized by factor 1 in the initial solution. In this initial solution the highest loadings on factor 1 are, for the most part,

Original variables with the ten highest associations.
Factor 1: Principal factor solution

7	Single females	.884
16	Resident domestic servants	.863
6	Single population	.840
25	Economically active females	.701
18	Population in professional and managerial occupations	.672
20	Population in skilled manual occupations	-.620
27	Females in service industry	.589
2	Population aged 5 to 14	-.586
26	Males in service industry	.570
24	Economically active population	.566

concerned with the single population and female employment, particularly of domestic servants. A high positive loading also occurs on the percentage of the population in professional and managerial occupations. Strong negative associations are with the percentage of the population in skilled manual occupations and the percentage of the population aged 5 to 14. The pattern suggests that the factor identifies the

servant employing population, but the picture presented is not quite this clear as the factor also identifies the skilled manual population and older children at the negative extreme. In the varimax solution two distinct factors have emerged with high loadings, for the most part, on the same variables, but the rotation has served to identify two different areas of differentiation within the basic servant employing and social rank axis identified by the first factor of the initial solution.

The first impression of the pattern of loadings on factors 1 and 2 in the varimax solution is that the dimensions they measure must be very similar. Of the ten variables with the highest association with these two factors, five of them are common to both. The two factors, however, clearly reflect two distinct lines of differentiation within the data. The two highest loadings on factor 1 are concerned

Original variables with the ten highest associations.
Factor 1: Varimax solution

25	Economically active females	.920
24	Economically active population	.896
6	Single population	.856
7	Single females	.850
16	Resident domestic servants	.603
1	Population under 5	-.477
21	Population in semi-skilled occupations	.356
22	Population in unskilled occupations	-.320
18	Population in professional and managerial occupations	.309
20	Population in skilled manual occupations	-.258

with the percentage of economically active females and the percentage of the total population over 15 economically active. These two

variables were originally very highly correlated, and it is only to be expected that they should occur together in this factor. Similarly the third and fourth highest loadings are for closely related variables, both being concerned with the percentage of the population unmarried. So far, therefore, the factor seems to be concerned with the economically active and the single population, but places particular emphasis on female employment. This latter assumption is strengthened by the next highest loading, with the percentage of the population who are resident domestic servants. The highest occupational strata, however, have relatively low associations with this factor and it is not, therefore, primarily concerned with identifying the servant employing population. Although nearly half the economically active women in the Hull sample were employed as servants, others were engaged in production industries, particularly in textiles and clothing, and in the retail trade. Much of this employment, like domestic service, was semi-skilled, and this accounts for the association of this variable with this factor.

The question of working women in Victorian England is a complicated one. Resident domestic servants will clearly swell the number of economically active females, and the necessity for women to work will here be reflected in high rates of economic activity in those areas of a town where servants are employed. In other cases the need for employment, whether to provide an income for a single woman or to supplement a family income, will be reflected in high rates of activity in those areas where such women live. This distinction is not reflected in factor 1, which clearly incorporates high female employment

in both groups, but also notes that such employment is not compatible with the presence of a large number of young children. The variable giving the percentage of the population aged under 5 is highly associated with this factor, but in a negative direction, The factor is basically, therefore, concerned with female employment, but in identifying female employment as a major line of demarcation in urban society it also defines a high general rate of employment as a differentiating feature. The percentage of the total population economically active also loads heavily on this factor, and a high proportion of female employment when this is not general will clearly both reflect and to a certain extent be reflected in a high overall level of economic activity.

Whereas the first factor in the unrotated solution could only be labelled servant employing population with qualifications, the second factor in the varimax solution unequivocally identifies this line of differentiation within the population. The highest loading

Original variables with the ten highest associations
Factor 2: Varimax solution

27	Females in service industry	.843
26	Males in service industry	.770
20	Population in skilled manual occupations	-.709
18	Population in professional and managerial occupations	.643
16	Resident domestic servants	.532
19	Population in skilled non-manual occupations	.508
9	Population born in East Riding and Lindsey	.488
7	Single females	.347
6	Single population	.343
2	Population aged 5 to 14	-.335

is with the number of females in service industries (as a percentage of the number of females in production and service industries), and the second highest with the number of males in the same category. The first is clearly associated with domestic servants, and the second with persons in skilled non-manual and professional occupations. Other high loadings confirm this view and help to fill out the picture suggested by these two variables. The percentage of skilled manual workers loads heavily in a negative direction, whilst the percentage in professional and managerial occupations and in skilled non-manual work have high positive loadings on this factor. The percentage of resident domestic servants is the fifth highest loading on this factor, and,,as the correlation matrix suggests, this is also highly associated with local migrants from the East Riding and Lindsey. The presence of large numbers of domestic servants must obviously affect the demographic structure of the population, and this feature accounts for the relatively high positive loadings on the proportion of single females and the single population as a whole and, at least in part, the negative loadings on variables measuring the percentage of children in the population. Robson (1969) finds the same negative association between high occupational status and fertility in twentieth century Sunderland, and the same feature has been reported elsewhere. Although the investigation of nineteenth century household structure suggests that this may be true for this period, the distortion of the demographic structure caused by the influx of young unmarried females as domestic servants makes it impossible to regard low fertility within the servant employing population as a contributory feature of this factor.

Factor 2 is clearly a bipolar factor in that it has both very significant positive and very significant negative loadings. In a sense any factor implies its obverse, but this opposite pole of the factor is much more accurately defined if the structure is a bipolar one. The highest positive loadings are with variables identifying the servant employing population, but at the other end of the scale a very strong negative association occurs with the percentage of the economically active in the skilled manual category. The very high associations with the numbers of males and females in service industries also demands consideration of its counterpart. Had these indices been framed the opposite way - the percentage of the economically active in production industries - the same high loadings would have been negative. On the one hand, therefore, the positive loadings identify the servant employing population of persons in professional and managerial occupations and, to a lesser extent, skilled non-manual occupations. On the other hand the negative loading in the percentage of persons in the skilled manual occupational group, and the association of this group with production workers, identifies the classic urban industrial population of the nineteenth century. The factor is, clearly, of great importance as an axis of differentiation according to social rank, and identifies the basic Victorian division between Masters and Men as the most apparant of the possible social rank divisions within the nineteenth century town.

The third factor in the Varimax solution accounts for 12.59 per cent of the total common variance within the data, and is undeniably a factor measuring migrant status. The three variables concerned

Original variables with the ten highest associations.
Factor 3: Varimax solution

10	Population born outside England and Wales	.827
17	Lodgers	.814
8	Population born in Hull	-.647
9	Population born in East Riding and Lindsey	-.506
22	Population in unskilled occupations	.405
20	Population in skilled manual occupations	-.291
11	Population in shared dwellings	.280
18	Population in professional and managerial occupations	-.272
13	Households with three or more children	-.241
15	Households with five or more persons	.222

with birthplace are amongst the four with the highest association with this factor. The highest loading of all is with the percentage of the population born outside England and Wales, the majority of which, in the Hull survey, are of Irish birth. The position of this group in nineteenth century society, and particularly of the Irish community, accounts for the presence of the other high positive associations with this factor. Contemporary evidence shows that the Irish often lived as lodgers or shared a dwelling with another family or families, and as a group also had an unbalanced occupational structure with a larger than average percentage of its number engaged in unskilled occupations. The correlation coefficients between the percentage of the population born outside England and Wales and these variables show that these features are not obscured by the inclusion of other immigrant groups, although it seems probable that the associations may be slightly weakened by this inclusion. The loadings on this factor bear out the importance of these features in the life of relatively long-distance migrants to the nineteenth century town.

Factor 3 is again a bipolar factor, and high negative loadings appear as the third and fourth largest on the percentage of Hull-born and the percentage of the population born in the East Riding of Yorkshire and Lindsey in Lincolnshire. The other highest negative loadings on this factor are not particularly significant in the statistical sense, but suggest that these locally born populations are also associated with the skilled manual occupational group, the professional and managerial group, and have a greater tendency towards family life. Both poles of this factor are clearly concerned with status as an immigrant to the town. If factor scores were computed a high positive value for an area would indicate a high proportion of immigrant population, particularly from outside England and Wales, and the consequent high percentage of residentially unstable population and unskilled workers. The lack of occupational equality would be partly due to the lack of urban skills and partly to discrimination by the local population. Negative scores would indicate areas of predominantly local population composition, with very few or possibly no long-distance immigrants, and scores between these two extremes areas where neither situation predominated.

The first three factors produced by the Varimax rotation have each accounted for a decreasing percentage of the total explained variance, but there is no reason why this should be so in such a solution. The fourth most important factor according to this criterion is, in fact, factor 5, which accounts for 11.84 per cent of total common variance. This is a very significant factor, again a bipolar one, concerned in part with household size, but in the main with tendency

towards or away from family life. The factor can without doubt be labelled family status. The highest positive association is with

Original variables with the ten highest associations Factor 5: Varimax solution		
14	Households with one or two persons only	.708
11	Population in shared dwellings	.647
15	Households with five or more persons	-.566
13	Households with three or more children	-.547
22	Population in unskilled occupations	.456
3	Population aged 60 and over	.453
23	Household heads in semi-skilled occupations	.422
1	Population aged under 5	-.336
26	Males in service industry	.327
18	Population in professional and managerial occupations	-,257

the percentage of households consisting of only one or two persons, and this is followed by the percentage of the population sharing a dwelling with another household or households. Other strong positive loadings occur with the percentage of the economically active population in the unskilled occupational group, the percentage of economically active household heads in the semi-skilled group, and the percentage of the population aged 60 and over. These positive loadings all point towards a lack of family life, and this is reinforced by consideration of the high negative loadings. These loadings add up, in fact, to the classic "urban" situation identified by Burgess (1925) as the "zone of transition", and to a certain extent modified by later sociologists. Using Gans' (1962) definitions of such city centre populations it is easy to identify the "deprived populations" of the very poor (unskilled and, to a lesser extent, semi-skilled workers), and the "trapped

populations" of the poor and the elderly. Gans also includes "ethnic villagers" in his classification of city centre dwellers, and it is clear from the loadings on factor 3 in the varimax solution that those immigrants from outside England and Wales fall into this category and share many of the same characteristics as the other city centre dwellers. Here, however, the fact of migrant status puts this group in a category of its own, and distinguishes it from the other populations of the city centre.

The negative loadings on factor 5 reflect the other extreme of the urbanism/suburbanism continuum identified in urban sociology. The highest negative loading is with the percentage of households with five or more persons, followed by the percentage of households with three or more children at or below school age (12 years old or under). Another negative association is with the percentage of the population aged under five, and a less significant loading is with the professional and managerial occupational category. Again this association with the highest occupational group is inconclusive, here because of the size of the loading, but the negative loadings paint a consistent and easily comprehensible picture of family life. Scores on this factor would, clearly, distinguish between areas with a strong preponderance of family units and those where very little emphasis was placed on the raising of a family. Whether or not this differing emphasis was reflected in urban and suburban locations at this time must await the mapping of the scores for this factor.

Although factor 4 accounts for the next highest percentage of

total common variance, it is more convenient here to examine factor 6, which accounts for 7.56 per cent of common variance and is the sixth most important according to this criterion. Factor 6 is again concerned with family life, but here the emphasis is on the stage in the development of the family itself. The three highest loadings are in

Original variables with the ten highest associations.
Factor 6: Varimax solution

2	Population aged 5 to 14	-.666
13	Households with three or more children	-.426
15	Households with five or more persons	-.378
28	Children at school	.336
22	Population in unskilled occupations	-.332
4	Fertility ratio	.305
16	Resident domestic servants	.302
14	Households with one or two persons only	.294
18	Population in professional and managerial occupations	.236
5	Sex ratio	-.209

a negative direction, and are associated with the percentage of children aged five and over, the percentage of households having three or more children, and the percentage of households with five or more persons. These three loadings tend to suggest a picture of older families, and the only inconsistent element is the positive loading on the percentage of children at school. From the original correlation matrix, however, there seems to be no clear connection between the percentage of children attending school and the number of school-aged children. This index is, in fact, surprisingly unpredictable from the other variables used in the analysis, the highest correlation being with lodgers as a percentage of the total population. It is understandable, therefore,

that this index should not appear to be closely related to the other variables more strongly associated with this factor. The other loadings are consistent with this pattern of older families, although none have a very significant loading with the factor. Again there is a tentative but inconclusive suggestion that high social rank may be associated with low fertility, and the loadings suggest that the positive extreme of this factor may be associated with families at an early stage of development, but this feature is not very well developed in the factor structure. On the whole it seems legitimate to label the factor type of family, bearing in mind that it is primarily a unidimensional factor concerned with the characteristics of families at quite an advanced stage of development.

Finally the two factors in the varimax solution which have not yet been interpreted can be seen as being for the most part concerned with residual variation - variation contained in the original seven common factors but not able to be distributed to any of the other

Original variables with the ten highest associations

Factor 4: Varimax solution

21	Population in semi-skilled occupations	.857
23	Household heads in semi-skilled occupations	.777
20	Population in skilled manual occupations	-.388
14	Households with one or two persons only	-.289
15	Households with five or more persons	.270
8	Population born in Hull	-.251
5	Sex ratio	-.241
2	Population aged 5 to 14	-.223
28	Children at school	-.206
22	Population in unskilled occupations	-.204

factors in the solution. Factor 4 is the fifth largest in terms of the percentage of common variance explained, accounting for 10.20 per cent, and factor 7 is the seventh highest, accounting for 5.45 per cent of common variance. Factor 4 accounts for the residual variation of the semi-skilled occupational category, and loads heavily on the percentage of the economically active population and the percentage of household heads in this group. This is the largest association of the latter variable with any factor, and to some extent this factor can be seen as drawing attention to this group. The as yet unallocated variation on the total population in this group, which includes the large numbers of domestic servants, is also a major constituent of this factor. The only other loading of importance is on the percentage of skilled manual workers, which loads negatively with the factor. This should not be given undue consideration, however, as the loading is a relatively low one, and the factor primarily concerned with the semi-skilled residual variance. Similarly factor 7 allocates the residual variation of the skilled non-manual category. The highest

Original variables with the ten highest associations
Factor 7: Varimax solution

19	Population in skilled non-manual occupations	.754
22	Population in unskilled occupations	-.405
4	Fertility ratio	.304
12	Gross population density	.259
1	Population under 5	-.242
15	Households with five or more persons	.202
28	Children at school	.180
17	Lodgers	.142
10	Population born outside England and Wales	-.134
26	Males in service industry	.129

association is with the population in this category, followed by quite a high loading on the percentage of the population in unskilled occupations. The other loadings are predictable, and support the interpretation of the factor as allocating the skilled non-manual residual variation. It is interesting that in the structure of both these residual factors the second loading suggests the opposing social group in terms of occupational status. Factor 4 almost certainly contains some element of semi-skilled domestic servants in its composition, and this is set against the skilled manual workers in the same way as the basic social rank pattern of factor 2. Factor 7 seems to imply more of an economic dichotomy between the middle classes and the urban poor, but in both these factors the residual element is uppermost.

The Contribution of the Varimax Solution

Even a straight forward interpretation of the Varimax solution has, quite clearly, confirmed many of the features of the hypothesised model of social differentiation in the nineteenth century town. The impact of the varimax model, the main limitation of which is its insistence on orthogonal factors, has in the present study been largely that of drawing attention to social rank, family status and immigration as the major distinguishing features of different residential areas. As spatial distance inevitably reflects social distance, the effect has been to define these axes as the major lines of differentiation in nineteenth century urban society as a whole. Five major common factors have been discovered, which together

account for some 70 per cent of total common variance within the space defined by the original 28 variables, and all five of these factors can be seen as reflecting different aspects of these three very significant lines of social differentiation.

The first factor, accounting for the largest single percentage of the total common variance, is in many ways the least satisfactory of the common factors. The employment of women other than in domestic service was not general, and in the majority of cases a married woman would not be engaged in paid employment: "The working woman was not, like "Punch" and Free Trade, a Victorian institution" (Neff, 1929, p. 12). In the Hull survey only about two thousand women were actively employed (36.73 per cent of the female population aged 15 and over), and approximately half of these were engaged in domestic service (Table 28). Women in the upper and middle classes were even more restricted in their choice of occupation than working class women, and:

> "Apart from teaching and prostitution, there were very few occupations by which an early Victorian middle-class woman could support herself - let alone any children she might have - if she were so unfortunate as to have to do so."
>
> (Reader, 1967, p. 167)

The Victorian working woman must, therefore, have been primarily motivated by considerations of economic need, and the concentration of women in the lower grades of the occupational classification supports this view. In carrying out factor analysis on an areal basis, however, the real social distance between working women and other groups in the society has been masked by the residential

Occupational Group		Production industry			Service		Total
		Textiles	Clothing	Other	Domestic	Other	
1	Manufacturers, upper professionals, etc.	-	-	1	-	-	1
2	Lower professionals, small employers of labour	-	3	3	-	89	95
3	Skilled non-manual workers	-	-	-	-	167	167
4	Skilled manual workers	67	386	41	75	5	574
5	Semi-skilled workers	155	44	1	727	41	968
6	Unskilled workers	2	-	-	188	19	209
	Total	224	433	46	990	321	2014

Table 28: Occupations of working women in Hull, 1851.
(Source: Census enumerators' books, 1851 census, 20% sample)

proximity of domestic servants to their employers. The factor, it might be suggested, with reason, is concerned with economic stratification in society, and is in fact a social rank index. The lack of residential freedom for domestic servants has, however, severely limited the value of the factor in this respect.

The other four common factors in the varimax solution are much more readily interpretable, and clearly fall within the dimensions of social rank, family status and migrant status. A feature of prime importance is factor 2, measuring on the one hand the servant employing population and on the other the extremely important working class population of skilled manual workers. Together with the first factor this bipolar factor draws attention to the very great importance of social rank as a line of demarcation within the urban population. Secondly factor 2 confirms the distinction between the professional and managerial population, and to a lesser extent skilled non-manual

workers, and the bulk of the urban industrial workforce - the skilled manual occupational category. This basic social rank division was formerly suggested as a fundamental form of social differentiation in the nineteenth century, and has been strongly confirmed by the varimax solution.

The third most important factor in terms of the proportion of common variance accounted for is concerned with immigrant status, and clearly reflects the inferior social position of immigrant groups from outside England and Wales. The lack of emphasis on family life and the clear association of this group with residential instability can be seen, from modern studies, to be a common feature of the social structure of recent immigrant groups. In the case of this group the factor loadings also draw attention to the lack of occupational equality between this population and the host population, and the position of the Irish born in nineteenth century English society suggests that this feature of the composition of factor 3 is largely due to the Irish forming the bulk of the population born outside England and Wales. This factor provides a bonus in that it is also associated with the locally born population, and therefore reflects the total pattern of immigrant and native born populations.

Factor 5 is clearly a measure of family status, and is fourth in order of importance in terms of the percentage of total variability accounted for. The difference between this factor and that of migrant status is not, however, very great, and not too much stress should be laid on the comparative placing of these two factors,

especially in view of the associations with family life inherent in the migrant status factor. In all cases, in fact, the percentage of variance explained is a function of the relationship between variables, and is therefore a reflection of the original selection of data rather than an objective measure of a factor's importance. Factor 5 places a greater emphasis on family size than on actual family composition, but is supplemented by factor 6. This "type of family" factor draws attention to an axis of differentiation highlighting families at a relatively advanced stage of development, with a large proportion of children in the 5 to 14 age group. These two factors - family status and type of family - together account for nearly 20 per cent of total common variance, and define two distinct axes within a single dimension of family status.

The most apparant difference between the varimax factors for mid nineteenth century Hull and similar factors in modern studies, using the same methods, is their composition in terms of the variables associated with each factor. The proportion of resident domestic servants in the population is clearly of prime importance in defining social status, whereas in modern studies relative classes based on occupational groupings have proved most valuable. Such indices are useful in the nineteenth century situation, but the employment of domestic servants over-rides such indices as a measure of high social status. This validates the stress placed on this index as a measure of social status by nineteenth century writers, notably Booth (Industry Series, I) and Rowntree (1901). In the present study, however, measures of overcrowding, also used by Booth as an index of

social status, do not load very significantly on the social rank factor, although they figure in a prominent position in the composition of the migrant status factor. Another index framed for its possible social rank connotations is that giving the percentage of households with three or more children of or under school age, which was largely inspired by Rowntree's (1901) poverty cycle concept. This measure has not proved strongly associated with social rank, but has proved invaluable as a measure of high priority to family life. The relationship between social rank and a family's age and size is without doubt a complicated one which could hardly, perhaps, be expected to emerge from an analysis of this nature.

On the whole the associations which might be predicted from modern work, for example Shevky and Bell's (1955) Social Area Analysis scheme, are apparent in the composition of the factors in the Hull study. One major exception lies in the field of female employment, where Shevky and Bell assumed that the proportion of women in the labour force would be a measure of "urbanization" or "family status". This index has, in fact, proved one of the most inconsistent of the indicants suggested by Shevky and Bell. McElrath (1968) sees this as part of the general tendency for family status to become increasingly independent of social rank with increasing societal scale, and the inconsistency of family status measures in less industrialized economies has been well illustrated (Clignet and Sween, 1969). In the present work employed females basically occur as an index of social rank, although there is clearly some indication of the incompatibility of family life with working women in the composition of factor 1.

The varimax solution has in the main, therefore, defined the major axes of social differentiation in the nineteenth century town, and the most important indicants associated with these axes. While this has been very valuable such a solution does not, in fact, tell all there is to know about the factor structure. The varimax factors are statistically uncorrelated, but the concepts they reflect may in fact be neither independent nor uncorrelated. The female employment factor has a close association in terms of high loadings on common variables with factor 2, the servant employing population, and there must clearly be some degree of inter-dependence between the two family status factors. In addition an important feature of the initial model of nineteenth century urban differentiation has not been reflected in the varimax solution - the hypothesised links between social rank and family status. Only a further rotation to an oblique solution could be expected to reflect these features of urban social structure.

Chapter Nine

The Spatial Pattern of Residential Differentiation

It is ironic that, when so much of the more valuable work carried out by Chicago sociologists in the 1920s and 1930s is largely overlooked by modern researchers, the lasting contribution of this "ecological school" to urban research has been one of its least satisfactory aspects. The models defining spatial patterns of land use and residential differentiation are now the main links with this early work on urban sub-areas and, although subjected to severe criticism from their inception, later researchers have so far failed to replace them by more scientifically defined models and have been content merely to introduce modifications. It is valuable, therefore, to look at these models in some detail, and to try to see what part they might play in an understanding of the spatial patterns of social differentiation.

The Burgess (1925) model of concentric zones within the city is perhaps the simplest and most easily criticised of any model dealing with urban phenomena. Burgess draws attention to five major concentric zones ringing an urban centre, largely based on rent gradients. Outwards from the central business district he identifies a zone in transition from residential to industrial use, followed by a "zone of working men's homes", a fourth zone of "better residences" and a final zone of commuter-belt suburbs and satellite towns. Into this basic zonal pattern isolated populations are fitted like those of "hobohemia"

within the central business district, immigrant colonies in the zone in transition, and second immigrant areas in the third zone.(Burgess, 1925). The "ideal" form which this model suggests has prompted much criticism of its applicability, but it must also be borne in mind that the model has more often than not suffered from being misrepresented, and is in fact a basic model of urban growth. Burgess (1953) has explicitly defended the limitations of the model, writing that:

> "My name has been identified with a zonal theory of growth of the city as it would be interpreted graphically if only one factor, namely, radial expansion, determined city growth. The critics of the theory have been rather obtuse in not realizing that this theory is an ideal construction, and that in actual observation many factors other than radial expansion influence growth."
>
> (Burgess, 1953, p. 178)

The Burgess model does, however, conjure up the image of relatively homogeneous zones circling a city centre and, Alihan (1938) suggests, is directly contradictory to Burgess's other main ecological tool - the gradient. Certainly empirical tests of the internal homogeneity of concentric zones have proved very unsatisfactory (Davie, 1938), and it is possible to say that:

> "The standard zonal boundaries do not serve as demarcations in respect of the ecological or social phenomena they circumscribe, but are arbitrary divisions. They can be treated only as conventional methodological devices for the classification of data."
>
> (Alihan, 1938, p. 224-225)

The Burgess model, although in theory limited in scope, must

clearly by its nature summarize much of urban life. In contrast the model's major opponent, the sector model developed by Hoyt (1939), has much more closely defined limits: the distribution of rental classes. High rent areas, Hoyt argues, occupy superior residential locations, often along major transport routes and, as demand increases, and transport facilities improve, a wedge-shaped high rental area tends to develop from the city centre to its periphery. This high status population acts as an attraction for intermediate rental areas, which tend to form alongside the high rental areas, or may form independently in other preferred residential locations. Low rental areas, Hoyt concludes, occupy the remaining sectors, filling in the circle of urban development. The basic defect of this model is clearly in the importance given to the high status population as an attracting force, and in the over-simplification of social stratification inherent in this attraction process.

Like much work of the Chicago school, theories of spatial structure contain a number of inbuilt assumptions which need not necessarily hold. The Burgess scheme, for example, assumes a large and rapidly growing population similar to that of Chicago, where the model was first applied. In addition the model is based on the classic ecological concept of impersonal competition, and assumes private ownership of property and an absence of city planning. The models were formulated in modern American industrial society, and work on urban areas elsewhere suggests that the models do not possess the universality they were once thought to. In pre-modern cities one

of the basic assumptions of the Burgess model is lacking, namely that persons of high social status prefer to live in suburban areas. Sjoberg (1960) writes that, in the pre-industrial city:

> "The disadvantaged members of the city fan out toward the periphery, with the very poorest and the outcastes living in the suburbs, the furthest removed from the centre."
>
> (Sjoberg, 1960, p. 97-98)

As Richardson (1971) suggests, however, behind these limitations and the over-simplification of both models "there lies a core of truth sufficient to enable these models to enhance our understanding of even the most modern cities" (Richardson, 1971, p. 57). More recent work has supported both models to a certain extent, and a notable contribution has been Andersen and Egeland's (1961) discovery that family life tends to be arranged concentrically around a city centre, whereas social status shows a greater tendency towards a sector form. The general concensus of opinion is that the two models are joint influences on the spatial pattern of urban social phenomena. Berry (1965) argues that:

> "If the concentric and axial schemes are overlain on any city, the resulting cells will contain neighbourhoods remarkably uniform in their social and economic characteristics. Around any concentric band communities will vary in their income and other characteristics, but will have much the same density, ownership and family patterns. Along each axis communities will have relatively uniform economic characteristics, and each axis will vary outwards in the same way according to family structure."
>
> (Berry, 1965, p. 116)

Few, however, would be this dogmatic, and the identification of such spatial patterns in any empirical study remains, for the most part, a question of personal conviction.

Spatial Patterns in Hull, 1851

Whereas factor loadings give a breakdown of the associations of each variable with each factor, factor scores give a measure of the association of each individual in the study with each factor. Scores have been estimated for the seven factor varimax solution, using the method of complete estimation (regression), for each of the 74 sub-areas used in the study. These scores have been standardised to zero mean and unit variance but are, like the factors themselves, mathematical constructs and have no real value but only a relative one. This obviously creates difficulties of where to divide the scores on a factor for mapping purposes. Preferably some scheme of equal divisions must be overlain on the scores - either allocating an equal number of areas (individuals) to each group, or an equal range of the scores to each division. The latter method tends to highlight extremes at either end of the range of values, but has the disadvantage of grouping a regrettably large number of scores in the middle ranges of the scheme. In mapping the Hull data a percentile scheme has been applied, giving a roughly even number of areas in each of four groups (Figure 12 - the cut-off points for the percentile divisions are shown by arrows). Occasionally this gives quite a wide range of values in the groups at the two extremes of the scale, but otherwise the method gives a very satisfactory cartographic summary of the factor scores.

Scores on factor 1 (female employment) and factor 2 (servant employing population) tend to suggest quite a complementary pattern, as the conceptual links between the two factors would suggest. Taking

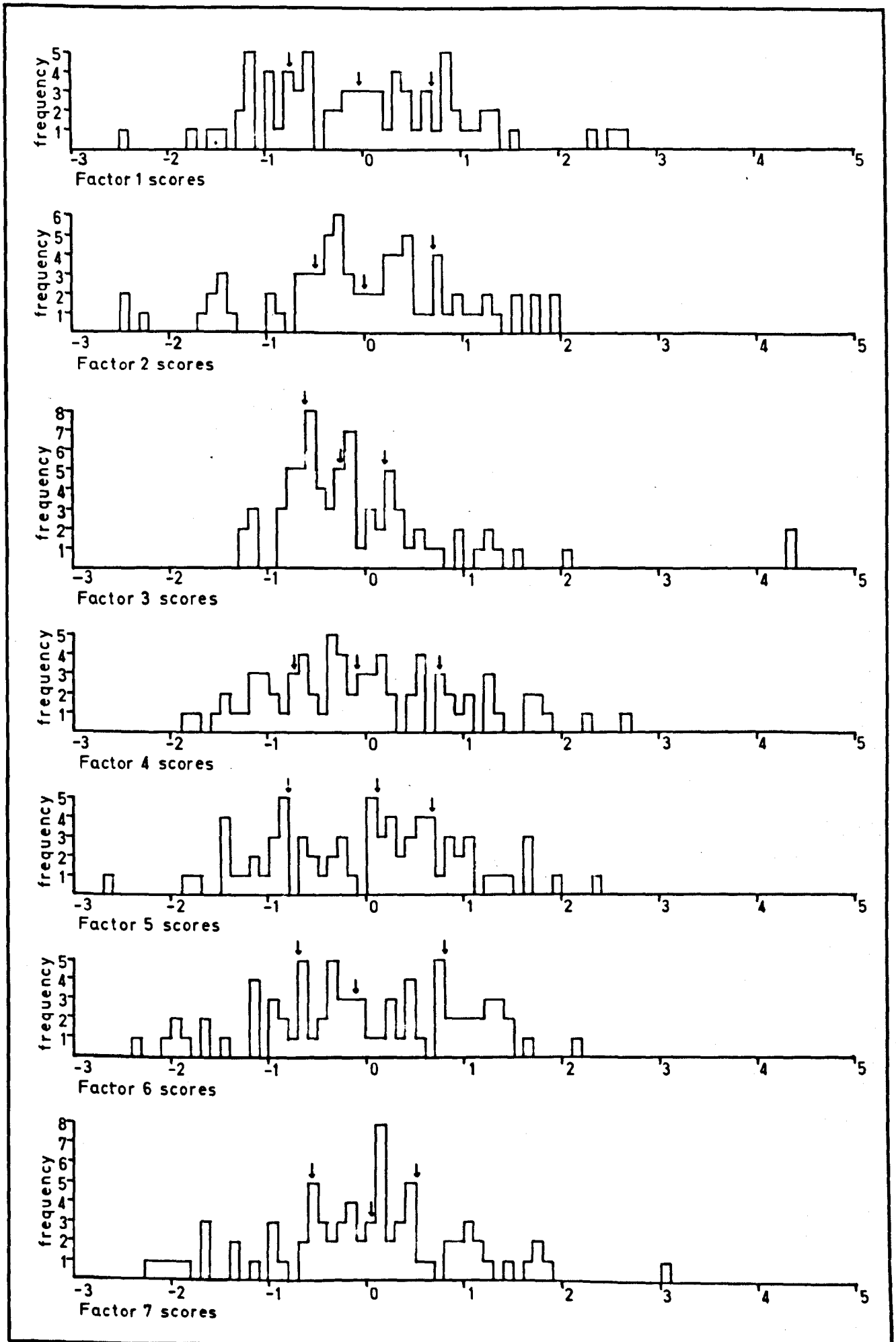

Figure 12: Distribution of scores on factors 1 to 7, Varimax solution for 28 variables, Hull, 1851.

the second factor first, this dichotomous factor, identifying the servant employing population at the positive end of the scale and skilled manual workers at the negative, shows quite an easily comprehensible picture (Figure 13). The most striking feature is the huge wedge of low scores directly to the north of the town centre, centred on the River Hull. Contemporary maps show this to have been the most industrial area of Hull, and it was in this area that the town's two cotton mills of the period were located (Figure 23). This in itself must have had a very significant influence on framing the social character of the area as employment in the industry amounted, according to the 1851 census, to some 2,050 individuals (Census 1851, II, Vol 2). Other important Hull industries were also located here, however, including such establishments as seed crushing mills and roperies. The large scale Ordnance Survey maps of the period record the industrial nature of the area very precisely, and much of this detail is retained on the maps in the contemporary six inches to one mile series.

At the other end of the scale the high scores on this factor show less of a general trend, but seem to suggest that the servant employing population prefers residential locations on the outskirts of the urban area. The highest scores on this factor are, in fact, largely for those suburban locations in process of development at this time. The only partly completed streets off Spring Bank and Beverley Road, and to a lesser extent Anlaby Road, show up very well on the maps of the period (Figure 23). On the other hand there are very significant areas with high scores on this factor elsewhere in

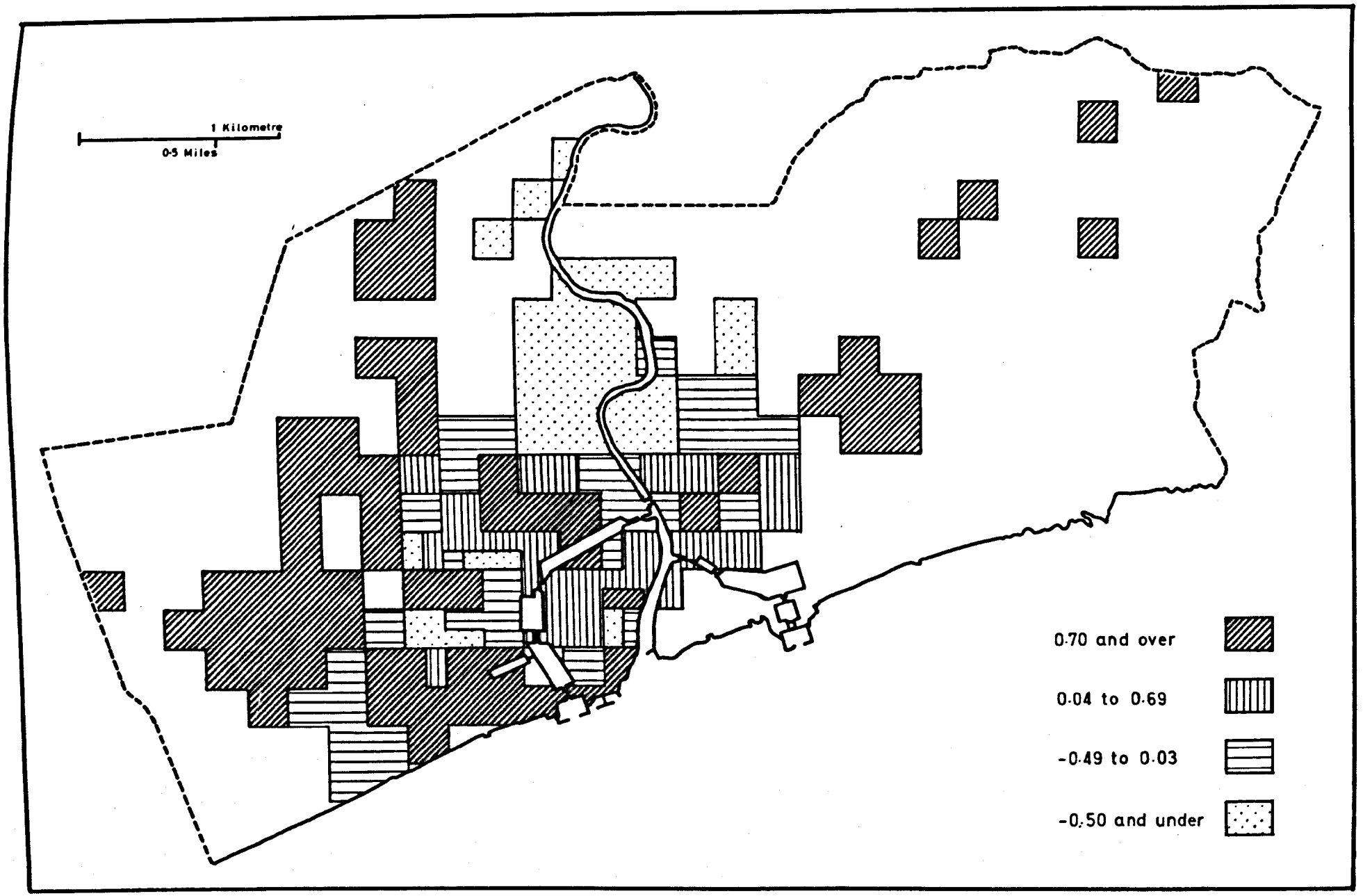

Figure 13: Scores on Varimax factor 2 - servant employing population - Hull, 1851.

the town, and of particular importance is that area to the north of Queen's Dock, and also extending to some degree south of the dock. This area is fringed by districts with lower scores on the factor, and is almost adjacent to the predominantly working class area around the River Hull. The history of the area serves as a very clear illustration of urban process. The suburb to the north of Queen's Dock was amongst the first to be developed outside the old town walls (later replaced by the town docks), and the process took the form of the speculative development of various estates as they became available. The transformation was begun in the 1770s, and by the end of the century this area of well proportioned Georgian housing was primarily the enclave of the better-off sections of the community (Victoria County History, 1969). Forster (1972) analyses the occupations of the inhabitants of streets in this area in 1791, and this gives a very clear picture of its high social status (Table 29). By this time various schemes to the south of the dock had also been carried out, notably the sporadic attempts to improve Whitefriargate by Trinity House, who carried out new building here between the middle of the eighteenth century and its close. Parliament Street also belongs to this period, being built during the last five years of the century at the instigation of a local lawyer who contrived to combine this scheme of urban renewal with a sound investment (Victoria County History, 1969). Here the mobility of the higher status residential area is very well illustrated. High status residential building was still continuing in the Old Town during the eighteenth century, and particularly noticable is the rebuilding of Maister's

Street	Merchants	Master mariners Shipowners	Professions Gentlemen	Tradesmen Others	Total
George St.	5	6	1	2	14
Savile St.	3	14	1	8	26
Charlotte St.	4	1	-	-	5
Dock St.	-	4	1	4	9
North St.	13	1	1	3	8
Total	15	26	4	17	62

Table 29: Occupations of inhabitants of streets north of Hull Dock, 1791.
(Source: Forster, 1972, from Battle, R. G., "The First Hull Directory", Hull, 1791)

House after a fire in 1743, and the building of later Georgian housing in the area (Victoria County History, 1969). By the end of the century, however, the new Queen's Dock area had become one of prime importance and by 1851, as the map of factor scores shows, the Old Town was of no great importance as a high status residential area, and new suburban developments had begun to equal, if not excel, the Queen's Dock suburb in terms of residential desirability.

Returning to the first factor, female employment, the map of factor scores (Figure 14) seems to have no easily comprehensible pattern until considered together with that of the servant employing population factor. The most notable feature is that the high scores on this factor coincide with areas at both extremes of the scale of social rank defined by factor 2. Female employment is clearly another factor of social rank, and the feature which has been responsible for

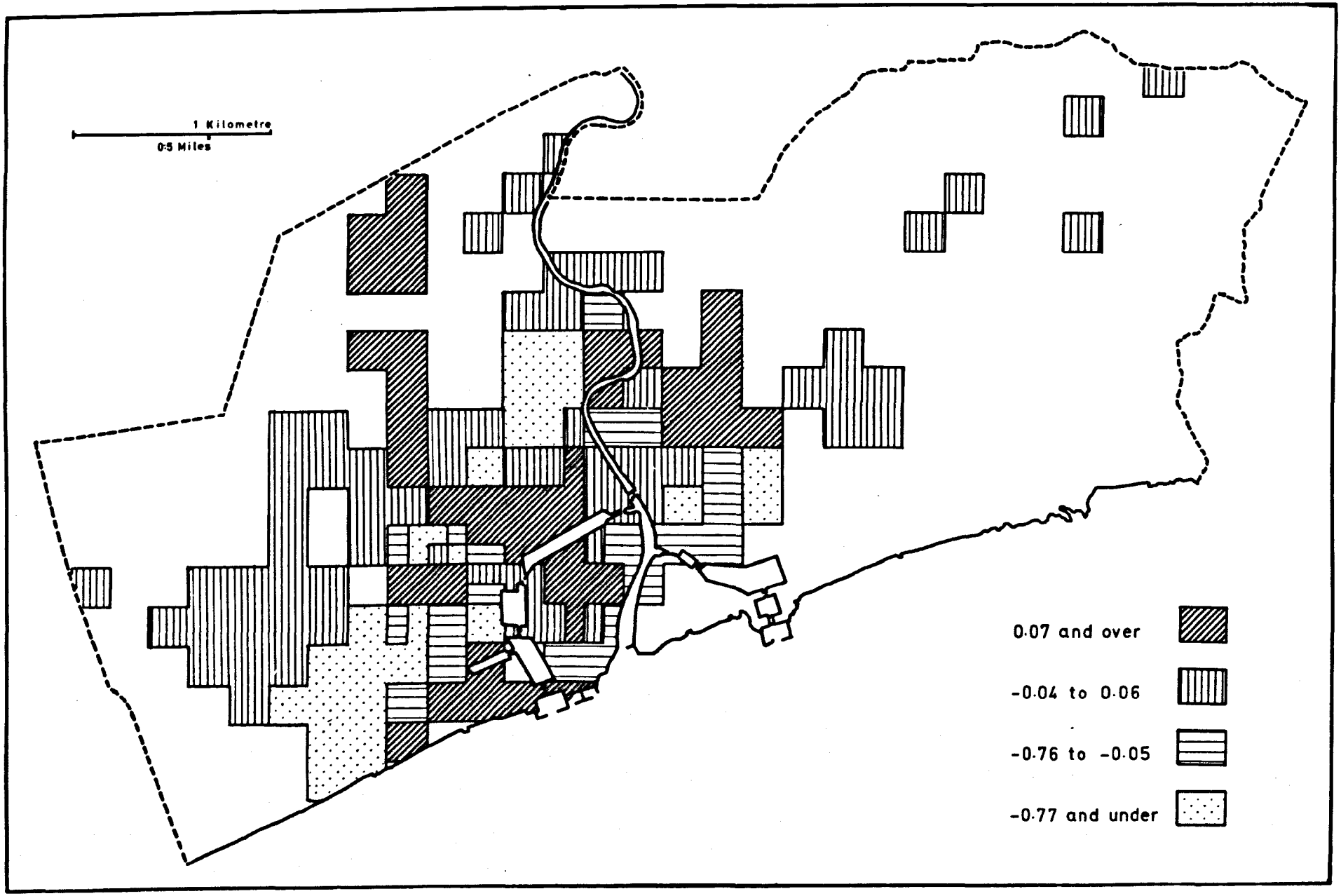

Figure 14: Scores on Varimax factor 1 - female employment - Hull,1851.

its emergence as a separate line of differentiation is the residential location of working women. Clearly the need to work is a common feature, but those women who find employment as domestic servants are for the most part resident in high status areas, whereas other working women have no such direct connection between their place of work and place of residence. The basic feature of social rank suggests that it might be constructive to consider these two factors together rather than in isolation.

One of the most readily comprehensible ways of comparing the scores on factors 1 and 2 is to cross-tabulate them, and map the information according to which cell of the table each area falls. This has been done using the previously defined percentile divisions for the two factors, and the resulting classification of areas into sixteen groups, while resulting in quite a complicated scheme, emphasizes the links between these two lines of differentiation (Figure 15[1]). The overall pattern has more in common with that of the servant employing facor than with that of factor 1. The wedge shaped working class area along the banks of the River Hull again shows up very clearly, but in this case the areas are also differentiated on the basis of the female employment factor. The pattern on the more dispersed higher status areas tends to confirm the picture of development suggested by factor 2 alone. It is interesting that the Queen's Dock area tends to stand out from suburban areas as having a higher proportion of working females, presumably as a result of large numbers

1. The shading scheme for this and figure 19 has been derived from that used by Robson, 1969, p. 180.

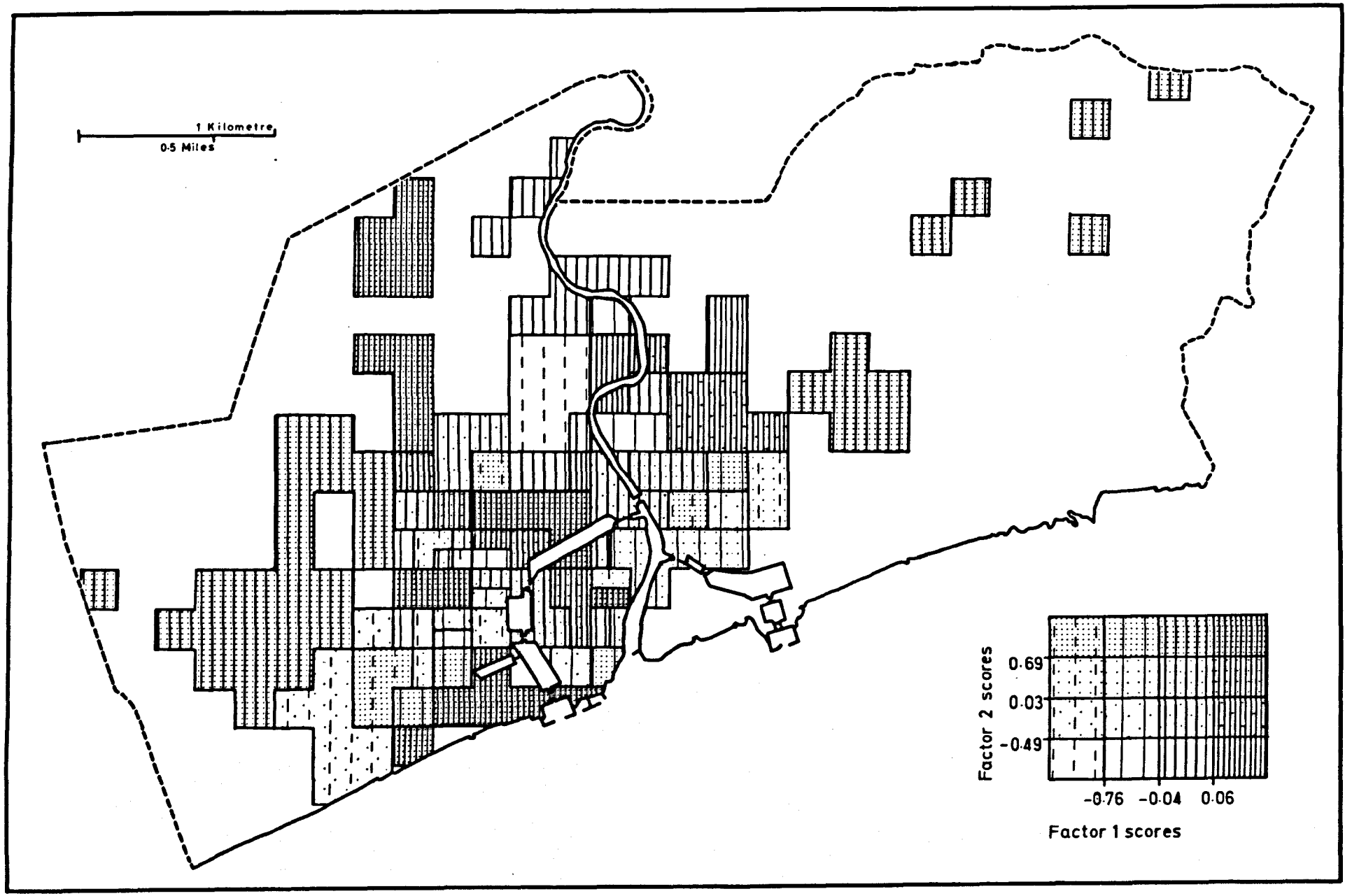

Figure 15: Scores on Varimax factors 1 and 2, Hull, 1851.

of domestic servants in the area. Although there is little direct evidence to explain this feature, it may be associated with the fact that this is a relatively well established high status residential area. Contemporary map evidence suggests that this is also true of the northern suburban area with high scores on both factors. The more recent development of most suburban areas and, it might be suggested, their more middle class character, would seem to work against high scores on both factors 1 and 2.

The Old Town area - enclosed within the Docks and the Rivers Hull and Humber - displays a very wide range of scores within a very small area. This must certainly be a relict feature of the time before the town had outgrown its original site to such an extent, and when the bulk of the population was housed here. Relatively high scores on both factors in the Old Town almost certainly reflect high concentrations of retail functions in the area, however, rather than the remnants of a high status residential area. The middle class retailer still preferred to combine his business premises and residence in one building. One incongruous feature of this composite pattern is the high status of the waterfront area, which can be explained as a result of an amalgam of features associated with a rather awkward spatial unit. The character of the area is largely framed by its western extremities, which are predominantly suburban and of quite high status, but elsewhere various retail establishments and a mixture of other features have combined to give scores just large enough for its inclusion in the highest percentile division of both factors.

The pattern produced by scores of factor 3 (Figure 16) is very

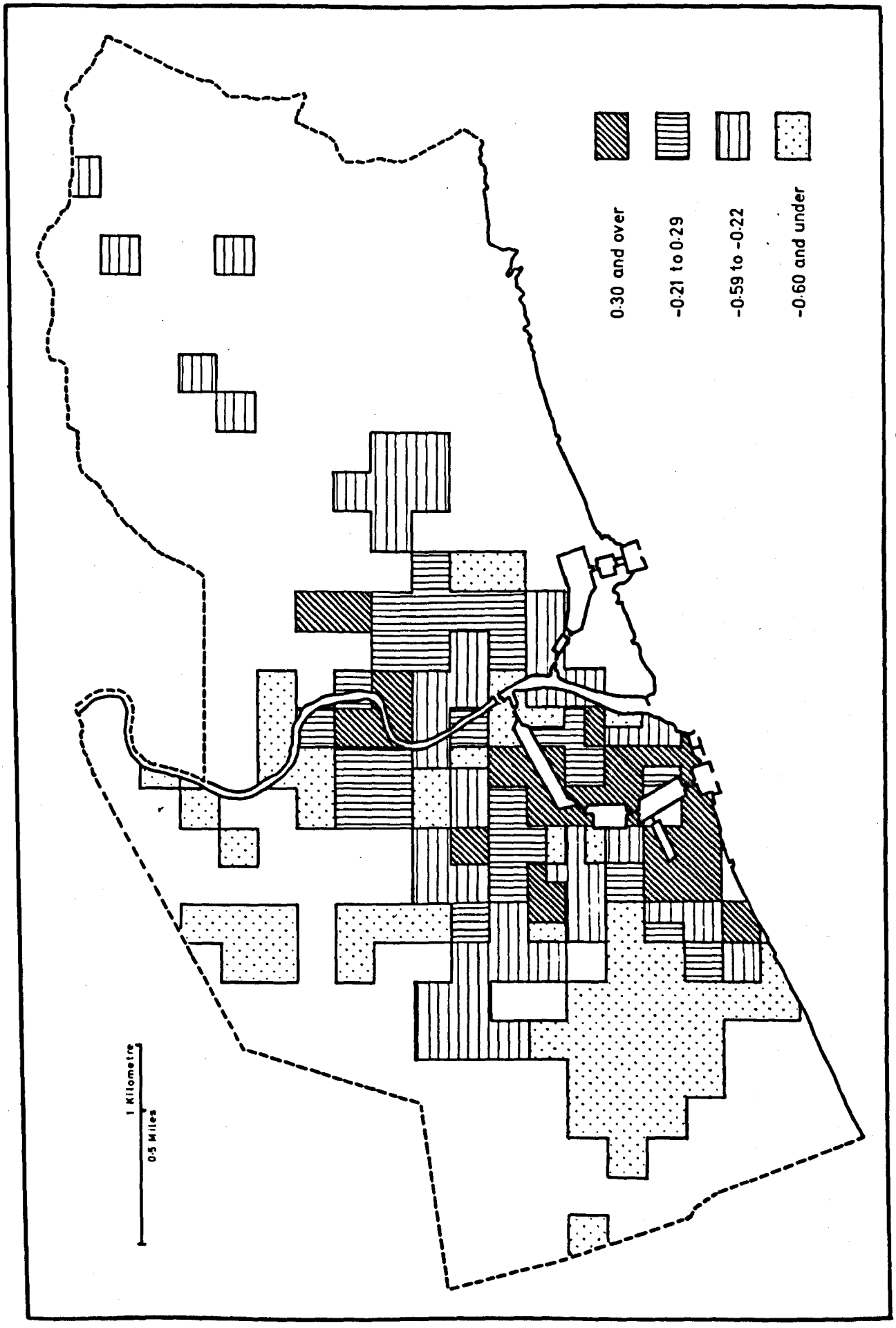

Figure 16: Scores on Varimax factor 3 - migrant status - Hull, 1851.

comprehensible, although the use of percentile divisions here tends to mask the wide range of values in the highest group (Figure 12). The two areas with the highest scores on this factor are, in fact, very strongly associated with the Irish community, as are the majority of areas with high scores on this factor. This Irish influence is tempered, however, by the factor's character as a general migration status indicator. The pattern produced by the factor scores suggests that, at least for the nineteenth century, birthplace is a reasonable approximation as an indicator of migration. The picture is easily understood, and accords well with the known characteristics of the residential decision amongst recent migrants to urban areas. Two main areas of high migrant status stand out very clearly - one in the town centre and another in the working class area along the River Hull. Here two processes can be seen to be at work. In the town centre the pattern reflects the expected residential instability of recent immigrants, and their concentration in areas where rented accommodation is most readily available. To the north the large percentage of immigrant industrial workers, especially in the cotton industry, produces a second area of high migrant status. Comparing this pattern with that produced by the social rank factors, there is no clear association between the two. High status suburban areas are, for the most part, also associated with a locally-born population, but elsewhere there is no such immediate relationship between the two dimensions.

Factors 5 and 6, like the first two factors, are in many ways complementary - both deal with aspects of family life. The pattern

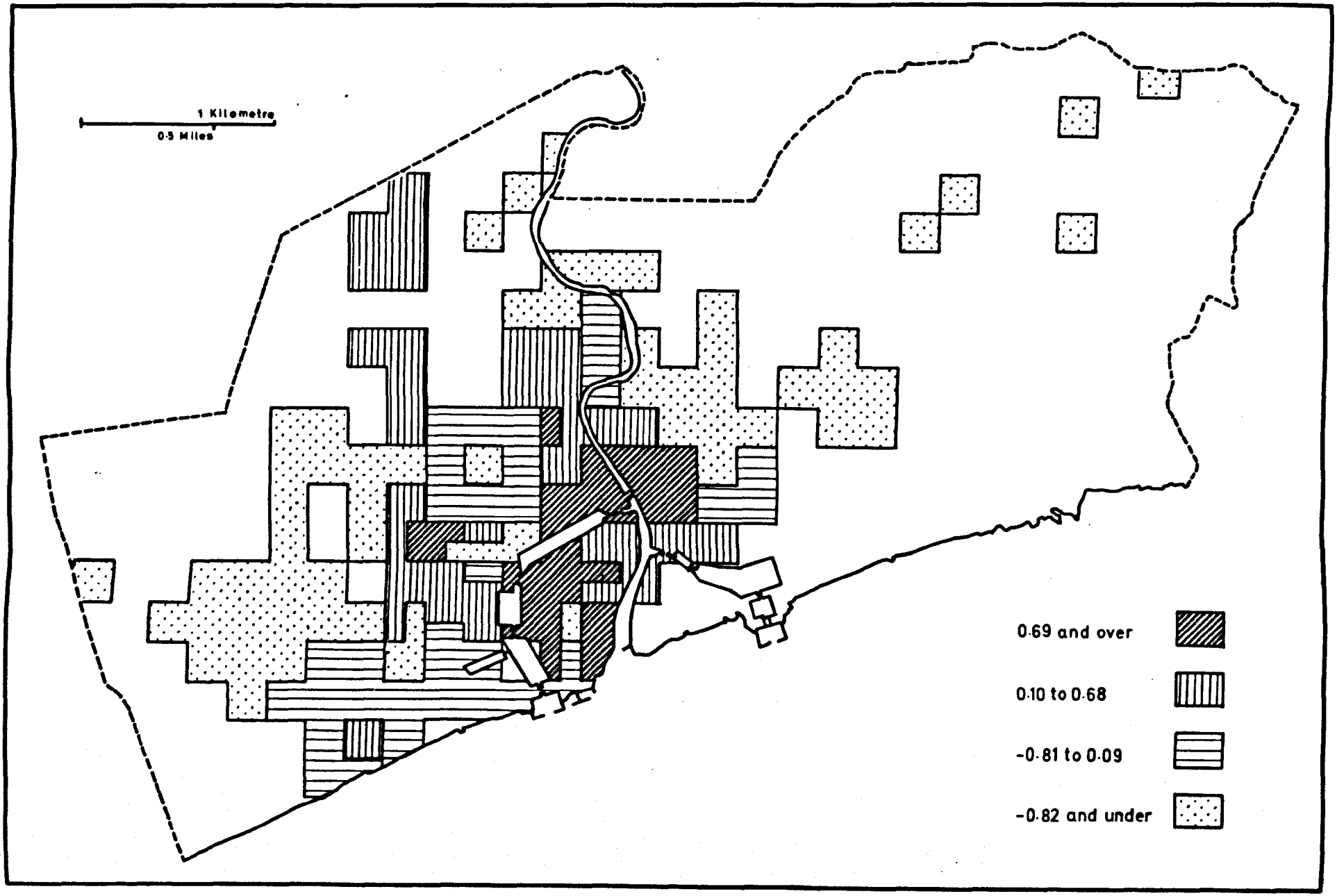

Figure 17: Scores on Varimax factor 5 - family status - Hull, 1851.

on factor 5 is very much as expected (Figure 17). Areas with high positive scores, representing a high proportion of small households and very little emphasis on family life, are almost exclusively confined to the town centre. The Old Town is particularly associated with such high scores, as are those other areas of older development immediately to the north and west of this area. The proportion of old housing in these areas, much of it by its design unsuitable, like the courts of the Old Town, for the raising of a family, is well reflected by the preponderance of small households and the lack of families in the child-rearing stage of development. Here the town centre conforms to the classic urban pattern which Burgess and other Chicago sociologists drew attention to. Away from this centre the factor scores grade into the lowest group, those areas with the highest emphasis on family life, which are for the most part in suburban locations. Although the suburbs are largely a high-status preserve, low scores on this factor are also found on the northern edge of the wedge-shaped working class area along the River Hull and elsewhere.

The pattern of scores on factor 6 (Figure 18), the type of family, shows some resemblance to the concentric pattern of factor 5, but this is obscured to some degree by those suburban areas where family life is at a less advanced stage of development. Here low scores indicate areas where older families are predominant, and high scores where this is not the case. The majority of the city centre areas of factor 5 tend to have intermediate scores on this factor, indicating the possibility of combining this stage in the family life cycle with town-centre dwelling. When the scores on these two

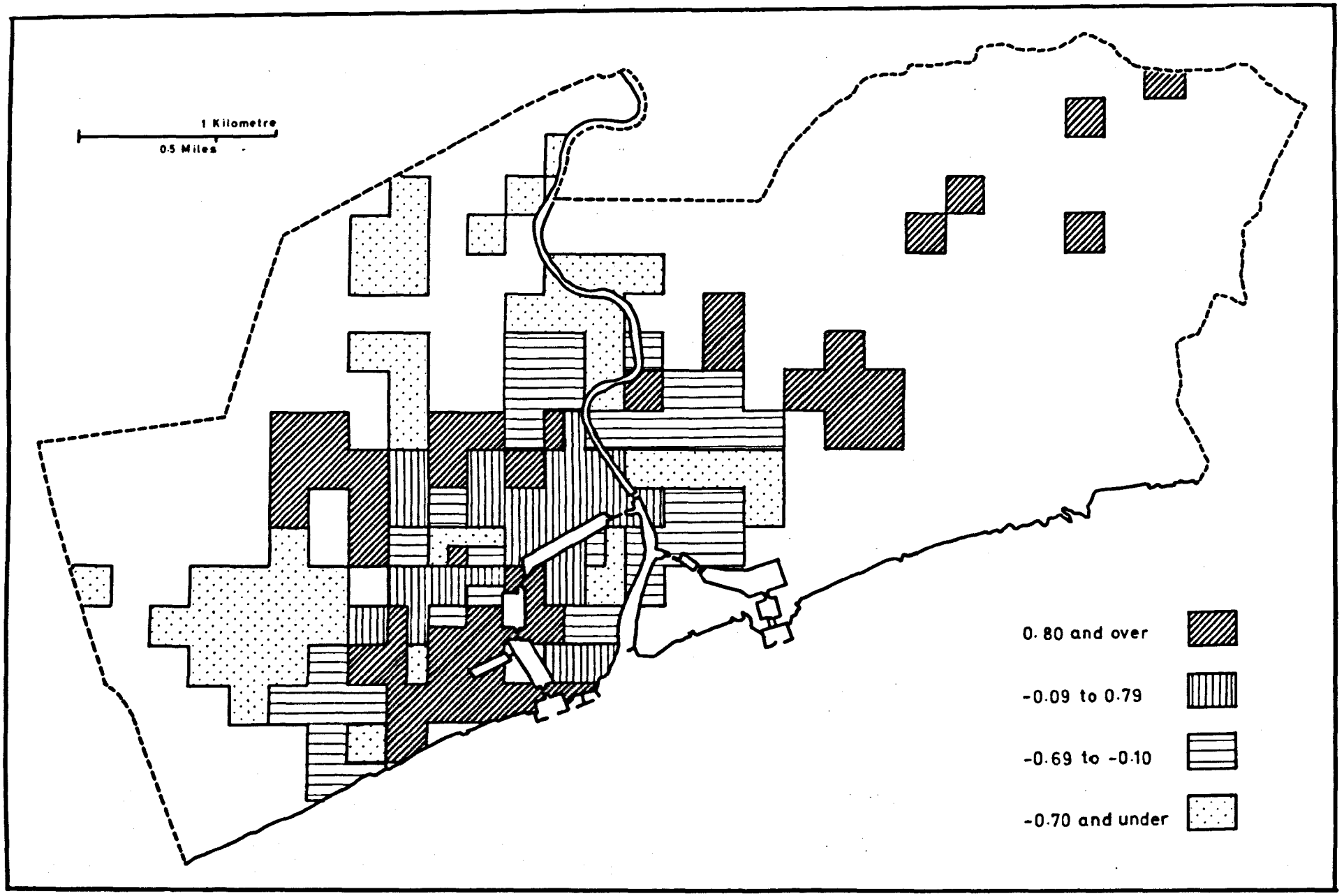

Figure 18: Scores on Varimax factor 6 - type of family - Hull, 1851.

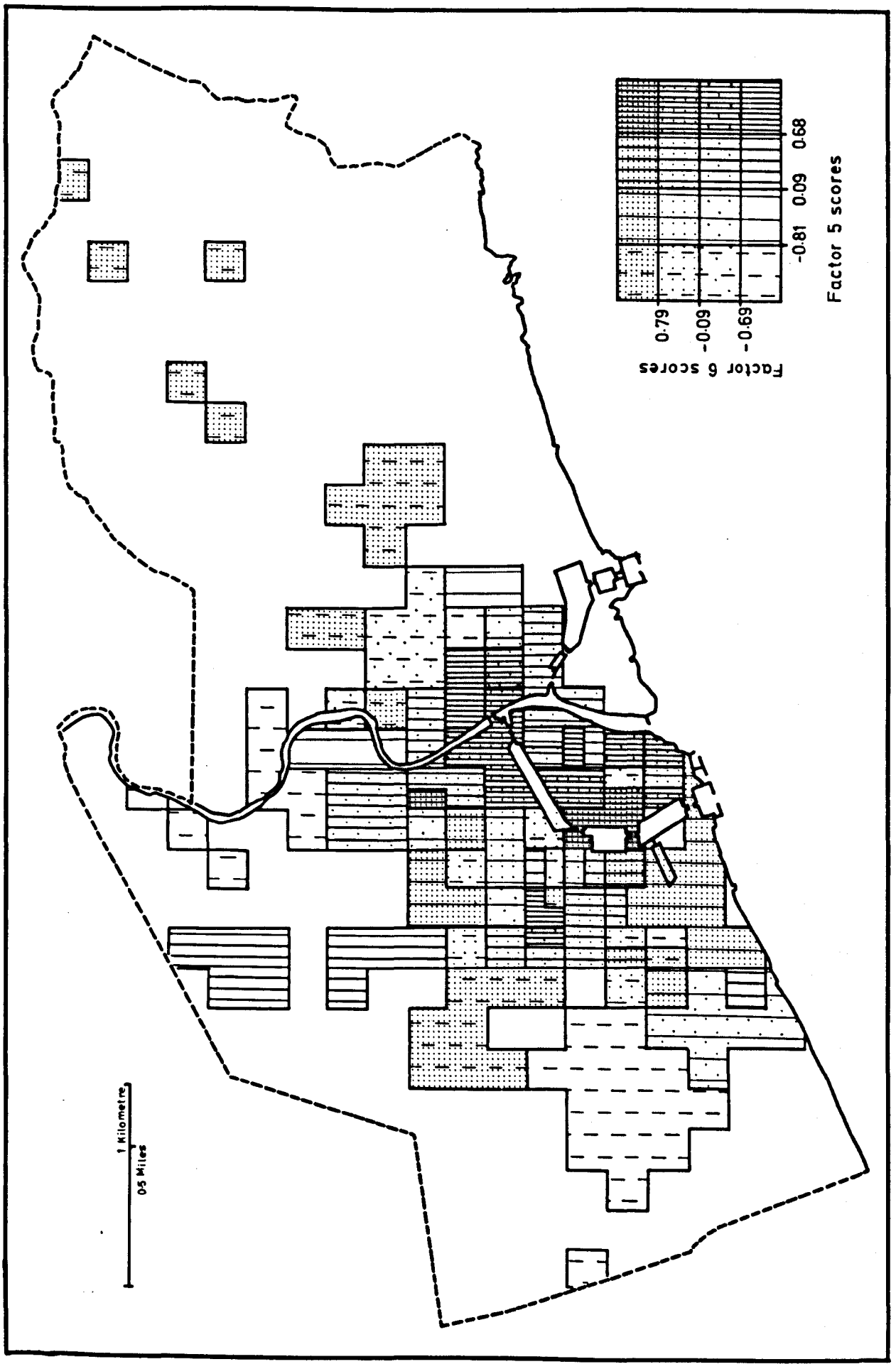

Figure 19: Scores on Varimax factors 5 and 6, Hull, 1851.

factors are combined on one map (Figure 19) the pattern retains the basically concentric form of factor 5, but the particular effect of adding factor 6 to this pattern has been to differentiate between suburban areas where family life is at an advanced or less advanced stage of development. At the same time those areas of the Old Town with a fair proportion of family-style households have also been highlighted.

Factors 4 and 7 are both residual factors, accounting for the previously unexplained common variance, and need have very little real meaning in terms of factor scores. The percentage of the economically active population in semi-skilled occupations, which has the highest association with factor 4, has already had much of its variation accounted for by factor 1, and also loads quite heavily on factor 5. The second highest loading on this factor is with the percentage of employed household heads in the same occupational category, which also loads quite heavily on three other factors. When mapped the scores are quite clearly those of a residual element (Figure 20). High scores occur in areas associated with working women - both in domestic service and industry - and in other locations throughout, for the most part, the central core of the town. The pattern in no way suggests a basic unifying feature between these areas, however, and its definition of summing up a great deal of previously unaccounted variation is certainly a correct one. Less negatively this factor does draw attention to the importance of this group in the nineteenth century town, and especially as a focus of female employment, but this importance may be slightly inflated due to the inclusion of two

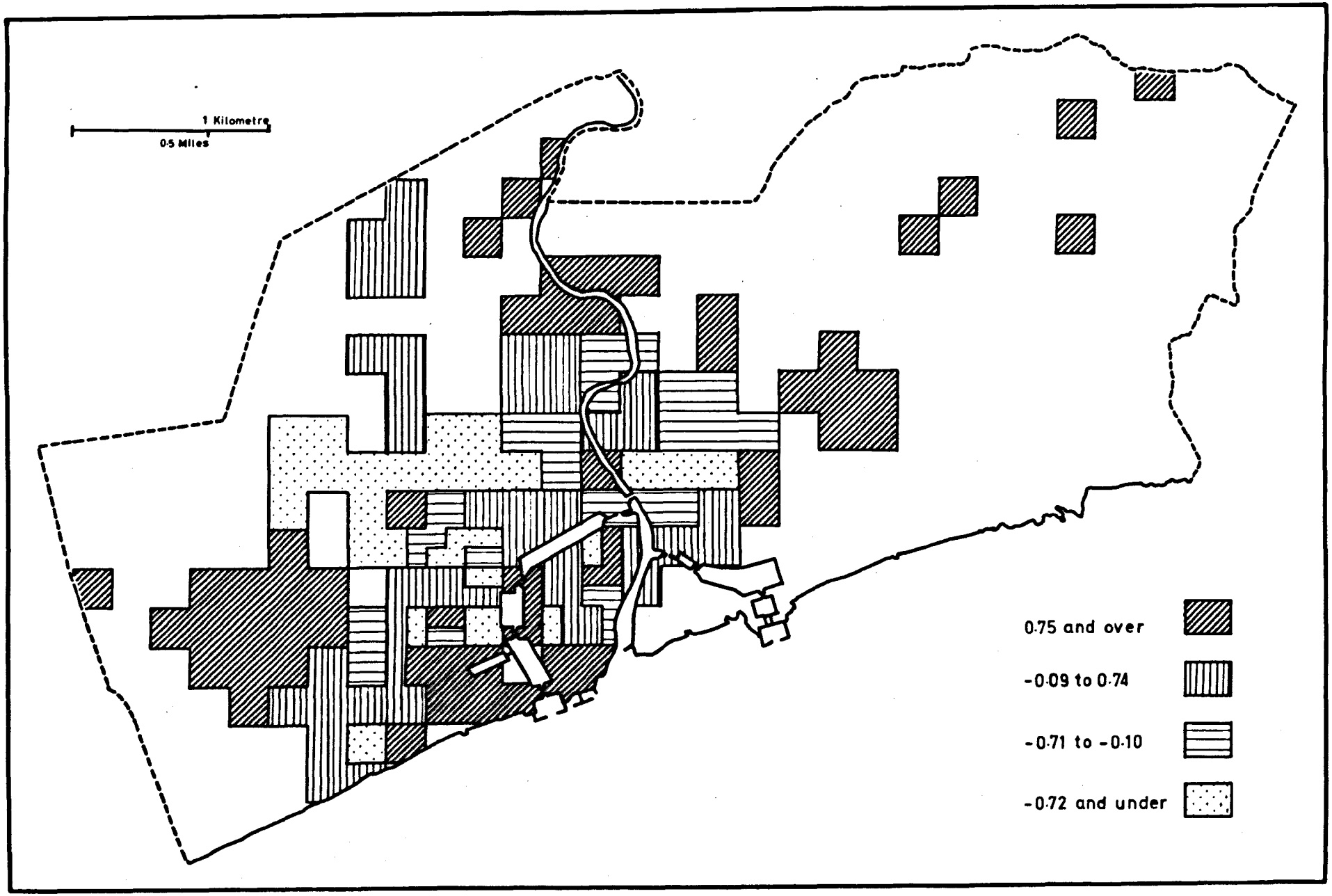

Figure 20: Scores on Varimax factor 4 - semi-skilled workers - Hull, 1851.

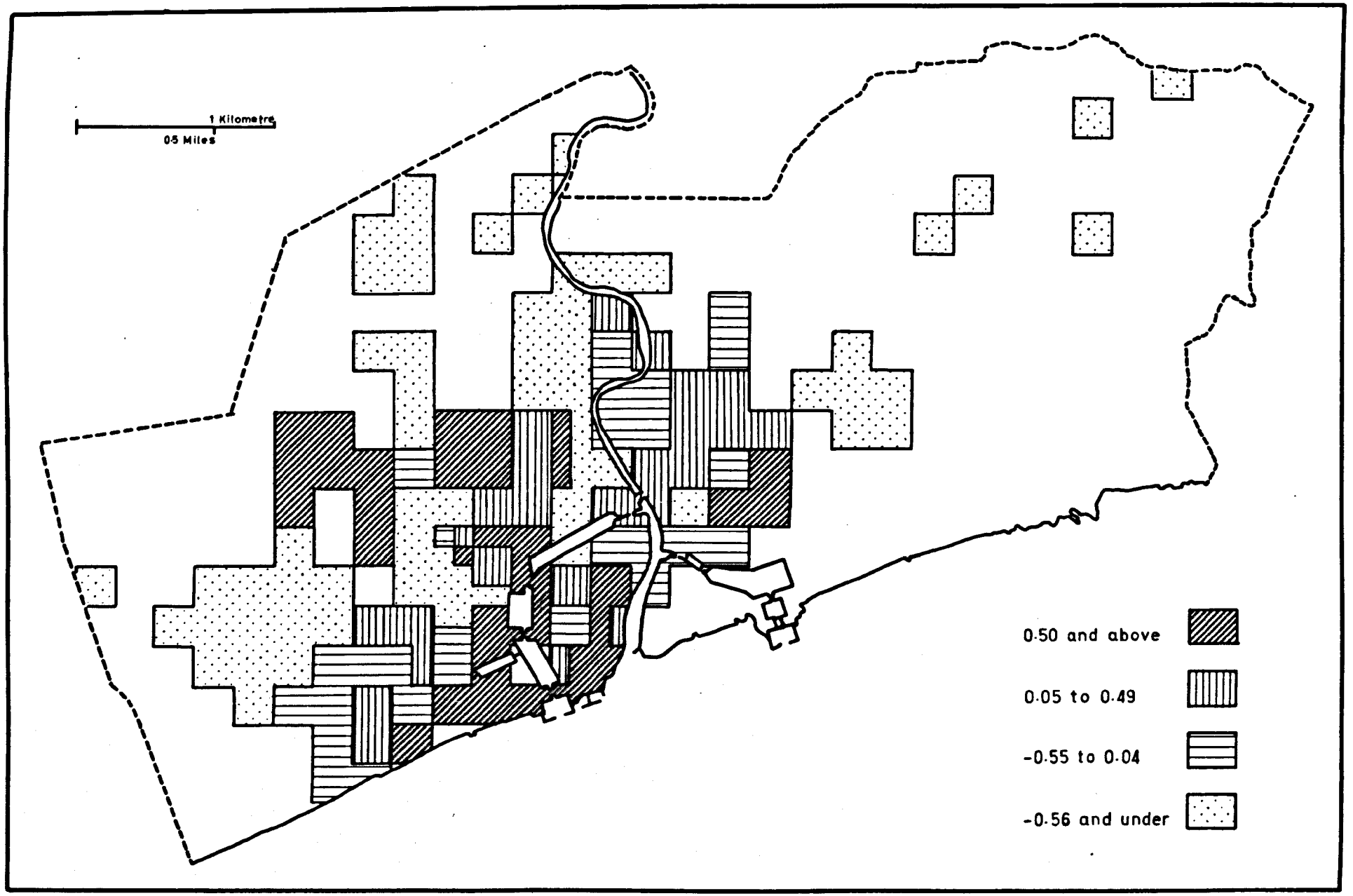

Figure 21: Scores on Varimax factor 7 - skilled non-manual workers - Hull, 1851.

indices dealing with the semi-skilled occupational group.

Factor 7 has much more meaning than factor 4 when mapped (Figure 21), although here the residual nature of the factor also affects the factor scores. The variable with by far the highest association with factor 7, the percentage of the population in skilled non-manual occupations, also loads heavily on factor 2. Here, however, the factor certainly reflects the importance of this middle class group as being largely unaffiliated with either of the two main social groups in the nineteenth century town. Some high scores occur in areas at both extremes of the servant employing/ skilled manual factor (factor 2), but in the majority of cases high scores are for areas which only score moderately on this social rank factor. In addition the scores bring out the importance of this group in the Old Town area, where much of the retail trade and office facilities of the period was concentrated.

Nineteenth Century Hull and Models of Spatial Structure

Both the Burgess and Hoyt models of urban social patterns can be seen as representing ideal types to which reality might be expected to correspond to greater or lesser degree. In the present study the most significant alignment with these basic models is the pattern of the main family status factor (factor 5), and to a lesser extent the supplementary type of family factor (factor 6). The clear concentric pattern of the family status factor is interesting in view of the basically free enterprise nature of housing development in the mid

nineteenth century, when even bye-laws to ensure the minimum standards of good housing were not introduced until, in the case of Hull, 1854 (Forster, 1972). Although areas of high family status occur even in the town centre, it is surprising that the concentric pattern of factor 5 has not been distorted to a greater extent by poverty and the economic necessity to seek poor quality and relatively inexpensive housing. A basic concentric pattern will, in fact, only be in evidence where housing development has a free hand. The provision of less economically orientated housing developments can easily distort the pattern, as Robson has illustrated with regard to present day Sunderland (Robson, 1969). In a free-enterprise situation, however, the economics of land prices and rent always tends to favour the suburbs as the location of more spacious housing suitable for family life. The migrant status factor also shows some inclination towards a concentric pattern, and this is again associated with the life cycle of urban property.

According to modern work on social rank, factors 1 and 2 might be expected to reflect a spatial structure more akin to Hoyt's sector pattern than Burgess's concentric zones. This does, certainly, seem to be the case, although the extent of this resemblance is quite limited. The most apparant manifestation of such a pattern is the wedge-shaped working class areas extending along the River Hull northwards from the Old Town. The high status residential area certainly seems to show a consistent movement towards the west, but this is by no means the continuous sector development envisaged by Hoyt. The older high status area to the north of Queen's Dock is separated

from the new suburban developments by a thin line of less affluent residences, and it seems likely that this was also the case when the Queen's Dock area began to attract residents from the Old Town. The pattern suggests a much more intermittent development than Hoyt's ideal model, and elsewhere the picture is much more haphazard.

The suggestion by Richardson (1971) that behind these classic models there lies a valuable element of truth does, therefore, seem justified. Even a composite model comprising both structures is, however, really inadequate to describe the spatial structure of a city. One feature which the classical models overlook is the influence of a town or city's size, and the stage at which a definite pattern might be expected to emerge. In mid nineteenth century Hull, with a population of just under 85 thousand, some association with the classical models is apparent, but this correspondence might be expected to increase as the town grows. The spatial structure of urban social phenomena is clearly a very complicated issue, and one which involves a great many intervening factors. Perhaps the application of simulation techniques to urban situations (Lowry, 1964; Garrison, 1960; Malm, Olsson and Wärneryd, 1966) will in the future throw more light on the processes at work in forming the spatial structure of urban areas, but very little progress has so far been made in this direction. For the moment the classical models of urban form have some value in aiding the appreciation of this structure, but it is certain that the processes behind this structure are only vaguely comprehended, and much more research is needed towards a really adequate model of social space in the urban environment.

Chapter Ten

Factor Analysis: The Oblique Approach

The initial principal factor solution for the twenty eight variables selected from the Hull 1851 census material, and the varimax rotation carried out on this solution, have both produced very comprehensible and meaningful results. Interpretation has been aided by the orthogonal properties of these solutions, and the whole concept of significant lines of demarcation within the population has been more readily understood because of the presence of this feature. Such orthogonal solutions do not necessarily, however, tell all there is to tell about the relationships between variables. Given the complex relationships usually involved in data selected for analysis by the method, it seems reasonable to allow that the major axes of differentiation within a set of data might themselves be related. It was not, however, until the 1940s that the idea of correlated factors became acceptable, and frequently seen as preferable to uncorrelated factors. In defence of the oblique approach the psychologist Thurstone (1947) writes that:

> "If we impose the restriction that the reference frame shall be orthogonal, then we are imposing the condition that the factors or parameters shall be uncorrelated in the experimental population.or in the general population..... It seems just as unnecessary to require that mental traits shall be uncorrelated in the general population as to require that height and weight be uncorrelated in the general population."
>
> (Thurstone, 1947, p. vii)

The concept of orthogonal factors is, in fact, a statistical one, and in the majority of factor solutions the concepts inherent in the factors need not be independent of each other. In the varimax solution for nineteenth century Hull, for example, the two factors concerned with family life, and the two social rank factors, are clearly not conceptually unrelated. This would only be the case if the factor loadings precisely fitted the simple structure criterion - that is with each variable having a loading of 1.00 on one factor and 0.00 on all others (Johnson, 1970). This is, to say the least, rarely the case. A rotation to an approximation of simple structure will go some way towards fulfilling this criterion, and clearly the solution is likely to be a better approximation if the factors are allowed to become correlated. Such a solution is, however, more complex than an orthogonal factor solution, and in particular requires consideration both of the factor pattern and of the correlations between factors.

On the grounds of defining a factor pattern which more closely reflects reality, the introduction of oblique (correlated) factors is clearly defensible. Despite this the theory of oblique factor solutions is much less well developed than that of orthogonal solutions. During the early development of factor analysis the preference was for orthogonal solutions, and there is still much discussion about the value and preferred form of the oblique solution. Whereas orthogonal approaches to factor analysis are very well defined, therefore, in many respects oblique solutions are still in the experimental stage, and there are a large number of equally valid techniques

for oblique rotation, each of which gives a slightly different solution[1].

One feature which all oblique solutions have in common is their general form. Whereas an initial orthogonal solution or an orthogonal rotation results in one factor matrix to be interpreted, oblique rotation delineates a pattern and a structure matrix, possibly for each of two types of oblique axis - the primary and the reference axes. Only two of these matrices, either the primary or the reference, are needed in the presentation of a factor solution. Considering the primary matrices first, the loadings of each variable with each factor is shown by the primary pattern matrix. These pattern loadings may be interpreted as measures of the contribution each factor makes to the variance of the variables, and are the coefficients of the basic factor model. The primary structure matrix, on the other hand, gives the correlations of the variables with the oblique factors. The distinction is basically one of the unique relationship in the case of the primary pattern and the direct relationship, including the interaction between factors, in the case of the primary structure. Given this basic distinction between the pattern and structure matrix, it is clear that values for the two will coincide in any orthogonal solution, and therefore only one factor matrix is required which can be interpreted in either way. In the oblique case the primary pattern will clearly be of greater value for the identification of factors, and more closely approximates to simple structure, but to

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1. Rummel (1970, p. 424) gives a summary table of the characteristics of the most widely used oblique rotation techniques to date.

maximise its value it also requires a supplementary matrix of correlations between the factors.

An alternative approach to oblique solutions was originally proposed by Thurstone to give a slightly better delineation of simple structure based on the reference matrices. A primary solution represents the situation when the factor axes have been rotated to a best oblique fit to the pattern of variables in space, whereas the reference solution represents the situation when the factor axes are taken perpendicular to each of the primary axes. Here the reference structure matrix is of equivalent status to the primary pattern matrix, and the reference pattern to the primary structure. In the orthogonal solution these two matrices would again be identical, and also identical to the primary matrices. On the whole the greater conceptual complexity of the reference solution is barely compensated for by the slight improvement in simple structure, and the direct primary solution is generally recommended (Harman, 1967; Rummel, 1970).

The Oblique Solution

In view of the greater degree of explanation likely to result from an analysis in terms of correlated factors, and also considering the likelihood of some degree of correlation between the major axes of differentiation in nineteenth century urban society, an oblique solution was considered a desirable further step in the analysis of the 1851 census data for Hull. The varimax solution was chosen as the starting point for rotation because this was the solution used in

the interpretation of the factor structure, and partly because this two stage method would speed the process of defining the oblique solution from the initial principal factor matrix. Again using a program from the University of Essex SALY project, an oblimin rotation was performed on the previously normalized varimax matrix. The oblimin method allows for a number of different solutions, depending on the controlling parameter in the equation for the Oblimin criterion. This value may be anything from 0 to 1, but in practice one of three values is commonly used. At one extreme the Quartimin criterion assumes a value of 0.00, and gives factors which are highly correlated. At the other extreme the Covarimin method assumes a value of 1.00, and minimises the correlations between factors. For the present solution a value of 0.50 was assumed - the Biquartimin method - which tends to give moderately correlated factors, and is usually seen as the most satisfactory criterion for oblique rotation (Harman, 1967). The rotation was completed in 27 major cycles and 1,426 iterations, with a convergence criterion of 0.05 for terminating the rotation.

Rummel (1970) suggests that if the interpretation of factors is not substantially altered by an oblique rotation, then a satisfactory solution has been found. According to this criterion the biquartimin rotation for the Hull factor matrix has been successful (Table 30a and 30b - the ten highest associations with each factor are underlined in the primary factor pattern matrix). For six of the seven factors the oblique solution merits exactly the same interpretation. For the most part the same variables have the strongest association with each factor as in the varimax solution,

Variable	Factors 1	2	3	4	5	6	7
1	-.494	-.162	.110	.138	-.172	-.395	-.144
2	-.147	-.136	-.036	.254	-.345	.684	.042
3	.015	.213	-.015	-.168	.406	.107	.043
4	-.083	.033	-.033	.029	.084	-.236	.342
5	-.050	-.055	-.171	.167	.170	.309	-.134
6	.865	.269	.018	.026	-.044	.153	.007
7	.860	.200	-.169	-.032	-.032	-.062	-.132
8	-.048	-.109	-.673	.104	.145	.280	-.080
9	.090	.413	-.494	.110	-.068	-.051	.027
10	-.102	.079	.893	.299	.030	.048	-.134
11	.092	-.011	.272	.000	.562	.239	.022
12	.019	-.093	.028	-.008	-.030	.051	.267
13	-.160	-.080	-.247	.194	-.646	.327	-.069
14	-.145	-.073	-.083	.085	.811	-.126	.036
15	.052	-.039	.185	-.092	-.744	.261	.213
16	.553	.396	-.090	-.060	-.072	-.247	-.085
17	.105	-.066	.831	-.030	.051	-.122	.130
18	.263	.567	-.228	.300	-.206	-.146	-.063
19	-.067	.530	-.021	.233	.003	.159	.775
20	-.173	-.768	-.296	.216	-.001	-.069	.114
21	.286	-.024	-.002	-.819	-.166	-.262	-.083
22	-.232	-.014	.440	.157	.389	.301	-.439
23	-.272	-.217	-.025	-.870	.053	-.120	-.066
24	.966	-.231	.093	.122	-.028	.081	.003
25	.979	-.127	.032	.157	.026	-.070	-.102
26	-.014	.803	-.049	.071	.246	.107	.090
27	.024	.883	-.011	.285	.038	.063	-.049
28	.097	-.146	.047	.159	.223	-.254	.202
Correlations between factors:							
1	1.000	.284	.042	-.144	.005	-.241	.247
2		1.000	-.139	-.151	.092	-.339	.132
3			1.000	-.263	.026	.214	.027
4				1.000	.174	-.149	-.051
5					1.000	.144	.201
6						1.000	-.106
7							1.000

Table 30a: Biquartimin oblique rotation, primary factor pattern.

Variable	1	2	3	4	5	6	7
1	-.496	-.239	-.017	.241	-.248	-.228	-.284
2	-.381	-.469	.049	.141	-.208	.667	-.168
3	.086	.251	.035	-.146	.420	.107	.153
4	.063	.143	-.088	.077	.126	-.263	.366
5	-.174	-.161	-.139	.212	.231	.304	-.045
6	.903	.453	.042	-.175	.014	-.155	.231
7	.897	.474	-.170	-.131	-.054	-.359	.105
8	-.209	-.137	-.625	.291	.159	.198	-.130
9	.189	.506	-.589	.159	-.025	-.347	.076
10	-.130	-.151	.806	.072	.092	.211	-.138
11	.051	-.049	.343	-.022	.607	.357	.138
12	.049	-.075	.061	-.030	.022	.053	.250
13	-.320	-.300	-.242	.136	-.594	.226	-.300
14	-.139	.007	-.106	.297	.806	.016	.160
15	.048	-.165	.259	-.322	-.678	.185	.053
16	.709	.641	-.164	-.147	-.098	-.527	.117
17	.187	-.084	.831	-.234	.071	.051	.195
18	.390	.650	-.413	.225	-.140	-.518	.029
19	.202	.527	-.103	.105	.270	-.125	.800
20	-.390	-.770	-.265	.439	-.030	.126	-.043
21	.439	.244	.166	-.842	-.364	-.217	.020
22	-.419	-.289	.454	.122	.381	.535	-.447
23	-.196	-.122	.196	-.760	-.150	.158	-.094
24	.868	-.018	.150	-.024	-.008	-.077	.193
25	.914	.136	.032	.046	.016	-.265	.128
26	.200	.794	-.149	-.013	.365	-.158	.226
27	.205	.824	-.195	.150	.168	-.276	.059
28	.147	-.015	-.013	.221	.243	-.231	.271
Contributions of primary factors:							
1	4.376	.411	-.012	-.015	-.002	.075	-.065
2		3.336	.048	-.149	.029	-.053	.072
3			2.790	-.005	.015	-.035	-.007
4				2.107	.013	-.168	-.017
5					2.669	-.075	-.044
6						1.553	-.005
7							1.212

Table 30b: Biquartimin oblique rotation, primary factor structure.

and more often than not they occur in the same relative position. Only in the case of the two factors concerned with family life does any noticable change occur. The interpretation of factor 5, the family status factor, is made clearer by the changes in the relative importance of the most highly associated variables. The variable concerned

Original variables with the ten highest associations

Factor 5: Biquartimin solution

14	Households with one or two persons only	.811
15	Households with five or more persons	-.744
13	Households with three or more children	-.646
11	Population in shared dwellings	.562
3	Population aged 60 and over	.406
22	Population in unskilled occupations	.389
2	Population aged 5 to 14	-.345
26	Males in service industry	.246
28	Children at school	.223
18	Population in professional and managerial occupations	-.206

with the percentage of the population sharing has fallen from fourth place in rank order of the values of the loadings, from second place in the varimax solution, which adds emphasis to the basic distinction between large family-type households and small households inherent in the factor. The basic interpretation of the factor is not, however, altered by these changes.

In the varimax solution factor 6 was seen to be largely a measure of the presence or absence of families at an advanced stage of development. In the oblique solution this factor is seen to have slightly more discriminating power than this. The variable with the highest loading, the percentage of the population aged 5 to 14,

Original variables with the ten highest associations

Factor 6: Biquartimin solution

2	Population aged 5 to 14	.684
1	Population aged under 5	-.395
13	Households with three or more children	.327
5	Sex ratio	.309
22	Population in unskilled occupations	.301
8	Population born in Hull	.280
21	Population in semi-skilled occupations	-.262
15	Households with five or more persons	.261
28	Children at school	-.254
16	Resident domestic servants	-.247

remains the same, and is again associated with large households and the percentage of families with three or more children aged 12 or under. Against this, however, is set a more meaningful picture than in the varimax solution. The highest negative loading is with the percentage of the population under 5, and particularly associated with this is the high positive loading on the sex ratio, indicating an increase in the proportion of females with an increase in young children. The fertility ratio loads negatively on this factor, but only falls twelfth in order of importance. The percentage of children at school, as in the varimax factor 6, is of very little regard for the interpretation of the factor due to the unpredictable nature of this measure. High positive scores on this factor will, therefore, highlight areas where families are at an advanced stage of development. Scores at the other end of the scale, which in the varimax solution indicated the reverse of this situation, here tend to identify areas where families are at an earlier stage of development.

Mapping the scores for this factor of type of family results in

a very interesting picture distinguishing between areas where younger or older children predominate (Figure 22). The suburbs are, clearly, preferred during the early stage of family development, but the high positive scores in the town centre show that the older family was very likely to be resident in the oldest and most central parts of the town. Within this area there are also isolated instances of young families predominating. Another instructive feature is the high family status of the northern working class area suggesting, like the patterns of the varimax factors, that the hypothesised picture of family life being most prevalent amongst this section of the population is a correct one.

Turning to the other features of the oblique solution, the contribution of each factor is very much the same as in the varimax solution. The key to the oblique solution is the matrix of correlation coefficients between factors, and in this case one of its most readily apparent features is the high degree of interdependence between the type of family factor (factor 6) and, in particular, factors 1, 2 and 3. The negative association with the female employment factor (factor 1), reflecting the incompatibility of working women and young children, is an obvious one. The highest association of all is between this family type factor and the servant employing population factor. This negative association clearly reflects the greater concentration of family life amongst the working classes, and must be the result of those factors affecting the development of family life discussed previously. Obviously such a correlation cannot define a causal relationship, but this study and other work on the nineteenth century

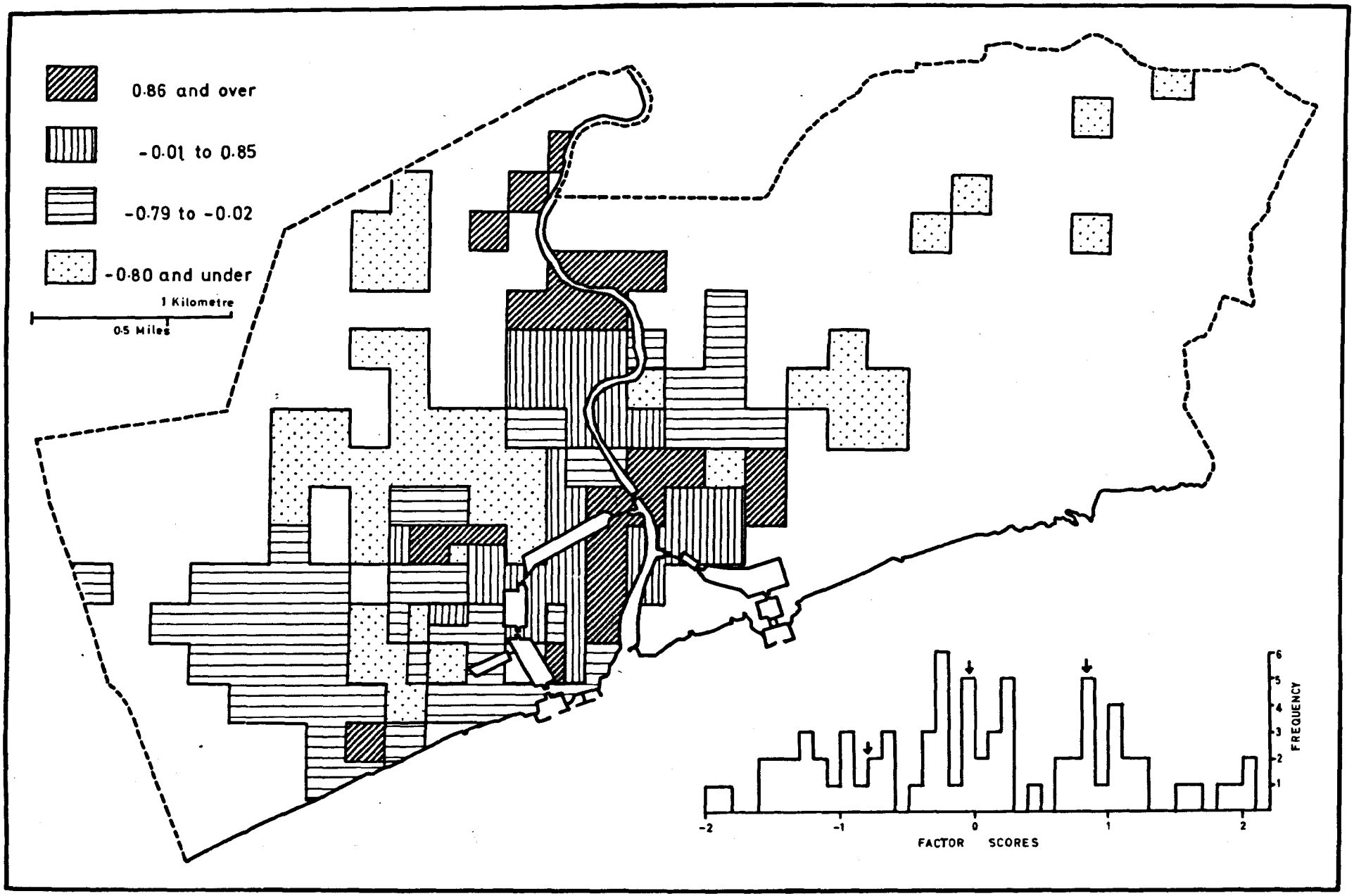

Figure 22: Scores on Oblimin factor 6 - type of family - Hull, 1851.

family suggests that this bias towards family life in the middle income groups is partly a feature of economic circumstance, including the ability to afford suitable healthy accommodation, and partly a question of a genuine preferance for the family amongst this section of the community. The migrant status of families seems to be of very little importance in this pattern, and some of the areas most orientated towards family life also have high scores on the migrant status factor. The positive association of factor 6 with migrant status (factor 3) almost certainly reflects the high proportion of immigrant working class with families, and also the likelihood of a disproportionate number of older children in such households. The other correlations with factor 6 support the conclusions drawn from the three highest associations with this factor. The negative association with factor 4, the semi-skilled residual factor, suggests the lesser importance of family life amongst both the servant employing population and other semi-skilled workers. The positive association with the skilled non-manual residual factor suggests that this group is also associated to some degree with high family status, and this also agrees with the general trend towards family life amongst the middle income groups.

Turning to the other factors, that concerned with the servant employing population also has a large number of quite strong associations with other factors. Its association with factor 6 has already been discussed, but the factor also correlates highly with factor 1, that concerned with female employment in general. This is almost inevitable in view of the relationship between these two factors,

and reflects the position of domestic servants as working women, although it is quite surprising that the correlation between these two factors should be quite so large. Statistically the two factors seem to be much more interdependent than the conceptual links between them would suggest. The moderate correlation of factor 2 with the semi-skilled residual factor, factor 4, and other correlations with this residual factor tend to suggest that the influence of domestic servants may have been largely excluded from this pattern in the oblique solution, but the exact composition of factor 4 is still far from clear. Other significant correlations are those between factors 1 and 2 and the skilled non-manual residual (factor 7), which reflect the relative position of this group and the servant employing population in the occupational hierarchy. Also important is the negative correlation between the servant employing population and the migrant status factor, emphasising the economic status of the immigrant group.

The Contribution of the Oblique Solution

The most significant feature of the oblique solution is clearly its emphasis on the relationship between family status and the other factors. This is obviously a very important link, and a very complicated one, and it is significant that the factor with the highest association is the supplementary family status factor - that dealing with the type of family. The relationship between family status and the other factors is not, primarily, concerned with the presence or absence of family life, but the development and survival of families

into an advanced stage in the family life cycle. The high positive loadings on factor 6 reflect not only a high proportion of older families, but also their predominance over large families at an earlier stage of development and the potential for family life amongst this population. The circumstances relevant for the development of family life in the nineteenth century, including the rate of infant mortality and economic and social restraints on the growth of a family, tended to favour the working class as the most likely to have a high proportion of family-type households. The pattern of scores on factor 6 tends to reflect this, with the highest proportion of large, well-advanced families in working class areas, and the pattern of the two indices dealing with the population under 15 also suggest the same relationship (Figures 4 and 5). The correlations of factor 6 with the other factors confirm the importance of this feature of social differentiation, and also adds to the interpretation of several other factors where the indices dealing with family development only suggested a negative association of family life with high social status.

The other main contribution of the oblique solution has been in linking more strongly the working women and servant employing population factors. The correlation matrix has tended to confirm the relationship between these two factors, both by the correlation between the factors themselves, and by the very similar pattern of correlations between the two factors and other factors. Resident domestic servants are clearly the feature factors 1 and 2 have in common. With regard to the migrant status factor, the matrix of

of correlations has also emphasized the position of the immigrant group as a population with low social status, and more strongly suggested the importance of an axis of social differentiation based on purely economic considerations. The value of the oblique approach, therefore, has been largely in identifying the linkages between factors, and bringing the factor solution somewhat closer to reality. At the same time the relaxation of the orthogonal limitation has served to define certain axes more clearly and thus assist their interpretation.

Summary and Conclusions

Chapter Eleven

Urban Residential Patterns in Mid Nineteenth Century Hull

Analysing the residential pattern of one town at one period of time has proved, if nothing else, that urban social structure is a very complex phenomenon. People living in one area of a city differ from people in other areas in innumerable ways, but underlying this detailed variation it is possible to uncover quite a small number of major axes of differentiation which account for the majority of these contrasts. Residential differentiation is both a result of individual decisions - the choice of residential location - and of the more general social structure. It tends to parallel the overall social structure of society. Although any attempt at a comprehensive theory of residential and social differentiation would be misguided in the present state of knowledge, some indication of the important elements of this structure has already been gained and, in this study, has proved of sufficient value to help in framing the research project. The picture presented by the analysis of Hull at mid century is important in two respects, both in its own right and in relation to other studies of social differentiation, and the results are consistent with our present state of knowledge of residential patterns.

Implications for the Study of Nineteenth Century Society

The patterns of social differentiation produced by factor analysis for nineteenth century Hull are particularly important in one major

respect - their close approximation to the hypothesised model of this structure defined largely on the basis of modern work in this field. By far the most striking feature of this pattern is the dominance of social rank as a differentiating factor. In the Hull study social status is measured by two distinct factors, which together account for some forty per cent of total common variance. The second of these two factors is really the most valuable, identifying the servant employing population at one end of the scale and the skilled manual worker at the other, and in many ways helps to explain the pattern of the first factor. This dichotomous structure of social rank defined by factor 2 was certainly not unexpected - Karl Marx and other writers of the same persuasion tended to accept this dichotomy as inevitable while other contemporary social critics, notably Charles Booth and Joseph Rowntree, hinted at its importance but emphatically denied its implications. Whether or not any consequences inevitably follow from such a social structure is beyond the scope of a study which aims at defining that structure, but certainly the presence of this pattern has been confirmed for mid nineteenth century Hull. In modern studies of urban social structure the pattern of social rank almost invariably differentiates between the highest and lowest groups in an economic scheme of social class based on the gradation of occupations. Here the line of differentiation is not strictly status-orientated in this respect, in that it does more than merely differentiate the rich from the poor. There were large numbers of the nineteenth century urban population in a worse position economically than the skilled manual worker, but, although

the other graded occupational groupings load in the expected direction on this factor, it is this basic working class group which forms the opposite extreme of the social rank continuum. Here, therefore, the social rank dimension is something more than a purely economic distinction, and incorporates important aspects of social distance based on social desirability.

Another interesting feature of factor 2 is the importance given to the employment of resident domestic servants over and above other indices concerned with social status. The predominance of this feature must be largely responsible for the non-appearance of this Masters and Men dichotomy when social distance was measured by indices of residential dissimilarity. The pattern supports the presence of resident domestic servants as a major social rank index for the nineteenth century, and helps justify Booth's reliance on this index in his later work (Industry Series, I). Booth's other social rank index, overcrowding, is not so readily acceptable. Overcrowding is not an important feature of factor 2, and as a social rank index would seem to assume a pattern of social distance based on a simple hierarchy of relative economic circumstance. Overcrowding may be an index of poverty, and occurs in this respect in the migrant status factor, but this economic hierarchy is clearly not the predominant social pattern of the nineteenth century town. The same is true of Rowntree's poverty cycle concept. The index giving the percentage of families with three or more children included in the analysis may or may not be a good indicator of lowly economic status, but this is

clearly not the predominant force at work in delimiting social distance during the period.

Returning to the first factor, mathematically the most important in the study, its interpretation must clearly imply another axis of social rank. The working woman in Victorian England was motivated by economic circumstances, and was only acceptable in quite a limited range of occupations. The potential of this index as one of economic status has, however, been destroyed to a large extent by a breakdown in the relationship between spatial and social distance. The majority of domestic servants, by the nature of their work, were residentially associated with their employers. In many cases this must have been regarded as an advantage of the work rather than a disadvantage. The structure of the female employment factor singles out working women regardless of their residential status, and in conjunction with factor 2 it is clear that high scores on this factor can be associated with both high-status residential areas and predominantly working class areas. Many of the high loading variables are common to both factors, and this suggests some measure of association between the two. The oblique rotation gives a positive correlation of .284, which is very significant in view of the fact that this correlation would not be expected to be particularly great. Domestic servants are clearly the major feature producing this correlation, and an important influence on the female employment factor as well as being of prime importance in the social rank axis of factor 2.

In interpreting factor 1 as a social rank factor it was assumed

that female employment was associated with low economic status. There seems no reason to doubt this, but the very complex structure of this factor has tended to obscure the real significance of economic stratification as a line of demarcation within the urban population. The problem is that with the female employment factor the basic relationship between social and spatial distance has been destroyed, and therefore the frame of reference of this factor is different to that of the other factors. The important lesson seems to be to differentiate between the two main groups of employed females at an early stage in the analysis if the requirement is to minimise the number of factors and simplify the factor structure. There is an element of economic status in this factor, and the migrant status factor (factor 3) also contains an element of economic stratification in its composition, tending to identify the poverty as well as the birthplace status of a large section of the urban poor. This lends greater support to Booth and Rowntree's conception of social rank, but clearly a strict economic interpretation based on relative wealth does not do justice to the complex pattern of social status found in the nineteenth century town.

Although migrant status is absorbed to a certain extent in the general pattern of social rank, emphasising the differing economic circumstances of the immigrant and local populations, in both the varimax and oblique solutions migrant status occurs as a distinct dimension of differentiation in its own right. The position of immigrant populations, and especially the Irish, leads to a

distinctly segregated residential structure. This segregation is partly voluntary and partly involuntary, and also has its effect on the economic circumstances of the immigrant group. Urban residential segregation of immigrant populations is, however, a complex theme, and features such as the availability of suitable accommodation also have their part to play. The pattern of loadings on this factor strongly suggest that, in an urban industrial environment, the results of prejudice against an immigrant group are always the same. Like the Jewish immigrants to London at the end of the nineteenth century (Booth, 1889), and the better documented immigrations to North American and British cities in the twentieth, the migrant status of immigrants from outside England and Wales (and especially the Irish) was reflected in residential segregation and the denial of economic equality. Whether or not these immigrant groups in the nineteenth century were culturally closer to the host population than twentieth century immigrants is questionable, but certainly their status reflects the smaller scale of social interaction in the mid nineteenth century, and has parallels with the segregation according to region of birth and ethnic status of nationals in some African cities today (McElrath, 1968).

The third major dimension of social differentiation, family status, tends to be the most complicated. The more important of these two factors, factor 5, deals with the classic family status concept identified in modern studies of social differentiation - the contrast between city centre and suburban living. This residential

choice, as Booth suggests, "depends not so much on class or on amount of income - over a certain minimum - as on the constitution of the family" (Final Volume, p. 205). The generally more crowded conditions of the city centre, characterised by older and often sub-divided housing, are clearly not so conducive to the raising of a family as the newer housing developments of the suburbs, and this contrast seems to be as true of the nineteenth century as the twentieth. Much of this contrast is, of course, primarily due to differences in the availability of housing and the housing stock in general. In nineteenth century Hull, however, the suburbs are for the most part the preserve of the higher strata of society, and high scores of the family status factor are found even in the town centre, suggesting the importance of income "over a certain minimum" in the pattern of scores on this dimension.

The problem of the dependence of family status on economic circumstances is an important one for the nineteenth century, when this relationship might be expected to be quite strong. The pattern of factor scores for the orthogonal varimax solution reflects the expected concentration of high family status associated with intermediate social class, and this relationship is equally true for the subsidiary type of family factor, factor 6. When further rotation is carried out to achieve an oblique solution it is this supplementary factor, the type of family, which correlates most strongly with the other factors. Of particular importance are the correlations with the two social rank factors, both in the predictable

direction indicating a negative association with female employment and a negative association with the bipolar servant employing population and skilled manual workers factor. Factor 6 is also associated positively with the migrant status factor, indicating the greater likelihood of family organisations amongst the locally born population. Emphasis on family life is clearly strongest amongst middle income groups, and particularly the skilled manual occupational category, and this pattern agrees both with contemporary nineteenth century work and with modern work on nineteenth century cities.

Although this pattern of social differentiation is clearly very close to the previously proposed model of this structure, the lack of published studies concerned with residential patterns is acute, and the picture cannot really be justified on the basis of reproducing a pattern familiar from other work on nineteenth century towns. The only really valuable study in this respect deals with nineteenth century Toronto (Goheen, 1970), and here the choice of indices for analysis is biased towards variables dealing with building type and condition, housing tenure, and land use and value. The importance of family status does emerge in this study, but the social rank dimension tends to be submerged in housing considerations, and only occurs as a separate factor in conjunction with associations of house type and tenure. The social rank dimension is therefore biased towards purely economic considerations. On the basis of work not directly concerned with residential differentiation, however, the pattern found in Hull is a very comprehensible one, and there seems no reason to doubt its validity.

The implications of the Hull study in terms of defining meaningful lines of social differentiation are obvious, and in many ways attention is drawn to the main fields of interest in nineteenth century urban society. Certainly more detailed study of the three dimensions of social rank, family status and migrant status is needed, and the patterns of dependence between these three axes. Rowntree's poverty cycle concept, and the relationship between income and family size, could certainly be looked at more closely in this respect. Anderson (1972) has emphasized the importance of the number of economically active members of a family, and has particularly stressed the impact on a family's economic status of working women, employed children, and the age at which children leave home. Studies along these lines, coupled with Rowntree's work, would almost certainly throw more light on nineteenth century social structure. Family size certainly does vary between classes during the period, and it would be interesting to gauge its effects on economic status more closely, and to see how effective this relationship proved as a dimension of social differentiation. Certainly occupational groupings have proved valuable as indices of social rank in this study, but it seems likely that a more relevant classification for the working class could be devised incorporating these considerations of family type.

A Wider View of the Nineteenth Century Model

The forces behind the main axes of differentiation in the nineteenth century town have already been explained in drawing up the model of the contemporary social structure, but so far only

very allusive references have been made to the process behind these forces. The nineteenth century in Britain was clearly a period of transition to an urban based, industrial society, and it is in this context that the pattern of social differentiation of the period was formed. Reissman (1964) sees the development of the modern industrial city as a distinct phase in urban history, and one which has very little connection with the form of cities prior to this development. He specifies four main components of this theory of urban development, all of which can be seen as having some part to play in the development of towns in nineteenth century Britain. The first two, urban growth on a large scale and the transition to an industrial-based economy, are in many ways complementary, and both these processes can be seen at work in the nineteenth century. Thirdly he defines the middle class as a pre-requisite of industrial growth, and writes that:

> "The development and the emergence of a middle class and of middle class leadership provide an answer to the question of what drives a society to abandon its more primitive and agricultural condition to pursue the distant and unfamiliar goals of industrial urban development. The middle class supplies the agents of change who challenge the existing power structure, usually a feudal or colonial one."
>
> (Reissman, 1964, p. 181)

In Britain this development of a middle class was a very gradual process extending over several centuries, but it was certainly the middle class managers and entrepreneurs who took the leading role in the development of nineteenth century industry. Reissman's final

component of this theory of urban development is the parallel rise of nationalism with industrialism, which he justifies on the basis of nationalism supplying "the ideology which can command loyalties, motivate action, and legitimate the changes to be effected" (Reissman, 1964, p. 188). This rise of nationalism seems to be less essential to the development of the industrial city as urban growth, industrial growth, and the emergence of a middle class, but certainly it is difficult to find an example of an industrial country where nationalism has not been important during the industrializing process. This was without doubt the case in nineteenth century Britain, and Victorian England was as renowned for jingoism and Empire as for industrial prowess.

Whether or not Reissman has identified the main constituents of a theory of the developing industrial town is really not so important as his having drawn attention to the feasibility of such a theory. In framing the original model of nineteenth century urban differentiation it was assumed that such a theory was relevant, and this assumption allowed contributions to be made to this model from those studies of social differentiation carried out for cities in today's less-advanced countries. Factor analysis has shown that this assumption was justified, and that there are many similarities between the dimensions of residential differentiation in nineteenth century Hull and present day industrializing cities. In addition to the confirmation of social rank, family status and migrant status as the main dimensions of social differentiation in industrializing

cities, the most striking similarity is the relationship between the social rank and family status dimensions. This dependence of family status on social rank is usually seen as primarily a result of the separation of occupation and family roles with increasing social stratification according to modern ranking systems, based on socio-economic criteria.rather than birth or kinship. The nineteenth century British situation suggests that crude economic circumstances are largely responsible for this lack of independence of the family status dimension, and perhaps this approach would also prove a valuable one when looking at this relationship in modern developing cities. The relationship is obviously a very complex one which may, in fact, be the result of different influences at different stages in the industrialization process.

The process of industrialization may be a feature linking nineteenth century Britain with modern developing countries, but the exact pattern of this development does differ in the two situations. The industrialization process is certainly much more rapid in today's developing countries, and works with the model of established industrial society before it. Developing countries aim at bringing about enormous changes within a short period of time, whereas in the nineteenth century there was no such single-minded drive towards a known goal and urban growth was much less rapid and more tentative. Urbanization today also involves a greater proportion of the population than it did in the nineteenth century, and the movement towards urban areas tends to outpace industrial development. In Britain

urban migration was the result of a demand for industrial labour, but cities in developing countries today are faced with a large labour force which they are unable to fully employ. Although there was certainly some under-employment in nineteenth century British towns, the scale of this problem is much greater in the twentieth century situation. The effect of migration has also been to create a discrepancy between the styles of urban and rural life which was never felt to such an extent in nineteenth century Britain. The problem is largely the result of the example of modern nations, and the time-lag between the development of industrial society and the achievement of the benefits of industrialization. The specific historical context of urban development is also important, and the industrialization process today is influenced by previous colonial status which tended to favour aspirations towards urban industrial society but delayed the beginning of these developments. The effective government control over industrialization is an advantage in the twentieth century situation, however, and is again largely a consequence of the colonial past.

For the development of urban theory, however, it is the very significant similarities in the process in the nineteenth and twentieth centuries which are important. Industrialization is clearly the same process in both situations, and would seem to have the same effects on society. Reissman (1964) has written that:

> "The time has come to stop concentrating upon Western countries alone as a source of urban theory because they cannot provide the contrast that is needed to develop a valid

> theory. The city in the West is already too complex and too differentiated in its organization for that purpose. Its origins are too well hidden by years of history. These considerations make it difficult, if not impossible, to pick out the social dynamics behind urbanization."
>
> (Reissman, 1964, p. 157)

To understand the modern city, therefore, it is important to look at the process at work in cities undergoing the industrialization process. Without such a change in emphasis it seems doubtful that the development of the modern industrial city will ever be fully understood. The present study has, for its part, illustrated the way in which mid nineteenth century Hull fits into such a general theory, and hopefully both substantiated and made contributions to a general understanding of the development of the modern industrial city.

Appendices

Appendix A

The Classification of Occupations from the Hull Enumerators' Books

The occupations encountered in the sample drawn from the Hull enumerators' books for 1851 were classified according to both socio-economic status and type of industry. The lists below give detailed allocations of occupations to each group. For the socio-economic classification the General Register Office "Classification of Occupations" for the 1966 census was used as a basis for allocation, supplemented by additional information from, for example, Booth (Industry Series) where the relevance of the modern grouping was in doubt. The classification by industry is based largely on the Central Statistical Office "Standard Industrial Classification" (1968a, 1968b), again supplemented by Booth where necessary.

Grouping of Occupations according to Socio-Economic Status

1 Manufacturers, upper professionals, etc.

A Professional

Architect; army officer (commissioned); attorney; chaplin; civil engineer; general practitioner; land surveyor; linguist; minister; preacher; priest (Roman Catholic); secretary (savings bank); ship surveyor; solicitor; solicitor's articled clerk; surgeon; town missionary; veterinary surgeon.

B Managerial

Employers in business with 25 or more employees.

C Private income

Gentleman; gentlewoman; independent means; lady; private income; yearly income.

D Property owners

House proprietor; interest on money; landed proprietor; mortgage proprietor; property owner; proprietor of docks; ship owner; shop owner (several).

2 Lower professionals, small employers of labour

A Sub-professional

Architect's pupil; artist; banker; bone setter; customs inspector; customs superintendent; customs surveyor; dentist; governess; government officer (weights); harbour master; keeper of asylum; keeper of infants school; matron; medical student; midwife; monthly nurse; musician; music master; newspaper reporter; nurse; parish clerk; pilot; portrait painter; proprietor of asylum; registrar of births; reporter, printing office; schoolmaster; schoolmistress; sculptor; sick nurse; sunday school teacher; teacher; workhouse master.

B Sub-managerial

Agent, builders; cashier, bankers; engineer, manager; engineer, steamer; first mate; foreman tailor; landing surveyor (customs);

manager, cotton mills; master mariner; master of a fishing smack; mate of ship; police inspector; police sergeant; railway inspector; superintendent of docks.
Also employers in industry with up to 25 employees.

C Agricultural self-employed and managers
Farmer; market gardener; nurseryman; yeoman.

D Shopkeepers, traders, service workers.
Agent; agent, coal; agent, corn; agent, grocer's; agent, land; agent, lime; agent, shipping; Baltic merchant; broker; broker, fur; broker, railway carriers; broker, ship; coach proprietor; commission agent; corn factor; corn merchant; horse dealer; keeper of circulating library; livery stable keeper; merchant; proprietor of medicine; salt merchant; timber merchant; wholesale druggist; wholesale grocer; wine merchant.
Also shopkeepers employing assistants and innkeepers employing servants.

E Annuitants
Annuitant; fund holder.

3 Skilled non-manual workers

A Clerical and skilled non-manual workers
Accountant; assistant clerk; assistant overseer clerk; assistant teacher; bale goods measurer; book-keeper; civil assistant, Ordnance Survey; clerk; collector, Inland Revenue; collector, rates; collector, taxes; conductor of seminary; customs, extra weigher; customs, searcher; deputy court messenger; keeper of zoological gardens; office boy; officer of Inland Revenue; police constable; police officer; policeman; postboy; pupil teacher; railway policeman; toll collector.

B Small shopkeepers, innkeepers, shop assistants etc.
Agent, bank; agent, land society; agent, railway company; auctioneer; beer house keeper; beer retailer; beer shop keeper; bookseller; boot salesman; cattle salesman; chartseller; chemist, druggist; clothes dealer; coal dealer/merchant; coffee house keeper; cotton waste

dealer; draper; draper's assistant; earthenware dealer; eating house keeper; fishmonger/merchant; florist; flour dealer; fruiterer; fruit seller; furniture dealer; general dealer; class and china dealer; glue merchant; greengrocer; grocer; grocer's assistant; hosier; hostler; innkeeper; insurance agent; ironmonger; leather seller; licensed victualler; linen draper; lodging house keeper; manure merchant; mercantile agent; marine stores dealer; milk woman; outfitter; oyster dealer; pawnbroker; potato dealer/merchant; provision merchant; publican; sailor's draper; salesman; seedsman; ship's chandler; shopgirl; shopkeeper; shopman; shopwoman; spirit merchant; stationer; tallow chandler; tapkeeper; tavern keeper; tea dealer/merchant; temperance hotel keeper; tobacconist; toyshop; traveller; victualler; yeast dealer.

4 Skilled manual workers

A Skilled agricultural and supervisory agricultural workers

Foreman gardener.

B Skilled industrial craftsmen

Bobbin linter, cotton; boiler maker; bleacher; brass founder; brass moulder; card loom weaver; carpet weaver; cloth dresser; cloth weaver; cotton factory; cotton finisher; cotton warper; dyer; engine driver, cotton; engine fitter; engineer; foreman, oil mill; foreman, tallow refinery; forgeman; furnace man; iron-founder; iron moulder; linen weaver; looker out of yarn; marine engine fitter; mechanic, factory; organ builder; organ pipe maker; power loom weaver; reacher, cotton factory; overlooker at cotton factory; roper; silk dyer; steam loom weaver; twine/cord/rope maker; warper, flax mill; wash sizer, cotton; weaver; working at carpet factory.

C Other skilled craftsmen and service workers

Bag maker; baker; barber; basket maker; birdcage maker; blacksmith; blacksmith's striker; boat builder/maker; bookbinder; bookfolder; booksewer; bootbinder; bootcloser; boot and shoe maker; breeches maker; brewer; brick maker; brick setter; brush maker; butcher;

butcher's assistant/boy; cabinet maker; cap maker; carpenter; carrier; carter; carver and guilder; chair maker; clock cleaner; clockmaker; coach builder/maker; coach painter; coach trimmer; coach wheel maker; coachsmith; coal carrier; colourer(printing); confectioner; cooper; coppersmith; cordwainer; currier; distiller; draper and tailor; draughtsman; drayman; dressmaker; edge tool maker; engine driver; engine man; engine smith; engraver; file grinder; foreman, dock company; foreman, joiner; foreman, timber yard; foreman, warehouse; foreman, victuallers vaults; french polisher; furrier; gasfitter; gateman; glazier; glover; grinder; gunmaker; hackney carriage man; hairdresser; hand loom weaver; hatter/hat maker; hearth rug weaver; house carpenter/joiner; jeweller; joiner; joiner/undertaker; knitter; lace maker/worker; last maker; lath render; leather cutter; link maker; machine maker; maltster; marble mason; mason; mast and block maker; mat maker; mattress maker; mechanic, fitter; miller; milliner; millstone maker; millwright; painter; paperhanger; paper maker; paper maker's assistant; paper stainer; pattern maker; piano maker; piano tuner; pipe maker; pipe trimmer; plane maker; plasterer; plastic figure maker; plumber; pot maker/potter; preserver of birds; printer/compositor/lithographer; printer, copper plate; railway fireman; railway guard; sackmaker; saddler; sailcloth weaver; sailmaker; saw maker; sawyer; shipsmith; shipwright; shoebinder; shoe clipper; smith; spade maker; stone cutter; stone mason; straw hat maker; tailor; tanner; tinner; tinplate worker; tinsmith; tobacco worker; truckman; turner; upholsterer; waxwork maker; wood carver; wood turner.

D Upper servants

Cook; housekeeper.

5 Semi-skilled workers

A Semi-skilled agricultural workers

Agricultural labourer; cattle drover; cowkeeper; dairyman; farm labourer; farm servant; farmer's son; gardener; gardener's son;

groom; horse breaker; ostler; pig jobber; shepherd.

B Mariners, fishermen, etc.

Fisherman; mariner; master of a fishing smack; sailor; seaman; steamship steward.

C Semi-skilled workers

Back tenter, cotton; bargeman; barmaid; barman; billsticker; blacking maker; boatman; bobbin reeler, cotton; bone dealer/merchant; boots; cake presser, oil mill; cap reeler, cotton; card hand; card stripper, cotton; card tenter, cotton; card winder; cement burner; cellar man; chicory manufacturer; chimney sweep; colour maker; companion; costermonger; cotton carder; cotton piecer; cotton reeler; cotton spinner; cotton twister; cotton winder; curer of smokey chimneys; doffer; drawing tenter; employed at cement works; employed at colour works; engine tenter; errand boy; excavator; fancy needle woman; fireman; firewood dealer; frame tenter; flax dresser; flock spinner; gaslighter; ginger beer maker; hair curler; harbour lighter; hawker; hemp spinner; jack frame tenter; keelman; labourer at forge; lady's companion; lambswool spinner; lamplighter; letter carrier; maker of naptha; maker up at cotton factory; manufacturer of baking powder; marine stoker; messenger; mule spinner, cotton; mustard maker; nail maker; needlewoman; night porter; office keeper; oiler, cotton factory; oil miller; oil pressman; paint and colour maker; paint grinder/colourman; plain sewer; porter, hotel; porter, medical school; porter, post office; rice dresser; riverman; rope spinner; sack-cloth spinner; sailcloth spinner; seamstress; seed crusher; seed crusher's assistant; self acting winder, cotton; sexton; slater; soap boiler; soap maker; soldier; stall holder; starch maker; starch maker's assistant; Starch works labourer; storekeeper, dock company; stoker; strap maker; stripper, cotton mill; thong maker; thread maker; thread winder; throstle bobber, cotton; throstle doffer, cotton; throstle spinner, cotton; tobacco paper maker; town crier; turnkey; turpentine distiller; twine spiner; waiter; waitress; warehouseman/keeper; waterman; wellsinker; whipmaker;

woodman; wool comber; works at lead mill.

D General domestic servants

Butler; chambermaid; footman; gentleman's servant; housemaid; house servant; kitchen maid; lady's maid; laundry maid; maid; nurse-maid; nursery governess.

6 Unskilled workers

A Labourers and unskilled workers

Bunkerer; customs, docker; customs, landing waiter; customs, weighing porter; factory hand; labourer (not elsewhere classified); lumper; manner; porter (not elsewhere classified); railway ticket collector; scavenger; sweeper-up, cotton; tidewaiter; wharfinger.

B Lower servants and service workers

Charwoman; keeps a mangle; laundress; manglewoman; washerwoman.

7 Residual occupations

A Undeclared

Persons of 15 and over with no stated occupation.

B Retired

Chelsea pensioner; Greenwich pensioner; pensioner; retired; Trinity House pensioner.

C Paupers, almswomen, etc.

Almswoman; parish relief; pauper.

D Unemployed

Out of work.

E Housewives, domestic

Husband away; mariner's wife; seaman's wife.

Also all married females described as "wife", or with no occupation given, and all females over 15 with the description "at home".

F Scholar

Scholar; scholar at home.

G Children under 15 at home

All persons under 15 with no stated occupation.

Grouping of Occupations according to Type of Industry

1 Extractive industries

A Agriculture, mining and quarrying

Agricultural labourer; cattle drover; cowkeeper; dairyman; farm labourer; farm servant; farmer; farmer's son; gardener; gardener's son; groom; horse breeder; market gardener; nurseryman; ostler; pig jobber; shepherd; yeoman.

B Fishing

Fisherman; master of a fishing smack.

2 Production industries

A Food, drink and tobacco

Baker; brewer; butcher; butcher's assistant/boy; cake presser, oil mill; chicory manufacturer; confectioner; distiller; foreman, oil mill; ginger beer maker; labourer, brewers; labourer, corn mill; labourer, dry saltery; labour, millers; labourer, oil mill; maltster; manager, starch works; manufacturer or baking powder; mustard maker; oil miller; oil pressman; presser, oil mill; rice dresser; seed crusher; seed crusher's assistant; starch maker; starch maker's assistant; tobacco maker; tobacco paper maker.

B Chemicals and allied trades

Blacking maker; cement burner; clerk, cement works; clerk, gasworks; colour maker; employed in cement works; employed in colour works; foreman, tallow refinery; labourer, cement works; labourer, colour works; labourer, distillery; labourer, gas; labourer, tar distillery; maker of naptha; paint and colour maker; paint grinder/colourman; soap boiler; soap maker; turpentine distiller.

C Metal manufacture and heavy engineering

Blacksmith; blacksmith's labourer; blacksmith's striker; boiler maker; brass finisher; brassfounder; brass moulder; clerk, engineers; engine fitter; engineer; engineer, manager; forgeman; furnace man;

ironfounder; ironmoulder; labourer at forge; labourer, ironfounders; labourer, lead manufacture; marine engine fitter; millwright; tinner; tinplate worker; works at lead mill.

D Light engineering and other metal goods.

Bird cage maker; brazier; chainmaker; clock cleaner; clockmaker; coppersmith; edge tool maker; engine smith; file grinder; grinder; gunmaker; jeweller; link maker; mechanic/fitter; nail maker; saw maker; smith; spade maker; tinsmith; watchmaker; whitesmith; wireworker.

E Textiles

Back tenter, cotton; bobbin linter, cotton; bobbin reeler, cotton; bleacher, cotton; cap reeler, cotton; card hand, cotton; card winder; carpet weaver; cloth dresser; cloth weaver; cotton factory; cotton finisher; cotton piecer; cotton, card stripper; cotton, card tenter; cotton, twister; cotton warper; doffer, cotton; drawing tenter, cotton; dyer, cotton/silk; engine driver, cotton; engine tenter, cotton; factory boy, cotton; flax dresser; flock spinner; frame tenter, cotton; handloom weaver; hemp spinner; jack frame tenter, cotton; knitter; labourer, cotton mill; labourer, dyers; labourer, rope makers; lace maker/worker; maker up, cotton factory; manager, cotton mills; mechanic, cotton factory; mule spinner, cotton; oiler, cotton factory; overlooker, cotton mill; overlooker of mules; overlooker of power looms; overlooker of spinning; power loom weaver; reacher, cotton factory; roper; rope spinner; sailcloth spinner; sack maker; sackcloth spinner; sailcloth weaver; sailmaker; scavenger, cotton factory; steam loom weaver; sweeper up, cotton mill; thread maker; thread winder; throstle bobber, cotton; throstle doffer, cotton; throstle overlooker; throstle spinner; twine/cord/rope maker; twine spinner; wash sizer, cotton; warper, flax mill; weaver; wool comber; working at carpet factory.

F Leather, leather goods and furs

Currier; furrier; labourer, tanner; leather cutter; saddler; strapmaker; tanner; thongmaker; whipmaker.

G Clothing and footwear

Bonnet maker; boot and shoe maker; boot binder; boot closer; breeches maker; cap maker; cordwainer; draper and tailor; dressmaker; fancy needle woman; foreman tailor; glover; hatter/hat maker; milliner; needlewoman; plain sewer; seamstress; shoe binder; shoe clipper; staymaker; straw hat maker; tailor.

H Bricks, pottery and glass

Brickmaker; brickmaker's labourer; bricksetter; china painter; looking glass maker; millstone maker; pipe maker; pipe trimmer; plastic figure maker; potter/pot maker.

I Timber and furniture

Cabinet maker; carpenter; carver and guilder; chair maker; coachbuilder/maker; coach painter; coachsmith; coach trimmer; coach wheel maker; clerk, sawmill; cooper; foreman joiner; french polisher; joiner; joiner/undertaker; labourer, coopers; labourer, sawmill; last maker; lath rinder; mattress maker; pattern maker; plane maker; sawyer; turner; turner's labourer; wheelwright; wood carver; wood turner; upholsterer.

J Shipbuilding and marine engineering

Clerk, shipbuilders; boat builder/maker; mast and block builder; shipsmith; shipwright.

K Paper, printing and publishing

Bookbinder; bookfolder; booksewer; clerk, newspaper office; colourer; engraver; paper maker; paper maker's assistant; paper stainer; printer/compositor/lithographer; printer, copper plate.

L Other manufacturing industries

Bag maker; basket maker; brush maker; cork cutter; hair curler; mat maker; organ builder; organ pipe maker; piano maker; preserver of birds; waxwork maker.

3 Service industries

A Construction

Agent, builders; bricklayer; builder; civil engineer; clerk, civil

engineer; clerk of works; excavator; gasfitter; glazier; house carpenter/joiner; labourer, builders; labourer, surveyors; marble mason; mason; painter; paper hanger; pavior; plasterer; plumber; slater; stone cutter; stone mason; well sinker.

B Transport and communication

Bale goods measurer; bargeman; boatman; bunkerer; carrier; carter; cartman; cellar man; coach proprietor; coal carrier; coal porter; clerk, dock offices; clerk, railway; clerk, railway carriers; clerk, shipowners; clerk, shipping agents; clerk, Trinity House; clerk, wharfingers; drayman; engine driver, marine/railway; engineer, steamer; errand boy; fireman, boat/steamer; first mate; foreman, dock gateman; foreman, Hull dock company; foreman, timber yard; foreman, victuallers vaults; hackney carriage man; harbour lighter; harbour master; keelman; labourer, gaol; labourer, corn/grain; labourer, dock; labourer, Dock Company; labourer, railway; labourer, ship; labourer, timber company; labourer, warehouse; lighterman; letter carrier; lumper; mariner; marine stoker; master mariner; mate of ship; messenger; night porter; pilot; porter; porter, corn; porter, post office; porter, railway; porter, steam packet; railway fireman; railway gateman; railway guard; railway inspector; railway jobber; railway policeman; railway ticket collector; riverman; sailor; seaman; shipping agent; ship broker; ship's carpenter; stoker, steamer; store keeper, Dock Company; superintendent of docks; tidewaiter; toll collector; truckman; warehouse foreman; warehouseman/keeper; watchman, railway; waterman; wharfinger.

C Distributive trades

Agent; agent, coal; agent, corn; agent, grocers; agent, lime; agent, railway company; agent, shipping; auctioneer; auctioneer's clerk; Baltic merchant; beer retailer; beer shop keeper; bone dealer/merchant; bookseller; boot salesman; broker; broker, fur; broker, railway carriers; broker, ship; cattle salesman; chart-seller; chemist/druggist; clerk, brokers; clerk, commission agents; clerk, druggists; clerk, hosiers; clerk, merchants; clerk, timber

merchants; clothes dealer; coal dealer/merchant; commission agent; corn factor; corn merchant; costermonger; cotton waste dealer; draper; draper's assistant; earthenware dealer; firewood dealer; fishmonger/merchant; florist; flour dealer; fruit seller; fruiterer; furniture dealer; general dealer; glass and china dealer; glue merchant; grocer; grocer's assistant; greengrocer; hawker; horse dealer; hosier; insurance agent; ironmonger; keeper of circulating library; labourer, grocers; labourer, wine merchants; linen draper; manure merchant; marine stores dealer; mercantile agent; merchant; milk woman; old clothes dealer; outfitter; oyster dealer; potato dealer/merchant; porter, druggists; porter, fruit merchants; porter, grocers; proprietor of medicine; provision merchant; sailor's draper; salesman; salt merchant; seedsman; ship's chandler; shopgirl; shopkeeper; shopman; shopwoman; spirit merchant; stallholder; stationer; tallow chandler; tea dealer/merchant; timber merchant; tobacconist; toyshop; traveller; victualler; wholesale druggist; wholesale grocer; wine merchant; woodman; yeast dealer.

D Insurance, banking and finance

Banker; bank agent; cashier, bankers; clerk, bankers; land agent; land society agent; postboy, bank; secretary of savings bank.

E Professional

Artist; architect; architect's pupil; assistant teacher; attorney; bone setter; chaplain; clerk, attorneys; clerk, lawyers; clerk, solicitors; conductor of seminary; dentist; deputy court messenger; draughtsman; general practitioner; governess; keeper of asylum; keeper of infants school; land surveyor; linguist; matron; medical student; midwife; minister; monthly nurse; musician; newspaper reporter; nurse; portrait painter; preacher; proprietor of asylum; pupil teacher; reporter, printing office; Roman Catholic priest; schoolmaster; schoolmistress; sculptor; sick nurse; solicitor; socicitor's articled clerk; sunday school teacher; surgeon; teacher; town missionary; veterinary surgeon.

F Public administration and defence

Army officer; clerk, county council; clerk, customs; clerk, Ordnance

Survey; clerk, workhouse; collector, inland revenue; collector, rates; collector, taxes; customs, boatman; customs, docker; customs; extra weigher; customs inspector; customs, landing surveyor; customs, landing surveyor; customs searcher; customs superintendent; customs, surveyor; customs, tidewaiter; customs, weighing porter; government officer, weights; gunner; labourer, corporation; lieutenant, army; officer of Inland Revenue; Ordnance Survey assistant; parish clerk; police inspector/constable; police officer; police sergeant; policeman; registrar of births; sergeant, army; ship surveyor; soldier; turnkey; workhouse master.

G Domestic service

Butler; charwoman; cook; footman; gentleman's servant; housekeeper; house servant; housemaid; keeps a mangle; kitchen maid; lady's maid; laundress; laundry maid; maid; manglewoman; nurse maid; washerwoman.

H Other services

Barber; barmaid; barman; beer house keeper; bill sticker; boots; chambermaid; charwoman, hotel; chimney sweep; coffee house keeper; companion; cook, hotel; curer of smokey chimneys; eating house keeper; footman, hotel; gas lighter; hairdresser; hostler; innkeeper; keeper of zoological gardens; kitchenmaid, hotel; lady's companion; lamp lighter; livery stable keeper; lodging house keeper; maid, hotel; office keeper; pawnbroker; piano tuner; porter, hotel; porter, medical school; publican; sexton; tavern keeper; temperance hotel keeper; town crier; waiter; waitress; washerwoman, hotel; watchman.

I Property owning and independent

Annuitant; dock proprietor; fund holder; gentleman; gentlewoman; house proprietor; independent means; interest on money; lady; landed proprietor; mortgage proprietor; private income; property owner; ship owner; shop owner (several); yearly income.

4 Indefinite

A No industry stated or industry not relavant

Accountant; almswoman; assistant overseer clerk; book keeper;

Chelsea pensioner; clerk; clerk, manufacturers; engine driver; engine man; factory hand; fireman; general labourer; Greenwich pensioner; husband away; labourer; labourer, factory; manner; mariner's wife; office boy; out of work; parish relief; pauper; pensioner; retired; sailor's wife; scavenger; scholar; scholar at home; seaman's wife; stoker; Trinity House pensioner; works at factory.

Also: Persons of 15 and over with no stated occupation.
Married females described as "wife", or with no occupation given, and all females over 15 with the description "at home".
All persons under 15 with no stated occupation.

Appendix B

The Principal Components Solution

The principal components solution (unities in the diagonal) was computed prior to carrying out principal factor analysis to give a measure of the number of common factors required. The Kaiser criterion suggests that, faced with a factor solution, the important common factors are those having latent roots greater than 1 when unities are inserted in the diagonal of the correlation matrix. In the present solution seven factors fulfill this criterion, and together account for over 75 per cent of the variance within the original data.

The structure of the components solution does not really differ greatly from the initial principal factor solution, and in both cases the emphasis is on the generality of the common factors rather than breaking down the generality into the major lines of differentiation (Davies, 1970). The problem of interpreting the resulting constructs is also greater for the components and principal factor solutions than for the rotated solutions. The principal components solution is, however, certainly consistent with the other solutions presented in the main body of the work. The first component is clearly most strongly associated with social rank, and tends to differentiate between the servant employing population and the family-orientated, working class element in the town. Component 2 is concerned with migrant status, and in particular reflects the status of immigrants

Variable	Components 1	2	3	4	5	6	7	Communality
1	.525	.358	.063	.229	.347	.530	.020	.489
2	.593	.182	-.107	-.216	.089	-.576	.101	.793
3	-.273	-.399	.268	.186	-.374	-.034	.357	.609
4	.632	.358	.096	.316	.279	.325	.152	.843
5	.582	-.340	-.118	.307	-.044	-.209	-.153	.632
6	-.850	-.160	-.257	-.162	.090	-.032	.042	.852
7	-.897	.055	-.200	-.204	.036	.080	.061	.899
8	.150	.364	.479	-.244	-.232	-.217	-.171	.575
9	-.503	.370	.304	.134	.159	-.030	.028	.528
10	.304	-.664	-.178	.127	.415	-.073	.307	.853
11	.063	-.723	.143	-.170	-.101	-.122	.009	.601
12	.473	-.553	.120	-.048	.262	.037	-.315	.715
13	.344	.605	-.180	-.019	.152	-.365	-.010	.674
14	.063	-.437	.650	-.258	-.249	.249	.009	.808
15	.104	.227	-.707	.186	.217	-.333	-.165	.732
16	-.916	.091	-.056	.122	.037	-.008	-.015	.867
17	.052	-.712	-.466	.109	.313	.157	-.074	.868
18	-.645	.348	.294	.161	.298	.041	.006	.741
19	-.479	-.148	.381	.204	.186	-.131	-.308	.585
20	.585	.253	.091	-.559	.027	.141	-.282	.827
21	-.410	.067	-.646	.361	-.414	.106	.026	.903
22	.550	-.500	.107	-.027	.052	-.215	.430	.798
23	.223	-.053	-.492	.350	-.599	.102	-.223	.835
24	-.580	-.182	-.435	-.484	.156	.028	.020	.819
25	-.708	-.089	-.309	-.464	.195	.165	.095	.894
26	-.533	-.231	.507	.334	.070	-.127	-.070	.732
27	-.552	-.039	.441	.478	.139	-.317	-.098	.858
28	.063	.504	.040	-.008	-.075	-.024	.622	.653
Latent root:	7.477	4.099	3.428	2.220	1.644	1.438	1.266	
Percentage of total variability accounted for by each component:	26.70	14.64	12.25	7.92	5.88	5.13	4.52	77.04

The ten highest associations with each component are underlined.

Principal components solution for 28 variables, Hull, 1851.

from outside England and Wales. Positive loadings on this component tend to emphasize family life. Component 3 is concerned with household size, and must contain a large element of family status in its composition. Overall the structure is reassuringly similar to that of the principal factor and rotated solutions but the interpretation of the constructs, especially when only a small percentage of variance is involved, presents many more problems than in the rotated solutions.

Appendix C

Factor Scores

Factor scores indicate the position of each individual in a factor analysis problem on each factor, and their computation is therefore a desirable final step in many solutions. Only when unities are employed as communality estimates, however, as in the principal components solution, can scores be arrived at directly and uniquely. In other cases a method of estimation based on a regression procedure (Harman, 1967; Rummel, 1970) is usually used, and this method has also been applied in this study, again using the University of Essex SALY factor analysis program. Scores derived by this method are not, however, unique, but the multiple correlation coefficient of factor scores with the variables of the original data matrix gives a measure of uniqueness. The factor scores, together with multiple correlations, for both the Varimax and Biquartimin rotated solutions are given below.

Factor Scores: The Varimax Solution

Scores are standardised to zero mean and unit variance.

Area	Factor 1	2	3	4	5	6	7
1	0.390	1.914	-0.802	0.798	-1.812	-0.739	-1.332
2	-0.944	-0.203	-0.709	0.514	-0.656	-0.344	-0.107
3	0.433	1.274	-0.332	-0.773	-0.884	0.939	0.615
4	-0.913	0.006	-0.354	-1.119	0.261	-0.936	0.448
5	-1.145	0.726	-0.101	0.159	-0.204	-0.186	0.426
6	-1.200	1.133	-0.709	-0.605	-0.314	1.217	-0.554
7	-1.103	-0.383	-0.847	-0.573	-1.455	0.719	0.404
8	0.831	0.702	-0.763	0.275	0.161	1.348	-1.985
9	1.061	1.742	0.916	0.959	0.019	0.733	1.080
10	-0.083	0.787	-0.273	0.750	-0.816	1.176	-0.116
11	-1.553	1.799	-0.103	0.105	-0.851	1.435	-0.465
12	-1.764	0.411	-0.537	1.880	-1.142	-0.936	0.065
13	-0.322	-1.404	-1.254	0.554	0.521	0.852	0.370
14	-0.796	-0.913	-0.683	-1.849	-1.230	0.755	0.100
15	1.170	0.972	-0.590	0.271	0.420	0.031	-0.620
16	-0.384	-0.943	-1.123	-1.303	0.169	-0.447	-0.593
17	-1.491	0.471	1.399	-0.651	0.943	-0.626	-0.947
18	0.269	-0.151	-0.289	1.060	0.419	0.424	-1.381
19	1.390	0.267	-0.158	-0.995	-1.384	0.483	-0.346
20	-0.569	1.599	0.970	1.639	-0.247	1.305	-0.202
21	-0.110	-0.606	0.136	-0.339	0.083	-0.839	-0.286
22	-0.624	-0.354	0.217	1.281	0.689	-0.308	-0.668
23	0.062	-0.050	1.151	-1.056	1.069	-1.644	-1.638
24	-1.294	-1.476	-0.590	-0.976	-0.980	1.155	1.141
25	-1.166	0.362	4.385	-0.406	0.860	-0.924	-0.048
26	-0.597	0.064	4.330	-1.175	1.965	-0.811	0.196
27	2.399	0.645	-0.206	-0.695	-0.405	-0.603	-0.584
28	0.142	-0.237	-0.551	-1.494	-0.567	1.205	1.152

Area	Factor 1	2	3	4	5	6	7
29	-0.956	-0.285	-0.287	-0.745	0.342	1.410	1.716
30	-0.529	-0.300	-0.700	0.020	0.136	-0.277	-0.884
31	0.302	-0.416	-0.406	-0.812	0.063	0.257	0.313
32	-0.186	-1.496	-0.671	-0.552	-0.914	-0.577	0.253
33	0.846	0.476	-0.112	-1.240	0.252	-1.119	1.881
34	2.637	1.337	0.289	0.067	0.027	0.759	0.332
35	-0.963	1.018	0.505	-1.489	-1.019	0.744	0.932
36	0.461	0.379	0.634	0.752	1.648	1.280	1.076
37	2.577	0.111	0.339	-0.171	-1.183	0.363	1.693
38	0.151	0.184	-0.515	-1.506	-0.160	1.685	0.162
39	-1.142	-0.823	-1.118	-0.677	-0.700	-0.379	0.159
40	-0.770	-0.577	-0.148	-0.090	0.286	-0.698	-0.990
41	0.114	-0.697	-0.712	0.888	-1.418	-2.329	-1.149
42	-0.295	-0.475	0.107	1.393	2.348	0.146	0.460
43	-0.715	-0.228	1.287	0.826	-0.684	0.294	1.741
44	0.082	0.331	0.378	-1.147	1.290	1.045	0.003
45	1.299	0.275	0.462	0.556	-0.873	-0.665	0.025
46	0.858	0.415	-0.003	0.484	1.073	0.259	0.293
47	1.508	0.736	0.316	-0.048	1.344	0.458	-2.021
48	-0.023	0.271	-0.548	-0.351	0.203	-0.080	0.821
49	0.796	-0.501	-1.220	-0.158	0.522	0.541	-2.116
50	-0.810	-1.688	-0.699	-0.299	0.831	1.377	0.533
51	0.551	-1.595	-0.489	-0.717	0.477	-0.056	-0.999
52	-0.216	1.537	-0.219	1.769	0.601	0.714	0.830
53	0.651	-0.532	-0.414	0.192	1.675	-0.175	0.958
54	-0.760	-0.345	-0.669	-0.248	0.969	-0.698	0.124
55	0.940	0.995	0.516	-0.375	0.532	-1.903	1.488
56	0.859	0.501	0.083	1.046	1.053	-2.094	3.082
57	0.646	-0.399	0.241	-1.013	0.666	-0.293	-0.418
58	-0.622	0.337	-0.737	1.215	0.697	-1.181	-0.415
59	0.455	-0.333	-1.124	-0.281	1.411	-0.061	0.119

Area	Factor 1	2	3	4	5	6	7
60	0.687	-0.236	0.273	1.731	1.665	0.436	-1.622
61	-0.073	-1.039	-0.428	0.003	0.544	-0.318	-0.398
62	0.853	-2.233	0.720	-0.208	-0.563	-1.195	-0.196
63	1.307	-1.556	1.270	-0.337	-0.815	-1.183	-0.017
64	-0.586	-1.329	-0.148	2.218	-0.257	-0.804	0.194
65	-0.102	0.429	-0.538	-0.043	0.309	-0.289	-0.211
66	0.326	0.240	-0.539	-1.031	0.849	-1.809	0.161
67	0.053	-2.470	1.545	0.434	-1.737	1.310	-0.175
68	1.240	-0.155	0.043	-0.199	-1.477	-0.468	0.430
69	-2.439	1.237	0.046	-0.303	0.718	-0.359	-1.687
70	-0.522	-0.002	0.259	0.503	0.091	-0.141	1.012
71	-0.632	1.906	-0.183	-1.792	-2.676	-1.652	-0.504
72	0.947	-2.449	2.004	2.609	-1.454	0.927	-0.510
73	-1.203	0.428	-0.652	1.285	-0.385	-1.465	1.205
74	0.307	0.866	-0.359	1.602	-0.953	2.152	-1.807
Multiple correlation:							
	0.986	0.979	0.956	0.977	0.942	0.909	0.946

Factor Scores: The Biquartimin Solution

Scores are standardised to zero mean and unit variance.

Area	Factor 1	2	3	4	5	6	7
1	0.453	1.812	-1.030	-1.030	-2.084	-0.730	-1.523
2	-0.987	-0.280	-0.638	-0.034	-0.812	-0.021	-0.422
3	0.682	1.223	-0.753	0.732	-0.430	-1.318	0.815
4	-1.053	-0.328	-0.412	1.154	0.363	1.032	0.132
5	-0.977	0.579	-0.200	0.111	-0.192	-0.381	0.253
6	-0.995	0.963	-1.073	0.991	0.131	-1.413	-0.428
7	-1.092	-0.574	-1.034	0.859	-1.113	-1.541	0.194
8	0.858	0.926	-0.907	-0.139	0.290	-1.579	-1.487
9	1.581	2.039	0.718	-1.527	0.042	-0.690	1.486
10	0.199	0.938	-0.431	-0.544	-0.697	-1.457	0.061
11	-1.126	1.646	-0.586	0.430	-0.472	-1.821	-0.319
12	-1.621	0.345	-0.359	-1.236	-1.657	-0.063	-0.447
13	-0.378	-1.126	-0.945	-0.169	0.541	-0.299	0.469
14	-0.994	-1.251	-0.980	2.160	-0.645	-1.134	-0.066
15	1.216	1.150	-0.580	-0.363	0.342	-0.297	-0.337
16	-0.768	-1.176	-1.088	1.491	0.317	0.436	-0.790
17	-1.526	0.095	1.244	0.531	0.944	0.911	-1.069
18	0.234	0.091	-0.104	-0.832	0.185	-0.223	-1.168
19	1.306	0.209	-0.454	0.713	-1.0773	-1.290	-0.212
20	-0.013	1.811	0.806	-1.596	-0.277	-1.085	0.132
21	-0.143	-0.578	0.088	0.568	0.292	-0.303	-0.125
22	-0.632	-0.224	0.521	-1.219	0.296	0.709	-0.714
23	-0.329	-0.298	1.126	0.841	0.857	0.877	-1.799
24	-1.330	-1.626	-0.679	1.471	-0.475	-0.977	0.968
25	-1.029	-0.047	4.173	0.077	0.753	1.627	-0.172
26	-0.546	-0.294	4.103	0.274	2.016	1.905	0.269
27	2.216	0.694	-0.338	0.130	-0.428	-0.266	-0.406
28	0.201	-0.311	-0.861	1.700	0.069	-1.126	1.294

Area	Factor 1	2	3	4	5	6	7
29	-0.708	-0.276	-0.419	0.837	0.886	-0.690	1.857
30	-0.699	-0.371	-0.612	0.360	0.037	0.200	-1.015
31	0.210	-0.442	-0.442	0.684	0.288	0.060	0.372
32	-0.516	-1.641	-0.538	1.014	-0.929	0.205	-0.128
33	0.831	0.333	-0.187	0.840	0.382	1.065	1.740
34	2.877	1.689	0.097	-0.382	0.165	-0.951	0.914
35	-0.721	0.649	-0.051	1.726	-0.408	-1.304	0.892
36	0.855	0.792	0.740	-0.821	1.759	0.096	1.627
37	2.705	0.383	0.225	-0.642	-1.031	-0.868	1.940
38	0.234	0.134	-0.885	1.688	0.538	-1.259	0.511
39	-1.359	-1.077	-1.081	0.824	-0.600	-0.010	-0.243
40	-1.015	-0.740	-0.032	0.086	0.109	0.634	-1.220
41	-0.337	-0.855	-0.415	-0.802	-2.142	1.266	-1.832
42	-0.152	-0.088	0.623	-1.243	2.029	1.599	0.686
43	-0.404	-0.177	1.308	-0.913	-0.712	-0.006	1.596
44	0.175	0.321	0.169	0.944	1.740	-0.279	0.391
45	1.279	0.366	0.488	-0.816	-1.140	0.207	-0.033
46	0.993	0.686	0.109	-1.081	1.004	0.264	0.589
47	1.434	0.936	0.280	0.084	1.313	0.157	-1.463
48	0.037	0.255	-0.546	0.358	0.316	0.124	0.807
49	0.496	-0.354	-1.114	0.556	0.524	-0.188	-1.838
50	-0.860	-1.537	-0.511	0.453	1.144	-0.390	0.686
51	0.126	-1.579	-0.327	0.925	0.493	0.650	-0.968
52	0.314	1.889	-0.148	-2.072	0.450	-0.432	1.090
53	0.640	-0.265	-0.050	-0.345	1.573	1.282	1.140
54	-0.903	-0.432	-0.681	0.433	0.881	1.132	-0.049
55	0.970	0.887	0.583	-0.320	0.299	1.830	1.291
56	1.054	0.714	0.516	-1.461	0.515	2.081	2.790
57	0.426	-0.480	0.262	0.966	0.764	0.855	-0.327
58	-0.656	0.389	-0.413	-1.008	0.187	1.175	-0.652
59	0.338	-0.180	-0.890	0.103	1.421	0.853	0.281

Area	Factor 1	2	3	4	5	6	7
60	0.695	0.218	0.725	-2.031	1.227	-0.269	-1.204
61	-0.306	-1.003	-0.204	-0.131	0.413	0.830	-0.455
62	0.357	-2.278	0.988	-0.085	-0.877	0.742	-0.536
63	0.922	-1.622	1.385	-0.292	-1.073	0.851	-0.272
64	-0.652	-1.080	0.389	-1.783	-0.937	1.042	-0.155
65	-0.114	0.400	-0.520	0.116	0.268	-0.010	-0.221
66	0.054	0.007	-0.449	0.595	0.706	2.027	-0.093
67	-0.076	-2.356	1.553	-0.258	-1.653	-1.265	-0.185
68	1.138	-0.169	-0.036	0.024	-1.517	-0.614	0.294
69	-2.403	0.815	-0.163	0.482	0.732	0.197	-1.847
70	-0.372	0.035	0.330	-0.836	0.007	0.242	0.892
71	-0.756	1.123	-0.794	1.867	-2.489	-0.911	-1.144
72	0.916	-1.928	2.369	-1.851	-1.980	-0.751	-0.432
73	-1.080	0.372	-0.416	-1.129	-0.851	1.043	0.667
74	0.602	1.231	-0.542	-1.203	-0.908	-1.993	-1.331
Multiple correlation:							
	0.990	0.984	0.965	0.971	0.952	0.921	0.951

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