An economic geography of consumer movement and expenditure patterns in county Durham

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AN ECONOMIC GEOGRAPHY OF CONSUMER MOVEMENT AND EXPENDITURE PATTERNS IN COUNTY DURHAM.

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ABSTRACT

An Economic Geography of Consumer Movement and Expenditure Patterns in County Durham.

The central theme of this thesis is the analysis of patterns of consumer movement, which is based upon extensive hypothesis-orientated survey data collected in County Durham.

The thesis falls into three related parts:
In part I a number of hypotheses relating socio-economic factors to household movement patterns for the purchase of different goods are tested. In addition, methods of predicting the sectoral and spatial distributions of incomes and expenditures are examined. Throughout this part of the thesis, elements of the social and settlement geography of the County are outlined and analysed, providing an important background for all parts of the thesis.

In part II, hypotheses derived from the framework of Central Place theory are tested against extensive consumer interaction data, related in turn to the system of centres in the area.

In part III the above data on consumer movement is employed with a gravity model for two main purposes: Firstly, to attempt a rigorous test of the performance of the model, both as an allocative model, and at the same time as a model to replicate spatial patterns. Weaknesses of the model are investigated. Secondly, the model is used to continue the search for explanation of observed patterns of movement. This analysis is set against a theoretical review of the nature of and problems associated with these models.

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CHAPTER 1

INTRODUCTION

This thesis examines some of the features of the patterns of consumer movement and the related system of central places in a part of North East England. The concern is both with what can be described as the 'determinants' of consumer movement, being the socio economic factors which influence any particular consumer decision, and also with attempts to 'explain' and replicate broader aggregate patterns of movement, using certain theoretical models. The theoretical problems and practical limitations involved in the use of these models are also considered, as an integral part of the work.

The analysis is firmly based in theoretical and hypothesis-orientated fieldwork, undertaken principally using survey methods. It is hoped also that the thesis makes a methodological contribution, in that the task of eliciting information which is both accurate and unbiased is an ever present problem in the social and behavioural sciences. The methodological aspects can be best examined by use of the appendices, where most of the technical data concerning the surveys appears.

It is also accepted that one of the features of geographical work is that it is related intimately to the actual environment in which the features under examination are found. The level of abstraction is kept as low as possible within the constraints of the application of theory and some reference to the real and broader features of the economic and social geography of the area or areas considered is both necessary and desireable. It is this characteristic of geographical work which is at once the greatest advantage and the greatest constraint in the development of meaningful theory.

The thesis is divided into three related parts:

Part I attempts to examine certain socio economic features of consumer decisions. The approach is one of intensive, rather than extensive analysis of household movement behaviour, in a few selected communities in County Durham. The basic data unit employed is the household, which is in turn set firmly in the geographic context of the community of which it is a part. Certain hypotheses are put forward and tested, and in some cases the results could possibly provide grounds for the modification of higher level models and theoretical constructs.

In this part of the thesis other forms of analysis, important methodologically, are also made. In particular, the problem of prediction or establishment of patterns of income and expenditure, both sectorally and in spatial terms for small areas, is examined and developed. This part of the thesis ends with a brief consideration of the possibilities of analysis of the structure of the retail sector of each of the communities, and analysis of initial results.

Part II of the thesis moves away from the intensive analysis of Part I to the extensive analysis of broad patterns of movement. The interest centres around the relationship between the number and spacing of centres and the associated patterns of consumer movement over a broad area of southern County Durham. More particularly, certain specific theoretical notions, arising directly from central place theory, are tested against empirical data. This part of the thesis in part parallels, but more importantly extends the type of analysis undertaken by Nader (1967) in the northern part of the County.

Important differences between theoretical expectations and empirical observations lead to the adoption of a gravity model, from the family of interaction models, in Part III of the thesis.

The aim is both to search for 'explanation' of patterns of movement by the use of the model, and, using the large body of movement data collected on an extensive scale, an attempt is made to provide a rigorous test of the power and limitations of the model. Gravity models are used increasingly for planning purposes, sometimes, it would appear, without their limitations and assumptions being fully understood. Here a gravity model is used both as a tool of analysis, assisting with explanation and in order to examine the theoretical and practical aspects of the use of such a model. A theoretical introduction to the gravity model preceeds the use of the model.

Thus the thesis is based very firmly in the field of analysis of consumer behaviour. This tends to be a comparatively neglected aspect of study in the tertiary sector, largely because of the considerable methodological problems involved. Clark, W.A.V. (1968) writes: 'Recently there has been a considerable concern with the lack of knowledge about the spatial behaviour of the individual purchasing units, the households'... 'Because it is after all the consumers who support the central places it seems realistic to increase our understanding of the relationship between households and central places' (p.387).

The thesis rests very heavily upon empirical data which is used to test explicitly stated and operationalised hypotheses. A number of surveys were undertaken, all with foregoing pilot surveys. Appendices 2, 3 and 4 provide technical details of of the surveys.

Firstly, an intensive sample survey, investigating household spatial behaviour in three communities was undertaken, in an attempt to relate movement patterns to various economic and social factors, within the geographical context of each community.

Secondly, a 100% sample survey of retail establishments was undertaken in each of the three communities in order to provide a background to the former surveys, to examine certain structural features of retailing in small towns in County Durham and to provide a methodological contribution to the problems associated with data gathering in the retail sector.

Thirdly, an extensive survey over a wide area of County Durham was undertaken to establish patterns of consumer movement for a range of goods. This survey, because of its dimensions was a considerable undertaking.

Fourthly, a survey of all central places was undertaken, in order to obtain a ranking of these central places over the area in which the consumer surveys were made.

The work is set firmly in the context of the essentially working class area of the North East. The historical geography of the North East has been dealt with extensively elsewhere, (see for example, Smailes (1935), and Daysh, G.H.J. and Symonds, J.S. (1953)). A few relevant features only are outlined here.

Historical geography

The North East is physically and culturally a very distinct region, in which the seaboard has played an important role in the development of the area.

Before the 16th. century it was a relatively poor agricultural area, emerging from many centuries of insecurity, being near to the Scottish border. Coal has been worked on a very limited scale and on a very localised basis at least from the 13th. century. By 1700 coal had outpriced wood as a fuel and demand for coal was growing, particularly in the largest towns, and London. The North Eastern coalfield was the nearest coalfield to London for the transport of coal by sea, which was essential, as overland transport was impossible. Coal was worked mainly in the areas close to the Tyne and Wear, adding emphasis to the importance of Newcastle and Sunderland, which were already growing. After 1821 a few shafts were sunk through the magnesian limestone of east Durham. The coming of the railways provided the greatest impetus for coal exploitation. In the west and south west, on the exposed part of the coalfield was development particularly rapid. Pits tended to be small and rather short term. This was both because of technological considerations and because the seams, though accessible, tend to be thin and rather broken. Consett Ironworks, opened in 1840 provided impetus for the development of the coal industry in North West Durham. Expansion of the coal industry south of Durham City proceeded apace with the growth of the Teeside steel industry. Towards the end of the 19th. century larger and more efficient pits were opening on the concealed eastern part of the coalfield. These larger pits tended to have larger accompanying settlements.

Vast social and geographic changes accompanied the industrial expansion of the 19th. century. In migration was considerable; new pits settlements sprang up throughout the County, either as new self standing settlements, such as Willington, or as pit settlements 'grafted' onto an already existent agricultural community, such as Trimdon. The overall population density in the County was, and is, high. Settlements in the west tended to be smaller and older than settlements in the east, and pit closure was not uncommon in west Durham throughout the 19th. century. The early importance of the large towns, Newcastle, Sunderland and Teeside continued to grow. By the early years of the 20th. century the period of rapid expansion was past, and after World War I, for secular economic reasons, the coal industry went into decline. This decline hit west Durham harder than eastern Durham and serious problems associated with economic decline set in in the west, which became one of the earliest problem areas in the North East. The depression caused considerable magnification of these problems and the familiar signs of economic decline appeared: high net outward migration, high unemployment and low activity rates. The large towns continued to grow whilst stagnation and physical decay were common in non conurbation areas. Under the early location of industry policy of the 1930's small trading estates were commonly developed in close proximity to the larger towns. Team Valley was an example of a large trading estate of this period.

It must be remembered that this very dense settlement pattern grew up not out of any overall influences of centrality but largely as a result of the technical requirements of the coal industry. Gross underprovision of central services was common as settlements tended to be too small and too many in number to support a full range of central functions. There were, however, important central places, such as the historically important towns of Durham City and Bishop Auckland; others such as Spennymoor, Chester le Street and Stanley, grew out of the sheer pressure of demand for certain central functions.

After world war II and the nationalisation of the coal industry, the post war coal shortage concealed much of the basic economic weakness of the area. After 1956, however, with the arrival of a period of coal surplus, plans for rationalisation were laid, which involved closure of almost every pit west of the A 1 trunk road and many more besides.

County Council Planning policy with regard to settlements, published in 1951 in the form of a settlement grouping policy, argued the need for a rationalisation of the 'relic' settlement pattern and a concentration of central functions in certain of the larger settlements, whilst encouraging a planned decline or even removal of other settlements. Chapter 9 of the 1951 County Plan (Durham County Council Planning Department (1951)) outlines details of a settlement classification policy.

Settlements were classified into 4 groups:

A: where considerable capital investment should be made because of population regrouping policy.

B: where only sufficient capital should be invested to cover depreciation.

C: where sufficient capital investment should be made to support a reduced population.

D: where no further investment of capital should be made : this involves planned run - down and eventual removal of the settlement.

The need for this sort of drastic policy was emphasisied on the grounds that the need to attract industry to an area which had an accessible labour force and a better environment was vital and also on the grounds of the need to concentrate investment in the social services. These aims were repeated in the 1964 County Plan Amendment. Here the rigid classification was removed in letter rather than form.

It is not here proposed to raise a critique of this planning policy, and in any case any critique rests finally very much upon thenature of the normative assumptions adopted. It will suffice to state that in the author's view alternatives have not been adequately costed and the normative assumptions are questionable.

From 1958 to 1965 pit closures involved 24,892 miners, according to House and Knight (1967). Over this same period the number of pits in the North East, south of the Tyne, decreased from 123 to 25 'safe pits' - a staggering decrease.

In an area with an already considerable poverty problem, pit closure was serious. Clearly much depended, and still does depend, upon an increasingly diversified economic structure.

It is interesting to note that the idea of centrality is given considerable importance in the County Plan, and that the breakdown of the 19th. century settlement pattern and the newly developing work and leisure patterns serve to emphasise the notion of centrality in new patterns.

Thus County Durham today remains a relatively densely populated area in close proximity to two or three urban areas. Main streams of internal migration tend in general to be from east to west, where the long life pits are to be found. Migration is also taking place to the conurbations. Out migration from the North East remains at a high level. There are three new towns, Peterlee, Newton Aycliffe and Washington, which are contributing to the redevelopment of the area.

For many reasons the area has traditionally been one of high immobility, which, as will be seen, is reflected in consumer behaviour.

It is against this background that the study is placed. Throughout the study emphasis is placed upon explanation and observation of the behaviour of the consumer, rather than attempting to deduce this from measures of centrality which are related but indirect measures of consumer behaviour.

Part I is concerned with intensive study of consumer interaction. Throughout part I the present tense is used for convenience; the date to which the text refers is the period spring 1967 to spring 1968, except where otherwise indicated.

PART I.

CHAPTER 2

THE ANALYSIS OF CONSUMER BEHAVIOUR. - INTRODUCTION, HYPOTHESES AND METHODS

The purposes of part I of this thesis are threefold:-

1. To test certain hypotheses, principally concerning the effect of socio-economic factors on travel patterns of consumers. The influence of socio-economic variables on such patterns of travel is much referred to but is seldom investigated. The influences of various socio-economic variables on movement patterns are interesting in themselves in that they add dimensions to understanding of movement patterns and they are also interesting in that they may possibly be able to modify inputs to some of the 'explanatory' models in use at present.
2. To produce a method for the derivation of the pattern of income and of expenditure, first sectorally and secondly translated into spatial flows, for a small area. The need for operationalised methods of deriving such patterns is increasingly yearly, with demands from market research, planning and the academic world. Much of the difficulty stems from the reluctance of the British Government to include census operations on income, so that reasonable alternatives must be used.
3. To outline the results of an essentially explanatory survey of the structure of the tertiary sector in a number of communities and to attempt to relate the results back to the consumer studies.

In this part of the thesis, the material used for testing of hypotheses and the derivation of methods is based upon work undertaken for this purpose in 3 communities in County Durham. The material was collected from a carefully designed and conducted sample survey in each community: technical details, the questionnaire used and sample errors are outlined in Appendix 2.

The three settlements were chosen from the settlements of the 'small town' size, circa 10,000 population. This size was chosen as increasing importance is placed upon the role of these settlements, in the non urban areas of the County, where, as has been seen, the settlement pattern is largely a legacy of the economic development of the area, closely tied to the coal industry.

The first, Murton, south west of Sunderland, is still very much a 'classic' large mining village, and as such is considered in detail, because of the central role of the mining community in the evolution of the settlement pattern of the area. In numerical terms, at least, this can be said to be a declining settlement type, though it has by no means become insignificant in the County.

Shildon, the second, whilst formerly an important mining town, is now heavily dependent upon one major industry - the British Rail Wagon Works, and represents a settlement where there is an extremely heavy dependence upon one basic industry, which at the moment at least does not share the same economic fate as the coal industry.

Crook, the third, has been through the now well known phase of pit closure, has experienced economic difficulties in the early '60's but is now turning into a more important employment center, in line with the category A bestowed upon it by the County Council Settlement Grouping policy.

In pursuing these investigations, the thesis will also touch upon the role of the small town, in the settlement geography of the County, particularly in relation to the planning policy of the County Council.

Shildon and Crook are both Category A centres under the County Council planning policy, Murton is Category B, but is included, for reasons outlined below.

The County Plan, 1951, defines settlements of category A as: 'those in which the investment of considerable further amounts of capital is envisaged because of an expected future regrouping of population, or because it is anticipated that the future natural increase in the population will be retained' (p.77). Both Crook and Shildon fall into this category, Murton does not, but was included as no review of settlements in County Durham is complete without some consideration of the mining community, and Murton is one of the closest examples to the Category A type of community, whilst still being a true mining settlement.

The Amendment to the County Plan, 1964 states: 'concentration of development in selected centers will allow the provision of new houses in better surroundings and in larger units to support more and better social facilities. It will also create modern urban units, expanding communities and groups of labour and attract industry by providing a modern industrial environment. The loss of young people would be reduced by the transformed living conditions and the attraction of industry'. (p. 42).

Thus it would appear that the small town has an important role to play in the evolving settlement pattern of the County. This study makes a cross - sectional examination of features of the social geography of three of them.

1. The hypotheses concerning consumer movement.

Formal models of consumer movement, central place theory and gravity model theory are presented as parts 2 and 3 of this thesis. In this first section hypotheses are tested which could be fed into these models to modify their use and power. More importantly, relatively little work has been undertaken in the field of consumer movement patterns. Central Place studies for example, have tended to concentrate on the locational and 'central' aspects rather than on the movement aspects implicit in central place theory. In this part certain hypotheses relating to consumer movement are tested, both to add to the body of material existent on the subject and, as suggested above, to raise possibilities for modification of other models.

Before the hypotheses are presented it must be remembered that the work has been done in an area in which working class households are strongly, if not overwhelmingly, represented, relative to other parts of the country.

First and foremost, it must be stressed that two principal influences on the spatial behaviour of consumers, namely: distance from a given set of shopping centres and the size, or attractiveness of these centres, are not here being ignored. These two factors are reviewed in detail in part III, here they are taken as given. That is to say, spatial patterns of consumer behaviour are taken basically to be the result of 2 opposing forces:- one that consumers are more prepared to travel to a centre offering a large range of goods than to one offering a small range, or, stated in probability terms, given two centres of equal distance away from a given zone, then there will be a greater probability of a consumer going to the one that offers more shopping facilities than to the one that offers less. The second, that distance is a 'friction' factor: other things being equal, the further the distance to a shopping centre, the less likely it is that a consumer will go there to shop. This is the socalled 'distance decay' function, (for a review of work in general in this field see Olsson, G. (1965a)). In general theoretical terms, it is the resolution of these two opposing forces which provides the basis for understanding the observed patterns of shopping movement. The basis of this fundamental hypothesis is examined in part III. Here concern is with the factors which tend to distort this basic pattern.

By way of introduction it may be pointed out that many of the points made by Garrison, Berry, Marble et al. (1959) still hold good, for example: 'The structure of the demand for movement by individual consumers or households has received little attention in the past. Theoretical constructs and empirical studies have, for the most part, been concerned with broad patterns of movement as exhibited by large masses of people while the study of the spatial behaviour patterns of individual consumers has been neglected, as is evident from the small number of theoretical works and good empirical studies available on this topic' (p.157).

'Isard does, however, provide some indication that spatial relationships may not be the only factors of importance when he introduces the concept of the consumer's space preferences (which is defined as a measure of the individual's desired level of social contact). Different individuals placed in the same spatial situation with identical levels of information may behave differently, and it is postulated that these differences in behaviour arise out of the space preferences (which we might consider to be expressed as a set of desired trip frequencies) and are held to be determined by social and psychological forces which are exogenous to the spatial system' (p.157-8). It is the effects of certain of these forces, in spatial terms, which are to be investigated.

Garrison et al. review some of the early work in this field, including work by Gardner (1949), and the University of Virginia (1951), both of whom showed positive relationships between occupational status and travel patterns (both frequency and distance) and between household income and travel patterns. They then proceed to review work by Nystuen, in Cedar Rapids, where he uses a linear multiple regression model to attempt to 'explain' movement patterns by three broad groups of variables: socio-economic factors, transport availability and location of residence. In both duration of trip and frequency of trip the influence of the socio-economic variable was found to be statistically significant, but in 'explaining' total distance travelled the model was found to be unsatisfactory.

It is particularly these economic and social variables which are of interest here. A series of hypotheses will be examined over the next four chapters, being tested most rigorously in the final chapter of the four. First, the hypotheses are here presented.

Definitions

Definitions are collected together in Appendix 1. A few that are relevant to the hypotheses are presented here:

Convenience and shopping goods: The main division in the analysis is between 'shopping' and 'convenience' goods. This typology is extensively used in marketing literature and was given formal expression by the committee on definitions of the American Marketing Association:

'Convenience goods are those consumers goods which the consumer purchases frequently, immediately and with the minimum of effort; shopping goods are those consumer goods which the consumer in the process of selection and purchase characteristically compares on such bases as suitability, quality, price and style' (taken from Kaish, 1967, p.28). These definitions were expanded by Kaish, borrowing the theory of cognitive dissonance from the behavioural sciences, which postulates anxiety or anticipation of regret as a basis for decision making, thus adding to the rather simpler notion of effort both physical and mental, implicit in the earlier definition. The word durable goods is used here synonymously with shopping goods.

Multiple stores: Retailing organisations having more than 10 separate branches.

Occupation status: based on the Registrar General's Socio Economic Group Classification. This has been extended by the author to cover additional categories of persons. See Appendix 1 for full details.

Social Class: based on the Registrar General's Social Class Classification.

Income groups in use: based on the income groups used in the Family Expenditure Survey 1965, viz:

Group B:	£ 5 - 10 per week net.	F:	£25 - 30
C:	£10 - 15	G:	£30 - 35
D:	£15 - 20	H:	£35+
E:	£20 - 25		

Household: A group of people who live in the same dwelling and share the same housekeeping unit. Usually are related. Lodgers are excluded.

The hypotheses

1. A household where the head is of a 'high' socio-economic status will be more willing to travel a given distance to purchase durable goods than will a household where the head is of 'low' socio-economic status.

The corollary is that one can expect to find a greater proportion of 'high' status households going to larger centres in any one situation, than 'low' status households, assuming that there are nearer smaller centres.

There are a number of reasons which can be offered as explanation. Higher status households will have a greater ability to overcome the friction of distance because of such factors as a higher level of car ownership and lower cost of travelling a given distance in proportion to total income. More importantly, perhaps, factors such as a different set of demands, the different social significance of a given purchase and a different level of expectancy of these demands being fulfilled may well play a part in creating different movement patterns.

There are a few examples available in the literature to support this hypothesis. Hess (1966) finds differences in movement patterns between occupational groups in the retail service area of Greater Aalborg, Denmark. In line with the above hypothesis he writes: 'occupational groupings play a significant role in the type and magnitude of purchases made in Greater Aalborg by households in its retail service area'.. 'Thus the drawing power of a central place will be greater not only for those households in its immediate vicinity, but also for consumers who have a relatively high social status' (p. 23). However, this results must be treated with caution, as the sample he uses is biased and inadequate. He also surprisingly ignores the factor of distance, so that one must ask is it really surprising that a greater proportion of merchants, craftsman and shopkeepers use Greater Aalborg than, for example, farmers?.

Clarke and Bolwell (1968) present more rigorously tested material (though again with a biased sample) and claim to show that 'attractiveness' of a particular centre, as a part of the gravity model formulation, is not uniform in its effect upon different social and economic groups. Their results indicate sorts of space preferences in line with this hypothesis, using material from South East U.K.

Nader (1969) claims that rateable values reflect socio-economic differences in the population and finds that significant differences exist in movement patterns between different 'rateable value' groups. These differences again broadly accord with the above hypotheses. Nader admits that it is lack of available data that prevent direct comparison between groups.

Wheeler (1969) finds similar results in the analysis of journey to work trips.

2. Households where the head is of a high socio-economic status will show a greater tendency to purchase convenience goods from independent retailers than from cooperative and multiple stores, than will households where the head is of a low socio-economic status.

The factors involved are perhaps less clear than with the previous hypothesis though it can be suggested that price cutting is less important, economically, to high status groups than to low ones. Instead notions of 'quality' may be important. McClelland (1966) suggests that the use of cooperative stores is more common amongst the lower than higher occupation status groups.

In this study occupation status is measured by the Registrar General's Socio Economic Groups.

The underlying assumptions are that for high status households, price competition is either less important or is regarded as less important than other considerations such as 'service' or 'quality', traditionally in the sphere of the private retailer.

3. Households where the head is of a high social class will be more prepared to travel a given distance for the purchase of durable goods than will households where the head is of a lower social class.

The corollary is that 'higher' households should be more prepared to use larger and more distant centres than low class households. The factors involved are similar to those described under 1. above, the difference in the testing being that the Registrar General's Social Class definition is used.

Analogously, Anderson (1962), on the subject of location of residential neighbourhoods, writes: 'Interaction rates are higher among individuals within a subgroup than among individuals between subgroups. On the basis of this evidence it is reasonable to assume that individuals prefer to interact with others who are socially similar to themselves' (p.168).

4. Households with a high income will be more prepared to travel a given distance for the purchase of durable goods than households with a low income.

There are possible social factors at work here to explain this hypothesis, in line with those provided in hypotheses 1-3. More particularly, higher income households should be able to overcome the friction of distance more easily than low income households because of a greater absolute amount of income available for travel, assuming even that the proportional amount available stays level, (which it does not); levels of car ownership and more multi-purpose trips, with heavier spending on entertainment will also tend to encourage travel.

Huff (1961) writes: 'the distance that consumers will travel for the procurement of various goods and services varies considerably among consumers of various types. Generally, consumers of higher economic status will travel further for shopping purposes than consumers of lower economic levels. Such a phenomenon can be explained partly on the basis that the demands of individuals of higher economic levels are greater due to the added social significance that various purchases have for them, and partly on the basis that consumers of higher economic levels generally have better means of transportation at their disposal and therefore experience somewhat lower shopping travel cost' (p. 26).

Clarke and Bolwell also fairly successfully relate income to consumer movement albeit at a fairly high level of aggregation, and their findings show results in line with those of the above hypothesis, again in South East U.K.

Blankertz(1950) noted the more restricted use made of Department stores by low income groups, in that low income groups tended to patronise a few department stores, rather concentratedly, whereas higher income groups tended to patronise a higher number of stores, with presumably a higher average total movement figure.

R.L. Davies (1969), in a study of 2 areas in Leeds attempted to show the influence of income upon consumer movement. He showed that of the two areas the one with the higher average income per household had (a) a greater number of shopping trips per week and (b) had a greater % of shopping trips out of the area - both for convenience and for shopping goods. He too used an interview method for gathering data, details of which appear in Davies, R.L. (1964).

Mertz and Hamner (1957) found that average income per household 'explained' only a little of the variability in the <u>number</u> of trips per day, when built into a multiple regression model. However, it must be remembered that the data was at a high level of aggregation, and in the multiple regression model the income variable was included with distance and car ownership variables. When correlated alone with the number of trips per day, over a range of areas, the correlation coefficient was +.655. However, as Garrison, Berry, Marble et al. point out, the income data was not linear in form which would of course have lowered the r^2 in a linear model.

There is, in addition, strong related evidence, for as Tanner (1961) points out, total expenditure on transport does vary directly and positively with household income. This would suggest that longer distances are travelled with increased income and it also seems likely that this will relate to shopping trips as well as other types of trip. This can be seen from diagram 1, which reveals that the increase in expenditure is proportional as well as absolute.

Ambrose (1968) attempts to use refrigerator ownership as an indicator of socio-economic level in a consumer study in South Eastern U.K., but finds little positive correlation with movement patterns, either temporally or spatially. This is probably because of the unsuitability of the indicator as well as other possible factors, such as a sample which appears to be unintentionally biased.

It must be remembered when examining this relationship between income and movement that in some studies use is made of total household income and in others of income of the head of the household. In this work, income data was collected on the basis of total net household income, for as will be seen, it was put to other uses as well.

5. Households with a high income will tend to use independent retailers more, for convenience goods, than will households with a low income.

This hypothesis is based on similar grounds to those offered in hypothesis 2. Davis R.L. (1969) found some tendency for this to occur in Leeds.

6. Car ownership. There are significant differences in willingness to travel for the purchase of durable goods in households where a car is owned, compared with households where a car is not owned.

The reasons for this hypothesis are fairly clear, and there is a certain amount of work on the subject. Most of the North American studies involving this show that car ownership is a highly important variable in explaining movement patterns. Mertz and Hamner found that it 'explained' 66% of the variation in numbers of journeys when incorporated in a linear multiple regression model. Results in this country have shown similar but less well developed tendencies, for example, the Haydock report (Department of Town and Country Planning, University of Manchester, 1964). Nader, in County Durham found significant differences in movement patterns between car owning and non car owning households (Nader, 1969). Ambrose, however, on the south coast, found little or no evidence attributable to this factor.

Synthesis

The above hypotheses are tested in each settlement and then are brought together for more rigorous testing in the chapter on synthesis. In addition, the following hypotheses and ideas are examined:

7. <u>That frequency of various forms of travel is related to household income.</u>

This hypothesis is supported by evidence from Davies, R.L. (1969), gathered in Leeds, and by Ambrose (1968).

8. <u>A preliminary investigation is made into whether or not shopping trips are really multi-purpose. This is a much referred to subject in questions raised about the 'distortion' of travel patterns.</u>

The remainder of the chapter of synthesis is concerned with problems arising out of attempts to predict income and expenditure patterns on a large scale and certain tests of methods are used. This is the concern of the next section of this chapter.

There is however, one possible variable not included in this work, which may very well have a profound influence upon movement patterns - the 'cultural' variable, as Murdie (1965) found with the Old Order Mennonites, and Ray (1967) found between French and English Canadians in Ontario. North Eastern English working class culture is very strong and colourful and may well influence results obtained from these analyses, particularly by distorting the expected results; this could be assumed on the basis of work elsewhere.

In summary, it can be said that although there is a body of work existent, upon consumer decision processes (for example, Nicosia 1966; Clark L.H. 1954; Alderson 1965), there is much less work translating consumer decision into spatial terms.

It is worth mentioning at this point that there appear to be two main streams of development in spatial studies of consumer movement, one along the lines taken in this study, attempting to find and refine the analysis of the 'determinants' of consumer behaviour, so that hypotheses can be used predictively and possibly incorporated into certain projective models, the other main line being that developed by the 'perceptionist' school. Elliott Hurst (1969) summarises some of the perceptionists' objections to the other line of approach: 'the basic data refers not to demands and desires, but to travel habits'... 'there is little reason to believe that the same correlations will hold in predicting travel in the future' (p.71). He continues to advocate the study of underlying decision processes as the only way to build up successful predictive hypotheses. He is correct in one sense, that the variables studied are in aggregate form, and do not relate to the shopping pattern of individuals, but whether or not these hypotheses 'explain', is a rather complicated matter, depending upon what one is trying to do with the hypothesis. A more serious criticism from the perceptionist school is that this sort of study of movement contains no explicit normative element, so that if used alone in planning, on the basis of extrapolation of past trends, no account is taken of desires or needs, or of changes in these, (which produces self fulfilling planning, as people must shop somewhere). This is at the root of the argument between Breese and Schnore (Breese, 1961, Schnore, 1961), when Breese, noting that the system of social relations is changing as rapidly as physical mobility, both of which have important consequences for overall movement patterns, writes: 'there is a general tendency to accept the proposition that what <u>is</u> will remain, only more so, - perhaps only slightly modified - and therefore there is no particular need to examine further the peculiar interest of the individual in the public and private transportation he will use'. (p.187). Schnore's reply is that 'transportation analyses are not especially prone to dehumanise the individual' and he argues that the only way one can infer about human behaviour change is to refer data to trends, whilst accepting that the trends themselves are part of a system which itself can be changed. System facts, he argues are more manageable than individual ones.

There is an important methodological question to be answered here, which can be conveniently broken down into two parts - (1) are studies of the 'determinants' of consumer behaviour 'explanatory' or 'descriptive'?, and (2) is one justified in using aggregate level hypotheses in planning for the future?. The two questions are frequently confused. The question of whether or not an aggregate level hypothesis 'explains' something is a complex methodological one; analysing the determinants of consumer behaviour is only in fact testing levels of association, but this itself can give rise to further hypotheses about the nature of the relationship. As long as one remembers that it is the closeness of a statistical association that is being tested, then it is reasonable to suggest that this work has a considerable contribution to make. On the question of the extrapolation of the trends for the planning of future facilities etc., one can argue that a knowledge of the nature of past trends, if combined with a dynamic study of the decision process, incorporating normative elements, can reasonably be used as a basis for future planning. Clearly the extrapolation of trends alone is not acceptable, for, as Breese suggests, the result is likely to be that: 'such a megalopolis will, in fact, be sterile and unimaginative, offering a hive like kind of existence with a gross minimum mediocrity of environment, and with little opportunity for privacy and development of the individual' (Breese, 1961, p. 197).

2. Methods of analysis of patterns of income and expenditure.

It becomes increasingly clear that a knowledge of the distribution of purchasing power (income) and the likely expenditure patterns in an area is of great importance in market research, geographical work and planning. Consumers in a given trade area do not have uniform patterns of demand, either in terms of the goods demanded or in terms of the direction of movement for a given good. The ability to predict spatial flows of income and expenditure, in the tertiary sector, has become of considerable importance.

Two separate but related problems are involved: (i) the problem of how to determine the pattern of income and expenditure in non spatial or sectoral terms and (ii) the problem of the translation of this into spatial flows.

The problem of how to determine the sectoral income and expenditure pattern of a given area arises because of the lack of census or parallel data on incomes and expenditures. This has encouraged certain workers to attempt to discover proxy variables which can be used to substitute for income information. Social class as a measure of economic status has been a favourite in a number of studies: Wilkins(1952) illustrates the use of this measure. The J index derived from electoral registers has been used as a measure of economic status of areas. Cox(1968) presents what he terms 'the first comprehensive approach to the estimation of incomes and expenditures in British towns'(p.258). He attempts to measure the mean income of local authority areas, using 'socio-economic classification of a town' and 'average number of persons per household', together with the Family Expenditure Survey (- Department of Employment and Productivity). He first derives the mean income group for any particular town and then uses the Family Expenditure Survey to predict likely expenditure patterns by sector, for that town. His work is, as he acknowledges, very simple and crude, but it is readily useable. This is indeed the case, but his method does raise specific problems, for example it takes into no account the spread of income within a town, and towns are classified on essentially rather dubious lines.

An alternative method of dealing with this problem is here outlined, but first a brief review of alternative methods available is made.

Taking firstly the problem of deriving a sectoral pattern of income and expenditure: this can be further broken down into the problem of deriving a pattern of income and of deriving a pattern of expenditure for an area. Most formal sectoral studies attempt to do both.

Studies of this nature usually begin with the household as the basic starting unit. H.S. Houthakker writes:' Family budgets - it is unecessary to stress here the great contribution they can make to our knowledge of the basic facts of economics' (Houthakker, H.S. 1952, p.1.).

Examples of early work can be found in : Ministry of Labour, (1949), Massey (1942) and Madge (1943). There are a number of underlying problems which apply whenever survey method is used: (i) the usual problems associated with sample surveys: bias, non response etc., (ii) higher levels of non-response in work on income and expenditure than in other fields, (iii) particularly, understatement of certain items, such as incomes, and certain types of spending, alcohol for example. (On the subject of understatement of incomes, Cole and Utting point out : 'The phenomenon of expenditure exceeding income in family budget studies has a long history' (p. 370), Cole D. and Utting J.E.G. 1956); (iv) savings and the holding of assets presents a very large problem indeed in data gathering.

The main methods of data gathering in use are as follows:

1. The family budget 'diary' method:

This involves the keeping of a detailed daily record of purchases, in a large 'diary' left with responding households. This is the basis of the method used in the annual 'Family Expenditure Survey' (see: Department of Employment and Productivity); they work with a random sample of 5000 households. This method is probably the most accurate, but may be biased because of low response rates; other disadvantages include long preparation and execution times and the fact that studies have shown that payment of respondents markedly affects results, in terms of response rates (see Kemsley and Nicholson, 1960). The response rate in the Family Expenditure Survey is as low as 67%. This method therefore appears unsuitable for the geographer, who is usually interested in the additional information of destination of flows of expenditure than with the more detailed 'sectoral' analyses of expenditure possible from this sort of work.

2. The interview method :

This involves detailed questioning of respondents, in doorstep interviews, about amounts of income and expenditure received and made, by all household members, over a given (short) time period. It is clear that by this method large errors in reporting are possible, but Cole and Utting write: 'we feel that it would be wrong at present to write off the interview method in favour of record keeping' .... 'it seems clear that reporting biases are more important than sampling error' (Cole D. and Utting J.E.G. 1956). It is because of a higher response rate with consequently less potential bias that this method seems to hold its own.

3. The simplified interview method:

This method involves interviewing, to ask 'key' questions about such things as the ownership of consumer durables (Cramer J.S. 1962) and from these attempting to generalise about patterns of expenditure. This method is fraught with the possibilities of error.

4. An alternative predictive method:

It can readily be seen that the above methods, for most planning, marketing and academic purposes will be either too involved or too costly or both. Here is presented a method of obtaining the income structure of an area, without the direct use of proxy variables. The method is as follows: using the census figures for Local Authority areas on Socio Economic Groups, the proportions of males in each of 17 occupation groups, in a particular area, is obtained. This is then compared with the table in the Family Expenditure Survey which shows income of head of household by occupation, in the sample for that Survey (Table 25, in the 1967 Family Expenditure Survey). Some amalgamation of census groups is necessary. It is then possible to 'weight' the figures appearing for the proportions of each occupation group appearing in each income group by the occupation structure of the area in question, and from that extract the probable spread of incomes in that area.

This method will only produce the income structure of any given area; the next problem then becomes the extension of this to include expenditures, sectorally. This is done simply by use of the Family Expenditure Survey. As Cox (1968) writes:

'the incorporation of the Family Expenditure Survey in the proposed method (his proposed method) could rest solely on its value in opening up a rich source of current and historical expenditure data' (p.257).

The simple fact is that although the Family Expenditure Survey operates at a high level of areal aggregation, its accuracy, even in relation to smaller areas is unlikely to be matched by all but the most extensive and costly surveys. This alone justifies its use.

Thus from the spread of derived incomes it is then possible to use the Family Expenditure Survey Tables to project expenditures for any one area, (using the national rather than regional figures, which have a greater reliability, on grounds of sample size). The advantages of this method are as follows: the need for long and laborious surveys, some of doubtful accuracy is avoided; the expenditure pattern provided is taken from what is acknowledged to be the most reliable source of such data available, and information is readily available.

Additional information can of course be fed in, particularly, for example, relating to the level of female employment in an area, which is obtainable for local Employment Exchange figures. Further checks are available at a rather general level by using the published data of the Ministry of Labour on Prices, Production and Incomes. The method can be applied to small areas by use of the Scale D special census tabulations, giving socio-economic group breakdowns for wards and civil parishes (though the data is on a 10% sample basis).

An example of the operationalisation of this method is presented in Chapter 6.

6. Incomes, expenditures and spatial patterns:

The above methods still do not solve the problem of how to translate these amounts into spatial terms. The author has derived a method from the above method, which does enable fairly rapid assessments to be made, of the size and direction of monetary flows, with, it is believed, some accuracy. The method involves ascertaining the income group into which each of a random sample of households falls, using interview techniques, and then,using the information provided in the Family Expenditure Survey, the likely expenditures for each household can be obtained, as long as the income groups used in the survey correspond to those in the Family Expenditure Survey. Questions are also asked, at the interview stage, about the last destination visited for the purchase of a set of particular goods, thus the expenditure for each household in question can be allocated directionally. When these are added up for a particular settlement there will be some indication of financial flows out of the settlement. The same could, in theory, be done for incomes, with a little more difficulty.

Examples of the operationalisation of this method are provided in each of the following 3 chapters, in the sections on 'Flows of Expenditure'.

It is almost impossible to test this method, unfortunately, with the resources available, but a few related checks are made, in the chapter on synthesis. These are:

(i) An examination of the relationship between 'raw flows' of households and the 'costed' flows of expenditure. Assuming that the above method is accurate, this will enable examination to be made of the traditional method of measuring patterns of expenditure.

(ii) A comparison will be made of the results produced by using method 4 above, to derive the income structures of an area, with what is found in reality in the settlement studied, from data produced by the surveys.

It is hoped that thework presented will make a contribution to the important need to be able to project the spatial flows of expenditure in an area. The chapter on synthesis will end up with some discussion of the possible changes in patterns of income.

Income and sectoral changes in expenditure

It is not without relevance for the thesis to examine theoretical ideas and empirical evidence concerning the relationship of income to expenditure in sectoral, or non-spatial terms.

Economic literature covers many aspects of the differences in patterns of income and expenditure between families of different compositon and different social types. Allen (1942) provides a good example of an analysis of purchase patterns, sectorally, of different types of families, using composition of family and occupation of household head as two main variables and drawing upon American data. This sort of analysis is beyond the scope and intent of this thesis, and will not here be treated. There are in any case considerable problems which arise in attempting to predict such things as change in family composition and social structure. Of more direct relevance here is to consider the effects of a rise or fall in real income in an area, on the sectoral patterns of expenditure. This is of direct relevance in the North East, which is experiencing varieties of rapid economic change.

Firstly a few relevant observations from the work of Lydall (1955) on incomes in the U.K. in 1952 is appropriate.

He demonstrated clearly the skewed nature of the distribution of incomes:

Table 2.1. U.K. Incomes 1952

Gross income £	Percent of all incomes
0-199	13.0
200-399	25.3
400-599	31.6
600-799	13.7
800-999	6.9
1000-1499	6.1
1500-1999	1.9
2000-	1.5

Source: Lydall 1955.

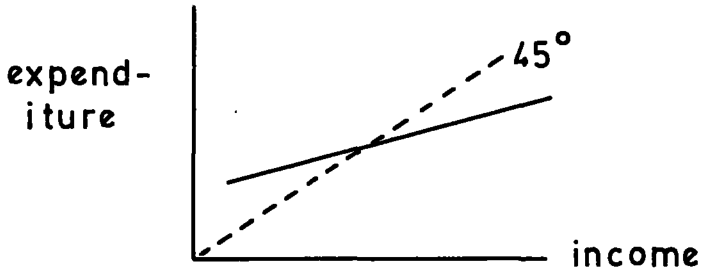
The average income of a owner occupier households was 43% higher than that of tenant households. Income of white collar households was 82% higher than that of manual households, and income of households where the head was retired or not working was 56% lower again, though the modal value was even lower because of a strongly skewed distribution.

More directly, Lydall compares real incomes of manual workers in 1938 with real incomes in 1952. He shows that the average net income of manual workers and their average net expenditure increased by 110% over the period. However, retail prices also increased by almost exactly the same amount, as he points out. He writes: 'We may conclude that the real value of the average household disposable income of manual workers in regular employment was about the same in 1951-52 as it was in 1937-38' (p.177). He goes on to argue that because of other factors there probably has been a small increase in real income over this period: free social services, non inclusion of unemployed in 1938 and a fall in average household size are named. However any increase in real income was not great. There are no reasonable grounds for assuming that the situation has changed markedly since 1952.

Lydall also illustrates the fact that saving in lower income groups is very low indeed.

The effects of income change

The general Keynsian hypothesis is that when real incomes in a community increase or decrease then consumption will increase or decrease, but not so fast. It is usually stressed that this is the short term view. This can be represented diagrammatically in simple linear form, where the regression coefficient b is less than unity:



Walters (1968) argues that evidence can be produced to show that this postulate does hold over the short run, but over the long term there is no evidence to indicate that increased real income produces increased saving, so that this general hypothesis would underpredict consumption and over predict saving, in the long term.

An analysis of the effect of changes in real income on the patterns of expenditure within family budgets is here made, based upon Family Expenditure Survey data. The results have direct relevance for the retail sector in any changed future situation.

Diagram 1(b) shows percentages of household budgets devoted to 7 broad classes of goods and services, for households of different average incomes. It must be stressed that this diagram shows only percentage changes within each budget, and that any increase or decrease in real income will almost always mean a net increase or decrease in absolute expenditure values.

In general, the diagram indicates that an increase in real household income will cause a fall in expenditure percentage devoted to food, as compared with total expenditure. This is another illustration of Engel's Law, which as Houthakker (1957) points out, can be best described by a negative logarithmic function, rather than a linear function. This means that for very low income households the importance of food expenditure as a percentage of the family budget rises dramatically, which can possibly be seen even from this diagram. This is one reason why the small general shop is able to persist even in areas of considerable economic decline.

Interestingly the importance of expenditure on housing also falls with increased income, and the same is the case for fuel.

Contrary perhaps to popular belief, the increase in the share of the budget of durable goods does not increase dramatically with income. However the rather sharp rise from the lowest income groups is again noticeable. Clothing shows only a slight but consistent increase. The rise in expenditure percentage on services is more marked. Most dramatic of all is the rise in increase on transport: from the data used, this related both to fares and the purchase of vehicles. The implications of this with respect to the consumer movement hypotheses are considerable: it is an indication of the different willingness to overcome 'distance friction' by different economic (and social) groups . The implication is that higher income households are more willing to travel a given distance than low income ones.

It could however be suggested that distortion enters the above diagram because of changes in family composition. In order to help overcome this, diagram 1(a) shows the same curves for the case of the one man one woman household, drawn also from the Family Expenditure Survey.

The curves take the same general form as in the previous case.. Percentages of food expenditure fall more dramatically however and housing expenditure does not fall off with income so constantly. Expenditure on transport still shows a considerable proportional rise with income.

The average income per household in the three communities considered, in 1968 lay around the figure of £17.5. The above diagrams provide an indication of the likely changes in the distribution of demand arising from an increase or decrease in real income per head in the communities, which will depend largely on factors external to the local economic systems of the communities concerned and more upon economic and location of industry policy.

3. Retailing in the local economy

In chapter 7, an explanatory study is made of the possibilities of investigation of retail structures, on a localised basis. An attempt is made to relate consumer movement patterns to the retail structure of the community in question.

CHAPTER 3

MURTON

Introduction

Each of the three settlements is examined in turn. Murton, the first, is still very much a 'classic' mining community and as such an important settlement type, though one which is diminishing in number. The mining village can well be regarded as the basic settlement type over much of the area of industrial County Durham and indeed in many other coal mining areas, and as such deserves consideration.

In an earlier chapter some outlineoof the development of the economy and settlement pattern in County Durham has been made, in which the growth and importance of the mining community has been elaborated. Murton is a good example of a present day large mining community, located on the concealed part of the coalfield, on the magnesian limestone. The village is contained bythe parish of East Murton which is a part of Easington Rural District Council. Sunderland is 7 miles distant, Seaham Harbour 3, Houghton le Spring 5, Durham City 9 and Newcastle 17. The general location can be seen from Diagram 2.

The impact of the coming of the coal industry to Murton can be clearly seen from the growth of population, shown in Table A1. Murton pit itself was sunk in 1838, with colossal difficulties caused by sand, water and sheer depth. Fordyce (1857) writes: 'the winning of this colliery was one of the most ambitious and expensive undertakings of the kind upon record' (p.587). Before 1838 Murton had been a tiny agricultural village of about 70 persons. Indeed, as with so many mining settlements in the County the old rural core is still visible both in house type and street pattern. McKenzie and Ross (1834) scarely mention Murton at all, giving more prominence to Dalton le Dale, now in comparison insignificant. The greatest rate of increase of popultion in the history of the village was between 1831 and 1841, coinciding with the opening of the colliery. Population growth continued rapidly until about 1881 when it reached 4710. Slower growth came after this, the population reaching 9687 in 1951 and falling to a little to 8615 in 1961. The impact of coal is clear and in migration into eastern Durham has already been discussed. In 1851 the census reports that 80% of the population of Murton was born in County Durham, 5% in Northumberland 4% in Yorkshire, 3% in Cumberland and Westmoreland and 2% in Ireland.

The growth of the built up area can be seen from Diagram 3. In 1861 Murton was divided into a small agricultural settlement at what is now the west end of the village and a large group of houses near to the pit at the eastern end. By 1898 the principal addition was that of a number of colliery rows to the north of the pit, and the development of what is now the commercial centre, Wood's Terrace. By 1923, Murton was expanding, westwards towards old Murton, with the addition of better quality 20th. Century housing. 1967 shows much of Murton as it now is, the agricultural village being contiguous with the colliery village. Changes since 1945 fall largely into one of two types: 1. further encroachment of housing estates onto farmland and 2. replacement of the colliery rows to the north of the pit, by council estates. Diagram 3. shows in a generalized way the present pattern of house types. There were in 1968, approximately 2930 households.

The employment situation since 1945 will be discussed

later

later and early developments can be summarised by noting the inordinately heavy dependence on coal for employment, since 1838. According to the 1851 census 76% of the working population was employed in the coal industry with agriculture coming second at 7%, the tertiary sector as a whole being only 4%. In 1968 71.5% of the male labour force worked in the coal industry.

<u>The development of retailing</u>

It will also be of interest to trace the development of retailing in Murton. For reasons of classification and definition it is not possible to treat the figures of 1938 and before with any accuracy; table A2 based on Kelly (1858,1873, 1890, 1921 and 1938) shows that the total number of shops grew from 9 in 1858 to 81 in 1938. In 1968 there were only 30 shops plus a large cooperative store (founded in 1877). The 1968 table is based on survey data, which in turn based on Census of Distribution (1961) categories. Consideration of the more recent changes in retail structure is reserved for a later chapter. For the period 1858 - 1938 it is sufficient to say that the number of shops increased approximately in proportion to the population, in particular with an increase in the food and small 'general shops'. The main feature of this period is that there are fewer shops there than one would have expected for the size of population. Two sources of explanation can be offered: one, the proximity of other large centres, Seaham, Sunderland and Houghton, and two, that industrialisation came later in East Durham than in the west so that growth tended to be inhibited. The paucity of shops is paralleled by a shortage of other professional services, in comparison with settlements of a similar size.

The social structure of mining communities

Before moving on to consider present day Murton and to test the hypotheses about consumer movement patterns, some consideration must be made of the nature of social life within mining communities, for it is from within this framework that the most important changes in consumption patterns may arise, from any changed relationships and life patterns. In addition it should provice a meaningful background for the work.

Surprisingly little has been written about the sociology of the mining community. Most notable is the study by Dennis, Henriques and Slaughter (1956) of Ashton (fictitiously named), a West Yorkshire mining village. This study has been condensed and a little expanded by Frankenberg (1966). Zweig (1948) also made valuable contributions. The main contribution of geograghers has been in the field of migration to and from these communities, for example, House and Knight (1965), and Taylor (1966).

Some work has been done on the problems of pit closure, for example House and Knight (1967) and Heughan (1953), which will be considered in more detail in a later chapter.

In the following section, the elements of the social structure in which a change would be likely to produce an effect in spatial patterns, particularly of consumer movement, are considered.

Frankenberg aptly describes Ashton as 'The town that is a village' (p.113); Ashton in 1951 had a population of 13,925, a little larger than Murton, but nevertheless displaying many features of intense similarity. 'In terms of national economy and society, the inhabitants of Ashton are part of a class divided society. It is interesting to note that Ashton itself, far from being a microcosm of that national framework is representative of only a part of it. To all intents and purposes the inhabitants of Ashton are all of the working class. In relation to the stratification of society they are all in the same category. In this, Ashton is typical of mining villages' (p.37. Dennis et al.). It is suggested by Dennis et al. that in order to understand fully the nature of social relations within the mining community it is necessary to look at the miner (a) as a member of the working class and (b) at the miner at work as a miner, both to be modified in turn by the fact of being an Ashton miner. This analysis is here omitted and the results of interest to this study alone are considered. It must however, be pointed out that in one important respect at least, the situation has changed, in that the system of payment of miners, in 1956 based heavily on piecework has been largely replaced by the introduction of time rates. This, within the context of the patterns of relationships outlined by Dennis et al. is likely to alter the pattern of relationships between men, employers and unions as a 'conflict' situation was much more likely when working on a piecework basis.

The main point that is made about the life of miners is that it is dominated by a feeling of insecurity, which arises from a number of factors: (1) the permanent and very real hazard of being killed, (2) the fear of injury, which leads to a significant drop in income, (3) the insecurity of employment, coal mining being suceptible to both cyclical and structural unemployment and (4) the important fact that the miner, in contrast with most salaried workers experiences the highest level of income whilst still young and his average weekly income actually <u>declines</u> with age, usually from 30 onwards. It is felt that any saving will be taken up by the unexpected, so that it really is better to save for a 'sunny' rather than 'rainy'day and then spend freely. Traditionally, miners have been well known for free spending, but it must be remembered that this is only in terms of percentage of income, for they do not have great amounts to spend. There are a number of hypotheses which attempt to 'explain' this phenomenon: first, the traditional standard of living of the miner has been very low, based as it was on low pay and terrible conditions. There is, it is suggested, a fear of allowing standards of living to rise greatly, as a return to the former situation would cause distress: 'It is not prosperity that the miner hates, but the pain of being deprived of it, and for him, at any rate the accession of riches may indeed be perilous, for he knows he cannot be sure of their permanence' (p. 140, Dennis et al. 1956). Secondly, the miner can be demoted to daywage (basically the pay of non-face workers), substantially below the pay of face workers. Thirdly, the miner expects a lower wage with increasing years, unlike many other forms of occupation. 'Insecurity in all the forms described, is the most important single factor which has moulded and still moulds the miners way of life in these hours when he is not at work.' (Dennis et al. p.140).

Thus it is here suggested that there is a tendency in mining communities to spend only that amount which keeps the family at an average standard of living for that community, which has important consequences for household spending patterns on such things as durable goods, lowering, it could be suggested, the effect of differences in the economic situation between households, and strengthening any 'cultural' element in purchase patterns, which, in the case of the mining community, means more homogenity in movement patterns than in other types of community. Future changes in the spatial spending patterns of mining communities could well stem from (1) the replacement by time rates of piece rates, allowing the miner to live on less of a hand to mouth basis (2) the removal of at least some of the sources of insecurity, which could have the effect of making the miner more prepared to spend on raising standards of living, which with the operation of Engel's law means heavier spending on non food goods, and (3) increasing mechanisation, needing more skills, which tends to produce a rise in real incomes.

Social relations in mining communities tend to be rather different from other types of industrial community. Frankenberg suggests the general factors: 'the obvious point that mining is dark dirty and dangerous, which sets miners apart from other manual workers let alone non-manual workers' and 'since pits can only be sited where there is coal to be found miners tend to live in <u>relatively</u> isolated villages, inhabited mainly by other miners and not in towns with mixed industries'. (p.122). Dennis et al. more fundamentally write: 'Is the simple fact of inertia based upon customs and adaptation to a given place sufficient to explain the hold of a place like Ashton? It is suggested that the additional factor is the existence and persistence in a mining community of its own standards, in particular its basic living standards limited by the weekly wage' (p.174).

Thus both the nature of the work, requiring close teamwork in dangerous conditions and the relative social homogenity of the mining village, in terms of social class, tend to make the community rather inward looking, which will have the dual effect of limiting movement out and directing a proportion of the spending within the village into entertainment activities 'with the lads' in which the bar of the workingman's club plays an important role.

The family relationship tends to be one of conflict, centered around the wage level of any one week. In Murton, most husbands and wives participate in the division of the weekly wage packet, which is a real difference between the situation described in Dennis et al.. Nevertheless, a legacy of family tension clearly exists, and there is a very clear role differentiation for men and women. The basic premises of Dennis et al. still appear to hold: 'tension exists as a social fact by virtue of the social structure of which all husbands and wives are a part' and'there is, in the Ashton family a system of relationships torn by a major contradiction at its heart: husband and wife live separate, and in a sense, secret lives' (p.288). One important factor in this situation is that in Murton, as in Ashton, there is a great scarcity of employment for women, so that in a sense the village exerts a centrifugal effect upon women whilst exerting a centripetal effect upon men. This is clearly borne out by the survey findings.

What are the implications of social change in this sort of situation? First, there is the rather dramatic change introduced by pit closure, which will be dealt with more fully later. In this situation any financial influence that 'village breakup' may have upon movement patterns tends to be more than offset by reduced income, so that far from being more 'outgoing' the community may well tend to become even more introspective. Second, there are the more subtle changes introduced by such occurences as the appearance of jobs for women near at hand, as for example has happened at Peterlee, supplying jobs for the surrounding villages. The probable net effect is one of increased spending outside of the home village, because of increased travel, increased awareness of alternatives and of course of increased income.

To conclude this section: it is suggested that the social structure of the mining community is so 'special' that some awareness of the nature of the social structure of these communities is necessary in order to be able to understand fully what follows, to be able to predict meaningfully from what follows.

The social structure of Murton

Here aspects of the social structure of Murton directly relevant to the later sections concerned with consumer movement and expenditure patterns, are outlined. This and later material was collected on the basis of the sample surveys details of which appear in Appendix 2.

Household structure

The average size of household was found to be 2.9 persons. The proportion of children (age 0-14) in the population is 22.7% compared with 25.7% for the County as a whole. 67% of households have no children and only 10% have 3 or more.

12.4% of Murton's population consists of old persons (over 65) compared with 10.2% for the county. There is however no direct relationship between the size of household and the number of old people in the household. 28% of households contain at least one old person, 72% contain none. 17% of households in Murton contain only old people. This is where a welfare problem of considerable proportions lies.

In analysing the number of dependents per household, it emerges that the activity rate for Murton (workers per 100 population) is as low as 39.5. Comparable 1966 figures are as follows:

U.K.: 57.4 Northern: 53.3 North Western: 58.3

This figure for Murton reflects a number of factors at work, principally the shortage of job opportunities, the higher percentage of children and old people than in the County and the underemployment of women. It also denotes quantitatively that welfare problems do exist in mining communities, even in relatively prosperous ones. 12% of households have all members working whilst 11% have 4 or more dependents. There are, on average, 1.75 dependents per household. The main points of note are that 25% of households have no members working, being entirely dependent upon social security payments, only 9% have 3 or more members working, 46% have one member and 21% have two.

Occupation structure

71.5% of all working males in Murton work in the coal industry. Of these, 90% work in the three pits of the Murton complex and 10% travel elsewhere, mainly to Seaham. There are approximately 2,240 working males in Murton. Thus 1600 work in the coal industry and 640 elsewhere.

The population of Murton, based on survey data, in 1968, was just under 8000, about 7,920 persons. Of these 3,120 are actually employed, and of these, 1,870 are heads of households. Table A3 reveals two points of importance: (1) assuming that the basis of the socio-economic group classification is well founded ('ideally each socio economic group should contain people whose social, cultural and recreational standards and behaviour are similar'.(p.xi., Classification of Occupations 1960)), then Murton is an extremely homogenous place, (2) Murton has an extremely strong hold upon the employment of heads of households. Less than 2% of the heads of households are in S.E.G. 1-5 which includes managers, teachers, and other professionals, 3% are in 6, which is mainly office and shop staff and 60% fall into groups 8-11. Group 8 consists og Deputies and Overmen who do share the same sort of cultural background as do those in groups 9-11. Groups 9 and 10 do contain a number of public service employees but group 9 consists mainly of face workers and group 10 contains other coal industry employees.

83% of working household heads work in Murton. The next major employment source, Seaham Harbour, takes only 6%, with Sunderland following at 3%. The main types of heads who travel out are (i) lower paid professionals, teachers, nurses, and (ii) miners. Within Murton, travel is almost exclusively by foot, whilst car travel is the most important form for external travel.

The location pattern for employment of workers other than the head of the household confirms the earlier stated expectations of patterns of employment: only 40% of these workers work in Mrrton itself, mainly in the coal industry. The other 60% go to a variety of occupations in Sunderland Seaham and Newcastle, in that order of importance. These people are usually in S.E.G. 6 or 10, office and shop workers in the case of women, and factory and unskilled workers in the case of men.

Analysis by the Registrar General's Social Class Classification shows that 90% of working household heads fall into groups III and IV again suggesting the relative social homogenity of the settlement.

<u>Housing and migration</u>

Housing in Murton, as seen earlier, dates from a number of different periods and varies widely in quality, Houses have been classified according to tenancy type: Council (including North Eastern Housing Asstn.). Privately owned (or mortgaged), privately rented and N.C.B. property. In Murton it is clearly the privately rented property which is most inadequate, in terms of quality. The proportion of household heads in S.E.G. 1-6 is greater in privately owned property than in Council housing - 18% as compared with 4%. 65% of Council houses heads are in S.E.G. 7-11 whereas in the case of the private housing this figure is 50%. In each case the percentage of heads in the groups 17-21 is approximately 30. The percentage of households in each tenancy type is as follows:

Council 67%	Privately rented 6%
Privately owned 20%	N.C.B. 7%

In-migration into Murton is of interest for two reasons: (1) it reflects upon the amount of change in the life pattern of the community and (2) it could potentially influence the results of the survey of consumer purchases. It was found that less than 6% of the households in Murton were in-migrants in the last 5 years and most of them came from nearby villages or towns. Out migration was not considered.

Income

An attempt was made in the survey to gain information on household income. Given the limitations on resources available it was not an easy task to obtain details of net income, (plus income from state benefits plus other net unearned income). There was a certain amount of unwillingness to answer this question, but as most of the interviews were conducted personally by the author there is at least some consistency in the level of rigour with which this question was pursued throughout all of the surveys.

Table 3.1.

Income Group	% of households
B (£ 5 - 10 per week)	25.1
C (£10 - 15 per week)	17.9
D (£15 - 20 per week)	26.3
E (£20 - 25 per week)	14.8
F (£25 - 30 per week)	8.3
G (£30 - 35 per week)	3.8
H (£ over 35 " ")	3.8

Table 3.1. shows the basic result for Murton. The income groups shown, whilst broad, were chosen specifically for further work with the Family Expenditure Survey. The distribution of income shown, when compared with national or even regional distributions shows a marked negative skew. 69% of household have a net income of less than £20 per week. 25.1% of the total are in income group B which contains almost exclusively retired people plus others on various types of social security benefit. It was impossible within the limitations of the survey to attempt to assess the level of holding of assets, though it was clear that differences in asset holding existed, for example between some retired house owners and many council house tenants.

Table 3.2. shows a general relationship between household size and income size, but there are anomalies - there are a few households with a large size and a low income, and a few with a small size and large income.

Table 3.2.

Average size of household in each income group

B	1.38
C	2.35
D	3.5
E	3.7
F	3.2
G	4.0
H	5.0

The average numbers of workers per household does also increase with income group in a constant manner.

Of the three main socio economic groups represented in Murton, namely, 8, 9 and 10, there are representative numbers of each in the income groups D - H, which suggests that in a community such as Murton, differences in movement patterns are more likely to be evident on the basis of income groups rather than occupation groups. The average income for a household in each of the socio economic groups shows, where the sample size is large enough, that there is some difference between groups 8, 9 and 10. There is a relationship between household size and income, producing a more even spread of real income per head than would be immediately apparent. This fact is of course intimately related to the low activity rate for Murton.

The average household income in Murton is £17.08 per week.

Consumer movement and expenditure patterns

The purpose of this section is to describe the basic patterns of movement of the social structure of Murton and to test some of the hypotheses outlined in the previous chapter, about the determinants of consumer movement. After this, an expenditure flow model is constructed, showing the destinations of actual flows of money in the tertiary sector in and from Murton. The threads of this analysis are brought together with those of the other settlements for more rigorous testing, in chapter 6.

The influence of the factor of distance is implicit in all of the analyses, but is made more explicit in the later part of the thesis, when distance is incorporated as one of the major variables in the gravity model formulation which appears there.

Convenience goods

Table A 4 shows 7 types of convenience goods classified according to the types of shop in which the purchase was made - Independent, Multiple and Co-operative. It is also indicated whether or not the purchase was made in Murton or elsewhere and purchases from vans are also noted. The figures in the table relate to percentages of households in Murton, (and as such are essentially 'raw' movement figures).

The most noticeable general fact is that almost all purchases of convenience goods are made within Murton itself. Fish purchases, not unexpectedly, are as high as 10% elsewhere, whereas groceries are 3%, greengroceries 1.5% and meat 5%, all of which are very low, Most of these extra-village purchases are made in Seaham or Sunderland.

These figures are a little modified when one considers the destination of expenditures (i.e.) including the destination of vans based outside Murton. Thus the total of purchases made from Murton shops drops slightly in most cases - to 86% for meat, 93% for groceries, 89% for bread and 88% for milk. The most noticeable drop is to 24% for fish, which is a reflection of the purely local conditions in that there is no wet fish shop in Murton.

These essentially 'raw' flows are costed in more detail later.

The usage of different types of shop for different goods presents some contrasts. Meat purchases go strongly to the independent retailers with 50% of the purchases (59% including vans from Murton), compared with 18% at the Cooperative (23%) and 4% at the multiple shops. There are a number of factors at work here, including the problem of accommodating a butchery department as a viable sub department of a multiple grocery store (see McClelland 1963). A large overall turnover is needed before this is possible at all. This is also a branch of retailing very traditionally dominated by the small retailer, because of the rather special skills needed and the perishable nature of the goods sold.

Fish purchases are a special case, being made either from fried fish shops, or more likely, from private vans, for similar reasons to the ones for the preponderance of the private retailer in the butchery trade.

With grocery purchases the situation is rather different: here the widely noted intrusion of the multiple store (usually the supermarket), into the market can be seen. 26% of the grocery purchases go to the grocery multiples, 27% to the independents and 40% to the Cooperative. From experience of interviewing shop managers it seems to be the independent retailer that has suffered at the hands of the multiples, rather than that of the Cooperative. This corresponds to the national picture (see for example, Corner, D.C. 1969). Interestingly however, with grocery sales from vans it is the Cooperatives both in and out of Murton that take by far the largest proportion of van trade. One reason of course is that they tend to deal with the less mobile elements in the community and these tend to be the older people, for whom the attraction of the Coop is perhaps stronger, and the high street price war situation less relevant.

Greengrocery purchases exhibit many of the characteristics of meat purchases. Indeed, McClelland suggests that many of the problems in retailing this type of good are similar to those of retailing meat. In addition to the factor of perishability, there is the fact that profits tend to fluctuate rather wildly in this line of goods, which does not encourage capital investment. Detailed knowledge of buying wholesale is also a highly important factor in trade in this line of goods.

Bread purchases are dominated by the small private baker, despite the fact that a Cooperative bakery is Murton's only secondary industry, though the Coop does lead the field with delivered bread. Milk purchases are almost completely deliveries and 56% of households use the Coop.

Though there is some discussion as to whether Chemists goods should be considered as convenience or shopping goods, they are treated here as convenience goods. If a settlement is large enough to support a chemist the main question appears to be whether or not Boots or a subsidiary opens a branch. If not, as in this case, the field is left to the independents. 97% of chemist good purchases take place within Murton, confirming its treatment as a convenience good. The independents have captured the market and are likely to hold it unless competition comes from a new dispensing department at the cooperative store or the opening of a branch of a multiple, neither of which seems very likely in Murton.

Determinants of consumer movement - convenience goods

Within Murton, two socio economic variables have been examined with regard to their influence upon spending patterns for convenience goods - namely occupation (based upon socio-economic group) and income. Two types of purchase - meat and groceries were examined. In particular, hypotheses 2 and 5 are tested.

Occupation

The more important differences in store patronage could be expected to occur between groups 1-6 and 8 and 9 and 10. Within the context of the coal mining community it is groups 8, 9 and 10 that are the basis of the divisions in social terms - the distinctions between supervisory, face worker and non face worker grades.

It can be seen from Diagram 4(a) that there is little difference in purchasing patterns between the socio-economic groups under consideration. There is a slight tendency for group 1-6 to patronise independent retailers more than groups 8, 9 and 10, but it is not marked. A Chi squared test was used to test the differences in purchase pattern between groups 1-6, 8 and 9 and the differences were found not to be significant at the .05 level. There is a similar tendency, but even less marked for group 8 to patronise independent retailers more than group 9, though this does not hold for group 10. One possible explanation is that as S.E.G. group 9 provides most of the active union members it is these men and their families who will tend to patronise the coop.

Broadly the same conclusions can be drawn from the diagram which shows orientation to the three types of shop for weekly grocery purchases. Again occupational groups 1-6 show a slight orientation to private retailing, whilst the main support for the coop tends to come from groups 8,9 and 10. The differences in purchase habits were again tested for significance and found to be not significant at the .05 level.

The main general conclusion which can be drawn from these figures is that occupational group is not an important determinant of consumer behaviour in Murton, with respect to store patronage for convenience goods.

Income

As suggested earlier, income could possibly be expected to play a more important role in influencing patterns of purchase in a community such as Murton. Diagram 4 (b) shows the % use by different income groups of each type of shop. No strong relationships emerge, but there seems to be some evidence to suggest that with increase in income from B to F there is a general decrease in the use of the coop and an increase in the use of independent retailers. Groups G and H show the reverse trend, possibly because of the increasing number of household members, with household income, at this level, where further increases in income are generally caused by the addition of another worker, and therefore lower real income per head. Orientation to multiples is low for both meat and grocery purchases and does not show any consistent pattern. The differences on the patterns of grocery purchase were tested for significance, using Chi square, and found to be just significant at the .10 level. It must be remembered however that Chi square gives no indication of the strength of the relationship. For that, the diagrams must be consulted. Blalock (1960) advises the use of percentages to demonstrate the strength of a relationship in this sort of situation. Chi square indicates the probability that differences can be considered as having arisen at random. Thus it is possible to conclude that in Murton convenience good shopping is not strongly related to shop types when either household Socio economic group or household Income group is considered, but income does show a slightly more consistent influence than socio-economic group.

Durable goods

Movement patterns for durable goods could be expected to reveal more salient features of consumer movement patterns, as greater distances are involved and, it can be argued, any economic or social effects upon movement become magnified.

The two factors of distance moved and the range of choice (size of shopping centre) will be dealt with as essentially implicit in this analysis. This formal treatment of these two crucially important variables is reserved for the gravity model analysis later. Interest here remains concentrated on socio-economic variables.

As a preliminary, Diagram 2 shows the distribution of centres around Murton that are used. The Table 3.3 lists these centres according to distance (in increasing order) and also gives an indication of their size. The derivation of this size index is discussed more fully in a later chapter but it will suffice to say that it reflects such features as relative amounts of turnover, number of shops, retail labour force etc. The figures are slightly modified results from the use of the 'Thorpe and Rhodes' method of centre ranking (see: Thorpe, D, and Rhodes T, (1966)).

The basket of goods used for analysis was carefully selected on the basis of a range of goods whichwould exhibit wide characteristics of consumer travel. These were: hardware, shoes, radio, television, washing machine, vacuum cleaner, children's clothing, women's clothing, mens clothing, jewellery, furniture or carpet, cinema.

The question asked in each case was which centre was last visited to purchase each good. It was thereby hoped to include the less frequently visited centres in the analysis, which might not occur if the respondent was asked where they 'usually' went.

The basic data obtained is shown in Table A5 which shows the percentage of households who actually purchase the goods in question, by destination. One row also shows the % of households in Murton not having purchased the good within the last 5 years and therefore not entering the body of the table.

Table 3.3

Centre	Distance from Murton (miles)	Centrality Index
Murton	-	100
Easington Lane	2.5	87
Hetton le Hole	3.0	240
Seaham harbour	3.0	645
Easington Colliery	3.0	415
South Hetton	3.5	11
Ryhope	4.5	36
Peterlee	5.0	578
Horden	5.5	528
Shotton	6.0	32
Sunderland	7.0	5,505
East Herrington	7.5	1
Thornley	9.0	63
Durham City	9.0	2,040
Chester le Street	9.5	870
Hartlepool	12.5	1,900
S. Shields	14.0	2,704
Ferryhill	14.5	296
Newcastle	17.0	12,320
Stockton	24.0	3,652
Middlesbrough	25.0	5,900
Darlington	34.5	4,230

The general observation presenting itself from this table is clear: if one assumes that the two factors which underlie the movement patterns are at work, namely attractiveness of centre, and distance from the centre, then it is clear that households are more willing to travel to the larger or more distant centres for some types of good than for other types of good.

Disregarding cinema visits as a special case, Murton retains its maximum trade from hardware, shoes, and radio purchases, in that order, and retains least in women's clothing, men's clothing and jewellery, in ascending order, from women's clothing, and holds about 30% of the trade in electrical and mechanical goods, television, washing machines and vacuum cleaners. Sunderland however offers facilities which are far in excess of those of Murton, but is 7 miles distant; the largest amount of trade going to Sunderland are in men's clothing, women's clothing and furniture purchases, in descending order. The trade taken least by Sunderland is in televisions, washing machines, vacuum cleaners and shoes, in ascending order from television purchase, but nevertheless in all cases except hardware and shoe purchases Sunderland takes more trade than Murton retains.

Newcastle takes most in women's clothing and furniture/ carpet purchases, with electrical goods having the lowest purchase intensity in Newcastle. In all cases Newcastle captures less trade than Murton retains. Seaham again captures less trade in any good than Murton retains, despite having roughly 6 times the facilities of Murton. It takes trade mainly in electrical goods, televisions, washing machines and does least well in clothing goods.

Few of the other centres visited have great significance: Durham, Houghton and Peterlee catch a little clothing trade and Easington Lane and Hetton a little trade in electrical goods, in spite of relatively close proximity. One feature of note is the almost complete failure of Teeside to capture trade from this area.

In general terms, this analysis suggests that the two most important factors at work are size of centre and distance that the centre is from Murton, and that this relationship is not constant amongst different types of goods, and that there is a 'modal good' type for each centre size. This has implications both in terms of central place theory and gravity model theory, to which the study will return later.

An alternative way of viewing the movement is to examine the average distance that the community as a whole, is prepared to travel for each good. The assumption is made that journeys to buy within Murton carry a distance factor of 1 mile.

Table 3.4.

Average distance travelled per household for each good

Hardware	4.11
Television	4.15
Radio	4.28
Washing Machine	4.44
Shoes	4.59
Vacuum Cleaner	4.79
Child's clothing	5.32
Jewellery	5.33
Men's clothing	6.02
Furniture/carpet	6.20
Women's clothing	6.63

Factors affecting consumer movement: durables.

Hypotheses 1 and 4 are examined.

Occupation

The investigation attempted to find the roleoof occupational status (of household head) in influencing consumer travel.

Diagram 5 shows the result of plotting households by socio-economic group and by the percentage using each of the 4 main centres - Murton, (Sunderland, Newcastle, and Seaham treated as one alternative for each of 6 goods). If the original hypothesis was to hold then one would expect that in group 1-6 more would tend to use Newcastle and Sunderland than in group 8 who would in turn use more than in group 9 and so on, and the converse being that one should expect to find increasing use of Murton as one proceeds from group 1-6 through

8, 9 and 10. What emerges from Diagram 5 is that there is no such direct and consistent relationship. Where the relationship appears to be strongest, this has been indicated with a broken line. In general, even in this predominantly working class community it is possible to suggest that there is some difference in occupational status between group 1-6 and groups 8, 9 and 10 considered together. In the 6 cases considered, the difference in proportional use of either Sunderland or Newcastle was found to be significant at the 5% level for the following goods: Men's clothing (Newcastle) women's clothing (Sunderland), shoes (Sunderland) hardware (Sunderland) and furniture (Sunderland), that is, significant differences exist between the behaviour of group 1-6 and of group 8-10 in the use made of the above centres. However, differences between groups 8, 9 and 10 were found to be generally not significant at this level, and more importantly, do not appear to vary consistently.

When all durables are considered together, it can be seen that the trends expected under the hypothesis begin to emerge more strongly. (Diagram [illegible]).

Thus there does appear to be some positive and consistent association between socio-economic status and choice of centre, for durable shopping, but the relationship is not strong.

Income

Diagram 6 shows some basic trends in the purchasing patterns of households with different incomes.

The basis of the diagram is to compare the totals of households which use Murton, as compared with the totals which use one of 3 distant competing centres - Newcastle, Sunderland, Seaham, for each income group.

Firstly, it is again noticeable that any relationship between distance travelled (and centre used) is not a strong one, It would seem that in such a relatively socially homogenous community such as Murton, the two underlying factors of distance and size of centre are the main determinants of consumer movement. Nevertheless, more significant patterns do appear to exist than with for example, Socio economic groups, In particular, there appears to be a stronger relationship between income and preparedness to move with the higher order goods, noted earlier --- Mens clothing, women's clothing, furniture/carpet and jewellery than with lower order goods --- shoes, hardware and washing machines. It is with these lower order goods that Murton is able to compete most effectively with the regional centres. The trends which appear as significant are marked with a broken line on Diagram 6. In the case of the 4 higher order goods shown there are two interesting features: (1), a reverse trend appears with groups F, G and H. This is possibly because it is at this level that the influence of extra wage earners, and therefore lower real income per head, is beginning to make itself felt, whereas up to group F the income per household is probably more closely related to the higher or lower earning power of the one head. (2), in some cases, notably furniture and carpets, with the amalgamation of the totals for Newcastle and Sunderland, the relationship becomes more as expected than is the case for single competing centres. This suggests that for furniture and carpets, a conscious choice is made between going to Sunderland or to Newcastle, whereas with the other goods there is a greater random element in deciding whether or not to go to Newcastle or Sunderland.

The differences between purchases made by different income groups at either Murton or Sunderland, as revealed numerically in the sample, were tested for significance, using chi square, with two goods, womens clothing and mens clothing. The difference in purchase patterns was found to be significant at a very high level (.01) , in each case. (For example, mens clothing:

$\chi^2_{calc.} = 37.8$ $\chi^2_{.01} = 22.48$).

Throughout there does seem to be some relationship between household income and the centre used, and reverse trends seem to appear with groups F-H.

Average distance travelled per income group for all durable goods was also calculated and is as follows:

Table 3.5

Income group	Distance(Miles)
B	4.70
C	5.00
D	5.30
E	5.78
F	4.69
GH	5.53

Here again, aforementioned trends do emerge, some fall off showing after group E, though overall the result does show some consistency with the hypothesis. Again, the change of slope in the two top income groups is apparent. The equation of the best straight line through all points when income is plotted against average distance travelled for the average durable is:

$$y = 4.744 + .021x$$

which means that on average, the rate of change of willingness to travel for the purchase of durable goods is .021

miles further for every £1 of extra income a family receives. The mean distance travelled to purchase durable goods, by households in Murton is 5.17 miles.

The regression lines for income as related to percentage use of (1) Murton and (2) Newcastle, Sunderland and Seaham together, by income group, were calculated to be:

(1) $y = 35.5-.20x$

which means that the probability of not shopping in Murton falls by .2% per £1 increased household income, and

(2) $y = 52.21 + .42x$

which means that the probability of shopping in one of the 3 named centres rises by .42% with each increase of £1 in household income.

Social class.

The influence of social class, for statistical reasons is analysed in the chapter on synthesis.

Car ownership.

The final factor to be examined here is the influence of car ownership on household travel patterns. Four high-order goods were considered in detail and the following results were found:

Table 3.6.

Average distance travelled for each good (miles)

Good	Car owning household	No car household	
Mens Clothing	6.84	5.62	++
Womens Clothing	6.84	6.79	
Furniture/Carpet	7.70	6.12	++
Jewellery	5.52	5.90	++
Total for all goods	6.72	6.12	+++

(level at which sample differences are statistically significant - + 95%, ++ 99%, +++ 99.9%)

As can be seen from the above table, the results are fairly, but not firmly conclusive, and analysis of all three settlements is reserved until later. The difference between the aggregate distance travelled for all four goods is significant at the 99% level, which suggests that the influence of car ownership on movement patterns in Murton is significant but not great. Thus the probability of a car owning family travelling a given distance is assumed to be $\frac{6.72}{12.84} = 52.3\%$ and of a non car owning family, 47.7%. In most macro scale models this could possibly be ignored.

Flows of Expenditure

This section is essentially exploratory and attempts to set out the results of a 'costing' of flows of expenditure used in the purchase of goods, in the tertiary sector, which, it is hoped, may prove a useful method for working the broad field of retail study. The method was outlined in Chapter 2 and here simply a presentation of the results is made, analysis being reserved for a later chapter.

First, Table A6 presents a composite list of the calculated total weekly expenditure of the community of Murton.

This provides, it is believed, a fairly close picture of the sectoral pattern of expenditure in Murton, and as such, is a basic data matrix, which may add a new tool of analysis in the study of the tertiary sector of local economies.

Of note are the important contributions to the flow of expenditure made by low income groups, and as expected, the greater than numerically proportionate contribution of the higher income groups. The overall figure is also of interest. It is calculated that the total amount of household expenditure originating from the local economy is £45,473 per week, whereas the calculation of household income in Murton produces a figure of £46,939 per week. The difference of £1566 represents a net figure of 3% saving, which is extremely low, but supports the evidence produced on a national basis by Lydall (Lydall 1955).

Of further note is the proportion spent on food - 31% of all expenditure, as compared with 27% for the national average. Expenditure on both services and transport are below the national average (8%:10% and 9%:12%).

The rest of the more detailed data is simply presented here and will be developed later. Table A7 details the weekly expenditure on convenience goods in and out of Murton, and shows, for example the amounts of money retained by Murton and 'lost' by Murton.

Table 3.7.

Murton 'loses' by (i) people travelling out of Murton to purchase and (ii) by vans taking expenditures out, each week:

	£	% of total expenditure of Murton on these goods
Meat	398.4	12.1%
Fish	156.0	65.0%
Groceries	320.0	6.0%
Greengroceries	140.7	7.0%
Bread	50.0	6.0%
Milk	152.0	13.0%
Chemist	13.0	2.0%

It is interesting to note that these figures are not entirely in accord with those derived from 'raw flow' study. The difference will be measured later.

What is clear, is that with the exception of wet fish purchase, Murton retains most of its convenience goods trade.

This is not the case with durable goods, as has been seen. In Table A8, 7 durable goods have been 'costed' and it is found that the proportions of expenditure going to various centres do not differ greatly from those derived from 'raw flows'. The closeness of this will be measured later.

Here the basic data matrix presents the amounts of money going each week to each centre; for example, from the table, Murton retains the following amounts each week:

Table 3.8.

	£	% of total expenditure of Murton on these goods
Womens Clothing	248.3	16
Mens Clothing	123.7	18
Childs Clothing	55.5	27
Shoes	378.1	48
Furniture	271.5	23
T.V./Radio	96.9	32
Jewellery	67.9	25
Hardware	189.5	53

Thus it can be seen that this sort of basic data matrix can be built up from surveys less complex than the usual types of income and expenditure survey undertaken.

The local economy and its future.

As has been seen, the County Plan provides for a settlement grouping policy, of which Murton, in 1951, fell into Category C.: 'Those from which it is believed that there may be an outward movement of some part of the population. In these cases it is felt that only sufficient capital should be invested to cater for the needs of a reduced population' (p.77, Durham County Council, 1951). This meant for Murton little reinvestment and consequent gross lack of facilities. In the Amendment to the County Plan, 1964 (Durham County Council 1964), something of a reappraisal is made: 'Murton is one of the larger colliery villages and the major source of employment is a long life colliery which is involved in the reconstruction scheme associated with a new Hawthorn Combined Mine. More houses are to be built in Murton than in any other village in the rural district because of the continuing employment in the colliery and its distance from Peterlee' (p. 89). Thus the future for Murton seems fairly static and the main source of change is likely to come about through changes in social patterns, as outlined earlier. The future fo the settlement is intimately connected with the future of the pit, the prospects for which seem, at the moment, good.

There are unfortunately no detailed Employment Exchange Statistics for Murton, but Table A9 presents figures for 3 post war years for the Seaham Employment Exchange Area, which includes Murton. There is no direct comparison possible between 1950 and 1960, because of a change in classification.

Nevertheless the main trends are clear - an ever growing percentage of women in the labour force, a decline in the importance of mining and a relatively static in employment in other industries, and widely fluctuating, but generally high, unemployment figures. Secondary industry employed only about 8% of the labour force, in 1966, primary industry 56.5% and the tertiary sector 35.5%. In Murton, primary industry is even more important and more stable over the years than for the area as a whole.

Centrality

A brief examination was made of Murton's function as a centre to the surrounding area. This was made from material collected for the work in the later chapters.

Murton was found to have virtually no influence as a centre beyond 3 miles radius. The only direction which it took significant numbers of customers from is to the east, the adjacent parishes of Hawthorn, Cold Hesledon and Dalton le Dale. These parishes have very small settlements with virtually no shops whatsoever. Murton drew about 30% of the convenience goods trade from Cold Hesledon and Hawthorn, but only about 8% of the durable goods trade, and this mainly in the lower order goods - electrical goods, shoes and hardware. Dalton le Dale registered only 2% as travelling to Murton for durables. A few families also came from Haswell to purchase lower order durables. (Diagram 7 can be used for reference).

In spite of Murton's population size its function as a centre is extremely limited. This is partly because of its development as a mining town not to supply a surrounding rural population with central functions, and partly because of its location in the 'shadow' of Sunderland and also of Seaham. Developed centres existed all around Murton before the pit was opened in 1838.

Thus it can be seen that in Murton many of the socio-economic factors assumed to influence consumer movement do not appear to have a strong influence. This may well be because of internal social factors, such as an increase in number of dependents with household income size, but probably more importantly the factor of relative cultural and social homogenity which tends to produce similar behaviour patterns in population subsections. It is possibly changes in this social and cultural background which are more likely to produce changes in patterns of movement than are relatively small changes in economic circumstance of subgroups of households. Murton, as always, is tied to the pit in very many ways, and its future and fortunes rest with the pit and the state of the national economy, affecting as it does, very directly, the lives of the inhabitants through the level of household income, and the unemployment rate. Distance and size of centre seem to be the main factors which exert strong and consistent influences on movement patterns.

CHAPTER 4

SHILDON

Introduction

The second of the three communities considered is Shildon, located in South West Durham. The town is contained by its own Urban District which also includes a few surrounding small settlements. It is 3½ miles from Bishop Auckland, 9 miles from Darlington and 6 miles from Spennymoor. Diagram 2 shows the general location.

Shildon is a Category 'A' centre, and a good example of the 'small town' centre in which development of all kinds is to be concentrated. It is a little larger than Murton, with a town population of 13,063 in 1961 (14,507 in the Urban District), andis in many ways a very different type of community, no longer a coal mining community. However, there are many similarities in the structure of the two communities and the associated movement patterns, and these are examined. From the point of view of development of the local economy, many of the advantageous and many of the disadvantageous aspects of small towns, as described by House and Knight (House and Knight, 1965), are exhibited here: a limited and unbalanced population structure, a dependence on a few sources of employment and a declining hinterland, offset by the sense of community, easy access to the countryside and short journeys to work.

The growth of the community

South west Durham was one of the earlier areas of mining development in the County and because of this, and because of the nature of the seams, the pits inthis area tended to be small short life pits compared with many other areas. Nevertheless, as Table A10 shows, population growth was fairly contPinous throughout the 19th. century, showing a widely observed 'flattening off' of the growth curve in the 20th. century. Massive in-migration, caused by the growth of the coal industry, and, in the case of Shildon, by the growth of other industry, took place during the 19th. century, not an uncommon experience. for settlements in County Durham.

The 1851 census shows a wide range of place of origin of the population, including Wales, Ireland and Scotland. 65% of Shildon's population was born in the County, Yorkshire being the largest single external contributor, at 27%. Cumberland and Ireland follow with considerably smaller percentages.

The early beginnings of modern Shildon were similar to those of Murton, in 1800 the settlement was a hamlet of just over 100 persons, employed largely in agriculture, with a few coal miners working in small and local pits. The massive 19th. century increase in population was however not only due to the opening of coal mines in the vicinity, but was also, and importantly, due to the rapid growth of the locomotive and wagon works, opened in 1825, by Timothy Hackworth. Both Fordyce (1857) and the Village Society history are in agreement that the railway works provided the most important element in the growth of the population in the 19th. century.

The railway works gave Shildon a twin focus of development which is very evident in the present day urban morphology, as Diagram 8 shows.

The earliest settlement was at a small crossroads to the north of where the wagon works now stands and near to the mining complex in the Gurney valley to the north. By 1850, there were three separate but associated areas of growth. The old centre of Shildon, a few colliery rows to the north, by the Adelaide pit, and a growing nucleus to the south around the railway workshops, called New Shildon. By 1893, these two latter areas had grown considerably, and in the 1920's eventually came to form one continuous built up area. Shildon however remains a very broken settlement in morphological terms. The large central park area is a result of the nature of the growth, and the railway lines to the south form a access barrier between parts of the town. In what was the older part of Shildon, the main commercial centre has developed despite a highly non central location, which has at least helped to encourage and preserve the existence of two small neighbourhood centres in the body of the town. Thus the morphology of Shildon has arisen from an economic situation other than one dominated by coal.

Shildon was however far from untouched by the coal industry. Diagram 8 shows the location of now closed pits on the 1967 map, some of which are very close indeed to the settlement. Most however were small in scale of operation, and the opening and closure of small pits was a common feature of the local economy until 1947. The Gurney valley, to the north, was, and still is, an area of considerable devastation by the coal industry. Temple (1937) suggests interestingly that the subjective view of residents of the valley of the 'status' of a settlement in the valley was related to altitude, in turn of course related to the level of pollution. Status increased with altitude.

Shildon appears to have weathered the economic fluctuations of the 19th. century better than many other settlements, largely because of the stabilising effect of the railway workshops on the economy, which was a more constant employer of labour than the coal industry. The 1851 census records the following occupation structure:

Table 4.1.

	% of the workforce, 1851
Coal mining	50
Railway works	22
Professional	3
Public service	8
Retail	9
Agriculture	4
Other	4
	100

It should not however be inferred that living conditions were good. They were, as throughout most of industrial England, appalling. Neither was Shildon without its share of industrial trouble, as the railway unions have a history of struggle second only to the miners' union. Neither did Shildon escape the great depression. Unemployment reached 80% at times, many collieries were closed, some never to reopen. During the 1930's West Durham became well known as a severely depressed area, as Daysh and Symonds (1955) have outlined, and it has never really recovered.

However, the location of industry policy of the late 1930's has provided Shildon with a trading estate and a few growing factories, but this has not curtailed the symptomatic net outward migration at a high level. House and Knight (1965) have shown that the two most important factors at work in migration are employment opportunities and housing. They also showed that in a 'type' small town in the north east the outmigrants tended to be the younger and more able members of the community, moving relatively short distances.

The study will now move to a consideration of present day Shildon, but first the development of the retail sector will be briefly outlined.

The development of retailing in Shildon

Table A11 shows the outline of the development of Shildon's retail sector. The table is comparable with the one for Murton, although again definitions are not rigorous throughout the period 1858-1938.

Most noticeable is the very much larger number of shops as compared with Murton. It is suggested that this arises for two main reasons:

1. The fact that Shildon has always been a larger centre than Murton, though not in the proportions indicated by the shops.

2. Shildon performs more of a central function than does Murton. This is rather difficult to explain, though the following reasons probably contribute:

(i) Murton, as a mining community proper is more closed and traditionally isolated.

(ii) Shildon had an earlier start in a densely populated mining area.

(iii) The population of Shildon was just sufficient to support goods with a greater range than those offered in Murton, in Central Place terminology, and so was able to continue on a higher heirarchical level than Murton.

Certainly both centres are located in the trade 'shadow' area of larger centres.

It is possible to infer from the figures of Table A11 that there has been a diminution of the centrality influence of Shildon, since 1921, marked by a decline in the provision of higher order goods, principally non foods goods. This would of course coincide with the development of an efficient public transport system and a consequent growth in the influence of Bishop Auckland. Increased efficiency in retailing is another important factor, as was seen in Murton.

Between 1890 an 1938 the number of shops in Murton increased by over 300%, whereas in Shildon it was only 6-7%. Clearly rather different forces have been at work.

The 1968 figures represent the effect of both the trend of increased efficiency and of a greater willingness to travel for goods: a lowering of distance friction in gravity model terminology. The current situation in the retail sector is dealt with in a later chapter.

The local economy - present day

Population

The population of Shildon is no longer growing, indeed there exists a situation in which net outward migration is balanced by natural increase.

1921-31 saw the first decline in the population since 1801, which was as large as 10.4%. Net outward migration over this same period was 18.1%. This can be compared with the County figures of a net increase of .5% and net outward migration of 10%. During this period however, Easington Rural District was experiencing rapid population growth and net inward migration.

1931-51 saw a small rise in the population total and a fall off in the rate of net outward migration.

1951-61 saw little change in the population total, though net outward migration still remained at a high level, at .79% per annum.

Industry and occupations

In the second half of the 1950's, after the initial post war coal shortage, the closure of mines in County Durham began in earnest. South west Durham was badly affected, and by 1968 all pits within 3½ miles of Shildon were closed.

A parallel development was the slow expansion of the British Rail wagon works, providing increasingly the backbone of the employment structure of the town.

Also taking place was the slow but significant increase in the number of firms operating on the trading estate. These are extremely important elements in the local economy of Shildon, but many of the problems associated with development area industrial location: they tend to employ females rather than males and there are large retraining problems.

Nevertheless, Shildon is developing as an employment centre, drawing workers from Bishop Auckland and Newton Aycliffe as well as other settlements.

Table 4.2.

Employment in Shildon by organisation 1968.

(firms employing over 20 people)

	Males	Females	Total
B.R. Wagon Works	2740	59	2799
B.R. Station	53	5	58
Davisons (transport)	122	5	127
Durworth (Clothing)	17	93	110
Eldon brickworks	76	-	76
Geest (Fruit and veg. dbtn.)	57	18	75
Morris (Carpets)	22	10	32
Morris (Furs)	91	416	507
Smart & Brown (electrical)	2	116	118
Northern clothing	49	209	258
Eclipse (T.V.)	26	20	46
Du Fay (Paints)	157	60	217

Source: Department of Employment and Productivity.

This table illustrates some of the aforementioned features of the local economy.

Table A12 shows the numbers and percentages of workers in the Shildon employment exchange area. Unfortunately this includes areas outside Shildon town, but these are mainly small villages.

It must be remembered that 1955 is not <u>directly</u> comparable with later years for reasons of definition.

The main trends are clear: a marked decline in coal mining, particularly from 1960 onwards; a slow growth in employment at the wagon works; a growth in certain light industries, notably clothing, light engineering and wood, mostly on the trading estate.

Over the period 1955 to 1967 the percentage of women employed increased from 17.4% to 25%, which is a little higher than in Murton. However like Murton, unemployment has been both high and fluctuating over this period.

<u>Housing</u>

The distribution of tenancy by type, in 1968 is as follows:

	Shildon	Murton
Council House & N.E.H.A.	44%	67%
Privately rented	8%	6%
Privately owned	48%	20%
N.C.B.	-	7%

It can immediately be seen that private housing is far more common in Shildon than in Murton. This arises from both socio economic differences and council policy.

Another feature in common with Murton was the nature of the standard of the housing. Private housing tends to be either large and of relatively good quality of which there is little, or small and of bad quality, of which there is much. Large areas of central Shildon are now being cleared of poor quality private housing and the inhabitants rehoused on the growing estate of council homes in Thickley ward.

<u>Centrality Function</u>

There are many definitions of a trade area, some of which will be discussed in a later part of the thesis.

However, under all definitions, Murton has a smaller trade area (and in fact lower centrality function) than has Shildon. Under the centre ranking method employed later in the thesis, Murton appears as a 'B' centre, whilst Shildon is an 'A' centre. (Not to be confused with the County Council settlement grouping policy categories). Trade area definitions can be examined in conjunction with Diagram 7.

Here, three types of good are considered: a high order durable good, womens clothing; a low order durable good, hardware; and the average movements for all durable goods.

Defining a trade area as that area in which the centre has the dominant influence, compared with all other centres then the following results are obtained:

All durables: Sunnydale and Central wards only. ($\frac{1}{2}$ mile radius maximum)

Hardware: Sunnydale, Central, Auckland terrace, Byerley, Middridge, Eldon and Thickley (Shildon U.D. in fact, a radius of about $1\frac{1}{2}$ to 2 miles)

Womens clothing: Nil.

Thus it is clear that Shildon has an influence as a centre only really in the lowest orders of durable goods, which is not unexpected from a very weak 'A' centre.

Defining a trade area as that area from which Shildon draws 70% of its trade, precisely the same patterns appear as above, indicating once again the weak centrality function, though certainly stronger than Murton. Both communities are in the trade 'shadow' areas of larger communities, though

Shildon is much nearer to Bishop Auckland than is Murton to Sunderland.

The present social structure

Features of the present day social structure of Shildon which are relevant to investigation of movement patterns are outlined.

Household structure

The average size of household in Shildon is 2.9 persons, as with Murton. The proportion of children in the community (0-14) is higher than in Murton, being 25%, or the County average (1961). 59% of households have no children and 7% have 3 or more. It is clear that the population structure of Shildon is more youthful than that of Murton. This comes in part from the higher birthrate as well as the more diverse job opportunities existant in Shildon. The proportion of old people (65+) is 11.2% which compares both with the County and Murton proportions. 73% of household had no old people as members and 6% had at least two, mainly the retired couples.

The activity rate (workers per 100 population) is higher than in Murton, being 42, but is still well below regional and national averages.

14% of households have all members working and 8.5% have more than 4 dependents, in both cases the situation being better than in Murton(with 12% and 11% respectively). There are 1.71 dependents per household as compared with 1.75 in Murton.

Table 4.3 also shows that 25% of households have no members working whilst 8.5% have 3 or more employed, comparing directly with Murton.

Table 4.3.

Numbers occupied	% of households
0	25
1	41
2	25.5
3	5.5
4	2.5
5	.5

Occupation structure

There are ca. 5,165 employed living in Shildon, of whom 3,038 are household heads.

In terms of socio-economic groups, there is a very close similarity between the occupation structures of Murton and Shildon.

Table A12a shows the occupation structure: 9.6% of household heads are in s.e.g. 1-6 and 59.4% in 8-11, comparing with 8% and 59% in Murton, However, in Shildon coal mining has dwindled to insignificance as an occupation, whilst the B.R. workshops are the main source of employment.

68% of household heads work within Shildon, compared with 83% in Murton. Newton Aycliffe draws 10%, Darlington 8% and Bishop Auckland 6%. Clearly the hold of Shildon is weaker than that of Murton upon its labour force. Concealed also within the s.e.g. figures is a greater diversity of job type in Shildon, compared with Murton.

There are 2,127 workers who are not household heads, of which 55% work in Shildon, compared with 40% in Murton, again another important difference in the nature of the local economy and employment situation, particularly as far as female employment is concerned. Bishop Auckland (17%), Newton Aycliffe (11%) and Darlington (9%) are the three main alternative work sources. Clearly though, Shildon exerts less of a 'centrifugal' effect on women than Murton (and of course, Ashton). In terms of socio economic groups, the occupations of those who travel out is rather similar, groups 6 and 10 being well represented. Shop assistants, office workers and machine operators are typical occupations of this group of workers.

Social class

In terms of the Registrar General's Social Class classification, there are some differences between Shildon and Murton: 80% of the household heads of Shildon are in groups 3 and 4, compared with 90% in Murton,: a slightly more diverse social structure, though still overwhelmingly working class.

Migration

In migration only was examined in the survey, and as with Murton, the proportion of the population who had moved to the town in the last 5 years was very low indeed: 6%. Almost all of these moves had been short distance moves: from Bishop Auckland, Chilton, Newton Aycliffe and Middridge.

Income

The income structure of Shildon is as the Table 4.4 shows.

Table 4.4.

Income Groups	% of households
B (£ 5 - 10 per week)	28.0
C (£10 - 15 per week)	11.5
D (£15 - 20 per week)	26.7
E (£20 -25 per week)	17.2
F (£25 - 30 per week)	10.2
G (£30 - 35 per week)	1.9
H (£ over 35 " ")	4.5
	100.0

66% of households have incomes of less than £20 per week (69% in Murton). The distribution of incomes in Shildon is slightly less skewed than that of Murton, there being higher percentages in the higher income groups and lower percentages in the lower income groups, than in Murton. There is also, it is believed, a higher level of asset holding in Shildon than in Murton, indicated partly by the higher level of house ownership.

Again the tendency for household income to increase directly with the size of household appears.

Unlike in Murton, there does appear to be some correspondence between socio economic group and income, though this is not strong. Amongst the 4 most represented groups, 9, 10, 11 and 17, there do appear to be significant differences between average income for each socio economic group.

Average income per household in Shildon is calculated to be £17.15. per week, and in Murton £17.08.per week. This difference is statistically significant at neither the .05 level nor the .1 level.

Clearly the differences in income structure between the two communities are not great, and they both share the same sorts of serious welfare problems. However, it must be borne in mind that Shildon's income does come from a much wider variety of sources than does Murton's. This is not without significance for the futures of the settlements.

Consumer movement and Expenditure patterns

This section provides an analysis of the basic patterns of movement in Shildon. It is again an exploratory study of the possibilities and methods of investigation on a household scale as well as making a test of the specific hypotheses about consumer movement.

The influence of distance and size of centre is again implicit rather than explicit in this section of the thesis.

Convenience goods

Table A13 shows the essentially 'raw' movement data for Shildon, for convenience goods purchase, by type of shop. As with Murton, most trips are made within Shildon, though the percentages of trips going outside the community is larger than in Murton. The percentages of trips going elsewhere are as follows: 8.1% for meat, 6.5% for fish, 9.5% for groceries, 3.6% for greengroceries, 3% for bread, 0 for milk, and 1% for chemist goods. Almost all of these purchases are made in Bishop Auckland, with Darlington coming a very poor second. Though it may seem surprising that Shildon, the larger centre, should lose more of its convenience goods trade than Murton, it must be remembered that Bishop Auckland is very close indeed, so that although the distance friction effect tends to be highest for convenience goods, Bishop Auckland appears to be able to catch a small part of this trade.

The usage of different types of shops is interesting. Considering only the trips which terminate in Shildon: Meat purchases go strongly to the independents, 74.2%, compared with 7% at the coop and 8% at the multiples. The special skills needed, the perishable nature of the goods and problems in selling by multiples are all factors here. Fish purchases are dominated completely by the independents (90.5%).

Grocery purchases present interesting comparisons with Murton, the cooperative being far weaker, and the multiples far stronger (13.8% : 53%), with the competitive large multiple store being very much in evidence. There is no selling from multiple shop vans, which in part reflects the fact that there is a very large number of shops indeed spread throughout Shildon. Independents hold 22% of the trade in groceries, a good proportion of this going to non high street shops.

With greengrocery purchase, the pattern returns to that of Murton: the predominance of the independents (72%), though the multiples now come in second place.

Bread purchases go even more strongly to the private baker, trips to the shop being made rather than purchases from vans. Milk purchases show a rather different picture from Murton, the coop not doing so well at all. This is partly a reflection of the strength of the coop in Shildon as compared with Murton. The independents take 64% of milk purchases (73%, with extra-Shildon operators), and the coop makes up the rest. It is interesting to note that the proximity of Shildon to the relatively prosperous rural areas to the south has given some opportunity for milk producers to sell in Shildon, whilst producing on a small scale on farms to the south.

The independent chemist appears to be holding its own very well indeed in Shildon, against the Multiples, with 59% of the trade. Boot's and Timothy Whites operate in Shildon.

Determinants of consumer movement: convenience goods

Certain of the original hypotheses relating socio economic variables to consumer movement patterns are examined, in particular, hypotheses 2 and 5 are examined.

Occupation

Meat and grocery purchases are examined as convenience goods.

Diagram 9 shows the result of analysis of trips by occupation. Regarding groups 17 upwards as special cases, then it can be seen that no strong relationships emerge. There appears to be possibly a downward trend in meat purchase from independents between groups 8 and 11, but this does not hold for groups 1-6. Likewise, there seems to be an upward trend in meat purchase from the coop over groups 1 to 11. When these results were tested for significance, using the Chi-square test, there were found to be no significant differences in shop use between different socio-economic groups, at the .05 level.

Broadly similar results are obtained for grocery purchases by occupation group. The differences between groups were found to be not statistically significant and even the incipient trends noted for meat purchase fail to appear.

Thus the original hypotheses relating socio-economic status to type of shop used must be said not to hold in this case.

Income

Diagram 9 shows the use of different types of shop by different income groups, for meat and for grocery purchase. Again no trends can be seen to emerge, and the difference in store patronage between income groups was found to be not significant using Chi square, for both meat and grocery purchase.

Thus the hypothesis concerning income and store preference by type is said not to hold here in Shildon, as was found in Murton.

There are however two possible sources of explanation for these findings: either the hypothesis simply does not hold, and there are no differences in store patronage by group, occupation, and income, at least under the groups which have been used, or alternatively, that the hypothesis may still hold but there are other factors which distort the expected pattern. For example, the intrusion on a large scale of cut price supermarkets, in Shildon, and the cultural factors associated with a coal mining community, in Murton.

Durable goods

The concern here is specifically with the influence of socio-economic variables on patterns of consumer movement. Hypotheses 1 and 4 are examined.

Diagram 2 shows the location of Shildon with respect to other shopping centres. The following table lists the centres actually used and gives an indication of distance and size, size being derived from the Thorpe and Rhodes (1966) centrality index.

Table 4.5

Centre	Distance from Shildon (miles)	size (index)
Shildon	-	475.0
Eldon Lane	1	12.0
St. Helen Auckland	3	4.3
Newton Aycliffe	3.5	364.0
Bishop Auckland	3.5	2652.0
West Auckland	4	24.4
Toft Hill	5.5	3
Spennymoor	6	955
Willington	8	169
Darlington	9	4230
Crook	9	961
Durham	12	2040
Stockton	15.5	3652
Thornaby	16.5	-
Billingham	18	-

Chester le Street	18	870
Middlesbrough	18	5900
Sunderland	24	5505
Newcastle	26	12320

The basket of goods used in the analysis was the same as forMurton, intended to cover goods of a wide variety of 'range' in the central place sense.

The basic 'raw' movement data (trips, not expenditures) appears in Table A 14. This shows the percentage of households who actually purchase the goods in question.

Again, as with Murton, it is clear that both distance and centre size are important factors in explaining the pattern of movement.

Excluding cinema visits, it can be seen that Shildon retains most of its trade in hardware, t.v., radio, washing machine, vacuum cleaner purchase, in that order. Shildon loses most in furniture (78% loss), men's clothing (71.5% loss) and women's clothing (70.8% loss). The table reveals that the most important competitors are Bishop Auckland, Darlington, and Middlesbrough, in that order, reflecting very much the factors of distance and size.

Bishop Auckland takes the largest proportions of Shildon's trade in furniture, men's clothing, shoes and women's clothing.

Darlington also catches Shildon's trade significantly in jewellery, furniture, men's clothing, women's clothing and radio and television purchases.

Middlesbrough only really shows influence in women's clothing purchase. Mail order shopping is evident over the whole range of goods.

Other centres take very little indeed of Shildon's durable trade, and Teeside has only a marginally stronger influence than has Newcastle, despite better transport connections and closer proximity.

It is mainly in appliances, electrical goods, and hardware that Shildon is able to retain the largest proportions of its available purchasing power, as is also the case with Murton. It can also be seen that in comparison with Murton, Shildon retains more of its purchasing power than the other is able to, in all goods, except for shoes. This is a function of Shildon's greater centrality, which has allowed the growth and continuance of a larger number and variety of shops that exist in Murton.

It seems therefore, that there is some form of 'ordering' of goods by size of centre used: certain types of goods are purchased more in larger or distant centres than are other types, which accords with notions of central place theory. One very useful way of analysing the rank ordering of goods is by considering the average distance that the community as a whole is prepared to travel for each good. The following table illustrates this:

Table 4.6

Average distance travelled for the purchase of each good (in miles) by the inhabitants of:

	Shildon		Murton	
	Rank	Distance	Rank	Distance
Jewellery	1	5.96	4	5.33
Women's clothing	2	5.50	1	6.63
Children's clothing	3	4.63	5	5.32
Men's clothing	4	4.27	3	6.02
Furniture/Carpet	5	4.22	2	6.20

Washing machine	6	3.99	8	4.44
Shoes	7	3.75	7	4.59
Vacuum cleaner	8	3.53	6	4.79
Radio	9	3.38	9	4.28
T.V.	10	2.53	10	4.15
Hardware	11	2.04	11	4.11

First and foremost, it can be seen that the actual distances travelled by the inhabitants of Shildon are, on average, less than those in Murton. This is a function of (1) the configuration of centres particular to the area around each community and (2) the greater centrality function and capacity to retain its own trade that Shildon possesses.

There does appear to be a general agreement between the ordering of goods on this basis in each settlement though there are exceptions, notably jewellery, and furniture. Shildon retains more of its jewellery trade and less of its furniture trade than does Murton.

To test the relationship between the ordering of the goods in the two settlements, the Spearman's Rank correlation coefficient was calculated and found to be + .867, showing a strong relationship between the orderings. This coefficient is significant at the .05 level.

Factors affecting consumer movement: durables

Hypotheses 1 and 4 are examined here.

Occupation

Diagram 10 shows the percentage use of Shildon and 4 other centres for 6 types of durables good and the average for the durables, by socio economic group.

If the original hypothesis can be said to hold, then the use of Shildon should increase with the higher numbers of the socio economic groups, and conversely, the use of larger centres further away should decrease with a higher group number. The centres considered in this analysis are Shildon, Bishop Auckland, Darlington, Middlesbrough, Stockton and Newcastle. All 5 external centres are considered together as a competitor with Shildon.

There seems more generally to be a relationship between socio economic status and the centre visited, than was the case in Murton. For most of the 6 goods the use of Shildon does tend to increase with the higher numbered (lower status) groups, and the converse also seems to occur. This is clearer in the diagram showing average movement for all durable goods. The difference between the two distributions was tested for significance using Chi square, and was found to be significant at the .01 level. Again, it must be remembered that Chi square gives no measure of the nature of the relationships, only of the chance that the difference between the two distributions could have arisen at random. It is perhaps the rather more socially diversified nature of the community in Shildon which produces the closer relationship, when compared with Murton.

Income

Under the terms of the original hypothesis it is to be expected that the use of Shildon will fall with increasing household income and the use of the larger more distant centres will rise with increasing income.

As Diagram 11 shows, there does appear to be some association between income level and willingness to travel. The most reliable indicator is that for all durable goods, and displays again the tendency noted in Murton, that the willingness to travel tends to increase up to and including group E (under £25 per week) and then a reverse trend begins to appear. This is difficult to explain. One possible source of explanation is that it is around this level that the contribution of a second male worker begins to affect the distribution of incomes, thus lowering the real income per head for the household.

Almost all of the individual goods show tendencies in accord with the hypothesis, furniture being perhaps most marked.. The difference between the use of Shildon, for each income group, and the use of the larger centres, for each income group, was tested for significance, using Chi square and found to be significant at the .01 level.

The average distance travelled by a household in each of the income groups is as follows: (for the average durable good)

Table 4.7.

Income group	Distance (miles)
B	2.84
C	3.61
D	3.92
E	4.80
F	3.96
G + H	3.91

which shows similar characteristics to the results for Murton, The equation of the best straight line for this relationship is:

$$y = 3.01 + .04x$$

which means that a household with a net income which is £1 higher than another household will, on average, be prepared to travel .04 miles further to purchase durable goods. This must be set against the overall average distance moved in Shildon, for durables, which is 3.94 miles.

The relationship between income group and choice of Shildon to shop, for the average durable good can be described by:

$y = 48.62 - .51x$

which means that for every £1 increase in household income, the probability of using Shildon to purchase durable goods falls by .51%.

The relationship between income group and choice of one of the 5 alternative competing centres can be described by:

$$y = 39.84 + .70x$$

which means that for every £1 increase in household income, the probability of using one of the 5 larger centres increases by .70%.

Thus it would appear that compared with Murton income in Shildon does exert a greater influence on movement patterns, both in terms of preparedness to travel and in choice of centre. It is possibly cultural factors that hinder the development of this relationship in Murton.

Social class and household size

The effects of these factors are analysed in a later chapter.

Car ownership

The influence of car ownership on purchase patterns was examined for 4 goods:

Table 4.8

Average distance travelled for each good (miles)

	Car owning households	Non car hh.
Mens clothing	5.48	3.74 ++
Womens clothing	6.06	5.43 ++
Furniture/Carpet	7.16	3.65 ++
Shoes	6.34	4.64 ++
Average of the 4	6.26	4.37 +++

(difference significant at the ++ .01 level or +++ the .001 level)

As can be seen from the table, the trends observed in Murton emerge more strongly here. The probability of a car owning household travelling a given distance is .589 as compared with .411 for a non car household. Car ownership can therefore be assumed to affect movement patterns, in accord with the hypothesis, the above probabilities giving some indication of the magnitude of the effect in Shildon, for high order goods at least.

Flows of expenditure

This section is again essentially exploratory, in that it sets out the results of the 'costing' of 'raw' flows into actual money flows in the tertiary sector in and out of Shildon. Analysis of the results is reserved until later.

Table A 15 provides the basic data for Shildon. The figures represent the weekly amounts of purchasing power available in the community of Shildon. This is a basic data matrix for local economy analysis.

It is interesting to note that total weekly expenditure in the community is nearly equal to total calculated weekly income, saving being at the very low level of 2.8%. This is extremely low, but is a similar result to that found for Murton, and by Lydall for the entire country (Lydall 1955).

This table corresponds very closely to the one for Murton. Expenditure on housing, food and fuel are above the national average per household, and expenditure on transport, services and alcohol are below the national average, reflecting the comparative poverty of the community.

Table A 16 presents details of weekly expenditure on convenience goods in and out of Shildon. Below are the results in summary form:

Table 4.9. - Shildon loses each week by (1) purchases made outside and (2) by vans based outside Shildon:-

	£	% of expenditure available
Meat	566	11
Fish	42	8.5
Groceries	656	10
Greengroceries	120	4
Bread	70	5.2
Milk	168	9.2
Chemists goods	22	2.0
	1644	7.7 (of food expend.)

These figures can be compared both with Murton, and more importantly, with the results from the crude flow analysis.

The overall percentage that Shildon loses from its food expenditure is about the same as that of Murton, 7.7%. However, this is lost in rather different subsectors. Shildon loses more heavily on grocery purchase than Murton, explainable partly by the proximity of Bishop Auckland and by the greater number of working wives. Murton loses more than Shildon on fish purchase, greengroceries andmilk. There is no wet fish shop in Murton and mobile traders compete effectively for the other two goods.

Comparison will be made in more detail later with the results from a crude flow analysis, suffice to say here that there is general, but not exact agreement between the two results.

Table A 17 presents the basic data for durable goods here in Shildon, costed out.

Table 4.10

Shildon retains the following amounts of expenditure on these goods: (weekly)

	£	% of expenditure available for these goods
Womens clothing	611	26
Mens clothing	313	29
Shoes	481	39
Furniture	278	18.4
Jewellery	106	27
Hardware	366	69

In comparison with Murton, it can be seen that Shildon retains more of the higher goods expenditure than does Murton, but Murton holds more in shoes and furniture purchases, largely because of the coop.

Again, the data compares generally with the results from the raw data analysis, but by no means exactly.

The future of the local economy

Shildon is a category A centre under the County Council's settlement grouping policy. This means that in theory, Shi- Shildon should be a 'growth' centre. The 1951 County Plan designated Shildon an A centre as: 'It appears that this community will grow in population because of regrouping from surrounding villages' (p.96). The 1964 Amendment to the Plan states: 'concentration of development will continue as Shildon is the main shopping centre and contains schools, playing fields and community facilities greater than those available elsewhere in the Urban District' (p.66). The surrounding small villages have been placed in the D category. However it has been shown that the above statement about Shildon's centrality is not entirely true.

It seems doubtful whether Shildon will be able to function as a growing centre of population. In the secondary sector, much depends upon the future prospects for employment at the B.R. wagon works. The trading estate provides a moderate element of industrial diversification, so that the future is not so closely tied to the fate of one basic industry, as is the case in Murton. The economic outlook in the railway industry certainly seems brighter than in coal. Expansion of job opportunities in Newton Aycliffe will only result in migration to the new town.

As a population centre, rehousing is certainly continuing, but seems to cater almost exclusively for movement of the present population, as in-migration is very low indeed, and that which does take place is not overwhelmingly from surrounding villages. Population is now slowly declining.

As will be seen in a later chapter, the tertiary sector is very remarkable indeed. Shildon has an excess of shops over and above any calculable level of demand would appear to profitably allow. The 'tightening of the belt' of the private retailer must be considerable. It is to be expected that the influence of Bishop Auckland as a centre will extend further into the available expenditure of Shildon. Falling distance friction will cause more and more consumers totravel there. If this sort of experience is common for the small town in County Durham, and it is possible to suggest that this is so elsewhere, then it can be suggested that the planning policy is creating not a number of thriving A centres from the relic settlement pattern of mining villages, but is causing either (1) out migration from the County or (2) migration to and the growth of the conurbation areas in the North East or (3) some growth in a very few of the largest A centres - notably Bishop Auckland and Durham City. These suggestions correspond to observed migration patterns within the County. If this is the case, then the policy of developing a relatively large number of growth ('A') centres should be called seriously into question. It may well be the case that when people have been 'persuaded' to move, from their village, it is not the nearest A centre to which they move.

However, Shildon is not attendant upon the precarious fortunes of the coal industry, and as such does have a different social structure and pattern of life and probable future development from that of Murton. The similarities between the patterns observed in the two communities almost certainly arise from the fact that as Dennis Henriques and Slaughter (1956) state: 'in that miners are wage workers, their social relations have much in common with millions of others in Great Britain' (p.26).

CHAPTER 5

CROOK

Introduction

The last community considered is Crook, located in West Durham. The town lies in Crook and Willington Urban District, which also unfortunately, for statistical purposes, includes the smaller but substantial settlement of Willington. The two communities are however both physically and in many ways socially separate. Crook is 10 miles from Durham, 5½ from Bishop Auckland, 25 from Newcastle, 17 from Darlington, 4 from Tow Law and 2½ from Willington. Diagram 2 shows the general location. The 1961 town population was 9,042, and in 1967 there were 2,701 households.

Crook is a category A centre and is afurther example of the 'small town growth centre' type of settlement. It is also interesting in that unlike the other two settlements considered, it has undergone a full range of problems associated with pit closure. Many of the observations made by House and Knight (1967) are directly relevant to Crook. By 1968 almost all surrounding collieries were closed, and the town remains beset with economic problems serious by standards of the North East.

The Growth of the community

McKenzie and Ross (1834) describe Crook as a 'scattered village'; in the early 1830's the area around Crook was still largely agricultural with a few isolated and small coal workings. The age of coal proper came in the 1840's with the opening of the West Emma pit in 1846, to the north of the town. Temple (1937) estimates that in 1801 3/4 of the town's labour force was engaged in agriculture, with a few employed in the working of coal. As elsewhere in the County, this situation was to change dramatically during the 19th. century. As table A 18 shows, there were rapid rises in population from 1841 onwards, attributable almost entirely to the development of the coal industry. The pattern of pit development was characterised by a large number of small sized pits surrounding the town, being especially concentrated to the north and to the south of the town. Amongst these small pits were a few operating on a more substantial scale, for example the Roddymoor pit. Almost all of the workings to the north were owned by a Mr. Pease, whose name is still in evidence today. Large coke ovens followed the coal mines in this area which was known as Pease's West, and Crook began headlong expansion. Completely new settlemeets were developed just outside Crook: at Billy Row (for officials) and Roddymoor (for the men). A heavily industrialised, unattractive and despoiled area developed rapidly to the north of the town.

Large scale in-migration was taking place in the middle of the 19th. century. In accord with patterns elsewhere in the County, the 1851 census showed that 67% of the town's population was born in the County, with Yorkshire contributing about 17%, followed by Cumberland and other areas.

Diagram 12 shows the now familiar occurrence of the 'grafting' of new developments onto a former small and essentially agricultural community.

By 1851 the Census records the following distribution of occupations in the town:

Table 5.1

	% of labour force
Coal and Coke	67%
Retail	7%
Public & Private Service	8%
Agriculture	6%
Professional	2%
Labourers	3%
Blacksmith	2%
Semiskilled	2%
Craftsmen	3%

Clearly the 1840's were a very important period in the history of the town.

The physical element was also changing rapidly; by 1857 Fordyce was able to write:- 'the houses of agents and other officers of the collieries, and rows of houses for the workmen are thickly scattered over the surrounding district, mingling with the older farmsteads which formerly were the only dwellings' (p.439).

The next half century was one of expansion for the town, coupled with the opening and closure of many small pits, especially in the area just to the south of the town. Diagram 12 shows that developments tended to be rather ribbon-like, giving some indication of the former importance of Crook as a route and market centre. The extensive industrial area to the north did however tend to encourage the spread of settlement in a general northward direction and it is this spread of settlement that accomodated the bulk of Crook's 19th century population growth. Later in the

19th century came a brickworks immediately to the west of the town.

The curve of population increase shows yet again the falling off of in growth at the turn of the century, attributable, as has been already outlined, both (i) to secular trends in the national economy and (ii) to the accelerating closure of smaller high cost pit workings. Many of the smaller settlements around Crook simply disappeared just after the turn of the century.

The latter half of the 19th century was filled with economic and welfare problems, dependent upon the state of the coal industry at any one time. Living conditions were in general however, appalling.

The interwar period in the 20th century saw new council housing developments, particularly to the west of the town, and some attempt at slum clearance. Crook seems to have weathered the depression of the 1930's a little better than some settlements because of the continuity of operations at Roddymoor. This situation as Temple (1937) remarked: 'may only be a temporary feature'. The main areas of closure were immediately to the south of Crook. The large pit at Willington also provided a continuous employment source.

Location of Industry Policy during the 1930's gave Crook its own Trading Estate like Shildon; it is to the south of the town, built on a derelict colliery area. Crook was now beginning to experience large-scale net outmigration, at a higher rate than Shildon, with again the youngest and ablest being most ready to move. Few factories came to the town in the 1930's and its economic future became more closely bound to the future of the Roddymoor complex.

After the second world war, two further large scale housing schemes were commenced, one on the south side of Crook and the other an extension of the western estate. These schemes provide houses of far better quality than the prewar schemes, which suffered also from the additional problem of replicating the mistakes of location in the height of the coal era: for example the redevelopment of Roddymoor, isolated, with no central facilities, close only to the pit: a clear problem settlement from the outset.

The development of retailing in Crook.

Table A19 outlines the development of retailing in Crook. The general pattern of development is similar to that in Shildon, with a rapid growth of shop numbers in the middle of the 19th century, followed by a fall in shop numbers from the 1920's. This arises from (a) rising levels of efficiency in retailing, with the accompanying effect of a reduction in the number of shops and (b) increasing willingness to travel to other larger centres to purchase goods, representing a net trade loss for all but the largest centres.

Crook has always had a greater centrality function than either Shildon or Murton, yet Crook has a smaller number of shops than has Shildon. This could well be because of the presence of (a) a strong large cooperative store, founded in 1865 and (b) early developments by multiple food retailers in Crook, relatively early in the 20th century, which did not take place so early in Shildon.

In common with Shildon, there seems to have been an expansion in durable good shops in the 19th century, and a general decline in the numbers of all shop types in the 20th century.

The local economy - Present day

Population

As can be seen from Table A 18 the population of Crook itself is now static at a little over 9,000. This, as with Shildon, represents a balance between a high rate of natural increase and high net outward migration. However, as will be seen shortly, Crook is essentially an ageing town, so that a high death rate is a demographic feature.

The fall in population from 1921-1931 was 8% for the entire Urban District, mainly arising from the 16.2% net outward migration over the period. 1931-51 saw a net loss of 11.2% of Crooks population and the net outward migration was 17.9%.

The period 1951-61 saw a continuation of the fall in population at the rate of .88% per year, again from the urban district. However, most of this recent decline was concentrated in Willington. New outward migration however remained high throughout.

Industry and Occupations

In the immediate post war period it became very apparent that Crook was very heavily dependent upon the future of the Roddymoor pit complex, and to a much lesser extent upon developments at Willington. The importance of development of the Trading Estate grew, as by 1945 only one or two factories had opened there. In 1956-57 after the coal shortage crisis, it became clear that Roddymoor, working at a loss since nationalisation, would close. In 1960 the coke works began to close, and in 1963 the Roddymoor pit itself closed. Early in 1963 Stephen Aris (1963) was writing that 'Crook is living on borrowed time', unemployment was over 10% and outmigration was increasing. 1963 was the worst year of post war Crook's economic history, and it was clear that either there was to be a fundamental change in the local economy or the nature of the settlement was going to change rapidly and fundamentally. One third of the ex-miners were over 40 and a hard winter made problems worse. Aris lists the principal disadvantages of Crook for the industralist, as: (1) its appearances and approach (2) its poor access and isolation and (3) the chronic shortage of skilled labour. Marshall Richards, and engineering firm, faced the choice of closure or the import of key labour from Newcastle, and fortunately chose the latter. Attention turned to the future of the Industrial Estate, only the brickworks continued slow expansion.

House and Knight (1967) provide a good review of the effects of pit closure upon communities. They examine in detail 4 alternative courses of action for the miner:

1. Redundancy and unemployment
2. Acceptance of alternative work with the NCB
3. To leave mining voluntarily
4. Early retirement

With redundancies, they noted a tendency for these to be concentrated in certain localised areas, and were mainly older miners described as 'unresponsive' to retraining.

They found that NCB transfers tended to be very short distance, i.e. within the coalfield, which meant large journeys to work and consequent loss of leisure time.

Those leaving mining voluntarily for other employment tended to be the younger miners, who consequently experienced a considerable fall in income. This group was the most mobile and tended to take up new occupations in engineering and in the service industries.

The effect on the local economy of pit closure is, as they point out, considerable. The majority of transferees interviewed reported a fall in income as did those leaving voluntarily. All redundant men reported falls in income, up to 70% for forceworkers and only 40% for officials.

Pit closure usually entailed the following sorts of spending cuts:- cigarettes, beer, meat, vegetables, entertainment and clothing, many of which disappeared altogether from budgets.

Actual changes in shopping habits were also recorded: the cooperative store became less used for durable good purchase and trade went more to cut-price stores. The use of supermarkets for food goods rose markedly. Even in 1963 Aris reported that the Crook supermarkets were not experiencing any great loss of trade - a significant indicator of the extent of increasing use of the supermarkets at a time of considerable economic hardship.

Further serious problems arise for the households affected by pit closure by rehousing, with higher rents. For the first time coal bills appear.

Pit closure tends to hit smallest families hardest as there are fewer income sources.

In the event, some new industry did come to Crook, taking advantage of Board of Trade factories, especially.

Table 5.2.

Firms employing more than 20 persons. 1969.

Whessoe (Plastics)	
Pickford Holland (Bricks)	
Advance Throwing Mills (Artificial fibres)	+
Paton & Baldwin (Engineering)	+
Ramar (Clothing)	+
Marshall Richards (Engineering)	+
Lax (Construction)	
Norvite (Timber)	+
Crook & Willington UDC	

(+ Operating on the Trading Estate)
(Source: Crook & Willington U.D.C.).

The industries listed above exhibit the main features of late industrial development in small towns in the North East - it is limited in scale and weighted towards female employment.

The changing structure of the local economy in the post war period is illustrated by Table A20 which shows employment in the Exchange Area, which includes Willington, between 1950 and 1966. Again for reasons of definition 1950 is not directly comparable with 1960 and later. The most marked trend over the period is the fall in coal mining from 50% to 16%, now even lower in Crook. Clothing, engineering and brickmaking have shown continuous growth over the period as have textiles and chemicals, partly lost in groupings. The total labour force has fallen by 36% over the 16 year period, but the percentage of women employed as a % of the labour force has risen from 13.8% to 28% - higher than either in Shildon or Murton. Unemployment continues to be both high and fluctuating. Crook also has a larger population of professional workers, living now mainly to the west of the town in housing of extremely high quality, a factor which scarcely exists in neither Shildon or Murton.

Housing

The distribution of housing by type of tenancy, in 1968 was as follows:-

	Crook	Shildon	Murton
Council and NEHA	47.7%	44%	67%
Privately rented	11.8%	8%	6%
Privately owned	40.5%	48%	20%
NCB	-	-	7%

Again, private housing is more important than in Murton. The pattern is closer to that of Shildon, though Council Housing is increasing at a faster rate in Crook than is either of the other two settlements. Private housing tends to be of better quality than in Shildon, and there is the phenomenon of the high value property West Road area.

Centrality

Crook has traditionally had a greater centrality function than either Murton or Shildon. However, Crook has also faced continuous and growing competition from Bishop Auckland, which has had 2 main effects upon its trade area: (i) The competition has tended to 'offset' the trade area of Crook, in that areas to the south and east of the town tend to fall into the trade area of Bishop Auckland, whilst the trade area of Crook tends to extend more to the north and west; (ii) Competition has tended to diminish the trade area of Crook overall.

Here, trade area is defined alternatively as (i) the area which Crook dominates and (ii) the area which supplies 70% of Crooks custom.

Trade areas are measured for - (i) the average durable good (ii) a high order good - mens clothing and (iii) a low order good - hardware. The following analysis can be taken in conjunction with Diagram 7.

Considering firstly the trade area in which Crook is the dominant centre - this embraces the followingwards -

Mens clothing

- the 4 central Crook wards (East, South, North and Wheatbottom)
- Sunniside ward
- Mount Pleasant ward

(approx. extreme diameter - 2 miles)

Hardware

- the 4 central Crook wards
- Sunniside ward
- Mount Pleasant ward
- Willington West ward
- Willington North ward
- Sunnybrow ward
- Helmington Row ward
- Howden ward
- Witton le Wear ward

(approx. 4 miles extreme diameter)

Average for durable goods:-

- 4 Crook central wards
- Sunniside ward
- Mount pleasant ward
- Helmington Row ward
- Sunnybrow ward

(approx. 3 miles extreme diameter)

When defined as the basis of 70% of total trade, for the average durable good - Howden ward is added to the above list. (Trade Area approx. 3 miles diameter, extreme).

Thus it can be seen that although Crook is a larger centre than Murton and Shildon, defined on both of the above bases, it is not significantly larger, as it appears that the very largest centres have the ability for widespread domination.

The present social structure

An outline of the features of the social structure of Crook relevant to movement patterns is presented.

Household structure

The average size of household in Crook is 2.9 persons, as with both Shildon and Murton. The proportion of children (0-14 years) in the community is lower than in Shildon, at 23.1% and the proportion of old people (over 65), higher than both Shildon and Murton, at 15.1%. 66% of households had no old people and 10.8% had at least 2, mainly elderly couples living alone. It is clear that the population of Crook is more aged than that of either Murton or Shildon. Additional information on male and female death rates confirms this, as Crook and Willington U.D. has one of the highest mortality rates of local authority areas, in the County. This is a legacy of pit closure, isolation and out-migration.

The activity rate also sinks in Crook, to 39.6 (workers per 100 population) well below regional and national averages, and below Shildon, at 42.

13.2% of households have all members working and 8.4% have 4 or more dependents. There are on average 1.78 dependents per household.

Table 5.3 reveals that the population of Crook has, on average, a lower number of workers per household than either of the 2 previously considered settlements. 30% of households have no employed person, being supported either by pensions or other forms of social security benefit.

Table 5.3

Numbers employed/household	% of households
0	30%
1	35.5%
2	23.0%
3	10.2%
4	1.3%

Occupation structure

Table 21 shows the distribution of socio-economic groups in Crook. There are 3090 persons employed living in Crook, of which 55.2%, or 1708 were defined as household heads. There are important contrasts in occupation structure between Murton and Crook and Shildon and Crook, the following being particularly marked:- there is a higher percentage of household heads in socio economic groups 1-6 than in the 2 other centres, a percentage as high as 18.9, explainable partly by a greater centrality function than the other 2 centres and partly by an area of high class housing previously mentioned, to the west of the town; in addition, socio-economic group 8, which is the 'skilled manual supervisory' grade is very poorly represented indeed, at .9%, which reflects the lack of a single large industry requiring special technical skills: the pit deputies and the railway workshop foremen are not to be found here. The skilled worker grade is however well represented - these work at the engineering firms or travel to pit face jobs in relatively distant mines. There still remain about 110 household heads who are miners in Crook. Socio-economic group 10, the semi-skilled, are well represented, working mainly at the brickworks, in haulage firms, plastic and clothing factories. Group 11, the unskilled, are represented on about the same level as in Shildon, but Murton has a much higher percentage, for industrial reasons.

66% of household heads work in Crook, which compares with Shildon at 68%. The remaining 34% appear to be very prepared to travel, one consequence of pit closure. A wide variety of destinations were indicated, including Stanhope and Washington. Bishop Auckland takes the largest single percentage. The travel pattern is even more diverse than in Shildon, and Crook clearly 'holds ' its own labour force to a much lesser degree than does Murton.

76.5% of workers who are not household heads work in Crook, compared with 55% in Shildon and 40% in Murton, representing a reversal of the 'centrifugal' force of Murton. The clothing factories are very important in this retention of labour. Shop and office employment are also well represented types of employment. Bishop Auckland again takes most of the labour force (non-head) which travels out, and again there is a wide variety of destinations, including

Durham, Stanhope and Newton Aycliffe.

A rather large percentage of lower professionals also travel out, mainly teachers and nurses.

Social class

The social class structure of Crook is similar to both of the 2 preceeding settlements, with however class II being better represented than in either of the other 2.

Table 5.4

CROOK	SOCIAL CLASS (% of households)
I	1.9%
II	11.5%
III	46.1%
IV	30.0%
V	10.5%

In-migration

This has been almost negligible over the last 5 years, in Crook. A few families from Bishop Auckland, a few from Roddymoor and Stanley (Crook), and a few professional and managerial families have come to the town. Rehousing has been mainly for the existant Crook population.

Income

The income structure of Crook is shown below:

Table 5.5.

Income group	% of households
B	27.5
C	15.6
D	21.8
E	13.1
F	9.4
G	5.0
H	7.5

The income structure of Crook is very similar indeed to that of Murton and Shildon, but higher income groups are here slightly better represented. Group B is larger than in Murton, as can be expected from preceeding observations. Again there is a direct relation between household size and income.

Average income in Crook was £17.81 per week per household, higher than both Shildon and Murton, at £17.15 and £17.08 respectively. There is however rather more of a polarisation to extremes in Crook than in either of the other 2 communities. Crook has lower percentages in income groups D and E than the other 2 communities. 34.9% of Crook households are in D and E categories compared with 44% in Shildon and 41% in Murton.

There appears also to be a closer relation between income and socio-economic status in Crook than in either of the other 2 communities, as might be expected from the more 'polarised' income distribution. Crook's income also comes from a wider variety of sources than does Murton's - potentially a more healthy situation.

Consumer movement and expenditure patterns

This section provides analysis of basic movement patterns in Crook, and various hypotheses are tested.

Convenience goods

Table A 22 shows the raw movement figures for Crook, by shop type and general destination. As with Murton and Shildon, the general feature is the same - most convenience goods trips are internal. This is however even more strongly marked than with either of the two previous settlements considered. The percentage of trips made elsewhere for purchase of convenience goods is as follows:- meat 2%, fish .9%, groceries 2.9%, greengroceries .9%, bread 2% and chemist goods, almost zero. These purchases are mainly made in Bishop Auckland. This arises both because Crook is the largest centre of all 3 considered and is also some distance from competing centres.

The use of different shop types shows some interesting comparisons with the two former settlements. 79.9% of meat purchases go to independents, for reasons already outlined, 15.2% go to the Coop and Multiples come a poor third. A similar pattern emerges with fish purchases, 97.9% going to the independents.

With grocery purchase, competition from multiples comes clearly to the fore, as they capture 48.5% of the grocery trade, with independents just beating the Coop to second place, with 27.5% of the trade, as compared to 24% for the Coop. In Crook, the large Coop appears not to be able to compete with the multiples as well as in Murton. The situation is more similar to that in Shildon.

The independents reassert themselves with greengrocery purchase, taking 74.1% of the trade, again for reasons rather similar to those affecting the situation in meat retailing. The Coop takes second place, with 16.5%.

Bread purchases are dominated by the private baker as was the case in both Murton and Shildon, with 67.8% of bread purchases being made at independents, the rest of the field being divided almost equally between Coop and multiple bakers. Milk is mainly delivered, with 58.9% coming from the Coop and the rest from the independents, being a more similar situation to that obtaining in Murton than in Shildon.

Crook has a Boots branch, so that the leader in the field of Chemist goods is the multiple chemist, as was the case in Shildon; here it holds 43.1% of the trade with the independents coming a close second at 38.9%.

Thus it can be seen that the basic purchase pattern is not identical between all 3 communities, when examined by shop type. Also the mobile shop is relatively unimportant in Crook.

Determinants of consumer movement: Convenience goods

The influence of certain socio-economic factors upon movement patterns is examined. Hypotheses 2 and 5 particularly, are tested.

Occupation status

Under the original hypothesis, it would be expected that theuse of the independent retailer would increase with occupation status.

Diagram 13 shows the results for Crook, for 2 convenience goods (meat and groceries). Again it can be seen that no strong relationships emerge, and the differences between groups were found to be not significant at the .05 level, using the Chi square test, for both grocery and meat purchase. Thus as was the case in the two previous communities, the hypothesis is rejected. The only general observation that can be made is that there appears to be a tendency for groups 8 and 9 to patronise the cooperative and multiple stores in preference to the independents, and that groups 17 to 21 are the greatest single users of the Coop.

Income

Under the terms of the original hypothesis, the use of the independent retailer should increase with higher household income. Diagram 13 shows the result for Crook, for meat and grocery purchase. Again the basic result is as found in the two other communities - that the hypothesis must be rejected. This is again confirmed by the use of the Chi square test, at the .05 level of significance. There may be a slight tendency for the use of independents to rise with income in the case of grocery purchase, but this is statistically dubious. Group C is the largest single user of the Coop for groceries, whilst the higher income groups show a tendency to patronise the multiples. As suggested before, the failure to substantiate the two preceeding hypotheses could be either because there is no such relation as is postulated, or alternatively because another factor is disturbing the expected pattern, for example, the 'intrusion' of cut price supermarkets into the tertiary sector of these communities.

Durable goods

Diagram 2 shows the location of Crook with respect to other shopping centres. The following table gives an indication of the distance to and size of other competing centres. The size measure used is based upon the Thorpe - Rhodes Index (1966)

Table 5.6

Centre	Distance from Crook (miles)	Size (index)
Crook	-	961
Howden	1.5	9
Willington	2.5	169
Tow Law	4	11
Bishop Auckland	5.5	2652
Esh Winning	6	52
Langley Moor	8	100
Spennymoor	9	955
Shildon	9	475
Durham	10	2040
Ferryhill	11.5	296
Newton Aycliffe	12.5	364
Consett	15	864
Chester le Street	16	870
Darlington	17	4230
Trimdon	18	9
Sunderland	22	5505
Newcastle	25	12320
Stockton	28	3652
Middlesbrough	31.5	5900

The basket of goods chosen for the analysis was again chosen to represent movement to all levels of centre.

The basic movement data is provided in Table A 22a and is in terms of percentage of trips made, not of expenditure, directly. Again, as with Murton and Shildon it is clear that both distance and centre size are important in 'explaining' overall patterns.

However, the pattern does differ rather fundamentally from that in both Shildon and in Murton. Crook is able to retain a much greater proportion of its purchasing power, in every good, than is either Shildon or Murton. Crook clearly exerts a greater centrality influence than either of the other two. This would not be revealed by a simple shop count, in comparison with Shildon.

However, when the ordering of goods based on percentages 'lost' is considered, the pattern does fall more into line with that of the preceeding settlements. Crook retains most trade in (in descending order): hairdressing (95%), radios (87%), T.V. (81%), hardware (79%), vacuum cleaners (78%), and washing machine (74%). Crook 'loses' most trade in Children's clothing (% loss - 55%), women's clothing (47.5%), jewellery (45%), men's clothing (39%), furniture (33%), and shoes (32%).

The principal competitor for the trade of Crook is Bishop Auckland, followed by Newcastle, with Darlington and Durham trailing well.

Newcastle competes most strongly in women's clothing, jewellery, and furniture purchase.

Bishop Auckland competes most strongly in children's clothing, mens clothing, shoes and women's clothing, slightly lower order goods.

Darlington shows only weakly in all goods, though competes most strongly in the clothing goods. Durham is even weaker, with only men's clothing reaching 2%. It is also interesting to note that the smaller but closer centres, Willington and Esh Winning, for example, have virtually no influence, and only appear at all for lower order goods.

Again, in terms of trade retention, Crook is strongest in electrical goods and appliances, though not far behind come shoes, furniture and men's clothing. Thus Crook appears to have the greatest centrality, of all 3 centres considered.

It would appear again that there is some ordering of goods - people seem more willing to travel for certain types of goods than for other types, which accords with notions of central place theory. Here again the analysis is pursued by considering the average distance travelled for the purchase of each good.

Table 5.7

Average distance travelled for each good (miles) and rank of good

	CROOK		SHILDON		MURTON	
Women's clothing	1	7.57	2	5.50	1	6.63
Jewellery	2	6.67	1	5.96	4	5.33
Children's clothing	3	5.88	3	4.63	5	5.32
Furniture	4	4.97	5	4.22	2	6.20
Men's clothing	5	4.86	4	4.27	3	6.02
Shoes	6	3.92	7	3.75	7	4.59
Washing machine	7	3.56	6	3.99	8	4.44
Vacuum cleaner	8	3.30	8	3.53	6	4.79
Radio	9	2.72	9	3.38	9	4.28
Tv	10	2.69	10	2.53	10	4.15
Hardware	11	2.50	11	2.04	11	4.11

It can be seen that there is a general close agreement between the ordering of goods in each case. To the above lists it is possible to add groceries and chemist goods, in that order. The Spearman's Rank Correlation Coefficient can be used to compare the closeness of the 3 distributions to each other. The following results are obtained:-

	Shildon	Murton	Crook
Shildon	+	.867	.973
Murton		+	.897
Crook			+

These coefficients reveal that all 3 centres display highly similar patterns, but that Crook and Shildon are closer to each other than either is to Murton. The implications of these orderings, for central place theory are examined in the next part of the thesis.

It can be seen that the average distances calculated for Crook extend over a greater range of values than is the case with either of the two previous settlements, representing perhaps a more 'ideal' central place situation in this area.

Determinants of consumer movement - durables

Hypotheses 1 and 4 are examined in the light of empirical evidence.

Occupation

Diagram 14 shows for 6 types of durable good and all durable goods, the percentage use made of Crook and of 7 competing higher order but more distant centres; these centres are:-

Newcastle, Sunderland, Bishop Auckland, Durham, Stockton, Middlesbrough and Darlington. Use of these centres is shown by different socio-economic group. Some of the groups have been amalgamated, for statistical reasons.

Under the original hypothesis, households of a high socio-economic status should be more prepared to travel for a particular good than households of low socio-economic status, which means, indirectly, that they should tend to patronise larger and more distant centres more frequently than low status households. Diagram 14 reveals that in Crook this generally does appear to be the case. The diagram shows percentages purchased in Crook compared with percentages purchased in any one of 7 larger competitors. The relationship shows most clearly for the average durable good, but seems to hold well for all goods, except for women's clothing, and if in this case distances were measured instead of choice, then the frequent appearance of Newcastle would make the distribution appear more in accord with the hypothesis.

The null hypothesis that there is no real difference in the status of households purchasing at each of the two alternatives for the average durable good, was tested, using Chi square, and rejected at the .05 level of significance. Thus it can be assumed that there is a relationship between centred used (and distance travelled) and socio-economic status of households, and that the diagrams reveal that this relationship is in accord with the original hypothesis. This relationship appears to be more strongly developed in Crook than in Shildon or Murton.

Income

Under the original hypothesis, willingness to travel for the purchase of durable goods increases with household income; thus it can be expected that the use of Crook should fall with increasing household income, and that the use of competing centres should rise.

Diagram 15 shows the percentage use of Crook as compared with the percentage use of the 7 other competing centres, by households in each of the income groups, for a number of durable goods.

Generally the results seem to indicate that the hypothesis does hold. The diagram showing movement for the average durable good indicates this perhaps most clearly. The relationship seems to hold less well for the two low order goods, hardware and washing machines, a feature noted earlier; it shows most clearly for furniture purchase.

The difference in purchase patterns for the average durable good was tested using Chi square, and the differences were found to be significant at the .05 level. The diagram indicates the alternative hypothesis that is to be accepted, and is in accord with the original hypothesis.

An alternative measure is to calculate average distance travelled, for the average durable good, by income group - the results are as follows:-

Table 5.8

Average distances travelled for the purchase of durables by household income

Income group	Distance (miles)
B	2.84
C	3.59
D	3.56
E	5.43
F	6.43
G + H	5.75

Thus it can be seen that there is a clear general tendency for willingness to travel to increase with household income. The reverse trend noted in both Shildon and Murton that tends to appear in the two highest categories does not seem to appear here as strongly. This could be because of the higher percentages of higher status workers in Crook, meaning that the tendency for incomes to reach groups F, G and H is probably due less to the addition of extra earners (lowering real income per head) than to an actual higher real income hper head.

The equation of the best straight line for the relationship between household income and distance travelled for the average durable good, for each household is:-

$$y = .96 + .13\ x$$

which means that for every £1 in household income a household will, on average, be prepared to travel .13 miles further to purchase a durable good.

The trends in choice of centre, by income group, when Crook is offered as an anternative to its 7 larger competitors, for the average durable good, can be described by the following:-

$$y = 80.4 - .84\ x$$

which is to say that for every £1 increase in household income, the probability of shopping in Crook falls by .84%.

The relationship between income group and choice of one of the 7 alternative competing centres can be described by:

$$y = 11.66 + .83\ x$$

which is to say that for every £1 increase in household income the probability of using one of these centre increases by .83%.

These relationships are more strongly developed in Crook than either in Murton or Shildon.

Social class and household size

The effects of these factors are analysed in the next chapter.

Car ownership

The influence of car ownership on purchase patterns was examined, for 4 goods:-

Average distances travelled for 4 goods by Crook residents (miles)

Table 5.9.

	Car owning households	Non car households	
Men's clothing	5.981	3.312	+
Women's clothing	8.868	7.111	+
Furniture/carpet	5.891	4.201	+
Shoes	4.667	3.510	+
	6.352	4.531	+

(+ Significantly different at the .05 level)

The trends previously observed also are observable in Crook, and the original hypothesis can be said to hold. More specifically, the probability of a car owning household travelling to a given centre is 58.38% compared with 41.62% for a non-car household.

Flows of expenditure

This section provides again an explanatory 'costing' of raw flows into actual monetary flows in the tertiary sector of Crook.

Table A 23 provides the basic sectoral expenditure pattern for Crook. The figures are for weekly expenditure. This again represents a basic data matrix for the study of the tertiary sector of local economy in Crook, and was derived by the method already described.

Total weekly expenditure is £46,114 and the total of personal income in the community is £48,108 per week. This means that saving is a higher percentage than either in Shildon or Murton, but is still at a low level.

The table corresponds very closely to that of Murton and Shildon. Again, expenditure on housing, food and fuel are above the national average and expenditure on transport, services and alcohol, below the national average.

Table A 24 presents details of weekly expenditure on convenience goods in and out of Crook. Below are the results in summary form.

Table 5.10.

Crook loses each week, by (i) purchases made outside and (ii) by vans based outside Shildon:-

	£	% of total expenditure
Meat	190	6%
Fish	3	1%
Groceries	113	2.3%
Greengroceries	7	.4%
Bread	3	.3%
Milk	49	4.2%
Chemist goods	0	0%
Food	365	2.62%

It is clear that the percentages of expenditure 'lost' from Crook are much lower than either in Murton or in Shildon - a reflection of greater centrality. The total loss on food purchases is only 2.62%, much lower than in either of the other 2 centres. It can also be seen that mobile traders operating from outside Crook have made little impact upon the local economy. The only sizeable losses are in meat and in grocery expenditure. Bishop Auckland supermarkets provide a little competition for grocery trade and some meat purchases are surprisingly made at independents outside Crook.

Comparison will be made later with the results of the 'raw flow' analysis.

Table A 25 presents the basic data for 5 durable goods in Crook and is summarised below.

Table 5.11

Crook retains the following amounts of weekly expenditure on the following goods:-

	£	% of total
Mens clothing	406	55.8 %
Womens clothing	953	49 %
Shoes	506	62.2 %
Furniture	739	61 %
TV	250	80 %

It can again be seen that Crook retains much more of its expenditure in all goods than do either of the two other settlements, though again the largest proportions are retained inlower order goods. Comparison will be made with 'raw flows' in the next chapter.

In conclusion, it is clear that these 3 types of expenditure data matrix presented in this chapter and the two preceeding chapters are a potentially useful starting point in marketing, planning and academic work. A relatively simple method has been presented with worked examples, for the derivation of income patterns and sectoral flows of expenditure and the translation of these into spatial terms.

The future of the local economy

The 1951 County Plan placed Crook as an A centre as it was expected that Crook would gain in population from the regrouping policy. Many surrounding villages were placed in the D category. The 1964 Amendment also continued in this vein: 'towns (Crook and Willington) which will be as attractive as their counterparts in other parts of the country; and compact and conveniently placed labour forces.' 'Both offer the basis around which, by concentrating development and investment of capital it is possible to create much better living conditions...' (p.63).

This policy has already been questioned in the case of Shildon, and much of the same criticism applies here. It seems doubtful whether Crook will in fact function as a growing population centre; in migration is very low, and out-migration high.

In terms of centrality, Crook is perhaps the most balanced of all 3 centres, but is losing ground slowly to Bishop Auckland. It is doubtful if Crook will be able successfully to resist this competition. There is the additional fact that fastest population growth is occurring in the conurbation areas and one or two of the very largest A centres. Out migration from the County is still high. Thus Crook's role as a future 'growth centre' must be called into question.

Economically Crooks future depends upon the success of the Trading Estate, which currently could be desribed as modest. Any increase in out-commuting to employment will be confirmation of the breakdown of planning policy. The future is certainly brighter than in 1963; factories have opened and the local economy has diversified. However, a 'better future' is not what the County Plan concerns itself with; the intentions are specific and considerable. Whether they will succeed is doubtful. This brief consideration of planning policy does not venture into the more thorny normative or even economic aspects of the planning policy.

CHAPTER 6

SYNTHESIS

This chapter is divided into two sections. In the first, the results of the testing of hypotheses in each of the three communities are drawn together, synthesised and tested again as one sample, with consequent higher levels of reliability. In the second section, methods of prediction of patterns of income and expenditure, both non spatially and spatially, are reviewed and utilised.

Determinants of consumer movement.

In chapter 2 a number of hypotheses were presented, relating social and economic variables to consumer movement. Here the results are reviewed and extended.

In general, it has been shown that shopping movement patterns of households are influenced by certain socio-economic factors, and attempts have been made to examine the nature and strength of these influences.

Methods

The analysis is firmly based in the collection of hypothesis - orientated survey data. Rather than operate at a broad aggregative level of attempting to measure movement patterns of different community 'types', the analysis has centred upon the household as the basic data unit. Direct measurement of household movement patterns, as well as the socio economic variables under consideration, including the difficult one of household income, has been undertaken. The material gathered has also been used to develop means of allocating actual quantities of expenditure spatially, which is the concern of the second section of this chapter.

Technical details about the surveys appear in Appendix 2.

One important problem with the extension of the analysis on the basis of one large sample is that it becomes impossible to relate actual distance travelled for any good directly to any of the various socio economic variables because the different configuration of centres around each community will produce different patterns of movement and travel distances. The solution here adopted is to use an indirect but closely related measure: it is here assumed that willingness to travel a given distance is related to willingness to shop in a centre other than the local one. Thus a falling percentage use of the local centre is taken to represent an increasing willingness to travel. A falling percentage use of the local centre will also mean an increased use of competing centres, which in these cases are almost all larger than the local centre and are usually at some distance from the settlement. The measure is not ideal, but does overcome the problem and is logically defensible.

The hypotheses

These are stated in full in chapter 2 and are here abbreviated.

(1) Socio economic status is related directly to willingness to travel for durable goods purchase.

Results from each of the 3 settlements indicated generally that this relationship could be assumed to hold. In Shildon, for example, 27% of group 8 used the local centre (Shildon) for all durables goods considered together and 44% of group 11 did likewise. The relationship appeared least well developed in Murton and best developed in Crook. The following table presents the result of all three considered together, for all durable goods:

Table 6.1

All durable goods: percentage use of two alternatives by socio economic group

S. E. G.	No. & % using local centre		No.& % using competito	
1-6	108	33.6%	213	66.4%
8	53	29.1%	129	70.9%
9	356	47.2%	398	52.8%
10	290	47.7%	318	52.3%
11	107	60.1%	71	39.9%
17	326	62.9%	192	37.1%

These results are plotted in diagram 16. It can be seen that with the exception of group 1-6 the relation can be assumed to hold. Group 1-6 probably contains too many and diverse socio economic groups to fall directly in line with the relationship. The major socio economic divisions in working class communities will, in any case, fall between groups 8 to 11, and retired persons are here assumed to be below group 11. The above table indicates that a household in group 11 is twice as likely to use the local centre as is a household in group 8.

The table indicates that for durable goods, a household whose head is in socio-economic group 8 will use the local centre on less than 1 out of 3 trips (29.1%) whereas a household in group 11 will use the local centre on nearly two out of three trips.

This measure of relationship by comparing percentages in contingency tables is recommended by Blalock (1960) (P.228). An additional measure of strength of relationship can also be used, $\emptyset^2$ which is derived from Chi square, and is outlined shortly.

The difference in movement patterns between different socio economic groups for the purchase of durable goods (all) was tested for significance using $\chi^2 = \chi_{calc.}{}^2 = 109.20$, $P < .001$ (with 5 degrees of freedom).

Thus it would appear that the null hypothesis can be safely rejected. However, caution must be exercised because although χ^2 suggests a significant difference, the difference cannot be properly accepted as significant as the test is designed to test observations which are technically independent. In order to check upon the above result the test is repeated for two single goods, mens clothing and furniture, which, taken alone, are independent observations. Both goods exhibit frequency distributions which appear like the one for the all goods case, and their frequency distributions are in line with the hypothesis.

Mens clothing: $\chi_{calc.}{}^2 = 17.33$, $P < .01$ (5 d. of f.)

Furniture: $\chi_{calc.}{}^2 = 21.36$, $P < .001$ (5 d. of f.)

Thus the differences in purchase habits between households of a different socio economic group can be regarded as highly significant in these two cases.

Where the alternative to the null hypothesis takes order into account, as here, the Kolmogorov - Smirnov Test provides a more powerful test of significance. (Hereafter termed the K.S. test). The K.S. statistic is D.

The test was run for the two above frequency distributions, with the following result:-

Mens clothing: D = 1695, $P < .025$.

Furniture: D = 1933, $P < .005$

Thus in both cases again the differences between the two distributions can be considered highly significant and are also in accord, directionally, with the above hypothesis.

An alternative measure of willingness to travel is to ignore the configuration of centres around each settlement and simply calculate the average distance travelled for the purchase of durable goods, by socio-economic group. The results are as follows:-

Table 6.2

Average distance travelled for durable goods

Socio economic group.	Miles.
1-6	6.06
8	4.71
9	4.60
10	4.11
11	3.25
17	2.98

Thus, it can be seen that the significance of 1 unit of distance is twice as great for a group 11 household than for a group 1-6 household. These figures relate closely to the foregoing percentage analysis. It appears that in these relatively working class settlements, socio-economic group does provide a clear and consistent measure for the weighting of movement patterns.

2.(Hypothesis 3). Social class is directly related to willingness to travel for the purchase of durable goods

No analysis was made in each of the three settlements. The basic result for all durable goods considered together is as follows: (for all 3 settlements)

Table 6.3

Percentage use of two alternatives by social class

Social class	Number and % using local centre.		No. & % using competitors	
I	20	29.9%	47	70.1%
II	80	41.7%	112	58.3%
III	697	43.0%	924	57%
IV	459	45.7%	544	54.3%
V	146	58.3%	105	41.8%

It can be seen that the above relation appears to be in line with the hypothesis, as is illustrated in Diagram 17. However, closer inspection reveals that the difference between groups II to IV are not very great. This implies that the most important differences are between 3 groups: I, II to IV, and V.

The important social class groups for differentiation within a working class community are groups II to V rather than group I. Thus the situation is not too clear. The implication is, that in these communities social class as here defined does notinfluence strongly travel patterns. For the above contingency table, $\chi_{calc.}{}^2 = 27.46$, $P < .001$ (4 d.of f.), which implies rejection of the null hypothesis. However, again a check was run on 2 sets of independent observations with the following result:-

Men's clothing: $\chi_{calc.}{}^2 = 2.43$, $P < .50$, (4 d. of f.)

$D = .0511$, $P > .1$

Furniture: $\chi_{calc.}{}^2 = 2.24$ $P < .70$

$D = .0479$, $P > .10$

Thus it appears that in both cases the null hypothesis must be retained and the differences considered not statistically significant. This casts doubt upon the significance of the general case outlined before.

Thus from the evidence collected it can be inferred that there may be a relationship between social and class and willingness to travel for the purchase of durable goods, but that this relationship has not been shown to be statistically significant and seems to be rather weak. If the relationship can be said to hold at all then it seems to hold best between three groups, I, II to IV, and V. This is confirmed by re running chi square for a 3 x 2 table consisting of groups I, III and V only. Clearly more research is needed with this variable.

3.(Hypothesis 4) Household income is directly related to willingness to travel for durable goods.

In all 3 communities this hypothesis was accepted, though some tendency for an inverse trend to appear was noticed above group E, and explanations were offered for this. It was found in most cases that a clear tendency existed for higher income households to shop in centres which were competing with the local centre. Furthermore, average distances travelled for all durables goods tended to increase directly with income of household, though again the reverse trend began to appear, the results are as follows:

Table 6.4

Income group	No. & % using local centre.		No. & % using competitors	
B	436	60.0%	291	40.0%
C	270	51.9%	250	48.1%
D	404	44.0%	515	56%
E	219	39.7%	332	60.3%
F	166	45.1%	202	54.9%
G	63	47.7%	69	52.3%
H	105	46.5%	121	53.5%

Diagram 18 illustrates these trends and shows that the hypothesis does seem to hold over groups B to E but the reverse trend again appears at group F. Reasons for this have already been explored.

The differences in purchase patterns were found to be significant, using chi square. $\chi_{calc.}^2 = 67.3$, $P < .01$ (with 6 d. of f.).

Again the test was repeated for individual goods:-

Men's clothing: $\chi_{calc.}^2 = 9.62$ $P > .10$

Furniture: $\chi_{calc.}^2 = 16.51$ $P < .01$ (5 d.of.f).

$D = .1740$ $P < .005$.

In the case of the two above goods, the null hypothesis is rejected. There is one suspect value of chi square, for mens clothing, significant between .20 and .10, but this is raised above .10 by the K.S. statistic, a more powerful test.

In each of the three communities a relationship between income and willingness to travel for the purchase of durable goods was observed. The following represents a summary of results.

Table 6.5

Marginal increase in travel distance for an increase of £1 household income

Crook	.13 miles
Murton	.02 miles
Shildon	.04 miles
	.06 miles

Marginal change in probability of use of each local centre for an increase of £1 household income

Crook	- .84%
Murton	- .20%
Shildon	- .51%
	- .52%

Thus it would appear that even in a relatively socially homogenous working class area, all households cannot be regarded as identical units of trip generation. Important differences are observable between households of differing social and economic backgrounds.

To help ascertain which of the three foregoing factors of occupation status, social class and income have the greatest effect upon movement patterns, the statistic $\emptyset^2$ is used. This is described by Blalock, H. (1960), and can be used with a 2 x k contingency table. $\emptyset^2$ is a measure of strength of relationship, based upon chi square, varying between 0 and 1, where 0 indicates complete independence between the two samples and 1 complete dependence. The value of $\emptyset^2$ cannot be interpreted in the same way as the value of the product - moment correlation coefficient, as $\emptyset^2$ should properly be used for comparisons between different 2 x k contingency tables, as here.

$\emptyset^2$ was calculated for each of the above 3 cases:

Table 6.6

Socio-economic group and choice of centre:		
All durables	:	.043
Mens clothing	:	.049
Furniture	:	.053
Social class and choice of centre:		
All durables	:	.008
Mens clothing	:	.007
Furniture	:	.006
Income and choice of centre:		
All durables	:	.019
Mens clothing	:	.025
Furniture	:	.037

The implication of these figures is that socio-economic status of a household has the greatest influence upon travel patterns, followed by income, followed by social class where the relationship found in this survey is weak.

These results have been obtained directly from empirical observation, obviating the need for approximating the 'average' social class or income group of an area and generalising from aggregate movement data.

4. (Hypothesis 2). Households of high socio economic status will tend to shop more in independent retailers for convenience goods than in either cooperatives or multiples, considered together.

In all 3 communities the hypothesis was rejected and is here examined for 1 good, groceries:

Table 6.7.

Socio economic status and shop patronage - grocery purchase

SEG.	No. & % using independents.		No. & % using others	
1-6	11	23.9%	35	76.1%
8	5	21.7%	18	78.3%
9	26	21.5%	93	78.5%
10	9	30%	21	70%
17	31	27.9%	80	72.1%

It can be seen that no trends are appearing, confirmed by the chi square test:

$$\chi_{calc.}^2 = 2.19 \quad (5 \text{ d. of f.}) \quad P > .80$$

Thus very clearly the null hypothesis must be retained.

5. (Hypothesis 5) Households of a high income are more likely to purchase convenience goods at independent retailers than are households with a low income.

In all settlements this hypothesis was tentatively rejected.

Here a test was first run for 1 good, groceries:

Table 6.8.

Income group and shop patronage - grocery purchase

Income group	No. & % using independents.		No. & % using others	
B	31	25 %	93	75 %
C	16	22.5 %	55	77.5 %
D	28	23.7 %	90	76.3 %
E	18	25.4 %	53	74.6 %
F	18	40.9 %	26	59.1 %
G	8	47.0 %	9	53.0 %
H	8	32 %	17	68 %

This produces the surprising implication that there does here appear to be some relationship between household income and preference for independents. This was tested, using chi square:

$$X_{calc.}^2 = 8.65. \quad (5.\ d.\ of\ f.) \quad P < .20$$

This result is rather inconclusive but conventionally, the null hypothesis must be retained. The K.S. statistic D also produces a similar level of significance (D = .116). However the significance levels indicated would suggest that further investigation is needed. In order to repeat the above analysis, meat purchases were examined. They too show a similar pattern to grocery purchases, and the chi square (8.88, 5 d. of f.) is again significant between .20 and .10 levels. The same applies to the size of D. Thus again the null hypothesis must be retained, though the result is interesting.

6. Car ownership (hypothesis 6).

All 3 settlements show differences in purchase patterns between households where a car is owned and where a car is not owned. As sample sizes were very adequate, the results are here only summarised:

Table 6.9

Average distances (miles) travelled by car and non-car households

	Car households			Non-car households		
	Shildon	Murton	Crook	Shildon	Murton	Crook
Mens cloth.	5.48+	6.84+	5.981+	3.74	5.62	3.31
Womens "	6.06+	6.84	8.87+	5.43	6.79	7.11
Furniture/Cpt	7.16+	7.70+	5.89+	3.65	6.12	4.20
Shoes	6.34+	----	4.67+	4.87	----	3.51
Average	6.26+	7.12+	6.35+	4.37	6.17	4.53

(+ Significant difference at the .05 significance level)

Or, expressed alternatively,: The probability of travelling a given distance to purchase durable goods (high order goods in this case) is for:

	Car households	Non-car households
Murton	.536	.464
Shildon	.589	.411
Crook	.584	.416

Thus car ownership can be seen to be a significant factor affecting movement patterns. The above figures give some indication of by how much. The original hypothesis is accepted.

7. (Hypothesis 7) Frequency of travel is related to household income.

Unfortunately the question used lacked precision in definition of trips and allowed movement by all family members for any activity other than work over a fixed time period. There was as a consequence very wide variation in household travel totals and many problems of information error. Consequently little reliance can be placed upon the results. In general there does seem to be some relationship between frequency of travel and household income when allowance is made for the effect of household size. Households of higher incomes tend to travel out of the home settlement more frequently than low income households. This is especially true in the case of households containing old people.

Multi - purpose trips

In existent literature on consumer movement the multi-purpose trip is often referred to as an important factor in introducing distortion into otherwise regular travel patterns, based upon single purpose trips. An investigation into the frequency of occurrence of the multi-purpose trip was incorporated into the surveys in each of the three settlements.

Respondents were asked: 'Which of the following things was done on the last visit of an adult member of the household to' ... (each of a named set of centres). The activities included were: work, visiting friends or relatives, entertainment, medical appointment, business, shopping and other (specify). This does not however include the important activities of shopping trips on which goods of different orders were purchased.

Results.

For each settlement and for each centre considered, the results were classified into two broad groups: (i) trips involving shopping and (ii) trips not involving shopping, and within each of these groups trips were classified according to how many activities were stated as a purpose for that trip.

In general, it was found that very few trips indeed involved more than two stated activities, below 2% of all trips in each of the three communities.

Table 6.10

Totals and percentages of trips for which more than one activity was named

	All trips		Trips in which shopping was included	
Shildon to				
Newcastle	21	17.9%	18	31.6%
Bishop Auckland	35	24.3%	32	26 %
Darlington	18	13.5%	18	18.6%
Durham	8	12.5%	8	72.7%
Crook to				
Darlington	6	10.5%	4	13.8%
Bishop Auckland	8	14.3%	7	15.6%
Durham	3	10.7%	3	25 %
Newcastle	12	27.9%	12	34.3%
Murton to				
Newcastle	11	11.7%	12	20.8%
Sunderland	16	16.2%	15	18.1%
Durham	11	13.4%	10	29.4%

In terms of all trips made, the multi-purpose trip reaches a maximum of 27.9% from Crook to Newcastle. It is also interesting to note from the table that almost all trips which are multi-purpose include shopping activity.

Overall, on average, about 13% of all trips made are multi-purpose. Of trips which include shopping activity, about 22% are multi-purpose. It can be seen from the table that there is one extreme value of 72.7%, based however on a small sample in this case. Otherwise all values lie below 34.3%. Thus it appears that on average, about 3/4 of shopping trips made out of the home settlement are single purpose, and 1/4 multi-purpose. The problem of how to overcome this distorting effect has not yet been solved.

One assumption which can be examined from the above figures is that the probability of any trip being multi-purpose increases with distance involved. The figures for trips of all types cannot be said to support this, but it must be remembered that these do include a wide variety of purposes. When shopping trips are considered, the assumption appears to be supported rather better: Shildon's lowest percentage multipurpose trips are to Darlington and Bishop Auckland and Murton's to Sunderland.

Conclusion

The main aim of this part of the thesis was to investigate the nature of and strength of the influence of certain social and economic factors upon the spatial expression of consumer behaviour, i.e. consumer movement. The influence of these sorts of factors is not well understood and most studies consider consumers as identical units of movement. This part of the thesis has demonstrated that consumer behaviour does vary in a consistent manner with certain social and economic factors. The spatial behaviour of consumer is, in comparison with studies of central places, a neglected field, as Szumeleck (1968) points out. The study has been set in the context of a working class area, yet discernable trends were seen to emerge. Large areas of the UK are primarily working class areas so that the findings of the surveys can be argued to have a wider context than that of County Durham. Elements of the human geography of the County have also been illustrated and analysed in the course of the investigation. This provides the background for the work in all parts of the thesis.

Prediction of non spatial patterns of Income and expenditure

It will be recalled that in chapter 2 of this thesis a method was presented in outline, for the determination of 'sectoral' patterns of income and expenditure, in a small area, without the need for lengthy surveys. The method is here operationalised and the results compared with survey findings, in the three settlements. The need for such a method was outlined in an earlier chapter.

Operation

The two inputs required are: the socio economic group structure for the area in question and the relevant Family Expenditure.Survey.

The socio economic group structure of an area is published down to Urban and Rural District level and is also available at a Ward and Parish Enumeration District level through the Scale D special census tabulations, which are not so detailed as the published material. Sampling error is possible, especially using areas at a low level of areal aggregation.

The Family Expenditure Survey includes a table which shows the distribution of households in their sample by household income and by occupational grouping of the head of the household. (Table 25,F.E.S. 1967).

First, some amalgamation of groups is necessary for compatability: F.E.S.:

(1) Professional and Technical, Administrative and Managerial, Teachers.

(2) Clerical, Shop Assistants.

(3) Manual

(4) Retired

Socio Economic Groups:

(1) (1,2,13,), + (3,4)

(2) (5,6)

(3) (11,16,17 (under the full s.e.g. definition)) + (7,10,15) + (8,9,12,14)

(4) Retired (17 as used here in the thesis)

Note that group 3 need not be so large if published s.e.g.data is used, rather than Scale D.

These 4 groups can be considered to correspond to one another. From the census material it is possible to calculate the percentage which each of the 4 groups constitutes in a given area. Turning to the Family Expenditure Survey, it can then be seen that each of these 4 groups has an associated income distribution, in categories B to H. The numbers of households appearing in each income group is multiplied by the percentage appropriate to each occupation group and the new columns are summed to give the new weighted income distribution for the area. These can then be expressed as percentages of the total number (row total), which can then be expressed as households in the given area simply by multiplying by the actual number of households in the area. Expenditures can then be derived for the whole area by using the Family Expenditure Survey.

Results

As the actual income distribution is known from the surveys to a fairly high degree of accuracy, then the likely sectoral expenditure pattern can be derived from this, for each of the three communities.

It must be first pointed out that the three communities are very far indeed from the 'average' income structure (national), on which the Family Expenditure Survey is based: the area is predominantly working class, as has been seen, and in the North East wages are in any case below the national average. Thus estimates of income for a community, based upon the F.E.S. can reasonably be expected to be higher than what actually exists.

Table 6.11

Predicted and survey derived expenditures

	(1) Predicted (£)	(2) Survey derived (£)	(1)/(2)x 100/1
Shildon			
Income, average hh.	23.5	17.5	137%
Total expend. available	87,544	70.059	124%
Total food expend.	25,584	21,387	119%
Total clothing exp.	7,371	5,737	128%
Murton			
Income, average,hh.	23.4	17.08	137%
Total expend. available	56,352	45,473	123%
Total food expend.	16,586	14,047	118%
Total clothing exp.	4,771	3,663	130%
Crook			
Income,average, hh.	23.10	17.81	129%
Total expend. available	55,338	46,114	120%
Total food exp.	16,205	13,945	118%
Total clothing exp.	4,648	3,778	123%

Thus in all three cases there are errors of prediction. However, the errors are of the same order and direction, which suggests the use of correction factors.

Income is 37% overestimated in Murton and Shildon and 29% in Crook. Total available expenditures is about 20-24% overestimated. It is interesting to note that Crook predicts the best of the three, suggesting again that Crook is a more nearly 'average' centre. The distributions of incomes predicted using the above method are illustrated in Diagram 19.

General

In all cases, the method is overpredicting, but does appear to be overpredicting consistently, and in accordance with expectations as outlined at the start, based upon knowledge of the area in relation to the national economy. There are two important points to be considered: do the results justify use of the method and is it possible to include a correction factor.

The results, whilst not being excellent, could not be described as unsatisfactory, particularly as the error is consistent both in size and in direction. This leads into the second point, that it would appear that it is very possible to incorporate a correction factor into these results, which could simply be some very simple constant derived from published data. In addition it was pointed out in an earlier chapter that the method could be refined by adding details of female employment, unemployment and other available figures. The method does appear to be potentially acceptable.

Income, expenditure and spatial patterns

It was indicated in chapter 2 that there was a need for a method of establishing incomes and expenditure patterns 'sectorally' and then to be able to translate these sectoral patterns in spatial terms: The author has derived a method for this based on survey techniques, but of less complexity than the traditional forms of income and expenditure surveys, outlined as method 5 in Chapter 2.

Using survey methods, the income structure of a town, or area is established, using income groups which correspond to the F.E.S. income groups. Likely expenditure for each household in the area is then deriveable from the F.E.S. using the collected income data. Respondents are also asked, at the same time, which centre they last visited for the purchase of certain types of good. Expenditure flows can then be summed, for each centre, for any good.

This method is essentially a 'weighting' of raw movement figures i.e. of persons, or households, which are the usual simple measures of expenditure flow. However, it may not always be the case that 'raw' flows do represent actual expenditure flows. Here the main problem in the method is that of establishing household income.

With the available resources it is unfortunately not possible to make an accurate check on the result of using the above method.

Here an analysis is made of the consequences of predicting expenditure flows by using 'raw' flows of households or people, with the results of the costing of flows.

Results of the operationalisation of the above method have been presented in each of the chapters on the settlements.

Table 6.12

Expenditures as represented by 'raw' flows compared with 'costed' flows (percentages)

Convenience goods:

Murton	Meat (1) Raw	(2) Costed	(1)-(2)% (2)	Groceries (1) Raw	(2) Costed	(1)-(2)% (2)
% going to indeps.	68.6	68	.8	29	30	3.3
% to coop.	26.8	28	2.8	43	43	0
% to multiples	4.6	4	15	27.8	27	2.9
% leaving Murton	11	12.1	9.2	7	6	16.6
TOTAL EXPENDITURE AVAILABLE: (weekly)			£3,336	£4,835		
Shildon						
% to independents	83	83.2	.2	24.2	24	1.6
% to coop.	7.8	7.8	0	15.3	12.9	18.6
% to multiples	8.9	9.0	1.1	60.2	63.1	4.6
% leaving Shildon	10.8	11	1.8	9.5	10	5.0
TOTAL EXPENDITURE AVAILABLE: (weekly)			£5,177	£7,159		

It can be seen from the above table that unweighted crude flows in the convenience goods sectors of the two communities provide a good overall fit to 'weighted' flows. However, whether or not the fit is satisfactory depends upon the intended use for the material: In terms of the total pattern, then the fit is very good: for example, the raw flow method shows that 7% of Murton's grocery expenditure leaves the local economy, whereas the costed flows (assumed here to have a greater accuracy) show 6%. This 1% difference is only £48 per week. However, in terms of the flow itself, the error is as large as 16.6%, as is shown. Thus if the interest is in the actual pattern rather than the accuracy of individual flows, then the 'raw' flow prediction method produces a highly similar result to that of the costed flow method; if interest is centred upon the size accuracy of individual flows then it is probable that the costed flow method is markedly more accurate.

This exercise is repeated for durable goods:

Table 6.13

Percentage flows:-

	Womens clothing			Furniture		
Crook						
TO:	Raw	Costed	R-C/C%	Raw	Costed	R-C/C%
Crook	52.5	55.8	5.9	67	61	9.8
Bishop A.	18	19.2	6.3	15.8	15.7	.6
Newcaslte	20	21.0	4.8	9.7	14.2	46.4
Sunderland	0	0	0	.6	1.0	66.7
Allcentres outside Crook	47.5	44.2	7.5	33	39	18.2
Shildon						
TO:						
Shildon	37.2	39.0	4.6	28.5	29	1.7
Bishop A.	47	46	2.2	49.2	51	3.5
Newcastle	1.2	1.3	7.7	2.1	3.3	36.4
Darlington	7.3	7	4.3	15.2	12	26.7
All centres outside	62.8	61	3.0	71.5	71	.7

From the above table it would appear that the situation here is slightly worse than is the case with convenience goods. However, again the purpose for which the flows are to be used will be an important factor in assessing which is 'best'. Absolute differences with respect to the total pattern are very small, but if interest is in the actual allocated flow, then errors expressed as a percentage of that flow reach 46.4% in the above table. To illustrate from the above table: the 'raw' figures for furniture purchases made by Crook households indicate that 67% of expenditure, or

£806 per week is spent within Crook. The costed flow figure indicates that the amount is 61% of expenditure available for furniture purchase, or £734. The error is only in the order of 6% when the absolute amount is considered, but is nearly 10% when considered in relation to the size of the flow. The difference between the two amounts calculated for mens clothing expenditure going from Shildon to Darlington is only 3.3% of the total expenditure used for mens clothing, but the error on that individual flow is as high as 26.7%.

Generally, therefore, it seems that if interest centres upon the general pattern of distribution of expenditure, spatially, then 'raw' flows probably provide a reasonable estimate of 'costed' (i.e. expenditure) flows. If the size of the individual flow is important then it is probable that costed flows, using the method presented give a more accurate representation. There is no satisfactory means of checking whether or not this is the case,nor indeed on the general accuracy of the method. The only meaningful statements that can be made about these various methods are statements that take into account both their logical basis and operational feasibility.

CHAPTER 7

THE RETAIL SECTORS IN CROOK, SHILDON AND MURTON.

An investigation was made into various features of the retail sectors in each of the three communities studied earlier.

The purpose was threefold:

(i) to provide a methodological contribution to the study of retail structure, particularly with respect to the possibilities of using survey methods with personal interviews in the collection of data.

(ii) to provide a background analysis to the foregoing chapters on consumer movement, investigating differences and similarities in the retail structure of the towns concerned.

(iii) to provide an investigation into some of the structural aspects of retailing in small towns in County Durham.

Methodological considerations are dealt with in Appendix 3, where a copy of the questionnaire also appears. This chapter is concerned with the results of the survey.

Theoretical

The notion of threshold is vital in the understanding of patterns of distribution of retail establishments, and is incorporated within the context of central place theory in the next part of the thesis.

Threshold is defined as the minimum level of purchasing power (usually measured simply as consumers), required to support the existence of one (the first) function of a given kind. Normal profits are included as a cost factor. It follows that if sales fall below the threshold level then the function will disappear, whereas if demand rises above threshold level then more units of the function will appear when demand has reached at least twice the threshold level. This allows excess profits to enter. Threshold is an integral part of the explanatory power of central place theory.

It is also clear that some functions in any one area are more numerous than other functions, which implies that threshold requirements for these functions are lower, which in turn implies that it is possible to order functions on the basis of their threshold requirements, and so directly to their frequency of occurrence upon a given surface. This is starting point for the analysis carried out by Berry and Garrison (1958(a)) in their search for a hierarchical ordering of centres.

It thus follows that the largest population served by a given centre will be for the function with the highest threshold requirements which is provided by that centre. As population tends to be more dense around large centres there will also tend to be larger populations available for the purchase of lower order goods, which means that the available population will be well in excess of threshold requirements for lower order goods, so that more units of lower order functions will spring up, their numbers having some relationship to their threshold requirements. In general, the lower the order of the function, the more units supplying that function will there be, over a given area.

The general nature of the relationship between number of functions and establishments takes the form shown in Diagram 48. This can be described in a linear equation as $\log Y = a + bX$

which implies that when there are few establishments the tendency is for extra establishments to provide different functions, but as the number of establishments increases then the rate of introduction of new functions falls off and replication grows, though at different rates for different functions.

There have been attempts to extrapolate threshold values from curves describing the relationship between population of central places and number of establishments of a given function; these have been described by Yates (1968). The equation used to relate population of central place to number of establishments usually takes the form of

$$E = aP^b$$

where: E: number of establishments and P: population of the central place. Threshold is found by setting E = 1.

However there are many problems in employing this extrapolative method, not the least being that it is trade area population which is more important than centre population. There are many further conceptual and practical difficulties in attempting to measure threshold, though it does remain a potentially useful concept in attempting to explain patterns of retail provision.

Murton, Shildon and Crook: Shops and Centrality

It can be seen from table A 26 that Murton had 41 retail establishments, plus a large cooperative store. Of these, 7 (16%) are multiples (1 non food), 9 (21%) are branch shops privately owned (4 non food), and 25 (63%) independents, (8 non food). 31% of shops are non food shops. The rate of replication of functions by establishments is 16:41. There are 16 main functions represented, the functions missing being all non food, mainly specialist, such as jewellery, booksellers, variety store, records and music, and others; there is no wet fish shop.

It should however be noted that the Cooperative store does provide a very wide range of functions, some on a limited scale. The cooperative store does considerably distort the retail structure of Murton. With an annual turnover of around £344,000 at the Murton branch alone (of which £239,000 were food goods sales) the cooperative store comprises nearly 30% of the total calculated turnover of Murton, which is calculated later in the chapter. There are 205 persons per retail establishment in Murton.

Diagram 20 shows the distribution of shops in Murton. The centre is set well to the east of the village and is rather underdeveloped, even by standards of the County, in that there is a very considerable residential element in the main shopping area, which is in any case dominated by the very extensive cooperative store. To the west are scattered isolated shops, and it would seem that there is a case for some shopping development more central to the expanding areas of residential development to the west. Non food shops do tend to concentrate on the main parade, however, as do multiples and the shops with the greatest floor areas.

There is an absence of non food specialist shops and an absence of other tertiary services, such as opticians, estate agents and so on.

The organisation of retail trade reflects a low central status, particularly with respect to non food goods. 16% of all establishments are multiples, compared with for example, Durham City at 26% and Bishop Auckland at 21%, in 1961, Moreover, there is only one non food multiple, a wallpaper shop, (a relatively low order good).

The most common way of extending the influence of a centre over a larger effective population is through the use of mobile shops. The rather large number of butchers in Murton has made this a necessary dimension in the retailing of meat. 6 shops have sales vans, all butchers vans, plus a number (unspecified) of cooperative vans which are important elements in the retail sector of Murton: from the consumer surveys vans from Murton cooperative store accounted for the following proportions of expenditure on various goods, as follows: Meat 5%, Groceries 10%, Greengroceries 18%, Bread 9%, Milk 56%. Between 30% and 50% of the turnovers of the butchers shops were brought in by the vans, principally from Murton, but also from Peterlee, Seaham and South Hetton.

It would seem that Murton faces a rather static trading situation in the future. Competition from outside will increase, particularly in higher order goods, which will not seriously affect Murton. Internal readjustments will take place within Murton as efficient retailers expand at the expense of the less efficient. This process is continuous; a recent good example of an intrusion of a private retailer successfully into the retail sector of Murton is provided by a grocery supermarket, located in the old police station at the head of the main street. This local 'success' was described in 'Self Serivce and Supermarket', a trade journal, (October 26th. 1967). Multiple supermarkets are also expanding at the expense of the independent retailer.

Earlier figures would however suggest that decline in shop numbers in the 20th. century in all 3 communities might continue. This decline arises from a number of causes, set against the overall phenomenon of the 'time lag' between change in economic and social conditions and change in retail provision. Rapid, but related over-expansive growth followed by too slow a decline in shop number is commonplace. The factors at work causing this 20th century decline in shop numbers are as follows: firstly, there is an overall decline in population, coupled with periodic economic problems of an external nature. Secondly, increases in efficiency in the retail sector have tended to further the development of larger but fewer shops. Thirdly, the growth in effective competition through increased consumer willingness to travel, and fourthly, after a period of rapid expansion, there tends to be overprovision of facilities, which can take a very long period of time to correct.

TableA26 indicates that the retail provision in Shildon is of a rather different nature to that in Murton. There are 119 establishments in Shildon, plus two cooperative establishments, one large. This is three times the number of shops in Murton, yet the populations are in proportions of 9:13 to each other. The immediate implication is that Shildon has a greater centrality function than Murton, which, as has been seen from the consumer movement chapters, is the case. This is also reflected in the greater numbers of higher order functions present in Shildon. There are 25 main functions present here, compared with 16 in Murton. However the contention here is that despite a greater centrality function than Murton, Shildon is still grossly over-provided with shops, in excess of what its centrality function would suggest would be adequate. This is reflected in a number of ways.

Firstly, there is still not a full range of retail provision. Compared with the 'missing' functions in Murton, the situation is somewhat better, fish, mens clothing, bicycles, jewellery and animal foods being amongst those that appear here. The function replication rate (functions: establishments) is 1:4.7, higher than in Murton. Secondly, the distribution of shops by organisational type reveals Shildon's weakness: there are only 12 multiple shops (5 non food), only 10% of all shops, compared with 16% in Murton, and 26% in Durham, Branch shops are 10 in number (not counting within-Shildon branches more than once), and cover a range of non food goods. Most are part of a 2 or three shop organisation, and lower order goods tend to have all establishments in the organisation within Shildon.

Shildon is dominated by the private retailer, with 97 establishments (36 non food) in the hands of a one-man shop organisation.

There are 109 persons in Shildon per establishment, lower than in Murton, though greater centrality does compensate. The trade areas shown in an earlier chapter are however not extensive.

Diagram 21 shows the distribution of shops within Shildon. Loosely defined, there are three centres: the main Church Street centre, with an extension westwards, the Alma road centre, and the New Shildon centre. Retail establishments are very widely spread throughout Shildon, with the exception of the Thickley estate area to the east. The town has a very broken urban morphology and it is clear that the pattern of retailing has been considerably influenced by this. New Shildon is relatively isolated from the rest of the town by the railway line, and has developed its own line of shops. Shildon centre proper lies well offset to the north of the settlement, and centrally placed shopping areas around the Alma/St. John's road area can be regarded as a nascent centre serving the centrally situated but densely populated area near to the British Rail works. Clearance is severely affecting this shopping area. The large area of parkland in the heart of the settlement has also affected the distribution of retailing, It is this very broken morphological pattern which has provided the necessary locational protection for small and relatively inefficient shops to flourish.

The background changes in retail provision outlined in an earlier chapter show the familiar pattern of a 19th. century increase in shop numbers, but the decline has not been as great as might be expected. Nevertheless, the diagram does show clearly that there were a large number (over 20) shops empty, particularly in the New Shildon and St. John's road areas. Currently in Shildon, expansion in housing provision is taking place on the Thickley estate and housing clearance is taking place to the north of the railway line, without rebuilding. This has the effect of diverting the trade to the main centre, particularly from the shops in the St. John's road area. In New Shildon trade is being lost to the multiple shops by the independent food retailers; this is because the multiples too have realised the partial monopoly situation in this area. Individual efficient retailers in the area report maintained or increased sales, but the less efficient ones do not. There is a considerable passing trade from women working on the trading estate in New Shildon.

The centre proper, Church Street, has residential use mixed in with retail use,suggesting that competition for central sites is not severe. There are few purpose built shops. Clearance in North east Shildon is however being replaced in situ so that the centre should not suffer unduly.

Non food shops are spread throughout Shildon, though they do tend to concentrate in the Church Street area. Non food multiples and branch shops are definitely concentrated in the Church Street area, as are food multiples, though two food multiples have realised the locational advantages of New Shildon.

There is an additional factor in the retail sector of Shildon: the existence of a weekly temporary market. 3 spot checks revealed the following average numbers of stalls:

Groceries	5	Fish	1
Greengroceries and flowers	11	Crockery and household	1
Womens wear	1	Woollen goods	1

Shildon cooperative store is again fairly large, but nowhere near as importantas in Murton. An important feature in the retail sector of Shildon is the fact that the trading estate clothing factories sell direct on certain evenings, which tends to reduce womens and mens clothing shops to selling very low unit cost goods. This partly helps to explain the relatively low threshold values for these types of shop. There are very few mobile shops in Shildon, only 4 shops operate them plus the cooperative store.

Other tertiary services are rëpresented in Shildon to a much higher level than in Murton.

Increased willingness to travel, and as a consequence, extension of influence of Bishop Auckland and the growing centre at Newton Aycliffe make the retail prospects for Shildon look bleak. Rehousing is working in favour of the Church Street centre, but it will not remain unaffected. Any expansion of multiple competition will worsen the situation. As a measure of the strength of competition over the previous 3 years all independent retailers were asked to state whether they believed that trade had got 'better' 'worse' or had 'stayed level' with respect to their turnover, in the previous three years. This point will be taken up again, but the results for Shildon alone are interesting:

Table 7.1

	Better	Worse	Level
Grocery shops	45%	23%	32%
Other foods	44%	22%	34%
Confect. News/Tob.	64%	18%	18%
Clothing	26%	32%	42%
Household	17%	66%	17%
Other non food	25%	25%	50%

Thus it seems that it is the higher order functions that have suffered most - the implication being that increased competition from outside is making itself felt.

Table A 26 shows that again there are differences between the retail structure of Crook and Shildon. In particular, there is a more even distribution of functions over establishments and not such a great proportional concentration in lowest order goods shops. There were 73 establishments in Crook plus one large Cooperative establishment. These figures do not include the small neighbourhood centre on the Mown Meadows Estate, to the west of Crook. Earlier work in the thesis has shown that Crook does have some centrality function over a short radius around the town. This is partly why there are about 75% more shops than in Murton, despite a similar population size. It is also clear that there is a less pronounced tendency for shops to have a number of functions in one establishment. Shops are more specialised than in Shildon, and there are more specialist shops than in Murton.

There are 27 different main functions represented, including a variety chain store, Woolworths, and a small department store. This represents a net replication rate of 1:2.7. Thus with almost half the number of establishments as compared with Shildon, more functions are represented.

The distribution of shops by organisation reveals Crooks greater strength as a centre: 16 of the shops (24%) are multiples (11 non food), 8 are branch shops, usually only part of a two shop organisation. The cooperative store again provides a wide range of goods and has a total branch turnover of £120,000 per annum.

Van trade from Crook is more developed than in either of the two foregoing settlements.

The competitive situation facing the independent retailer in the 3 years before the survey is as follows:

Table 7.2

	Better	Worse	Level
Grocery	17%	50%	33%
Other food	18%	36%	46%
Confectionery	30%	40%	30%
Clothing	0%	43%	57%
Household	67%	33%	0%
Other non food	20%	40%	40%

This shows that the most serious eompetition has been faced by the food retailers. This corresponds with the growth of large scale grocery multiples in Crook, some of which have very high turnovers. Clothing shops also face competition, but this tends to be from outside.

Thus it seems that Crook is the most developed as a centre of all 3 communities considered and probably has best future prospects, though these are not good. There is a high level of provision of other tertiary services. The 'multiples' figure of 24% can compare favourably with that of Bishop Auckland (21%) and that of Durham (26%). There are 139 persons per establishment.

Diagram 22 shows the distribution of shops within Crook. The diagram show a much more conventional 'centre' configuration of shops - a radial shape along main communications axes, with an almost continuous business frontage at the centre. Non food shops are clustered in the centre and food shops appear sporadically towards the edge of the town.

Multiples are concentrated around the central area, the lower part of Hope Street, and around the Market Square are several large multiples and the large cooperative store. A few closed chops are in evidence.

There is atwice weekly open market in Crook and again 3 spot checks revealed the following average provision of stalls:

Grocery	3	Shoes	3
Greengrocery	5	Household	5
Womens & Childrens clothing	7	Textiles & Wood	4
Mens clothing	2	Electrical goods	1

Thus the market in Crook is larger than that of Shildon, again denoting greater centrality.

Thresholds.

It has already been argued that other things being equal (which they are not) the number of shops providing a given function in an area can be considered as an indication of the relative size of the threshold values for this function. Thus a ranking of functions by frequency of occurrence should approximate a ranking of functions on the basis of their thresholds. Work undertaken by Garner (1966) was based upon this postulate.

In theory, the thresholds for various goods should be shown in a relative manner by the relative numbers of shops taking all 3 settlements as one. There remain of course, considerable problems of definition.

Table 7.3

Ranked functions (main functions only)

Rank	Number observed of each type	
1	0	Records/Music; Prams; Bookseller; Photography; Leather Goods; Sports Goods; Flowers;
2	1	Cycles; Surgical; Department Stores; Variety Stores;
3	2	General Clothes; Hardware; Household; Jewellery; Toys; Animal Food;
4	3	Other foods; Fish;
5	4	Furniture; Fancy Goods;
6	5	Ladies clothing& Childrens clothing;
7	6	Woollen Goods; Electrical goods;
8	7	Chemist;

9	8	Shoes; Mens Clothing;
10	9	Confectioner (Sweets);
11	10	Greengroceries; Ladies Clothing; Wallpaper;
12	12	Newspapers;
13	14	Supermarket; Bread; Tobacco;
14	24	Butcher;
15	47	Grocer;

Ranked functions (main and major functions, together)

Rank	Number observed of each type	
1	0	Records/Music; Prams; Books; Leather; Flowers;
2	1	Photographs; Surgical; Department Store; Variety Store;
3	2	Cycles; Sports goods;
4	3	Fish;
5	4	General Clothes; Hardware; Jewellery;
6	5	Woollen goods; Furniture; Household;
7	6	Ladies & Childrens Clothes; Chemist; Toys;
8	7	Other Foods;
9	8	Electrical;
10	9	Shoes; Wallpaper;
11	11	Men's Clothing; Fancy Goods;
12	12	Ladies Clothes;
13	13	Newspapers;
14	14	Supermarket;
15	17	Bread;
16	22	Greengrocer;
17	24	Butcher;
18	59	Tobacco;
19	60	Sweet Confectioner;
20	65	Grocer;

It can be seen that there is some correspondence with what might be expected from the 'willingness to travel' analyses of the consumer surveys. There do however remain many anomalies, largely, it is believed, through problems of definition, particularly with clothing. Supermarket thresholds are higher than grocery shop thresholds. Wet fish shops seem to have high threshold requirements as do

Ironmongers. The cooperative store undoubtedly does distort patterns of retail provision, as relatively high level functions are provided in low level centres.

Structural Aspects

The three centres can be considered together for analysis of certain structural aspects of retailing in small towns in County Durham.

Labour Force

83% of establishments have 3 or less full time workers including the manager. The average number of employed per shop is 2.04. 55% of employees are women. McClelland (1966) shows that the 1961 proportion of women was 58% for the U.K., in retailing.

The average hours of opening for multiple shops was 49½ and for independents 54 hours, indicating a more efficient use of time by multiples, Partly to counter this some of the independent grocery shops belong to voluntary buying chains. The figure for grocery retailers is 20%, over the three settlements.

Deliveries

As noted in the Appendix, this question was very largely a failure in its present form. The only results which can be gained from the information collected are general and should be treated with caution. There are very wide differences in patterns of supply and frequency of supply, between different types of goods and between different types of shop. Non food goods shops have fewer deliveries per week than food goods shops and they often come direct from the manufacturer. There are however exceptions, such as in pharmaceuticals. Multiple food shops have regular deliveries, usually from a central depot, located on the outskirts of subregional or regional centre. Independent food retailers which are members of a voluntary buying chain have more regular deliveries than non members. 'Cash and Carry' discount warehouses are becoming more popular for the very small trader, these usually being located on trading estates. Some sources of supply are nearly always direct, such as cigarettes. Some butchers slaughter their own meat.

Any rationalisation of patterns of supply must be based upon a firm and clear knowledge of the existant situation, no matter how complex. It is not yet clear how that information can best be obtained, and considerable investigation of possibilities must be made.

The retailer as entrepreneur.

Various aspects of the retail manager (or owner) as entrepreneur are examined, using data collected in the three settlements.

A comparison was made between length of experience in retailing of multiple and of independent shop managers. No significant differences were found. Another dimension of 'experience' is to compare proportions of managers who have worked in more than 1 retail establishment:

	Only 1 shop experience	more than 1 shop
Multiples	33%	66%
Independents	43%	57%

Here begin to appear some perhaps expected trends: the managers of multiples have had a wider experience of different shops than have managers of independents.

Multiple shop managers also tend to be a little more specialist in the sense that the survey reveals that a lower percentage have been employed in jobs outside retailing than is the case with independent managers. The figures are 26% and 34% respectively, having had outside employment.

It is a commonplace to hear of the independent shop as being a 'family business'. An attempt was made to estimate the extent to which the shop of the independent retailer really was a family business. Managers of independent shops were asked how many members of their immediate family worked (i) full time, (ii) part time, (iii) occasionally, in the shop. The same question was put to manager of multiples, as a control. Only in 3 multiples (8.5%) were family members in full time employment, with virtually no family members in part time employment. 44 independents (28%) had family members as fulltime employees and many more had part time and occasional help.

Another analysis made was to ask about the location of the place of residence of the manager:

Table 7.4

Residence of manager.

	On the premises	In the town	Out of the town
Multiples	3.0%	69%	28%
Branch shops	14.0%	50%	36%
Independents	54%	34%	12%

Here again the difference in the way of life of the independent retailer is clear. 54% of the independent retailers 'live on the job', whilst only 3% of multiple managers do so. Multiple managers also show a tendency to travel further to work, when they live out of the town, than do the independents.

An examination was made as to how far the independent retailer and his family were dependent upon the shop that they owned and ran. The results are shown in Table A 27.

The table shows the rather heavy dependence of the private retailer upon his shop. 76.3% of managers were household heads and in 73.6% of the cases it is highly probable that the shop is the main source of income for the household. Cases 4. and 6. in the table tend to be the cases where a wife manages a shop and is helped by a husband in his free time from work. Corner (1969) has shown that it is the independent who is suffering most in the present U.K. competitive situation, whilst the multiples tend to gain ground and the cooperatives remain fairly static. The heavy economic dependence of the private retailer upon his own shop will tend to produce a 'tightening of the belt' situation. The main trends in retailing are towards larger and more efficient units, which produces higher gross margins. The reasons for this lie in the internal economies of scale available to large establishments, and are outlined by McClelland (1966). The case for the continued existence of the corner shop as a planned shop unit has been outlined by Cheer (1957). The situation for the independent retailer does however seem bleak.

Cost and Competition

One of the aims of the survey was to attempt to measure occupancy costs and wagebill in relation to turnover. This proved to be impossible within the framework of this survey. Some information was however forthcoming on turnover, in 37% of the cases of responding shops.

Turnover

Turnovers provided have been related to two other factors, namely floor area of sales space, and size of workforce, in each shop. This analysis was developed with respect to food and to non food goods.

The relationships between turnover and labourforce and floor area in each of the two above cases were summarised by the use of a linear least squares regression line. These relationships are shown in Diagram 23. (See also footnote).

This diagram confirms aspects of earlier analyses. Considering food goods firstly: Shildon has 13 points below the line and 8 above, mostly closer to the line, whilst there are some very low values below the line. Crook has 6 points above and 4 below, mostly relatively close. Murton's values are generally very close to the line. Generally points above the line are multiples and those below are independents.

It must however be borne in mind that this analysis of turnover throughout assumes that the very considerable non response was distributed randomly, which it is believed, is reasonable in this case.

In the linear equations to describe the relationship between turnover and size of labourforce, a logarithmic transformation of y (turnover) was employed. In the case of the relationship between turnover and floorspace a logarithmic transformation of both x and y was employed.

For food shops, the relationship between floorspace (log) and turnover (log) was found to be slightly closer than that between size of sales staff and turnover, though the difference is not significant. Thus turnover and floorspace were used.

The estimating equation was found to be

$$y = 1.3716 + 1.075x$$

$$r = .714$$

In the case of non food goods neither relationship was as strong as was the case with food goods, but the number of employees was a closer relationship than floorspaces, so was used in the estimating equation.

The semi logarithmic estimating equation of

$$\log y = \log a + x \log b$$

$$= y = 3.5 + 0.149x$$

$$r = .505$$

Non food goods reveal the same sort of pattern, Shildon showing 11 points below the line and 3 above, Crook 6 below and 10 above, and Murton, less strong in non food goods with all 4 below.

Shildon has some extreme low values, and Crook some high values. There are many problems arising from the use of these two approximating variables: clearly there are differences in space need between shops selling different types of durable goods; the average value of each transaction will tend to be higher for durable goods than for food goods but the variance will also be higher, thus confusing the relationship between staff and turnover. In less efficient shops, particularly the small general shop, there may well be no longer a close relationship between floorspace and turnover, particularly where trade is declining. There appears to be a relationship between 'enterprise' and level of turnover, not reflected directly in these figures.

Centre Turnover

Each equation was used to interpolate values for all shops in each settlement. This produces the following results:

Murton			£'000
Survey calculated turnover:	Food	530.4	
	Non food	168.1	
		698.5	698.5
Plus 20.5% for non response	Food	108.6	
	Non food	34.4	143.0
Plus Coop sales		249.2	
	Non food	94.8	
		344.0	344.0
ESTIMATED 1968 TURNOVER FOR MURTON			£1185.5

which includes	
Food sales	£888.2
Non food sales	297.3

<u>Shildon</u> £'000

Survey calculated turnover:

	Food	697.6	
	non food	436.2	1133.8
Plus 14.4% for non response			
	Food sales	101.0	
	non food sales	63.0	164.0
Plus <u>estimate</u>	for coop sales	62.0	
	Food sales	38.0	100.0

TOTAL ESTIMATED TURNOVER FOR SHILDON 1968 £1397.8

which includes food sales 860.6

non food sales 537.2

<u>Crook</u> £'000

Survey predicted turnover

	food	553.1	
	non food	472.6	1025.7
Plus 10.6% for non response			
	food	60.5	
	non food	49.0	109.5
Plus Coop sales 120.8			
	estd food	65.0	
	estd. non food	55.0	120.0
Plus <u>estimates</u> for			
Woolworths	Food	30.0	
	non food	70.0	100.0
Doggarts			
	non food	50.0	50.0

ESTIMATED TOTAL TURNOVER 1968 FOR CROOK 1405.2

of which food sales: 708.6

non food sales: 696.6

These figures can now be compared with earlier consumer survey figures.

In chapter 3 it was estimated that in Murton in 1967 there was £730,444 available for food purchases, of which 6% went outside Murton, giving a figure of £686,000, which compares with the £879,000 turnover calculated for Murton when deduction is made for the van trade outside the town. This means that if these figures are correct, then Murton attracts 22.5% of its food trade from outside the town. This is very possible when it is remembered that Cold Hesledon was not included within Murton, but is very close to the town.

It was calculated for Crook that in 1968 there was a turnover of £703,600 for food expenditure, which must be reduced to £699,000 to allow for van sales made outside the town. This compares with a survey derived total, available expenditure of £725,140, which must be reduced by 3% to allow for expenditure going outside the town, giving a result of £703,000. However Crook does provide some very small central function in food goods for households living outside the town, so that predicted turnover is probably low, or predicted available expenditure high. The predictions are surprisingly close to one another however.

Shildon had a predicted turnover of £860,000 in food sales, which compares with a survey derived available expenditure of £1112,124, which must be reduced by 10% to allow for outside expenditure, giving a figure of £998,000. There is clearly some error in one or both of the predicted figures, though it is not too serious, particularly as Shildon's influence as a centre for food goods outside the town is almost nil.

It is interesting to note that the 1968 predicted turnover of £1,397,000 compares very well with the 1961 census turnover figure of £1,240,000.

The survey derived turnover figures confirm certain earlier observations: Murton is as strong as both Crook and Shildon in convenience goods purchase but cannot compare in centrality function for non food goods, though their total turnovers are similar. The average turnovers per establishment are: Crook, £19,200, Shildon £11,600, and Murton £29,000, (though this is inflated by the very strong cooperative store).

Competition

The overall competitive position in all 3 centres, as has been seen, is rather different, However, the results of the attempt to measure competition for the independent retailer are here presented.

Table 7.5

Over the past 3 years is trade:

	Better	Worse	Level
Groceries	39%	37%	34%
Other food	29%	32%	39%
Confectionery/News			
Tobacco	42%	29%	29%
Clothing	20%	33%	47%
Household	38%	54%	8%
Other non food	36%	28%	36%

In general, the least efficient retailers are hit hardest by competition. Competition comes from two main sources: Clothing and Household goods retailers are probably the hardest hit overall, which represents competition from larger centres, whilst the convenience goods shops are facing competition largely from within the town, particularly from the multiples. Here the shops hit hardest are the least efficient, more so than is the case with higher order goods shops.

Reasons offered for a changed trading situation were many and varied. The state of the economy was commonly offered as a reason for decline in trade, and many local reasons also were offered, such as housing redevelopment in Shildon or direct sales from clothing factories. Competition from supermarkets was acommonly referred to factor responsible for falling sales of private food retailers. Increases in trade were usually thought to be the results of individual effort on the part of the independent retailer.

Conclusion

This chapter has been essentially exploratory, and should be regarded partly as a methodological contribution, supported by Appendix 3. The results of an attempt to examine the structure of retailing in three communities has been here presented. Many methodological problems remain to be solved, particularly with respect to gaining information on the cost structure of the individual retail establishment. However, it would seem that from a relatively simple survey it is possible to gain information on a wide range of factors, including the important one of turnover.

PART II.

CHAPTER 8

CENTRAL PLACE STUDIES, AVAILABLE DATA AND THEORETICAL CONSIDERATIONS.

Introduction

This part of the thesis draws upon a second body of data on consumer movement collected by the author, in County Durham. The general hypothesis is investigated that the system of centers and consumers in a part of County Durham, hereafter termed 'South Durham', displays spatial features explainable by the postulates of Central Place Theory.

Most studies of Central Place systems usually confine themselves only to a part of the system, either the demand side or the supply side and rarely integrate both aspects into one study, though there are exceptions, for example, Berry, Barnum and Tennant (1962) and Brush and Gauthier (1968). This part of the thesis attempts to combine both elements, centres and consumers, into the same study.

This part of the thesis in part parallels, and in part extends the work of Nadur (1967) (see also Thorpe and Nader, 1969), who worked in a part of County Durham immediately adjacent to the author. Replication of data has been a serious consideration, in order that a large area can be subjected to the same sort of treatment, as few large scale studies exist. The analysis has however been considerably developed and extended.

The area

Diagram 24 shows the area here treated, which has been called South Durham. The area labelled North Durham was treated by Nadur. The two areas together comprise about 420 square miles and are densely populated, with many free-standing settlements. The boundaries of South Durham were chosen in an attempt to encompass the coalfield area, with its distinctive geographical patterns and having a high degree of internal homogenity. Accordingly, the eastern boundary is the coast, the northern boundary reaches to the edge of Nadur's area and the western and southern boundaries were drawn where the coalfield ends, this usually being dramatically clear. A few rural areas in the south and west have however been included.

Diagram 24 also shows the boundaries of wards and civil parishes (hereafter all are termed wards for convenience); in South Durham some of these wards were amalgamated for data collection purposes and this is indicated with a broken line. The result is that South Durham now contains 79 'wards' and North Durham 71, 150 in all. South Durham contains over 310,000 people. The population of both North and South Durham is over 500,000. It is an area that whilst being large and densely populated, can in no sense be described as a conurbation so that one can reasonably expect to be free from the specifically urban types of shopping area, as outlined by Berry (1959, 1967), which do not fit into the central place pattern: the ribbon and the specialised area.

The data

It is the nature of data availability which makes this study a worthwhile undertaking. Data was collected by the author in South Durham in two main surveys:

First, a survey of all centres was made, centres being defined as having more than 3 shops within 20 yards of each other, or a cooperative store. The centres were classified using a centre ranking system, described in the following chapter and which is available in detail in an article by Thorpe and Rhodes (1966). The same system was used by Nadur.

Secondly, data on consumer movement for a range of goods was collected on a large scale over the entire area of South Durham. Assistance with the survey, which used interview methods was provided by senior pupils at more than 14 schools in the area.

Appendix 4 gives technical details about the survey, of which a brief outline is here presented. A questionnaire of a deliberately simple nature was drawn up and respondents were asked for destination information for 17 goods:
weekly groceries, butchers meat, wet fish, greengroceries, chemist goods, shoes and boots, mens clothing (over 7/6d), women's clothing (over 7/6d.), child's clothing, T.V. set (or rental), radio, furniture or carpet, washing machine, vacuum cleaner, hardware, cycle or pram and jewellery.

As far as was possible, an attempt was made to control the accuracy of the survey. A simple random sample of households was drawn from the electoral registers (on the basis of households, <u>not</u> electors), for each ward. The final total sample was a little over 4,600 households, or an average of about 58 per ward, with non response lowering this figure. Each pupil was allocated a number of addressed questionnaires near to his or her home address, with a full set of instructions. Clearly the use of non-professional interviewers must make the results less reliable, though the quality control checks undertaken revealed work of a high quality, reflecting partly the deliberate simplicity of the questionnaire.

Thus there is available a body of origin-destination data, collected in 1968, covering a wide area and a wide range of goods, at a reasonable level of accuracy. The greater part of the data is compatible with that collected by Nadur in the north.

Problems of data collection

1. There are a number of problems of a statistical nature over which control was attempted. These are dealt with in Appendix 4.

2. There were inevitably problems of definition: the categories of goods are wide and many types of purchase are included under one heading.

3. There were inevitably problems of accuracy: information was required for the last centre visited for the purchase of each of the goods. In this way it was hoped that less frequent but important trips could be included, rather than by asking for which centre was usually visited.

4. The huge problems of data collection and organisation were partly overcome by the use of computing facilities.

Any use of the data collected by Nadur is acknowledged. In this part of the thesis Nadur's data is used only in one or two limited instances.

Central Place Theory: theoretical background.

A full review of developments in Central Place Theory to date is not here presented. This appears adequately elsewhere: (for example Szumelck, 1968). The barest essentials are reviewed here, mainly aspects which will be taken up in the analysis.

Following Christaller (1933), formal Central Place Theory begins with two assumptions: that there is an isotropic surface and that the model relates to economic man. It is then postulated that the price of a good to the consumer will increase with increasing distance from the point of purchase and that the consumer will act with what Berry and Garrison (1958a.) call'explicit extremisation of behaviour', in that he will shop at the nearest point of supply. It is also postulated that there is a maximum distance (cost) which a consumer is prepared to travel (pay) for each type of good, called the range of the good, and that there is a direct relationship between the population of a central place and the number of goods sold from that place. Goods of a high range will be supplied from points more widely spread than goods of a low range. Based upon the assumption of an isotropic surface it can then be shown that a hierarchy of centres will emerge in which all central places will supply the goods of the centres of a lower order plus the supply of a marginal heirarchical good. If trade areas are not allowed to overlap and no area can be left unserved, then a hierarchical ordering of centres will have one size of trade area associated with each hierarchical level. Trade areas of different levels will tend to nest into each other and will tend to be hexagonal in shape as this is the most efficient shape in terms of movement minimisation with which a surface can be filled.

Lösch (1954) importantly extended the theory by explicitly deriving the demand cone and verifying theoretically the hexagon as an optimal market area shape. He further extended the Christaller K=3 heirarchy to K= N and showed that they could all be incorporated theoretically within the same model.

An important contribution came from Berry and Garrison (1958b.) who show that if an additional concept of threshold of a good is introduced, then the comprehension of the general theory is much simplified. Threshold is defined as the minimum level of sales necessary for the supply of the good to exist, (i.e. for the first establishment supplying a particular good to remain open). In the theoretical system outlined, free entry into the market of functional units means that trade areas are compressed to threshold size, which in turn means that the range is also the threshold. It should be noted that normal profits must be considered as a cost factor in assesing the level of threshold sales.

Berry and Garrison (1958c.) also argue that the principle that excess profits cannot enter the system can and must be relaxed.

Central Place theory gives rise to many problems, both theoretical and empirical, some of which are taken up in the following analysis. One important assumption is made beforehand however, which is that a hierarchical arrangement of centres does exist in this area and that the system of classification employed adequately describes this. The argument over the existence or non existence of hierarchical arrangements of centres is well known. Berry and Garrison (1958a.) provide an important contribution in this respect. Beckmann (1958) shows importantly how both the 'hierarchical argument' and the 'continuum argument' can be incorporated into the same general argument by the introducation of a random variable. Berry tends to accept the existence of hierarchies and tries to explain variations on this basis.

There are many methods available for the ranking of service centres, W.K. Davies (1966) providing a review of these techniques. He divides them under three main headings: 1. Direct measurement, as used by Bracey (1953) and Thorpe and Rhodes(1966), 2. Indirect measurement, for example using accessibility (Green , 1950) and 3. Statistical grouping procedures, which require data of detail not available here. As Davies has elsewhere pointed out: 'it is the multitude of individual functions within a town that provides the basic problem for any study of its tertiary functions' (Davies, W.K., 1965, p.221). It is clear that the ranking of centres by statistical techniques is preferable, (although their so-called objectivity is now falling seriously into question). Davies own index is basically of the first type. Here, for reasons of (i) contiguity and (ii) data availability, the Thorpe-Rhodes (1966) index was utilised.

Particular problems

There are a number of problems associated with the study of the central place system in this particular area.

Firstly, there is the 'illogical' distribution of cooperative stores, carrying a wide variety of functions down to very low levels of centre, and having forms of organisation which are, in spatial terms. irrational, allowing interpenetration of market areas without competition within one centre. Secondly, there is the problem of the mobile shop, a fairly common form of retailing in the North East. These mobile shops 'distort' the destinations of money flows, as has been seen, in part I. Other problems arise from such factors as the multi-purpose trip, changes in consumer habits, refrigerator ownership and so on.

This part of the thesis now proceeds to attempt to estimate to what degree the central place model can be used to explain the pattern of centres and of consumer movement in a part of County Durham.

One of the important theoretical weaknesses of the Central Place model is that it is deterministic. In the following part of the thesis the possibility of using an alternative model, a probabilistic model, is investigated, and possibilities for amalgamating the two are discussed.

CHAPTER 9.

THE SHOPPING CENTRES OF THE AREA

Almost all of the area of South Durham has at some stage been a mining area. Mining areas tend to have particular and characteristic patterns of settlement and centres: isolated free-standing communities are common, centres tend to be poorly developed, having no extensive rural trade area. High immobility produces complex sets of central functions.

During the 19th. century mining colonisation of the area many small communities appeared upon the landscape. They were usually either developed as extensions to existing agricultural villages, or were established as completely new settlements, adjacent to a pit head. Settlements in the west were generally smaller than settlements in the east, for reasons already discussed.

As the population of the County grew, so demand for central services expanded, and it was usually the older established centre that was most easily able to expand its functions, for example, Durham, Bishop Auckland and Chester-le Street. However, many centres were able to grow, even in the economic shadow of a large centre, as for example, Shildon. Other large centres grew simply because of the pressure of demand, for example, Consett and Stanley.

The largest centres of the region, Newcastle, Sunderland, Darlington, Middlesbrough, Stockton and Hartlepools grew throughout the 19th. century and the 20th. century has seen this growth accelerate. These regional and sub-regional centres are amongst the fastest growing communities in the region and supply a wide range of the highest level services and functions. There is ,amongst the lower orders of centre a general decline in the centrality function, reinforced by planning policy. Diagram 25 shows the distribution of centres throughout the whole area of North and South Durham, the centres in the south being classified by the author and those in the north by Thorpe and Nadur.

The centre ranking procedure

Full details can be found in Thorpe and Rhodes(1966). The ranking procedure operates as follows: centres are identified and in each centre the total number of shops defined as non food shops (using census definitions) are recorded. The number of non food shops is then weighted by a score derived from the existence of certain other functions. More specifically:

A Certain non-food multiples

B Banks

C Grocery multiples and cooperative stores.

The index is then derived thus:

Index = $\sqrt{\text{Number of non food shops x Score(A+B+C)}}$

The most important single element in this index is the total number of non food shops. It can be suggested that in order to use the index to analyse the ordering of centres for higher order (durable goods) functions, the removal of the square root may give results which relate better to the centrality of the place in question, as a square root function has the effect of disproportionately compressing the higher values, though it does not affect rank order.

Accordingly, four relationships were tested, over all centres that lie within both North and South Durham for which survey data exists on the total numbers of households using each centre, 152 centres in all. These relationships are:

1. The index for each centre correlated with the total number of grocery shoppers(households) using each centre: r = .900

2. The index for each centre correlated with the total numbers using each centre for the average durable good: r = .852.

3. The index, squared, for each centre, correlated with numbers ofgrocery shoppers using each centre: r = .850.

4. The index, squared, for each centre, correlated with numbers using each centre for the average durable good: r = .945.

Thus the above proposition appears to be confirmed, as well as the overall value of the ranking technique.

On the basis of the calculated index (or its square), centres are divided into four categories:

A Major shopping centres
B Suburban centres
C Small suburban and village
D Neighbourhood

It is also possible to add Regional and Sub regional centres to the above list, above A.

The system of centres in South Durham

Diagram 25 shows the distribution of centres in both South and North Durham.

Neighbourhood Centres (D centres)

There are 55 of these centres in the area. The median number of shops in these centres is 6, the range is 3 - 22.

If the range is taken to be between 0 and the 9th. decile, then the result is 3 - 11 shops. The centres showing extreme values, measured by shop numbers, are interesting: Low Spennymoor(22), Bowburn (16), Station Road, Seaham, (15), Belmont, Durham(15), Sherburn Road Estate, Durham,(11). All, with the exception of Bowburn are small centres on the periphery of a settlement with a larger centre. The sorts of functions which contribute to the score are simply elsewhere, though relatively close. The rest of these centres tend to fall into one of two categories:(i) further examples of the large settlement neighbourhood centre, Tudhoe and Chilton for example and (ii) very small local centres, free standing, serving small local populations, Ludworth, Byers Green and Hunwick, for example.

Analysis using the index squared, instead of shop numbers, reveals roughly the same rank order of centres, though free standing centres do tend to rise on the list. In descending order from the highest: Low Spennymoor(9.0), Bowburn (7.8), Sherburn(5.9), Belmont(5.9), Neville Parade, Newton Aycliffe(5.9),Station Road, Seaham(5.9), St. Helen Auckland (4.3).

The functional structure of these centres is simple. There are always more food than non-food shops, offering a modest range of convenience goods. In the larger centres a cooperative store may be found, together with a dispensing chemist. The sale of durable goods is very limited indeed, with the occasional electrical goods shop. Newsagents are fairly common.

<u>Small Suburban and Village Centres. C centres</u>

There are 23 in all. The median number of shops is 17.

The range is 7 - 35 and between the first and ninth decile 12 - 35.- The centres can be ranked as follows:

Table 9.1.

C centres ranked by numbers of shops and by index value.

By shop numbers		By index Squared	
Q. Alex.Rd. Seaham +	35	Chilton Bldgs.	40
Shotton Colliery		Framwelgate Moor +	39
Cornforth		Fishburn	38
Framwelgate Moor +	35	Shotton Colliery	32
Trimdon Colliery	29	Cockton Hill B.A. +	32
Fishburn	26	Carrville	28
Chilton Bldgs.	25	Ushaw Moor	26
Ushaw Moor	22	West Auckland	25
Deneside, Seaham +	21	Gilesgate +	24
Cockton Hill,B.A. +	21	Cornforth	23
Coundon Grange	20	Trimdon Grange	22
West Auckland	19	Q.Alex.Rd. Seaham +	22
South Hetton	17	Trimdon Colliery	21
Carrville	16	Haswell	17
Meadowfield		Deneside, Seaham +	16
Trimdon		Meadowfield	14
Haswell	16	Coundon Grange	12
Ferryhill Broom +	13	South Hetton	11
Trimdon Grange	12	Ferryhill Station +	11
Howden	11	Ferryhill Broom +	11
Gilesgate +	10	Trimdon	9
Ferryhill Station +	7	Howden	9

(centres marked with + are small centres on the periphery of larger settlements)

Again, the extremes are interesting: when ranked by shop numbers, at the lower end lie Ferryhill Station, Gilesgate, Howden and Trimdon Grange and at the higher end, Queen Alexandra Road, Seaham, Shotton Colliery, Framwelgate Moor, Trimdon Colliery and Chilton Buildings. At the lower end appear further examples of the small centre adjacent to the larger one, whilst in the body of the table and towards the top the emergence of the village centre proper can be seen: Chilton Buildings, Trimdon Colliery and Shotton, for example.

Ranking on the basis of the index causes some change in this pattern. The village centres proper rise and the large settlement neighbourhood centres fall. Gilesgate rises dramatically, this is because of the existence of a few specialist functions (banks) connected with the town's university status. Fishburn has a bank and 2 cooperatives; Chilton Buildings a multiple grocer, a bank and a coop; Cockton Hill has no contribution in its score and only holds its position by the number of non food shops as is nearly the case with Framwelgate Moor. The cooperative store plays an important role throughout in the upgrading of centres.

The functional structure of this level of centre is more complex than that of the D centres. There is nearly always a full range of convenience goods and a few centres have supermarkets. Many have a chemist and nearly all a coop. T.V. and radio shops appear at this level and in about 50% of cases there is a bank. Clothing shops appear very occasionally.

Suburban Centres.B centres

There are 13 in all. The median number of shops is 45, the range is 17 - 78 and the range between the 1st. and 9th. deciles 30 - 74.

Table 9.2.

B centres ranked by shop numbers and by index value

By shop numbers		By index value	
Horden	78	Horden	225
Willington	74	Blackhall	180
Blackhall	62	Wingate	174
Wheatley Hill	49	Willington	169
Wingate	49	Tow Law	110
Coxhoe	40	Wheatley Hill	108
Langley Moor	37	Murton	100
Tow Law	36	Langley Moor	100
Esh Winning	34	Coxhoe	73
Thornley	34	Thornley	63
Murton	32	Coundon	58
Coundon	30	Sedgefield	52
Sedgefield	17	Esh Winning	52

This level of centre is dominated by the free standing centre supplying its own substantial population, or alternatively having a wider central function to cater for the surrounding area, as for example with Sedgefield. Again extremes are interesting: based on shop numbers, Sedgefield has a low rank and has in fact been raised to the B level by the existence of banks and a cooperative store, serving partly a rural population. Coundon, Thornley and Murton are classic examples of large mining settlements with centres which cater largely for their own substantial populations. Horden is a special case of planned decline, being adjacent to Peterlee. Willington has always faced competition from Crook.

The index again causes considerable adjustment in order. Tow Law and Murton both rise, offering two banks each and a number of multiple grocers. Willington has 5 multiple grocers, 2 banks 1 coop and 1 non food multiple. Blackhall offers 3 banks, 4 grocery multiples and a coop. Wingate has 3 banks, 5 grocery multiples and 2 coops. Esh Winning has 2 important cooperative stores, a bank and a grocery multiple.

The functional structure of B centres is more complex again than those of lower rank. In all centres except for Esh Winnig and Murton there are more non-food than food shops. In B centres there is a very full range of convenience goods and a wide but irregular range of durable goods. All centres have a coop and most have electrical shops, T.V. shops and shoe shops are common.

On the basis of the index it is possible to suggest a tentative division into weak and strong centres. This is not easy to justify functionally however, and is not pursued.

Major shopping Centres. A centres

There are 10 in all, with a median number of shops of 100 and a range of 48-214, or 55-174, removing the top and bottom cases (deciles). It is at this level that the two New Towns begin to confuse the analysis, as they appear to have a greater shopping provision than their size would warrant.

Table 9.3.

A centres ranked by shop numbers and index value

By shop numbers			By index value	
Bishop Auckland	214		Bishop Auckland	2625
Durham	174	A1	Durham	2040
Spennymoor	126		Crook	961
Crook	122		Spennymoor	955
Shildon	121		Seaham Harbour	645
Seaham Harbour	82	A2	Peterlee	578
Easington	82		Shildon	476
Peterlee	63		Easington	421
Ferryhill	55		Newton Aycliffe	364
Newton Aycliffe	48		Ferryhill	296

On the basis of these rankings it is possible to suggest a two or three fold division of category A centres. The two fold division into A1 and A2 seems most realistic in functional terms. It is to be noted that assuming that the New Towns deserve their place, then Easington and Ferryhill are two A level centres which in functional terms are doubtful members of this group.

The A1 centres offer a very full range of goods and services indeed. Bishop Auckland has 7 banks, 7 grocery multiples and 12 non-food multiples; Durham has 10 banks, 8 grocery multiples and 12 non-food multiples. Seaham has only 4 banks, 5 grocery multiples and 4 non-food multiples.

In Durham and Bishop Auckland the ratio of non-food shops to food shops is about 5:1. In Ferryhill, Spennymoor, Crook and Seaham it is only 2:1. In Shildon it is nearly 1:1. In the New Towns it is 4:1.

Spennymoor and Crook occupy a rather intermediate position, Spennymoor having 5 banks, 5 grocery multiples and 5 non-food multiples. The functional structure of A2 centres is very diverse indeed, all having full ranges of convenience goods, multiple chemists and some having small department stores, Woolworths, some clothing shops and an occasional multiple tailor.

The A1 centres strengthen the clothing lines, often with more multiple tailors. Furniture, banks, professional services, jewellers and multiple shoe shops are much in evidence.

Regional and Sub regional centres

Table 9.4.

	Centrality Index, Squared
Newcastle	12321
Sunderland	5505
Middlesbrough	5900 +
Stockton	3652 +
Darlington	4230 +

(+ estimated using related measures)

These centres offer the fullest possible range of goods. Newcastle dominates the area, as can be seen from shop numbers, numbers of specialist shops and multiples. Detailed analysis of the structure of these centres is not the concern here.

Summary

It can be argued that the classification system used does appear to produce a ranking and grouping of centres which can be substantiated empirically.

Table 9.5.

Summary of centre classification results

Centre level	Median no. of shops	Range of shop nos.	Range of shop nos. 1-9 decile
Regional/ sub regional	---	300+	------
A level	100	48-214	55-174
B level	45	17-78	30-74
C level	17	7-35	12-35
D level	6	3-22	3-11

Analysis of the spatial pattern of centres

The next stage of the analysis of the Central Place system in South Durham is an analysis of the spatial pattern of centres, using the 'Nearest Neighbour' technique. This is a potentially very powerful technique for the analysis and comparison of spatial patterns. It is possible to use the technique to investigate whether a pattern is random, or whether it tends towards being clustered or towards being uniformly(hexagonally) spaced. The technique has been used by Dacey(1962) and by King (1962) in the United States.

The technique

The method is described in detail by Clark and Evans (1954). The nearest neighbour statistic was devised to help overcome the problem of how to express the nature of a given pattern in mathematical terms, capable of being used for comparison.

The measure is based upon the degree to which the distribution of a given population of individuals departs from what would be expected under the assumption that the population was distributed at random. This raises important boundary problems known to the geographer in many contexts. Here it is assumed that meaningful boundaries have been drawn and that the analysis may proceed.

The nearest neighbour statistic, R, measures the degree to which a population is, at one extreme, clustered, at the other extreme, uniformly spaced, or in between is randomly distributed. The statistic utilises the measure of the distance between every individual in a given population (in this case, centres) and its nearest neighbour in that population. The mean distance to nearest neighbour is then calculated. The ratio of the observed mean distance to nearest neighbour to that mean distance which would be expected if the same population was distributed at random, is the basis of the statistic, R. Significance tests can then be applied to measure the significance of this departure from random.

Expressed mathematically:

$$R = \frac{r_a}{r_e}$$

Where:

$$r_a = \frac{\Sigma \; r}{N}$$

Where:

- r: the distance from each individual to its nearest neighbour
- N: the total number of individuals.
- r_e: can be shown to be equal to:

$$\frac{1}{2.\sqrt{p}}$$

Where:

- p: an expression of density: $\frac{N}{A}$

Where:

N: is as defined above

and A: the area expressed in the same units of measurement as r_a.

Thus:

$$R = \frac{r_a}{r_e} = \frac{\frac{\Sigma r}{N}}{\frac{1}{2.\sqrt{\frac{N}{A}}}}$$

This expression appears in Haggett(1965) in error.

When r_a is as would be expected under the assumption of a random distribution, then it is clear that R = 1.0 . When all points are completely clustered (i.e. are all on one spot), then R = 0.

It can be shown that when all points are uniformly spaced (hexagonally) then R reaches a maximum of 2.1491, (see Clark and Evans, 1954, p.451).

Thus the nearest neighbour statistic represents a continuum of values from R=0 to R= 2.1491, with 1 being a random distribution, values below 1 tending to clustering and values above one to uniformity. In all cases a test of significance must be applied to find out whether or not the deviation from random is statistically significant at any given level.

As a test of significance of the departure of r_a from r_e, the following can be used:

$$c = \frac{r_a - r_e}{\sigma \ r_e}$$

Where:

C: the standard variate of the normal curve, thus enabling the reliability of the estimate of R to be read direct from z tables.

and σr_e can be shown to be:

$$\frac{0.26136}{\sqrt{Np}}$$

Where:

N and p are defined as above.

<u>Application to central place theory</u>

In a perfect Christaller type of Central Place system with a number of hierarchical levels, certain settlements will form a uniform pattern and others will not. To give an example: from the case in point, assume a hierarchy with 4 levels of centre, a,b,c,d, with a the highest and d the lowest rank. The following patterns will be hexagonal:

1. All centres, regardless of rank, with respect to each other. This is the same as saying that all high order centres have a full range of lower order functions. This level will be called abcd.

2. All a,b,andc centres, regardless of rank will be distributed hexagonally with respect to each other.

3. All a and b centres, regardless of rank will be distributed hexagonally with respect to each other.

4. All a level centres will be distributed hexagonally, (though technically higher order centres must be included).

An example of a non hexagonal pattern is: all d level centres, with respect to each other.

<u>Application to County Durham</u>

Tests were made at each of the above four levels for three areas:

1. Both North and South Durham together.

2. North Durham alone.

For the two above areas data collected by Thorpe and by Nadur was utilised in the analysis.

3. South Durham alone.

All measurements were taken throughout in millimetres from a one inch Ordnance Survey map.

1. North and South Durham together

Table 9.6.

	N	r_a (mm.)	r_e (mm.)	p	$r_a - r_e$	c	R	$$
abcd	166	21.14	20.12	.000613	1.02	1.344	1.051	82%
abc	72	31.10	30.67	.000265	0.43	0.229	1.014	18%
ab	35	53.20	43.94	.000129	9.26	2.381	1.210	98.3%
a	15	87.20	67.57	.000055	19.6	2.161	1.291	96.9%

($$: level of confidence that $r_a - r_e$ did not occur by chance).

A = 270,939 sq. mm.

These figures provide an interesting result. Firstly, they show that the average distance to nearest neighbour of the same or greater rank is:

abcd level: 0.832 miles ab level: 2.090 miles
abc level: 1.220 miles a level: 3.430 miles

These low figures for r_a can be explained by a number of factors:

Firstly, because of the way that the statistic is constructed, centres are allowed to pair, to become each other's nearest neighbour. This lowers the average r_a.

Secondly no allowance has been made for an uneven population distribution, which will tend to cause pairing as described above.

Thirdly, distances are straight line distances.

The R statistic shown in the above table is not significantly different from 1 (random) for the two lowest levels of centre (abcd and abc). However, the statistic shows a tendency to increase towards uniformity from the abc level up to the a level: 1.014, 1.210, and 1.291. The last two are significantly different from random, using the .05 significance level and both tend towards a uniform pattern, the A level more strongly. The implications of this are discussed shortly.

North Durham.

Table 9.7.

	N	r_a (mm.)	r_e (mm.)	p	$r_a - r_e$	c	R	$$
abcd	68	22.40	20.88	.000577	1.52	0.420	1.072	32.5%
abc	27	33.52	33.04	.000229	0.48	0.200	1.021	15.8%
ab	13	60.23	47.62	.000110	12.6	1.400	1.265	90-95%+
a	5	113.0	76.78	.000042	36.2	2.010	1.472	90-95%+

($$: level of confidence that $r_a - r_e$ did not occur by chance)
(+ : based on the t statistic, rather than z)
A = 117,894 sq. mm.

The above figures again exhibit the trends noted for the whole area, but more markedly. The R statistic again shows a tendency to increase with centre rank, more markedly than for the entire area. The two lowest levels of centre have a distribution which is not significantly different from random, whilst the two highest levels are, using the .1 significance level with the t distribution and N-1 degrees of freedom. The highest level of centre shows the most marked tendency towards hexagonal spacing.

South Durham

Table 9.8.

	N	r_a (mm.)	r_e (mm.)	p	$r_a - r_e$	c	R	$$
abcd	98	21.18	19.76	.000640	1.42	0.342	1.072	27%
abc	45	29.76	29.16	.000294	0.60	0.115	1.021	---
ab	22	51.41	41.70	.000144	9.71	2.110	1.233	97.5%+
a	10	72.90	61.73	.000065	11.2	1.400	1.181	90%+

($$: level of confidence that $r_a - r_e$ did not occur by chance).
(+: based on the t statistic rather than z)
A: 153.045 sq. mm.

Here in the south the situation is confused somewhat by the insertion of two New Towns into the pattern of a level centres. There are in addition two dubious a level centres: Ferryhill and Easington. Nevertheless, the basic trend appears to emerge again: the higher levels tend towards uniformity and are significantly different from random.

Conclusions

It appears from the results that if a Central Place system based upon the classical model does exist on the ground in County Durham, then it is only the higher levels of centre that are conforming to expectations. The lower level of centres appear to be distributed at random. However, the introduction of the dynamic element could possibly provide a source of explanation for this. The lowest levels of centre will be most closely associated with the 19th. century pattern of mining settlement, which grew up with little or no regard for notions of centrality, depending first and foremost upon coal availability. However, with a large and growing 19th. century population the demand for central services grew, which the lower orders of centres were not able to provide. The complex of forces which determine relative centrality were able to come into play, causing some centres to grow more as would be expected in accord with Central Place Theory. Historically important centres such as Durham and Bishop Auckland appear to have had an advantage whilst other centres were largely 19th. century creations, such as Shildon, Stanley and Consett. The suggestion made here is that there is an emergent Central Place system in County Durham which may well develop more strongly as the influence of the coal industry declines.

Problems

1. One basic problem has not been faced: the Christaller model is here being tested under non-isotropic conditions, i.e. population is not here evenly distributed on the surface to begin with. One solution to this problem would be to employ a map transformation (see: Tobler,1961 and Getis,1963).

2. The efficacy of this method depends upon the accuracy of the classification in picking out the real hierarchical differences.

3. The New Towns in any case distort the basic pattern.

Hypotheses

The following hypotheses can be presented:

1. That there is a hierarchy of central places in County Durham, but it is not deriveable from the postulates of Central Place Theory.

2. That there is a hierarchy of central places in County Durham but the classification system is not adequate.

3. That there is a central place system emerging from the 19th. century settlement pattern, showing most clearly

in the highest levels of centres.

4. That there is no central place system explainable by formal central place models, in County Durham.

On the basis of the preceeding evidence, hypothesis 3 is tentatively accepted. Further investigation is needed, both forward in time and using map transformations.

CHAPTER 10.

CONSUMER MOVEMENT PATTERNS AND THE HIERARCHY.

Consumer movement patterns are now analysed in relation to the system of centres outlined in the previous chapter. Rushton, Golledge and Clark(1967) write of:'the need for conducting further studies in the field of consumer behaviour studies to complement the functional base studies already produced' (p.272). Such a study is developed here, in the general context of the analysis of consumer behaviour in relation to the Central Place model applied to South Durham.

The main theme of this thesis is that of the analysis of spatial patterns of consumer movement, a fairly neglected but important element in Central Place systems.

The general problem underlying the analysis of the demand side of central place systems (i.e. consumer interactions) is that of data availability, which presents a formidable obstacle to study. This work is based upon specially collected data covering a large area of County Durham, thus utilising a source of data in a field where source material is very scarce indeed.

There are in addition a number of problems which relate more specifically to consumer study as well as problems more peculiar to the area. Firstly, wide ranges of goods are included under one heading, such as 'women's clothing'. Secondly there are important scale problems in defining a function. Thirdly, there is the difficult problem of the cooperative store.

Orders of goods

Central Place theory postulates that goods of a similar range will group together at each level of the hierarchy and so provide specialist functions for that level in the group of goods having the longest range. All goods of a lower order (range) than this specialist group will also be supplied at each higher level of the hierarchy and some lower levels. Here an examination is made to find out whether or not it is possible, in terms of consumer travel patterns to relate specific goods to specific hierarchical levels. Golledge, Rushton and Clark(1967) have pointed out that in Iowa:' grouping of central place functions on the basis of travel behaviour produces a different ordering of functions than does grouping on the basis of occurrences of functions'(p.271).

The following table is a basic data matrix relating to South Durham, showing the percentages of the entire population of the area(households) who shop for various goods by which level of the hierarchy is used for each good. This table, table 10.1, is ranked on the basis of percentages using the regional centre for different goods, which gives a general indication of willingness to travel for each good, though overall movement patterns are overlooked.

Two aspects of the same problem are considered: one, the problem of attempting to relate specific goods to specific hierarchical levels and two, that of ordering goods in relation to each other, which becomes more important with interaction models but is also of interest with the general problem of allocating goods to hierarchical levels.

Table 10.1.

Percentage use of centres of different hierarchical levels by households in South Durham

Good	Rank	Centre level				
		Reg	A	B	C	D
Womens Clthg.	1	54.3	36.3	5.8	3.0	0.8
Jewellery	2	47.3	40.3	7.7	3.3	1.4
Childrens Clg.	3	44.7	43.7	7.0	3.5	1.1
Mens Clthg.	4	44.4	45.2	5.7	3.8	0.9
Furniture	5	39.6	48.3	6.9	3.7	1.5
Shoes	6	34.6	49.1	9.3	4.7	1.8
Wash. Machine	7	32.7	51.0	10.2	4.0	2.1
Vac. Cleaner	8	32.0	51.2	9.0	5.1	2.7
t.v.	9	21.6	59.0	10.3	5.4	3.7
Hardware	10	17.3	56.9	14.3	7.7	4.0
Chemist	11	2.6	51.1	18.5	20.2	7.6
Grocery	12	2.5	52.1	19.3	12.9	13.2
Meat	13	2.4	50.0	20.2	13.5	14.1

Table 10.1 reveals that the goods, as defined here, cannot be directly allocated to the hierarchy as marginal hierarchical goods. It is however clear that proportions of goods purchased in lower levels of centre increase progressively down the list. It appears that it is only in chemist, meat and grocery goods that the D and C levels are able to compete effectively with the higher levels of centre. At the same time it must however be remembered that the uneven distribution of population will distort the picture: Bishop Auckland will, for example tend to supply its own large population with both high level goods and with groceries. However, B centres and below do account for 45.5% of grocery sales, compared with only 2% at the regional centres. It is also clear that A centres are very important

for the whole range of goods. Low level centres also supply some high order goods to very small populations.

The relative ordering of goods is perhaps more interesting. The above ranking is compared with that derived from the 3 centres examined in part I. There goods were ranked according to average distance travelled for the purchase of each good, for each settlement. The results of that analysis are here compared with the rather less rigourous form of ranking above.

Table 10.2

Ranking of goods

	Shildon	Murton	Crook	Table 10.1
Jewellery	1	4	2	2
Womens Clothing	2	1	1	1
Childs Clothing	3	5	3	3
Mens Clothing	4	3	5	4
Furniture/carpet	5	2	4	5
Washing Machine	6	8	7	7
Shoes	7	7	6	6
Vacuum Cleaner	8	6	8	8
T.V.	9	9	9	9
Hardware	10	10	10	10
Groceries	11	11	11	12
Chemist goods	12	12	12	11
Meat	-	-	-	13

The Spearman's Rank Correlation Coefficients were calculated to measure the closeness of each of these distributions to each other. These appear below in table 10.3. This table reveals that (i) the 3 centres can reasonably be considered as typical centres in the area and (ii) that Shildon and Crook are'more typical' than Murton.

Table 10.3

Spearman's Rank Correlation Coefficients

	Shildon	Murton	Crook	Table 10.1
Shildon	+	.876	.973	.979
Murton		+	.897	.910
Crook			+	.979
Table 10.1				+

Another interesting feature is that it is possible to reduce the results from the three centres, as has been seen in part I, into 3 or 4 categories of good. This was on the basis that although the ranking of goods does change from settlement to settlement, at no time does a good cross the broken lines shown in table 10.2. It seems that these divisions can be extended into the fourth column without upsetting this pattern. It is now tempting to allocate these 4 classes of good to each of the 4 hierarchical levels in the analysis, but table 10.1 suggests that this is unwise. There can be at least two alternative explanations for this: either the goods as defined here cannot be related to the hierarchy,or alternatively that this ordering of goods is meaningful but the situation on the ground in County Durham is confused by other factors. These could include:(i) the traditional immobility in the area, which will tend to encourage limited provision of high order functions at low levels (the general store is common),(ii) related to (i), the cooperative store has the same effect. However, both of these factors are gradually changing, with greater mobility and rationalisation of cooperatives.(iii) the uneven population distribution will tend to give the larger centres a distributional advantage.

Thus the allocation of the 4 classes in table 10.2 to the four hierarchical levels,(with jewellery and women's clothing possibly classed as regional centre goods), cannot be fully accepted. It is more reasonable to suggest that these classes represent the goods in which each of the four levels of centre is able to retain proportionally most of its own trade, though even this begins to break down.

In the centres, it is the D level of centre which is dominated by food shops, with dispensing chemists in some centres. In C centres T.V. shops begin to appear along with ironmongers. Shoe shops are a regular feature of B centres, particularly where the cooperative store is large. In the weak A centres electrical appliance sales become important, whilst strong A centres have clothing shops and furniture shops well in evidence; here the multiple tailors appear. Women's clothing can perhaps best of all the goods be classed as a regional centre good. This may also be the case for jewellery, though this good has probably been confused partly with fancy goods. Women's clothing was specified in the survey with a lower price limit to exclude everyday purchases.

The nearest centre hypothesis

It is one of the postulates of formal central place theory that consumers will travel to the nearest centre which offers the particular good in demand. Ways in which this highly deterministic assumption can be relaxed are examined briefly in the next part of the thesis.

This postulate is here examined by the selection of 11 settlements (based on re-constituted ward data), to examine movement patterns of the inhabitants of these settlements for 4 goods. The aim was to examine what percentage of the population of each settlement used the nearest available centre to purchase each good. Under the assumptions of formal theory it should be 100%.

The settlements were selected purposively, to take a cross section of settlement types in the area. This non-random selection should not affect the result for the postulate should apply equally to all settlements in the area.

The 4 goods examined are groceries, butcher's meat, hardware and men's clothing. In order to overcome the difficult problem of defining realistically what is the nearest alternative, the assumption was made that meat and groceries were available at all levels of centre, hardware at level C and above and mens clothing at level A and above only. Throughout, an indifference zone was allowed: if there was another alternative centre lying within a radial zone .5km further out from the settlement in question than the nearest centre,then interaction with this centre lying in the 'indifference zone' was added to the nearest centre interaction. Mobile shops are included as nearest centre purchase.

The results of the analysis are shown in table A 28. From this table, it does seem that the nearest centre postulate does appear to hold fairly well for the two convenience goods, more so indeed than Clark (1968) working in New Zealand found, with 63.1% for groceries and 52.1% for meat(within his indifference zone). Here the proportions are 92% and 91%,respectively. The closeness of the column totals for nearest centre and indifference zone show that in spite of the frequency of occurrence of these low level functions, the nearest centre is usually chosen. The lowest individual figures are for Sherburn and Brandon, both very close to Durham City. Cassop and Kelloe, more isolated, show better results.

However, with hardware purchase this begins to break down, with only 53% of purchases being made inside the indifference zone and 47% going elsewhere. It is mainly the larger centres that take this 'elsewhere' trade.

With men's clothing the situation is even worse. Only 22% shop at the nearest centre and 78% go elsewhere, mainly to larger and more distant centres.

Thus the nearest centre hypothesis fundamental to formal Central Place theory can only be said to hold for convenience goods and even then not completely. For durable goods an important probability element seems to have entered the situation, in which size of centre and distance have become very important.

Effective populations and Thresholds

Berry and Garrison(1958b) have pointed out that an underlying principle in Central Place theory is the notion of the threshold of a function, which is the lower limit of the range. The threshold is usually defined as the amount of sales necessary and available for the support of one functional unit (the first functional unit) supplying a particular function. This amount can be represented by a regular shape on an isotropic surface. In terms of the cost revenue balance of the individual unit, the threshold is the minimum level of sales required to cover costs plus normal profits included as a cost, for one establishment. The threshold is inversely related to the frequency of occurrence of different functional types in a given landscape , which in turn reflects upon their spacing. The lower the threshold of a function, the more frequently will that function appear in a given landscape. Garner (1966) has expressed this relationship formally, using a system of inequalities.

In a perfect system, with free entry, all firms are operating at threshold size, excess profits do not enter the system. Berry and Garrison (1958a) derive from an empirical study a hierarchy based upon the lowest point of entry of different functional units, related to settlement size. They found that the relationship between the number of establishments (E) of a particular function and the settlement population size(P) could be described by the equation:

$$P = ab^E$$

or, in linear form:

$$\log P = \log a + E \log b$$

By extrapolation, they found P where E = 1. However, they only used the populations of the settlements concerned instead of available purchasing power and they further did not incorporate hinterland populations.

The problem of attempting to locate thresholds is encountered frequently and is an important element in the understanding of any Central Place system. Threholds have not yet been satisfactorily located in any system. This has led Haggett and Gunawardena (1964) to suggest that there is an 'entry zone' of threshold values, with a range of tolerance before a function will actually appear or disappear. They propose a bioassay method to find the mid point of this zone. This is intuitively an attractive idea, but cannot be incorporated into the rigourously defined system, with free entry, no overlapping trade areas and no excess profits; in this system there must be an absolute minimum, a zone would throw the system spatially out of gear.

Here an analysis is made of the 'effective population' supporting each centre, which is the household population actually using a centre for a given good, from which tentative ideas about threshold can be derived. Theoretical and practical difficulties prevent more rigourous analysis.

Now familiar problems of definition return: has a grocery supermarket the same threshold as a corner grocery shop?, and so on. For food goods as a whole the following figures are interesting:

Table 10.4

Proportions of customers(households) to one food shop

A centres	140:1
B centres	66.7:1
C centres	51.3:1
D centres	49.0:1

These figures correspond to the findings of Clark (1968), that individual functional units are more attractive in higher levels of centre than in lower levels. This does not conform with strict theoretical ideas. Diagram 26 shows effective populations for a number of goods for centres in South Durham.

As far as centres are concerned, the diagram reveals that the patterns of centres produced tends towards what would be expected under central place theory. The column showing interaction for all durable goods should theoretically appear something like it does, with centres of the same rank appearing closer to each other than to those of other ranks. Analysis of variance on the population totals supported by each of the 4 classes of centre reveals that the groups are significantly different, at the .05 level.

Thus the classification of centres is, in a general way substantiated by the consumer movement analysis. The approximate lower and upper limits of populations (households) supported for the purchase of durable goods is as follows:

Strong A	over 6500	C	less than 600
Weak A	1500 - 6500	D	occasional sales
B	550 - 1200		

However, with threshold applied to individual goods the picture is less satisfactory. In an ideal system an A level centre should sell groceries to the same size (threshold size) of population as a D level centre. Garner (1966) has argued for the relaxation of this notion. It is in fact clear that centres tend to have larger numbers of lower order shops than higher order shops, and that relative numbers are related to thresholds. The uneven distribution of population and economies of scale in retailing are some of the main causes of this departure from the theoretical pattern, not to mention the difficult problem of definition of a function.

The column showing effective populations for groceries seems to indicate that threshold does vary with centre rank: this is in accord with the findings of Clark (1968): ' Although onecan reject the hypothesis that the ranges of the same good distributed from different heirarchical levels of business centres do not differ, this does not mean that there is no order in spatial behaviour. There is already evidence that consumers carry out several purchases on one trip or visit business centres from a base other than household residence'(p.396). It can be seen that the diagram shows this tendency for individual goods, that there is no clustering around one threshold.

If the concept of threshold is applied to clasees of centre instead of functions then each of the classes can be seen to form a more or less compact group, particularly in the 'all durables' case. However it seems that excess profits have entered the system as the clusters within a class are spread over a range of population values.

If it can be accepted that the central place model can be distorted by variations in population density and differing levels of retail efficiency then the general outline of the hierarchical classification used does seem to be in order.

Many of the centres noted in the previous chapter as extremes within the centre classification do appear here on the consumption side. Ferryhill and Easington always appear as A centres with a low effective population, as do the New Towns. Horden, Wheatley Hill and Wingate and Willington appear continually in the top ranks of the B centres, with

Sedgefield at the bottom. Esh Winning does unexpectedly well in some goods. Shotton, Cornforth and Chilton Buildings appear as strong C centres whilst the Ferryhill outlying centres do badly. Sherburn always does well as a D centre in all of the columns. Thus there does seem to be some clear correspondence between the results from the two surveys.

Theoretical and practical problems concerned with the concept of threshold.

Some of the problems have already been outlined, here a review and extension is made.

1. There are very considerable problems of definition, of functions and of goods. Scale problems are particularly acute.

2. Functional thresholds are in any case extremely complex, and problems of scale again enter. Laulajainen(1968) has investigated a number of related hypotheses in Finland. These were:

(i) that maximum sized establishments are more common in higher than lower class centres.

(ii) that the average size of establishment is larger in higher than lower class centres.

(iii) that threshold sized establishments are more common in lower than higher class centres, and

(iv) that more polyopolistic competition in higher rather than lower class centres tends to reduce the average establishment size.

He found that (i) and (iii) were impossible to test for statistical reasons, that (ii) seemed to hold and he tried to formulate the nature of the relationship and (iv) seemed to hold for cooperative stores.

3. Traditional immobility in the area has made the general store a common occurrence, making it possible to purchase very high order items at a very low level of centre without it being necessarily possible to define the existence of a functional unit.

4. The cooperative store has a similar distorting influence,

5. The area has undergone and is still undergoing rapid economic and social changes. The tertiary sector always follows these changes with a delayed response.

6. It appears from studies elsewhere, as well as here, that consumer willingness to travel is different for the same function at different hierarchical levels. This is to say that the range of a good varies according to the hierarchical level at which it is obtained, which reflects directly upon threshold, which is the inner range.

It seems possible to suggest that a number of changes in the area may well serve to modify the system and help create a more 'logical' central place system:

1. It seems likely that there will be a lessening of immobility in the area for various economic and social reasons. This will encourage people to travel more for higher order goods and the general store should decline in numbers.

2. Not unrelated to 1. above, is the factor of rationalisation of the cooperatives in the area.

3. The retreat from an intensive mining economy will change the apparent pattern of population to a more even distribution within the area.

However, over and above these problems the measurement of threshold has remained elusive and has usually been derived by extrapolation. Here data limitations prevent further analysis.

The general accordance between the ranking of centres and populations served has been demonstrated. D centres do drop out of the system for higher order goods, and a good deal of overlap does take place within individual goods, as it in theory should. The column showing all durable goods in Diagram 26 is distributed fairly well in accord with expectations under Central Place theory and alternative class divisions are tentatively shown. Excess profits do clearly enter the system and ranges of goods do seem to be related to the level of centre used. Alternative models are implied.

CHAPTER 11

MOVEMENT PATTERNS AND HIERARCHICAL LEVELS

This chapter deals with the observed fields of movement of consumers in South Durham. Two aspects relevant to Central Place theory are examined: the distance decay function and trade areas.

The distance decay function

Full discussion of the concept of the distance decay function is reserved for the next part of the thesis. Here it is introduced as a concept to be used in an essentially empirical manner. It centres around the use of probability notions in explanation of patterns of movement. The concept is based upon the observation that the probability of interaction with a given centre declines with increasing distance from that centre. The rate of decline is the functional relationship between interaction probability and distance. A number of standard functions have been fitted to interaction data by certain research workers in an attempt to generalise about patterns of interaction.

The fact that distance decay appears to exist in reality raises theoretical problems for Central Place theory in its unmodified form.

Formal Central Place theory has the concept of range near its heart. The range of a goods is defined as the upper limit of distance beyond which consumers are not prepared to travel for the purchase of a good. This arises because the cost of the good to the consumer is calculated to be the purchase price at point of sale, plus the cost of travel for the consumer to that point, which is a variable cost. At some point on the rising cost curve for a good a consumer will no longer be prepared to travel for the purchase of the good. This point is termed the range, and will determine the boundary of the trade area for the good in question. As no areas can be left unserved and because consumers will only shop at the nearest available source the spacing of centres of a given heirarchical level will also be determined. Under formal theory it is not strictly possible to introduce the notion of distance decay in the sense that the probability of using a centre declines with distance, as it does not. In the sense that increasing proportions of a centre's total served population are included at increasing miles distance from the centre; but at a decreasing rate, the concept does hold, but this is not strictly speaking what the distance decay function represents. The next part of the thesisbriefly investigates theoretical possibilities of incorporating probability notions into Central Place theory.

Since trade areas cannot overlap(theoretically) and no area can be left unserved and movement minimisation underlies the theory it follows that trade areas will be as near circular as is possible within the constraints of the packing problem. The optimal trade area shape is thus the hexagon.

It is, however very evident that consumers do have a real choice of centre which they can visit. Trade areas do thus interpenetrate, as Thorpe and Nader(1968) show, in

North Durham. The purpose of this chapter is to investigate the nature of this interpenetration of trade areas, which is in turn based upon the existence of the distance decay function in reality. Central Place notions are incorporated within probability concepts to help explain empirical observations.

What follows is an empirical analysis of movement patterns at each hierarchical level, to be placed against the postulates of Central Place theory; by necessity, probability notions are introduced.

Distance decay around centres of different hierarchical levels in South Durham is examined below.

Regional centres

Surrounding South Durham there are a number of regional and sub-regional centres which draw trade from the area. Diagram 27 shows the regional and sub-regional centres which enter into this part of the analysis, in addition to the A centres, considered next.

Orientation to regional centres is examined for 2 cases: that of a regional centre level good, women's clothing, and that of all durable goods, considered together. Theoretically, for a regional centre good, the probability of interaction with the nearest regional centre should not decrease with distance and regional centre trade areas should not overlap. Diagram 28 reveals that the case is rather one in which percentage use of the regional centre for all durables is considerably lower at all distances than the percentage use for women's clothing, which is as would be expected in modifying probability notions with Central Place notions.

Nadur (1967) observed that there seemed to be a tendency for regional centre competition to be at a fairly constant level over distances between 9 and 15 miles from regional centres, at a level of about 50% for regional centre goods and 35% for all durables. Diagram 28 shows the case for increasing miles radius from Newcastle and Teeside when these two centres are considered alone. Any wards showing a greater percentage use of Sunderland or Darlington were not included. Diagram 29 shows the percentage use of Sunderland plus Newcastle and of Teeside plus Darlington at increasing miles radius from a point mid way between each pair. Throughout this analysis geometric distance is used whilst it is accepted that other measures of distance are possible and even perhaps more desireable. This point is taken up again in the next part of the thesis.

These two diagrams reveal that patterns of interaction do conform to expectations under the distance decay hypothesis, in that regional centres are most strongly attractive for the regional centre good, at all distances. It is also noticeable that the northern plateau of purchase intensity fails to be maintained and falls away. It must however be noted that in neither diagram do regional centre interactions fall below 29%, for regional centre goods, whilst the minimum is lower for all durables, at 17%.

A further interesting feature is that the use of Teeside and of Teeside plus Darlington falls off much more rapidly than does the use of the northern centres. The consequence is that the line of equal competition between northern and southern centres is offset well to the south of the County. It is possible to introduce explanation for this: firstly, Newcastle is larger than the combined centres of Stockton and Middlesbrough. Under Central Place theory this would make no difference to the areas of interaction as both supply full ranges of goods, but here it seems that willingness to travel is closely related to centre size. Secondly, Teeside is separated from the coalfield area of County Durham by an intervening area of a relatively sparsely populated nature and an agricultural economy. It is possible to suggest that there is a cultural divide here which tends to induce the idea that Teeside is further away from any point inside the coalfield than it in reality is. There could well be an effect caused by differential perception of opportunities.

There is also a very considerable area of interpenetration. If a 2½% cut-off point is taken (below this purchases being considered random), then the area of overlap covers large areas of South Durham.

A level centres

These centres are treated as two groups, on the basis of the foregoing analysis, weak and strong A centres. Distance decay is examined for 4 cases: 1 low order good, chemists goods; 1 'A level' good, men's clothing; 1 regional level good, women's clothing, and for all durable goods. Diagram 30 gives an indication of what could theoretically be expected, supplementing probability notions with Central Place notions, for each of the four goods.

(i) Strong A centres

Diagram 31 shows the distance decay curves for all 4 goods, at increasing miles radius around Bishop Auckland and

Durham City. This diagram reveals that actual rates of interaction decline for the different goods are generally in accord with what could be expected under theoretical assumptions.

(i) Chemists goods, the low order good, shows high interaction percentages at close distances but falls off more rapidly than any of the other goods. Chemists goods are supplied also at lower order centres lying usually within 2 to 4 miles radius of the A centres.

(ii) Men's clothing, a typical A level good, also conforms to expectations in that at most levels up to 7 miles it has a higher percentage interaction than any of the other goods.

(iii) All durables: this curve shows that on average, these 2 centres exert an influence which is strong but falling, over a distance of 0 to 7 miles and beyond 7 miles interaction is rather spasmodic, as the factors of detailed local accessibility and competition weigh very heavily.

(iv) Women's clothing. This reveals that regional centre competition is experienced even relatively close to the A level centres, for this good.

Certain irregularities in these curves can be explained: the curves for Durham City show a marked upward swing at about 4 miles radius. This arises mainly because of the unusually heavy dependence of the densely populated area to the west of Durham, which lacks its own large centre. An upswing in the curves for Bishop Auckland at about 4 miles can possibly be explained by the inclusion of rural areas to the west, at this radius, which have rather different movement patterns from the coalfield area.

The overlap of movement fields, as illustrated by

Diagram 32, is very considerable. For all durable goods, the level of A centre competition between Durham and Bishop Auckland ensures that nowhere does the use of an A level centre fall below 27%. For low order goods this minimum is of course much lower.

The general shape of the curves is interesting: they tend to fall steeply and have long tails. Thus the relationship between interaction and distance is not a simple linear one. The shape of the curves suggest a Pareto or an exponential function; this point is taken up again later, in more detail.

Weak A level centres

The weak A level centres here included are: Crook, Shildon, Seaham and Spennymoor. The New Towns are treated separately. Diagram 33 shows the basic distance decay curves for these centres: two are selected from the four as examples. Expected trends appear, chemists goods have high interaction over short distances but fall off very rapidly; washing machines, a weak A level centre type of good, have consistently higher levels of interaction over space than do all durables considered together and women's clothing purchase shows low levels of interaction throughout.

It can also be seen that the influence of these centres over space is considerably less than the influence of the strong A centres.

It is difficult to conceive of overlap in this two dimensional diagram, where centres only exhibit noticeable influence up to 4 miles, so that analysis of interpenetration is reserved for trade area analysis.

New Towns

The decline in interaction with Peterlee and Newton Aycliffe over distance is as follows:

Table 11.1

% Interaction at increasing miles radius from: miles:	0-1	1-2	2-3	3-4	4-5
Peterlee					
Chemists goods	90	6	1	0	0
Washing machine	15	12	2	1	0
All durables	24	17	2	0	0
Newton Aycliffe					
Chemist goods	92	0	0	0	0
Washing machine	41	0	3	0	0
All durables	37	0	0	0	0

It is clear that the attractive power of the New Towns is very limited indeed, though Peterlee is able to attract some trade from Horden. With grocery purchase, Peterlee is able to attract trade from Horden in small measure but retains 82% of its own trade, whilst Newton Aycliffe retains 86%. Differences do lie within these figures, however. Peterlee has 5 neighbourhood centres and Newton Aycliffe only 2. 73% of the population of Peterlee which purchases groceries within Peterlee itself uses the main centre and 27% the neighbourhood centres. In Newton Aycliffe the corresponding figures are 91% and 9%.

Competition

Distance decay arises because of interpenetrating competition. For A level centres, 3 types of competition can be defined: Competition from regional centres, from other A centres and from B,C and D centres. The intensity of competition from each of these three sources varies from good to good as well as over distance. The nature of this competition for certain goods, for strong A level centres, was examined and the results appear in Table A 29. Competition from regional centres is strongest for regional centre types of goods and is almost non existent for groceries. Regional centre competition varies least over distance of all three types of competition. Other A centre competition increases outwards from the given centre, as the spacing of A level centres is fairly regular. Lower level centres compete most effectively in lower order goods; and this tends to occur at distances of 2 to 4 miles from these centres. Thus competition can be seen to be a fairly complex phenomenon.

B level centres

B level centres face very severe competition indeed, particularly from A and Regional level centres. 3 examples are here presented in table 11.2.

Table 11.2

% interaction with certain centres at increasing miles radius.

	0-1	1-2	2-3	3-
Willington				
Groceries	73	6	0	0
Men's Clthg.	11	0	0	0
Women's Clthg.	7	0	0	0
T.V.	36	11	1	1
Hardware	43	6	0	0
All durables	30	7	2	0
Wheatley Hill				
Groceries	92	34	0	0
Men's Clthg.	40	15	1	1
Women's Clthg.	40	11	1	1
T.V.	26	14	0	1
Hardware	77	33	3	3
All durables	42	18	1	3

Table 11.2 (cont.d')

	0-1	1-2	2-3	3-
Blackhall				
Groceries	64	0	0	0
Men's clothing	27	0	0	0
Women's Clthg.	27	0	0	0
T.V.	32	1	1	1
Hardware	45	2	0	0
All durables	29	2	1	0

An alternative means of analysing the type of good in which this level of centre competes most effectively is to examine the percentage of households served for each good which live within 1 mile radius. This was done for 6 centres, the three above, plus Tow Law, Sedgefield and Murton.

Table 11.3

% of households served by 6 B level centres which live within 1 mile radius of that centre

Chemist Goods:89%	Jewellery:21%
Groceries:79%	Furniture:21%
Meat:75%	Men's Clothing:18%
Shoes:48%	Women's Clothing:16%
T.V.:23%	Average, durables:26%

It can be seen from these tables that it is only in convenience goods that B level centres compete strongly. With durable goods they are most competitive in the lower order goods. It is clear that the ability of B level centres to compete is related directly to the ranges of the goods in question.

C level centres

This level of centre is only able to dominate the most immediately surrounding area for convenience goods, though some of the larger level C centres supply up to

35% of households within 1 mile radius with the lowest orders of durable goods. The following table indicates the importance of the range of the good in question in determining the influence of the centre, over space.

Table 11.4.

% of households served living within 1 mile radius of each of 6 C level centres.

Groceries: 74%	T.V. : 11%
Meat: 71%	Hardware: 30%
Women's clothing: 9%	All durables: 16%
Shoes: 20%	

It is difficult to talk of distance decay at this level of measurement.

D level centres

These are almost exclusively convenience goods centres, though the presence of a cooperative store confuses the picture in some areas. The largest free standing centres of this level, such as Bowburn or Brandon are able to retain about 50% of their own convenience goods trade. Such measurement is rather more difficult for neighbourhood centres within larger settlements. D level centres with a large cooperative are able to retain some very low order durable goods purchase, such as hardware, as well as occasional purchases of higher order goods.

Distance decay is treated theoretically in the next part of this thesis.

Trade Areas

Analysis of trade areas follows from the preceeding discussion of observed distance decay functions.

Central Place theory postulates that trade areas should be hexagonal, should not overlap and should leave no area unserved. This here is clearly not the case.

Trade areas have usually been defined in a number of ways:

(1) On the basis of accessibilty, as for example in Green's (1948) work, using bus routes.

(2) As an area which contains a certain proportion of a centre's total trade. Applebaum and Cohen(1961) provide examples of these definitions.

(3) The area for which the centre is the dominant supplier of a good or goods. This is termed the Umland, after work by Godlund (1954).

Recently Huff(1964) has argued for the construction of trade areas from interaction probability surfaces. This question is developed more fully in the next part of the thesis. Here, the areal extent of empirically derived interaction probability is examined and trade areas are defined on the basis of (3) above, which represents a first step towards the construction of interaction surfaces. The theoretical construction of Umland boundaries is taken up in more detail in the next part of the thesis; it is in fact shown in Diagram 67.

The base map used in the following analysis is the ward and parish map (hereafter termed 'ward map') shown in Diagram 24, where South Durham (treated here) is differentiated from North Durham.

Regional centres.

The following are identified as Regional and sub regional centres which enter the analysis: Newcastle, Sunderland, Teesside, Darlington and Hartlepools.

The main point of interest at this level is the umland boundaries between north and south. Diagram 34 shows percentage interaction with Newcastle and Sunderland for women's clothing and for all durables. This reveals that the regional centre good has wider and more intense interaction fields than other goods. The high interaction level in the north east corner of the area is because of the proximity of Newcastle and especially Sunderland. Interaction falls off regularly with distance, with the apparent exception of the Bishop Auckland area, which tends to interact more with Newcastle and Sunderland than might be expected for women's clothing. This is possibly a factor of the social status of the area, as Durham City also exhibits a similar trend. Transport links are also probably important. Diagram 35 shows percentage use of the southern centres. This reveals a much more rapid decline in interaction than is the case with the northern centres, which partly obscures the differences between all durable and regional centre goods patterns. There are considerable areas of overlap with interaction northwards. The most heavily shaded area in the south and east is largely rural and exhibits a very heavy dependence upon Teesside.

Umland boundaries have been drawn for movements to regional centres alone, and are shown in Diagram 36. The umland boundary lies well to the south, for reasons already discussed. In the case of women's clothing the umland boundary has a more southerly displacement than is the case for all durable goods, reflecting Newcastle's very strong position in the area as a regional goods centre. The umland of Hartlepools actually disappears. Many places lie within the umland of Newcastle but are in fact closer to Sunderland. The greater size of Newcastle and the importance of the north-south communications axis serve to extend the influence of Newcastle.

A level centres.

Strong A level centres

Diagram 37 shows various defined fields for Durham and for Bishop Auckland. On the diagram where both appear together the shading nowhere overlaps. For food purchase, intensive interaction near to the centre with very rapid decline is clearly visible, over space. Durables show a more gentle decline with distance. There are considerable areas of overlap of fields of movement for durable goods. The diagrams show that interaction fields with Bishop Auckland are more extensive than those with Durham, as well as being more intensive near to the centre. It can also be seen that Durham's field of influence extends more in an east-west direction than in a southerly (and northerly, as indicated by Nadur) direction. It is the important north south transport axis which partly causes this distortion.

Weak A level centres

The movement fields to these centres are shown in Diagram 38. Most of the fields here shown overlap partly with the fields of the strong A centres, and both overlap with regional centre movement fields. In some cases there is even interpenetration amongst the weak A level centres themselves. Food purchases show intense localised movement and durables more extensive movement fields. Diagram 38 shows movement fields for a single good, washing machines, revealing an even more intense and widespread interaction field than was the case for all durables.

The poorly developed position of the New Towns can be seen clearly. Diagram 39 shows umlands plotted for A centres, using patterns of movement for electrical appliance purchase. Teeside was included in this Diagram because of its dominance over all A centres even for appliances, in areas in the extreme south. Ferryhill and Easington are included in this diagram. Sunderland also dominated completely the north east corner. Umlands of B level centres are also shown, based upon either T.V. or hardware purchase, whichever was larger. Coundon and Sedgefield fail to exhibit an umland. Easington and Ferryhill have umlands the size of B level centres, and Peterlee disappears.

Using a very approximate measure of trade area size, based upon:longest axis x shortest axis/ 2 = diameter, the following results were obtained as trade area diameters:

Table 11.5

	Trade area diameters	
Bishop Auckland	8.0	(miles)
Durham	9.0	
Shildon	2.3	
Spennymoor	3.5	
Crook	3.5	
Seaham	2.5	
Newton Aycliffe	2.0	
Easington	2.0	

(These diameters should be treated with caution as they do not represent a unique solution)

For B level centres, the average diameter was usually less than 2 miles.

B level centres

The location of these centres can be seen from Diagram 40 which can be used in conjunction with Diagram 41 which shows their movement fields. There is some shading overlap on these diagrams. Movement fields for food goods are very intense near to the centre but fall off extremely rapidly. Movement fields for T.V. purchase are wider, but not so intense; Sedgefield disappears completely; only in two instances does purchase intensity rise over 50% - in Langley Moor and in Esh Winning. The intensity of purchase of televisions is not so intense near to each centre as is appliance purchase near to each centre at the A level; thus both field intensity and extent are declining in lower levels.

C level centres

Interaction fields for chosen C centres are shown in Diagram 42, which relate to the C centres shown in Diagram 40. Here, even intensive localised food purchase is beginning to diminish, as can be seen in Carrville, West Auckland and Howden, though the stronger free standing centres are able to retain most of their own food trade. Durable purchase is very limited in areal extent at this level, being dominated by low order goods. Movement fields usually do not exceed 1 mile radius.

D centres

It is not possible to construct umlands for D level centres at this level of data. There are additional problems in that some D level centres are not free standing centres but are neighbourhood centres in larger settlements. Here centres tend to serve adjacent housing areas, having very circumscribed intensive trade areas indeed. Food goods and newspapers are sold at this level.

General

Trade areas can thus be seen to be complex phenomena with very considerable interpenetration, raising serious problems for the application of formal central place theory. Nevertheless certain important notions derived from central place theory do appear to assist in the interpretation of these complex phenomena.

Thesis part II - Conclusion

This part of the thesis has drawn upon empirical data gathered in two separate and extensive surveys undertaken by the author in southern County Durham. One set of material concerned the nature of shopping centres, the other the size and direction of consumer movements to these centres throughout South Durham.

The aim was to examine the system of central places and consumer movements in the area. Certain specific postulates of Central Place theory were examined and tested against empirical data. In part the work parallels, but more importantly it extends, the sort of analysis undertaken by Nadur (1967) in the northern half of the County.

It has been possible to identify a close correspondence between patterns of provision of goods and the patterns of consumer movement in this area. It has also been shown that the use of various central place notions, such as hierarchy, size related trade areas and ranges of goods and possibly even threshold, have value in the analysis of empirical data.

However, when the strict theoretical postulates of formal central place theory are imposed upon the system, the applicability of the model begins to break down, though certain features do continue to conform to expectations, as has been seen. Thus the researcher is faced with a number of alternatives:

(1) to assume that there is a system of central places and consumers in this area of North Eastern England, which would be found to conform more closely to the postulates of formal Central Place theory if better classifications, definitions and tools of analysis were employed.

(2) to assume that the historical and cultural factors in this area have been important in causing distortion in an otherwise more regular central place system, and that as these influences diminish in influence, a more 'normal' system will emerge.

(3) to assume that there is as yet an unidentified, or rather, unformalised, system of central places and consumers in the area which can be described by a different model, other than the formal Central Place model. This is an attractive alternative, though the problems which it raises are considerable. The Central Place model as formally stated has the important advantage that it is theoretically deriveable from a set of definitions and

assumptions; it is a static equilibrium model, which is a serious disadvantage, despite being a simplifying factor. Any new model would certainly have to be both a dynamic and a non-equilibrium model of a highly complex nature and very difficult to operationalise, for testing.

(4) To attempt to modify the Central Place model, possibly by the introduction of probability notions. This theoretical possibility is briefly explored in the next part of the thesis. In this chapter Central Place ideas have been partly integrated with a probability approach in an attempt to explain observed patterns. Modification of the Central Place model is intuitively attractive in that consumer behaviour clearly cannot be regarded in the way that Central Place theory demands (i.e. that there should be an 'explicit extremisation of behaviour') which means that the expectation must be that of the behaviour of a completely rational economic man, yet Central Place theory does provide a logically integrated theoretical base which is not easily replaceable. Modification is an attractive alternative solution.

(5) to attempt to explain observed patterns by employing an alternative model. There have been many features observed in the data, both in parts I and II of the thesis which seem to suggest that a probability model would better explain observed patterns.

This latter course is taken in the final part of this thesis. An attempt is made to examine the theoretical bases and limitations of certain interaction models and to use the collected data to conduct a thoroughgoing examination of the performance and the weaknesses of the models, as well as using a model as a tool of geographical analysis. Gravity models in particular are used widely, but very few rigorous tests of their power and performance are made, largely because of problems of data availability. It is against a firm theoretical background that a number of interaction models are examined and rigorous testing is carried out upon two such models.

The Central Place model is not rejected completely. At worst, certain concepts used in the theory are useful when employed in analysis of central places and movement fields; at best, the main problems to be overcome are merely operational ones. It can be repeated that in common with most other analyses the central place model here tested has been tested under conditions for which it was not designed : the condition of an isotropic surface was not fulfilled.

Clark(1968), testing formal hypotheses derived from Central Place theory writes: ' Although we can reject the hypothesis that the ranges of the same good distributed from different levels of business centre do not differ, this does not mean that there is no order in spatial behaviour'(p.396).

PART III.

PART III

INTRODUCTION:

The partial breakdown of the Central Place model in explaining patterns of consumer movement in South Durham suggests a search for an alternative explanatory model.

For a number of reasons it was decided to develop the analysis with the use of a gravity model.

Firstly, gravity models are becoming increasingly popular as planning tools, despite their considerable theoretical weaknesses. A review and examination of the present state of development in the use of these models is presented.

Secondly, the large body of consumer movement data covering an extensive area is utilised to provide a thorough test of the power of the gravity model. For reasons of data availability this sort of exercise is not usually undertaken.

Thirdly, the model is employed as a tool to 'explain' empirically observed movement patterns in County Durham.

Lastly, tentative ideas on the future theoretical developments are extended in certain places, particularly with respect to the idea of development of general theory from both Central Place and probability constructs.

The general outline of this part of the thesis is as follows:

Firstly a thorough review is made of the development of the gravity model and the theoretical problems which it introduces.

Secondly, important practical and operational problems are discussed.

Thirdly a gravity model is used as a tool of analysis for the empirical data on consumer movement. The work undertaken in this respect is outlined at the beginning of Chapter 15.

CHAPTER 12

THE DEVELOPMENT OF THE GRAVITY MODEL: FIRST GENERATION MODELS.

Introduction

In very general terms the 'gravity' concept of human interaction postulates that there is an interactive force between two areas of human activity, which is created by the population 'masses' of the two areas. It is also postulated that the intervening space between the two masses has a frictional effect upon interaction, operating against the attractive force. More specifically, interaction between two centres of population varies directly with some function of population size and inversely with some function of the distance between them. This can be expressed mathematically:

$$I_{ij} = \frac{f(P_i, P_j)}{f(D_{ij})} \qquad \ldots\ldots(1)$$

Where:

I_{ij} : the interaction between centre i and centre j.
P_i, P_j : the population of area i and j
D_{ij} : the distance between i and j.

This is frequently written less rigourously:

$$I_{ij} = G.\ \frac{P_i . P_j}{D_{ij}} \qquad \ldots\ldots(2)$$

Where:

G: a constant.

It should be noted that the gravity concept of human interaction developed analagously to the Newtonian Laws of Gravitation. The development of this concept to explain human interaction will be reviewed in this and the following two chapters, but first a derivation of the above formulation is presented, based simply upon probability principles. Although the derivation of the gravity concept was originally analagous, it can be shown to hold in logical terms alone, using the language of probability. This is done by Isard(1960) and Olsson(1965a).

A probability derivation.

Take a region with a population P, which is divided into many subareas. The total number of individual trips taken by inhabitants is T. There are no significant differences in tastes, incomes, occupations and other socio-economic factors amongst subareas. Suppose that one wishes to determine the number of trips which originate in subarea i and terminate in subarea j. Assume, for the moment that the friction of distance (i.e. the cost of travelling or the time loss) is zero. It can then be assumed that for an individual in i, the number of journeys terminating in j will be P_j/P. It is possible to state this in terms of the total number of trips by first estimating the average per capita number of trips: T/P, which will be called k, and then $k(P_j/P)$ represents the actual number of trips made by an individual in i to j. It is then possible to multiply the number of individuals in i by this expression to obtain the total number of trips originating in i and going to j:

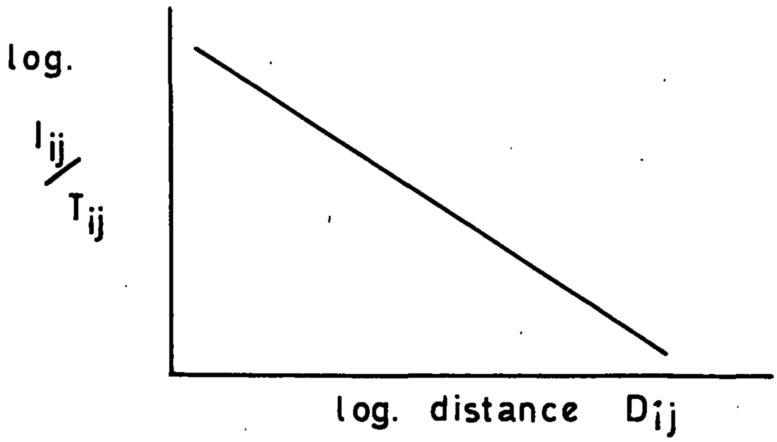
$$T_{ij} = k.\frac{P_i.P_j}{P} \qquad \text{......(3)}$$

Where:

T_{ij}: the total number of trips taken by individuals in i which terminate in j.

To include the effect of the actual distance separating a pair of subareas, one is forced to return to empirical observation: in particular, data must be obtained for interaction between every pair of subareas in the region. This actual trip volume is designated I_{ij} and the ratio of actual to expected trips is I_{ij}/T_{ij}. If this ratio is then plotted on double logarithmic axes, against distance separating pairs of subareas a linear relationship with negative slope is usually obtained.

Thus:



The general feature of interaction declining with distance has been widely observed empirically, and is the so-called distance decay function. It has also been shown empirically to fall off in the manner shown above, although alternative distance decay functions have been suggested and are discussed in Chapter 14. As the above relationship is usually found to be linear, it can be expressed:

$$\log \frac{I_{ij}}{T_{ij}} = a - b.\log D_{ij} \quad ......(4)$$

Where:

a: the intercept on the y axis

and b: the slope of the line

If z is the antilog of a, then (4) can be written:

$$\frac{I_{ij}}{T_{ij}} = \frac{z}{D^b_{ij}} \quad ......(5)$$

Or:

$$I_{ij} = z. \frac{T_{ij}}{D^b_{ij}} \quad ......(5)$$

Substituting for T_{ij}, as defined in equation (3),and allowing

$$G = \frac{z.k}{P} \qquad \text{(all constants)}$$

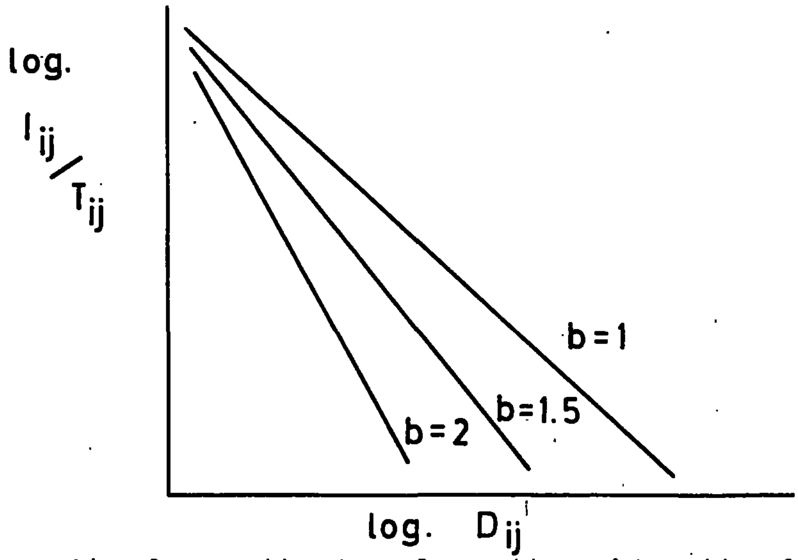
Then:

$$I_{ij} = G. \frac{P_i.P_j}{D^b_{ij}} \quad ......(6)$$

which, if b=1 is the same as equation (2). The importance of the size of b will be returned to frequently in this part of the thesis. A brief introductory outline of its implications is given here:

The distance decay function.

Olsson (1965à writes:'Practically all of the studies on interaction have shown that interaction intensity falls off very regularly with increasing distance'(p.53). Haggett (1965) provides graphic examples, as does Isard(1956) and Zipf(1941). More specifically, so does Nadur(1967) in County Durham. Exceptions are discussed later. The size of b relates to the rate of fall off in interaction with distance. This can be seen graphically below:



Thus the lower the b value, the wider the field of movement and the gentler the gradient. Various studies have shown that the value of b varies between trips of different types and indeed within one trip type.

<u>A probabilistic extension of the gravity model</u>

Isard(1960) and others have pointed out that equation (6) can be extended, using probability assumptions only. The interaction between subarea i and all other subareas can be written:

$$I_{i1} + I_{i2} + I_{i3} \ldots + I_{in} = G.\frac{P_i.P_1}{D^b_{i1}} + G.\frac{P_i.P_2}{D^b_{i2}} \ldots\ldots + G.\frac{P_i.P_n}{D^b_{in}}$$

Which can be written:

$$\sum_{j=1}^{n} I_{ij} = G.\sum_{j=1}^{n} \frac{P_i.P_j}{D^b_{ij}}$$

Which can be written:

$$\frac{\sum_{j=1}^{n} I_{ij}}{P_i} = G.\sum_{j=1}^{n} \frac{P_j}{D^b_{ij}} \qquad ......(7)$$

The division by P_i gives interaction with all areas on a per capita (or more correctly, per unit mass) basis. This has been termed the potential at i, or ${}_iV$.

$${}_iV = \frac{\sum_{j=1}^{n} I_{ij}}{P_i}$$

and from (7):

$${}_iV = G.\sum_{j=1}^{n} \frac{P_j}{D^b_{ij}} \qquad ......(8)$$

Equation (8) is the basis of the population potential model and of the family of potential models, which will only be briefly referred to.

<u>The development of the gravity concept</u>

Gravity models originally developed analagously to physical concepts rather than by the above reasoning. Carrothers(1956) provides a review of much of the work with what is here termed 'first generation' models. He notes that there were important 19th. century contributions to these ideas of social physics, by Carey and by Ravenstein who both suggested population movements could be explained by analogy to Newtonian gravitational laws. In 1924 Young(1924) attempted to relate migration volumes to attraction and distance squared, introducing the well known inverse square law. Thus b was 2 and his formulation appears thus:

$$M_{ij} = k. \frac{Z_j}{D_{ij}^2} \qquad \ldots\ldots(9)$$

Where:

Z: the attraction of j.

M: migration volume from i to j.

D: distance from i to j.

The next step in the development of these models came with the work of Reilly(1931) whose work will be discussed shortly. First, the main line of development of these models is traced.

The first major user of these concepts was Zipf (1941, 1949 and others) and Stewart, drawing heavily upon physical analogy, equated demographic force with gravitational force (F). (Stewart, 1941,42,47,48, and others). In Newtonian physics F is defined by:

$$F = G. \frac{P_i . P_j}{D_{ij}^2} \qquad \ldots\ldots(10)$$

He further equated demographic energy,E as:

$$E = G. \frac{P_i . P_j}{D_{ij}} \qquad \ldots\ldots(11)$$

and demographic potential, produced by mass j at i as $_iV_j$,

where:

$$_iV_j = G. \frac{P_j}{D_{ij}} \qquad \ldots\ldots(12)$$

Thus if all the potentials created by all masses upon a location are summed, then:

$$_iV = G. \sum_{j=1}^{n} \frac{P_j}{D_{ij}}$$

which is identical with equation (8) if b=1. Potential values can be calculated for every subarea in a region and an equipotential contour map constructed. It is important to remember that this map does not directly represent accessibility to a population, only indirectly.

It is not within the scope of this thesis to examine some of the interesting implications of the potential concept. Harris(1954) analysed industrial location in the U.S.A. using the concept of 'market potential' and found that the point of maximum potential did not coincide with the point of least transport cost in serving the entire population. Dunn(1956) attempted to reconcile these two facts in a test exercise in Florida.

It is now time to turn back to examine another trend in the development of the first generation models: the contributions by Reilly and others. Reilly(1931) was the first to use the broad ideas of gravitational analogy in the field of tertiary economic activity. His original 'law' of retail gravitation states that :'two centres attract trade from intermediate places approximately in direct proportion to the sizes of the centres and in inverse proportion to the square of the distances from these centres to the intermediate point'.

Or:

$$\left(\frac{T_a}{T_b}\right) = \left(\frac{P_a}{P_b}\right) \left(\frac{D_b}{D_a}\right)^2 \qquad \ldots\ldots(13)$$

Where:

T_a and T_b : are the proportions of trade going from an intermediate place to centres A and B.

P_a and P_b: are the sizes of A and B.

D_a and D_b: are the distances from A and B to the intermediate place.

As Berry (1967) points out, this model is essentially deterministic, this arising from the fact that it deals only with two centres rather than because of the nature of the model.

A significant development in the refinement of the Reilly model was provided by Converse(1949). In attempting to define a trade area, abreak point between towns was sought, i.e. where $T_a = T_b = .5$ probability. The resulting formulation, derived from the Reilly formulation was as follows:

$$T_b = \frac{D_{ab}}{1 + \sqrt{\dfrac{P_a}{P_b}}} \qquad ......(14)$$

Where:

T_b: the breaking point between cities A and B in miles from B

D_{ab}: the distance A to B.

P_a and P_b: the populations of cities A and B.

The derivation from Reilly is easy to illustrate:

Since $T_a = T_b$

Then $\left(\dfrac{P_a}{P_b}\right)\left(\dfrac{D_b}{D_a}\right)^2 = 1$

and $\dfrac{D_b}{D_a} = \sqrt{\dfrac{P_b}{P_a}}$

thus $$\frac{D_b}{D_{ab} - D_b} = \sqrt{\frac{P_b}{P_a}}$$

therefore $$\frac{D_{ab} - D_b}{D_b} = \sqrt{\frac{P_a}{P_b}}$$

thus $$\frac{D_{ab}}{D_b} - 1 = \sqrt{\frac{P_a}{P_b}}$$

and $$D_b = \frac{D_{ab}}{1 + \sqrt{\frac{P_a}{P_b}}}$$

It was with this formulation that retail area was first substituted for population as an attraction index. Trade areas are constructed by linking breakpoints on the straight line between each pair of centres.

Empirical work has been undertaken, using these formulations, for example, by Converse(1949), and Reynolds (1953), using the Converse formulation in Iowa, where he found that reasonably good results were obtained when compared with sample data; he also found that willingness to travel varied over time. Illeris(1967) used the basic Converse model in Denmark.

A further contribution to the development of these models was made by Voorhees(1955) using basically a Reilly type of formulation in the analysis of various kinds of trip. He reiterates the need for further research in the manipulation of both the distance exponent and the attractiveness index:'Research has shown that in applying this principle, the distance factor should be raised to some power depending upon the type of trip, and that the best results are obtained if distance is expressed as 'auto driving time'. In selecting the units to express the size of the 'attractor' it has been found that these should be in line with the type of trip under consideration' (p.50/51).

Problems in the use of the first generation models.

There are many important problems arising out of the indexing of variables and calibration of models. As these are common both to first and second generation models these will be dealt with in the next two chapters. The following more specific problems are briefly reviewed.

First and foremost the model is an analagous one and as such lacks a firm theoretical base, and can be seen to 'explain' certain movement patterns in certain situations without providing adequate theoretical backing. There are also a number of additional problems:

The breaking point formulation does not provide graduated estimates of interaction above and below the break point.

More importantly, when two centres in a region are being considered, delimitation of the trade areas can result in both overlapping areas and in unserved areas, which, as Huff(1964) points out:'in the case of multi-trading area delimitations, derived from using the breaking point formula, there may be areas that are not even within the confines of any shopping center's trading areas. Such a development is certainly not very realistic ' (p.36).

An additional problem, not allowed for in the Reilly formulation is that the exponent b may vary over both time and trip type.

Conclusion.

These above models are here termed 'first generation' models, and, as can be seen, have an analagous basis and are rather inflexible. The study will move on to what are here termed 'second generation' models which are in many ways more satisfactory predictive models than the first generation models.

Before moving on, it is perhaps worthwhile considering briefly a further development of the first generation models which uses the concept of social distance. The development is the intervening opportunities model, developed by Stouffer(1940). Stouffer suggests that the important relationship in measuring mobility is not that between mobility and distance, but that the number of persons moving a given distance is directly proportional to the number of opportunities at that distance and inversely proportional to the number of intervening opportunities, This raises the important problem of how one is to measure an opportunity. These ideas are closely related to the concept of social distance: Isard (1960) points out:' the Puerto Rican who migrates to New York is, from a social distance standpoint, migrating to the closest location of significance to him. As a migrant he is traversing little, if any, intervening social distance and is aware of few, if any, intervening economic opportunities'(p.542).

SECOND GENERATION MODELS

Introduction

A distinction is made between what have been called the first generation models and what are here called the second generation models. These are differentiated as follows: generally speaking, the first generation models are concerned with the influence of 'masses' upon each other over a given distance. They basically deal with a two mass-one distance situation. The second generation models described here shift the focus of study of movement to the spatial behaviour of the consumer as a member of a continuous population distribution. They thus are able to examine interaction between a number of centres rather than between only two. Cordey Hayes (1968) writes: 'The model differs (from Reilly's formalisim), because it now describes the interaction between a continuous population distribution and a large number of shopping centres, i.e. a change from the 'two centre interaction' to the 'many centre interaction', and a consequent change in emphasis from the market area of the seller to the shopping area of the buyer' (p.18).

This chapter presents a critical review of the development of the second generation models. Other reviews have been made, with different emphasis and purpose, as for example by Cordey Hayes (1968) or The National Economic Development Office (1969). Here the purpose is to provide a theoretical background for an examination of the basic form of the model. It is a second generation model which is later tested.

The development of the models

The groundwork for much of the formalisation of these models was laid by Huff (1962,1963 and 1964) who in turn based his work partly upon ideas developed by Luce (1959).

The Huff models

Huff's formulation rests upon the following notions:

1. That it is possible to estimate the Utility of a given set of centres (J) to an individual consumer located at point i. Utility to a consumer is a difficult concept to understand and is only here described in probabilistic terms. Thus, the probability of a given centre, j, being chosen from the set of centres, J is proportional to the observed utility of centre j, as compared with all alternatives. Thus, formally:

$$P_{ij} = \frac{U_j}{\sum_{j=1}^{n} U_j} \qquad \text{......(1)}$$

Where:

P_{ij}: the probability of a consumer going from zone i to centre j.

U_j: the utility of the jth. centre.

The formulation is subject to the constraints that $\sum_{j=1}^{n} P_j = 1$, which ensures that the consumer shops somewhere, and also that $P_{ij} > 0$, which is reasonable.

2. The utility of a centre is assumed to be a function of two variables: (i) the number of items that a consumer desires that are carried by each of the set of centres, which is in turn related to the size or attractiveness of the centre, and (ii) the distance from the customer's starting point to each centre, which is related to the

travel cost of getting to each centre in the set of alternatives. It is basically the balance between these two opposing variables which determines the 'utility' of each of a given set of centres to the consumer. The theoretical notions involved in this are examined in the next chapter. Stated more formally:

The probability that a consumer at a given location i, (usually a zone centroid location), will go to a given shopping centre, j, which is one of a set of alternative and competing centres, defined as J, is:

(1) directly proportional to the size of the centre (S_j).

(2) inversely proportional to the distance D_{ij}.

(3) inversely proportional to the competition from all other centres in the set J, the competition being determined in each case by size and distance.

It is also probable that the relationship between willingness to travel and distance does not decline in a simple and linear manner with increasing distance, so that a function should be fitted to the distance variable.

Expressed mathematically, equation (1) becomes:

$$P_{ij} = \frac{\dfrac{S_j}{D_{ij}^b}}{\sum\limits_{j=1}^{n} \left(\dfrac{S_j}{D_{ij}^b} \right)} \qquad \ldots\ldots(2)$$

Where:

P_{ij} : the probability of a consumer going from zone i to centre j

S_j : the size of centre j (measured variously)

D_{ij} : the distance from i to j (measured variously)

b : an empirically determined behavioural parameter.

This of course can be written:

$$P_{ij} = \left(\frac{S_j}{D_{ij}^{\,b}}\right)\left(\sum_{j=1}^{n} \frac{D_{ij}^{\,b}}{S_j}\right) \quad \text{......(3)}$$

The form of equation (2) perhaps emphasises more clearly the links with Reilly.

Equation (2) can now be extended, making a further assumption that a given time period is implicit in this and following formulations. The probability of a consumer making a particular shopping journey can be translated into the total numbers of people using each centre, simply by multiplying the right hand side of equation (2) by C_i where C_i is the number of consumers in zone i. This can be even further extended, by including not only numbers of consumers but also average per capita expenditure on the good or goods in question in the given time period; this is termed E_i.

Thus equation (2) becomes:

$$S_{ij} = C_i . E_i . \left(\frac{\dfrac{S_j}{D_{ij}^{\,b}}}{\sum_{j=1}^{n} \dfrac{S_j}{D_{ij}^{\,b}}} \right) \quad \text{...(4)}$$

Where:

S_{ij}: the total amount of expenditure going from i to centre j.

C_i : the total numbers of consumers in zone i.

E_i: the average expenditure per consumer in zone i on the good or goods in question.

Thus it can be seen that a fourth variable can be incorporated with those that appear on the preceeding page, in the basic model formulation.

Thus, the amount of expenditure going from zone i to centre j is:

(1) directly proportional to the size of centre j

(2) Inversely proportional to some function of the distance between i and j.

(3) Inversely proportional to competition from other centres.

(4) Directly proportional to retail spending power available in i.

Lakshmanan and Hansen

The next significant, though logical extension of this came with one of the first applications of the model, by Lakshmanan and Hansen(1965) in Baltimore. They employed the basic Huff type of model because:' The location or sales potential of a retail centre is not to be viewed as a function of the purchasing power of an arbitrary spatial slice of the region. More realistically, it describes a situation of overlapping competition between shopping centres and develops a mathematical framework for measuring it'(p. 135).

They extend the model by showing that the total sales in shopping centre j is equal to the sum of the sales going from all subareas to centre j.

Thus:

$$TS_j = \Sigma S_{ij}$$

Where:

TS_j: the total sales at centre j.

Or, in their own notation:

$$S_j = \sum_{j=1}^{n} \left(C_i \cdot \frac{\dfrac{F_j}{D_{ij}^{\,b}}}{\sum_{j=1}^{n} \left(\dfrac{F_k}{D_{ik}^{\,b}} \right)} \right) \quad ..(5)$$

Where:

S_j : total sales in centre j.
C_i : total consumer expenditure available in zone i.
F_j : the size of the retail activity in j.
D_{ij} : the distance i - j.
b : an exponent.

Haydock

A further important extension is one used in the 'Haydock' shopping model (Department of Town and Country Planning, Manchester University, 1964). The important addition was that an exponent was fitted to the index of attraction.(The index of attraction was, incidentally of a composite nature). The mathematical expression now appears:

$$S_{ij} = C_i \cdot \left(\frac{\dfrac{F_j^{\,a}}{D_{ij}^{\,b}}}{\sum_{j=1}^{n} \left(\dfrac{F_k^{\,a}}{D_{ij}^{\,b}} \right)} \right) \quad \ldots (6)$$

Where:

a and b : are exponents.

The implications of fitting a function of this nature to the attraction index are that if a is greater than 1, then a given larger centre has an attractive power which is greater than a given smaller centre, in proportion to the difference in size, plus an extra attractiveness. That is, attractiveness increases with size, but disproportionately. (greater than proportionately if a >1 and less than proportionately if a <1). This is clearly an interesting addition and is discussed more fully later.

Parry Lewis and Trail

Parry Lewis and Trail(1968) suggest another extension, based upon the notion that there is competition amongst consumers for facilities such as parking space, service etc., and that the competitiveness of consumers decreases with increasing distance. They suggest that the effective number of competitors for the opportunities in j can be written as:

$$K_j = P_j + \sum_i \frac{P_i}{D_{ij}^{\lambda}}$$

Where:

K_j : the volume of competition for facilities at j.
P_i and P_j : the populations of zones i and j.
D_{ij} : distance i - j.
λ : an exponent.

Parry Lewis and Trail write:' If one thinks of a local resident as being a completely effective competitor, then the more remote ones are only partly effective, and one may perform a summation to obtain a measure of the total effective competition'(p.322).

This addition would be incorporated into the general model as follows:

$$S_{ij} = C_i \cdot \left(\frac{\dfrac{S_j}{K_j \cdot D_{ij}^{b}}}{\sum_{j=1}^{n} \left(\dfrac{S_j}{K_j \cdot D_{ij}^{b}} \right)} \right)$$

There are however, a number of important conceptual problems associated with acceptance of this modification. For example, by implication there should be a threshold value for K_j, as congestion can only be said to occur when car parking space is actually all used up. The determination of this threshold value would be by no means easy. Even the authors note that:' This approach to competition depends upon the nature of the opportunity being considered, and it may not necessarily always be valid',(p.322).

Thus far has the development of the gravity model proper been traced. The next section deals with a consequent problem, that of the means by which these second generation models (and, partly, the first generation ones also) can be indexed, calibrated, operationalised and used predictively.

Usage

The mass variable

In the first generation gravity models, P_i or P_j was usually taken to be the population of the respective areas. Converse was the first to use retail area as an index of attraction.

With the second generation models indices have been used which are supposed to represent the level of consumer choice within a centre. The theoretical reasons for this are investigated in the next chapter. Retail floor area has been commonly used. There are however inevitably problems: should total floorspace or central area floorspace be taken as the index?. What of the wide variations in turnover per square foot and of variations in this over time?. In addition, specific indices have been used, derived from composite 'weighting'processes using, for example, specific types of store as a weighting factor. Thorpe and Rhodes(1966) suggest a possible index. R.L. Davies(1970) has recently argued for generality in the selection of both centrality and attraction indices.

Total sales presents a very sensitive index of attraction, where obtainable. It has been suggested that the use of sales involves circular reasoning, but as Cordey Hayes(1968) points out:' this is no more the case than using numbers of employees or floorspace as an index'. All are highly related. In any case, as will be argued in the next chapter, the explanatory power of the model rests in the exponents fitted rather than in the index used.

It is also possible to use any alternate measure of attraction of a similar nature to turnover, such as the total numbers of people using a centre, if this is available.

Berry(1965) has suggested the use of factor analysis to help to identify the 'best' variables to use.

Clarke and Bolwell(1968) have suggested that the attraction of a centre also varies depending upon the social class or income group of all centre users.

Bucklin (1967) has further investigated the role of mass, using discriminant analysis, and concludes:' Mass retains its overall significance as a factor in determining the attraction of a center, but it appears that the adjustment of gravity models to fit differential consumer perceptions of mass would improve predictability'(p.42).

The distance variable

As Watson (1955) pointed out, it is possible to regard distance in many ways. Model users have used straight line distance, whilst others have used time or cost distance. Clearly the nature of the terrain and the human occupance of the area will affect choice of index. An index related to the consumer perception of distance is clearly the ideal in any given situation. Operational constraints do however come frequently to the fore. If many zones and many centres are being used then the only feasible means of dealing with the resulting matrix may well be with the use of grid co-ordinates and Pythagoras theorem on a computer. A crucial element to be dealt with is that if a centre falls within a zone of origin a finite distance must still be allocated to the zone - centre interaction otherwise S_{ij} tends towards infinity, and the model becomes inoperable. This problems can be of considerable importance in using the model and is taken up again later. Black(1966) took intrazonal distance to be the radius of a circle whose area was equivalent to the zone area. Others have approximated.

Other variables

Such as for example, population and average expenditure must be extracted from published material.

The exponents

The exponents are at the very core of the model in that they represent the behavioural parameters which are at the centre of any explanation. S_{ij} is most sensitive to changes in the value of the exponents as compared with changes in the variables.

The implication of exponent a in equation (6) has already been partly discussed. In equation (2) it is simply set to equal 1. If the exponent on this variable is greater than 1 the implication is that the larger the centre the more extra attractiveness it has, over and above that in proportion to its size. This may well be a reasonable assumption to make, and it does seem to hold in part with the regional centres in this area. It would be interesting to investigate whether relationships exist between:

1. The size of the attraction exponent and the behaviour of different population sub groups.
2. Whether the exponent varied over space.
3. Whether the exponent varied over time.

As Olsson (1965a points out, many studies have shown wide variations in the distance exponent. Differences in the value of the distance exponent implies differences in willingness to travel or ability to overcome the friction of distance. It has been found in nearly all interaction studies that interaction does decline with increasing distance, though there are possibly exceptions.

Differences in the distance exponent can perhaps be accounted for in a number of ways:

1. Because of the different nature of different trip types. It is clear that people are prepared to travel further on certain types of trip (e.g vacation) than on others (e.g. shopping). This was the conclusion of Voorhees (1955), and seems reasonable. It seems likely that there may be a spectrum of trip types each havinga different relation with the friction of distance, ranging from trips with a low 'ability' to overcome the friction (e.g. certain types of social trips) to trips with a high ability to overcome the friction (for example vacation trips).
2. Within one trip type it is also possible that there may be variations in willingness to travel. For example, people are usually more prepared to travel for the purchase of shopping goods than for the purchase of convenience goods. Huff(1962) suggests that this related even to shopping goods of different types.

3. The exponent can vary between different socio economic groups. The implication is that distance friction affects certain groups more than others. This is implied by Clarke and Bolwell (1968) and stated by Marble (1959). It is also a finding of part I of this thesis.

4. The exponent may also vary over time, which could involve many factors, not the least that of changing levels of economic development.

Operationalisation

Given a set of centres (J) and a set of zones (I), with appropriate mass and distance values, then the two parameters, a and b are determined by the analysis of data from a past date. Assuming for the moment that the exponent on the mass, a, is set to 1, then an iterative search procedure is usually employed to find the optimal value of the distance exponent. The optimal value is usually the value which minimises the sum of the squares when expected model values are related to actual values:

$$\text{Minimise} \qquad \Sigma\,(\,P_{ij} - P_{obs.\ ij}\,)^2$$

Usually however, interaction data does not exist, as such. Thus it is not usually possible to calibrate the model at the level of the movement generation zones. The alternative solutions are (i) to use data of a related nature which provides origin - destination - interaction information or (ii) and commonly, to use known centre sales and compare them with predicted centre sales from the model,(as provided by equation (5) for example)and to minimise the sum of the squares of the differences between these two sets of figures:

$$\text{Minimise} \quad (S_{j\ actual} - S_{j\ pred.})^2$$

It is argued later in the thesis that this method can potentially carry many drawbacks and problems.

When two exponents are being determined instead of one the basis of the iterative procedure is the same, except that there is a two dimensional search procedure instead of the simpler one dimensional procedure.

Uses of second generation models

Static use

1. The model will demonstrate the different willingness of consumers to travel for goods of different types. The exponents so derived have important implications, both theoretical and practical.

2. Trade areas can now be represented as demand surfaces over space. Huff and Jenks (1968) have graphically portrayed the nature of various theoretical surfaces. Trade areas will thus be determined basically by the nature of the probability gradients, which do allow trading areas to overlap, which is realistic. Competitive equilibrium can be said to occur when equi-probability contours intersect. Thus probability contours can be used to delimit trade areas. These provide a realistic basis for prediction.

3. Through the use of the model it is theoretically possible to replicate flow and movement patterns from areas to centres,

Predictive use

The inputs necessary to run the model predictively are as follows (basing the argument upon equation (6)):

(i) projections of population and of expenditure per head for each ith. zone in the total set of zones (I).

(ii) a set of parameters, a and b or just b, derived from the past which can reasonably be expected to hold in the future.

The model will then reallocate expenditure flows to each centre in the set (J) from the I zones.

If a third input - changes in retail service provision is fed into the model for some future date, by the manipulation of the mass variables; the effectiveness of any one proposed change in provision of facility can be assesed.

Furthermore, new interaction patterns can be predicted and transport demands estimated.

The key to the power of explanation of the model lies in the parameters. Thus also the power of prediction of the model is also intimately related to the parameters. Is the attractive power of shopping centres likely to remain in a given relationship to their size over time?. Is willingness- to travel for one type of good or goods likely to remain constant over time?. Taking a longer view, the distance exponent has probably been falling in value fairly continuously over historical time, for most types of journey, and more specifically for purchase trips. In the Western world at least, there are now however two important forces at work: congestion and increased mobility. The resolution of these two opposing factors will largely determine willingness to travel in the future.

The broad and crucial question remains however unanswered: how justified is one in taking present day behavioural parameters from the past and assuming that they will hold now or at some future date?. Unfortunately, largely because of replication problems there are no studies of the long term trends in changes in behavioural parameters, from which at least an extrapolation could be made.

The next chapter reviews the theoretical basis of these models and some of the important conceptual problems arising from their use.

CHAPTER 14

GRAVITY MODELS: THEORETICAL CONSTRUCTS; THEORETICAL PROBLEMS AND RELATIONSHIPS WITH CENTRAL PLACE THEORY.

Introduction

As was argued in an earlier part of the thesis, theory can be regarded as the corner-stone of science and scientific method. One major drawback to much of the work with gravity models is that they have appeared to be based rather heavily upon empirical observation rather than theoretical constructs. As Huff(1961) points out: 'It tells us nothing about why observed regularities occur as they do under various situations and,as a consequence,leaves one at a loss when discrepancies occur that cannot be accounted for'(p.20). Schneider (1959) writes: the cardinal failiure of the gravity model is that it is not explanatory and does not really try to be'(p.52). This chapter attempts to explore the theoretical basis of these models. Further,it attempts to review some of the important conceptual problems associated with their use, and in particular looks at the relationship between 'gravity' and 'central place' theory. It is the second generation Huff/ Lakshmanan and Hansen type of model on which the discussion is based.

Theoretical notions

Utility

These models rest upon the postulate that the utility of a shopping centre for a consumer is a meaningful and useable concept. This postulate of utility is in turn based upon a few variables which are abstracted from the entire complex of variables which affect consumer movement behaviour.

Classical economic theory postulated that the consumer would select only one particular destination, which had the greatest utility for him, i.e. which provided him with the greatest level of satisfaction, adopting a rather loose definition of utility.

The gravity model is based upon the rather different notion that the consumer is not able to discriminate amongst his choices perfectly and as a consequence does not choose one place exclusively. Utility is therefore expressed in a probabilistic way. Awareness of utility for the consumer is assumed to be dependent upon the following variables:

(1) The 'amount' of goods offered (or, the attractiveness of the centre).

The model states that the larger the centre the more probable it is that the consumer will use the centre. This is to say that the greater the range of goods which a centre carries, the higher is the probability that the consumer will be satisfied. However, as Baumol and Ide(1956) point out:' A shopper does not know in advance (with certainty) whether he will obtain what he wants by entering a particular shop...... Generally there will be one of several alternative sets of items, the availability at acceptable prices of any one of which will make the shopping trip successful in the consumer's view. The greater the number of items carried by the store he enters, the greater, ordinarily is the consumer's reason for expecting that the shopping trip will be successful'(p.92). Thus it is possible that consumers will be more willing to travel further for various goods and services as the number of items available at each centre increases. This is shown graphically in diagram 43. The alternative projection of x suggests that larger centres are even more attractive than their size would suggest and y suggests that utility begins to fall off with increased size, after a certain size. This is because of supposed diseconomies of increased choice, congestion, etc.. Baumol and Ide suggest projection y.

These considerations underlie diagram 44 used by Huff (1961) to illustrate the postulate that up to a certain point consumers will show a willingness to travel for various goods, as the number of sources supplying these goods increases.

(2) The cost of the trip (related directly to distance).

The model states that the probability of interaction with a centre declines with increasing distance. Effort, both physical and mental, is required to travel a given distance, which is in turn related to a financial cost, usually fairly directly with distance or some function of distance. This will detract from consumer satisfaction. From diagram 45 it can be seen that there is a fixed cost of travelling anywhere, which is reasonable, and that after a certain point the cost rises more sharply.

This is where opportunity costs set in.

(3) Perception of utility.

Huff, using the above ideas proceeds to show that a consumer's perception of the levels of service function offered at various locations increases with distance, up to a certain point. Some workers have suggested that the logistic curve best describes this level of perception. It is not too clear how Huff reaches diagram 46, but it can be accepted here, as at least it is in accord with Central Place theory, i.e. there is greater aggregate travel to larger centres than to small ones, or in the terms being used here, the probability of being satisfied increases with distance. Huff then combines diagrams 44 and 45 to produce diagram 47, which shows that the consumer will travel to location D_x, where the marginal satisfaction is greatest. Huff then proceeds to state this more formally, unfortunately with error. The argument reads correctly: In order for a consumer to travel from i to centre j the following must hold:

$$V_{ij} > C_{ij}$$

$$\text{and} \quad V_{ij+1} - C_{ij+1} < V_{ij} - C_{ij}$$

Where:

V_{ij}: the satisfaction anticipated from going from i to centre j.

C_{ij}: the costs anticipated in going from i to j.

V_{ij+1} : the satisfaction anticipated from going to the next further centre beyond j.

C_{ij+1} : the costs anticipated from going to the next further centre beyond j.

This is the basis of the theory underlying the use of the gravity model. It is now necessary to extend the theory to cover the behavioural parameters.

The mass exponent

This parameter is one of the features of the gravity model which merits further research. The implications of variations in the size of this parameter have already been discussed, but the theoretical base is far from clear. Why should a large shopping centre be either disproportionately more or less attractive than a small one?.

One possible explanation draws on Central Place Theory, which shows that the number of functions in a landscape increases with the number of establishments, but at a decreasing rate. This is simply a function of threshold values, and the relationship is shown in diagram 48, and is usually found to be linear in the semi logarithmic case. Assuming that establishments will have a tendency to cluster, then the larger the centre, the more the comparison between shops of the same type becomes possible, and, it can be argued the pay-off therefore rises for that centre.

An alternative explanation could be offered in that some shopping is done on multi-purpose trips, combined for example, with entertainment. A wide variety of services would tend to increase people's demand for the facilities of the larger centres.

Both of the above arguments would produce an exponent with a value greater than one.

In the case of an exponent less than one, the most obvious explanation is that congestion and excessive choice represent diseconomies and so the larger centres lose some attraction.

It does seem that in the North East there is a case for assuming an exponent a little greater than one. This is because the forces adding to attraction are not yet outweighed by the forces detracting from this.

The distance exponent

Theoretical ideas to explain variation in the distance exponent have been more common. Possible sources of variation have in general already been outlined. A more rigourous theoretical analysis is presented here, drawing partly upon the work of Huff.

Variation in the distance exponent can occur amongst:

(1) Different products.

There are a number of factors at work here, but an important one is that where the degree of product sub-stitutability is low, willingness to travel is corres-pondingly higher, in order to obtain greater real choice.

Another source of explanation is that where the absolute price of a product is high in relation to consumer income, consumers will generally be prepared to travel further, to minimise the chance of a bad purchase.

There are also certain goods which provide the consumer with a considerable 'psychic income' i.e. they have considerable social significance to the consumer. For these goods the consumer should be willing to travel further.

Many of these ideas are being generalised, using the theory of Cognitive dissonance, borrowed from the behavioural sciences, including as it does, the anticipation of regret as an important decision-governing factor.

(2) Different groups of consumers.

Huff suggests that consumers of a higher economic status will travel further to shop than consumers of lower economic levels. The sources of explanation for this have already been examined in Chapter 2. Both better means of transport and the level of social significance of purchases are involved here.

(3) The nature of the area travelled over.

The awareness of the friction of distance will vary according to the geographic situation of the consumer. For example, a shopping trip through an area of congestion will involve a different appreciation of the effort of travel than through an uncongested area. Similar observations can be made about an area of difficult terrain. Social distance can also be important.

(4) Extraneous factors.

As has been argued earlier, it seems highly likely that the value of the distance exponent varies over time and varies according to the level of economic development.

As was argued earlier, it is the parameters which lie at the heart of the model, both because they represent the actual consumer behaviour and because the model is very sensitive to their adjustment.

The discussion now moves on to the conceptual problems associated with the use of these models.

Conceptual problems

The first generation models rest on less firm theoretical foundations than the second generation models.

Schneider (1959) writes: 'Newtonian gravity is an energy force field characterising the motions of particles, not their intentions'(p.51), and 'The theoretical supports on which the gravity method rests appear to be these: an interchange between two regions is clearly a descending function of the distance between them and inverse proportion descends with engaging convenience. These are by no means contemptible grounds, but neither are they entirely satisfactory. The cardinal failiure of the gravity model is that it is not really explanatory and does not really try to be'(p.52).

As has been suggested, the second generation models are conceptually stronger, but nevertheless important criticisms do remain:

(1) The model is still not explanatory in the strict scientific sense

The models remain aggregative and as such are unable to predict individual behaviour; this cannot be stressed strongly enough. It has been argued that a model which claims to be based upon individual consumer perceptions should, to be properly explanatory, be based in the analysis of the perceived movement space of the consumer and should aggregate upwards. Work by Elliot Hurst (1969) and Andrews (1969) has stressed the importance of this approach. It must of course be admitted that the behavioural parameters used in this model do replicate rather than explain. This presents considerable conceptual and practical difficulty when attempting to introduce change into the model.

The view taken here is that these models do have a considerable value, both predictively and in the generation of new theoretical notions, provided that their limitations are understood and accepted.

(2) the distance decay function

A serious criticism concerns the major assumption of the model: that the distance decay function can be represented by a function of negative slope and that this function, by transformation is usually linear. This may of course not hold, the relationship between interaction and distance may for example be non-linear; it is however generally accepted that the slope is negative (though it is claimed, there are even exceptions to this, as Marble (1959) argues. This is fortunately rather unusual). Most studies do reveal that interaction does decline with distance, and in a more or less regular manner. This is at once the great strength and the great theoretical weakness of the models.

More seriously, Olsson(1967) notes the general tendency of the Pareto and other functions to overestimate close-in interaction.

(3) The adequacy of the Pareto function in describing distance decay

The distance decay function used in all of the models so far described is the Pareto function, in general form:

$$y = aD^{-b} \qquad \text{......(1)}$$

Where:

y: the probability of interaction
D: distance
a and b : parameters.

This can also be written in linear form:

$$\log y = \log a - b \log D \qquad \ldots\ldots(2)$$

Morrill and Pitts (1967) suggest that alternative functions may better fit the distance decay of certain types of movement. They suggest that the Pareto function is best where movement is not permanent or costly, and that the exponential function:

$$y = ae^{-bD} \qquad \ldots\ldots(3)$$

better fits migration, marriage and other costly moves. Equation (3) can also be written in linear form:

$$\log_e y = \log_e a - bD \qquad \ldots\ldots(4)$$

Other possible functions suggested include:

the Pareto-Exponential:

$$y = aD^{-b}\ e^{-cD} \qquad \ldots\ldots(5)$$

or, in linear form:

$$\log y = \log a - b \log D - c(D \log e) \qquad ..(6)$$

Where

c: represents an 'absorption coefficient'.

Within certain parameters (5) can approximate a gamma distribution. This is important because a number of other empirically observed distributions also approximate a gamma distribution, for example, distances to nearest neighbours betweensettlements ; migration distances have also been fitted to the gamma distribution.

The lognormal:

$$y = ae^{-(b \log D)^2} \qquad \ldots\ldots(7)$$

or, in linear form:

$$\log y = \log a - (b \log D)^2 (\log e) \qquad \ldots.(8)$$

(which appears in error in Morrill and Pitts(1967)).

It is also clear that some non-linear functions may also provide a good fit. Olsson (1967) suggests the quadratic:

$$\log y = a - b_1 \log D_{ij} - b_2 (\log D_{ij})^2 \quad ....(9)$$

An important feature involved in the use of the quadratic is that the function allows the inclusion of a plateau of interaction intensity near to the point of origin, where in reality the relationship between interaction and distance is weakest.

More simply, the model could be calibrated from a point a' one distance unit away from the origin, and the ordinary Pareto function be used:

$$\log y = \log a' - b \log D \quad ......(10)$$

Other functions have been suggested, notably the sine and fourrier functions, both of which seem promising.

An investigation is made in Chapter 19, based upon empirical data, of the adequacy of two alternative functions in describing distance decay in County Durham.

(4) The equilibrium assumptions

The gravity models rest upon strong equilibrium assumptions: they are basically allocative. The model is calibrated to a date in the past and at the moment there is no satisfactory means of predicting parameter changes. Change cannot be theoretically predicted from the model assumptions. However, as Parry Lewis and Trail (1968) argue:'Often.... in a given region, the existing pattern is more or less an equilibrium one'(p.324). The model will be less potentially reliable in estimating the effect and performances of completely new centres than simply with changes in the old ones, as less of a behavioural change is implied.

(5) the boundary effect

This is a difficult problem which has far reaching implications in many types of geographical work, as for example in Nearest Neighbour analysis. The problem is that of where can one reasonably take the areal cut-off point?. This will affect the results markedly; the constraints are usually operational, in that the system is usually closed so that $\Sigma S_{ij} = S_j$.

(6) Operational problems

The problems relating to satisfactory indexing and calibration of the models have already been discussed. The overall problem can be expressed as: do the indices and exponents satisfactorily represent significant elements of the consumer decision process?.

There are a number of important problems which arise out of the operationalisation of the model, which will be considered as they appear in the text.

In general, it can be concluded that any movement study will fail hopelessly to explain if it tries to incorporate all variables involved. There are a number of important conceptual and practical problems involved in the use of these models, but provided their limitations are appreciated they can prove very useful. This view is supported by Olsson (1965b) who writes: 'Verification of empirical laws for the behaviour of whole groups is valuable, but the final goal must still be the understanding of the individual behaviour which has produced and governed the growth of these large scale regularities' (trans.).

In order to use the model predictively, some attempt should really be made to 'explain' the exponent values.

If the model is used by only guessing at the exponent values in the future or by extrapolation of these values, then the causal explanations have not been taken into account and any possible change in these causal factors over time cannot be taken into the prediction and the prediction becomes less reliable.

The links with Central Place Theory

There is often confused thinking about the relationship between interaction theory and Central Place theory. They are frequently offered as alternative planning models, as for example by the National Economic Development Office(1969, unpub.) and by Berry et al. (1963). Berry provides a series of equations which describe and operationalise the Central PLace model. The N.E.D.O. report suggests that: 'Central Place Theory's main value is as a conceptual aid to the design of plans...... The spatial interaction models chief function is to test the design, by showing how people are likely to behave in the new situation'(p14.) It is believed that this argument does not encompass the real nature of and problems with the area which lies between the two. Any fusion of interaction and Central Place theory will represent a step towards more general interaction theory. General theory is the overall aim of scientific disciplines.

An earlier part of this thesis investigated some of the notions of Central Place theory in the area of County Durham. Here are developed some of the points on which Central Place and Interaction (or 'gravity') theory appear to be in conflict; afterwards possible areas of linkage and fusion between the two fields are briefly considered and ideas tentatively extended.

Areas of conflict

(1) The Central Place model is essentially deterministic, wheras the second generation gravity models are stochastic.

(2) An isotropic plain is an essential assumption for the Christaller model as is a uniform population distribution. Gravity models make no such assumptions, only that the notion of a population zone centroid is meaningful.

(3) The notion of threshold of demand (implicit, as Berry and Garrison have shown) in the original Christaller model means that there must be a minimum population (and therefore trade area size, under isotropic conditions) for the provision of a good.

(4) In c.p.t. centres are classified into a hierarchy according to the sizes of their maximum trade areas. Discrete breaks are required bewteeen each level which reflects the population thresholds involved.

(5) The range of a good, under c.p.t. is the maximum distance which a consumer is prepared to travel for the purchase of a good. With free entry into the market the range is compressed down to the threshold size, expressed spatially.

(6) The result is a uniform spacing of centres with hexagonal trade areas, which nest into each other. The hexagonal shape represents the optimal result of a simple packing problem.

(7) Under c.p.t. the consumer will go to the nearest and only the nearest source of the good.

The relevant points from gravity theory to correspond to points 3 to 7 above are:

Centres do not need to be identified in any hierarchical manner, except incidentally , for the model to be operative.

The range of a good is impossible to define strictly, as under the gravity assumptions very low probabilities of interaction can occur over very long distances.

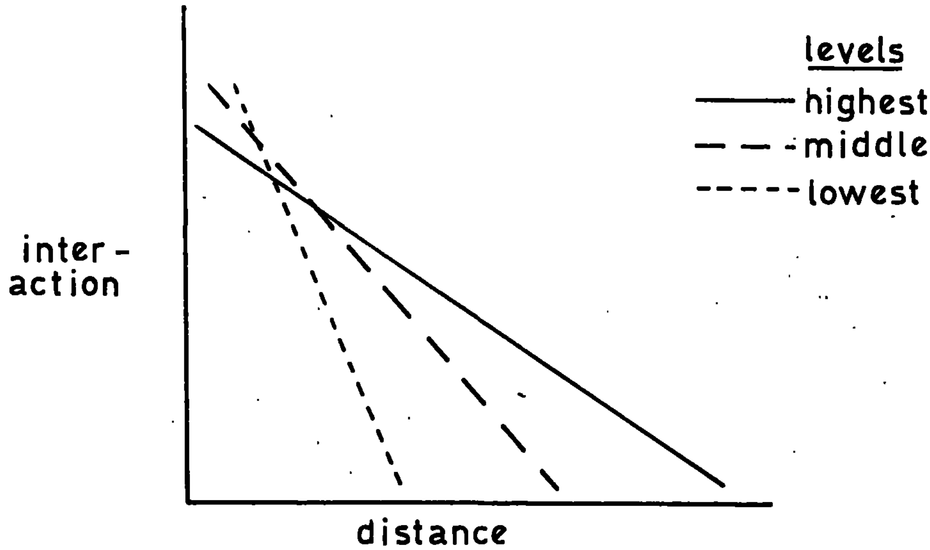
Perhaps most importantly, trade areas are derived from probability surfaces, which do allow trade areas to overlap, which central place theory does not.

Clearly the idea of range is important in both approaches, as range in Central Place theory includes the idea that travel cost increases with distance, implicitly, wheras in gravity theory this is an explicit idea. Clark(1968) found that two assumptions about range that should hold under Central Place theory did not hold, in a study in New Zealand. These were: that range should be invariant with centre size and that the consumer should always use the nearest source. This raises the important and crucial question of how far can theoretical assumptions and constraints be relaxed before a theory can be said to break down?.

Linkages

The following ideas have represented and do represent a move towards more general interaction theory.

Olsson (1965b) suggests that the distance decay function can be related to the hierarchy by relating different distance decay parameters to different hierarchical levels .(See following diagram).

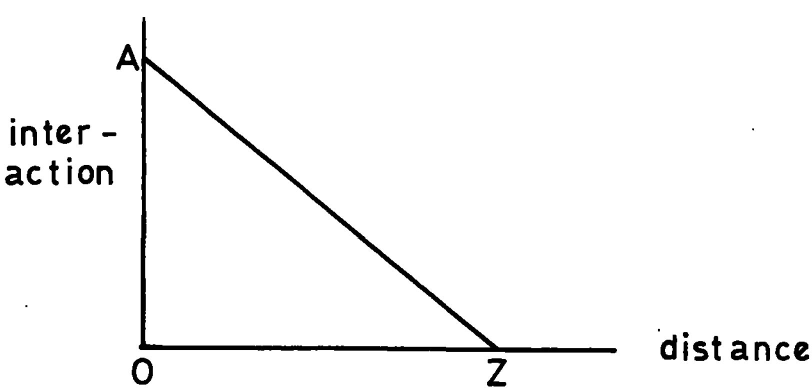


Research is necessary where hierarchies have been satisfactorily defined to test this postulate.

It is also possible to relate the two types of theory through their basic common variable: spatial distributions. It may well prove possible to relate nearest neighbour distances and interaction distances to the same distribution function, thus enabling a considerable generalisation of theory to take place. The gamma distribution seems a likely candidate, of which the chi square distribution is a special case. The Pareto-Exponential also approximates a gamma distribution.

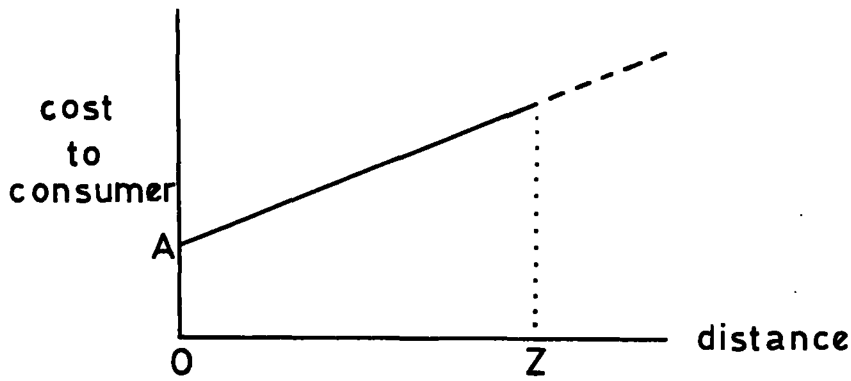
It may also prove possible to develop links via the concept of range: Olsson(1967) has shown that the general distance decay function can be related to both threshold and range:

With the general distance decay curve:



OZ is the maximum distance that consumers are prepared to travel for the good in question. This is the range of the good.

Under Central Place theory, the range of the good can be illustrated thus:



where AO is the cost at the source of supply. Cost to the consumer rises with increased travel distance, and at some point on this rising cost curve, z, will the consumer no longer be prepared to travel to O to purchase the good. z is therefore the range of the good, which has a direct parallel with the earlier diagram.

In the earlier diagram, AOZ represents a simple Lösch demand cone. Therefore the threshold of the good is represented by the area of the triangle AOZ.

One further and interesting possible avenue of development arises from an apparent anomaly of the Christaller system: assuming an isotropic surface, with a uniform population distribution, then it must be assumed that on the lowest level individual units of population are distributed uniformly. The anomaly arises when one wishes to step up from individuals to the level of the smallest centres: it is important that this is possible. The Christaller system postulated that in a k=3 hierarchy (see diagram 49i) the trade areas with respect to individuals will appear as in diagram 49ii. Are not simple probability notions introduced at this very point?. If so then is it unreasonable to assume that trade areas are circles, rather than hexagons, which would produce intersections over the individual as shown in diagram 49iii rather than as in 49ii. Each is equally meaningful.

It should then be noted that if circles are used, this implies that there are either overlapping trade areas or unserved areas. The first can be accepted, even within Central Place theory, the second cannot. At the very lowest level, it should be noted that although circles overlap, there is no consumer in the area of overlap. Thus at the lowest level it appears that the only reason for not allowing overlapping trade areas is aesthetic. It should also be noted that it is possible to construct a variable k hierarchy of trade areas using circles instead of hexagons. This is shown for the k=3 case in diagram 49iv. This is possible without affecting the basic postulated ideas of threshold and of range, upon which central place theory is based. Stepping up from the lowest level then consumers do appear in areas of overlap, but there is no reason why a probability situation involving distance decay could not operate in these areas.

One implication of this is that trade areas could in fact be of the large k case, with wide areas of overlap. Olsson and Persson(1964) begin to explore this idea by using Converse's type of trade area in a study in Sweden, but do not follow through the implications of this as they only deal with one level of central place and none of their trade areas touch . Thus it is possible to agree with Christaller that the entire area must be covered, but the stipulation that there must be no overlap could be relaxed, without affecting the basic theoretical ideas. The only addition that has to be made is that diagram 49iii is as meaningful as 49ii, which is not unreasonable. The central variables, threshold and range, remain unaffected.

This chapter ends with a brief review of some of the empirical work done using gravity models, before moving on to the empirical analysis undertaken in the remaining chapters of the thesis.

Empirical work

Empirical work with gravity models can be loosely divided into two categories: (i) academic and (ii) planning.

Academic work

This has been largely concerned with testing of hypotheses relating to movement patterns. One important problem facing all workers in this field is the lack of data against which to calibrate and test the model. This thesis tries in part to remedy this situation.

Huff(1962) used the conventional one parameter model using square footage of retail selling area and travel time as the two main indices. In a pilot study in California, for 3 areas(i's) and 14 centres(j's) he found distance parameters of 3.191 for clothing and 2.723 for furniture. His sample was limited, both in scale and response. However, the model was calibrated from actual zone to centre flows rather than by minimising errors at the centre sales level, which is less reliable.

Lakshmanan and Hansen (1965) use the above typeref model in Baltimore.

Ellis and Van Doren(1966) provide one of the few rigorous tests that have been made of the gravity model, in this case in comparison with a systems theory analogue model. They write of the gravity model :'This feature is at once the great strength of the gravity model(one formula works for everything) and a great drawback (interaction is not invariant with the structure and nature of the phenomenon)'(p.60). They also emphasise the need for detailed data on movement for the testing of the efficacy of the models. They produce a test of the first and second generation types of gravity model as compared with the performance of a systems analogue model for movement to 55 recreational areas in the U.S.A.. They found that the systems model gave marginally better results, but argue that this is probably offset by the much greater difficulty in setting up the model. They add:'Unfortunately, if each origin in the gravity model had been assigned its own exponent or gravitational constant, marvellous results would have been obtained. But it is precisely such tinkering with a model which causes it to lose its generality of approach and hence its predictive power' (p.68).

Grunewald (1966) tests in a non rigorous way the hypothesis that student applications to universities in Sweden are related to the fact that:'each university has a specific gravitational force. This force diminishes in some proportion as the intervening distance increases' (p.2). The hypothesis is suggested very tentatively to hold.

A few empirical uses of the first generation models have already been outlined. Further can be mentioned the work of Illeris(1967) who delimited functional regions in Denmark using a first generation type of model, using an exponent of 1.5 on the distance variable.

Planning Uses

The gravity model is becoming increasingly popular as aplanning tool in forecasting the performance of shopping centres. These forecasts are made sometimes without the limitations and assumptions of the model being fully taken into consideration. It is partly because of the popularity of this type of model that an investigation of its performance is made here.

The Teesside Survey and Plan (1967) uses a gravity model to predict future sales in a set of centres, using a two exponent type of model, calibrating the model at a known date by minimising the error in total centre sales. Attractive power was indexed by square footage of shopping area and distance was straight line, weighted by a constant. The exponents were found to be 1.38(mass) and 2.36(distance) for durable goods and 1.0 and 0.0 for convenience goods, suggesting that the model tended towards the trivial solution of 0 as the distance exponent.

The South Bedfordshire Sub Regional Study Technical Sub Committee Shopping Report (1968) used the basic Lakshmanan and Hansen type of model to help evaluate the best of a set of shopping centre development alternatives. Attraction was indexed by shopping centre floorspace and distance by driving time. For durables the exponent was found to be 1.3 and for convenience goods 1.6. Calibration again was based on centre sales. The model was then run predictively.

Cardiff City Planning Department (1969) used a Lakshmanan and Hansen type of model with an attraction exponent fitted, to investigate the opening of the Severn Bridge on the retail trade of Cardiff. Retail floorspace and road distance were used as indices. The parameter values were taken directly from the Teeside survey and Plan and the operation performed manually.

Rhodes and Whittaker (1967) use the basic one parameter model for 18 centres and 62 zones in south London and run the model predictively. They use retail sales as an attraction index and driving time as the distance variable. Calibration at the centre sales level revealed an exponent as low as 1.1 .

The use of a gravity model in the Haydock report has already been mentioned.

The following empirical analysis provides an examination of the performance of the gravity model, tested against the extensive consumer movement data for County Durham. The data itself is then analysed using the basic model.

CHAPTER 15

EMPIRICAL WORK

Introduction

The empirical work here presented falls conveniently into four parts, all related:

(1) The setting up of a gravity model, the indexing of variables, and the calibration of the model, based on consumer movement data for the whole of County Durham. Exponents for different types of goods are then derived, and the ordering of these goods is compared with alternative orderings. This is the concern of this chapter.

(2) A test of the power of the model: Results from using the calibrated model are compared with

(i) empirical findings in each ward, which constitutes a test of the power of the model over space, and

(ii) empirical findings of the total flows of trade going to each centre in the system, which constitutes a test of the power of the model as an aggregative and allocative model. 2 (i) and 2 (ii) are then related.

In both cases explanation of residuals is attempted, from a knowledge of the underlying economic geography of the area.

The results show that some modification of the original model used under (1) above is necessary.

(3) The model is then used as a tool of geographic analysis (i) to construct interaction probability surfaces over the County and (ii) to derive trade areas from these surfaces.

(4) The model is then used as a tool to investigate the impact of the future proposed changes in retail provision

in the area on movement patterns. The likely success of proposed changes is evaluated. Brief consideration is made of the likely effect of changes in the values of exponents.
Finally, future trends in model use and theoretical development are suggested.

Throughout the underlying theoretical notions raised in the preceeding three chapters are used to underpin the interpretations placed upon the results of using the model.

The model and its calibration

The area

Detailed consumer movement data exists for a large area of County Durham, depicted in Diagram 24. Some of this data has already been utilised in the second part of this thesis. Here in addition, compatible data collected by Nadur (1967) is utilised, for the northern part of the area. There are, as shown, 150 zones, which are wards or amalgamations of wards (or parishes). Each zone has been allocated a centroid point which represents the population centre of gravity for that zone.

There are, within the boundaries of the area, 169 shopping centres as identified by field survey and in addition, 6 grade A (+) centres which attract people from the area but actually stand outside the area itself; these are: Newcastle, Sunderland, Darlington, Middlesbrough and Stockton (here amalgamated to 'Teeside'), Hartlepools, and Gateshead.

Household movement data has been collected for each of these 150 zones with respect to the 169 + 6 = 175 centres. It is this material which is used in the following analysis. The collection and treatment of the data has already been described. The movement data common to both South and North Durham is for the following goods:

Weekly Groceries	Boots and Shoes	
Butchers Meat	Mens clothing	
Chemist goods	Womens clothing	
T.V. Set	Washing machine	
Hardware	Vacuum cleaner)	South Durham only
Jewellery and Watch/Clock	Radio)	
Furniture or Carpet		

Data relating to movement in Northern Durham, in 1966, was supplied by Nadur (1967), for which acknowledgement is gratefully made.

This material provides a firm starting point for a thoroughgoing analysis of the power and results of gravity model use. As Ellis and Van Doren (1966) point out: 'knowledge of origin - destination information to a high degree of accuracy was necessary in guiding the early model building stages ..... and was indispensible for providing a test for the models' (p.59.).

The Model

For satisfactory calibration of any gravity model, the use of a computer is necessary. Thus an important constraint is placed immediately upon the use of these models by the availability of programs. It was finally decided to use a program published by Huff and Blue (1965).

The program is designed to solve 3 broad types of problem:

(1) to estimate the amounts of consumer shopping movements from a zone (i), or from many zones (i's), to each centre (j) in a set of centres (J). The model is calibrated for each individual zone, and the parameters obtained can be averaged to obtain a general model parameter for the whole area.

(2) to measure the market area of each centre (j) in the set of centres (J). Given an average exponent, the model can be run to calculate probabilities of interaction between each centre (j) and each zone (i). Probabilities can then be multiplied by zone populations to obtain total movement figures for each $j^{th.}$ centre from each $i^{th.}$ ward, and trade areas can be thus defined variously.

(3) The program can be extended to cover the consequences of adding a size increment, linked to an expected profit percentage for each centre, and searching for optimal locations.

The model is a basic one-parameter Lakshmanan and Hansen type of model which is expressed thus:-

$$P_{ij} = \frac{S_j / T_{ij}^{\alpha}}{\sum_{j=1}^{n} S_j / T_{ij}^{\alpha}}$$

where P_{ij} = the probability of <u>one</u> household in zone i shopping at centre j

S_j = the size or attractive force of centre j in the set of centres J.

T_{ij} = distance in some form between i and j

α = a parameter

n = number of j's in the set J.

the extensions of the model are:-

(1) $E_{ij} = P_{ij} \, . \, C_{ij}$

where E_{ij} = the expected number of consumers E originating from zone i, terminating at centre j

and C_{ij} = the number of consumers in zone i.

(2) $A_{ij} = E_{ij} \cdot B_{ik}$

where A_{ij} = the expected annual sales terminating in centre j, originating from zone i

and B_{ik} = the average annual amount B budgeted by consumers at i for goods of type k.

<u>α determination</u>

Firstly, actual movement data is required for one or more of the i zones in the set I, to each of the centres j in the defined set J. The movement data can be of the same type as the model is concerned with (i.e. shopping) or of a different (though less reliable) type, for example, traffic surveys.

Secondly, the attraction and distance variables must be indexed for the zones and centres in question.

The program then continues with a statistical search procedure for each zone, called a Fibonacci search, which is an optimising approximation method for the determination of the value of α. The search is conducted as follows:-

1. Upper and lower limits for the search are specified.
2. Values of α are selected within this range by means of a simple incrementing procedure.
3. The error (ERR) is defined as the sum of the squared differences between the expected values of P_{ij} and the actual values $(\frac{C_{ij}}{C_i})$, for each centre, in any one ward.

This can be written:

$$ERR = \sum_{j=1}^{n} (\frac{C_{ij}}{C_i} - P_{ij})^2$$

where P_{ij}: as defined above

and C_{ij}/C_i: is the observed probability value

4. The procedure terminates under one of three conditions, each of which ensures that ERR has attained a minimum value.

Measures of goodness of fit are provided by the product moment correlation coefficient and Thiel's Inequality Coefficient.

Operationalization

In this chapter the gravity model is first employed to determine the value of α for various goods and for all goods, in County Durham. From the theoretical chapters it will be recalled that the values of α derived should theoretically provide information or willingness to travel by consumers for each good, and so will present, it is hoped, a meaningful ranking of goods on this basis. As was emphasised in earlier chapters, the explanation for this ranking must be sought outside of the model, and a wide variety of factors such as frequency of purchase and the social significance of the good will all enter into the explanation.

Olsson (1967) writes: 'Unfortunately... (the basic Huff model).... has not yet been as thoroughly studied as ... (the simple gravity model)....... and although nothing clearly contradicts the supposition that b (the distance exponent) varies as b in ... (the simple gravity model) ... this still has to be proven.' (p.18).

It was first intended to use the body of data for all 150 wards, and 17 goods to derive the parameter. As has been outlined, 175 centres were defined. It is these usefully large figures which provide an important scale constraint in the use of the model. The researcher is faced with 17 matrices each containing 150 x 175 =

26,250 cells.

Distance

It is clear that the preferable measures of distance are by cost or time variables, or even shortest road distance. In using this model, geometric straight line distance was employed. The justification for this is simply that of keeping the scale of operation as large as possible within the limits of the data. Clearly the calculation of 26,250 individual distances is nearly impossible for the individual researcher, so that a coordinate system was used whereby the program calculated distances from the simple expression

$$T_{ij} = \sqrt{(x_1 - X_1)^2 + (y_1 - Y_1)^2}$$

where T_{ij} = distance from i to j, in coordinate units

x_1 and y_1 = coordinates of zone i

X_1 and Y_1 = coordinates of centre j.

The use of this measure further seems reasonable in that the area in question does not have a diverse topography, and there is a well developed road network, overlaid by an efficient bus service, run by one company with a uniform pricing system related directly to distance.

Olsson (1965a notes:- 'It must be admitted that the extra work involved in computing other than straight line distances is not justified' (p. 58). Olsson also points out that: 'Attention should be drawn to recent work by Nordbeck (1964), in which correlations between actual street distances and straight line distances were shown to be so high that practical results would be very little influenced by the kind of measurement used' (p.58). This assertion was tested on a number of routes in the County and found to hold.

Attraction

An important problem with this index was that for the set of 175 centres only limited data existed:

(1) the number of people using each centre for each good

(2) the numbers of food and non-food shops

(3) the Thorpe-Rhodes centrality index.

For a few large centres turnover and other data is available in the census.

It was finally decided to use the total numbers using each centre as a measure of attraction. This was considered reasonable because first and foremost, the size variable need only represent the attractive power of a centre, rather than 'explain' it. This is because, as shown in the theoretical chapters, the model is allocatory rather than explanatory. There is no conceptual difference between using this as an index and using total sales as Rhodes and Whittaker (1967) do. Cordey Hayes (1968) writes: 'A better measure is that of retail sales itself; shoppers are more likely to visit a centre with high sales than with low sales. With high sales the choice is likely to be wider and also the consumer more likely to be able to make multiple purchases. It is sometimes suggested that the use of sales as an index for an attractive power to predict future sales involves circular reasoning; but this is no more the case than using number of employees or floorspace as an index' (p. 21).

It was necessary to approximate the attraction index on the same scale for the 7 centres which lie outside the area. This was done by relating numbers using centres for which totals were known to numbers of shops, turnover and number employed in these centres and translating this to a figure for these 7 external centres.

However as the index used should adequately represent attractive power a number of checks were made to examine how closely this was taking place, using the product moment correlation coefficient.

(1) r was calculated for the relationship between the Thorpe Rhodes index, (squared), and the total numbers served for the average durable good, for 169 centres, and was found to be + .95.

(2) The total number of nonfood shops in each centre was correlated with the total numbers using that centre for the average durable good and r was found to be +.91.

(3) In addition the Chi squared goodness of fit test was applied in 1 above and the difference between the two distributions was found to be not significant at the .05 level.

In addition, tests of the adequacy of the attraction index were made for 19 A level centres, for which census data is available:

(1) The correlation coefficient was calculated for the relationship between the attraction indices for durables and the 1961 centre estimated durable turnover. The estimate was made by weighting total turnover by proportion of non food shops, where the data was not directly available. r was found to be + .99.

(2) r was calculated for the relationship between numbers of shops in each centre and the derived attraction indices for durables and was found to be + .95.

(3) r was calculated for the relationship between the durable attraction index and the square of the Thorpe Rhodes index, where R = +.97. However, as 6 of these centres had their indices derived indirectly from some of these mea-

sures, a further test was made with 13 centres on the same relationship as with (1) above, and r was still high at + .97.

Calibration

The basic data consists of 17 matrices of dimensions 150 x 175. Ideally, α should be calculated for each of the 150 wards for all goods. However, this would involve the punching of 150 x 175 x 17 data inputs, which is impossible. This was reduced by (1) reducing the number of goods to 12 and (2) by taking a random sample of wards, which was necessary because of the constraint of some of data input needed. As large a sample as was possible was taken for each good, which was always between 20 and 25. The distribution of the calculated α for each zone (ward) was both normal and peaked, so that a high degree of reliability could be placed on the estimates.

Results

Table 15.1

The average α for each good was found to be as follows:-

		Rank
Mens clothing	1.7216	1
Womens clothing	1.7290	2
T.V.	1.9767	3
Furniture	1.9819	4
Jewellery	2.0035	5
Shoes	2.0037	6
Washing Machine	2.2300	7
Vacuum Cleaner	2.2503	8
Radio	2.3002	9
Hardware	2.5886	10
Groceries	2.6153	11
Chemist Goods	2.6781	12

Average for all durable purchase, together - 1.95

(Generally speaking, a difference greater than .35 is significant at the .05 level though this does vary and smaller differences are significant at lower levels).

This table is a fundamental data source for further model use. It also provides a ranking of goods of relevance to central place study.

The implications of these exponent values are interesting in that they give an indication of the importance of the factor of distance involved in the purchase of goods of different types. In general, the higher the exponent, the more likely it is that the good will be purchased from the nearest available source. A further implication is that goods with a low exponent value have a high social significance in that the customer is more willing to travel for such a good than for one with a high exponent value.

These exponents thus give meaningful measures extracted from a large body of data.

In addition, the ranking of goods is interesting.

The above table partly fills the need outlined by Gambini, Huff and Jenks (1968): 'Very little empirical research has been done to specify various values of the parameter r with respect to different types of products' (p. 92).

Comparison is first here made with results from the earlier parts of the thesis. 11 goods, to which groceries and chemist goods can be added, were ranked for each of Shildon, Crook and Murton by average distance travelled for each good. Here 1 good, Children's clothing, is removed, for compatibility.

The rankings appear thus:-

Table 15.2.

	Shildon	Murton	Crook	Model
Jewellery	1	4	2	5
Womens clothing	2	1	1	2
Mens clothing	3	3	4	1
Furniture/Carpet	4	2	3	4
Washing machine	5	7	6	7
Shoes	6	6	5	6
Vacuum cleaner	7	5	7	8
Radio	8	8	8	9
T.V.	9	9	9	3
Hardware	10	10	10	10
Groceries	11	11	11	11
Chemist Good	12	12	12	12

As has been already observed, the 3 settlements in question show a considerable similarity in ranking in that 3 boundaries are drawn, as shown in table 15.2., then although goods are ranked differently in each of the three settlements, no good changes rank over a boundary.

These 3 ranked distributions are compared with the ranking on the basis of model - derived exponents.
Though this does appear at first sight to be somewhat different, closer inspection reveals that the only good significantly out of place is Television purchase. People seem more willing to travel for the purchase of televisions than other evidence would suggest. However, an explanation for this ranking may well lie within the data. The supply of televisions is a rapidly changing service, particularly with the dramatic growth of television rental in the area, so that

patterns are likely in the first instance to be confused. In the large scale survey, on which material the model was run, information was required about the place of purchase, or rental. It is suspected that replies were frequently given which indicated that the television actually came from the regional head office of the rental company, whilst in fact the order was placed locally. This sort of error was rigorously controlled in the 3 settlements, but no such control was possible in the large scale survey.

Other implications of the model results are that clothing, particularly women's, is confirmed as a high order good and jewellery may not be quite so 'high' as Nadur suggests, although there may well be problems of definition with 'fancy goods' appearing here. The Spearmans Rank Correlation Coefficients were calculated between each of the 4 distributions, and were found to be as follows:-

Table 15.3.

Spearman's Rank Correlation Coefficient

	Shildon	Murton	Crook	α deter.
Shildon	+	.92	.98	.79
Murton		+	.96	.81
Crook			+	.80
α determination				+

It can be seen that the 3 centres are more similar in their movement patterns than any of them is to the model result, though that distribution still correlates highly with all 3. Analysis of the calculation shows that it is the ranking of television purchases which is causing a great deal of the dissimilarity, which has already been partly explained, and to a lesser extent the low ranking of jewellery has an effect. The overall coefficients however, remain very encouraging.

The model produced ranking was compared with a further available ranking from this study, namely the ranking of goods by proportions purchased in the regional centre. The Spearmans Rank Correlation Coefficient was in this case .80.

Thus it can be seen that the results from the model confirm to a considerable extent the empirical findings of central place studies. They also confirm that at present the concept of a hierarchical ordering of goods, as defined here, is not yet adequate to be used with the postulated central place theory: there is both variation in the distance exponent within each good category, and there is no clear 'clustering' of exponents around hierarchical levels.

CHAPTER 16

THE POWER OF THE MODEL

Area of operation

Further analysis of results from the model is now developed with respect to the overall pattern of movement in this area of County Durham. Movement to A level and regional level centres only is isolated from the remainder of the pattern for continued analysis. Movement to this level of centre is the most important single element in the pattern of movement for the purchase of durables. In each ward the percentage of households actually using the centres of this level for particular goods and for all durable goods considered together is taken to be the available population for each ward, thus isolating A and regional level of interaction at the ward level.

The 19 centres included are:

Newcastle
Sunderland
Middlesbrough)
Stockton)Teeside
)
Darlington
Gateshead
Chester le Street
Durham
Consett
Stanley
Houghton le Spring
Washington
Hartlepool
Seaham
Crook
Peterlee
Newton Aycliffe
Shildon
Spennymoor
Bishop Auckland

The location of these centres is shown in diagram 50. Ferryhill and Easington Colliery were not included as

A centres because of their doubtful status.

Tests of the power of the model

Most published work with gravity models has attempted to use the model as follows:
Given: a set of centres and source zones, with data on total sales at each centre and population of each zone, a one or two parameter model is run which attempts to minimise error in some way between predicted and actual sales. Sometimes sales themselves are used as an attraction index (for example, Rhodes and Whittaker, 1967). This method of operation carries a number of serious disadvantages: first and foremost the movement patterns generated by the model are not based directly in any way upon observed movement patterns, as it is not the error between two patterns of movement which is being minimised, but the error between summed results of movement. When change is introduced into the system this can only be reflected in changed totals.

Secondly the above method does not allow for the entry of external influences into the system: the assumption is that all centre sales originate from within the area considered, or at most, external influences areevenly spread. In many ways the model does seem to be of greater use in the intra-settlement case than for centres within an urban area, having relatively more complex movement fields.

Thirdly, because of data problems the model must frequently be used in a situation where convenience and durable good purchase patterns are treated together as Rhodes and Whittaker do. It is very clear from the earlier parts of this thesis that the differences in movement patterns between durable and convenience goods purchase is very considerable indeed, with a probability type of situation being far more relevant in the case of durable goods. It would seem very advantageous to be able to disaggregate to this level at least.

In general it is here suggested that the 'centre sales error minimisation method' of operation, not related directly to movement patterns, whilst in some cases producing results of surprising accuracy, may not be as valuable as it initially appears, without reference to the movement patterns; another facet of this argument is that models are usually run at high levels of areal aggregation, if only on grounds of data availability, which itself will tend to produce good results as random background 'noise' is minimised.

Here the test of the power of the model is carried out on a three-fold basis:

(1) The movement patterns for each and for all durable goods is known from the survey data to a reasonable level of accuracy. The movement patterns generated for each ward are compared with actual movement patterns and the power of the model over space is examined. This answers the question of how well the model replicates a given pattern. It must however be remembered that error can in fact arise both from the model and from the survey results themselves, despite attempts to control the accuracy of the survey by holding error to a constant

level, which was not always successful. Nevertheless the survey results do in most cases represent reasonably patterns of movement.

An examination of residuals is made and explanation is sought for areas of higher levels of error, which in turn modify ideas about the performance of the model over space.

The test of the model is at a very low level of areal aggregation indeed and so a wider range of results, in terms of accuracy might reasonably be expected beforehand than would be obtained from a higher level of data, or a centre summation type of test.

(2) For each centre, the model prediction of the total numbers of households using each centre is compared with the totals derived from the survey. This is a test of the overall allocative power of the model, which has been calibrated using movement data. Initially a one parameter model is used, but this is followed by a two parameter model and a third test is then made:

(3) A two parameter model is calibrated on the 'centre sales error minimisation' basis. The resulting most satisfactory prediction at the centre level is then examined with reference to the pattern of movement which it predicts and the accuracy of this pattern.

These tests, run at low level of data aggregation will provide a thoroughgoing test of the operationalised model. Only movement patterns for all durable goods are considered, as Central Place notions seem more relevant in the case of convenience goods.

The Model

The model outlined in the last chapter is used again in the first instance in this analysis, being the basic one parameter type of model. Later a two parameter model is used.

Distance input is again geometric as there still remains a basic interaction matrix of 150 wards by 19 centres.

For the attraction index, an attempt was made to collect floorspace data from the relevant local authorities and from the County Planning Office. The total return was rather incomplete, most authorities which were contemplating expansion replying positively whilst most of those not contemplating expansion were often unsure of the amounts of floorspace in their local authority.

An alternative measure of attraction was to take total turnover figures for each centre, available in most cases from the census of distribution. However, in most cases there is no breakdown available for durable goods turnover. In an earlier chapter a crude estimate of durable turnover was obtained by weighting the total turnover by the percentage of durable goods shops in each centre, available from the centre surveys.

It was finally decided to use again the total numbers of households using each centre as the basis for the measure of attraction. This is different for the case of each good and an average is obtainable for all goods together. For centres which clearly serve populations outside the area approximation from related census data is necessary. As was demonstrated in the previous chapter the index does seem to be satisfactory when compared with other related measures.

The use of this index also enabled the use to be made of the exponents derived in the previous chapter. The actual values used are given shortly.

Pattern Replication

An important problem in analysis of the spatial performance of the model is that of the choice of the appropriate test to use. One possible question which can be asked is: are the differences in movement patterns, expected and observed, in each ward significant at a given level or not?. This would seem to suggest the Chi square test or the Kolmogorov-Smirnov test. The Chi square test cannot be satisfactorily used in this instance because of the nature of the resulting 2 by 19 contingency tables: many expected cell values fall below 5 and a few are 0, which makes the test inoperable. Amalgamation of groups is possible, but in some cases this makes the results meaningless. The K.S. test is not appropriate both because the results are not of an ordinal level of measurement and because the distributions are not strictly one dimensional. An additional complication is that in each ward the sample size does vary somewhat and tests of significance are based directly upon sample size. It could be argued that a measure of strength of relationship is more appropriate. This in turn raises further problems: the product-moment coefficient of correlation requires that at least one of the two variables is distributed normally. If this data was to be used with this correlation coefficient then transformation is required as there tends to be a small group of very high values and a larger group of low values, including some zeros. The data will not respond to any of the usual transformations so consequently the product moment correlation coefficient has no great reliability. Non parametric methods are immediately suggested, but the most suitable, Spearman's Rank Correlation Coefficient is not appropriate because of the pronounced 'bunching' at the lower end, where order is less important than numerical value. For example, the case of Gilesgate Ward, Durham City, where the following results were obtained:

Table 16.1

Gilesgate Ward: All durable goods trips: Predicted and Observed

Centre	Model prediction	Observed
1.	23	25
2.	11	37
3.	6	3
4.	4	0
5.	3	0
6.	9	11
7.	333	329
8.	1	0
9.	3	0
10.	3	0
11.	0	0
12.	3	0
13.	1	0
14.	0	0
15.	0	0
16.	0	0
17.	0	0
18.	3	1
19.	6	6

The model is clearly predicting well here and is predicting low end values well, but it would appear unreasonable to take precise rank order at this lower end as an important element in the coefficient.

As a consequence of these difficulties an arbitrary but numerically sound method of investigating the relationship between expected and observed values was employed: the absolute difference between each paired value was summed and exressed as a percentage of the sum of the totals of the two distributions. This provides an absolute measure of the size of the error, which ranges upon a continuum with 0% as a perfect prediction and 100% as a completely incorrect prediction. The main disadvantage of this method is that it treats all errors of the same numerical size as having the same weight: for example, the error between a predicted value of 533 and an observed value of 530 has the same weight as an error between values of 8 and 5.

This method of analysis is supplemented by the use of the product moment correlation coefficient, which provides interesting,though technically unreliable results. A grouped Chi square test is run in one instance.

The analysis is throughout based upon the movement patterns for 'all durables', common to the baskets of goods used in the surveys in the two halves of the area. This analysis is supplemented by analyses relating to individual goods. Very considerable preparation of material for each run prevents a multiplicity of analyses.

Results

Inputs

The inputs for the first test, for all durable goods were as follows:

Attraction index

Newcastle	150,000	Washington	3,000
Sunderland	49,200	Hartlepools	22,450
Teeside	75,900	Seaham	3,740
Darlington	37,900	Crook	2,550
Gateshead	16,100	Peterlee	1830
Chester le Street	8,570	Newton Aycliffe	1,700
Durham	12,390	Shildon	1,690
Consett	7,680	Spennymoor	3,860
Stanley	7,640	Bishop Auckland	18,000
Houghton le Sp.	3,300		

There exists one means of attempting to verify the suitability of these attraction indices, which is to compare them where possible with published Census data on turnovers.

This involves multiplication of the total household movement figures by the average 1961 durables goods expenditure per household available from the Family Expenditure Survey. This can then be compared with the 1961 total durable goods turnovers available for certain centres in this area in the Census of Distribution.

This raises two problems. Firstly, the basket of goods used in this survey may not exactly represent proportionally their contribution to centre turnovers. The model is internally consistent, but turnover as such is external to the model.

Secondly, as has been seen, in Chapter 6, estimates of expenditure in this area, derived from methods based upon Family Expenditure Survey data, tend to be over-estimated by about 20%. This figure was derived independently of the work in this chapter. Thus it is reasonable to reduce all estimates by 20 %.

The average annual 1961 household expenditure on durable goods was found to be £351.75. Comparison is made below between turnover calculated from the consumer surveys and 1961 turnovers, where the data is available for non food goods:

Table 16.2

Actual and Predicted turnovers: 6 centres, 1961

Centre	(1) Survey pred. '000£	(2) 80% of(1) '000£	(3) 1961 turnover '000£	(2)/(3) %
Stanley	2884	2307	2464	93.6
Seaham	1195	956	1104	86.6
Houghton	1160	928	1169	79.4
Durham	4326	3460	3501	98.8
Consett	2743	2194	2291	95.8
Bishop Auckld.	5881	4704	4677	100.6

The results are surprisingly good and suggest justification for the attraction indices used.

The assumption can be made therefore that this level of error relates to the remaining 7 centres inside the area. Turnovers can then be estimated for 1968 by the same means:

Table 16.3

1968 estimated turnover in durable goods (£000)

Stanley	£3040	Gateshead	£5969
Seaham	£1260	Chester le St.	£3403
Houghton	£1223	Washington	£1112
Durham	£4560	Crook	£927
Consett	£2892	Peterlee	£678
Bishop Auckld.	£6200	Newton Aycliffe	£630
		Shildon	£601
		Spennymoor	£1409

It is believed that these estimates represent the turnovers in durable goods in each of the above centres in 1968 to a fair degree of accuracy.

Distance

Straight line, geometric. Distance exponent 1.95.

Wards

Household populations which are involved in interaction with this level of centre only. Overall population: 73%.

Output

For the area as a whole, the overall absolute size of error was found to be 27% which is to say that the model is replicating 73% of the movement pattern. This compares well with an overall r^2 value of .75 . This error is encouraging. It can so far be assumed that from the point of view of the centre totals, the errors will tend to cancel out.

Diagram 52 shows the distribution of error values and reveals that they are not evenly distributed over the whole area. In general, there is a tendency for the model to predict worse in the south and east and better in the north and west. North Durham predicts slightly better than South. There are about 12 wards where the sample size falls below 20. These have received special treatment in that the calculated error for these wards has been weighted by the size of error in the wards which are immediately adjacent, which has the effect of smoothing the pattern slightly. Diagram 52 is supported by diagram 53 which shows the r^2 values for each ward, which represent the level of statistical explanation. The pattern is very similar indeed to the preceeding diagram, suggesting that the measure could be used, in spite of technical unrelia-bility.

Examination of these residuals is now undertaken and attempts are made to explain them, which in turn will help provide some understanding of the limitations of the model.

The two above diagrams suggest in general, that the greater the number of centres competing effectively in an area, the worse it is that the model predicts. Diagram 54 provides an indication of the level of residual compet-ition throughout the area, for all durable goods. It is compiled by subtracting the two largest probabilities of interaction in each ward from the total probability, 1, and plotting this as a residual as shown. It thus indicates the areas which are not dominated by one or two centres, indirectly, the areas of most intense multi-directional competition - which are the areas with the highest values in the diagram.

It does thus seem reasonable to relate level of competition to the performance of the model, but this alone is not sufficient to explain the main areas of error.

Firstly, considering the poorly predicted area in the south east of the area: this is an area of confused move-ment patterns. This arises from a number of causes. First, the proximity of Teeside causes some of the bad prediction: decline in interaction with Teeside is greater than either the model or a priori reasoning would suggest, for reasons already discussed. This is confirmed by analysis of the results which show that the model tends consistently to overpredict interaction with Teeside from these south eastern wards. Secondly, there is in this area, a large number of centres all exerting a considerable influence: Hartlepools, Peterlee, Seaham, Teeside, Sunderland and Newcastle; this will, under the above general argument, tend to lower the power of the model. Thirdly, there is a noticeable consistent tendency by the model to overestimate interaction with Newcastle, in this area, and to underestimate interaction with Sunderland. This can be partly explained by the configuration of transport routes to the two centres. Sunderland is relatively more accessible than Newcastle than would be suggested by straight line distance. This is not necessarily a failing of the model but of the nature of the inputs, which could be changed. It could also alternatively mean that there is a distance threshold over which size of centre is less important if there is a nearer possible alternative. This sort of analysis is beyond the scope of this work. The coastal communications route, direct to Sunderland, is very important in this area. Fourthly, there is the problem of Peterlee: in common with most New Towns, there is a rapidly changing pattern of movement in and around Peterlee, as new centre- distance concepts grow up and are expressed in changing movement behaviour. The model predicts that Peterlee will retain nearly 50% of the durable trade from within the town itself, wheras the figure is nearer 25% in reality, with Sunderland competing effectively, which is grossly underpredicted by the model. Horden, immediately adjacent, also exhibits the same sort of movement pattern with respect to Peterlee, though to a less developed extent. The model is not designed to incorporate the effects of a very dynamic situation without modification of the inputs. In Peterlee there is both rapidly changing patterns of movement and rapidly changing patterns of retail service provision.

Thus in general it does seem possible to explain the breakdown of the model in this area.

A second area of bad prediction around Houghton le Spring must also be explained. Examination of the results reveals that the model over-predicts interaction with Houghton and under-predicts interaction with Sunderland. This is probably because the Houghton area is crossed by a very fast communications route between Sunderland and Durham, which has the effect of bringing both closer to Houghton than the geometric distance would indicate. It is also an area of considerable competition from a number of centres all at a relatively close range.

A third area of bad prediction is the central western area, in the hills: Cornsay, Tow Law, East Hedley Hope and Sunniside. This is also an area of considerable competition, though from many centres all at a distance. The relative isolation of the area means that the frequency and direction of transport media plays a very important role in determining consumer movements, partly destroying the effect of simple linear distance. Other explanatory factors can also be introduced: This is an area of rapid economic and social change, in this case of decline, based upon the disappearance of the coal industry and the effect of the settlement grouping policy; there are now long journeys to work and there is a growing agricultural element in the economy, having different movement patterns from the less rural elements in the economy.

A fourth area in the extreme south: Bradbury, Stillington and surrounding parishes also predict worse than many areas. This again may be the consequence of being essentially agricultural areas, which, as argued earlier, tend to have rather different movement patterns as compared with densely populated industrial areas. This arises from generally longer movements, both for convenience and for durable goods, and as a consequence a greater tendency appears to shop at the nearest available source, more in line with Central Place notions.

The small area of bad prediction near to Shildon is due in part to the complicating factor of the unusually close proximity of Bishop Auckland.

The Chilton-Ferryhill area does not predict too well. This is mainly a consequence of being located at one of the most intense points of competition in the area. It is no accident that there is in fact a weak A level centre located here.

Certain areas do predict better than otherwise might have been expected: Newton Aycliffe, another New Town, appears to have a more settled movement pattern than Peterlee. Durham City, one of the few areas of significantly different social composition also predicts surprisingly well, as indeed do the Bishop Auckland No. 3 and 4 wards, which are also relatively high status areas. Sedgefield, another high status area does however predict badly.

The tendency of the Pareto function to overestimate short distance interaction does not appear strongly here, perhaps because in this, a relatively poor area, small centres are able to compete effectively over short distances, with a rapid fall off, effort minimisation being relatively important.

The analysis is repeated for a single good, Furniture, and diagram 55 shows the result. Most of the foregoing observations apply in this case. In general, the model does not perform so well for this one good case. Men's Clothing purchases show a very similar pattern, with a slightly worsened performance. There appears here an additional area of bad prediction between Durham and Sunderland where the model is in fact tending to underpredict interaction with Sunderland and over-predict for Durham and Chester le Street. This is probably because a unit of attraction for a relatively high order good such as furniture does not have the same meaning in Sunderland as it does in Durham and in Chester le Street, because of much greater choice, larger stores, etc..

An additional analysis was made in order to examine the variability of the fitted distance exponent over space. Diagram 51 shows the result of the calibration of the model for each individual ward in South Durham. The exponents were fitted for all durable goods movements, and individual fitted exponents naturally give a good fit in the case of almost every ward, but that is not the aim of the model: the aim is to provide a general case model which will predict adequately. The average exponent for these 79 wards in this area is 2.12 . The calibration was only undertaken in the southern half of the area because of the huge amounts of data preparation necessary for this run alone. With individually fitted exponents the product moment correlation coefficient in each ward is usually in the range of .96 to .99, and rarely falls below .90 . The magnitude of both positive and negative deviations from the mean is shown in diagram 51 . This diagram reveals that the accuracy of prediction in any one ward does not only depend upon the degree of exponent deviation from the average, for that ward. Durham and Bishop Auckland areas have fitted exponents which deviate considerably from the mean, but do predict well. Wingate, Hutton Henry and Trimdon have near average exponents, but predict badly. This seems to be because of the effect of the pattern of location of centres: in certain locations, quite wide deviation from the average in the distance exponent will not greatly affect the distribution of trips. For example, close to large centres, the centre will continue to exert a strong influence over a considerable range of exponent values. Another example is that of the 'isolated' area, such as the Etherley and Escomb wards, where Bishop Auckland effectively stands between them and other centres.

The distribution of the variation in the exponent is also interesting. There appears to be a trend for areas <u>between</u> centres to have <u>positive</u> deviations and for areas <u>closer</u> to centres to have <u>negative</u> deviations. This in effect means that for households in areas between centres (e.g. Ferryhill, Pittington, Brandon North and Cassop), movement to the <u>nearest</u> centre is a more important element than the general case model would allow. In the case of households close in to centres, it appears that they are somewhat less dominated by the local centre than the model would suggest. For example, households in Crossgate ward, Durham, do shop in Newcastle for a percentage of their durable goods.

The more rural areas in the south have high positive values, which emphasises the importance of distance to communities in this area. This has implications for Central Place theory.

Allocation of households to centres

The allocation of expenditures to centres is usually of greater interest to the planner than the ability to replicate a pattern of movement, though it is here argued that these are really both aspects of the same problem of prediction.

Models in use are usually calibrated in a way which minimises the error between actual and predicted sales in a set of centres. Problems involved with this have already been discussed. This usually means that durable and convenience purchases must be considered together, because of data problems. However, here, from survey data it is possible to derive totals of households using each centre for each and for all goods, to a high degree of accuracy, with random sampling errors tending to cancel each other out, the sample being unbiased.

Here interest is focused upon the ability of the model to replicate total numbers of households using each of the 13 centres within the area and also of the 6 outside.

Data for the turnovers of centres in durable goods is not available for all centres, from the census, and as the area is fairly homogenous socially, the usually employed methods of weighting population flows by expenditure, derived from a measure of percentages of occupied males in professional and managerial occupations, is not really relevant. However, as part I of the thesis demonstrated, there are differences in movement patterns between different social and economic groups; for example, the effect of the presence of a relatively high status area within a ward is to weight positively the flows to larger centres and to weight negatively the flows to smaller centres.

Here the analysis is conducted on the basis of the ability of the model to replicate net household movement totals.

Interest is focused upon the 13 centres that lie within the area, as prediction will not be so greatly confused by externality problems. The following table shows, for each of the 13 centres, and the other 6 together, the number of households which empirically were found to use each centre, for the purchase of durable goods, and the number of households allocated by the one parameter model, fitted with the derived exponent from ward interaction analysis, of 1.95. The attraction indices used were shown earlier in the chapter:

Table 16.4

Actual and predicted numbers of households using 13 centres in County Durham in 1968. The prediction is made by a one parameter gravity model.

Centre	Actual numbers	Model prediction	Model / Actual %
Chester le St.	8570	8909	104.0
Durham	12390	11655	94.1
Consett	7680	9066	118.0
Stanley	7640	9035	118.3
Houghton	3300	4608	139.6
Washington	1990	2800	140.7
Seaham	3740	5154	137.8
Crook	2550	3376	132.4
Peterlee	1830	4254	232.5
Newton Aycliffe	1700	2535	148.1
Shildon	1690	2578	152.5
Spennymoor	3860	4828	125.1
Bishop Auckland	16720	13389	80.1
Regional and sub-regional centres	64380	53844	83.6

(The sums of the two above columns are slightly different because of rounding errors)

It is clear from the above table that from the point of view of the centres the model is not predicting satisfactorily. Closer inspection reveals that this is because the model is consistently overpredicting interaction with smaller centres and underpredicting interaction with larger ones, with the exception of Bishop Auckland.

As this is the best fit one parameter model, it appears that it is necessary to introduce a second parameter, in the form of an exponent fitted to the mass index.

A Two Parameter Model

The program was re-run with different exponents fitted systematically to the mass index and a range of distance exponents were fitted systematically with each individual mass exponent until the error described below was minimised. This is the basis of the two parameter iterative search procedure. The model was run over the ranges of mass exponents: .8 to 2.0 and distance exponents: 1.2 to 3.0, with incremental steps of .1 . The best fit was taken to be the point at which the sum of the squared differences between expected and observed values for centre totals was minimised:

$$\text{Minimise:} \quad \sum_{j=1}^{n} (AV - PV)^2$$

Where:

AV: observed totals at centre j. (For 13 internal
PV: predicted totals at centre j. centres)

This is essentially the same method that Huff and Blue(1965) use .

When calibrating using this method the constraint that $\Sigma \; S_{ij} = S_j$ must hold is satisfied because the interactions and the centre totals originate from within the system being utilised.

The search procedure showed a convergence towards the finally accepted values of 2.3 for the distance exponent and 1.4 for the mass exponent.

The model thus now appears:

$$P_{ij} = \frac{S_j^{1.4} / D_{ij}^{2.3}}{\sum_{j=1}^{n} (S_j^{1.4} / D_{ij}^{2.3})}$$

The implication of a mass exponent of this size was discussed in the theoretical chapters.

The model now produces the following predictions:

Table 16.5

Actual and predicted numbers of households using 13 centres in County Durham in 1968. The prediction is made by a two parameter gravity model

Centre	Actual numbers	Model prediction	Model / Actual %
Chester le St.	8570	7324	85.5
Durham	12390	10628	85.8
Consett	7680	7321	95.3
Stanley	7640	7516	98.4
Houghton	3300	3342	101.2
Washington	1990	1793	90.1
Seaham	3740	4426	118.3
Crook	2550	2926	114.7
Peterlee	1830	2920	159.5
Newton Aycliffe	1700	1819	107.0
Shildon	1690	1963	116.0
Spennymoor	3860	3892	100.8
Bishop Auckland	16720	14005	83.7
Regional and sub-regional centres	64380	66156	102.7

The above prediction is regarded as an acceptable fit and can be used for further work. The overall r^2 for the above figures is .992 .

The implication of using a mass exponent of 1.4 in the model is that Newcastle, and to a lesser extent the sub-regional centres, are more attractive than their relative size would suggest. This can be related to the observed underlying level of regional centre competition which has been observed throughout the area. A mass exponent of 1.4 and a higher distance exponent of 2.3 has the effect of cutting down the interaction fields of all of the smaller centres when compared with the results of the one parameter model. It also means that the model breaks down slightly in the case of centres which do fulfil a considerable central function but are much smaller than the higher level centres. The cases of Durham and of Bishop Auckland are particularly relevance here, where the model is underpredicting.

Other discrepancies deserve attention: All 3 New Towns are over predicted, as might be expected. Peterlee however is the most serious error of the model, where the overprediction is 59.9%. This is simply a function of the rather unique circumstance of Peterlee, where there is a very high level of interaction with outside centres from households within the town. Peterlee retains only about 27% of its total durable goods trade, wheras the model is allocating nearer 50% to Peterlee centre.

The model overpredicts for Shildon and underpredicts for Bishop Auckland. Shildon is of course very close indeed to Bishop Auckland.

The important question must now be raised of how accurately are movement patterns predicted, over space, when this 'centre sales error minimisation' method is used. This is important because any attempt to predict into the future using a model which generates an incorrect pattern of movement and interaction, whilst satisfactorily allocating to centres carries certain risks. Diagram 56 shows the performance of the two parameter model by wards.

This diagram is important because it shows that if the model is calibrated at a centre level, then serious errors in pattern replication can occur. The diagram shows that although prediction at the centre level has improved considerably, the overall performance of the model in replicating spatial patterns does not improve very much. There is aslight overall improvement to 23% error from 27% for the one parameter model.

The spatial distribution of errors is very similar to that from the one parameter model and so it is argued that the explanations of these residuals offered earlier can still be assumed to hold. However, interaction fields do change somewhat: this is partly the concern of the next chapter.

Finally, a chi square test of significance was used to test whether or not the differences between actual and predicted values for each ward, using the two parameter model, were significant at the .05 level. The difference was found to be not significant in 119 wards, or about 80% of the cases.

Apart from the analysis of the limitations of the performance of the model, it would however appear that an interaction model based upon the assumption that:
The probability of a consumer travelling to shop, from point of origin, i, to centre j, one of a set of centres, J, is:

(i) directly proportional to a function of the size of the centre j,

(ii) inversely proportional to a function of the distance, ij,

(iii) inversely proportional to competition from the other centres in the set J,

is reasonably successful in 'explaining' customer movement patterns, and in allocating trade to centres, in County Durham.

CHAPTER 17

PROBABILITY SURFACES AND TRADE AREAS.

Fields of movement to particular centres can perhaps be best represented as probability surfaces. Surfaces have been most commonly used to portray population density distributions; they have also been used by Haggett(1965) to describe land use. Von Thunen's rings are also a simple form of surface. A surface is essentially a portrayal of some phenomenon in three dimensions. Two dimensional cross sections have been used earlier in the thesis to represent certain features of movement patterns, and here the analysis is extended into the third dimension, where interest develops from such features as change in gradient along a linear axis to spatial variations in slope. Contours provide a suitable means of representation of surfaces.

Here, individual ward point probabilities are used as the basic material for the construction of surfaces, in this case not of density, but of the probability of interaction. Huff and Jenks(1968) have provided theoretical examples of the nature of various surfaces deriveable from a gravity model formulation. It is further contended that the only hitherto meaningful definition of trade area is one based upon the approp- riate interaction probability surface.

Surfaces

Diagram 57 shows, for all durable goods, for the case of the one parameter model, probability contours for the 19 centres under consideration. The diagram should properly be regarded as the resulting surface from the intersection of 19 separate probability surfaces. This point is taken up again shortly. The umland boundaries shown are also discussed later in this chapter; at the moment it is the pattern of contours which is under consideration.

The diagram illustrates a number of general points. Firstly, in accord with expectations using a Pareto formulation, contours tend to be closely packed around a centre and there is a decreasing gradient with increasing distance. Secondly, it also appears that those centres in closer proximity to the larger regional level centres tend to have steeper slopes than comparably sized centres further away from regional centres. Compare Chester le Street with Durham for example.

Thirdly, contours tend to be closer together in directions where competition is closer than in directions where it is more distant, Spennymoor providing a good example in relation to Bishop Auckland.

Fourthly, bearing in mind the above observations, it does appear that gradient of slope is inversely related to centre size.

Fifth, 16 centres, the exceptions being Darlington, Gateshead and Hartlepools, are able to exhibit some degree of upward slope. These three centres have their own probability surfaces completely submerged under the general surface.

Lastly, the diagram reveals clearly that the A level centres are placed as residuals upon the underlying surface of regional centre interaction.

Diagram 58 shows a general probability surface for the two parameter model (mass 1.4 and distance 2.3). All of the preceeding observations are still relevant, but certain differences do appear. There is a general steepening of interaction decline gradients around A level centres and a slackening of gradient for regional centres. In addition, the lowest contour on this diagram is .3 and on the preceeding diagram .2 . The surface of Hartlepools appears on this map. Probabilities of interaction with Teeside are also higher, though the base level is higher.

The one parameter model was re run for a single good, the high order good of womens clothing. The exponent used is 1.72 and the attraction indices are altered for the type of good; the resulting surface is shown in Diagram 59. The result is interesting in that it seems to contain elements of both preceeding diagrams. The base level for the surface is at a higher level than is the case for the single parameter all durables case, because regional centre influence is very strong for this good. However, Bishop Auckland is able to maintain or even extend its surface. Surprisingly, contours around individual A centres do not seem to be closer to each other than in either of the two preceeding diagrams, though lower level contours are now submerged. This is partly due however to the fact that probabilities at the centre itself are generally lower than in the preceeding cases. This can clearly be seen in the cases of Peterlee, Stanley and Seaham. Correspondingly, some surfaces do disappear altogether, namely, Hartlepools, Houghton and Newton Aycliffe. The contours indicating upward slopes to regional centres are bolder and more regular, suggesting greater competitive power.

These general surfaces are however the product of the intersections of 19 separate surfaces. As such, much is concealed below the general surface. An examination is here made of certain individual centre probability surfaces.

Diagram 60 illustrates the probability surface for Newcastle, for all durable goods, for both the one and the two parameter case. In both diagrams there is a general downward slope southwards, and gradient also decreases southwards. Slopes are extremely steep in the northern part of the area, though the Ryton - Blaydon area lies on a plateau of high probability, discovered already from empirical observation, by Nadur. This surface, and to a lesser extent the surfaces of Teeside, Darlington, Sunderland and Hartlepools, represent the underlying regional centre competition, upon which the A level centres sit. There are differences between the one and two parameter cases: the overall level of the surface is higher in the two parameter case. However, in the two parameter case the 'holes' occupied by the A level centres are correspondingly deeper, but are little different in areal extent. This amounts to saying that A level centres are able to compete effectively over short distances over a range of exponents. Also revealed is the importance of Bishop Auckland in serving a remote but extensive corner of the area. Probability contours relating to Newcastle all 'bend' around Bishop Auckland.

Diagram 61 shows the individual probability surface for Teeside. It is noticeable that the decrease in gradient northwards is not as great as might be expected. This arises from the truncation of the influence of Teeside in County Durham, which has already been discussed. It is only the .05 contour on this surface which wraps around the A centres in a similar manner to that of Newcastle. In general interaction with Teeside appears to be a less complex phenomenon than interaction with Newcastle. Nevertheless, the interpenetration of these two surfaces is considerable, particularly in the south east corner, noted already as a complex area.

Diagram 62 shows the probability surface for Bishop Auckland, for the two parameter model. Here in fact differences between the two and one parameter cases are less pronounced. The diagram reveals that the areal extent of the interaction surface of Bishop Auckland is very considerable. 3 centres, Crook, Shildon and Spennymoor lie within the .1 probability contour, and though the gradient towards these centres tends to be very steep indeed, the holes produced in the surface are not very deep.

Diagram 63 shows the probability surface for Durham City, for durable goods. Durham has a surprisingly extensive influence, much concealed in the general surface case. Its influence is more extensive in an east west direction than in a north south one, providing a theoretical explanation for a phenomenon noted already empirically. Again the spacing of contours is as would be expected from a model based upon the Pareto function. Durham's influence is able to extend in a south easterly direction, reflecting the lack of an A level centre in this area. This theoretical surface has a considerable correspondence with reality: surprisingly perhaps, interaction was found empirically with Tow Law, Cornsay and East Hedley Hope.

Diagram 64 shows the probability surface for Chester le Street again for all durable goods. Chester le Street faces very severe competition indeed, producing steep gradients. However, a shadow effect south of Chester le Street, noted by Nadur, emerges from the theoretical postulates of the model. Competition gives rise to a very circular shape of contour, a marked feature of all of the centres in the north of this area.

Diagram 65 shows the surfaces of Spennymoor and of Seaham, for the two parameter case only. Very steep gradients indeed are evident, with even steeper gradients towards immediate competitiors.

These individual surfaces have served to emphasise the underlying complexity of diagrams 57 and 58.

An alternative way of viewing the general surface is to consider its reverse, to illustrate where the areas of most diverse competition lie. Diagram 66 shows such a result for the case of women's clothing purchase, using a one parameter model. The diagram was constructed from point probabilities, derived by subtracting the sum of the two highest interaction probabilities from the total probability of 1, the remainder being the value used. The higher the contour, the greater the level of residual competition. This reveals that the areas of highest competition are 3 in number: a wide belt stretching in a south-westerly direction from the southern coastal area, reaching its highest point, significantly in Ferryhill parish. It is in this belt that many of the B centres lie: Horden, Blackhall, Wheatley Hill, Wingate, Coxhoe, Thornley and Sedgefield, as well as Easington and Ferryhill, weak A level centres. It would seem that there was a place for a large A level centre, central to this area, with good access, certainly before the construction of Peterlee, which does not serve the area.

Secondly there is an area of strong competition to the west of Durham City, where direction and frequency of bus services to each of the rather distant centres is probably the major factor in deciding consumer orientation.

Thirdly, there is an area of high competition in the area between Chester le Street and Houghton le Spring. This seems to be caused by the close proximity of many centres all competing equally.

Trade Areas

It is here contended that with the partial or complete breakdown of the formal central place model in an area, any attempt to delimit trade areas on the basis of 'explicit extremisation of behaviour', not allowing for alternative choice, is inadequate.

Trade areas can be better considered as probability surfaces, as has been illustrated. There is however a link with earlier trade area studies, through the concept of umland, introduced by Godlund(1954).

The umland of a centre is defined as the area over which the centre has the dominant influence. This is illustrated in diagram 67, based on Godlund (1954). Applying the concept to this area, it follows that umland boundaries can be drawn where lines of equi-probability can be drawn. By definition this must include all areas lying within the .5 contour surrounding a centre, but will include lower probabilities for any case with more than two centres. This is a more sophisticated boundary than that obtained by Converse (1949).

Diagrams 57 and 58 have umlands marked. It can be seen in the two parameter case the umland of Newcastle has expanded at the expense of all other umlands when compared with the one parameter case.

In the two parameter case, the umlands of the northern centres are more nearly circular than the more southern centres, a product of competition intensity. The umland of Newcastle appears to be extremely complex indeed, and cannot be adequately portrayed cross-sectionally.

An interesting feature is the way in which Bishop Auckland extends its umland eastwards into the area of high competition noted earlier. It can also be seen that the three centres surrounding Bishop Auckland have rather small umlands, as they face both regional centre and closer competition.

Consett tends to extend its umland westwards towards the rural areas which interact with Consett more than might be expected.

If umlands are redrawn using wards boundaries as the base instead of contour lines, then the single parameter model produces the umlands shown in diagram 68. This can be compared with the umlands derived empirically for all durable goods, shown in diagram 68, and as can be seen, the fit is fairly good.

Umlands are also here drawn for a regional centre good, women's clothing, using a one parameter model. The result is indicated in diagram 59. The regional level centres have become more dominant, both because of a lower distance exponent and an attraction index weighted more heavily in favour of the regional level centres. Some umlands disappear completely: Newton Aycliffe, Houghton le Spring, Washington and Hartlepool; all A level centres have smaller umlands than in the all durables case, again with the exception of Bishop Auckland.

Trade areas, and umlands, as Godlund emphasises, are dynamic features. One advantage of the gravity model formulation is that change can easily be incorporated into the system and a result derived.

Trade areas defined three dimensionally as surfaces are possibly the most meaningful way of defining an otherwise difficult concept. Interpenetration of trade areas and the relation of this to consumer decision processes provide an interesting and vital research area for the development of theory.

CHAPTER 18

PREDICTION

Gravity Models are used increasingly as tools for predicting the effect of changes in a system of shopping centres and consumers. Here the calibrated model is used to predict future shopping patterns in this area of the County.

Dynamic aspects of model use

The following inputs can be varied when using a calibrated model to predict into the future:

(1) The pattern of provision of retail outlets.

(2) The populations of zones.

(3) The amounts of available expenditure.

(4) The exponent values.

In the theoretical chapters of this part of the thesis it was argued that the 'explanatory' power of the model really lay in the values given to the exponents fitted. The problems of including change by varying number (4) above, are many. Firstly, until the value of the exponent has been fully explained independently of its use in the model it is dangerous to predict changes in the value of the exponent. Secondly, it would appear that there is an inverse relationship between the size of the distance exponent and levels of economic development. This means that with increasing levels of development travel becomes easier; this trend has been observed in various parts of the world; it would however seem that a reverse trend may possibly be setting in as problems of congestion and competition for facilities grow, tending to raise distance exponent values.

Thirdly, there are no long term reliable studies in changes in the distance exponent over time, so that even extrapolative prediction becomes difficult.

As a consequence, nearly all users of gravity models assume that exponents will remain constant over time, which they will not.

By way of investigation of the effect of falling distance friction, the distance exponent in the one parameter model was arbitrarily lowered to 1.30, and the resulting probability surface is shown in Diagram 69. This surface should be compared with Diagram 57, constructed with a distance exponent of 1.95. The picture is now rather different. Interaction with Newcastle has increased both in extent and intensity. A level centres compete much less effectively, with relatively low probability contours near their centres and much smaller umlands.

The umlands of a number of centres have disappeared. Gradients are less steep however, indicating that individual probability surfaces of all centres extend over larger areas, concealed under the general surface, and examination of individual cases confirms this. With a falling distance exponent there are wider movement fields at lower levels of probability.

Predictive runs

The exponents are not altered for runs of the model into the future. This is probably the best solution to an awkward problem.

Of the three other modifications of inputs possible, changes in the patterns of expenditure are not introduced, as the model is primarily dealing with household movements. It should be noted that there will probably be a very slight increase in the proportion of expenditure on durable goods as compared with convenience goods, over the period 1968-1985, assuming small increases in standards of living.

Changes in the distribution of population are introduced into the model. Trends in population change over the period 1951 to 1966 were extrapolated for 1985, for local authority areas, and fed into the model on a ward basis. New towns received special treatment in that their population estimates for 1985 were obtained direct from the development corporation concerned. Changes of population over the period will nowhere be dramatic, other than in the New Towns. In general population will decline in the west and grow slightly in the east. Certain areas will grow relatively rapidly, notably Durham City, Chester le Street U.D., Durham R.D. and parts of Easington R.D.. Greatest declines in population will probably occur in Tow Law U.D. and Crook and Willington U.D.

The main concern was with the change in the pattern of retail service provision to some future date, 1985 being chosen. The 19 local authorities involved were approached for information regarding proposed increases in shop floor area over the period 1968-1985. This was unfortunately not always available, though it is believed that centres which will experience major positive changes have all been included. The County Planning Office was able to assist with estimates in some cases. The information required was for increases in gross floor space, As requirements of confidentiality about precise floor areas were made in some cases, only the proposed percentage increases or decreases in shop floor area over the period are presented here:

Table 18.1

Changes in Gross retail floorspace 1968 - 1985.

Newcastle Central area	+ 9%
Sunderland Central area	+16%
Teeside Central areas	+43%
Darlington C.A.	+42%
Gateshead C.A.	+37%
Chester le Street	+19%
Durham	+ 8%
Consett	+ 9%
Stanley	0 ? believed to be negative
Houghton	0 ? believed to be positive
Washington New Town	+350% (in comparison with present U.D.total)
The Hartlepools	+17%
Seaham	0 definite with probably some decline
Crook	0 definite, with probable decline
Peterlee	+120% estimate only
Newton Aycliffe	+220%
Shildon	-46% estimated decline
Spennymoor	? 0
Bishop Auckland	+ 3%

Thus it is the New Towns, Teeside and Darlington where the pattern changes significantly.

The 1968 attraction indices were weighted by these increases and raised to the power 1.4. This, method involves certain assumptions about the 'attractiveness' of new development as compared with existent shop floor area.

Comparison can then be made between the 1968 and 1985 model predictions. The 1968 2 parameter model prediction was regarded as acceptable, though some centres had better fits than others. This fact becomes less important when percentage change in trading position over the period is considered. The estimates for the new towns must be treated with caution.

The results for 1985 are as follows:

Table 18.2

Change in movements of households, 1968-85.

Centre	(1) 1968 totals (households)	(2) 1985 prediction	(3) % change	(4) proposed % shop area change	(5) col (3) col (4)
Chester le St.	7324	7584	+ 3.5	+19.0	-15.5
Durham	10628	10554	- .7	+ 8.0	- 8.7
Consett	7321	7583	+ 3.6	+ 9.0	- 5.4
Stanley	7516	6637	-11.7	0	-11.7
Houghton	3342	3005	-10.1	0	-10.1
Washington N.T.	1793	12623	+600+	+350+	$$
Seaham	4426	3876	-12.5	0	-12.5
Crook	2926	2440	-17.6	0	-17.6
Peterlee	2920	8091	+177	+120.0	+56 $$
Newton Ayc.	1819	6788	+273	+220.0	+53
Shildon	1963	1205	-38	-46.0	+ 8.0
Spennymoor	3892	3526	- 9.4	0	- 9.4
Bishop Auck.	14905	12664	- 9.6	+ 3.0	-12.6
Regional Centres	66156	66322	+ .3		

($$ - treat with caution: refer to the following text).

The general interaction surface for 1985 has been calculated and constructed, and is shown in Diagram 70, based on the above 2 parameter model.

In table 18.2 column (3) gives an indication of the expected net addition to the trade of each centre, when compared with the situation in 1968. Column (4) indicated the sizes of proposed increases in shop floor areas and column (5) gives an indication of how successful or not proposed changes will be, on the basis of model predictions, Positive numbers represent a better trading position than in 1968, negative numbers a worse trading position.

It must be remembered that the predictive runs of the model are based primarily upon the predicted changes in total number of households using a centre, and as such the percentage changes shown in column (3) of table 18.2 are most reliable. However it was suggested in the previous chapter that the actual totals of households using a centre did in fact, when multiplied by average durable expenditure per head, give a good approximation of the durable turnover of certain centres.

In view of this fact, an extension can be made to these figures by making an estimate of probable 1985 turnover in each of the 13 centres which the model can meaningfully predict for. This is provided in the table below, which gives turnovers at 1968 prices, for durable goods only.

Table 18.3

Predicted turnovers 1985, for durable goods, at 1968 prices.

Centre	1968 turnover (£,000)	% change in trade	1985 turnover (at 1968 prices) (£,000)
Chester le St.	3403	+ 3.5	3522
Durham	4560	- 0.7	4528
Consett	2829	+ 3.6	2996
Stanley	3040	-11.7	2684
Houghton le Sp.	1223	-10.1	1087
Washington	1112	-----	4681 $$$
Seaham	1268	-12.5	1102
Crook	927	-17.6	764
Peterlee	678	-----	3000 $$$
Newton Aycliffe	673	-----	2517 $$$
Shildon	601	-38.0	373
Spennymoor	1409	- 9.4	1290
Bishop Auckland	6200	- 9.6	5667

($$$ - not calculated on a % basis, but direct from movement figures because of problems of changing assumptions)

Individual Cases.

The case of each centre is now examined in detail, with reference to tables 18.2 and 18.3.

Chester le Street has a planned expansion of 19% over the period. The model suggests that this is excessive and that Chester le Street is near optimum size. The predicted increase in trade is only 3.5%. Chester le Street is likely to suffer more than most centres should the value of the distance exponent fall, as is likely; Newcastle is in a very powerful position to capture the trade of Chester le Street should this occur.

Durham City rather surprisingly shows a small net fall in trade over the period, despite an 8% increase proposed in the shopping provision. Analysis of ward figures reveals that this is because of an intensification of competition on all sides, with increased losses to Teeside, Newcastle and Chester le Street. The implication is that development in Durham must be treated with caution, though it may be the case that more extensive development may be more successful in resisting all-round competition.

Consett, according tothe model, will experience a small net increase in trade due to a slightly improved competitive position with regard to the regional centres after internal development. Any fall in the value of the distance exponent will destroy this.

Stanley, according to the model, should experience a net loss of trade, principally lost to Gateshead, Consett and Chester le Street, rather than to Newcastle, which retains its share of the trade of the Stanley area at a fairly constant level, though making some gains to the north of Stanley. Stanley's problems are made slightly less serious by the fact that there is a fairly large proportion of low order goods shops in Stanley, which will suffer less than higher order goods shops if the value of the distance exponent should fall. However it seems that trade will be lost by Stanley, particularly as part of the loss is accounted for by population decline in the surrounding area.

Houghton le Spring also exhibits a considerable loss of trade. Washington New Town is responsible for some of this loss, though at a very low level, and mainly from areas to the north and east of Houghton. It is literally a case of probabilities of interaction with Washington being raised from nearly nil to between .05 and .1 in the area to the north of Houghton. Sunderland extends its influence slightly and Durham remains at the same level of competition. However, any drop in distance friction will certainly benefit both Sunderland and Durham, particularly in view of the fact that this is the main communications axis throughout the area.

Seaham loses 12.5% of its trade according to the model. This is to Sunderland and also noticeably,to the southern sub regional centres, Teeside and the Hartlepools. Peterlee encroaches a little on the southern edge of Seaham's field, though Teeside remains more important as a competitor than Peterlee. It is very possible that the southern centres might extend their influence up this east coast area, with a well developed coastal communications axis. A fall in population in Seaham U.D. will also contribute to the loss.

Crook shows a relatively large loss of trade, at 17.6%. This loss appears to arise in equal measure from population decline in the Urban District and to increased competition from Darlington and from Teeside, reducing even Crook's interaction with Newcastle. Bishop Auckland maintains an even proportion of trade captured from the Crook area. Thus it seems that the trading position for shops in Crook will worsen considerably over the next decade. This is reinforced by the relatively strong multiple store competition inside Crook, especially for convenience goods.

SHildon will face very severe competition by 1985, according to the model. This is based upon the assumption that the present gross overprovision of retail facility will decline. Competition will increase markedly from Teeside, Darlington, and especially from Newton Aycliffe, in close proximity. Bishop Auckland will expand its already underpredicted influence into the Shildon area. It is expected that the fall in shopping provision over the period will be in the order of 45%, which is overoptimistic, but drastic cuts in shopping provision would seem to be appropriate and probable. There is likely to be a net population decline in the area of 3,5 - 4.0% which will contribute to the worsened situation.

Spennymoor faces a decline in trade of 9.4%. This is interesting in that analysis by ward reveals that the competitive position with respect to other centres deteriorates only slightly, in favour of Darlington and Teeside. Most of the decline comes from a predicted net population decline of 3.5% in the Urban District. This would seem to suggest that Spennymoor is one of the more favourable locations for investment designed to reduce population decline, particurlarly as it is near to the A1 road.

Bishop Auckland's position also weakens, losing 9.5% of its trade, though an expansion of 3% in shop area is expected. The loss of trade is almost exclusively one-directional: to Darlington and Teeside. A population decline contributes to the problem.

Use of regional centres rises only very slightly, though the distribution of movements does show more marked changes. In particular, interaction with Teeside and Darlington grows whilst interaction with Newcastle and Sunderland is constant or declines slightly.

The New Towns

The three new towns, Peterlee, Washington and Newton Aycliffe present the greatest changes and the greatest problems of prediction. These problems arise partly out of theoretical problems associated with the model.

An important problem is the difficulty which is built into the model of locating the zone centroid or zone centre of gravity. In theory it is a problem which involves the use of integral calculus. The problem of locating this centre of gravity becomes very acute when a centre lies within one of the origin zones. The zone centroid cannot be placed upon the location of the shopping centre (to which it might reasonably be allocated) as the model then becomes inoperative when D^b becomes 0^b, as this will involve zero division and P_{ij} will tend towards infinity. This being the case, a zone centroid must be found which (a) represents the average distance friction of intra - zonal interaction and (b) does not distort interaction with outside centres unduly. This is an impossible task and approximation is necessary. The model is very sensitive indeed to alterations in the value of D, the distance variable, when D is very small. This is why the problem of finding an adequate zone centroid is so serious. In this study the value of 1 kilometre has been used in this sort of case. A further problem is that the model, because of the nature of the Pareto function, consistently tends to overpredict interaction over short distances. This occurred at almost every centre in the area. Another problem arises because the model cannot incorporate the influence of rapidly changing perceptions and shopping habits such as occur in the immediate area of a new town.

These problems are all directly relevant to the situation of the new towns: a centre lying within an origin zone, with a large and changing population, relatively close to the centre, and a centre in a town in which perception of space and opportunity are in a rapidly changing state. Thus it could be suggested that gravity models perform better for the type of situation where extension to existent shopping centres is contemplated, rather than introduction of New town shopping centres. Out-of-town centres will not of course usually have such large problems of allocation of a mean distance to the intra zone interactions.

To this must be added the problems of relating turnover to square feet of retail space, particularly as this does differ between planned and unplanned centres.
Thus it can be seen that prediction of future sales for new towns is a difficult task. These sorts of considerations underlie the argument concerning the future performance of Washington New Town between Nader (1968) and Stephenson, in the same article.

Washington

A population growth of from about 23,000 to 60,000 -

70,000 is planned for the period - 1968-85, for the New Town. The present Washington centre is not to be developed as the main centre, and a completely new centre will be developed within the town. The attraction index used in the model is based upon the increases in floor space proposed for the whole (old) Urban District.

The new town plan assumes that the town will retain 90% of its own trade indurable goods. Stephenson admits (Nader, 1968) that'the feasibility of the new town's centre holding a high proportion of resident's durable goods spending is crucial' (p. 393).

Assessment of the likely success of Washington using this gravity model is partly impared by Washington's peripheral location in that the model cannot predict interaction from areas well to the north and east of the centre. However, the plan assumes that little trade will be attracted from these areas and so comparisons between model predictions and plan expectations can proceed on the basis of the interactions from the area covered by the model.

The model predicts that 12,584 households will use the centre in 1985 for durable goods, which represents a turnover in durable goods of £4,68 million (at 1968 prices). Further examination reveals that 9820 households out of this number interact from within the old Washington Urban District, which represents 67% of the trade which originates within the town, when all 5 wards in the Urban District are considered. Probabilities are over .8 for 3 of the wards.

The model predicts for 1985 that the attractive power of the new centre will be concentrated within a 2 mile radius of the centre. Between 2 and 3 miles the probability of interaction is never greater than .18 and falls to .98. From

3 to 4 miles the average probability of interaction with the centre is about .05. The town report estimates that Washington will attract 40% of the durable goods expenditure from what is called the secondary trade area, which extends from about 2 miles to well beyond 3 miles. The report also estimates that about 33% of convenience goods purchase from this secondary zone will be made in Washington, which on the basis of earlier work in the thesis seems highly unlikely. The model predicts that about 10-12 % of durable purchases will be attracted from this area. The plan also suggests that 23% of durable goods expenditure will be attracted from the tertiary trade area, which includes Houghton le Spring and Chester le Street. Nader (1968) alleges: 'at present no trade is attracted from this area to New Washington'.. 'There is no likelihood of significant attraction of trade from either of these two areas to the proposed shopping centre in Washington' (p.391). The model tends to support this assertion. The model also suggests that Washington may be able to compete marginally more successfully at a very low level, with Houghton than with Chester le Street. The model predicts that beyond 3 miles interaction will be very sporadic and rarely greater than 5% in any one area. It would appear that for the area outside the new town itself the report is overoptimistic. As little trade is expected from the conurbation areas, by the report, it is clear that much depends upon the prediction of the future movment patterns of Washington!s own population. It is here where the model is at its weakest, so that analagous arguments must be introduced:

The situation in 4 centres in 1968 is examined: Bishop Auckland, Durham, Newton Aycliffe and Peterlee.

Bishop Auckland retains 75.8% of its own durable goods expenditure, losing most in womens clothing and jewellery and least in hardware and electrical goods. Durham City retains 62.0% of its own durable goods expenditure, again losing most in higher order goods and least in lower order goods. This estimate compres well with Nader's estimates for A level centres in North Durham.

Peterlee retains however only 24% of its own durable goods expenditure, losing 46% to Sunderland and Newcastle and 15% to the southern sub regional centres. Newton Aycliffe retains 36% of its durable goods trade losing principally to Darlington and to BIshop Auckland.

Washington will face very severe regional centre competition indeed and is not isolated as is Bishop Auckland. Any decline in the distance exponent will affect Washington considerably. In 1968 the model predicted internal interaction within Washington Urban District fairly well, with a probability of around .3. There is no guarantee that the adequacy of this prediction will continue up to the values of over .85 which obtain in three Washington wards. For the entire Urban District, the model prediction of 67% interaction seems fairly acceptable, especially as it is in line with the figures for Durham; the case of the other new towns must however be borne in mind, though they are smaller than the planned Washington; the implication is clear: that in a dynamic and rapidly changing situation shopping habits will tend to change much more slowly than the change in shopping provision, more so for durable goods shopping than for convenience goods shoppping. There are also problems arising from the more efficient use of floorspace possible in new planned centres. The model has only utilised direct floorspace increase in the case of Washington, which has been weighted by an arbitrary of 10% to take into account greater efficiency in the new centre. It would seem that the most probable figure for internal interaction within Washington will be 65-70%.

Using directly the numbers of households predicted by the model to use Washington centre, in 1985, and assuming the model is correct in its 67% internal movement allocation, the 1985 turnover was calculated to be £4.68m at 1968 prices. The expected figure for the new town centre, appearing in the report, is £10.1m (at 1985 prices). Under the assumption made in the report of a 2% price rise per annum an equivalent turnover at 1968 prices is about £7.5m. Thus the model is predicting a considerably smaller durable turnover than is expected in the report. It is also unrealistic to assume that 33% of trade in convenience goods will be attracted from the 'secondary trade area', so that further falls in total sales estimates can be expected. The nearest available source will usually be used for convenience goods, though sometimes travel occurs even to centres used before migration, which will not help the case of Washington. If the assumption is made that the centre will in fact draw 90% of the custom from the old U.D. area, this addition brings the model prediction up to £5.64m, still short of the proposed target.

Stephenson (Nader, 1968) argues that the centre should be compared with centres such as South Shields, Tynemouth and Gateshead. The interesting feature of these three named centres is that their central area turnovers are a small proportion of the total turnovers, less than a third in two of the cases, whereas Washington centre is planned to provide more than two thirds of the sales of the town. Nevertheless, a further investigation was made into the effect of raising the attraction index of Washington to a size comparable with that of the three named centres, disregarding the relationship with proposed floorspace increases. The model then predicted 16,500 households, representing a turnover in durable goods of £6.1m at 1968 prices, still short of the proposed figure. It is only when an attraction index the size of that of Darlington (!) is included in the model that sales rise to £9.0 m at 1968 prices.

This sort of activity is however dangerous, for the shopper will interact on the basis of his perception of the nature of the centre which will be more closely related to floorspace provided than to hopes of a planned turnover.

Thus, based on the original model, a figure of £4.68m at 1968 prices seems probable, for durable goods turnover in Washington centre. If, in addition, some adjustment is made to the convenience goods turnover by assuming that the inflow from the secondary trade area will be 16% instead of 33% (which is still generous), then this will reduce turnover estimates even further. The final estimates for the centre would then appear:

Washington main centre

Turnover estimates, 1985: (£)

	Town report		Model derived prediction
	1985 prices	1968 prices	1968 prices
Convenience	5.2m	3.9m	3.1m
Durable	10.1m	7.5m	4.7m
	15.3m	11.4m	7.8m

The figure derived from the above is thus £7.8m, or 68% of the report estimate.

It must again be stressed however that the model is at its weakest in this sort of situation. Unfortunately this also applies to planners' gravity models.

Newton Aycliffe

Newton Aycliffe's trading position is likely to improve over the period, both from the point of view of the individual shop and absolutely. A straight weighting of movement totals for 1985, by 1968 durable expenditure gives a total turnover of £2,51m, at 1968 prices, or probably £3.36 at 1985 prices. The movement figures indicate a net addition of trade in the order of 270% of the 1968 figure, which compares well with a proposed floorspace increase of 220% net. The model predicts in 1985 that Newton Aycliffe will retain 69% of its trade in durables compared with the 1968 actual figure of 34% which compares well with the 1968 model prediction of 38%. Thus it does seem possible that Newton Aycliffe should be able to move a long way towards retaining 69% of its own trade in durables, in spite of increasing competition from the south and east. Consolidation and slow growth seem to face Newton Aycliffe.

Peterlee

Peterlee was overpredicted by 59% in the original model calibration, and the estimate of 1985 turnover of £3.0m. (at 1968 prices) may well contain such a percentage overestimate, (whereas the 1968 turnover estimate does not, as it was based on observed flows). This level of error can be explained by reference to the 1968 model prediction: the model was predicting about 50% intra-zone interaction when the real figure was nearer 24%, very low indeed. The 1985 prediction assumes a level of 69% of interaction within Peterlee for the purchase of durable goods. If this comes about then the estimate of 1985 turnover will be good, if it does not, then a maximum level of error of 59% would produce an estimate of £1.9m. The probable figure almost certainly lies in between these two, probably between £2,5m and £3m. However it is clear that the implication of table 218.2 ist total trade will rise more than extra shopping provision, so that the trading situation in Peterlee is likely to improve slowly, Peterlee will also extend its field of influence over the period, but only effectively up to about 3 miles.

Conclusion

In this chapter the results of using the calibrated gravity model predictively have been examined, and certain theoretical problems have also been noted. The predictions are based upon predicted changes in household movement totals for each centre, and a percentage change in these is taken to represent a percentage change in trade. This is because at this level the survey data available provides the best data against which the model can be calibrated.

Probable changes in the amounts of trade going to each of the centres involved have been predicted, and an attempt has been made to examine the position of the new towns. It can again be repeated that any fall in the distance exponent value (which is likely), over the period, will take trade from the A level centres and give trade to the sub regional and regional centres.

CHAPTER 19

GRAVITY MODELS, PROBLEMS AND FUTURE DEVELOPMENTS

This part of the thesis has presented the results of the use and test of the gravity model in County Durham. The intent was both to use the model as a tool of analysis and explanation and to test the performance of the model against the available detailed data.

General Conclusions

The general conclusions after examinations and use of the model are as follows:-

(1) A model based upon the assumption that consumer movement can be regarded as a stochastic process in which the probability of a consumer travelling to a certain centre is related

(a) directly to a function of the size of that centre,

(b) inversely to a function of distance from point of origin to the centre,

(c) inversely to competition from all other centres in the set of centres under consideration

provides a satisfactory 'explanation' of observed patterns of movement at a fairly low level of aggregation in County Durham.

(2) It has been verified that willingness to travel, and therefore the value of the exponent fitted to the distance variable, does vary between purchase trips for different types of good. Goods have been ranked on this basis and results compared with the more intensive analyses of consumer movement.

This has consequences for Central Place Theory, in that goods can be ranked upon their basis of willingness to travel and therefore indirectly on the basis of their ranges.

(3) Calibration of the basic one parameter model against ward movement data revealed that there was a fairly good overall replication of the pattern of interactions in the area, but there were also important spatial variations in the performance of the model. Examination of these residual errors was undertaken in an attempt to explain the breakdown of the model.

(4) The basic two parameter model was calibrated in a way which minimised the error of allocation of households to centres. This is the usual means employed to calibrate such models. At the same time it was possible to relate the movement patterns predicted by this calibrated model to movement patterns in reality and serious discrepancies were found to be present. This has implications for the predictive power of the model.

(5) More specifically, features of the human geography of the area have been illustrated and analysed:

Trade areas have been derived from probability surfaces and interaction patterns replicated and explained. In many cases this has provided theoretical justification for empirically observed phenomena.

(6) The model was also used predictively in the County to provide an estimate of the future performances of A level centres.

As observed in earlier theoretical chapters, the gravity model raises serious theoretical problems. Here specific practical problems can be attached to the theoretical points of difficulty raised earlier. It is convenient to classify these problems into high level and low level problems, which does not reflect upon their seriousness.

High level problems

The theoretical problems raised by the model were covered in earlier chapters. Here emphasis and addition is made.

Firstly, the problem that the model does not contain an explicit normative element, with the serious consequences thus raised if used for predictive use, has not been overcome. If the model is used for predictive and planning purposes there is the very real danger that centres will be planned on the basis of extrapolated trends, which raises serious problems - one of whether or not it is reasonable to expect that these trends will continue and the other of whether or not the extrapolation of these trends produces the 'best' situation for the actors involved.

Secondly, the enormous problems of data availability have been illustrated here. The main source of data for model users in the U.K. will continue to be the Census of Distribution. This immediately means that the models can only operate at high levels of areal aggregation because of data difficulties. In particular, it is believed to be essential to separate convenience and durable good shopping, raising further data problems. There are inevitably problems arising from the nature of the census itself - such as the fact that it is a sample census, or the definition of a centre is unclear.

This study has circumvented these problems by utilising very low level data available in this special circumstance. In utilising this low level data the performance of the model has been slightly impared, when compared with higher level uses.

A third problem raised by the model is that it has been shown that by calibrating the model to minimise errors at the level of the centres it does not mean that movement patterns are either well replicated or replicated with a consistent level of error over space. This itself has important consequences when change is introduced into the model. This point is emphasised by Olsson (1965b):

'The model also seems to carry an implicit assumption of effort minimisation, but unfortunately this indication should not be taken to mean that the necessary assumptions about the individual behaviour pattern lying behind it have been satisfactorily defined' (p. 6. Trans.)

Fourthly, there is the ever present boundary problem and the fact that externalities must be ignored, the system must be closed. In some cases this is more easily done than in others, for example, in a large conurbation, movement fields are very likely to be different for households living within the conurbation than for households living outside using the conurbation, yet these cannot be excluded.

There is a further problem of the influence of social, economic and cultural variables, with which the model cannot deal. Each individual consumer within a zone is treated as being identical to all others in that zone. Although these variables are not of great importance in this area, differences in travel patterns do exist between population subgroups, as was shown in part I. The model results can be modified by one of two methods: either by disaggregation and running the model for subgroups within zones, or, if the zones are sufficiently small and homogenous, by simply weighting populations by some factor. It is because the model treats all individuals within a zone as equal that the model must remain aggregative and will not successfully explain individual behaviour, which as Olsson suggests, must be the final goal. Thus the higher the level of aggregation the more successful is the model likely to be.

A further field of development would possibly seem to be in the integration of probability notions with postulates of Central Place theory, which would provide additional theoretical rigour to a satisfactory operationalised model. Possible theoretical developments have already been outlined.

Further research areas, in the longer term, will probably be concerned with the nature of changes in the exponents, particularly the distance exponent, over time, It may be that the implicit movement minimisation concept behind the model may actually become less relevant over time as problems of congestion grow, and out-of-town shopping centres appear, causing distance exponents to rise.

Low level problems

It is here where serious practical problems lie, not unconnected however, with theoretical difficulties.

The first problem considered is that of how to allocate the population of a zone to a point which is the 'centre of gravity' or 'zone centroid'. In theory it is a problem involving integral calculus. However, the problem becomes more acute when centres lie within origin zones. The zone centroid cannot then be placed on the location of the shopping centre (to which it could reasonably be allocated) as then the model becomes inoperative as probabilities tend to infinity. This being the case a zone centroid must be found which (a) represents the average 'distance friction' effect of interaction within the community and (b) does not distort interaction with outside centres. This is an impossible task and must be approximated. Throughout the preceeding work an attempt has been made to allocate the value of 1 kilometre as the mean intra-community travel distance. Nevertheless, because of the nature of the function the model has a built-up tendency to overpredict interaction over short distances. This was observable in the case of all A level centres in the model runs, though the effect is perhaps less in County Durham than in other areas.

Immediately this raises further problems for prediction-not only is it necessary to estimate the future population trends in zones, but future population distributions should be incorporated as well. This is over and above the problem of estimating changes in exponents over time, which is not at present feasible.

Clearly in the case of the New Towns, estimates of the success of planned development hinge upon estimates of the proportional use of that town centre made by the town population. It is precisely at this point where (a) changing habits are involved and (b) where close-in interaction is to be estimated, that the model is weakest. This lies at the root of the arguments about the assessment of the shopping potential of Washington New Town made by Nader (1968).

Secondly, there are the problems of translating floorspace into turnover or profit or both, a problem which is well covered in literature, but for which there is no optimal solution.

Thirdly, it was argued in the theoretical chapters that the real 'explanatory' power of the model rests in the meaning of values given to the exponents. An extension of this is that alternative functions can perhaps provide a better fit with interaction data, i.e. can better represent the true distance decay function in an area.

A number of alternative functions were described earlier.

The basis of the gravity model is the assumption that the Pareto function adquately describes the rate of distance decay. This function can be written:

$$y_{ij} = aD_{ij}^{-b} \qquad \text{-------(1)}$$

where y_{ij} = the probability of interaction between zone i and centre j

D = the distance between i and j

a = a constant, of proportionality

b = a constant, indicating the slope of the curve

As has been seen, it is possible that other functions better fit empirical data. Here a comparison is made between two functions, the Pareto (above) and the Exponental:

$$y = ae^{-bD} \qquad \text{--------(2)}$$

The adequacy of their fit to empirical data is here investigated. The distance decay profiles for strong A & weak A level centres shown empirically in part II, Chapter II are here used in the analysis. The two functions are fitted to the data and compared.

The best fit equations, using both of these functions were obtained by the least squares method, for both strong and weak A level centres, and for 3 goods. The 12 regression equations and their product moment correlation coefficients are given below:-

Strong A level centres:

	Pareto	Exponential
Chemist Goods	y=2.06-1.87x r = .921	y=1.78-.194x r = .847
Men's Clothing	y=2.34-1.69x r =.814	y=2.29-.188x r = .932
All Durables	y=2.28-1.68x r =.851	y=2.190-.178x r= .942

Weak A level centres

Chemist Goods	y=2.23-2.60x r = .852	y=2.66-.516x r = .924
Men's Clothing	y=1.545-1.99x r =.888	y=1.70-.321x r = .889
All Durables	y =1.952-2.27x r=.893	y=2.22-.393x r = .963

(All values of r are significant at the .05 level).
(It should be noticed that to obtain the gradient of the straight line, b should be multiplied by $\log_e 10 = 2.303$, as logs to the base 10 were used in the calculations).

Two of these fitted functions are shown in diagram 71. The implication of these results is that although both the Pareto and the Exponential curves fit the data well, in every case but one the Exponential provides a slightly better fit.

Morrill and Pitts (1967) write in conclusion:- 'In general we believe that a Pareto formulation may work better for moves or contacts which do not involve permanent or costly moves and other functions may be better for migration and marriage distances' (p. 416).

Morrill and Pitt's observations seems perhaps not to hold in this case.

This must cast some doubt upon the suitability of the Pareto formulation for use in the gravity model.

A reformulation of the model could now appear:-

$$P_{ij} = \frac{S_j^a/e^{-bD}}{\sum_{j=1}^{n} (S_j^a/e^{-bD})}$$ (which is the basic Black, 1966, model)

where P_{ij}: the probability of interaction between zone i and centre j

S_j : distance from i to j

a and b: constants.

Further avenues of development are opened by modification of inputs: more satisfactory representations of distance as perceived by the consumer, of centre attractiveness as perceived by the consumer and of competition as perceived by the consumer. Thompson (1963) reviewed the concept of 'Subjective Distance' and developments are taking place within the field of perception study.

Conclusion

This part of the thesis has outlined the theoretical basis of gravitation and other interaction models, and then proceeded to derive distance exponents, representing willingness to travel, for various goods. The model was then used as a tool of geographical analysis and as a predictive model in its own right, both to analyse certain features of interaction patterns in County Durham and to analyse problems, theoretical and practical, in the use of the model. The model was used in conjunction with the extensive consumer movement data available over a large area of County Durham and, as Ellis and Van Doren (1966) point out: 'Knowledge of origin destination information to a high degree of accuracy was necessary in guiding the early model building stages and was indispensible for providing a test for the models' (p.59).

Thus it is important that the serious limitations and assumptions involved with the gravity model are appreciated before it is employed. Here, it has been seen that the model certainly has the ability to allocate and replicate to a reasonable degree of accuracy. The accuracy could be improved if separate calibration was undertaken for each piece of work. However, any model will be a perfect fit when disaggregated down to the level of the original data. The basic question of model building is that of how far should generalisation proceed. With every step of abstraction detail and accuracy are lost, yet some abstraction must be made in order for the model to be workable. The key question facing all model users is what level of abstraction represents the optimum in resolving the conflict between ease of operation and of generalisation,and loss of accuracy. There is a basic inverse relationship between complexity and input,and level of error, The researcher must generalise from original data and so should search, on the negatively sloping curve between inputs and level of error, for a point of major inflexion at a low level of error.

It is here believed that the inclusion of a mass exponent is warranted, but is seems doubtful if further real gains can be made, using the Pareto function.

Thesis: General Conclusions.

Consumer movement is the central theme of this thesis. Analysis was based upon survey - collected data in County Durham.

Part I investigated the relationship between certain socio-economic variables and features of the movement pattern of households. Various hypotheses were tested. In general, it was shown that important differences do exist between movement patterns of households, and that these differences are related in a positive way to certain socio-economic variables. It was also shown that inside of the traditional definition of a working class household, there are important differences in patterns of movement, again related to social and economic factors.

Within part I methods for translating the patterns of movement into patterns of expenditure flow were also disussed and operationalised. Chapter 6 provides a summary and synthesis of results.

The retail structure of the communities involved was also investigated in an essentially exploratory survey.

Certain of the results from this part of the thesis have direct relevance for the following study of the wider area as a central place system, for example, the finding that households cannot be treated as identical trip generation units, or, the implications of the rankings of goods derived from the intensive surveys. These rankings are carried forward into both parts II and III.

In part II the analysis turned to the investigation of extensive patterns of consumer interaction in relation to the system of centres in the County. In particular, various hypotheses derived directly from the framework of Central Place theory are tested, and the model is found, partially at least, to break down when faced with empirical observations from the County. Certain features of the observed system did correspond, or show a tendency to correspond to theoretical constructs, and certain theoretical constructs were useful in explaining observed patterns, but as a whole the model was not satisfactory. Chapter 11 provides a summary of available alternative hypotheses after the investigation.

This led to the adoption of a gravity model in part III of the thesis, both to 'explain' patterns of movement and also to analyse the weaknesses and performance of such models, using the available data. The main conclusions are presented earlier in this chapter.

The thesis thus provides an analysis of consumer interaction on two different but complementary levels and models and hypotheses are tested against empirical data.

APPENDICES, TABLES AND BIBLIOGRAPHY.

APPENDIX 1 DEFINITIONS

Convenience goods. See page 14

Shopping goods. See page 14

Durable goods. See page 14

Multiple shop. See page 14

Household: A group of people who live together in the same dwelling and share the same housekeeping unit. Usually are related. Lodgers are excluded.

Household head: The owner or the tenant of the accomodation.

Children: Persons under 15 years of age

Old people: Persons over 65 years of age.

Net Income: Gross income minus taxation and National Insurance contributions.

Income groups See page 15

Occupation status: Based upon the Registrar General's Socio-Economic groups and partly extended:

1. Employers & managers. Large establishments.
2. Employers and managers. Small establishments
3. Professionals: self employed
4. Professionals: employees.
5. Intermediate non- manual
6. Junior non-manual.
7. Personal service worker.
8. Foremen and supervisors_ manual
9. Skilled manual
10. Semi-skilled manual
11. Unskilled manual.
12. Own account workers
13. Farmers: employers and managers
14. Farmers: own account.
15. Agricultural workers
16. Armed forces

_ _ _ _ _ _ _ _ _ _ _ Addition....

17. Retired persons
18. Unemployed persons
19. Sick benefit recipients
20. Student
21. Unemployed widows.

The assumption is made that over groups 1 to 11, there is a ranking of occupational status.

Social Class : Based on the Registrar General's Social Class Classification:

- I Professional occupations
- II Intermediate occupations
- III Skilled Occupations
- IV Partly skilled occupations
- V Unskilled occupations.

Throughout the analysis the Classification of Occupations (1960) was used as a source reference for classification.

Function }
Establishment } See Appendix 3.

APPENDIX 2. THE INTENSIVE SURVEYS

Intensive surveys of household structure and movement behaviour were undertaken in 3 communities in County Durham, Shildon, Crook and Murton. Questionnaire surveys were used to gain information on various features of the social and economic structure of households and of movement patterns of these households. Geographers have infrequently attempted to measure various aspects of households' behaviour, though interest in the household as a basic data unit is growing, it was for example used by Davies, R.L.(1964), who then aggregated his information rather than continuing the analysis on a purely household basis. It is the formidable operational problems which are at the root of the reluctance to use survey methods at this level.

The Questionnaire

The questionnaire used was designed primarily to obtaing material for the testing of the hypotheses which appear in Chapter 2. It was also designed with the intention of developing methods of constructing patterns of income and expenditure, spatially as well as sectorally. These were outlined in Chapter 2 and the analysis was developed throughout part I. The final questionnaire in use appears with this Appendix. Information was required which related to the household and usually, but not exclusively, it was the lady of the household who was respondent.

Section 1 is designed to determine basic elements of householdn structure and gave rise to few problems

Section 2 was designed to determine the occupation structure of households and to establish movement patterns to work and means of transport used. Again this section gave rise to few problems. As full a definition of occupations as was possible was obtained from respondents and these were classified using 'The Classification of Occupations' 1960.

Section 3 is again straightforward.

Section 4 introduces the collection of material on consumer purchase patterns. 7 convenience goods were selected and respondents were asked to name the town or village at which they normally purchased the good. This was asked in an attempt to obtain the principal shopping movements for these goods. Convenience good purchase is very complex and price competition is very improtant. Campbell and Chisholm (1970) have investigated variations in grocery prices at retail and have attempted to explain these variations in terms of certain factors, incorporated into a multiple regression model. Here, in addition to place of purchase the type of shop at which the purchase was made was also recorded, as was the origin of vans if the purchase was made from a van. The question was largely answered adequately, though care was necessary in order to ensure that only one entry was made for each good, and in some cases careful questionning was necessary.

Section 5 represents an extension into durable goods, though the question is now phrased as where was the last place visited, in anattempt to include less frequently made trips.

Section 6 was less satisfactory, as has been noted in the text, as wide varieties of trip type and also work trips confuse the movement patterns which emerge.

Section 7 is designed to investigate the tasks undertaken on trips to particular places, and as such was reasonably successful.

Section 8 includes the most difficult problem, that of gaining information on incomes. After experimentation it was found that the best way of approaching the problem was to present a card showing various income groups and asking the respondent which group the household income came under. The groups used were based upon those used in the Family Expenditure Survey, so that work with that Survey could proceed further. These groups were as follows:

B £5 - 10 per week
C £10 - 15 per week
D £15 - 20 per week
E £20 - 25 per week
F £25 - 30 per week
G £30 - 35 per week
H £ over 35 per week.

Plus a corresponding form for yearly salaries

Careful questionning was employed in an attempt to gain information on NET income, including social security benfits, unearned income and take home pay. The questionning was largely successful, only about 4 - 5 % of responding households refusing to answer this question.

Method

A pilot survey was conducted in Cassop Colliery in Spring 1967 and modifications were made to survey techniques and to the questionnaire until this final one was produced.

From Spring 1967 until spring 1968 interviewing was undertaken in each of the three communities, though the Christmas period was avoided.

The sample was a stratified random sample of households, chosen from the electoral registers, divided up on the basis of households, for each community. Rateable value was employed as the stratification factor as the survey was concerned primarily with socio-economic variables. Sample size within each stratum was proportional to stratum size. Each stratum represented one population divided by quartiles. Interviewing was undertaken largely by the author alone and it was frequently necessary to interview at the weekend or in the evening.

Managers of retail establishments were not included in the surveys, as other information was required from them.

Samples were of the following sizes in each of the three communities:

	Population Size	Sample Size	Response	Response Rate
Murton	2930	216	162	75%
Shildon	4203	209	166	79.4%
Crook	2701	210	165	78.6%

Standard Errors

Examples of the confidence intervals attatched to estimates of population parameters are provided.

In general it can be said that estimates of population parameters for each community have fairly narrow confidence intervals and are fairly accurate. Estimates of parameters for population subgroups have wider confidence intervals because of the smaller size of N. This is however overcome in Chapter 6, where amalgamation produces much more accurate estimates.

The standard error of the mean can be calculated from:

$$\frac{\hat{\sigma}}{\sqrt{N}}$$

Where:

$\hat{\sigma}$: the best estimate of the population standard deviation.

Confidence limits are given by:

$$X = x \pm z. \frac{\hat{\sigma}}{\sqrt{N}}$$

or t can be used instead of z in the case of small samples.
The standard error of a proportion is given by:

$$\sqrt{\frac{p(1 - p)}{N}}$$

Where p: the sample proportion,
Confidence limits are given by:

$$\pi \quad p \pm z. \sqrt{\frac{p(1 - p)}{N}}$$

The situation can be improved slightly be the use of a stratified random sample, for which the standard error of the mean is derived from:

$$\sqrt{\frac{\Sigma\ \hat{\sigma}^2.n\ (1 - f)}{N}}$$

Where:

$\hat{\sigma}$: the best estimate of the population standard deviation for each stratum

n: sample size in each stratum

N: overall sample size

$\sqrt{(1 - f)}$: finite population correction

Examples:

Average household income, Murton

X = £17.17

at the 95% level: X = £17.17 ± £1.3

or the 67% level: X = £17.17 ± £.66

Proportions in income groups, Shildon:

Group B: 28% ± 7% (at 95% level) ± 3.6% (at 67% level)

Group E: 17.2% ± 5.9% (" ") ± 3.0% (" " ")

Group H: 4.5% ± 3.23% (" ") ± 1.65%(" " ")

Synthesis: Income group C- percentage purchasing in the nearest centre:

42.0% ± 11.6% at the 95% level

42.0% ± 5.9% at the 67% level.

Synthesis: All durables. Percentage purchase in local centre S.E.G. 1 - 6

33.6% ± 5.2% at the 95% level

33.6% ± 2.6% at the 67% level.

General

As almost all of the interviewing was undertaken by the author, there is some consistency of approach throughout. Geographers seem to be rather unwilling to use direct interview methods, though it is admitted that the problems are not small, ranging from the structure of questionnaires (for example, see Cowie, 1968) to the complex problems of sampling and execution. Interviewing itself demands a certain stamina, as noted by Cole(1956). Households in this area do seem more willing to answer questions than might be commonly believed.

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CONSUMER SURVEY.

Address:

Date:

Section 1

1. How many people normally live in this house? ________
2. How many are lodgers?......................... ________
3. Excluding lodgers, from now on:
   How many are male?........................... ________
4. How many are female?......................... ________
5. How many are children, (under 15) ?......... ________
6. How many males are over 65?................. ________
7. How many females are over 65?............... ________
8. Are all of 6. and 7. retired?............... ________

Section 2

1. What are the occupations (in detail) of all who work and live in this household, and where do they work?

Relation to Head	Occupation	Place of work	Age(if under 21)
A. Head			
B.			
C.			
D.			
E.			
F.			
G.			

2: What means of transport does each use to get to work?

A. ________ B. ________

C. ________ D. ________

E. ________ F. ________

G. ________

Section 3

What sort of tenancy do you have on this house:

Council. Privately owned

N.E. Housing Asstn. N.C.B.

Privately Rented

Section 4.

In which town or village do you normally buy the following and from what type of shop (or van):

I: independent, C: Coop, M: Multiple -V : Van

	Place	Origin of van	Shop type					
Meat			I	C	M	IV	MV	CV
Wet fish			I	C	M	IV	MV	CV
Groceries			I	C	M	IV	MV	CV
Greengroceries			I	C	M	IV	MV	CV
Bread			I	C	M	IV	MV	CV
Milk			I	C	M	IV	MV	CV
Chemist			I	C	M	IV	MV	CV

Section 5.

From which town or village was the last article of the following bought?

A piece of man's clothing (over 7/6d.) ____________

A piece of women's clothing(over 7/6d.) ____________

A piece of childs clothing ____________

A pair of shoes or boots ____________

A piece of furniture or carpet ____________

Television or rental ____________

Radio ____________

Washing machine ____________

Vacuum cleaner ____________

Cycle/Pram ____________

Jewellery, watch or clock ____________

Cinema ____________

Hardware ____________

Does anyone in the household own a car or motorcycle?..

Section 6.

In the last 3 months how many times has any member of the household visited any of the following places for any reason, other than to go to work?

Newcastle	______	Hartlepoopls	______
Darlington	______	Teeside	______
Sunderland	______	(Various)	______
Durham	______	(Various)	______
Bishop Auckland	______	(various)	______

Section 7

Can you tell me which of the following thimgs was done on the last visit by a member of the household to the following places?:

	Visiting Rels.	Work	Shopping	Enter.	Medic.	Busin.	Other
Newcastle							
Sunderland							
Durham							
Darlington							
Various)							
Various)							

Section 8

Which of the groups on this card does the total NET weekly household income come under. Include only pay brought home plus family allowances, pebsions, social security benefits unearned income, etc.

----- The same for salary earners with another card.

Answer ______________

What do you think of this town as a shopping centre for:

Groceries ______________

Hardware/ Household goods ______________

Clothing ______________

Comments:

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APPENDIX 3

THE RETAIL SURVEY

A survey was conducted which included every retail establishment in the three settlements of Crook, Murton and Shildon. The questionnaire used accompanies this Appendix.

There were 236 establishments in all, and 29 were non respondents (12.2%). For multiple shops information was requested from head office for the final section of the questionaire. Otherwise the information was requested from the manager (usually the owner in the case of the independents).

Section 1. is an attempt to overcome the important problems of classification. Adequate and operational definitions of establishment and function are serious problems facing the researcher in the field of tertiary activity. Function, particularly, defies definition, because of the very mixed nature of the stock of many shops. Establishment was defined as a basic physical selling unit. Each establishment was allocated a main function. This was done by asking the manager which of the items in the table accompanying this Appendix has provided the greatest part of his turnover. This analysis was carried further in that managers were also asked to state which other functions brought in over 10% of their turnover, and these were allocated as major functions. The table of functions was derived from work by Davies, W.K. (1967). There were inevitably problems of definition and information in this section though they were not overwhelming.

Section 2 is designed to establish the nature of the organisation of the shop, The main divisions used were (i) Multiple: greater than 10 branches (ii) branch shop (less than 10 branches) and independent, (single shop).

Section 3 is designed to establish the nature of certain structural elements. Both sections 2 and 3 were answered satisfactorily.

Section 4 is designed to investigate features of the nature of entrepreneurship in the tertiary sector, particularly with respect to differences between multiple and independent managers. This was satisfactorily answered.

Section 5 is an attempt to analyse the nature of retail supply. In its present form the question was not satisfactory because of the very diverse and complicated nature of the answers. Further work is necessary with this sort of analysis to gain satisfactory results.

Section 6 represents an attempt to analyse the nature of the competitive situation in each settlement for the independent retailer only, and was answered satisfactorily.

Section 7 is one of the more important sections. An attempt was made to investigate certain items of the cost structure of the individual retailer. Wagebill and occupancy costs are the two largest elements deducted from retail gross margins. McClelland estimates gross margins nationally to be 24.8% of turnover in 1961. It is the size of these gross margins which are important in any changing locational situation, for it is the absolute size of these gross margins which decides whether or not the retailer continues business. This section as a whole was badly answered. It proved impossible to get accurate information on occupancy costs and wagebills were not much better. This was both because of reluctance and also ignorance in some cases. Only 36% of responding shops were willing to disclose turnover and this was sometimes of doubtful accuracy. This question of how much turnover increase would be necessary before taking on extra staff was almost unanswerable by the private retailer.

The interest in the questionnaire really centres around methodological problems in gaining information from the private retailer, as the multiple can be approached differently.

List of Functions used in the Retail Survey

Supermarket.
Grocery
Butcher
Fish
Greengrocer
Confectionery/Bakery
Other food
Off licence
Confectionery/Sweets
Tobbacco
Newspapers
Shoes
Men's Clothes
Ladies' Clothes
Ladies' and Childrens' Clothes
Woollen goods
General clothes
Furniture
Electrical
Records and Music
Cycles
Prams
Hardware
Wallpaper/paints
Household
Books/Paper
Chemist
Photographic
Jewellery
Fancy
Toys
Leather goods
Sports goods
Flowers
Animals and Pet foods
Surgical and Health goods
Department stores
Variety stores.
Cooperative stores.

RETAIL ESTABLISHMENTS. QUESTIONNAIRE.

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Name and address
(check with map)

Section 1.

1. Which of the goods on the accompanying list brings in the largest part of your turnover? Code 1-38 ________
2. Which of the other goods on the list do you sell and which of them bring in more than 10% of your turnover? Codes
   1 ________
   2 ________
   3 ________

Section 2.

1. Is the manager also the owner? YES/NO.
2. Are there more than 10 branches of this shop? YES/NO.
3. If the answer to 2.2 is no, are there more branches of this organisation? YES/NO.
   If yes, where are they, and where is head office?

1. ________ 4. ________ 7. ________
2. ________ 5. ________ 8. ________
3. ________ 6. ________ 9. ________

head office ________

Section 3.

1. How many full time staff are there working at this establishment, including the manager ? Male ____ Female ____
2. How many part time staff? (not including cleaners)...
   Male ________ Female ________
3. What are the hours of business of this establishment?
   Weekdays ________ ½ closing ________
   Saturday ________ Sunday ________
4. Has this establishment any vehicles for
   (i) sales ______ (no.) (ii) deliveries ______ (iii)both ____
   If the answer to 3.4 (i) is positive ... What are the three largest places that they visit?

1. ________ 2. ________ 3. ________

Section 3 Contd.

5. In the case of independent grocers...Are you a member of a Voluntary Buying chain (prompt names)...YES/NO.
6. Have you any other business based upon this shop...for example repairs, wholesale, agencies etc. If yes, give details YES/NO

____

____

Section 4.

ADDRESS TO THE MANAGER

1. Manager Age group 20-40 / 40-60 / over 60 (delete) m/f.
2. How long have you worked in retailing? ________ years
3. Have you had employment other than in retailing YES/NO.
4. How long have you worked in this shop? ________
5. When you first came to this property was it already an open shop? YES/NO.
6. How many other members of your immediate family have paid employment not connected with this shop? What employment?

   Head ____________________

1. ____________________
2. ____________________
3. ____________________

7. Do any members of the managers immediate family work in this shop?

   Full time ____ (no.) Part time ____ Occasionally ____ NO ____

Section 5.

DELIVERIES TO THE SHOP

From where do you obtain your deliveries for the goods mentioned in section 1, and how often?

Item 1. ____________________

2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

Section 6   DO NOT PROCEED WITH THIS SECTION IF THE SHOP IS A MULTIPLE DEFINED UNDER 2.2. ABOVE

1. Are these premises owner occupied or rented O / R (delete)
2. What rent and or rates are currently paid? ____________

____
3. How much is the weekly staff wage bill (excluding manager and unpaid employees? ____________
4. Could you please tell me as accurately as possible what is the annual (or weekly/monthly) turnover for this establishment, as near as is possible to the current trading years? ____________
5. By how much do you estimate that turnover must increase for you to employ another sales assistant: Full time or part time? ____________Full / part.
6. Over the last 3 years of trading is trade (turnover) getting Better, Worse, Staying level, (allow for price rises).
7. Why do you think this is?

____
8. Over the next three years are you contemplating any alterations to these premises?
   Major / Minor / None /
9. If you have sales vans, what percentage of your total turnover is brought in by them? ____________
   If they go outside the town, what percentage of this turnover of the vans do you estimate arises from out of town sales? ____________

____

ESTIMATE:

SHop dimensions ____________ = ____________sq.feet.

(Sales space only)

Frontage ____________feet.

is the shop run with: Counter service/ Self service/ part self service/ as a Supermarket/

____

Comments

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APPENDIX 4 THE EXTENSIVE CONSUMER SURVEY

An extensive survey of consumer movement was undertaken in the area defined in this thesis as South Durham (see diagram 24), in the early summer of 1968. The purpose was two-fold: one, to provide empirical consumer interaction data to relate to an analysis of the central place system in the area and two, to provide data for the calibration and testing of a gravity model. In addition features of the movement pattern were to be analysed.

A number of important constraints were faced at the outset:

1. Operational constraints.
2, Compatability with similar data collected by Nadur (1967) in the northern half of the County, two years earlier.
3. The wish to contrel the level of error to a constant level throughout the area.

As with much of survey work, the first constraint proved to be the most important: operational constraints facing the single research worker are usually the most serious. The most serious single operational constraint was that of maintaining a reasonable level of return. Evidence from elsewhere, and a pilot survey within the area (see for example Moser, 1958) suggested that the return on a postal survey would be very low indeed, so that interview methods were judged to be preferable.

Assistance with interviewing was obtained from senior pupils at 14 secondary schools in the area, the arrangements being made through the headmaster in each school.

Methods

The basic unit for data collection in South Durham was the ward or the civil parish (hereafter all are termed wards). Certain of these wards were amalgamated to ease problems of data collection. The final result was 79 wards to be used as basic statistical units. These reconstituted wards are shown in diagram 24. The next task was to determine the sample size for each ward.

The aim was to take as large a sample as was possible within each ward, but to hold the sample size constant in an attempt to hold the size of the standard errors constant. Sample size was allowed to fall in wards with small populations, because of the effect of the finite population correction factor in reducing standard errors: $\sqrt{(N - n)/(N - 1)}$. With regard to the availability of interviewers a sample size of 58 per ward was used. This was allowed to fall in some wards where the standard error would have otherwise been smaller than in general. The total sample was 4612 households. The household was utilised as the basic data unit.

The sample was drawn as follows: Electoral Registers were obtained for every ward and divided into households. Random samples were drawn for each ward from this list of households. Each address was entered upon a questionnaire. The place of residence of each pupil taking part in the survey was plotted on 25 inch O.S. sheets and the locations of each of the 4612 households was also placed upon appropriate sheets. Each pupil was allocated 8 - 10 questionnaires in the vicinity of his or her own home. Each interviewer was given detailed instructions about the questionnaire, return visits and other necessary technical details. A short explanation of the survey was also provided.

The Questionnaire

A copy of the questionnaire used appears with this Appendix. Although a large scale survey should ideally attempt to collect as much directly relevant data as is possible, a major constraint here was that of what could reasonably be expected of the interviewers. It was decided to use a simple questionnaire to obtain only origin- destination information for 17 goods. The only additional information required was that of whether or not a vehicle was owned in the household. Rateable values were also collected from Local Authority lists.

The information required was for the last centre visited for each of 17 goods. It was hoped thereby to catch the less frequent but important purchase trips, which might be missed if the question asked which centre was visited most frequently.

The empty columns on the questionnaire were filled out in each case by the names of the local centres for each ward.

Results

Each questionnaire was checked and coded and then punched onto I.B.M. cards. Non response and rejected questionnaires lowered the total sample size to 3332, or an average of 42 per ward. The overall response rate is 72.5% which can be regarded as satisfactory especially in view of the resources utilised. Unfortunately it proved impossible with the resources available to control rigourously the sample size in all wards, both because of the availability of interviewers and of non-response. The author personally undertook some interviewing in particularly difficult areas, but imbalances remain.

In addition, a quality control check was undertaken by selecting a random sample of 20 households from the sample itself and re-interviewing. This revealed a very high level of accuracy in the original survey.

Analysis

Post completion coding was undertaken by the author. On each card one questionnaire was represented and the respondent was identified by (i) an index number, (ii) a ward code, (iii) a settlement code (iv) a rateable value (v) a binary coding for vehicle ownership and (vi) seventeen treble columns for coded destinations. Computing facilities at the University of Durham were used for tabulations.

The processed data, which is a very considerable amount, rests with the author and is banked on punched cards.

Standard Errors

For an extensive survey it is impossible to calculate standard errors for all estimates. Certain typical results can be calculated however.

9 wards have a sample size which fell below 20.

The average ward sample size is 42. 12 wards have a sample size greater than 60 and 28 wards greater than 50.

The confidence intervals for the estimate of a population proportion (π) from a sample proportion can be obtained from tables showing the normal deviate for any given confidence limit, using the following:

$$\underline{\bar{\pi}} = p \pm z \sqrt{\frac{p(1-p)}{N}}$$

Where:

$\underline{\bar{\pi}}$: the upper and lower limits of the confidence interval.

p : the measured sample proportion

N : the number of observations

z : the normal deviate.

For any good it is unusual that more than 10 destinations are recorded in a ward. Thus, equiproportionally, p = 10% in this instance. At the 95% confidence level the confidence intervals can be calculated for samples of 3 different sizes:

<u>20</u>

$\underline{\bar{\pi}}$ = 10% $\pm$ 13%

= 10% $\pm$ 6.6% (at the 67% level)

<u>42</u>

= 10% $\pm$ 9%

= 10% $\pm$ 4.6% (at the 67% level)

<u>60</u>

= 10% $\pm$ 7.6%

= 10% $\pm$ 3.9% (at the 67% level)

In part II of the thesis a number of wards are frequently combined when the analysis concerns interaction at different miles radius. As many as 6 wards are frequently combined. This raises the size of N considerably:

for example:

$\underline{\bar{\pi}}$ = 10% $\pm$ 4.15 (95% level)

= 10% $\pm$ 2.12 (67% level)

SHOPPING SURVEY OF SOUTH DURHAM

Durham University

ADDRESS :

For this household:
Please indicate with a X which shopping centre was LAST visited to buy each of the following items

	NEWCASTLE	SUNDERLAND	MIDDLESBROUGH	STOCKTON	DARLINGTON	HARTLEPOOLS	DURHAM	BISHOP AUCKLD	SPENNYMOOR	CROOK	SEAHAM HARBOUR						MOBILE SHOP *	WRITE AN[Y] OTHER ANS[WER] IN THIS CO[LUMN]
WEEKLY GROCERIES																		
BUTCHERS MEAT																		
WET FISH																		
GREENGROCERIES																		
CHEMISTS GOODS																		
BOOTS & SHOES																		
MENS CLOTHING (ABOVE 7/6d.)																		
WOMENS CLOTHING (ABOVE 7/6 d.)																		
CHILDS CLOTHING																		
TELEVISION SET (OR RENTAL)																		
RADIO																		
PIECE FURNITURE OR CARPET																		
WASHING MACHINE																		
VACUUM CLEANER																		
HARDWARE OR SMALL ELECTRIC																		
CYCLE OR PRAM																		
JEWELLERY OR WATCH OR CLOCK																		

DOES ANYONE IN THIS HOUSEHOLD OWN A CAR OR VAN ? — YES / NO
(Delete)

TABLES

A1. Murton. Population growth. Murton Parish

1801	75	1861	2104	1921	8694
1811	71	1871	3017	1931	9344
1821	72	1881	4170	1951	9687
1831	98	1891	5052	1961	9042
1841	571	1901	6514		
1851	1387	1911	7721		

Source: Census.

A2. Murton Retail Structure - Numbers of Shops.

	1858	1873	1890	1921	1938
Grocer	2	1	3	8	13
Pub.	3	4	4	3	5
Butcher	1	1	2	3	8
Shoemaker	2				
Grocer/Draper	1	2	3	1	
General		3	2	10	17
Post Office		1			
Greengrocer			1	1	1
Chemist			1	1	3
Shoes			1	1	8
Draper			1	2	4
Newspapers			1	1	3
Confectioner/ Baker				12	4
Furniture				2	
Ironmonger				1	2
China				1	
Fishmonger					1
TOTAL	9	12	19	47	69

1968

Groceries	11
Other food	10
Confectionery/ Tob./News.	5
Clothing/Shoes	2
Household	2
Other non food	1
Cooperative	1
Total	32

Sources: 1858-1938, Kelly's Directories.
1968: survey.

A.3. Murton: Heads of households, socio-economic group by location of workplace. Sample figures. 1968.

S.E.G.	Murton	Sunderland	Seaham	Newcastle	Easington Lane	Hetton	Peterlee	Ryhope	Easington	Fencehouses	South Hetton	Philadelphia	Other	TOTAL	Percent.
1														0	0
2														0	0
3	1													1	.5
4	2													2	1
5						1		2	1					4	2
6	4	1												5	3
7	2													2	1
8	14		1		1									16	10
9	28	1				1				1	1	1		33	21
10	39	1	5											45	29
11	2													2	1
12															
13															
14															
15															
16													1	1	.5
TOTAL	92	3	6	0	1	2	0	2	1	1	1	1	1	111	
%	83	3	5	0	1	2	0	2	1	1	1	1	1		
17-21	Not working													51	31
														162	100

Source: Survey

A4. Murton: Convenience goods, purchase. Percentages of households using different outlets

	Meat	Fish	Groc.	Bread	Milk	Chemist	Greeng.
Independent in Murton	50	20	25	48	6	86	41
Coop in Murton	18		30	16	2	10	18
Multiple in Murton	4		26	7		1	4
Indep. Van from outside	5	28	1	4	10		4
Coop Van from outside			3	5	1		2
Multiple van from outside				1			
Independent Elsewhere	5	10	1			2	.5
Coop Elsewhere			1				
Multiple Elsewhere			1	1		1	1.5
Not Purchasing	3	38		1	1	1	
Indep. van from Murton	9	4	2	8	24		12
Coop van from Murton	5		10	9	56		17
Multiple van from Murton							

Source: Survey

A.5. Murton: % of households using various centres for the purchase of durable goods

	Mens clothing	Womens clothing	Childs clothing	Shoes	Furniture/Carpet	T.V.	Radio	Washing Machine	Vacuum Cleaner	Jewellery	Cinema	Hardware
Murton	21	19	27	46	17	33	40	31	32	23	52	52
Sunderland	67	65	55	42	63	34	42	37	42	56	31	35
Newcastle	4	9	5	4	6	1	3	3	2	5	13	5
Seaham	4	3	5	4	7	18	7	16	11	5	2	4
Out of County	1			1			4	1	2	6	1	
Durham	2	2		2	2	1			1			2
Chester le St.	1				1		1	1	1			
Houghton		1	2	1		2		1	2	1	1	1
Catalog.		2	4				1	2	3	3		1
Easington La.				1	1	3	1	4	2			
Hetton	1	1		1	1	1	1	2	2			1
Hartlepool						2		1		1		
Peterlee		2										
Easington							1					
Thornley						1		1	1			
Stockton									1			
Shotton						1						
S. Shields											1	
Ryhope											1	
Ferryhill									1			
S. Hetton						1	1					
Horden					1			11				
% giving nil return	14	15	66	0	33	10	10	14	17	10	30	1

(not entering the above table)

Source: Survey.

A.6. Murton : available weekly expenditure 1967

	£	£	%
HOUSING		6053	13.5
FUEL AND POWER		3631	8.0
FOOD		14047	31.0
ALCOHOL		1612	3.5
TOBACCO		2649	6.0
Mens Clothing	769		
Womens Clothing	1640		
Childs Clothing	470		
Shoes	782		
CLOTHING		3663	8.0
Furniture	1177		
Hardware	356		
HOUSEHOLD GOODS		2610	5.5
Chemist	615		
Jewellery	317		
TOTAL OTHER		3242	7.1
TRANSPORT		4198	9.0
SERVICES		3588	8.0
MISCELLANEOUS		180	.5
GRAND TOTAL		£45473	

Net Income, for Murton: £46,939. Weekly.

Source: Survey plus Family Expenditure Survey.

A.7. Destination of expenditure originating in Murton. 1967. (weekly)

	Money staying in Murton		Money going out of Murton By van	By purchase out
Meat	£		£	£
Indeps.	1988	(68%)	197	161
Coop.	802	(28%)	41	
Multiple	130	(4%)		
	2920	(87.9%)	238 (7.5%)	161 (4.6%)
	GRAND TOTAL £3319			
Fish				
Indeps.	80	(95%)	113	43
Coop.				
Multiple	3	(5%)		
	83	(35%)	113 (47%)	43 (18%)
	GRAND TOTAL: £239			
Groceries				
Indeps.	1351	(30%)	86	22
Coop.	1923	(43%)	39	27
Multiple	1243	(27%)		66
	4517	(94%)	205 (4%)	115 (2%)
	GRAND TOTAL: £4837			
Greengroceries				
Indeps.	1100	(60%)	86	7
Coop.	702	(38%)	39	
Multiple	59	(20%)		9
	1861	(93%)	125 (6%)	16 (1%)
	GRAND TOTAL: £2002			
Bread				
Indeps.	485	(62%)	33	
Doop.	228	(29%)		
Multiples	71	(9%)	10	7
	784	(94%)	43 (5%)	7 (1%)
	GRAND TOTAL: £834			
Milk				
Indep.	331	(33%)	141	
Coop.	681	(67%)		
Multiple				11
	1012	(87%)	141 (12%)	11 (1%)
	GRAND TOTAL: £1164.			

Table A.7. (contd.)

<u>Chemist Goods</u>

INdep.	526 (89%)	9
Coop.	58 (9.8%)	
Multiple	6 (1.2%)	4
	590 (98%)	13 (2%)

GRAND TOTAL: £603

Table A.8.

<u>Murton: Weekly expenditure pattern for certain durable goods. Figures are in £.</u>

	Women's Clothing	Men's Clothing	Child's Clothing	Shoes	Furniture	T.V. / Radio	Jewellery	Hardware
Murton	248	123	56	378	271	97	68	190
Sunderland	1064	483	117	329	723	176	151	131
Newcastle	133	44	12	30	65	5	19	159
Seaham	46	16	11	22	67	32	12	11
Elsewhere	17	8				9	11	
Durham City	23	16		14	11			5
Houghton	9							
Catalog.	21						7	
Easington La.				5	14	9		
Hetton		6				5		
Thornley	6							

Sums of less than £5 are omitted

Source: Survey and Family Expenditure Survey

A.9.

Totals employed, by industry, Seaham Employment Exchange Area

1950		%	1960		%	1966	%
Agriculture	95	.7	Agric.	98	.6	82	.5
Mining and Q.	9430	70	Mining and Q	8741	54	9025	56
Other non metals	87	.6	Food	518	3.2	676	4
Chemicals	5		Chemicals	212	1.4	252	2
Metal Manufac.	31		Metal	74		85	
Engineering and Ships	98	.7	Engin.	109	.7	76	
Vehicles	78	.5	Ships	5		3	
Metal Goods	5		Vehicles	37		1	
Precision	2		Metals	2		1	
Textiles	3		Textiles	4		1	
Leather, fur.	-		Leather/Fur	-		-	
Clothing	33		Clothing	299	2	125	
Food, drink/Tob.	530	4	Bricks/Glass	72		25	
Wood	5		Timber	39		54	
Paper	23		Paper	13		11	
Other	-		Other	-		-	
Building	443	3	as 1950..	905	6	624	4
Gas/Elec. Water	3			103	.7	205	1
Transport	692	5		832	5	758	5
Distributive	728	5		1516	9.5	1314	8
Finance	56			88		81	
Pub. Admin.	325	2		1503	9.4	1521	9
Professional	163			570	3.5	798	5
Misc.	556	4		317	2	249	1
TOTAL	13410			16119		16002	

Source: Department of Employment and Productivity.

A. 10.

Shildon U.D. : Population growth

1801	114	1861	4089	1921	14165 +
1811	137	1871	7137	1931	12691
1821	126	1881	8704	1951	14510
1831	892	1891	9537	1961	14015
1841	3038	1901	11752		
1851	2766	1911	11759		

(+ indicates a boundary change)
Source: Census.

A.11. Shildon : Retail Structure - Numbers of shops

	1858	1873	1890	1921	1938
grocer	2	19	21	23	24
pub.	8	18	15	14	21
butcher	3	5	16	16	18
shoes	3	8	14	17	10
grocer/draper	1	11	5	-	-
general	10	6	35	42	36
post office	1	1	1	1	2
greengr.	-	1	7	5	10
chemist	2	3	3	2	2
draper	3	7	11	13	11
newspapers			3	6	7
Confectioner/ baker			13	14	21
furniture			2	5	1
ironmonger			2	2	2
china		1	5	1	2
fishmonger			2	2	3
jeweller		2	4	2	2
electrical					2
tailor	3	10	7	1	1
tobacco				3	2
	36	92	166	170	177

1968

Grocers	35
Other food	30
Cofect. news. tob.	14
Clothing/shoes	21
Household	11
Other non food	9
Coop	1
TOTAL	121

Sources: 1858-1938, Kelly's Directories.
1968, Survey.

A. 12. Shildon Employment Exchange: Totals employed, by industry

1955		%		1960	%	1966	%
Agric.	60	1	Agric.	108		73	10.8
Mining& Q.	1379	20	Mining& Q.	1688	26	676	
Other non metals	77		Food	37		39	
Chemicals	9		Chemicals	3		22	
Metal manuf.	6		Metal	2		4	
Engineering &	6		Engin.	18		98	
ships				1			
Vehicles	3299	48	Ships	1		-	
Metal goods	6		Vehicles	2640	40	2959	47
Precision	-		Metal goods	2		47	
Textiles	235	3.5	Textiles	193	3	136	2.1
Leather/Fur	183	2.7	Leather	290	4.5	413	6.5
Clothing	497	7	Clothing	435	6.6	390	6
Food	74		Bricks	67		70	
Wood	10		Timber	6			
Paper/Printing	-		Printing	8			
Other	6		Other	8			
Building	210	3	As with 1955:	155	2.4	193	3
Gas/Elec/Water	-			2		-	
Distributive	203	3		227	3.5	319	5.1
Financial	9			13		10	
Administrative	112	1.6		152	1.9	124	2
Professional	179	2.5		234		198	3.1
Miscellaneous	139	2.0		127	3.5	124	2
Transport	137	2.0		143	2.2	308	4.9
TOTAL	6836			6560			

Source: Department of Employment and Productivity.

A.12(a). Shildon: Heads of Households: Socio economic Group by place of work

S.E.G.	Shildon	Bishop Auckland	St. Helen Auckland	Spennymoor	Eaglescliffe	Newton Aycliffe	Darlington	Other	Sunderland	TOTAL	Percent.
1	1									1	.6
2											
3											
4	2						1			3	1.8
5			1	1					1	3	1.8
6	5			1		2		1	1	10	6
7											
8	4	1	1			1		3		10	6
9	36	1	1			3		4		45	27.2
10	15	3			1	6		2		27	16.5
11	15	1								16	9.7
12	4	1								5	3
13											
14											
15											
16											
TOTAL	82	7	3	2	1	12	10	10	2	120	
17	-	-	-	-	-	-	-	-	-	39	
18-21	-	-	-	-	-	-	-	-	-	7	

Sorce: Survey.

A.13.. Shildon: Convenience goods purchase. Percentages of households using different types of outlet.

	Meat	Fish	Groc.	Greeng.	Bread	Milk	Chemist.
Independent in Shildon	70	90	22	70	66	9	59
Coop in Shildon	6.3	0	12	5	4.5	4	0
Multiple in Shildon	8.0	1.5	53	17.7	19	0	40
Indep. van from Shildon	4.2	1.5	0	2	4.5	55	0
Coop van from Shildon	.7	0	1.8	1	.5	23	0
Multiple van from Shildon	0	0	1.2	0	.5	0	0
Indep. van from outside	2.7	.5	0	.7	2	9	0
Coop van from outside	0	0	0	0	0	1	0
Multiple van from outside	0	0	0	0	0	0	0
Indep. Elsewhere	5.4	6	1.5	1.3	2	0	1
Coop Elsewhere	.3	0	0	0	0	0	0
Multiple Elsewhere	2.4	.5	8	2.3	1	0	0

Source: Survey.

(Non - purchasing households not included)

A.14. Shildon: Percentages of households using various centres for the purchase of durable goods

	Men's clothing	Women's clothing	Child's clothing	Shoes	Furniture	T.V.	Radio	Hardware	Washing Machine	Vacuum Cleaner	Jewellery	Cinema
Shildon	29	29	37	37	22	66	50	69	45	45	31	44
B. Auckland	49	41	44	47	53	21	24	20	36	33	23	34
Newcastle	2	4		1	3			1	3	1	2	2
Sunderland					1		2		2	1		
- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - -
N. Aycliffe		.6			.6	.7			.7	1.4		
Out of Cty.	.7	1.3	1.4	1.2			3	.6	.7	1.4	12	7
Stockton		1.3	1.4	.6	.6					.7		1
Darlington	15.2	11.5	7	7.3	17.4	12	14.4	4.3	9	8	22	9
Middlesbro'	.7	6.5	2.9	1.6	.6						2	1
Durham	.7									.7		
Chester le S.					.6							
Catalog.	2.1	3.8	4.3	4.9	1.2		3.8	3.7	1.4	3.5	7.5	
Grook											.7	
St. Helen		.6										
Eldon	.7				.6		1.5	1.9	1.4	2.7		
W. Auckland						.7						
Thornley			1.4									
Toft Hill							.8					
Willington							.8					
Spennymoor					.6		.8					1

Source: Survey.

% giving nil return	15.8	6	58	1.2	4.7	10.2	18	3.6	17	12.6	12	42

(and therefore not entering the above table)

(figures above the broken line are rounded)

A.15. Shildon: available weekly expenditure 1967

	£	%
Housing	9,307	13.3
Fuel and Power	5,605	8.0
Food	21,387	30.4
Alcohol	2,527	3.6
Tobacco	4,115	5.9
Clothing	5,737	8.2
Household	4,056	5.7
Other	5,022	7.1
Transport	6,565	9.5
Services	5,571	7.9
Misc.	204	.3
GRAND TOTAL	£70,059	

Total net income of Shildon per week:

£72,088

A.16. Destination of expenditure originating in Shildon 1967. Weekly - £

	Money staying in Shildon		Money going out of Shildon: By van	By purchase out
Meat				
Indeps.	3849	83.2%	104	325
Coop	362	7.8%		17
Multiples	410	9%		110
	4621 (89%)		556 (11%)	
GRAND TOTAL: £5177				
Fish				
Indeps.	440	98%	4	33
Coop	0			
Multiple	8	2%		5
	448 (91.5%)		42 (8.5%)	
GRAND TOTAL: £490				
Groceries				
Indeps.	1563	24%		112
Coop	841	12.9%		0
Multiple	4099	63.1%		644
	6503 (90%)		756 (10%)	
GRAND TOTAL: £7159				
Greengroceries				
Indep.	2124	73.5%	13	37
Coop	223	7.7%		
Multiple	534	18.8%		70
	2881 (96%)		120 (4%)	
GRAND TOTAL: £3001				
Bread				
Indep.	933	74%	24	28
Coop	64	5.2%		
Multiple	264	20.8%		16
	1261 (94.8%)		68 (5.2%)	
GRAND TOTAL: £1339				
Milk				
Indep.	1122	70%	143	
Coop	484	30%	25	
Multiple	0			
	1606 (90.8%)		168 (9.2%)	
GRAND TOTAL: £1774				

Table A. 16 cont'd

Indep.	635	56%	
Coop	484	30%	
Multiple	0	0%	22
	1131 (98%)		22 (2%)

GRAND TOTAL: £1153

Source: Survey and F.E.S.

A. 17. Shildon: Weekly Expenditure patterns for certain durable goods. Figures are in £.

	Shoes	Furniture	Jewellery	Women's clothing	Men's clothing	Hardware
Shildon	481	278	106	611	313	366
B. Auckland	568	878	99	945	551	115
Newcastle	16	38	15	268	36	4
N. Aycliffe		7				
Out of County	12		41	38		
Stockton	12	33		17		
Darlington	89	237	91	197	131	19
Middlesbro'	8			178	8	
Billingham				16		
Catalog.	52	21	37	66	25	16
St. Helen Auckl.				9		
Eldon Lane		8			8	11

(Sums under £5 have been omitted)

Source: Survey and Family Expenditure Survey

A.18. Crook U.D. : Population

1801	193	1861	5134	1921	12706
1811	176	1871	9401	1931	11690
1821	228	1881	11096	1951	9056
1831	200	1891	11430	1961	9042.
1841	538	1901	11471		
1851	2764	1911	12308		

Source: Census.

A.19. Crook: Retail Structure: Numbers of shops

	1858	1873	1890	1921	1938
Grocer	6	22	16	17	14
Pub.		19	21	27	22
Butcher	4	14	13	10	9
Shoemaker/ Shoes	7	7	8	7	8
Grocer/Draper	10	4	2	1	
General	1	5	15	33	34
Post Office	1	1	1		
Greengr.	5	6	11	5	2
Chemist	1	3	2	3	3
Draper/Clothes	8	6	8	16	12
Newspapers	1	1	1	1	2
Confect/ Baker		3	2	15	14
Furniture			1	1	1
Ironmonger	2	3	2		1
China		1			
Fishmonger				1	
Beer	8	6	5	6	
Jeweller	1	2	3	4	
Wines		1	2	1	1
Tailor	2	7			
Fancy		1	1	1	
TOTALS	57	112	112	149	122

1968

Grocers	16
Other food	11
Confect/tob./news	12
Clothing/Shoes	12
Household	9
Other non food	8
General	2
Coop	2
	72

Sources: 1858-1938 Kelly's Directories.
1968: Survey.

A.20. Totals employed, by industry, Crook and Willington Employment Exchange Area

1950		%		1960	%	1966	%
Agriculture	344	2	Agric.	333	3	282	3
Mining & Q.	7214	50	Mining & Q.	4011	36	1445	16
Non metals	953	7	Food	38		37	
Chemicals	702	5	Chemicals	582	5	+	
Metal	599	4	Metals	567	5	726	8
Engineering &	253	2	Enging.	244	2	394	4
ships			Ships	-		-	
Vehicles	124	1					
Metal goods	9		Vehicles	97		+	
Precision	-		Metal goods	-		-	
Textiles	31		Textiles	2		+	
Leather	-		Leather	1		-	
Clothing	387	3	Clothing	642	6	779	9
Food	89		Bricks	656	6	1086	12
Wood	267	2	Timber	113	1	67	
Paper	11		Paper	4		12	
Other	15		Other	-		601	7
Building	471	3	As in 1950...	471	4	689	8
Gas/Elec./Water	7			105	1	93	
Transport	480	3		374	3	289	3
Distributive	717	5		806	7	756	8
Finance	40			73		63	
Pub. Admin.	457	3		898	8	733	8
Professional	481	3		534	5	626	7
Misc.	700	5		498	4	284	3
TOTAL	14363			11053		9015	

(+ : grouped under 'Other')

Source: Department of Employment and Productivity.

A. 21. Crook. Heads of Households: Socio-Economic Group by place of work

	Crook	Darlington	Bishop Auckland	Stockton	Newton Aycliffe	Tow Law	Durham	Stanhope	Washington	Shildon	Spennymoor	Other (9 other destinations)	TOTAL	Percent
1	5												5	4.7
2														
3														
4	2												2	1.8
5	4			1								1	6	5.7
6	7												7	6.7
7	1												1	.9
8	1												1	.9
9	21		4		1	1	3	2				8	41	39
10	16	1	1		2	1				1		6	28	27
11	9						1				1		11	10.4
12	3												3	2.9
13														
14														
15														
16														
TOT:	69	1	5	1	3	2	4	2	1	1	1	15	105	
17													41	
18-21													19	

Source: Survey. 1968.

A.22. Crook: Convenience goods purchase. Percentages of households using different types of outlet

	Meat	Fish	Groc.	Greeng.	Bread	Milk	Chemist
Independent in Crook	66	82	24	70	51.9	8.4	38.9
Coop in Crook	15.2	1.4	21	9	14	7	17.2
Multiple in Crook	3	.7	45	8.5	14		43
Indep. van from Crook	9.8	15	3.5	4.1	15.2	50.1	
Coop van from Crook	1.2		3	7.5	1.6	30.1	
Multiple van from Crook			.6		1.3		
Indep. Van from outside	2.4					4.4	
Coop van from outside							
Multiple van from outside							
Indep. Elsewhere	1.7	.9			.8		
Coop Elsewhere							
Multiple Elsewhere	.3		2.9	.9	1.2		

(non-purchasing households are not included)

Source: Survey . 1968.

A.22a. Crook: percentages of households using various centres for the purchase of durable goods

	T.V.	Hardware	Washing Machine	Hairdresser	Jewellery	Mens clothing	Womens clothing	Childs clothing	Shoes	Furniture/Carpet
Crook	81	79	74	95	55	61	53	44	68	67
Bishop Auckld.	7	7	13	4	13	20	18	37	18	16
Newcastle	2	2	4		11	7	20	5	6	10
Sunderland	1	2	1		2	1				1
Darlington	1	2	2		2	3	4	3	3	2
Stockton	1		1							1
Middlesbro'					1			3		
Consett			1					2		
Shildon	1					1				
Out of Cty.	1	2	1		7	2	3	5	1	1
Durham	1		1		1	2	1	1	1	1
Catalog.	1	3			4	2	1		2	1
Willington		2				1				
Langley Moor									1	
Esh Winning	1		1							
Spennymoor	1		1							
Ferryhill	1									
Coxhoe	1									
Q. Hill										
Howden										
Tow Law					2					
Gateshead					2					
Trimdon										

(households giving a nil return do not enter the above table)

Source: Survey . 1968.

A. 23. Crook: Available weekly expenditure 1968

	£	%
Housing	6052	13.5
Fuel and Power	3631	7.9
Food	13945	30.2
Alcohol	1675	3.6
Tobacco	2673	5.7
Clothing	3778	8.2
Household	2632	5.7
Total, other	3309	7.2
Transport	4484	9.7
Services	3753	8.1
Miscellaneous	141	.3
GRAND TOTAL	£46,114	

Net total incomes, per week: £48,108

A.24. Destination of expenditure originating in Crook.

1967. Weekly: Convenience goods : £

	Money staying in Crook		Money going out of Crook By van	By purchase out
Meat				
Indeps.	2541	80.5%	82	97
Coop	531	16.8%		
Multiples	85	2.7%		11
	3157 (94%)		190 (6%)	
GRAND TOTAL: £3347				
Fish				
Indeps.	330	98%		3
Coop	42	1.2		
Multiples	3	.8		
	375 (99%)		3 (1%)	
GRAND TOTAL: £378				
Groceries				
Indeps.	1352	28.4%		
Coop	1082	22.8%		
Multiples	2315	48.8%		113
	4749 (97.7%)		113 (2.3%)	
GRAND TOTAL: £4862				
Greengroceries				
Indeps.	1436	77%		
Coop	254	13.6%		
Multiples	175	9.4%		7
	1865 (99.6%)		7 (.4%)	
GRAND TOTAL: £1872				
Bread				
Indeps.	578	69.8%		
Coop	117	14.1%		
Multiples	134	16.1%		3
	829 (99.7%		3 (.3%)	
GRAND TOTAL: £832				
Milk				
Indeps.	548	49.2%	49	
Coop	194	17.4%		
Multiples	371	33.4%		
	1113 (95.8%)		49 (4.2%)	
GRAND TOTAL: £1162				

Table A: 24 (cont'd.)

Chemists goods

Indeps.	219	34.6%
Coop	87	13.8%
Multiples	326	52.6%
	622	(100%)

GRAND TOTAL: £ 622

A. 25. Crook: Weekly expenditure patterns for certain durable goods. Figures are in £

	Mens clothing	Womens clothing	Shoes	Furniture	T.V.
Crook	406	804	506	739	250
Bishop Auckld.	151	315	163	189	36
Newcastle	64	344	68	172	3
Sunderland	9			13	
Darlington	31	82	35	30	
Stockton				17	
Middlesbro'		14			
Consett					
Shildon	12				3
Out of Cty.	18	41	10	26	5
Durham	11	41	8	8	10
Catalog.	22		19	9	
Willington	3		3		
Trimdon				3	

(Sums of less than £3 are omitted)

Source: Survey and Family Expenditure Survey.

A.26. Numbers of functions in Crook, Shildon & Murton

CROOK Main & Major	CROOK Main	SHILDON Main & Major	SHILDON Main	MURTON Major & Main	MURTON Main	
5	5	6	6	3	3	Supermarket
16	7	35	30	14	10	Grocer & General
1	1	3	2	3	0	Other food
3	3	14	14	7	7	Butcher
1	1	2	2	0	0	Fish
6	3	13	6	3	1	Greengrocer
4	4	7	6	6	4	Confect/Baker
0	0	0	0	2	1	Off licence
15	4	37	4	8	1	Confect/ Sweets
13	6	35	5	11	3	Tobacco
5	4	6	6	2	2	Newspapers
3	3	5	4	1	1	Shoes
3	3	8	5	0	0	Mens clothes
3	3	9	5	2	2	Ladies clothes
2	2	2	2	2	1	Ladies & Childrens "
2	2	4	4	1	0	Woollen goods
1	1	2	1	1	0	General clothes
3	3	1	0	1	1	Furniture
2	2	4	4	2	0	Electrical
0	0	0	0	0	0	Records & Music

/continued

Table A 26 (Cont'd)

CROOK Main & major	CROOK Main	SHILDON Main & major	SHILDON Main	MURTON Main & major	MURTON Main	
0	0	2	1	0	0	Cycles
0	0	0	0	0	0	Prams
1	1	2	1	1	0	Hardware
5	4	4	4	2	2	Wallpaper
2	1	2	1	1	0	Household
0	0	0	0	0	0	Books & Paper
2	2	4	4	1	1	Chemist
0	0	0	0	1	0	Photo
1	1	3	1	0	0	Jewellery
5	3	5	1	1	0	Fancy
3	1	2	1	1	0	Toys
0	0	0	0	0	0	Leather
0	0	2	0	0	0	Sports
0	0	0	0	0	0	Flowers
1	1	1	1	0	0	Animals & Pet
0	0	1	1	0	0	Surgical & Health
1	1	0	0	0	0	Department Stores
1	1	0	0	0	0	Variety Stores
-	1	-	2	-	1	Coop.

A.27. Family occupation structure in relation to the private shop

	% of cases
1. Manager is head of household and the only worker	58.2%
2. Manager is head of household and 1 member of his family works elsewhere	15.4%
3. Manager is head of household and 2 members of his family work elsewhere	2.7%
4. Manager is not head of household. Head works elsewhere. No other workers	16.4%
5. Manager is not household head. Head plus one family member works elsewhere	6.4%
6. Manager is not household head. Head plus two family members work elsewhere.	0.9%

Source: Survey.

A. 28. A test of the nearest centre hypothesis

	(1) Total sample	(2) No. using nearest centre	(3) (2) plus indiff. zone	(4) No. going elsewhere	$\frac{(3)}{(1)}$ %
GROCERIES					
Brandon	66	31	44	22	66
Chilton	20	18	18	2	90
Cassop	9	9	9	0	100
Kelloe	33	30	33	0	100
Mordon	7	4	6	1	86
Seaham	423	412	412	11	97
Trimdon	36	31	31	5	86
Willington	72	69	69	3	96
Wingate	19	18	18	1	95
Shotton	41	37	37	4	90
Sherburn	29	20	20	9	69

/ Continued..

Table A. 28 continued.

	(1) Total sample	(2) No. using nearest centre	(3) (2) plus indiff. zone	(4) No. going elsewhere	(3)/(1) %
MEAT					
Brandon	66	31	44	22	66
Cassop	9	8	8	1	89
Chilton	20	18	18	2	90
Kelloe	32	30	30	2	94
Mordon	7	6	6	1	86
Seaham	419	399	399	20	95
Sherburn	29	19	19	10	65
Shotton	41	40	40	1	97
Trimdon	35	32	32	3	91
Willington	72	66	66	6	92
Wingate	19	19	19	0	100
HARDWARE					
Brandon	61	22	22	39	36
Chilton	18	2	2	16	11
Cassop	9	0	2	7	22
Kelloe	30	5	7	23	23
Mordon	7	0	0	7	0
Seaham	388	241	241	147	62
Sherburn	26	6	6	20	23
Shotton	38	22	22	16	58
Trimdon	35	20	20	15	57
Willington	68	35	35	33	51
Wingate	14	10	10	4	72
MENS CLOTHING					
Brandon	61	33	33	28	54
Cassop	9	3	3	6	33
Chilton	18	0	0	18	0
Kelloe	25	9	9	16	36
Mordon	7	0	0	7	0
Seaham	381	94	94	287	25
Sherburn	26	12	12	14	46
Shotton	41	0	0	41	0
Trimdon	35	0	0	35	0
Willington	72	0	0	72	0
Wingate	17	0	0	17	0
TOTALS					
Groceries	755	679(90%)	697(92%)	58(8%)	
Meat	749	668(89%)	681(91%)	68(9%)	
Hardware	694	343(52%)	367(53%)	327(47%)	
Mens clothing	692	151(22%)	151(22%)	541(78%)	

Source: Survey.

A.29. Percentage interaction at increasing miles radius around each of the two strong A level centres

Miles radius	Strong A	Regional	Other A	BCD
GROCERIES				
Under 1	90	1	1	5
1-2	61	0	3	35
2-3	30	2	10	54
3-4	15	3	30	50
4-5	11	1	42	44
5-6	10	0	58	30
6+	3	2	60	30
HARDWARE				
Under 1	84	11	1	2
1-2	60	15	4	18
2-3	51	17	7	23
3-4	30	17	35	18
4-5	17	19	41	21
5-6	15	24	42	18
6+	7	20	47	23
WOMENS CLOTHING				
Under 1	53	39	3	2
1-2	38	51	5	2
2-3	29	53	11	4
3-4	25	50	14	7
4-5	24	52	15	8
5-6	15	49	21	11
6+	13	47	31	8
ALL DURABLES				
Under 1	73	20	2	2
1-2	56	27	3	11
2-3	47	32	7	12
3-4	43	30	15	11
4-5	26	31	20	19
5-6	18	33	30	18
6+	11	32	42	13

Source: Survey.

Table A. 30 : WARDS AND CIVIL PARISHES IN THE EXTENSIVE SURVEYS OF NORTH AND SOUTH DURHAM:

To be used in conjunction with diagram 24.

NORTH DURHAM

RYTON U.D.

1. Crawcrook
2. Crookhill
3. Ryton
4. Ryton Woodside

BLAYDON U.D.

5. Blaydon
6. Chopwell
7. High Spen
8. Rowlands Gill
9. Winlaton

CONSETT U.D.

10. Benfieldside
11. Blackhill
12. Consett N.
13. Consett S.
14. Crookhall and Delves Lane
15. Ebchester
16. Leadgate
17. Medomsley

STANLEY U.D.

18. Annfield PLain
19. Burnopfield
20. Catchgate
21. Collierly
22. Craghead
23. Havannah
24. South Moor
25. Tanfield
26. Townley

LANCHESTER R.D.

27. Cornsay
28. Esh
29. Greencroft
30. Healeyfield
31. Lanchester
32. Langley Park
33. Satley

CHESTER LE STREET R.D.

34. Birtley
35. Burnmoor
36. Edmondsley
37. Great Lumley
38. Harraton
39. Lambton
40. Lamesley
41. Little Lumley
42. Ouston
43. Pelton
44. Plawsworth
45. Sacriston
46. Urpeth
47. Waldridge

WASHINGTON U.D.

48. Great Usworth
49. Springwell
50. Usworth Colliery
51. Washington
52. Washington Station

HOUGHTON LE SPRING U.D.

53. Fencehouses
54. Herrington
55. Houghton
56. Newbottle
57. Penshaw

DURHAM R.D.

58. Bearpark
59. Kimblesworth
60. West Rainton
61. Witton Gilbert

HETTON LE HOLE U.D.

62. Easington Lane
63. Hetton Downs
64. Hetton le Hole
65. Rainton

CHESTER LE STREET U.D.

66. Chester le St. Central
67. Chester Moor
68. Chester le St. N.
69. Pelton Fell
70. Chester le St. S
71. Chester le St. W.

TOW LAW U.D.

72. Tow Law

LANCHESTER R.D.

73. East Hedley Hope

CROOK & WILLINGTON U.D.

74. Sunniside
75. Mt. Pleasant
76. Crook N/S/E/ W'bottom
77. Howden
78. Sunnybrow/Helm. Row
79. Willington W/N
80. Willington S/E
81. Hunwick/Newfield
82. Bitchburn
83. Witton le Wear

BISHOP AUCKLAND U.D.

84. Coundon/Binchester
85. St. Andrew Auckland
86. B.A. no.3
87, B.A. 1/2/ Newton Cap
88. B.A. 4.
89. Woodhouse Close
90. St. Helen Auckland
91. West Auckland
92. Escomb

BARNARD CASTLE R.D.

93. Etherley

SHILDON U.D.

94. Auckland Terrace
95. Byerley
96. Sunnydale/Central
97. Coundon Grange/Eldon
98. Thickley

SEDGEFIELD R.D.

99. Chilton
100. Ferryhill
101. Cornforth
102. Bishop Middleham/ Mainsforth
103. Sedgefield
104. Fishburn
105. Bradbury/ Mordon/ Woodham/ Windlestone
106. Stillington/Elstob /Preston/Foxton

SPENNYMOOR U.D.

107. Byers Green
108. Middlestone
109. Spennymoor
110. Tudhoe
111. Low Spennymoor
112. Merrington/Middlestone

DURHAM R.D.

113. Sunderland Bridge/Hett Shincliffe.
114. Cassop cum Quarrington
115. Kelloe/Coxhoe
116. Sherburn/Sherburn Ho. Whitwell Ho.
117. Shadforth
118. Belmont
119. Pittington
120. Brancepeth

BRANDON & BYSHOTTLES U.D.

121. Brandon W.
122. Brandon N.
123. Ushaw Moor
124. Brandon Central
125. Brandon E.
126. Brandon S.

DURHAM M:B:

127. Framwelgate
128. Nevilles Cross/ Crossgate /Elvet
129. St. Nicholas
130. Gilesgate/Pelaw.

EASINGTON R.D.

131. Wingate
132. Thornley
133. Hutton Henry
134. Monk Hesleden
135. Shotton
136. Horden
137. Easington
138. Haswell
139. Cold Hesleden/Hawthorn
140. E. Murton
141. Dalton le dale/Burdon /Warden Law/ Seaton

SEAHAM U.D.

142. Colliery
143. North
144. South
145. Princess
146. Deneside
147. Park
148 PETERLEE NEW TOWN
149. NEWTON AYCLIFFE
150. Trimdon(Sedgefiled R.D.)

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EG: Economic Geography.
GA: Geografiska Annaler.
GJ: Geographical Journal.
GR: Geographical Review.
GT: Geografisk Tidsskrift.
JAIP: Journal of the Institute of American Planners.
JM: Journal of Marketing.
JRS: Journal of Regional Science.
JRSS: Journal of the Royal Statistical Society.
JTPI: Journal of the Town Planning Institute.
PPRSA: Papers and Proceedings of the Regional Science Association.
PRSA: Papers of the Regional Science Association.
TESG: Tijdschrift voor Economische en Sociale Geografie.
TIBG: Transactions of the Institute of British Geographers.
TPR: Town Planning Review.
US: Urban Studies.

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