DEVELOPING AND USING A DYNAMIC MODEL OF THE HOUSING SYSTEM IN ENGLAND AND WALES TO AID UNDERSTANDING OF THE SYSTEM AND EXPLORE POLICY PROPOSALS.

By

ANNABEL M.E. GILL B.A.

A thesis submitted for the Degree of Master of Philosophy to the Council for National Academic Awards after research conducted in the School of Mathematics, Statistics and Computing of Thames Polytechnic - London.

MAY 1978

ACKNOWLEDGEMENTS

I would like to thank Mr Ray Ward (Reader in Operational Research, Thames Polytechnic), who has acted as overall supervisor of this research project for his constant encouragement and conviction that work of this broad nature must be carried out if the problems with policy formulation, evaluation and implementation are ever to be solved.

Also I am indebted to Mr John Payne (Principal Lecturer at Thames Polytechnic) and Mr Giles Brennand (former Lecturer at Thames Polytechnic) who by completing our 'team' have provided further invaluable support and advice. In addition Mr Payne and Mr Brennand together wrote the computer programme to reproduce my interpretation of how the housing system works in reality.

Many thanks also go to all members of Staff in the Department of Mathematics, Statistics and Computing with whom I have had cause to be involved; all Staff in the Computer Centre and in both libraries at Thames Polytechnic who so willingly gave assistance.

Very special thanks go to my mother who performed the unenviable task of typing the completed manuscript, and to my future husband Mr Martin Lubikowski who so carefully drew the diagrams. Both my mother and father have, as ever, given me unbounded support for which I am deeply grateful.

The efforts to calibrate and the experimental runs provided four useful types of information:

(i) An increased understanding of the housing system.
(ii) Insights into modelling such a system.
(iii) Research and data collection requirements.
(iv) Guidelines for policy makers.

The conclusions are discussed in Chapter Eight. The most significant would appear to be:

(i) The actual process of formalizing this dynamic model has proved to be of immense value in structuring the process of learning about the housing system.

(ii) There is a severe lack of a clearly defined and consistent set of housing objectives and hence also of a proper definition of 'the housing problem'.

(iii) Problems exist in unravelling the mass of data to support the rigorous demands of a computer model.

(iv) The learning experience from this type of model development needs to be embedded more deeply into the decision making process. It is recommended that any future model should be developed in close liaison with government policy makers.

not just one clear aim towards which all are working. The housing objectives that different parties assume should be sought by the nation either reflect the standpoint of the parties making the declarations thus producing a set of often unrelated and conflicting aims or are vague and ill-defined such as,'a decent home for every family at a price within their means'. (25)

In any complex and interconnected system the pursuit of one aim invariably means that some other aim must be forfeit. But the problem of determining priorities is only exarcerbated when the policy aims are ill-defined.

In the process of building up a total picture of the housing system it became apparent that it is no trivial matter to specify a structured and systematic hierarchy of aims towards which a nations housing policy can be directed. It was found possible, however, by taking a broad view, to specify a number of questions which policy makers must consider if a usable statement of housing objectives is to exist. This list is contained in Appendix A.

The apparent difficulty in expressing housing objectives as a set of clearly defined and consistent aims is allied to the diversity with which the housing 'problem' is perceived. An examination of the literature quickly shows that there is not just one housing 'problem' clearly understood by all. Like beauty the 'problem' appears to be in the eye of the beholder. The following extracts are illustrative of ways in which the national housing problem and its solution has been perceived:

> 'there is not an absolute shortage of dwellings, the problem is (that) only the better-off can afford to buy a house...(because there are) ... not enough building

important feature of variations with time can be dealt with. The computer programme for the model equations was written in Algol language; an ICL 1900A machine being used.

Before describing this model in outline two practical difficulties which were encountered will be discussed. These are the problems of classification and of definition of terms.

2.2. THE CLASSIFICATION AND DEFINITION PROBLEMS

A difficulty which affects data collection and modelling is that of choosing a method by which households and dwellings should be designated into sub-groups. In both cases the options are very wide. Even when the decisions are made there will be generated all the cross-product possibilities thus creating a much larger sub-division in the allocation section of the model. This combinatorial effect can pose severe problems in defining the level of complexity that the model should take. Chapters Three and Four examine fully the many ways in which households and dwellings can and have been classified. At the end of these chapters the reasons are given for choosing the sub-divisions used in this particular model building research. In the last analysis, the method of classification is determined by the type of policy the model is intended to evaluate. Guidance on this point was provided by the list of policy proposals in Chapter One.

A second major problem concerns the inconsistency in definitions of data from varying sources. For example,

Registrar Generals classification system.

Age - households are divided according to age of the head of household - Old (45 years and over) and Young (Aged 18-44 years).

Family Status - four different states are defined: Single persons, married couples without children, married couples with children, single parent families.

The number of each type of household will depend upon some or all of the following rates of change -

New Households (i.e. children becoming 18 year olds)
Marriage
Birth
Separation
Immigration
Emigration
Ageing (From age 44 to 45 years)
Death

These demographic phenomena operate so that their effects are to shift groups of people through a range of life experiences from leaving home at eighteen years to death in old age.

The Dwellings Sub-Model

Twenty four different types of dwelling are defined, arising from a three way classification system -

Tenure - Three modes of tenure are considered: owner occupied, local authority rented, and others (mainly privately rented).

Size - Dwellings are classified as very small, small, medium and large (The traditional three-bedroom house is included in the medium category).

Condition - Dwellings are classified as being in good condition if they are fit and have all basic amenities, and bad if unfit and/or lacking one or more basic amenity. These

changing needs or desires. But it must be remembered that these are only characteristics and care must be taken not to attach importance to one as opposed to any of the others. Neither can any of these divisions be regarded as independent influences on the choice of residential location.

Despite the plethora of characteristics by which households can be identified much of the detailed variation may be accounted for in terms of the underlying variation along two or three basic differentiating factors.

The method of factor analysis has been used in many studies to describe the residential differentiation of the urban population. Factor analysis attempts to account for the manifold variation in the characteristics in terms of a much smaller number of underlying constructs.

Since the results of these studies vary not only with the nature of the data input and the particular type of factor analytic technique employed but also with the theoretical predilections of the investigators, difficulties arise in the deduction of hard and fast rules as to the selection of those factors which will always adequately describe the population in question. (118)

However, despite the many differences in factors chosen by different studies a general consistency of the findings emerges.

Gans (46), for example, maintains that if households have an opportunity to choose their housing that class, in all its economic, social and cultural ramifications, and life-cycle stage will go far in explaining the kinds of housing and neighbourhoods they will occupy and the ways of life they will try to establish within them.

A more complete understanding of the workings of the housing system must include analysis of how these factors are affected by the processes, determinants and institutions involved in organising the urban system. This will be discussed in a later Section.

3.2.1. Family Life Cycle

The method of analysis most widely applied to housing in Britain has been the family life-cycle. In this an important explanation of the differences in both requirements and resources of a household is its position in the family life-cycle. (93)

Rossi (111) finds that shifts in family composition accompanying life-cycle changes constitutes the major reason why families move at all; mobility being the process by which families adjust their housing to the changing needs generated.

Professor D.V.Donnison (43) suggests that people pass through five 'housing stages' in the course of their lives involving six basic household types:

(1) For the first twenty years or so they live in their parents home.

(2) Then a growing proportion of them spend a brief period on their own or with friends after leaving home to study or find work. The first year or two of marriage when wives generally remain at work, may be regarded as a continuation of this phase: the household is small and mobile, and out all day; their home is not the centre of their lives.

(3) As soon as their first baby is born, the households needs change again and become, during this

expanding phase, increasingly extensive and demanding.

(4) In time, all or most of their children leave home, and for those who do not have elderly relatives living with them there follows a fourth phase. The household is again small and less dependent upon its neighbours and the services offered by the surrounding district, but a home has been established and filled with possessions, roots have been put down, and people are less likely to move than in earlier years.

(5) Finally, in old age, households shrink still further; they become even less mobile, and their comfort and peace of mind depend increasingly upon security of tenure, upon the design and equipment of the home, the services available in the neighbourhood and the support of nearby relatives and friends.

In Stage (1) individuals do not constitute a separate household whilst still dependent upon their parents.

In Stage (2) two household types can be defined:

Young Single Person Households.
Young Couple Households.

In Stage (3) families emerge and grow defining:

Young Family Households.
Young Single Parent Households.
Old Family Households.
Old Single Parent Households.

In Stage (4)the fifth household type can be defined:

Old Couple Households.

In Stage (5) are:

Old Single Person Households.

These six household types involve only three different household structures - single, couple and family, although single will encompass all never-married, widowed or divorced persons now requiring separate accommodation.

Analysis by structure alone imparts a limited understanding of either present needs or future demands; age of the head of the household will define more precisely at what stage of the family life-cycle the household is situated. The housing behaviour of a young couple anticipating becoming a young family will differ considerably from an old couple the next stage for which may be old single household . Classification of households by age is an integral aspect of the life-cycle theory. In most studies young implies aged under 45 years and old implies aged 45 years and over.

Although this formulation provides a useful structure for analysis its limitations must be recognised. Previous studies indicate that there is a wide and contradictory variation in patterns of housing use among households at similar stages of the family cycle. Constraints and inertia factors may prevent housing adjustments in accordance with the family life-cycle. The family cycle formulation is intended to indicate 'needs'; it does not imply that the housing system distributes resources according to need. Other considerations need to be taken into account if family life-cycle is to be fruitful in housing analysis. Family life-cycle is best regarded as one of the factors which may be most important in determining the housing expectations, aspirations and demands of households.

At this stage it is useful to distinguish between housing 'need' and housing 'demand'. Murie, et al, (82) cover this point very clearly and show that it is essential that the two concepts be distinguished:

> "Housing need has been defined as 'the extent to which the quality and quantity of existing accommodation falls short of that required to provide each household or person in the population, irrespective of ability to pay, or particular personal preferences, with

accommodation of a specific minimum standard and above. (90)
Demand, on the other hand, is an economic concept: the standard and amount of housing a household can command is a result of income and ability to pay. It does not imply the achievement of any specified minimum standard. There is a third possible concept, namely housing 'desires', based on household preferences and aspirations. In some circumstances, 'desires' can merge with both 'need' and 'demand'

3.2.2. Social Class and Socio-Economic Group

Social Class or Socio-Economic Group is commonly taken to give a good indication of:

(a) A households ability to demand certain types of housing - and

(b) A households desire for certain types of housing.

Both are aspects of social stratification. The latter term being used to refer to any hierarchial ordering of social groups or strata in society.

Social class/group is a much more elusive concept than say age or sex and difficulties arise in defining its nature and meaning. There are some clear historical indications that divisions in society which exhibit most of the characteristics of social differentiation have long been recognised. Plato, for example, writing about 300 BC, wrote of gold, silver and tin people. The rights and privileges of these groups he saw as being based on inheritance, effort and worth to society. Aristotle wrote that the best administered states had a large middle-class- larger if possible than both the others - which is clearly a reference to the different degrees of political power enjoyed by the classes. Romans used the term classis, which was a division of people on the basis of taxation and property. Hence the usual concomitants of class - status, power, wealth and so on have been recognised as a basis for dividing people into groups probably for as long as societies have existed. However, Briggs (16) has argued that social class/group as we know it emerged after the Industrial Revolution. Industrialisation broke up existing order of society and replaced it with a greater division of labour. People's occupations became much more differentiated in terms of skills and rewards. Together with the migration to the cities these differences brought about separation in residence, styles of life and interests.

One criterion which has been suggested for determining social class/group is income, recipients being graded according to the size of their income, irrespective of how it has been earned. But the income per se is not a satisfactory principle for establishing class, if only because, as Lockwood (76) describes, the question of occupational prestige interferes with simple economic gradations. Manual work is generally considered to have lower status than non-manual work yet many occupations within the skilled manual range receive higher wages than the lesser clerical jobs. Curates for example earn less than dock labourers. The difficulties of using income as a criterion of differentiation are further increased by the incidence of graded taxation and death duties, which reduce inequalities in the distribution of income.

Whereas the overall national income has doubled in recent years the lower income groups share of it has trebled hence narrowing the income gap between the middle and working classes. Although one person may command a higher annual income than another he may not be able to effectively demand better housing. In order to obtain a mortgage, for example, security of earnings and incremental salary scales are as much importance as the absolute level of earnings.

In British research almost the sole criterion of social class/group which has been used is occupation - it appears to be accepted as a reasonable general-purpose tool for classifying people. Or as Monk (81) has argued:

> 'occupation has remained the backbone of social grading because no better methods have been found and therefore it has remained a powerful and useful stratification factor even though the interpretation has become more complex'

Very little research has been carried out on the development and use of scales of social class/group based on other factors or on multidimenional measures. In America, however, combinations of factors such as occupations, income and education have been used. Even such unusual factors as participation in the community, and the contents and condition of living rooms (52) have been implemented but usually only for particular studies, their general use in other studies has been limited.

In terms of research use in Britain, data on occupation is easy to collect and has remained universally a popular criterion. In addition, occupation has been consistently shown to be highly related to most other factors associated with social grading, particularly income and education. As Berger (14) has written:

> 'Different classes in our society not only live differently quantitatively, they live different styles qualitatively. A Sociologist worth his salt .... can make a long list of predictions about the individual in question even if no further information has been given .... the Sociologist will be able to make intelligent guesses about the part of town in which the individual lives, as well as about the size and style of his house'.

There are a number of reasons why occupation is recognised as an important descriptive element of social grading. In all societies where they exist occupations are differentially rewarded. Income is obviously an important determinant of possessions, style of life, andplace of living in societies based on a cash nexus. Households with similar incomes are likely to be able to afford similar housing. Furthermore, individuals participating in similar occupations will interact with each other in particular ways, the experience of work affecting in some way a person's view of the world, his attitudes and opinions. i.e. not only will households with similar occupations have similar ability to demand certain types of housing they most likely will also desire similar types of housing.

The census contains two forms of classification of occupations:

Social Class - and
Socioeconomic group

3.2.2.1. Census Classification by Social Class

The official collection of statistics related to social class can be traced back to the middle and late nineteenth century to the work of the General Register Office (GRO). 1937 saw the introduction of civil registration of births, marriages and deaths, which when combined with information collected in the decennial censuses of population of the number of males in different occupations showed striking differences in mortality between groups of workers in particular occupations. For the first time statistics were available which underlined the probability that hardship arising from poverty and its correlates in housing, nutrition, hygiene and clothing might also contribute to differential mortality.

The first systematic attempt to construct a social classification of the population in England and Wales was undertaken by Dr. Stevenson in 1911 primarily for the purpose of analysing infant mortality. The classification grouped relatively homogeneous occupations according to the degree of skill involved and the social position implied. (115) Eight social groups were identified, the first five being ranked in descending order of social position. These have become widely referred to as the Registrar General's Social Classes:

I	-	Upper and Middle
III	-	Skilled
II	-	Intermediate bwteen I and III
V	-	Unskilled
IV	-	Intermediate bwteen III and V
Others	-	Textile workers
		Miners
		Agricultural Workers.

Due to certain defects in the 1911 classification (e.g. failure to distinguish between employers and employed or between skilled and unskilled in the manufacturing industries), in 1921 Dr. Stevenson made certain revisions to ensure that social grading was made entirely on the basis of occupational information. (116)

This broad criterion for allocating occupational groups to the social classes has survived through successive population censuses, although its application is nowadays regulated by such factors as occupational training and skill, education and professional qualifications. Since 1961 distinctions have been made between people with different levels of responsibility; account is taken of individuals employment status (e.g. if he is a foreman) in addition to his occupational group before being allocated to a social class.

In the 1970 Classification of Occupations Social Class III was split into manual and non-manual components thus enabling the social classes to be readily recombined into a non-manual and manual dichotomy. The social class categories currently used together with examples of the occupations covered are listed below:

<u>Non-Manual</u>

I - Professional Occupations (e.g. Doctors, Lawyers)
II - Managerial and lower Professional Occupations (e.g. Sales Managers, Teachers)
III N- Non-manual skilled occupations (e.g. clerks, shop assistants)

<u>Manual</u>

III M- Skilled manual occupations (e.g. bricklayers, underground coal miners)

IV - Partly skilled occupations (e.g. bus conductors, postmen)

V - Unskilled occupations (e.g. porters, ticket collectors, general labourers)

Changes in the social standing of particular occupations and shifts in occupational structure have led to modifications on the grouping of occupations into social classes at successive censuses since 1921. Such changes raise problems of comparability over time between statistics on the social classes but may be less than the corresponding problems brought by time alone in an age of rapid technological change.

In 1931 for example half a million male clerks were transferred from Social Class II to Social Class III. In 1911 they had been classified in Class I. With the growth in technology employees in many occupations have had to undergo extensive training and so such occupations have tended to climb the social class scale. Correspondingly, other groups have fallen in social status. The effect of such changes on the comparability of censuses will depend upon the size of the occupational group concerned.

The social classes are derived from aggregates of precisely defined occupational groups. Individuals are assigned to one of more than 200 groups on the basis of their current, most recent or last occupation as recorded for example at birth, marriage or death registration, or on census schedules. The most accurate statements probably are found at the census where generally the individual answers questions of a more specific nature than at registration where the informant might not know precisely the kind of occupational statement required. A 'mechanic' for example could, if unqualified, relate to several occupations - motor, electrical and so on - each of which falls into a different occupational group. A mechanic who was a foreman would be assigned to the wrong social class if his status were omitted. Over reporting of status - the street vendor who is reported as a travelling salesman - also give rise to bias.

Analysis using occupational data from different sources can give rise to errors. Statements about the occupation of individuals given at vital registration may not always be consistent with statements about the same individuals recorded at census. A certain amount of the discrepancies may be accounted for by social mobility after the census but the majority will be due to the inconsistency of statements. Such inconsistencies will affect the accuracy of rates derived from vital events.

3.2.2.2. Census Classification by Socio Economic Group

In 1947 a Socio Economic Group System was developed by the GRO in conjunction with Professor Glass in response to the suggestion that a need existed for 'a method of grouping (occupations) into a relatively small number of classes, larger than five, but still manageable' in order to analyse fertility patterns.(112)The SEG classification was not another attempt at ranking but rather the construction of social status divisions for a more limited field of comparison. For example, comparisons can be made between those professional workers who are self-employed and those who are employees. Thirteen SEG's were used. In 1961 the Conference of European Statisticians recommended that the groups be revised to contain 'people whose social, cultural and recreational standards and behaviour are similar. In practice, however, this ideal is considered difficult to obtain as it is impracticable to ask enough questions. The allocation of occupied persons to socio economic group is determined by considering their employment status. Further modifications to the SEG's is expected before 1981 to bring them in line with the EEC requirement of harmonization of classifications.

The groups used in 1961, 1966 and 1971 are as follows:

1. Employers and Managers in central and local government, industry, commerce etc. - large establishments (with 25 or more employees)
2. Employers and Managers in central and local government, industry, commerce etc. - small establishments (25 or fewer employees).
3. Professional workers - self-employed
4. Professional workers - employed.
5. Intermediate non-manual workers.
6. Junior non-manual workers.
7. Personal Service workers.
8. Foremen and supervisors - manual.
9. Skilled manual workers.
10. Semi-skilled manual workers.
11. Unskilled manual workers.
12. Own-account workers (other than professional)
13. Farmers, employers or managers.
14. Farmers, own-account.

15. Agricultural workers.

16. Members of the Armed Forces.

17. Indefinite (inadequately described occupations)

Government research, particularly the General Household Survey, has also made use of a collapsed version. This collapse is achieved, as shown below, by placing fifteen groups into six categories. These categories are not identical with the Registrar General's classification of social classes but are clearly parallel:

Collapsed Groups	Socio Economic Groups	Descriptive definition
1	3,4	Professional.
2	1,2,13	Employers and managers.
3	5,6	Intermediate and junior non-manual.
4	8,9,12,14	Skilled manual (with own-account non-professional).
5	7,10,15	Semi-skilled manual and personal service.
6	11	Unskilled manual.

Thus a households 'need' for housing will be determined largely by its position in the family life cycle and its 'demand' and 'desires' for certain types of housing will depend upon its social class/socio economic group.

3.3. DEMOGRAPHIC FACTORS AFFECTING THE NUMBER OF HOUSEHOLDS OF EACH TYPE.

For each socio economic group/social class at each stage of the family life cycle certain phenomena will cause the actual number of households of each type to change. These demographic phenomena, some affecting households at every stage of life and some being specific to particular stages are: births, deaths, marriage, divorce, emigration, immigration, growing old and children leaving the parental home. In the following sections these phenomena will be discussed in terms of their changing nature and influence over time, and their importance in affecting and being affected by the housing system.

3.3.1. Immigration and Emigration

No population is ever static, movement taking place not only from one part of the country to another (internal migration) but also from one country to another (international migration). The motives for moving are manifold. Those concerned with internal migration will be discussed in a later section (Section 5.2). One of the strongest motives for movement between countries is the relative employment opportunities available. (101)

When a household emigrates a dwelling is necessarily made vacant. An immigrant household will require a vacant dwelling. It has been suggested in the previous section that certain household types will occupy certain types of dwelling. By analysing the household characteristics of immigrants and emigrants it may be possible to draw certain conclusions as to the effect of migration on the changing balance of vacant dwellings. If the characteristics of immigrants differ widely from those of emigrants the housing released by emigrants would not satisfy the needs or demands of immigrants.

Statistics referring to migrants are collected according to the following internationally agreed definitions. An immigrant is a person who having resided elsewhere for at least a year states on entry to this country that he intends to stay here for 12 months or longer. An emigrant is a person who has been a resident of this country for at least the past year and who says on departure that he intends to stay abroad for at least one year. This definition is strictly a statistical one unrelated to the laws defining whose entry into the country is subject to immigration control.

Since 1964 information on international migration has been collected in the International Passenger Survey (IPS). This procedure involves the selection of a sample of passengers entering and leaving the UK by the principal air and sea routes excluding traffic between the UK and Eire. Information is obtained by interview on migration, tourism and the effect of travel expenditure on the balance of payments.

About 7 per cent of outgoing passengers and 4 per cent of incoming passengers, although a smaller proportion on small airports and sea ports, are sampled. In 1973 a total of 315,000 passengers were interviewed of whom over 10,000 were migrants. Allowance has to be made to population estimates for visitors who in fact become immigrants and for intending immigrants who subsequently do not stay for 12 months. Both these adjustments are fortunately not large.

Both immigrants and emigrants consist of foreigners and UK citizens (holders of UK passports). During the decade 1964 to 1974 the pattern of net migration has been relatively stable, more foreigners entered the country than left but even larger numbers of UK citizens left the country than entered. The overall picture being in line with Britain's traditional role as a net exporter of people and in contrast to the exceptional experience of the late 1950's and early 1960's when mainly due to an influx of New Commonwealth citizens the country was a net importer of people.

A study by Christopher Walker at the Office of Population Census and Survey (OPCS) discusses the sex, age, marital status and occupational characteristics of international migrants with reference to data obtained from the International Passenger Survey. (97)

In every year between 1964 and 1975 the UK had a net loss of both adult men and adult women (apart from 1972) as a result of migration - an annual average of 22,000 men and 18,000 women over the 12 years. In general both immigrant and emigrant streams have been characterised by a greater number of female migrants in the early years of the period and only since the early 1970's have men consistently outnumbered women.

The age characteristics of migrants are heavily biased towards the younger age groups and hence bears little relation to the age structure of the population from which they come. Of emigrants from the UK about half were under 25 and 90 per cent under 45. For immigrants the corresponding proportions were rather more than half for ages under 25 and 90 per cent under 45. About one third of all immigrants are concentrated in the 15-24 age groups; this has remained a consistent proportion for the 12 years.

A similar proportion accounts for 25-44 year olds with children amounting to one fifth of the flow. The median age for immigrants for the period 1964-75 was around 24 years.

In contrast the median age of emigrants has centred around 26 years for the period with a rather higher proportion of children and those in the age group 25-44 than for immigrants and fewer in younger age groups.Of all migrants men were more concentrated in the 25-44 age range and women in the 15-24 year age range.

This small asymmetry between the age and sex structures of the immigrants and emigrants has some interesting effects. The net migration losses in virtually every year since 1964 have led to consistent net losses of males and females in all but one of the identified age groups. The exception being the 15-24 year olds where a net migration balance has roughly occurred for both men and women.

On the whole, since 1967 married immigrants have always slightly outnumbered single immigrants who have accounted for between 44 and 50 per cent of the adult inflow. A much higher proportion of emigrants is married. It is suggested that families make up a larger proportion of emigrants than immigrants; there is some evidence that married workers entering this country leave their families in their home country.

As there have been more emigrants than immigrants in this period and because a higher proportion of emigrants are married there has been a considerable net loss of married people, totalling 50,000 in some years. In contrast in 5 of the 11 years there were net losses of single persons and net gains in the other years.

Due to the relatively small size of the IPS sample estimates of the occupational status of migrants are available only for broad categories. The economically active are divided into 'professional and managerial' and 'manual and clerical' occupations whilst non-gainfully employed groups are 'students', 'housewives' and others. Data refers to the migrants regular occupation before travelling and will not necessarily agree with the migrants intended occupation. (34)

During the 12 years 1964-75 about 39 per cent of economically active emigrants and over 40 per cent of immigrants belonged to the professional and managerial groups. Although taking into account that emigrant flows have exceeded immigrant flows it is estimated that less than 20 per cent of the net loss of economically active migrants were in professional and managerial occupations. To a certain extent the loss of higher qualified workers from Britain has been offset by the arrival of workers with similar skills.

Over this period the proportion of workers in the 2 occupational groups has remained fairly stable although since 1974 more selective immigration policies have been pursued by the main countries receiving UK migrants which has led to a decline in the numbers of clerical and manual emigrants. Among immigrants there has been a corresponding increase in professional and managerial workers.

has shown how the Victorian middle classes postponed marriage until the income of the bridegroom was such as to ensure that the couple started life with a well-equipped home. Nowadays, most building societies require prospective first-time buyers to have saved with them for a minimum of two years before being granted a mortgage. Many couples in this situation find it cheaper to remain living in their respective parental homes during the period they wish to save for a deposit. It is hypothesised that less stringent regulations on the part of the building societies might lead to earlier marriages for some sections of the community. The governments proposed policy towards first-time buyers involving an interest free loan of £500 so long as the couple have saved the same amount in a minimum of two years with a building society will possibly increase the proportion of couples delaying marriage until they have saved enough capital to buy a home of their own.

Until the 2nd World War marriages, in general, would occur at a relatively late age and a high proportion of persons remained unmarried. Subsequently there has been a change to an earlier age pattern. In 1974, for example, spinsters were marrying on average 2½ to 3 years younger than their counterparts 40 years earlier when the average age at marriage was 25.5 years. In addition a higher proportion of persons now marry. In 1931 17 per cent of all females remained unmarried at ages 45-49 but in 1974 this percentage had fallen to only 7 per cent at the same ages. Similar trends have been experienced by males although the decline in the average age is slightly less than for females and the proportion remaining unmarried at ages 45-49 has only shown minor changes over the same period.

One major factor associated with these changing marriage patterns has been the changing sex ratio at marriageable ages. The 1st World War resulted in the deaths of large numbers of males and at the same time more males than females were lost through emigration, hence by the 1930's there were significantly more females than males at the most marriageable ages. By 1951 a more evenly balanced ratio was achieved. Since the early 1950's there has been a slight surplus of males (See Figure 3.1).

This change in the proportion of males may have helped to produce the greater decline for females than males in the average age at marriage in addition to giving rise to pressures for a higher proportion of females to marry.

3.3.2.1. First Marriages

In terms of the effect on or by the housing system first marriages are of greater importance than re-marriages. Most first marriages will represent a new demand for housing as many newly-married couples leave the parental home to set up home for the first time. With a remarriage each partner will most likely already possess an individual home.

In the decade 1965-74 trends for first marriages and

remarriages have differed. Up to 1970 there was an increase in first marriages which could be explained as those born in the post war baby boom passing through the marriage ages. Since 1970 there has been a downward trend of first marriages particularly at ages 20-24 which usually records the highest number. This reduction may be due in part to fewer numbers in this age group with the passage of the effect of the post war boom. The Family Law Reform Act 1970 which lowered the age of majority from 21 to 18 had the immediate effect of increasing the number and rate of marriages for those under 20. Many people who might have waited until 21 to marry (in 1968 and 1969 this was the peak age at which spinsters married) brought forward their marriages to age 18-20. There have not been commensurate changes in the proportion married by ages 21 and over. The decline in marriage rates (first and remarriage combined) in 1974 led to lower proportions ever married for most generations compared with preceding generations at the same age. See Table 3

Whether a significant trend towards later first marriages is to be expected as has been seen for example in the USA in recent years or is merely a temporary phenomenon in response to recent economic constraints is open to conjecture. A significant decline in the popularity of marriage is not likely since even if first marriages continued at its present rate over 90 per cent of all persons aged 16 now would be married by the age of fifty.

Table 3.1 Proportion (per 1000) of women who were ever married* before attaining selected ages in England and Wales.

Birth generation†	Age (exact years)**								
	17	18	19	20	21	22	23	24	25
1950	18	65	157	283	430	564	665	732	777
1951	19	71	263	305	440	571	665	730	
1952	22	73	189	323	459	579	668		
1953	21	76	190	322	447	555			
1954**	23	78	194	322	442				
1955	25	81	194	313					
1956	25	79	185						
1957	23	72							
1958	18								

* The figures in the right hand diagonal represent marriages up to the end of the calendar year 1974; those in the next diagonal to the left represent marriages up to the end of 1973 and so on.

† The 1950 birth generation represents a group with dates of birth ranging from 1/1/49 to 31/12/50 and so on.

** The figures to the right of the dotted line are affected by the reduction in 1970 of the age of majority.
(Source: (105))

3.3.2.2. Remarriages

The recent increase in divorce (see next Section) has been accompanied by a sharp rise in remarriages. In 1965 11 per cent of marriages involved a divorced bride or groom; by 1974 this had increased to 25 per cent. The number of widows remarrying has also risen slightly. Evidence suggests (see Table 3.2)that persons of a given marital status are more likely to choose partners of the same marital status, but this could be because most people marry within a narrow age band from their own age group and in these circumstances most eligible spouses tend to be of the same marital status. There is however, a considerable variation in age of remarriage depending upon the marital status of the partner of the remarriage. The average age at remarriage of divorced women and widows is 35 and 54 respectively although the average age of divorced women marrying bachelors is 20 years younger than that of divorced women marrying widowers.

Table.3.2.Marriages by marital status of husband and wife - England and Wales.

Marital status	Number of marriages Thousands.			Per cent change.
	1965	1971	1974	1965-74
Groom single				
Bride single	311.2	320.4	271.7	-13
Bride divorced	12.8	19.2	26.9	+111
Bride widowed	4.5	4.0	3.7	-18
Groom divorced				
Bride single	14.2	22.3	29.1	+105
Bride divorced	7.5	16.1	29.8	+297
Bride widowed	2.7	4.0	5.2	+ 94
Groom widowed				
Bride single	6.3	4.7	3.8	-39
Bride divorced	3.3	4.3	5.0	+50
Bride widowed	8.6	9.7	9.2	+7
TOTAL:	371.1	404.7	384.4	+4

Source(105)

Although the number of remarriages has increased over the last ten years little change has occurred in the rates of remarriage of divorced persons (calculated per 1000 divorced men or women in the population). The increase in the number is due to the increase in the population 'at risk' i.e. number of divorced men or women in the population. From 1970 to 1974 the number of divorced females under 60, for example, rose by over 50 per cent.

The highest remarriage rate occurs for both divorced males and females in the age group 25-29; the rate declining in each subsequent age group.

3.3.3. Divorce

The effect of divorce on the housing situation or, conversely, the effect of the housing system on the rate of divorce is difficult to ascertain and very little work has been carried out in this field. When a couple divorce one of the partners will have to leave the marital home to find separate accommodation thus exerting a pressure on the demand for housing. Depending on the financial situation of the other partner, especially if children are concerned, it may not be possible for them to continue living in the marital home. Thus a move and increased pressure for cheaper housing may be generated. The more prevalent is divorce the greater will such activity be.

Civil divorce first became available in 1857 (110) The number of divorce decrees granted has since continued to rise; fluctuations in the numbers occurring only when there were either changes in the legal grounds for divorce or changes relating to financial assistance to litigants. Pre World War II divorces amounted to 10,000 per annum. Between 1945 and 1947 the number of decrees made absolute quadrupled. The Legal Aid and Advice Act.1949 increased the financial assistance to litigants resulting in a temporary increase in divorces but this gradually declined to 24,000 divorces per annum by 1960. Again to 1970 the trend was upward when there were 58,000 divorces. The 1969 Divorce Law Reform Act which came into effect in 1971 resulted in a doubling in the number of divorces to

119,000 by 1972. In 1973 the number fell back temporarily but has since continued to rise.

The post war rise in the number of divorces cannot be accounted for by the increase in the number at risk (married persons in the population). The divorce rate per 1000 married women aged 15-59 years has shown an increase at all ages. The number of persons divorcing for a second time has however increased in proportion to the increased number at risk. The proportion of divorces involving persons divorcing for a second time increased only slightly from 9 per cent in 1964 to 10 per cent in 1973.

Up to 1971 and since 1973 there has been a growing tendency for husbands and wives to divorce at younger ages and at shorter durations of marriage. The reversal of these trends in 1971 and 1972 was a result of the new legislation allowing a backlog of broken marriages to be dissolved. In many cases cohabitation had ceased some years earlier and the new legislation allowed these and couples who had been previously debarred or reluctant to petition for divorce to proceed with their claims. A considerable number of couples now obtain a divorce because they have been separated for five years or longer or through both partners consenting after two years separation - both new provisions introduced in the legislation of 1969.

The divorce experience of couples marrying in the same year can be compared for different marriage cohorts at equivalent intervals from marriage.

Evidence suggests there is a very much greater risk of divorce at any given duration if the bride was aged 20 or under at marriage. This risk is enhanced still further if the groom is also under age 20 at the marriage.

In attempting to predict future levels of divorce it is difficult to isolate these factors which have led to the present unprecedented high level of divorce. Undoubtedly new legislation has made the process easier and cheaper. In addition divorce has become a more acceptable means of terminating a broken marriage. There may have been, as in the case of marriage, a feed-back effect whereby increased social acceptance of divorce and remarriage has led couples to initiate divorce proceedings. Assuming the 1971-73 divorce rates were to continue at the same level and also the marriage rates were to continue at the current rate, 22 per cent of all females would divorce at least once by the age of 45 years.

3.3.3.1. Children of Divorcing Couples

A 'child' of a divorcing couple refers to a child who was aged 16, or if over 16 still receiving full-time education at the time the divorce was filed. Since there would be a delay before the decree absolute is filed the number of dependent children enumerated may be overstated.

In recent years there has been a decline in the proportion of childless couples divorcing and an increase in the average family size of divorcing couples with children. In part this may be related to the trends in duration of marriage and age of divorcing couples already mentioned. Present evidence does not permit judgement of whether marriages with children are more, or less, prone to divorce than marriages without children.

3.3.4. Births

Considerable debate has been generated in recent years as a result of the continuing drop in the number of births. As the death rate also declines and migration continues to cause a net loss to the population serious questions have been raised as to what effects the possibility of not being able to replace the population might have.

Possibly the first impact of a declining birth rate will be a decline in the average completed family size - unless the decline in births is due to mothers having children later in life rather than fewer children per family. Some couples may not have any children thus reducing the number of families in the population. As the size of the household declines the need and demand for certain types of housing will be adjusted.

During the last twenty years births were at first increasing but then followed a period of sharp decline. (See Figure - 3.2.)

Up to 1964 births in England and Wales increased by 3 per cent per annum. In contrast since then annual births fell by an average of 2 per cent each year to 1970, remained the same in 1971 and then showed sharp annual declines of around 7 per cent in 1972 and 1973 and 5 per cent in 1974; giving a figure of 642.000 births in 1974 compared with 876.000 births ten years previously. In the year ended March 1976 deaths exceeded births by a few thousand, the first time this has happened in peace time

since central records were first introduced 140 years ago.

The main source of data is information collected at birth registration under the Population (Statistics) Act, 1938. The fathers occupation as shown on the birth certificate is coded using the 1970 Classification of Occupations (HMSO) and these codes allocated to the Registrar General's Social Classes as used in the 1971 Census Reports. Supplementary statistics are obtained from the General Household Survey.

An understanding of the changing reproductive behaviour of the population will be gained by analysing the characteristics of the women bearing the children - commonly the age of the mother at birth, also the age at marriage and duration of marriage (if married) the number of previous liveborn children, and where possible, the socio-economic group or class of the household into which the child is born.

Table 3.3. shows how the major source of the overall decline in births during 1970-1975 has been the substantial decrease in births to women with husbands in the lower social classes. For Social Class I and II there has been virtually no change in the level of births over this period; in contrast births fell by around one third for Social Classes IV and V. Social Class III N births fell by about one quarter - approximately the annual rate.

TABLE 3.3. - Estimated legitimate births by social class of husband, 1970 to 1975, England and Wales

Year	Social Class of husband						
	All Classes	Non-manual			Manual		
		Total	I and II	IIIN	Total	IIIM	IV and V
Number (000s)							
1970	720	224	148	76	468	301	168
1971	717	230	155	75	458	298	160
1972	663	223	152	71	413	272	141
1973	618	213	148	65	376	246	131
1974	583	206	146	60	353	232	120
1975	549	199	142	57	326	214	112
Index (1970 = 100)							
1970	100	100	100	100	100	100	100
1971	100	102	104	99	98	99	95
1972	92	99	102	94	88	90	84
1973	86	95	100	85	80	82	78
1974	81	92	99	78	75	77	72
1975	76	89	96	75	70	71	67

Source (108)

Evidence suggests that the recent drop in annual births has affected women no matter what their age, previous number of liveborn children, length of marriage or socio-economic group. This suggests that there are factors at work which generally affect the reproductive behaviour of all women at any one time. It may be that women are just timing the birth of their children differently rather than changing the completed family size significantly. In fact this latter statistic has shown more stability during this century than annual fertility rates. Other factors affecting the fertility behaviour of a generation include current and anticipated economic conditions and social attitudes, changes in contraceptive practices and legalised abortion. (109)

3.3.4.1. Duration of Marriage Before First Birth

It might have been expected that with the earlier marriage patterns (discussed in Section 3.3.2)of the last decade an increase in births would have occurred to young married women; instead the number of births to married women under 20, for example, has fallen from 60,000 in 1969 to 53,000 in 1973. This suggests that getting married and starting a family are no longer so closely related as was the case a few years ago.

Cohort analysis for women married in a particular year is an effective method of studying such changes as the family building histories of difference cohorts can be examined. The percentage of women remaining childless after a given number of years of marriage is shown below.

The general picture is of a declining childlessness for couples married in 1961 compared with 1951 and then postponement of family building for those married later particularly since 1966. As the Table indicates -

TABLE 3.4 % of women who remained childless after a given number of years of marriage, for women married at ages 20-24 and married once only-England and Wales.

Year of Marriage	Duration of marriage (exact years) 1	2	3	4	5	10	15
1951	73	52	39	32	26	14	11
1956	72	50	37	29	23	11	9
1961	70	48	34	25	19	8	
1966	73	52	38	28	21		
1967	74	54	40	29	22		
1968	75	57	42	31	24		
1969	77	59	45	34			
1970	78	61	47				
1971	81	65					
1972	83						

Source(108)

3.3.4.2. Number of Previous Liveborn Children

One of the dilemmas in projecting future births is to assess whether and if so what extent the late start in family building will lead to an increase in the eventual proportion of childless families or to a smaller average completed family size. Table 3.5 below sets out figures for earlier cohorts although the distribution of family size amongst women married in recent years will not be known for some time.

TABLE 3.5 Family size distribution after 10 years of marriage for women married at ages 20-24 and married once only - England and Wales.

Number of liveborn children	1951 %	1956 %	1961 %	1963 %	1964 %
0	14	11	8	9	9
1	27	22	18	17	17
2	35	38	44	46	48
3	16	19	22	21	19
4 or more	8	11	9	8	7

Source(108)

This Table points to a decline in the proportion of families going on to have four or more children a marked decline in childlessness and one child families and an increased proportion of two child families.

Whereas the annual changes in the number of first and possibly second births will in part reflect the timing of having children changes in the number and proportion of third or fourth or higher births will be associated with changes in completed family size.

Data from the 1971 Census indicates that the lowest family size was in Social Class III N. For this Group family size was 10 per cent lower than the national average. The highest average family size was in Social Class V, 15 per cent above the average. Recent trends suggest that women married in the late 1960's will have lower completed family sizes than women married in the 1950's or early 1960's. (For data on this period see Table 3.6 below)

Table 3.6. Average family size for women married once only (under 45) by social class of husband and selected duration of marriage-England and Wales

Marriage Duration	All Classes	Social Class of Husband I	II	IIIN	IIIM	IV	V
10-14 Completed Years (1956-61)	2.24	2.23	2.12	1.99	2.28	2.30	2.56
Index (All Classes = 100)	100	100	95	89	102	103	114
15-19 Completed Years (1951-56)	2.29	2.25	2.17	2.00	2.34	2.37	2.66
Index (All Classes = 100)	100	98	95	87	102	103	116

Source(108)

The change between 1970 and 1975 in the number of births to women who have had 3 or more children (Table 3.5) and information from the General Household Survey suggests declines in completed family sizes for each of the Social Classes but without necessarily any significant narrowing of the fertility differentials. The evidence, therefore, points to a decline in the size of the household particularly to Social Class IV and V.

3.3.4.3. Illegitimate Births

The foregoing discussion has centred on legitimate births since they comprise 90 per cent of all live births. Recent trends suggest that illegitimate births as a proportion of all births is declining. - Table 3.14.

Information on the social class of the father of an illegitimate child will only be available for those parents registering jointly. This may give a biased picture of social class distribution because illegitimate births registered jointly by both parents tend to occur to older women (higher social classes tend to have older age distributions of women). It is estimated that of the 27,000 illegitimate births registered jointly in 1975 around 20 per cent were to fathers with manual occupations compared with nearly 40 per cent for legitimate first births.

3.3.5. Ageing

Another topic which has aroused public debate in recent years is the changing age structure of Britain's population. In the period 1931-1974 Britain's population increased by just under ten million, of that increase 30 per cent were aged over 70, 43 per cent were over 65 and 56 per cent over 60. By 1974 16.8 per cent of the population was over the normal retirement ages of 65 for men and 60 for women compared with only 9.4 per cent in 1931. The sharp decline in births experienced in recent years (discussed in previous Section) has meant that the growth of population has virtually ceased. In a society where great emphasis is placed on education for the young and proper care for the elderly, such a changing age structure has widespread implications. If these trends are to continue many aspects of social and economic life need to be revalued. Is the housing stock capable of satisfying the specific needs

were over 70 elderly to every 100 young persons.

With the present decline in fertility this ageing of the population is expected to continue at least until the 1980's when the trend will possibly reverse. The population over retirement age will by then be increasingly made up of those born in the inter-war years when birth rates were low and their numbers will decline both in absolute terms and as a proportion of the total population.

The DDR (See Figure 3.3) shows that while in 1931 there were only 51 people under 15 years and over retirement age for every 100 persons in the so called working age groups, by 1974 every 100 workers had to support 68 dependents. It is expected that the DDR will fall sharply in the next few years as the sharp decline in fertility more than compensates for the further increase in the proportion of elderly people in the population.

3.3.6. Mortality

Linked with the discussions on the influence of birth rates on the size of the population is discussion of the effect of lower mortality rates, since both phenomena reinforce the effects of each other i.e., both tend to lead to an ageing of the population. Such phenomena have far reaching effects in terms of housing. Elderly households very often require specific forms of accommodation; for example the 'sheltered' housing increasingly being provided by many local authorities and housing associations. An ageing population will exert pressure on these limited resources, unless policies can be devised which are capable of being adapted to these new and changing needs.

A broad idea of the sizes of the death rates involved, and the amounts of improvement is given in Table 3.7 for males in Britain over a 35-year period. For women the ratios of actual to expected declines have been higher than for men.

Table 3.7. Approximate death rates for males over a 35-year period - Great Britain

Age	Estimated mortality rate 1942-44	Reduction in 35 years expected	Actual reduction in 35 years (approx.)	Mortality rate today (approx.)
0	.0565	.0276	.0385	.0180
10	.0010	.0005	.0007	.0003
20	.0024	.0007	.0014	.0010
30	.0028	.0014	.0018	.0010
40	.0042	.0020	.0017	.0025
50	.0098	.0036	.0023	.0075
60	.0230	.0060	.0010	.0220
70	.0524	.0090	-	.0524

Source (27)

Actual improvements in mortality have created a small growth in the total population at all ages and have tilted its age-distribution slightly in the direction of the elderly. These results were obtained from results of work carried out in the Government Actuary's Department (27) on the effect of changing mortality on population projections. Estimated projections of the population made in 1942-44 were adjusted by comparing the actual fall in mortality, for various age groups, with the 1942 assumed fall and amending the expected population accordingly; and also by measuring the difference between actual population today and an estimate of what it would have been if mortality had remained as it was in the 1940's.

For the population of working age the increase in size is of the order of three per cent. The numbers of people aged 65 and over have however been raised by about six per cent. The proportion of old age pensioners in the population is now up by around two per cent as a result of declining mortality alone.

3.3.7. Children leaving home

'One of the principle uncertainties about the increase in the number of households relates to the number of single, widowed and divorced persons who will live as separate one person households' (61). So far the largest part of this increase has been among older people, most of whom are survivors of family households, and the tendency for an increasing proportion of widows and widowers to live longer as separate households is expected to continue. There appear to have been no marked increase in the number of young single people living as separate households. But this is an area where forecasting is extremely difficult, in that the effects of supply and demand are very much intermingled and it is not known whether young single people prefer to remain living with their parents or that institutional factors prevent them from setting up on their own. The increase in the availability of higher education, for example, has influenced the growing trend of young single persons to attempt to cater for themselves outside the family home. Especially in London more and more young persons decide to either live on their own or share with friends once they embark on full-time employment.

The number of single person households who will share voluntarily is even more difficult to predict especially as the vast majority will occupy dwellings in the privately rented sector and this itself is declining rapidly.

The number of 'children' leaving the parental home per annum not only affects the demand for housing by young single households but also the family household from which it has moved out. As dependent children continue to leave home the family household effectively diminishes in size. A point may be reached when the parent household decides to look for smaller accommodation to match their reduced needs. Thus the rate at which children leave the parental home is of considerable importance.

3.3.8. Social Mobility

Throughout their careers people change jobs and sometimes this entails a change of social class. Such 'movement' is referred to as intragenerational mobility, that is, upward or downward movement between social classes during a person's working life. Results from a government social survey concerned with this phenomenon are shown below.

Table 3.8 Social Class of Men in 1963 Compared with that in 1953 (percentages)

Social Class 1953	Social Class 1963					
	I	II	III(N.M)	III (M)	IV	V
I	94	2	3	-	1	-
II	-	86	8	3	3	-
III (N.M)	2	10	76	5	6	1
III (M)	1	4	4	78	10	3
IV	-	4	3	14	73	6
V	-	1	1	10	20	68

Source (59)

The careers of 4062 men who were working both in 1953 and 1963 were studied. The figures in boxes show the percentage of people in each social class (following the Registrar General's classification) who remained in that class throughout the survey; the other figures show the movement taking place during the ten year period. Social Class III (N.M) and III (M) showed most movement in both directions although males in Class III (N.M) were equally likely to move up or down whereas males in Class III (M) were slightly more likely to move down.

Evidence from the same survey (59) suggests that social mobility typically involves a change of employer (only 2.4 per cent of the male mobility took place within the same employment). Of the men in the sample who had remained in the same employment, 97.6 per cent experienced no mobility, 1.9 per cent upward mobility and 0.5 per cent downward mobility thus indicating a general upward movement in social class. Job mobility, which does not necessarily mean social mobility, is a comparatively frequent phenomenon that also shows social class differences. In 1973 some 17.4 per cent of all male employees had been with their present employer for less than twelve months; the non-manual figure being 19.3 per cent whereas the manual figure was 13.9 per cent.

A model was constructed to describe in a very broad sense the growth and dissolution over time of the various types of household drawing on the evidence presented in these Sections. The Households Sub-Model will now be described.

3.4. DEVELOPING THE HOUSEHOLDS SUB-MODEL.

3.4.1. The definition of a household

The definition of a household used in the model differs from that used in the Census (i.e.'Either one person living alone, or a group of persons (who may or may not be related) living at the same address with common housekeeping. Persons staying temporarily with the household are included') in that all persons requiring separate accommodation are regarded as individual households.

This is an attempt to ensure that the total demand for housing is made explicit and in so doing to reduce the number of 'hidden homeless'. These are the households who are not necessarily houseless or even in an over-occupied dwelling but only desire separate accommodation for themselves.

All persons reaching their eighteenth birthday are assumed to require separate accommodation. Eighteen was chosen arbitrarily although as it is the age of majority there are certain legal implications. It is also the earliest age that most students enter higher education in which a move away from the parental home is involved. With hindsight however it would appear more sensible to include only a proportion of eighteen year olds as separate households as many persons of this age are willing and, in fact, prefer to be classified as a member of the parental household. Such a decision would necessarily introduce further complexity into the model structure as varying proportions of each age group above eighteen would then have to be considered as becoming new households.

It was further assumed that all couples, with or without children, require separate accommodation. The concept of the extended family i.e. more than one generation living together, is regarded as several independent households sharing accommodation either voluntarily or involuntarily.

Such a definition is closer to that of the 'potential household' as discussed on page 21.

3.4.2. The Classifications used

Guidance on an appropriate classification of households was given by the list of possible experimental policy changes as given on page 7. Each policy change was examined to identify the household characteristic(s) which would be relevant for such a policy to be implemented.

For example, Selling Council Dwellings at 20 per cent below Market value would require a distinction to be drawn between tenants able and unable to meet the cost. A classification by income would be ideal but could be partly satisfied by a more general division of households in Socio-economic groups.

It became apparent from this analysis that very many classifications could be defined but by using proxy variables where possible three major classifications were identified as the most all-embracing:

(i) Socio-economic Group (4types)
(ii) Stage in Family Life Cycle (4 types)
(iii) Age of Head of Household (2 types)

Subdividing in this way enabled thirty-two types of households to be defined. These are discussed below:

(i) Socio-Economic Group (SEG)

Four groups are used based on the Registrar General's Classification of heads of household and being a collapsed version of the six used in the General Household Survey (GHS) shown on page 36. These six groups were reduced to only four to help equalize the numbers of households to be found in each group. In effect the GHS groups 1 and 2 are combined to form SEG I; GHS 3 becomes SEG II and GHS 4 becomes SEG III thus preserving the distinction between the manual and non-manual professions; GHS 5 and 6 become SEG IV. Note that this assumes that households in the GHS groups 1 and 2 will behave similarly in the housing market as also will households in GHS groups 5 and 6.

Thus the formal definitions assumed are as follows:

SEG (I) which consists of heads of households who are:

(i) Employers and managers in central and local government, industry, commerce etc. i.e. large establishments.

(ii) Employers and managers in industry, commerce etc. i.e. small establishments.

(iii) Professional workers - self employed.

(iv) Professional workers - employees.

(v) Farmers - employers and managers.

SEG (II) consists of heads of households who are:

(i) Intermediate non-manual workers.

(ii) Junior non-manual workers.

SEG (III) consists of heads of households who are:

(i) Foremen and supervisors - manual.

(ii) Skilled manual workers.

(iii) Own account workers (other than professional).

(iv) Farmers - own account.

SEG (IV) consists of heads of households who are:

(i) Personal service workers.

(ii) Semi-skilled manual workers.

(iii) Unskilled manual workers.

(iv) Agricultural workers.

(v) Members of armed forces.

(vi) Indefinite.

(vii) Other Economically inactive.

(ii) <u>Stage in the Family Life Cycle.</u>

Households are assumed to belong to one of four types of family group each representing a different stage in the life cycle. As discussed in Section 3.2.1. different housing need will be experienced at different stages of a persons/households life. The four most pertinent stages appear to be:

SINGLE
MARRIED COUPLE WITHOUT CHILDREN
MARRIED COUPLE WITH CHILDREN
SINGLE PARENT FAMILY

The decision to include a single parent family group was based largely on the evidence presented in Section 3.3.3. on Divorce. If the annual number of divorces continues to rise as in previous years the special housing needs of the single parent family will have to be examined more fully.

Only married couples are considered as little or no data exists on the housing behaviour of unmarried couples. However, the model does consider unmarried couples since some young single person households are likely to share

Young is taken as between the ages of eighteen years and forty four years inclusive;

Old is taken as aged forty five years and over.

As mentioned earlier, with hindsight it would be more appropriate to include a proportion of over eighteen year olds as separate households as clearly many sons and daughters share their parent's home voluntarily.

Forty five years was taken as the dividing age between Young and Old for several reasons. For example, this is the age after which little family building takes place. During the period 1967 to 1974 only 1.4 per cent of all live births were born to women forty and over. (4) Similarly, this is also the age (approximately) when children will be in process of moving from the parental home and, depending upon the size of the family changing needs may be generated. Perhaps of overriding importance was the fact that a considerable volume of government collected statistics are presented in terms of age groups such that the distinction between under forty-five years of age and over forty-five is most easily dealt with.

3.4.2.1. <u>The Number of Households of Each Type.</u>

Input data for the households model was developed as follows:

The number of housoholds of each of the 32 types in England and Wales was calculated directly from Census data on Household Composition and the Registrar General's estimates of the population for the years 1966 and 1971.

It will be noted that for the total model 1967 is used as the starting date. Census data on households does not exist for 1967 therefore the households sub-model was developed from 1966 and, when 'calibrated', model output for 1967 used as input data for the total model. The Household Composition Tables for both the Sample Census of 1966 and the full Census of 1971 enumerates 'families' by socio-economic group of the head of the household, type of head and number of dependent children.

'Family' in the Census is defined as either:

(i) A married couple with or without their never-married child(ren); or

(ii) A mother or father (lone parents) together with his or her never-married child(ren).

Hence as a starting point the number of households in each of the following categories was calculated for each SEG.

(i) Young Single Parent Family Household (YSPFH) i.e. male or female lone parent under forty-five years and over eighteen years with one or more dependent children under eighteen years.

(ii) Young Couple Household (YCH) i.e. married couple with head of household under forty-five years with no dependent children under eighteen years.

(iii) Young Family Household (YFH) i.e. married couple with head of household under forty-five years with one or more dependent children under eighteen years.

(iv) Old Single Parent Family Household (OSPFH) i.e.male or female lone parent over forty-four years with one or more dependent children under eighteen years.

(v) Old Couple Household (OCH) i.e. married couple with head of household over forty-four years with no dependent children under eighteen years.

(vi) Old Family Household (OFH) i.e. married couple with head of household over forty-four years with one or more dependent children under eighteen years.

The following Table shows the total number of households in all SEG's of each type for 1966 and 1971.

TABLE 3.9 - Total number of households by type of head and age of head (excluding single person households) in England and Wales for 1966 and 1971.

thousands

	YCH	YFH	YSPFH	OCH	OFH	OSPFH
1966	1173	4021	276	4737	1565	167
1971	1163	4202	367	4968	1585	212

Source (17,21)

The total number of single person households, as defined in the model, was more difficult to determine as such information is not published in the Census.

With reference to the total adult population aged eighteen to forty-four and aged forty-five and over the number of young single households (YSH) was taken to be:

(Total population aged 18-44) - (2 x No. of YCH + 2 x No. of YFH + No. of YSPFH)

The number of old single households (OSH) was taken to be:

(Total population over age 45) -(2 x No. of OCH + 2 x No. of OFH +No. of OSPFH)

From Table 38 Population Trends I, Autumn 1975 (104) estimates of the total population in each of the two age groups were as shown below:

TABLE 3.10. Total population by Age for 1966 and 1971 England and Wales.

Thousands

	1966	1971
Number of people aged 15-44	19000	18941
Estimated number of people aged 18-44	17100	17047
Number of people aged over 44	17872	18389

Hence the totalnumber of YSH in 1966 (in thousands) was:

17100 - (2 x 1173 + 2 x 4021 + 276) = 6436 and in 1971 was:

17047 - (2 x 1163 + 2 x 4202 + 367) = 5950

Similarly the total number of OSH in 1966 (in thousands) was:

17872 - (2 x 4737 + 2 x 1565 + 167) = 5101 and in 1971 was:

18389 - (2 x 4968 + 2 x 1585 + 212) = 5071

It was assumed that the number of young single households in each SEG occurred in the same proportion as the number of Young Couple plus Young Family household types in that Group.

The number of Old Single households in each SEG was assumed to occur in proportion to the number of Old Couple plus Old Family households in each SEG five years previously. See Table 3.11 below for proportions used.

TABLE 3.11. Proportions of couple and family households by age and SEG.

		Socio-Economic Group				
		I %	II %	III %	IV %	ALL SEG's
(YC + YF)	1971	19.7	16.8	42.1	21.4	100.0
	1966	17.0	16.4	42.9	23.4	100.0
(OC + OF)	1971	19.7	16.7	34.9	28.7	100.0
	1966	17.6	16.2	35.4	30.9	100.0
extrapolating backwards						
	1961	15.5	15.7	35.9	32.9	100.0

See Table 3.12 below for the number of households by type, age and SEG for 1966 and 1971 derived from these assumptions.

TABLE 3.12 (a) Households by SEG of Head, Type of Head, Age of Head in 1966 - England and Wales.

Thousands

	SEG I	SEG II	SEG III	SEG IV	ALL SEG's
YSH	1094	1056	2761	1525	6436 (E)
YCH	181	231	500	261	1173 (C)
YFH	700	620	1730	971	4021 (C)
YSPFH	10	58	35	173	276 (C)
TOTAL YOUNG HOUSEHOLDS	1985	1965	5026	2930	11906 (E)
OSH	791	801	1831	1678	5101 (E)
OCH	736	757	1683	1562	4737 (C)
OFH	370	262	551	382	1565 (C)
OSPFH	11	31	22	103	167
ALL OLD HOUSEHOLDS	1908	1851	4087	3724	11570 (E)
TOTAL HOUSEHOLDS	3893	3816	9113	6654	23476 (E)

TABLE 3.12 (b) Households by SEG of Head, Type of Head, Age of Head in 1971 - England and Wales.

Thousands

	SEG I	SEG II	SEG III	SEG IV	ALL SEG's
YSH	1172	1000	2505	1273	5950 (E)
YCH	222	254	457	230	1163 (C)
YFH	834	647	1803	918	4202 (C)
YSPFH	15	80	40	232	367 (C)
TOTAL YOUNG HOUSEHOLDS	2243	1981	4805	2653	11682 (E)
OSH	892	822	1795	1562	5071 (E)
OCH	886	828	1728	1526	4968 (C)
OFH	402	268	558	357	1585 (C)
OSPFH	19	35	22	136	212 (C)
TOTAL OLD HOUSEHOLDS	2199	1953	4103	3581	11836 (E)
TOTAL HOUSEHOLDS	4442	3934	8908	6234	23518 (E)

(C) Data from Census.
(E) My estimate based on estimates from Population Trends I - Autumn 1975.

The 1966 figures provide essential input data for the households model and together with the 1971 information permitted 'calibration' of the model to follow known trends.

3.4.3. Designing the Model Structure

A key requirement of the model was that it should be dynamic i.e. capable of describing changes over time. As mentioned in Chapter 2 the modelling technique chosen was that of Systems Dynamics. The model structure can be represented diagrammatically by means of a flow chart as an aid to understanding. See page 95 for the structure of the model finally developed. The Households Sub-Model is presented there by a flow diagram in formal System Dynamics notation:


indicates levels or physical quantities that can usually be measured directly - in this case the number of households of each type.

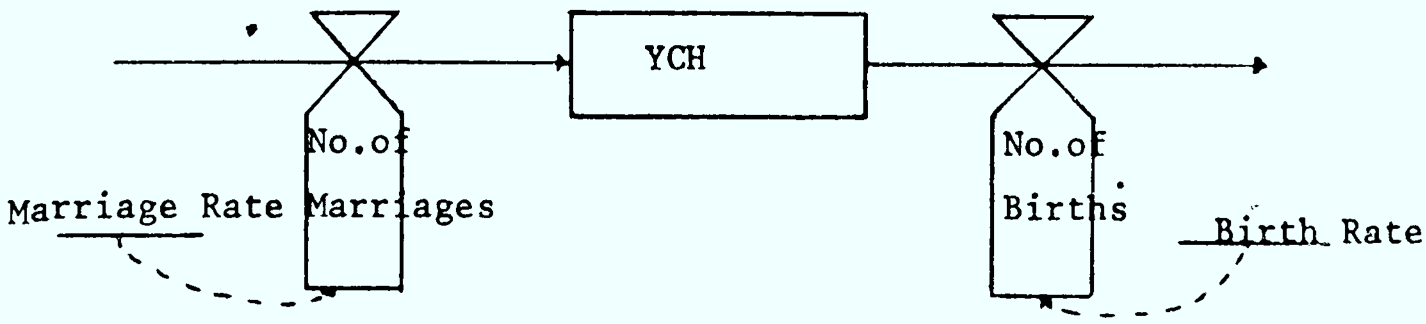

indicates flows that influence those levels e.g. death rate.


indicates the direction of the flows of people.


represents sources or sinks that are not important to the model behaviour e.g. source of net emigration.


indicates the rate determining the magnitude of the flow.

For example, take the 'level' Young Couple Households (YCH)



Very simply, at any point or time, the number of Young Couple Households (the 'level') will be influenced by the number of marriages taking place (tending to increase the number of young couples) and the number of couples having their first child and becoming young families (tending to increase the number of young families). In turn, the number of marriages (the 'flow') will be influenced by the marriage rate (the 'rate') as will the number of births be influenced by the birth rate.

There are, of course, other factors not illustrated here which affect the number of young couple households.

Having decided upon the most appropriate method of classifying households for the purposes of this model (Section 3.4.2.) i.e., defining the 'levels', and then determining the numbers of such households for some past period (Section 3.4.2.1.) the next stage of the model development involved the determination of the magnitude of those phenomena believed to be of importance in affecting household behaviour in the housing system. i.e., the flows. From these flows the rates of change were determined.

The process by which the final model was constructed can be viewed in four main stages:

I. Defining all conceivable flows of households in order to ascertain the complexity of the system which was to be studied. In so doing, the nature of the data required to render such a model operational was also clarified. This stage was carried out purely as an aid to model design. It was believed that without having at least an idea of the true complexity of the system it would not be feasible to construct the necessarily simplified representation of that system.

II. Comparing the data needs with the data available to determine what data was available and how best it could be used.

III. Redefining the structure as dictated by the data availability. In effect, choosing those rates where the magnitude of the flows implied the existence of important phenomena.

(28) The number of married couples with children under age 45 years who emigrate.
(29) " " " single persons without children over age 44 years who emigrate.
(30) " " " " " with children over age 44 years who emigrate.
(31) " " " married couples with children over age 44 years who emigrate.
(32) " " " " " without children over age 44 years who emigrate.
(33) " " " single persons without children under age 45 years who immigrate.
(34) " " " " " with children under age 45 years who immigrate.
(35) " " " married couples without children under age 45 years who immigrate.
(36) " " " " " with children under age 45 years who immigrate.
(37) " " " single persons without children over age 44 years who immigrate.
(38) " " " " " with children over age 44 years who immigrate.
(39) " " " married couples without children over age 44 years who immigrate.
(40) " " " " " with children over age 44 years who immigrate.

This list is hereafter referred to as 'data needs (1) to (40)'. Furthermore, the data would need to be interpreted in terms of the impact on households rather than on individuals. Hence for a model only slightly more complex in structure than that finally used a minimum of 40 (x 4 SEG's) rates would need to be determined.

Stages II and III

A discussion of the available data will demonstrate some of the difficulties in determining many of the rates listed above and how the data needs were redefined in an attempt to make maximum use of the available data without undue loss of model realism.

Births

The Annual Abstract of Statistics produced by the Central Statistical Office provides information on the number of live births per annum in England and Wales. For the purposes of the model where the number of families is important, not the actual family size, the number of legitimate first births is taken to represent the number of 'new' families formed each year and the number of illegitimate first births taken as the number of young single households becoming young single parent family households.

The best indication of the number of legitimate first births is given in Table 20 Annual Abstract of Statistics No.112 - 1975 as shown below:

TABLE 3.13 - Number of first born legitimate children to women married once only in England and Wales.

Year	Number of Births
1964	283716
1965	284778
1966	284823
1967	282613
1968	279377
1969	275340
1970	274252
1971	280257
1972	262155
1973	249335
1974	237600
1975	221500

The problems associated with using this data to satisfy data needs (1) to (4) are:

(a) 'There is no distinction between the socio-economic groups.

(b) There is a limited classification by mother's age.

(c) Data is only available for women married once only.

Problem (a) could not be overcome.

Table 26 Annual Abstract of Statistics suggests that of all live births in England and Wales from 1967 to 1971, on average, only 0.14 per cent were to women aged over

forty-four years. It was therefore assumed that data on first births could reasonably be applied to women under forty-four years only and thus reduce the data needs.
Table 28 from the same volume indicates that over the same period, on average 97.6 per cent of all legitimate births were to women married once only. Hence the data given in Table 3.3. slightly under-estimates the total number of first-born legitimate children, but was not adjusted.
In addition Table 30 Annual Abstract of Statistics indicates that from 1966 to 1971, on average, 1.8 per cent of babies born each year die before reaching the age of one year.

Hence using the number of first births as an indication of the number of newly formed families gives an over-estimate as deaths of babies are not included, but also under-estimates the numbers as only births to mothers married once only are included.
Therefore, data need (1) can be partially satisfied

(2) was found not to be important

and the first step towards model simplification taken.

The best indication of the number of illegitimate births is given in Table 25 Annual Abstract of Statistics No.112 - 1975 as shown in Table 3.14 below. The problems with the data are:

(a) There is no distinction between socio-economic groups.

(b) The number of first-born births are not enumerated separately.

(c) There is no classification by mother's age.

Again, problem (a) could not be overcome.

Due to the magnitud of the flows involved it was assumed that in the model death only occurred to old households thus reducing the data needs. See Table 3.15 for the average annual deaths by age of persons in England and Wales.

TABLE 3.15 - Annual Average Deaths by Age - England and Wales for 1966 and 1971

Age	1966	1971
1	16147	13720
1-4	2783	2204
5-9	1341	1484
10-14	1104	1109
15-17	1643	1301
17-19	1095	868
20-24	2467	2558
25-34	5174	4882
35-44	12855	11211
Total 18-44	21591	19519
45-54	35926	34320
55-64	90023	86459
65-74	146904	153819
75 and over	246162	253327
Total over 44	519015	527925
Total over 18	540606	547444

Source (9)

Marriage

Data on marriage are available by sex, age and previous marital status, but not by age and previous marital status together. Once again, there is little classification by socio-economic group.

Hence data needs (13) and (14) cannot be fully satisfied. But Table 22 Annual Abstracts No.112 - 1975 indicates that over the period 1966-1971, 93.3 per cent of all marriages were between persons age under 45 years.

Hence it was assumed that in model terms only young single households marry. In this way data need (13) can be partially satisfied and the model simplified for data need (14) to be excluded. Table 3.16 shows the total number of marriages per annum from 1966 to 1974.

TABLE 3.16 - Total Annual Marriages in England and Wales 1966-1974

	1966	1967	1968	1969	1970
Marriages	384497	386052	407822	396746	415487
	1971	1972	1973	1974	
Marriages	404737	426341	400435	382590	

Source (7)

Divorce

Statistics on divorce are published in terms of absolute decrees granted, duration of marriage, age of wife at marriage, age of wife at divorce, divorces with no children, one or more children. Again their is no classification by socio-economic group. Neither are there any cross-classifications of the type specified by data needs (15) to (18)

The problem of not being able to classify by SEG cannot be reasonably overcome.

Of the total number of divorces granted in England and Wales from 1966 to 1971 approximately 27 per cent involved couples with no dependent children. i.e., in model terms 27 per cent of divorces involved couple households; 73 per cent involved family households.

In addition 18.6 per cent of all divorces during this

period were between couples where the wife was aged under 45 years. Using these proportions it would be possible to approximate the numbers of divorces between couples under age 45 years with and without children and the number of divorces between couples over aged 45 years both with and without children. i.e., data need (15) to (18). But such assumptions would inevitably introduce considerable errors. It was decided, despite the evidence presented earlier in Section 3.3. that divorce is a growing social phenomenon, that due to the magnitude of the flows involved and that relatively little is understood about the relationship between divorce and households housing behaviour that it would be more reasonable to ignore the phenomenon than to introduce large sources of error.
See Table 3.17 below for the total number of divorces granted 1966-1973.

TABLE 3.17 - Absolute Decrees granted - England and Wales 1966 - 1973

	1966	1967	1968	1969	1970
Divorces	39067	43093	45794	51310	58239
	1971	**1972**	**1973**		
Divorces	74437	119025	106003		

Source (10)

Emigration and Immigration

Published statistics on emigration/immigration are very sparse. As explained in Section 3.3.1. the only indication of socio-economic group is given by numbers of migrants in very broad categories of occupational status.

Data is collected in terms of persons rather than households or families i.e., no classification by marital status. Data needs (29) to (45) are almost impossible to satisfy with any degree of confidence.

Evidence from the International Passenger Survey (IPS) suggests that families take up a large proportion of both immigrants and emigrants and that the typical age structure of migrants is heavily biased towards the younger sections of the community.

Due to the difficulties shown in using data on the number of immigrants and emigrants it was decided that in model terms there would be a net emigration of young families only. Justification for this assumption is provided in the literature review on migration. On page 42 the broad conclusions of this review are stated. Items (c) and (d) indicate that the majority of migrants are married and under age 45 years. Table 3.18 below shows the net migration of migrants aged 15 and over. Statistics are only available for the whole of the United Kingdom.

TABLE 3.18 - Net Migration, Migrants aged 15 and over, 1964-1975 - United Kingdom

Year	Persons (Thousands)
1964	-37
1965	-46
1966	-42
1967	-62
1968	-46
1969	-54
1970	-41
1971	-23
1972	- 8
1973	-33
1974	-64
1975	-19

Source (97)

It was desired to know whether the 'new' young household left a young family household or an old family household. As children leave home, depending upon the size of the family the parents may find their housing needs changing. As the last child leaves home the 'Family' household becomes a 'couple' household. Without making many simplifying assumptions it is not possible to determine from existing data the rate at which the phenomenon occurs.

Social Mobility

The only data which could be found on this phenomena is that presented in Section 3.3.8. It was decided that the phenomenon could only very crudely be incorporated into the model. First the magnitude of the net upward movement of each SEG, was determined by comparing data for 1966 and 1971. Then it was assumed that only YSH, YCH, YFH, OCH and OFH would move across the SEG's.

Stage IV

Thus having carried out the first three stages it was seen that it would not be possible to construct a model as complex as initially envisaged. There were many areas in which data was very limited and somewhere it was not possible to make reasonable assumptions to achieve the required degree of disaggregation.

From the original list none of the data needs could be satisfied in terms of SEG, only data needs 1,3 and 13 could be partially satisfied. The remaining 37 data needs could not immediately be satisfied without using various

Death or divorce in an old couple household will result in an increase (OCTOS) in old single households. Finally the number of old single households will be decreased by deaths (DOS). Thus, for each of the four SEG's, thirteen net flows were incorporated into the model as defined below:

CLFH	Children Leaving the Family Home.
YSTYSPF	Young Single To Young Single Parent Family.
YSTYC	Young Single To Young Couple.
YCTYF	Young Couple To Young Family.
YCTOC	Young Couple To Old Couple.
EYF	Net Emigration of Young Families.
YFTOF	Young Family To Old Family.
YSPFTOSPF	Young Single Parent Family To Old Single Parent Family.
OSPFTOS	Old Single Parent Family To Old Single.
OFTOC	Old Family To Old Couple.
OFTOSPF	Old Family To Old Single Parent Family.
OCTOS	Old Couple To Old Single.
DOS	Death of Old Single.

3.4.3.1. Model Equations.

Thus thirteen flows were finally incorporated into the model to describe how the 'levels' i.e., numbers of households of each type were changing over time.

Each level depends upon the size of the 'level' in the previous time period plus all those flows of households entering that level during the time interval minus all those flows of households leaving that level during the time interval.

Hence for each SEG at time t where DT represents the size of the time interval: (Refer to Figure 3.4 for reference).

$YSH_t = YSH_{t-1} + (CLFH - YSTYSPF - YSTYC) \times DT$ ......(i)

$YCH_t = YCH_{t-1} + (YSTYC - YCTYF - YCTOC) \times DT$ ....(ii)

$YFH_t = YFH_{t-1} + (YCTYF - EYF - YFTOF) \times DT$............(iii)

$YSPFH_t = YSPFH_{t-1} + (YSTYSPF - YSPFTOSPF) \times DT$ ....(iv)

$OSPFH_t = OSPFH_{t-1} + (YSPFTOSPF + OFTOSPF - OSPFTOS) \times DT$..(v)

$OFH_t = OFH_{t-1} + (YFTOF - OFTOSPF - OFTOC) \times DT$........(vi)

$OCH_t = OCH_{t-1} + (YCTOC + OFTOC - OCTOS) \times DT$..........(vii)

$OSH_t = OSH_{t-1} + (OCTOS + OSPFTOS - DOS) \times DT$..........(viii)

In the model the magnitude of most flows depends upon the corresponding rate of change assumed to be effective. The rate pertaining to a particular flow is distinguished from that flow by the addition of a letter N to the label. Thus, in any period,

YSTYSPF	=	Number	of	YSH	x	YSTYSPFN
YSTYC	=	"	"	YSH	x	YSTYCN
YCTYF	=	"	"	YCH	x	YCTYFN
YCTOC	=	"	"	YCH	x	YCTOCN
EYF	=	"	"	YFH	x	EYFN
YFTOF	=	"	"	YFH	x	YFTOFN
YSPFTOSPF	=	"	"	YSPFH	x	YSPFTOSPFN
OFTOSPF	=	"	"	OFH	x	OFTOSPFN
OFTOC	=	"	"	OFH	x	OFTOCN
OCTOS	=	"	"	OCH	x	OCTOSN
OSPFTOS	=	"	"	OSPF	x	OSPFTOSN
DOS	=	"	"	OSH	x	DOSN

The number of children leaving the family home i.e., CLFH is read in annually, based on the number of seventeen year olds in the previous year. The following section describes in detail how the magnitude of the net flows and the corresponding net rates of change were calculated.

3.4.4. Determining the magnitude of the Net flows and the corresponding Net rates of change.

As explained in Chapter 2 both the Households Sub-Model and the Dwellings Sub-Model were 'calibrated' independently before being put together with the Allocation Sub-Model. For the Households Sub-Model it was not possible to 'calibrate' i.e., 'match' model output with available data on the levels since the magnitude of the rates of change were chosen such that for the period over which data was available for the levels, model output was made to match data.

There were thirteen net flows to be calculated for each SEG. From these the thirteen corresponding net rates of change were determined. Due to the lack of data on SEG, however, it was decided to treat all SEG's in the same way i.e., to determine the net flows into and out of each level for all SEG's combined and then to apply the same rates of change to each SEG (except in the case of social mobility).

The process consisted of comparing the levels for the years 1966 and 1971 in order to find the total flows experienced during the five year period. The net rates of change were then inferred from the size of these actual flows. See Table 3.20. for the magnitude of these five year flows derived directly from the data on households presented in Table 3.12.

TABLE 3.20. Difference in levels from 1966 to 1971.

For all SEG's Combined	Thousands Net change in 5 years
YSH	-486
YCH	- 10
YFH	+181
YSPFH	+91
OSH	- 30
OCH	+ 231
OFH	+ 20
OSPFH	+45

The process by which all thirteen flows were determined was divided into three stages:

<u>Stage I</u>

In the first stage entries to and exits from the system were calculated irrespective of the household type concerned, in terms of number of persons. See Figure 3.5.

The following five-year flows were determined:

(a) The number of new young single persons i.e., CLFH.
(b) The number of deaths.
(c) The number of net migrants.

Estimates of the total adult population for 1966 and 1971 were taken from Table 16 Population Trends I-Autumn 1975 (103).

Total population aged 18 years or over in 1966	=	3497.2×10^4
Total population aged 18 years or over in 1971	=	3543.6×10^4
∴ Net Increase in population in 5 year period	=	$\underline{\underline{46.4 \times 10^4}}$ ..... (i)

Net Increase in population equals,
(Births) - (Deaths) + (Net Migration) .... (ii)

In the model,

(a) Births refers to 'new' young single households i.e., CLFH. In the 5-year period 1966-1971 the number of 'new' young single households is assumed to be equal to the number of 13-17 year olds existing in 1966.

From Table 15 Population Trends 7-Spring 1977 (107)

No. of persons in age range 13-17 years in 1966	=	344.8×10^4
∴ No. of CLFH in the 5-year period 1966-1971 is taken as		344.8×10^4 .... (iii)
∴ Annual No. of CLFH	=	$344.8 \times 10^4 \div 5$
	=	68.96×10^4

STAGE 1; TOTAL EXITS FROM AND ENTRIES TO THE HOUSING SYSTEM

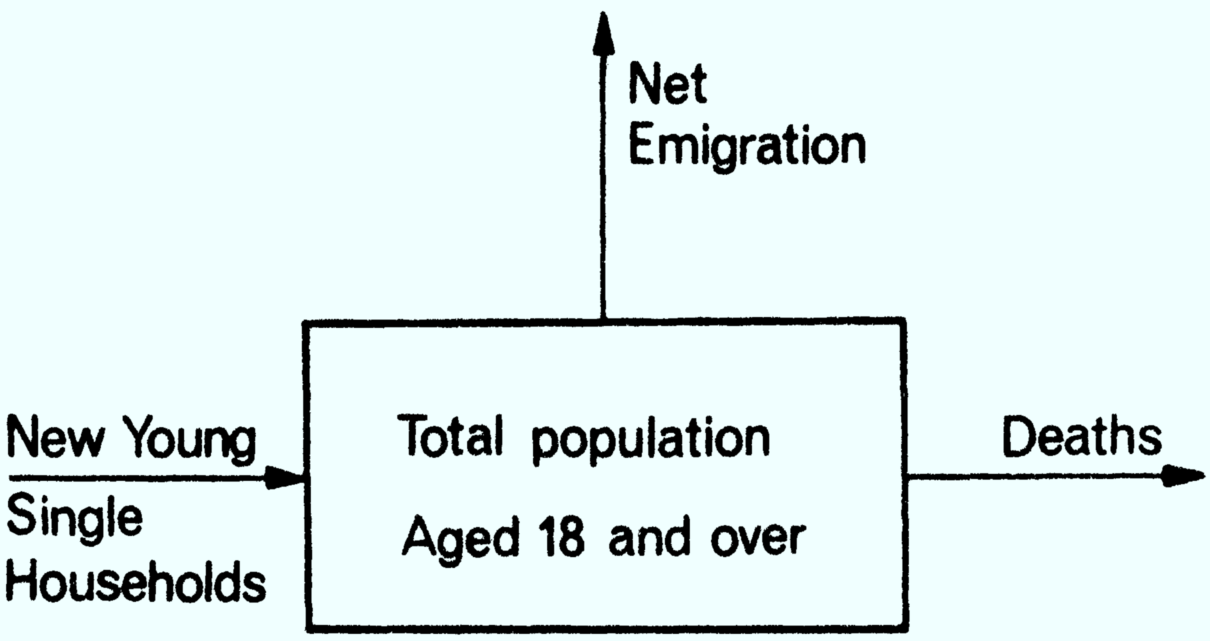


Fig.3.5

STAGE 2: AGGREGATION OF OLD HOUSEHOLD TYPES SHOWING THOSE RATES WHICH DIFFER FROM STAGE 3

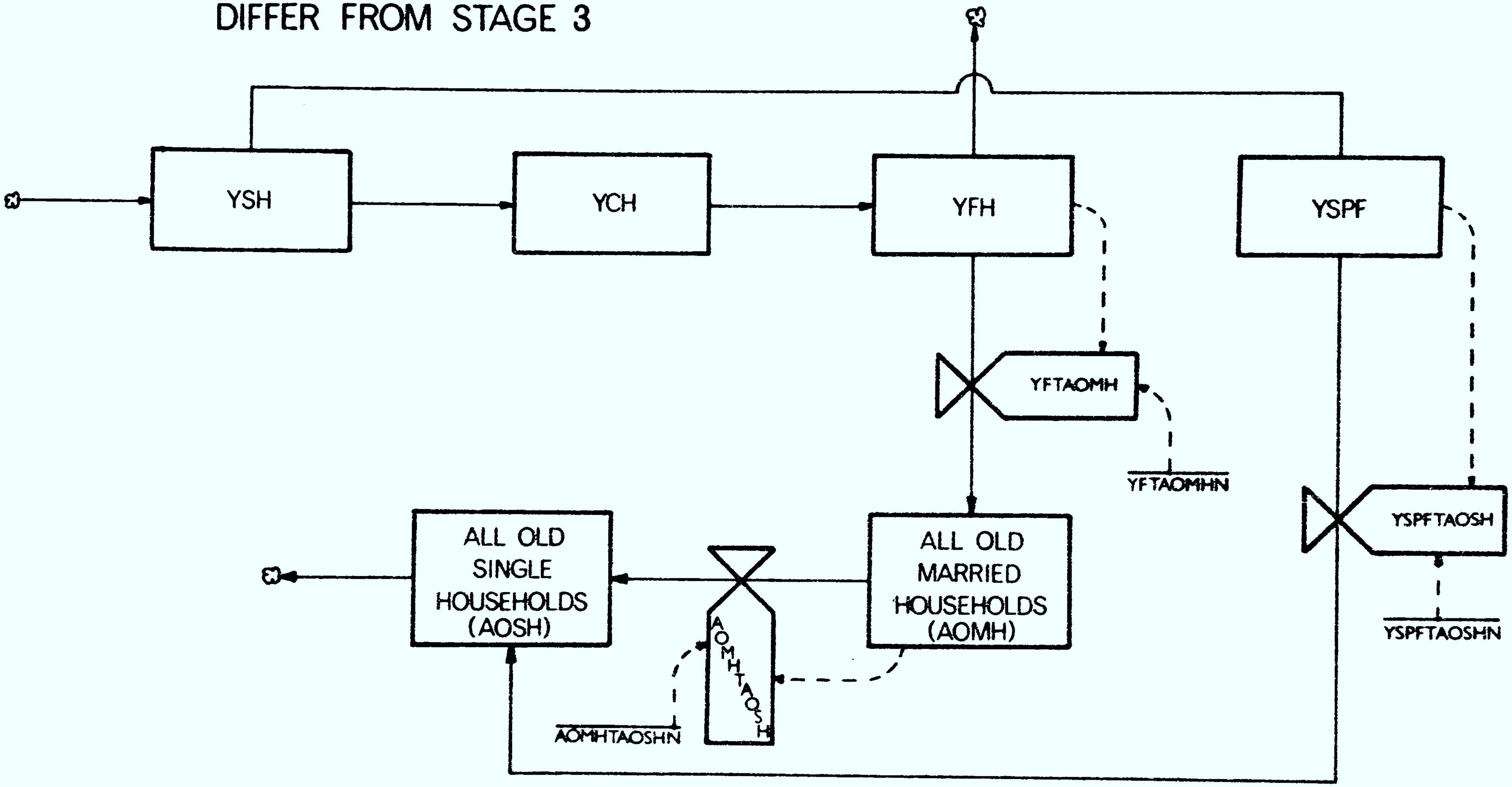


Fig. 3.6

(d) ΔYSH = CLFH - YSTYSPFH - YSTYC .... (vi)

where,

Δ denotes change in the magnitude of the level.

CLFH represents Children Leaving the Family Home.

YSTYSPFH represents Young Single To Young Single Parent Family Household.

YSTYC represents Young Single To Young Couple.

Δ YSH = -486×10^3 (From Table 3.20)

CLFH = 344.8×10^4 (From (iii))

YSTYSPFH = 5 x Average Annual No. of 1st born illegitimate births.

Average Annual No. of 1st Born Illegitimate Births = 2.86×10^4 (From Table 3.14

$\therefore$ YSTYSPFH = 14.3×10^4 .... (vii)

Substituting in (vi)

$-486 \times 10^3 = 344.8 \times 10^4 - 14.3 \times 10^4$ - YSTYC

$\therefore$ YSTYC = $\underline{379.1 \times 10^4}$

$\therefore$ The Net number of Young Single Households becoming Young Couples in the 5-year period is 379.1×10^4 ... (viii)

The net number of 'New' Young Couples in the 5-year period is $379.1 \times 10^4 \div 2$ (1 couple = 2 singles) = 189.55×10^4 ... (ix)

On average the annual number of Young Single Households becoming Young Couples is $379.1 \times 10^4 \div 5 = 75.82 \times 10^4$

Consequently the average annual number of 'new' Young Couples is $75.82 \times 10^4 \div 2 = 379,100$.

This estimate compares favourably with data on the average annual number of marriages over the period 1966 to 1971 (See Section 3.3.2.) of 399224. The apparent discrepancy is largely the result of introducing net flows to incorporate divorce and deaths to young couples.

(e) $\Delta YCH = YSTYC - YCTYF$ .... (x)

where,

YSTYC represents Young Singles To Young Couples.

YCTYF represents Young Couples to Young Families.

$\Delta YCH = -1.0 \times 10^4$ (From Table 3.20)

$YSTYC = 189.55 \times 10^4$ (From(ix))

Substituting in (x)

$-1.0 \times 10^4 = 189.55 \times 10^4 - YCTYF$

$\therefore YCTYF = \underline{190.55 \times 10^4}$ .... (xi)

Thus, on average, the annual number of 'new' families formed each year $= 190.55 \times 10^4 \div 5 = 381100$

According to the data in Table 3.13. the average number of legitimate first born births to women married once only in the period 1966 to 1971 was 279281. If first born births to all women were known the apparent discrepancy of the model could be reduced.

(f) $\Delta YFH = YCTYF - EYF - YFTAOMH$ .... (xii)

where,

YCTYF represents Young Couples To Young Families.

EYF represents Net emigration of Young Families.

YFTAOMH represents Young Families To All Old Married Households.

$\Delta YFH = 18.1 \times 10^4$ (From Table 3.20)

$YCTYF = 190.55 \times 10^4$ (From (xii))

Substituting in (xii)

$18.1 \times 10^4 = 190.55 \times 10^4 - YFTAOMH$

$\therefore YFTAOMH = \underline{158.45 \times 10^4}$ .... (xiii)

This estimate cannot be compared with actual data since it is a flow introduced merely to aid estimation of other flows. Similarly this applies to the following three estimates.

(g) Δ YSPFH = YSTYSPFH - YSPFHTAOSH .... (xiv)

where,

YSTYSPFH represents Young Single To Young Single Parent Family Household.

YSPFHTAOSH represents Young Single Parent Family Household To All Old Single Households.

Δ YSPFH = 9.1 x 10^4 (From Table 3.20)

YSTYSPFH = 14.3 x 10^4 (From (vii))

Substituting in (xiv)

9.1 x 10^4 = 14.3 x 10^4 - YSPFHTAOSH

$\therefore$ YSPFHTAOSH = $\underline{\underline{5.2 \text{ x } 10^4}}$ .... (xv)

(h) Δ AOMH = YFTAOMH - AOMHTAOSH .... (xvi)

where,

YFTAOMH represents Young Families To All Old Married Households.

AOMHTAOSH represents All Old Married Households To All Old Single Households.

Δ AOMH = 25.1 x 10^4 (From Table 3.20)

YFTAOMH = 158.45 x 10^4 (From (xiii))

Substituting in (xvi)

25.1 x 10^4 = 158.45 x 10^4 - AOMHTAOSH

$\therefore$ AOMHTAOSH = $\underline{\underline{133.35 \text{ x } 10^4}}$ .... (xvii)

(i) Δ AOSH = AOMHTAOSH + YSPFTAOSH - DAOS ..... (xviii)

where,

AOMHTAOSH represents All Old Married Households To All Old Single Households.

YSPFTAOSH represents Young Single Parent Families To All Old Single Households.

DAOS represents Death of All Old Singles.

Δ AOSH = 1.5 x 10^4 (From Table 3.20)

AOMHTAOSH = 133.35 x 10^4 (From (xvii))

YSPFTAOSH = 5.2 x 10^4 (From (xv))

Substituting in (xviii)

$$1.5 \times 10^4 = 133.35 \times 10^4 + 5.2 \times 10^4 - DAOS$$

$$\therefore DAOS = \underline{\underline{137.05 \times 10^4}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (xix)$$

Of the thirteen flows to be determined values have been obtained for seven of them, namely

CLFH, YSTYC, YSTYSPF, EYF, YCTYF, YSPFTOSPF, DOS.

The remaining six flows are estimated in the following way.

Stage 3

In the third stage the amalgamated levels AOMH and AOSH were reverted to their component levels i.e., OFH and OCH and OSH and OSPFH respectively.

The final model structure, as shown in the flow chart on page 95 now being used.

The remaining flows to be estimated for the 5-year period are YCTOC, OFTOC, OFTOSPF, OCTOS, OSPFHTOSH, YFTOF.

Letting,

YCTOC	be	represented	by	x
OFTOC	"	"	"	y
OFTOSPF	"	"	"	z
OCTOS	"	"	"	u
OSPFHTOSH	"	"	"	v
YFTOF	"	"	"	w

Remembering that,

(OCH + OFH) = AOMH and

(OSH + OSPFH) = AOSH

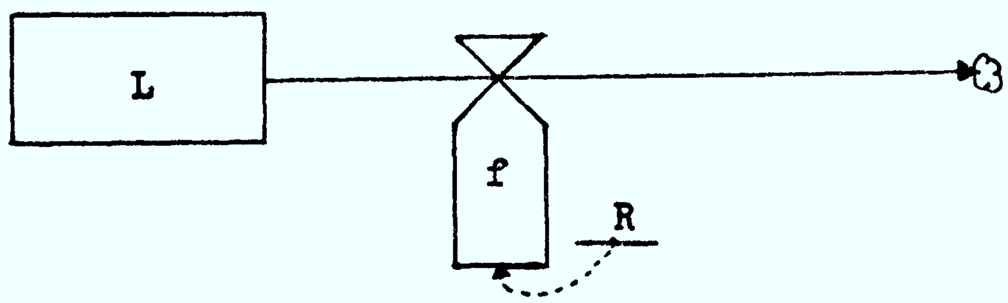
and comparing Figures 3.4 and 3.6

Substituting in (xxiii), (xxv), (xxvii) (xxx), (xxxi) and solving:

$$
\begin{aligned}
x &= 14.4 \times 10^4; \\
v &= 17.8 \times 10^4; \\
z &= 17.1 \times 10^4; \\
y &= 124.9 \times 10^4; \\
u &= 116.2 \times 10^4;
\end{aligned}
$$

From this information on flows of households, the rates of change were calculated.

If



Where L is the average of the 1966 and 1971 levels and f the 5 yearly flow of households, then the annual rate R is given by:

$$R = \frac{f/5}{L}$$

In the computer programme the rate pertaining to a particular flow is distingushed from that flow by the addition of a letter N to the label i.e., the flow YSTYC is influenced by the rate YSTYCN.

The rates of change used were as follows:

YSTYSPFHN	0.005
YSTYCN	0.122
YCTYFN	0.302
YCTOCN	0.025
EYFN	0.007
YFTOFN	0.07
YSPFHTOSPFHN	0.032
OSPFHTOSN	0.188
OFTOSPFHN	0.022
OFTOCN	0.159
OCTOSN	0.048
DOSN	0.054

These rates were applied equally to all socio-economic groups.

Some flows, however, were not determined by the rate of change but are read into the model directly as a piece of data i.e., CLFH.

CLFH was determined from data shown on Page i.e., 6.9×10^5

In addition, YSH, YCH, YFH, OCH and OFH were moved across the SEG's in the following ways:

From SEG II to I at the rate of 3 per cent per annum.
SEG III to II " " " " 1.5 " " " "
SEG IV to III " " " 1.5 " " " "

3.4.5. Model Results 1967-1976

The households sub-model annually outputs information on the total number of households and the number of households by socio-economic group, age and family status.

Fig. 3.7. shows the model output of the number of households and how they are divided among the four socio-economic groups for the period 1967 to 1976. The total number of households increased only slightly from 23.47 million in 1967 to 23.72 million in 1976; an average annual increase of just under 30,000 households. These results reflect the almost zero population growth that has been experienced over the period and which was discussed in Section 3.3.5.

According to the model, SEG III forms the largest group of households with SEG II forming the smallest. In 1967 SEG III being just over twice the size of SEG II; this difference persisting for the period up to 1976. The two groups showing the greatest change over this period are SEG I and SEG IV. The number of households in SEG I rose

MODEL OUTPUT: HOUSEHOLD CHARACTERISTICS

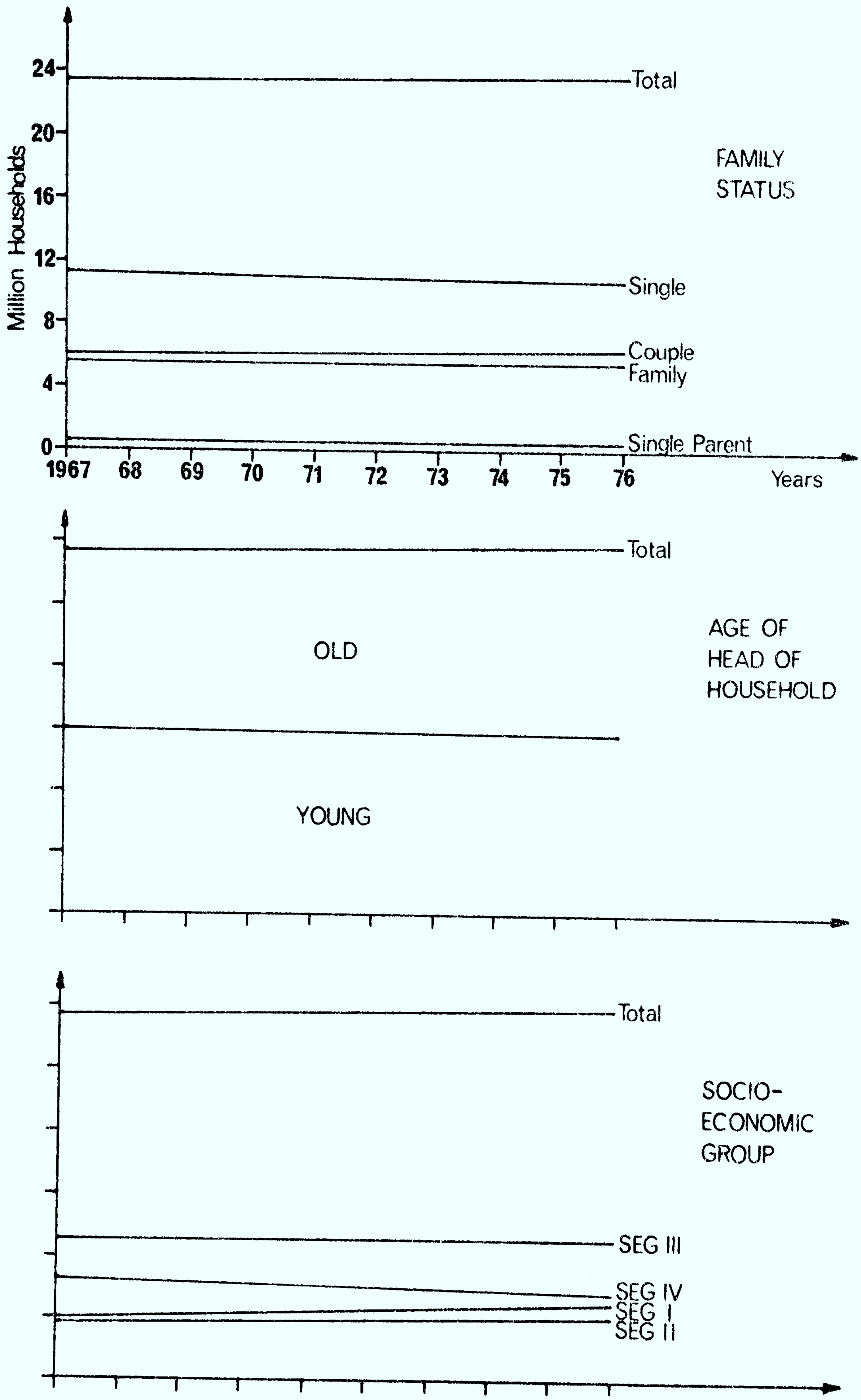


Fig. 3·7

rapidly from just under 4 million in 1967 to just under 5 million by 1976. For SEG IV the model shows a rapid decline in the number of households from just over six and a half million in 1967 to five and three-quarter million by 1976. The model is clearly reflecting the effects of social mobility. Evidence presented in Section 3.3.8. suggested there had been a general upward movement in society in terms of households socio-economic grouping. The model further suggests that movement into SEG III and SEG II had been compensated by movement out of these two groups so that over the period net change was only experienced in SEG IV and SEG I.

Fig. 3.7. also depicts model output of total households by family status. The number of married couple households without children slightly exceeds the number with children, this difference increasing as the number of families declines by 1976 and the number of childless couples increases. This phenomena produced in the model is a reflection of the world situation of a declining birth rate affecting the number of first births. The number of single person households (as defined in the model) is approximately twice the number of childless couples or families although over the period 1967 to 1976 the number of single households in the model has decreased.

Single parent family households, according to the model, increased from 2 per cent of all households in 1967 to 3 per cent by 1976.

Fig.3.7. further shows model output of total households by age of the head. The number of households where the head

was aged under forty-five years is taken to have declined slightly, the increase in total households being accounted for by the increase in older households. Such a result reflects the evidence presented in Section 3.3.5 on the progressive ageing of the population being experienced in England and Wales.

Thus the general trends produced by the model for the period 1967 to 1976 of the total number of households and their mix between socio-economic group, family status, and age broadly agree with those trends known to have occured for the period.

Only two complete sets of data for the 'levels' were available. One set arising from the 1966 census and one set from the 1971 Census. The 1966 data were used as the initial conditions for the model; the 1971 set being used against which to calibrate the model. Table 3.21 below shows a comparison of the results from model output (M) with the 1971 data (D). The 1971 data was previously presented in Table 3.12 (b).

Model output of the total number of households agrees with the data. The 'row totals' i.e. total numbers of households subdivided by age (old and young), and by status (single, couple, family, single parent) is in very close agreement with the data. In fact in every case except young couples the agreement is within one half per cent, in the case of young couples the difference between model output and data is about one and a half per cent.

TABLE 3.21 Comparison of Model Output with available data for 1971.

Thousands

	SEG I	SEG II	SEG III	SEG IV	ALL SEG's
YSH M	1162	1016	2470	1310	5958
D	1172	1000	2505	1273	5950
YCH M	221	202	475	249	1147
D	222	254	457	230	1163
YFH M	819	714	1743	926	4202
D	834	647	1803	918	4202
YSPFH M	34	73	90	180	377
D	15	80	40	232	367
All young households					
M	2236	2005	4778	2665	11684
D	2243	1981	4805	2653	11682
OSH M	801	805	1796	1671	5073
D	892	822	1795	1562	5071
OCH M	959	814	1778	1416	4967
D	886	828	1728	1526	4968
OFH M	351	266	614	354	1585
D	402	268	558	357	1585
OSPFH M	32	38	58	85	213
D	19	35	22	136	212
All Old households					
M	2143	1923	4246	3526	11838
D	2199	1953	4103	3581	11836
All single households M	1963	1821	4266	2981	11031
D	2064	1822	4300	2835	11021
All couple households M	1180	1016	2253	1665	6114
D	1108	1082	2185	1756	6131
All Family households M	1170	980	2357	1280	5787
D	1236	915	2361	1275	5787
All single parent households M	66	111	148	265	590
D	34	115	62	368	579
All households					
M	4379	3974	9024	6191	23522
D	4442	3934	8908	6234	23518

The 'column totals', i.e. total numbers of households in each SEG, all agree within one and half per cent the model values being higher than the data for SEG's II and III andlower for SEG's I and IV. Most of these errors arise for the old households; the reasons for which are not clear but in any case the errors lie within the tolerance levels that may have been expected.

The 'cell totals' are not in such good agreement with the data as the row and column totals. This is most likely because the various rates in the model were of two types only i.e. (1) movements from one household type to another and these are assumed to be independent of SEG, (2) movements from one SEG to another and these are assumed to be the same for all household types to which they apply.

In percentage terms the greatest disagreements are for YSPFH and OSPFH. In the model YSPFH arise from illegitimate births to YSH, and OSPFH either from ageing of YSPFH or deaths of one parent in an OFH. Also single parent family households belong to the same SEG as the one they originated from. The model only allows YSH, YCH, OCH, YFH, OFH to migrate across the socio-economic groups, However the data shows a preponderance of single parent family households in SEG IV i.e. in 1971 sixty three per cent of YSPFH and sixty four per cent of OSPFH were in SEG IV; in SEG I there were only four per cent of YSPFH and nine per cent OSPFH. The model structure means that as time goes on, the spread of single parent family households will be broadly the same as for all other household groups.

It must be noted, however, that in absolute terms the errors in single parent family households are not large since these represent a household type of low numbers.

The largest absolute errors occur for OSH and OCH in SEG IV - however it will be noted that the data for YSH and OSH are in fact estimates so any lack of agreement between these estimates and the model are unimportant.

In the case of OCH the model gives 1416×10^3 for SEG IV whereas the data gave 1526×10^3. This underestimate is balanced by over estimates in SEG I and III. The Census, from which the majority of the data is obtained, enumerates retired persons according to their last mode of employment. There will almost certainly be included in SEG IV some retired persons who when in full-time employment may have been in higher SEG. The model however, has no mechanism for explicitly moving people down the socio-economic scale as they age due to the use of net flows. This may account for the discrepancy.

If the model output is to match the data then a first step would be to stop the 'migration' applying to OCH and to move households to a more appropriate SEG when they become single parent family households.

In its present form the households sub-model is said to be calibrated to an acceptable standard.

3.5. A review of the Households Sub-Model

Looking back over the review section of this chapter it will be seen that the final model used represents a considerable simplification of what is currently believed to be the real situation.

But as emphasised in Chapter One, the primary function of this research was essentially to provide a learning experience of how to approach the problem of developing an operational model of the housing system. Households demographic behaviour i.e., The Households Sub-Model represents but an aspect of that total model.

The object of the review section of this chapter was to identify the nature of those phenomena which an ideal model would have to include. The evidence presented in the previous section has shown why it was not possible to model exactly that reality at this stage.

A number of points remain which summarize the simplifications made and the drawbacks and advantages of such an approach.

In many ways it was unsatisfactory to work with net flows. The most important limitation being the resultant loss of realism as individual flows and rates of change could no longer be sharply defined as physical phenomena.

Take, for example, the flow YSTYC (Young Single To Young Couple) which is the net result of both young singles becoming young couples and young couples becoming young singles i.e., divorce in young couples, deaths in young couples, marriages of young singles. But many phenomena are taking place to affect the numbers of young singles and young couples in addition to the interchange between the two household types i.e., immigration, emigration, ageing, divorce in young families. Hence YSTYC has to account for all of these phenomena. The danger exists of trying to attach physical meaning to these proxy flows. But there is no physical meaning; these flows were introduced merely to facilitate the development of the sub-model.

This problem underlines the need for a complete array of information if anyone is to construct a model of any realism. Development of the households sub-model showed quite clearly the conflict which exists between model size and complexity (i.e., number of variables) on the one hand and data availability on the other. This point is discussed at greater length in Section 6.1.

Also of particular importance is that by amalgamating individual flows into net flows the assumption was made that the corresponding net percentage rates of change were constant. Quite clearly from the literature review rates of change are not constant. For example, the divorce rate (taken as the number of decrees granted divided by the number of households at risk i.e., All YCH YFH OCH OFH) was 3.4 divorces per thousand households at risk in 1966 but had increased to 6.2 per thousand by 1971.

A brief summary of how the major phenomena affecting the numbers of households were incorporated into the model will indicate the extent to which the model reflects the reality described in Section 3.3.

Immigration and Emigration

These two effects were simplified by assuming that all migration was effectively net emigration and involved only young family households i.e., the rate $EYF^{\dagger}$. Justification for these assumptions is provided by the evidence summarized on page 42.

Marriage

Marriage has been inadequately dealt with due to the use of net flows. Whereas the marriage of young single households and old single households is implicitly included in the flows YSTYC and OSTOC respectively, the remarriage (or indeed first marriage) of young or old single parent families has been omitted from the model in an attempt to reduce complexity and is justified only by the fact that the phenomenon involves relatively few households. In 1971, for example, out of 404.7 thousand marriages only 84.3 thousand were marriages in which at least one partner had been married previously. (See Table 3.2.).

Divorce

The evidence presented in Section 3.3.3. suggested that divorce is a growing social phenomenon and for this reason the levels YSPFH and OSPFH were included in the model structure. In the event, however, divorce was explicitly omitted from the model, although divorce of OFH is implicitly included in the flow of OFTOSPF and represents the dominant phenomenon. The divorce behaviour of couple households is also implicitly included in the flows YSTYC and OCTOS but does not represent a significant proportion of the household flow. The divorce experience of Young Families is not included since the data suggests that relatively few households are involved.

Births.

In the model only first births have been dealt with. This resulted from the decision not to include family size explicitly but to distinguish Family households by age alone. Age does permit a certain distinction between families of different sizes to be made since a family must age before it can grow in size. Illegitimate births were included but to young single households only and thus provides an input to the level YSPFH. In retrospect this may be an unnecessary detail which could be excluded in a future model. The omission of this flow would, however, mean that there would be no imput to the level YSPFH. These households would consequently gradually disappear, unless an alternative input flow is incorporated into the model structure. For example, the divorce of YFH.

Ageing

The evidence presented in Section 3.4.3. suggested that the most dominant flows of households were from Young Couple To Old Couple and Young Family To Old Family, and hence these flows were incorporated into the model structure. The flow YSPFTOSPF was included largely to allow YSPFH to change their status but also to prevent the number of YSPFH accumulating indefinitely.

Mortality

This phenomenon has been considerably simplified in direct response to the difficulties in using the data for this model. Only deaths of Old Single Persons are included explicitly.

Children leaving the Family Home

The major drawback to the method by which this phenomenon has been incorporated into the model is that there is no tie-up between children leaving home and the rate at which OFH and OSPFH become OCH and OSH respectively.

The assumption is made that the flows OFTOC and OSPFTOS implicitly include this phenomenon of households changing their classification when the last child leaves home. Any direct link would of course require information about family size to be added since a family only becomes a couple when the last child leaves home.

Social Mobility

Social Mobility is a phenomenon which is known to exist but about which relatively little data is available to qualify that knowledge. The phenomenon was very crudely incorporated into this model by first determining the magnitude of the net upward movement of each SEG by comparing data for 1966 and 1971 and then by making certain subjective assumptions as to which household types in fact change SEG. It was assumed that only YSH, YCH, YFH, OCH and OFH would move across the SEG's.

Thus a model describing the growth and dissolution of certain household types was developed and rendered operational. The next task involved the similar development of a model to describe the nature of the dwelling stock which these households attempt to occupy.

It is the aim of Chapter Four to discuss the process by which this was achieved.

CHAPTER FOUR

DWELLINGS

4.1. DEFINITIONS

At any point in time the housing stock is comprised of all those buildings, parts of buildings, and structures which are used or are usually used as living quarters. A very wide range of types and living arrangements exist. The majority of households live in either a detached, semi-detached or terraced house or in a flat, but substantial numbers also occupy chalets, huts, shacks, tents, converted railway carriages and mobile structures such as caravans, houseboats and barges. For yet others common lodging houses, hospitals, mental institutions, boarding houses, bed and breakfast accommodation and hotels constitute the usual place of residence.

The basic unit of the housing stock has been termed the **DWELLING**. The Sample Census 1966 defines a dwelling as:

> 'Structurally separate accommodation with independent access to the street or to a public staircase or hall.... (structurally separate accommodation is that which is) all contained behind its own front door; bathrooms and water closets did not count as part of the accommodation for this purpose,(independent access is the ability of the occupant to)come and go without having access to anyone else's living quarters. ' (18)

Another method of classification of dwellings used in the Census is to define the unit of accommodation occupied by a household as a household space. Thus there is always a one to one correspondence between households and occupied household spaces. As such no household is recorded as sharing a dwelling with another. Other difficulties with the use of this measure arise when considering the extent of

(f) water supply
(g) drainage and sanitary conveniences
and (h) facilities for storage, preparation and cooking of food - and for the disposal of waste water;

and the house shall be deemed to be unfit for human habitation if, and only if, it is so far defective in one or more of the said matters that it is not reasonably suitable for occupation in that condition.'

This list was subsequently amended in the Housing Act 1969 to include after (c)' (cc)internal arrangements ' and the word 'storage' was deleted from (h). This means that bad internal arrangement is now grounds for considering any house unfit and, secondly, because of the availability of refrigerators, facilities for storage of food are no longer a necessity. (44)

The concept of 'unfitness' has existed in housing legislation for over a century and slum clearance was undertaken in the last quarter of the nineteenth century but no reliable national estimate of the number of unfit dwellings was made until 1967; before that there were estimates submitted by local authorities along with their clearance programmes, but these were drawn up on varying bases and could not be added to produce a reliable national total.

The last publication to use a local authorities own assessment of housing conditions was No.1 of Housing Statistics which gave a regional analysis for 1965 of the estimates of unfit houses and the number of dwellings they contained. In 1967 a more realistic attempt was made in the House Condition Survey to provide data on the structural condition of the dwelling stock in England and

Table 4.5 above shows how repair costs differed for the different tenures in 1967. Over 64 per cent of all repairs costing over £500 were in the privately rented sector whereas under 5 per cent were to local authority dwellings. A significantly smaller proportion of local authority dwellings required repairs totalling over £250 than less than £250. Almost half the entire stock of privately rented housing required expenditure of over £250 to bring the dwellings up to standard.

Tenure comparisons between the 1967, 1971 and 1976 House Condition Surveys are complicated by the complex flows of dwellings between tenures, especially between vacant and occupied houses. The number of the local authority dwellings requiring extensive repairs more than doubled between 1971 and 1976, but this is by comparison with a very small number in 1971; more-over some of the increase may be due to outstanding repairs required on dwellings acquired during the period under municipalisation programmes.

The total cost of outstanding repairs in 1971 was estimated to be £3200 million at then current prices. An additional £800 million was required for the installation of all missing amenities. At 1976 prices the total cost of £4000 million equates £9400 million. The 1976 Survey showed that the total cost of outstanding repairs plus the cost of missing amenities would be £9350 million, of which £1000 million was for the cost of supplying missing amenities. Therefore, in total, the situation has changed very little although the proportion attributable to

at the expense of those with two bedrooms.

Table 4.9. compares trends in the size of new houses in the public and private sectors.

TABLE 4.9. Houses and flats completed in England and Wales 1945-1975 by number of bedrooms.

	1945-1960	1961-1965	1966-1970	1971-1975
For local authorities and new towns; as a percentage of total.				
1 Bedroom	4.1	27.4	26.7	32.3
2 Bedrooms	23.2	33.6	32.2	27.6
3 Bedrooms	70.0	37.0	38.1	35.9
4 or more bedrooms	2.7	2.0	2.9	4.2
TOTAL (000's)	1561	548	724	512
For private owners: as a percentage of total.				
1 Bedroom	N/A	2.0	2.0	2.3
2 Bedrooms	"	31.3	22.1	17.6
3 Bedrooms	"	62.6	68.8	70.4
4 Bedrooms	"	4.0	7.1	10.5
TOTAL (000's)		921	939	791

(Source: 72, 64.)

The trend for local authority housing is quite different. Since the early sixties theproportion of 1-bedroom loc al authority dwellings has increased from just over a quarter to nearly one third. The proportion of 2-bedroom dwellings has declined slightly from its early 1960's level of one-third. Theproportion of dwellings with three or more bedrooms has scarcely changed from about four in every ten.

4.3.2. Demolitions

Dwellings are demolished for several reasons. By far the most common being that undertaken by local authorities as part of slum clearance programmes. Road widening schemes, office development, shopping developments may also give rise to the demolition of dwellings.

Local action to demolish unfit buildings goes back to the nineteenth century, but the initiative was then entirely local. The first action by central Government occurred in the nineteen thirties when local authorities were given financial assistance and encouraged to attack the slums. (Some 1.7 million houses have been demolished or closed under slum clearance powers since 1930). Following the second World War the main emphasis was inevitably on reconstruction and the building of new homes, and it was several years before the pre-war drive for slum clearance was resumed. In the ten years from 1945 to 1954 the average rate of demolition/closure was only about 9000 houses per annum, but the figure rose rapidly from 1954. Local authorities were asked to estimate the number of unfit houses and to submit 5-year plans to deal with them. The estimate totalled 850,000 and in the five years 1955-1959 the average annual rate of demolition/closure rose to over 42,000. In the early nineteen sixties the need to find large sites for the industrialised building drive added to the impetus of the slum clearance programme. Clearance rates remained high until the nineteen seventies, but in 1974 showed a sharp drop to less than 42,000 and have remained below 50,000 in subsequent years. This was probably due to a combination of factors, including the increasing emphasis on the renovation of older housing, and specifically the introduction of the concept of gradual renewal in the 1973 White Paper "Better Homes - The next Priorities" (26). The 1974 Housing Act gave authorities the opportunity to reconsider clearance proposals and introduce housing action areas (HAA) for which grants were available for the improvement of areas of older housing.

For the purpose of local authority collected statistics the building unit which is demolished is defined in terms of a house where a house may consist of two or more separate dwellings according to the number of families occupying it. Since many unfit dwellings are in multi-occupation there is considerable scope for error in converting the figures from a house to a dwelling basis.

Hence, annual demolitions tend to underestimate actual demolitions. Also statistics are not collected on other forms of demolitions or on demolitions not undertaken by local authorities.

4.3.3. Modernisations -of dwellings which are unfit or lack basic amenities

Modernisation is concerned with improving the condition of dwellings. A dwelling can be said to have been modernised if such work has been carried out so as to render the dwelling fit andhaving all basic amenities. (See Sections 4.2.2.)

Little reliable information is available on the level of modernisations at any time. The House Condition Survey 1971 comparing results from the 1967 House Condition Survey gives an estimate of the number of dwellings lacking at least one basic amenity in 1967 but having all by 1971. In the five year period it is estimated that 16.5 per cent of dwellings lacking one or more amenity in 1967 had all five by 1971.

at both dates. Another factor leading to errors in the estimate is that no account is taken of the number of dwellings moving into unfitness during the five-year period and being demolished before the 1971 Survey.

The 1976 House Condition Survey in England only estimates that since 1971 a further 350,000 houses became unfit.

4.3.5. <u>Conversion of dwellings from one size to another.</u>

Improvements of the standing stock in terms of the conversion from one size to another - splitting up of large dwellings into several smaller units or for example extensions and conversions of lofts into usable rooms - are not estimated nationally. The Censuses classify houses according to size by the number of rooms, whereas in statistics of new building, size is classified by number of bedrooms so that the number of houses with rooms added - or subtracted - cannot be estimated by comparing the net change between censuses with new building. Distribution by number of bedrooms can be estimated for 1971 and subsequent years from the General Households Survey but the errors involved are too great to permit estimates of the net change in the number of houses to which rooms have been added.

4.3.6. <u>Change of Tenure</u>

Another phenomenon affecting the number of dwellings in each tenure is the rate at which dwellings themselves change tenure. The major flows between the tenures are:

(a) A local authority rented dwelling becomes owner occupied.
(b) A privately rented dwelling becomes owner occupied.
(c) An owner occupied dwelling is let privately.
(d) A privately rented dwelling is bought by a local Authority.
(e) An owner occupied dwelling is bought by a local Authority.

These will now briefly be discussed in turn:

One of the most significant results of these factors is that large numbers of formerly privately rented dwellings have been transferred to the owner occupied sector. Table 4.4 in Section 4.2.2.3 on the age of dwellings gives an indication that a substantial number of dwellings in recent years have passed from the private rented sector into owner occupation. Statistics on new buildings show that owner occupation has been a major feature of the last war period, and that more than three-quarters of privately rented dwellings were built before the 1914-1918 War. The relatively high incidence of owner occupation in dwellings built in the pre-1919 and inter-war years is a reflection of the number of dwellings which have in the postwar period passed into owner occupation from the privately rented sector. More detailed statistical evidence on this trend is very fragmentary.

(c) A further factor in the decline of the privately rented sector but again one which is increasingly difficult to quantify, is the rate at which former owner occupiers let their dwelling privately. There continues to be flow in this direction as households are taken abroad for job reasons for example, but increasing rent controls and declining profitability has meant that this source of privately rented accommodation is slowly drying up, especially in the situation where one or two rooms are let as part of a house - an important area for young single households.

(d) In certain circumstances the local authority is empowered to buy up privately rented accommodation if the landlord refuses to undertake essential repairs for example. Again little statistical evidence exists to validate this, although Holmans in his paper 'A Forecast of the effective demand for housing in the 1970's', has estimated that the number of households becoming local authority tenants who had formerly rented from a private landlord was 60,000 in 1967, that this number would rise to 61,000 in 1971 and possibly to 73,000 by 1981.

(e) In other circumstances a local authority may wish to compulsorily purchase a dwelling if, for example, the dwelling falls in an area designated for slum clearance or for a road widening scheme. The Council will then be under an obligation, as in the example above, to rehouse the displaced occupants.

A model was constructed to describe in a very broad sense the changes in the numbers of dwellings of different types drawing largely on the evidence presented in Sections 4.1. to 4.3.

The way in which the Dwellings Sub-Model was developed will now be described.

4.4. DEVELOPING THE DWELLINGS SUB-MODEL

4.4.1. The definition of a dwelling

The definition of a dwelling used in the model is that used in both House Condition Surveys of 1967 and 1971. For these Surveys the same definition was used as in the 1966 Sample Census; this required that the living accommodation should be structurally separate and have independent access. Although in the House Condition Surveys an adjustment was made to include a number of very small dwellings which were not self-contained behind their own front door.

Only permanent, private dwellings were included i.e., caravans, houseboats, shacks, camps, hotels, hospitals, guest houses, medical institutions, childrens homes, old peoples homes etc., were excluded.

For the purposes of this model the concept of a household space was rejected as being an unsuitable definition for the number of dwelling units available for occupation. The household space is merely that unit of accommodation occupied by a household with no regard to its suitability for occupation in terms of privacy. Also as there is always a one to one correspondence between households and occupied household spaces, difficulties arise in estimating both the number of households sharing a dwelling with another and also the number of dwellings which are vacant.

4.4.2. The Classifications of Dwellings Used.

As discussed on page 111 there are very many criteria by which dwellings can be classified but little agreement as to the best method to use. But as Murie (82) discusses,

> 'the divisions which are appropriate depend on the orientation of the study and the main areas of concern'.

This study is aimed at aiding our understanding of housing as a system. The choice of classification arose directly from this approach. Guidance was also provided by the list of possible experimental policy changes given on page 7. As in developing the households sub-model, each policy change was examined to identify the characteristic, this time of the dwelling, which would be relevant for such a policy to be examined.

It was apparent that policy is significantly tenure specific; that proposed legislation is aimed at the differences which exist between dwellings as a result of their tenure. See policy proposals 1,2,3,4,8,9,12,13,14, 15,16,20,21.

The next most important classification appeared to be that of size. Take, for example, policy proposals 5,6,7,13,20.

The third most important factor in distinguishing between dwellings appeared to be their general condition.

Thus, the three major classifications identified as being the most all-embracing and relevant for model purposes were:

(i) Tenure
(ii) Size
(iii) Condition

Therefore for the Dwellings Sub-Model dwellings were sub-divided in this way, 24 types being defined.

A further classification could have been included on the distinction between different types of construction i.e.,detached, semi-detached, terraced, flat, maisonette,etc., but it was considered that this would introduce considerable complexity into the model structure and which largely could not be validated by existing data nor meet any apparent analytic need.

The classifications used are discussed below:

(i) Tenure

The evidence presented in Section 4.2.1. stresses the important differences which exist between dwellings as a result of their different tenures. Tenure determines the legal basis for distinguishing how dwellings are used; the difference in property rights leading to different patterns of use. The major justification of the use of tenure as a classification criterion lies in the view that tenure indicates principle features of access into the housing system. This point is discussed at greater length in a later Section 5.2.3.

It was decided to concentrate the analysis on the three major tenure types:

i.e., owner occupied
local authority rented
privately rented

The smaller 'other' tenures described in Section 4.2.1.4. were, grouped together with the tenure type where access to the housing system is defined by similar criteria.

Thus the three classifications were defined as:

(a) Owner Occupied (OOCC) - either owned outright or by a mortgage. Access to this section of the system is determined by the ability to pay albeit over an extended period of time.

(b) Rented from a Local Authority (LAR). This also included rentals from New Towns, local authority tied accommodation and housing associations. Access to this sector is broadly determined by the urgency of the households housing need.

(c) All other tenures (PR). This corresponds to dwellings rented from private owners but also includes privately owned tied housing and dwellings owned by government departments. Access into the PR. sector is again largely determined by ability to pay but not to the extent needed to enter the owner occupied sector. In fact households most likely to become private rented tenants are usually those who cannot satisfy the eligibility criteria for the other tenures (OOCC and LAR) rather than choosing private tenancies as a preference. In many cases this sector acts as a stepping stone to the other two sectors.

In the model all private tenancies are included under the one classification. It was decided not to distinguish between furnished and unfurnished or between protected, controlled or regulated tenancies. The major reason for this being a lack of data on such classifications. Also a change in the law in 1974 has made security of tenure a feature of furnished as well as unfurnished tenancies.

This system of classification corresponds exactly with that of the 1967 and 1971 House Condition Surveys.

(ii) Size

The size of dwellings was considered to be a very important classification since it determines the quantity of living space available to households, and hence gives a sensible indication of the under or over occupation of dwellings.

For the purposes of this model it was decided to classify dwellings according to the number of rooms available in the dwelling, as the most consistent data is found in this form. As explained in Section 4.2.3. the other most common methods of classification by size are by number of bedrooms and internal floor area. The number of bedrooms available would be a useful indication of size, but unfortunately the statistics on this factor are of limited value as they apply to newly built dwellings only. Statistics on internal floor area are scarce but also the concept itself was felt to be of limited value in indicating the actual living space available to households. Different internal arrangements of rooms could cover identical internal floor areas and might provide quite different amounts of space.

It was decided to define four sizes of dwelling thus:

(a) Very Small (VS) - representing one-roomed dwellings.
(b) Small (S) - representing two or three-roomed dwellings.
(c) Medium (M) - representing four, five or six-roomed dwellings.
(d) Large (L) - representing seven or more roomed dwellings

Bathrooms and Kitchens not used for eating are not included.

(iii) Condition

The third distinction between dwellings thought to be of great importance for inclusion in the model structure is the general physical condition of dwellings. As discussed in Section 4.2.2. there are three basic measures in common usage:

(1) Fitness of the dwelling structure.
(2) Availability of amenities.
(3) Age of dwellings.

A further classification described in the literature review section was that of disrepair. Whilst representing a useful indication of the general condition of dwellings, the data on this subject is in terms of the cost of bringing dwellings up to the 5-point amenity standard or to an acceptable standard of fitness not in terms of the number of dwellings involved. For this reason it was decided that disrepair could not usefully be used in this model as an indication of the general condition of the stock of dwellings.

It was felt that for the purposes of this model (designed to aid understanding of the system and explore policy proposals) that classification was needed in terms of both (1) and (2) above, but for the reasons discussed in Section 4.2.2.3. it was decided not to classify dwellings according to their ages.

Both fitness and availability of amenities have important policy consequences as well as affecting the types of household to be found in different parts of the system. If, for example, a very large proportion of dwellings are found to be structurally unfit this would most likely lead to large scale demolition as opposed to rehabilitation.Similarly, if the majority of dwellings in one particular tenure are found not to possess all five basic amenities this must have implications for the type of households most likely to be found there.

In the model a single classification was defined to combine both fitness and availability of amenities and was called condition. A combined classification was preferred in an attempt to reduce the complexity of the model structure.

Thus, in the model, dwellings are defined as being in either:

(a) Good Condition, or
(b) Bad condition,

where, 'Good' is defined as being fit on the basis of Section 4 of the Housing Act 1957 (See Section 4.2.2.1.) and, possessing all five basic amenities (See Section 4.2.2.2.) 'Bad' is defined as being unfit and/or lacking at least one basic amenity.

The following section describes how the number of dwellings of each of the types described here was calculated from available data.

4.4.3. The Number of Dwellings of Each Type

The number of dwellings of each type in England and Wales was calculated from results from the House Condition Surveys carried out in 1967 and 1971.

The decision was taken to use information from these Surveys rather than from the Census as they provided the most consistent evidence on a wide range of subjects. Of greatest importance was information on the fitness of the housing stock which had not been previously collected and is not included in Census data.

Although much of the survey data is subject to certain sampling errors, for the purpose of this model - where the major objective is to first set up a working model with not too much emphasis being placed on the numerical results- the use of a wide range of internally consistent statistics was seen to be of greatest importance.

The House Condition Survey, England and Wales, 1967 was the first large scale survey of its kind covering about 6,000 dwellings and employing skilled public health inspectors.

In 1971 a further House Condition Survey was carried out by the Department of the Environment so providing more recent estimates of the physical condition of permanent dwellings.(36) The sample of rateable units drawn in 1967 was re-used in 1971 as this enabled more 'precise' estimates of change to be made than if a new sample had been chosen. Adjustments were necessary to allow for additions to and subtractions from the housing stock since the sample had been drawn. As a result 6215 addresses were issued to Inspectors in 1971, 12 of whom had assisted in 1967.

The total stock of dwellings by tenure for 1967 and 1971 is shown below in Table 4.10 In the 1971 Survey vacant dwellings were classified separately, 410,000 vacant dwellings were enumerated representing 2.4 per cent of the stock. Of these, 162,000 were declared unfit. No indication was given of their previous mode of tenure. In the Survey it is stated that:

> ' Sixty per cent of the occupied unfit dwellings were of 'Other tenures' - primarily those privately rented - and the remainder were mostly owner occupied; in 1967 the distribution was very similar'.

TABLE 4.10 Dwelling Stock by Tenure, England and Wales, 1967 and 1971

Thousands

	Owner Occupied(OOCC)		Rented from Local Authority(LAR)		Other Tenures (PR)		All Tenures	
		%		%		%		%
1967	7971	51.1	4248	27.3	3368	21.6	15587	100
1971	9265	54.3	4858	28.4	2953	17.3	17076	100

Source: (80,36)

It is assumed that vacant unfit dwellings were similarly distributed i.e., 60 per cent were previously of 'other tenures', 40 per cent previously owner occupied.

According to the Shelter Publication 'Another Empty Home', fit vacant dwellings are distributed in equal proportions among all tenures. Hence fit vacant dwellings were redistributed among tenures accordingly.

The House Condition Surveys 1967 and 1971 enumerate:

(a) Dwellings by Condition and Tenure 1967 and 1971

Thousands

	OOCC	%	LAR	%	PR	%	All Tenures	%
1967 Unfit	556	32	72	4	1118	64	1746	100
Fit	7415	54	4176	30	2250	16	13841	100
Total	7971	51.1	4248	27.3	3368	21.6	15587	100
1971 Unfit	420	34	58	5	742	61	1220	100
Fit	8845	56	4800	30	2211	14	15856	100
Total	9265	54.3	4858	28.4	2953	17.3	17076	100

(b) Dwellings by Availability of Amenities and Tenure 1967- and 1971.

Thousands

	OOCC	%	LAR	%	PR	%	All Tenures	%
1967 Stock	7971	51.1	4248	27.3	3368	21.6	15587	100
Lacking 1 or more basic amenity.	1288	33	675	18	1895	49	3858	100
1971 Stock	9265	54.3	4858	28.4	2953	17.3	17076	100
Lacking 1 or more basic amenity.	1080	38	530	19	1234	43	2844	100

(c) Dwellings by Condition and Availability of Amenities 1967 and 1971.

Thousands

	UNFIT		FIT		TOTAL DWELLINGS	
1967 Stock.	1746	100	13841	100	15587	100
Lacking 1 or more basic amenity.	1505	86	2353	17	3858	25
1971 Stock.	1221	100	15856	100	17076	100
Lacking 1 or more basic amenity.	986	81	1857	12	2844	17

From these Tables it was estimated that the following situation occurred in 1967 and 1971:

TABLE 4.11 Dwellings by Condition and Tenure 1967 and 1971

Thousands

	GOOD CONDITION	%	BAD CONDITION	%
1967 OOCC	6587	57.3	1384	33.8
LAR	3561	31.0	687	16.8
PR	1340	11.7	2028	49.5
Total	11488	100.0	4099	100.0
1971 OOCC	8099	57.9	1166	37.7
LAR	4314	30.8	544	17.6
PR	1571	11.3	1382	44.7
Total	13984	100.0	3092	100.0

Neither of the House Condition Surveys classified dwellings by size so certain assumptions had to be made. The Sample Census 1966 and Census 1971 enumerated rooms in permanent buildings by tenure and type of household space. A household space is defined as the space taken up by a household so there is not nessarily a 1:1 relationship between the number of household spaces and the number of dwellings. The proportion of each sized household space in each tenure has been taken as an indication of the proportion of each sized dwelling in each tenure. This method is likely to have over-estimated the number of smaller dwellings. It was further assumed that the same proportion of each sized dwelling occurs in each type of condition. See Table 4.12 (a) and 4.12 (b) for the number of dwellings by size, tenure and condition estimated for 1967 and 1971.

TABLE 4.12 (a) Dwellings by Tenure, Size and Condition in 1967 - England and Wales.

Thousands

	VS	S	M	L	ALL SIZES
OOCC, G	40	1080	4282	1186	6587
OOCC, B	8	227	900	249	1384
PR, G	138	469	610	123	1340
PR, B	209	710	923	187	2028
LAR, G	75	1232	2144	110	3561
LAR, B	14	238	414	21	6870
Total in good condition.	253	2781	7036	1419	11489
Total in bad condition.	231	1175	2237	457	4100
Total Dwellings.	484	3956	9273	1876	15589

TABLE 4.12. (b) Dwellings by Tenure, Size and Condition in 1971 - England and Wales.

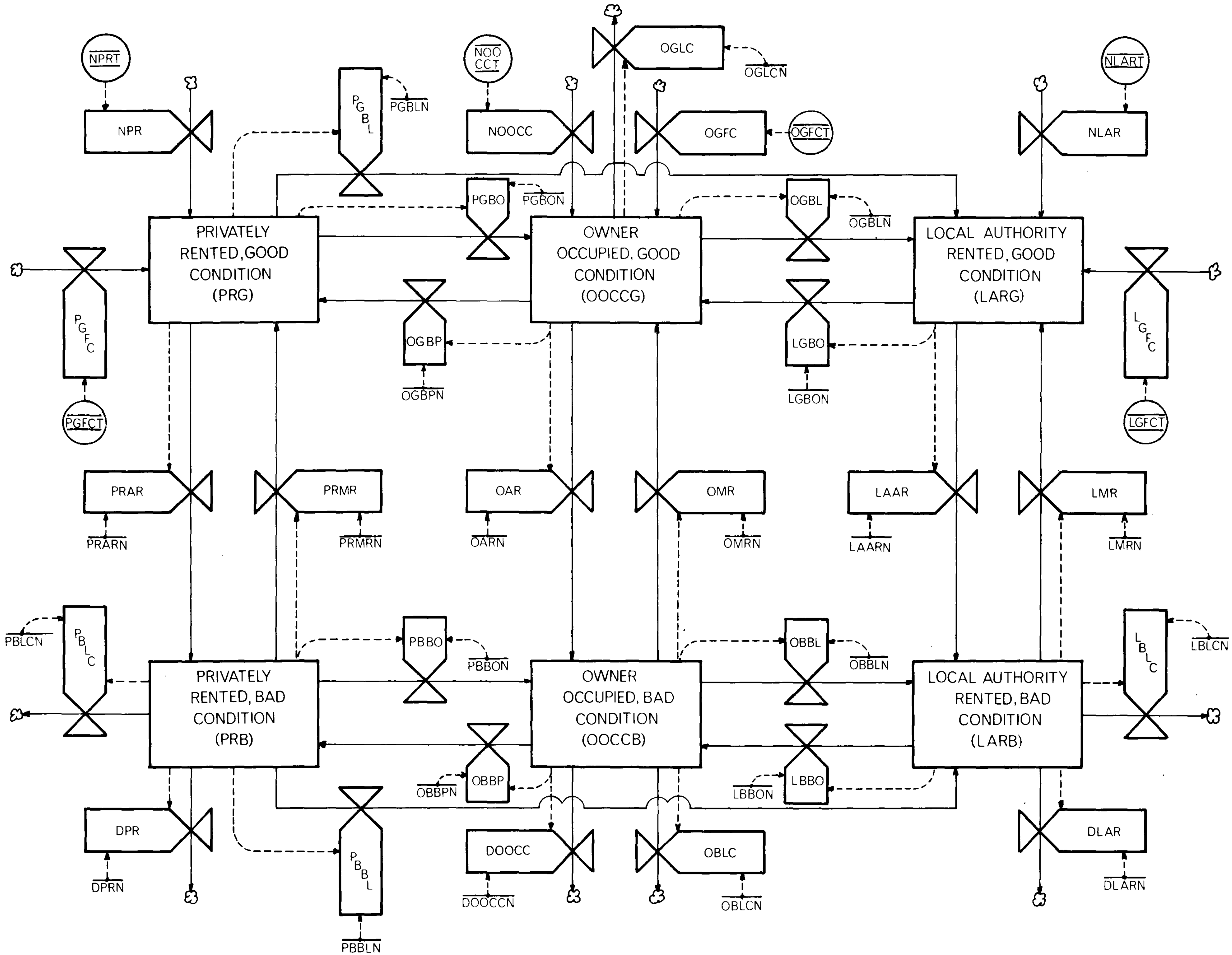
Thousands

	VS	S	M	L	ALL SIZES
OOCC, G	49	1798	5119	1134	8100
OOCC, B	7	259	737	163	1166
PR, G	259	613	599	101	1572
PR, B	228	539	527	88	1382
LAR, G	276	1700	2261	78	4315
LAR, B	35	214	285	10	544
Total Good Condition Dwellings.	584	4111	7979	1313	13987
Total Bad Condition Dwellings.	270	1012	1549	261	3092
All Dwellings.	854	5123	9528	1574	17079

4.4.4. The Structure of the Dwellings Sub-Model

The structure of the sub-model used can be appreciated most easily with reference to the flow chart (See Fig.4.3.) The Dwellings Sub-Model is presented here in formal System Dynamics notation as explained in Section 3.4.3.

Far fewer difficulties were encountered in the construction of the dwellings sub-model than with the



DEVELOPMENT OF DWELLING TYPES

Fig.4.3

Definitions of terms used in Figure 4.3.

Where,

OOCC	represents all privately owned dwellings.
LAR	represents all local authority rented dwellings including those owned by housing associations.
PR	represents all privately rented and other tenures.
G	represents good condition dwellings.
B	represents bad condition dwellings.

PRG	Privately Rented Good condition dwellings.
PRB	Privately Rented Bad condition dwellings.
OOCCG	Owner Occupied Good condition dwellings.
OOCCB	Owner Occupied Bad condition dwellings.
LARG	Local Authority Rented Good condition dwellings.
LARB	Local Authority Rented Bad condition dwellings.
PGFC	Privately rented Good condition dwellings From Conversions. (No. of PRG from conversions per annum)
PGFCT	Privately rented Good condition dwellings From Conversions Table. (No. of PGFC per annum per total dwellings used for conversions per annum from 1967)
NPR	New Privately Rented good condition dwellings. (No. of PRG per annum)
NPRT	New Privately Rented good condition dwellings Table. (No. of NPR per annum from 1967).
PGBL	Privately rented Good condition dwellings Become Local authority rented dwellings. (No. of PRG becoming LAR per annum)
PGBLN	Privately rented Good condition dwellings Become Local authority rented dwellings Normal. (No. of PRG becoming LAR per annum per total No. of PRG)
PGBO	Privately rented Good condition dwellings Become Owner occupied dwellings. (No. of PRG becoming OOCCG per annum)
PGBON	Privately rented Good condition dwellings Become Owner occupied dwellings Normal. (No. of PRG becoming OOCCG per annum per total No. of PRG)
PRAR	Privately Rented good condition dwellings Ageing Rate. (No. of PRG becoming PRB per annum)
PRARN	Privately Rented Ageing Rate Normal. (No. of PRG becoming PRB per annum per total No. of PRG)
PRMR	Privately Rented Modernisation Rate. (No. of PRB becoming PRG per annum).
PRMRN	Privately Rented Modernisation Rate Normal. (No. of PRB becoming PRG per annum per total No. of PRB).
OGBP	Owner occupied Good condition dwellings Become Privately rented. (No. of OOCCG becoming PRG per annum)

OGBPN Owner occupied Good condition dwellings Become Privately rented Normal.
(No. of OOCCG becoming PRG per annum per total No. of OOCCG)

NOOCC New Owner Occupied dwellings.
(No. of new OOCCG per annum)

NOOCCT New Owner Occupied dwellings Table.
(No. of new OOCCG per annum from 1967)

OGLC Owner occupied Good condition dwellings Lost to Conversion.
(No. of OOCCG used for conversion purposes per annum)

OGLCN Owner occupied Good condition dwellings Lost to Conversion Normal.
(No. of OOCCG used for conversion purposes per annum per total No. of OOCCG)

OGFC Owner occupied Good condition dwellings From Conversions.
(No. of OOCCG from conversions per annum)

OGFCT Owner occupied Good condition dwellings From Conversions Table.
(No. of OOCCG from conversions per annum per total No. of dwellings used for conversions per annum from 1967)

OGBL Owner occupied Good condition dwellings Become Local authority rented dwellings.
(No. of OOCCG becoming LARG per annum.)

OGBLN Owner occupied Good condition dwellings Become Local authority rented dwellings Normal.
(No. of OOCCG becoming LARG per annum per total No. of OOCCG).

OAR Owner occupied Ageing Rate.
(No. of OOCCG becoming OOCCB per annum)

OARN Owner occupied Ageing Rate Normal.
(No. of OOCCG becoming OOCCB per annum per total No. OOCCG)

OMR Owner occupied Modernisation Rate.
(No. of OOCCB becoming OOCCG per annum)

OMRN Owner occupied Modernisation Rate Normal.
(No. of OOCCB becoming OOCCG per annum per total No. of OOCCB).

LGBO Local authority rented Good condition dwellings Become Owner occupied.
(No. of LARG becoming OOCCG per annum).

LGBON Local authority rented Good condition dwellings Become Owner occupied Normal.
(No. of LARG becoming OOCCG per annum per total No. of LARG).

NLAR New Local Authority Rented dwellings.
(No. of new LARG per annum).

NLART New Local Authority Rented dwellings Table.
(No. of new LARG per annum from 1967).

LGFC Local Authority Good condition dwellings From Conversions.
(No. of LARG from conversions per annum)

LGFCT Local authority Good condition dwellings From Conversion Table .
(No. of LARG from conversions per annum per total No. of dwellings used for conversions per annum from 1967)

LAAR	Local Authority rented Ageing Rate. (No. of LARG becoming LARB per annum)
LAARN	Local Authority rented Ageing Rate Normal. (No. of LARG becoming LARB per annum per total No. of LARG)
LMR	Local authority rented Modernisation Rate. (No. of LARB becoming LARG per annum).
LMRN	Local authority rented Modernisation Rate Normal. (No. of LARB becoming LARG per annum per total No. of LARB)
LBLC	Local authority rented Bad condition dwellings Lost to Conversions. (No. of LARB used for conversion purposes per annum)
LBLCN	Local authority rented Bad condition dwellings Lost to Conversions Normal. (No. of LARB used for conversion purposes per annum per total No. of LARB)
DLAR	Demolition of Local Authority Rented bad condition dwellings. (No. of LARB demolished per annum)
LBBO	Local authority rented Bad condition dwellings Become Owner occupied. (No. of LARB becoming OOCCB per annum).
LBBON	Local authority rented Bad condition dwellings Become Owner occupied Normal. (No. of LARB becoming OOCCB per annum per total No. of LARB)
OBBL	Owner occupied Bad condition dwellings Become Local authority rented. (No. of OOCCB becoming LARB per annum).
OBBLN	Owner occupied Bad condition dwellings Become Local authority rented Normal. (No. of OOCCB becoming LARB per annum per total No. of OOCCB)
OBLC	Owner occupied Bad condition dwellings Lost to Conversions. (No. of OOCCB used for conversion purposes per annum)
OBLCN	Owner occupied Bad condition dwellings Lost to Conversions Normal. (No. of OOCCB used for conversion purposes per annum per total No. of OOCCB).
DOOCC	Demolition of Owner Occupied bad condition dwellings. (No. of OOCCB demolished per annum)
DOOCCN	Demolition of Owner Occupied bad condition dwellings Normal. (No. of OOCCB demolished per annum per total No. of OOCCB)
OBBP	Owner occupied Bad condition dwellings Become Privately rented. (No. of OOCCB becoming PRB per annum)
OBBPN	Owner occupied Bad condition dwellings Become Privately rented Normal. (No. of OOCCB becoming PRB per annum per total No. of OOCCB).

PBBO	Privately rented Bad condition dwellings Become Owner occupied. (No. of PRB becoming OOCCB per annum).
PBBON	Privately rented Bad condition dwellings Become Owner occupied Normal. (No. of PRB becoming OOCCB per annum per total No. of PRB)
PBBL	Privately rented Bad condition dwellings Become Local authority rented. (No. of PRB becoming LARB per annum)
PBBLN	Privately rented Bad condition dwellings Become Local authority rented Normal. (No. of PRB becoming LARB per annum per total No. of PRB)
DPR	Demolition of Privately Rented bad condition dwellings. (No. of PRB demolished per annum).
DPRN	Demolition of Privately Rented bad condition dwellings Normal. (No. of PRB demolished per annum per total No. of PRB).
PBLC	Privately rented Bad condition dwellings Lost to Conversion. (No. of PRB used for conversion purposes per annum).
PBLCN	Privately rented Bad condition dwellings Lost to Conversion Normal. (No. of PRB used for conversion purposes per annum per total No. of PRB).

for new building in the private sector between dwellings built for owner occupation and those built for private rental. Evidence elsewhere (71) suggests that the number of dwellings built for letting by private owners was unlikely to have exceeded 100,000 in the period 1960 to 1975.

Table 4.13 below shows the number of new dwellings completed in the public and private sectors by the number of bedrooms. As an initial assumption no new building was assigned to the private rented sector.

TABLE 4.13. Permanent Dwellings completed in England and Wales by number of bedrooms.

	PUBLIC SECTOR (LAR)				
	1 Bedroom	2 Bedrooms	3 Bedrooms	4+ Bedrooms	TOTAL
1965	36351	47723	46226	2724	133024
1966	37732	49460	52115	3123	142430
1967	41054	51610	62301	4382	159347
1968	39087	47092	57768	4102	148049
1969	37169	44140	53904	4637	139850
1970	38503	41179	50165	5027	134874
1971	36606	35087	40685	4837	117215
1972	29569	26456	33367	4243	93935
1973	26741	21599	27500	3439	79289
1974	34260	26232	34474	4457	99423
1975	38842	32303	46905	4807	122857
1976	39356	31877	47717	4994	124152

	PRIVATE SECTOR (OOCC)				
	1 Bedroom	2 Bedrooms	3 Bedrooms	4+ Bedrooms	TOTAL
1965	3879	55773	136658	9936	206246
1966	3976	49374	132873	11288	197502
1967	3537	44009	133124	12270	192940
1968	3677	45158	149502	14936	213273
1969	3532	35845	120169	13831	173379
1970	3646	33634	110118	14631	162029
1971	3583	33409	125512	17549	180053
1972	4437	32252	128127	19619	184435
1973	4529	29331	118761	21283	173904
1974	4443	23351	83439	17174	128407
1975	5167	31077	82493	20954	139691
1976	4992	31967	80654	20864	138477

Source (72,62,65)

The information recorded in this Table was used as the initial input to the model with 1,2,3,4+ bedrooms being used for sizes VS, S, M, L. Hence data needs (1) and (2) (See List on Page 192) was assumed to be satisfied. Data needs (3) is found not to be important at this stage.

Demolitions (i.e. Data Needs 4, 5, 6)

Housing and Construction Statistics publish details of the number of houses demolished or closed as a result of slum clearance orders by local authorities.

As mentioned in Section 4.3.2. the problem with such data is the definition of a 'house', as a 'house' may contain more than one dwelling. At this stage all demolitions were assumed to take place in the local authority sector at the levels shown by the data from Housing and Construction Statistics (73, 66, 63) given below.

TABLE 4.14 Houses Demolished by Local Authorities-1965-1976 in England and Wales.

Thousands

	1965	1966	1967	1968	1969	1970
No. of Demolitions.	60666	66782	71152	71586	69233	67804
	1971	1972	1973	1974	1975	1976
No. of Demolitions.	70057	66098	63557	41698	49083	48208

Thus data needs (4) and (5) cannot be satisfied from existing data. Assuming all sized dwellings are demolished at the same rate, data need (6) can be approximated.

Modernisations (i.e. Data Needs 10, 11, 12)

The rate of modernisation in the model is defined as the rate at which dwellings are brought up to the 5-point amenity standard.

From the House Condition Survey 1971 information is given on the number of dwellings of each tenure lacking one or more of the basic amenities in 1967 now having all.

Assuming all sized dwellings in each tenure are modernised at the same rate,

Number of dwellings of a particular size modernised

= proportion of that sized dwelling in that tenure x number of modernisations of that tenure.

TABLE 4.15 Average Number of Modernisations by Size and Tenure, England and Wales 1967-1971

Number

	OOCC	LAR	PR
Total Modernisations 1967-1971	347000	143000	137000
∴ Average Annual Modernisations	77000	32000	30000
Annual Average by size:			
Small (Very)	77	384	540
Small	2541	5952	5880
Medium	63602	25120	21480
Large	10780	544	2100

Hence data needs (10), (11) and (12) have been estimated from existing data.

Ageing (i.e. Data Needs 7,8,9.)

Ageing is defined in the model as the rate at which dwellings in good condition decline into bad condition. Information on this phenomenon is highly spurious. The House Condition Survey 1971 states that there were 400 x 10^3 dwellings not unfit in 1967, unfit in 1971. Hence the average annual estimated number of dwellings falling into unfitness was 89 x 10^3 over this period.

Assuming further that dwellings decline in condition in proportion to the number of dwellings in each tenure and that all sizes decline at the same rate, see Table 4.16.

TABLE 4.16 Average Annual number of Dwellings to Decline in Condition by Size and Tenure in England and Wales.

Thousands

	Very Small Dwellings	Small Dwellings	Medium Dwellings	Large Dwellings
Owner Occupied	45	1498	37500	6356
Local Authority Rented	288	4464	18840	408
Privately Rented	353	3841	14034	1372

Hence data needs (7), (8), (9) are satisfied.

Change of Tenure (i.e., Data Needs 13-22)

Data on the number of dwellings transferring from one tenure to another is extremely poor. No information is provided from the House Condition Survey. A.E. Holmans' (61) estimates the demand for local authority houses arising directly from slum clearance and other demolitions. (As explained in Section 4.3.2. data for slum clearance only states that carried out by local authorities. Most of the demolition will be of their own property but some private property will have been bought specifically for this purpose. One of the statutory obligations of local authorities is to rehouse households displaced by slum clearance). Table 4.17 below is reproduced from the same article.

TABLE 4.17. A forecast of demand for local authority houses arising directly from slum clearance and other demolitions.

Thousands

	1967	1971	1976	1981
Former Owner Occupiers.	12	13	15-26	16-27
Former Tenants of Private Landlords	60	61	58-92	57-89
Total	72	74	73-118	73-116

Assuming each household separately occupied a dwelling and taking the average values for 1967 and 1971:

12500 dwellings were transferred from owner occupancy to the local authority.
60500 " " " from private tenancies to the local authority.

It was further assumed that dwellings of all sizes transfer at the same rate.

TABLE 4.18. Average Annual Number of Dwellings transferring to the local authority sector 1967-1971 by size and tenure.

Size of Dwelling	Owner Occupied	Privately Rented
Very Small	12	1089
Small	413	11858
Medium	10325	43318
Large	1750	4235

It is further assumed that only dwellings in bad condition will be bought up by the local authority.

Hence data needs 16 and 22 are satisfied. Data needs 15 and 21 are assumed not to be important.

Privately rented property will also be transferred to the owner occupied sector.

From Table VII Components of Supply and Demand for Owner Occupied Housing in A E Holmans' (61)

The number of houses formerly rented adding to the supply of owner occupied dwellings = 75×10^3 in 1971 (estimate)
and 65×10^3 in 1976 (estimated)

Assuming an average annual transference of 70×10^3 dwellings with this number divided proportionally between privately rented dwellings in good condition and bad condition, the numberof each size transferring is given in Table 4.19 below.

TABLE 4.19. Average Annual, Formerly Privately Rented Dwellings transferring to the Owner Occupied Sector by Size and Condition

	Privately Rented Good Condition	Privately Rented Bad Condition
Total	37240	32760
Very Small	670	590
Small	7299	6421
Medium	26664	23456
Large	2607	2293

Hence data needs 19 and 20 are satisfied.

On average 3993 dwellings were sold by local authorities per annum and 571 dwellings were sold by New Towns per annum in the period 1960 - 1969 (75)

It was assumed that only good condition dwellings are sold and that equal proportions of each size are sold. Table 4.20 below shows the average annual number of local authority dwellings sold by size. These figures were used to satisfy data needs 17 and 18.

TABLE 4.20 Average Annual Number of Local Authority Dwellings Sold in England and Wales 1960-1969

Size of Dwelling	Number Sold
Very Small	55
Small	867
Medium	3606
Large	91

It was not possible to find data to satisfy data needs 13 and 14.

Stages III, IV, V

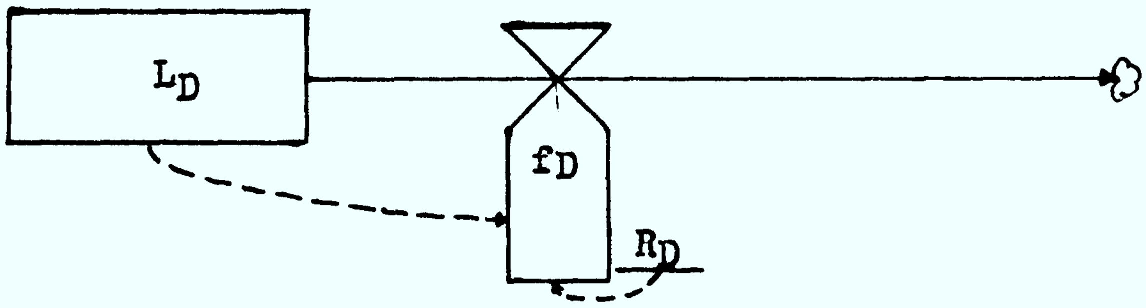
As in the households sub-model each 'level' depends upon the size of the 'level' in theprevious time period plus all those flows of dwellings entering that 'level' during the time interval minus all those flows leaving the

LMR	= No of	LARB dwellings		x	LMRN
LAAR	= " "	LAR,G	"	x	LAARN
DLAR	= " "	LAR,B	"	x	DLARN

Some flows hoever, are not determined by the assumed rate of change but read into the model as a piece of data from a time-based table. In these cases the flow is distinguished by the addition of T to the label,

i.e., NOOCCT, NLART, NPRT

Having determined from existing data the size of the flows from each dwelling type to all other dwelling types, it was necessary to calculate the annual rate of change. If,



where L_D is the magnitude of the 1967 levels, then the annual rate $R_D = \frac{f_D}{L_D}$

In the computer programme, as in the households sub-model, the rate pertaining to a particular flow is distinguished from that flow by the addition of a letter N to the label i.e., the flow OAR is influenced by the rate OARN.

Stages III and IV of the modelling process involved running the computer programme with this data and comparing the models results for 1971 with the available data for the levels.

Adjustments were then made to the magnitude of the rates in order to 'correct' the model output for the levels for the year 1971. Justification for making such adjustments to the rates was based largely on the incongruency existing between some model definitions of the levels and the definition of terms in statistics used for determining the rates. Statistics on slum clearance, for example, are only for the total number of houses demolished. One house may incorporate several model dwellings, hence, the rate at which model dwellings are demolished may differ from the rate at which actual houses are demolished. It is one of the functions of the calibration process to bring existing data into line with model definitions.

In some instances however, the discrepancies between model output and available data seemed too great for minor adjustments to be made to the rates. According to early results for model output for 1971 there appeared to be too few of the following dwelling types:

Very Small, privately rented good condition PR,G (VS)
Very Small, local authority rented, good condition LAR,G (VS)
Small, privately rented, good condition PR,G (S)
Small, owner occupied, good condition OOCC,G (S)
Small, local authority, good condition LAR,G (S)
Medium, local authority rented, good condition LAR,G (M)

and too many of these dwelling types:

Small, local authority rented, bad condition LAR,B (S)
Medium, privately rented, bad condition PR,B (M)
Medium, owner occupied, bad condition OOCC,B (M)
Medium, owner occupied, good condition OOCC,G (M)
Medium, local authority rented, bad condition LAR,B (M)
Large, privately rented, bad condition PR,B (L)
Large, owner occupied, bad condition OOCC,B (L)
Large, owner occupied, good condition OOCC,G (L)
Large, local authority rented, bad condition LAR,B (L)

This situation suggested that the real world phenomenon of conversion of dwellings was not being depicted by the model. Due to lack of data the conversion rates had all

	VS	S	M	L
DOOCCN	0.0	0	0	.068
DLARN	.2724	.103	.174	.916
DPRN	0.0	0	0	0
OARN	.0076	.0078	.0078	.0078
LAARN	.0130	.0077	.0082	.1100
PRARN	.0980	.0150	.0077	.0430
OMRN	.0600	.0560	.0640	.0580
LMRN	.0630	.0560	.0467	.0467
PRMRN	.0340	.0183	.0183	.0150
PGBON	.0210	.0210	.0210	.0210
OGBPN	.1210	0	0	0
PBBON	.0190	.0210	.0210	.0210
PBBLN	.0436	.0348	.0610	.0348
OBBPN	.4800	.0057	0	0
PGBLN	0.0	0	0	0
OGBLN	.0092	0	0	0
LGBON	.0013	.0013	.0134	.0172
LBBON	0.0	0	0	0
OBBLN	.0955	.0105	.0176	.0190
PBLC	0	0	.0238	.1072
OBLC	0	0	.0246	.0037
OGLC	0	0	.0006	.0298
LBLC	0	.0187	.0753	.5019
LGLC	0	0	0	.0061

Flows determined by time-based data inputs:

		1967 - 1970	1971 onwards
NOOCCT	(VS)	2755	3505
	(S)	39127	29201
	(M)	131537	98392
	(L)	15192	19995
NLART	(VS)	41574	37875
	(S)	47235	31047
	(M)	57016	42630
	(L)	4916	4917
NPRT	(VS)	1000	1200
	(S)	500	400
	(M)	2106	2006
	(L)	311	311
PGFCT	(VS)	.277	.277
	(S)	.293	.293
	(M)	0	0
	(L)	0	0
OGFCT	(VS)	0	0
	(S)	.765	.765
	(M)	0	0
	(L)	0	0

		1967 - 1970	1971 onwards
LGFCT	(VS)	.025	.025
	(S)	.437	.437
	(M)	.031	.031
	(L)	0	0

4.4.5. Model Results 1967 - 1976

The dwellings sub-model annually outputs information on the total number of dwellings and the number of dwellings by size, tenure and condition.

Figure 4.4. shows output of the total number of dwellings and how they are divided between the three major tenure types. The total number of dwellings is believed to have increased by just over sixteen per cent in the period 1967 - 1976; from 15.6 million in 1967 to 18.2 million by 1976. These results reflecting the observed situation in the real world over the period of a steady but continuous increase in the housing stock.

In terms of tenure, the model shows that the greatest increase has occurred in the owner occupied sector with the local authority rented sector rising moderately and the privately rented sector steadily declining. As a proportion of all dwellings in the model the owner occupied sector has increased from 51 per cent in 1967 to 56 per cent in 1976. The privately rented sector falling from 22 per cent to 15 per cent. The direction and magnitude of these trends according well with the information presented in Section 4. 2. 1.

Fig. 4.4. also depicts model output of total dwellings by condition. The number of dwellings in good condition has increased whereas the number of bad condition dwellings has decreased. The proportion of the housing stock in bad condition declined from 26 per cent in 1967 to 14 per cent in 1976. In absolute terms the number of bad condition dwellings declined from 4.1 million to 2.6 million over the period. These model results reflecting the trend experienced of a general improvement in the quality of the housing stock discussed in Section 4.2.2.

In terms of size the model shows how the stock is dominated by medium sized dwellings - the tradional three bedroom house - with very small and large dwellings forming the smallest proportion. The number of very small dwellings has increased slightly - mostly in the local authority sector. - The number of large sized dwellings has shown a steady decline - a reflection of the real world situation of households adjusting their needs in terms of space requirements as average complete family size has fallen. Section 4.2.3. on the changing size distribution of new dwellings built over this period presents evidence to justify these model results.

Thus the general trends produced by the model for the period 1967 to 1976 of the total number of dwellings and their mix between tenure, size and condition broadly agree with these trends known to have occurred for the period.

Only two complete sets of data were availablo for the 'levels! One obtained from the House Condition Survey

1967 and used as the initial conditions for the model, the other from the House Condition Survey 1971, this set being used to calibrate against.

Table 4.21 shows a comparison of model results (M) and 1971 data (D). The 1971 data was previously presented on page 186

TABLE 4.21 Comparison of Model Output (M) with available data for 1971 (D).

Thousands

		VS	S	M	L	ALL SIZES
OOCC,G	M	48	1766	5092	1136	8042
	D	49	1798	5119	1134	8099
OOCC,B	M	7	257	741	165	1171
	D	7	259	737	163	1166
PR, G	M	253	607	600	101	1562
	D	259	613	599	101	1571
PR, B	M	221	544	540	97	1403
	D	228	539	527	88	1382
LAR, G	M	268	1683	2261	78	4290
	D	276	1700	2261	78	4314
LAR, B	M	33	216	291	11	551
	D	35	214	285	10	544
Total in Good Condition	M	569	4056	7954	1315	13894
	D	584	4111	7979	1313	13987
Total in Bad Condition	M	261	1018	1571	274	3124
	D	270	1012	1549	261	3092
Total Dwellings	M	830	5074	9525	1589	17018
	D	854	5123	9528	1574	17079

VS = Very Small. S = Small. M = Medium. L = Large.

Model output of the total number of dwellings agrees well with the data. The 'row totals' i.e. total numbers of dwellings sub-divided by tenure and condition is also in very close agreement with the data i.e. a maximum of 2 per cent discrepancy for privately rented bad condition dwellings. As the absolute numbers concerned are small the problem is not serious.

The 'column totals' i.e. total number of dwellings by size agree within one per cent except for very small dwellings which are under-estimated by three per cent. The reason for this discrepancy is not clear. Again in absolute terms only small numbers are concerned. Subdividing size by condition produces a similar match between model results and the data, although large,bad condition dwellings are over-estimated by five per cent.

The 'cell totals' are not all in such good agreement with the data as the row and column totals. All output for small and medium sized dwellings agrees with the data to within at least two per cent. Very small dwellings are less well matched although the maximum difference in percentage terms is for local authority, bad condition dwellings which are under-estimated by 5 per cent. In absolute terms however this only represents 2,000 dwellings. Output for large dwellings agrees almost perfectly except for privately rented bad condition and local authority, bad condition dwellings. Again, in absolute terms the total discrepancy amounts to only 10,000 dwellings.

In general therefore the model results agree well with the 1971 data although the number of some large dwellings are over-estimated and the number of some small dwellings slightly under-estimated. This suggests that the phenomenon of converting large dwellings to small dwellings has not been implemented in the model on a large enough scale.

As such, the dwellings sub-model is said to be calibrated to an acceptable standard.

4.5 A Review of the Dwellings Sub-Model

Looking back over the review section of this chapter and comparing information contained there with the structure and results of the model developed it will be seen that the model is a fair, if simplified, representation of that reality as we know it.

As was mentioned previously, the process of matching model output to known data was much easier for the dwellings sub-model than for the households sub-model for two major reasons:

(a) the real world situation is far less complex than for households. There are a limited number of factors which can affect dwellings, and,

(b) the data available was of better quality and more easily accorded with model definitions.

The way in which the structure of the model was decided upon has been discussed in Sections 4.4.1 and 4.4.2. This choice of structure and method of classification being based on the orientation of the study i.e. the aim of aiding our understanding of how the total housing system works. Guidance on this choice was also provided by the list of experimental policy changes.(See Page 7).

From the literature review it appeared that there were six fundamental phenomena which occur to alter the number of dwellings of a particular type over a period of time. These are:

(1) New building.
(2) Demolition.
(3) Modernization.
(4) Ageing - i.e. moving from good to bad condition.
(5) Changing size - i.e. Conversions.
(6) Changing tenure.

A brief summary of how these major phenomena were incorporated into the model will indicate the extent to which the model reflects the reality described in Section 4.3.

(1) New building

In the model it is assumed that only dwellings in good condition are increased by new building. All tenures are affected by this phenomenon although data on newly built privately rented dwellings is very scarce. For this reason the annual number of such new dwellings is included in the model by means of an informed estimate. Clearly many factors affect the level of new building at any time but no feedbacks exist in this model. Factors which have been omitted are, the availability of land, availability of mortgage funds, availability of funds to local authorities, the level of demand for dwellings, the cost of new dwellings. The assumption was made that past trends in new building would continue at the same rate. Although an experiment was later conducted to note the effect of altering this assumption about the future. The omission of feedback loops in the model of the type just described was only accepted because of the relative ease with which they could be added at a later stage if data was found to support the phenomenon involved.

For the standard run the actual number of dwellings built was read into the model for the period 1967 to 1971. Recent statistics indicate that the rate of housebuilding is falling steadily and hence the figures for 1971 onwards were chosen accordingly.

(2) Demolitions

Information on demolitions is only available for that undertaken by local authorities, although demolition of privately owned dwellings also takes place. Demolition of all tenure types was therefore included in the model, although only bad condition dwellings were demolished. This was considered to be a reasonable assumption since it was suggested in Section 4.3.2. that the most common reason for demolition was as part of slum clearance programmes. Initially, data on local authority demolitions was used as input to the demolition of bad condition,local authority dwellings in the model. As part of the calibration process further flows were introduced into the model i.e. when the first set of model results based entirely on available data showed too many bad condition owner occupied dwellings, the demolition rate of these dwellings was increased from zero upwards to 'correct' the model output. It was believed that privately rented dwellings would not on the whole be demolished by their owners but first be purchased by the local authority. Hence the flow PBBL was introduced and the rate at which local authority dwellings were demolished in the model was increased accordingly. This approach was justified by evidence presented in Section 4.3.2. which suggested that data on demolitions considerably underestimated the total number of dwellings involved.

By modelling the phenomenon in this way it was felt that best use was made of the available data and also that the reality of the situation had been grasped.

(3) Modernizations

As emphasised in the review section, little reliable data is available on the level of modernizations at any time. The term modernization means the improvement in the condition of a dwelling and it was possible to incorporate into the model the limited data available from the results of the House Condition Surveys. Fortunately, the model definitions of 'good' and 'bad' accorded well with the definitions of condition given in these Surveys.

Thus although the data is poor it is felt that the concept has been adequately and meaningfully incorporated into the model.

(4) Ageing

Ageing is the term used to describe the phenomenon of dwellings deteriorating from good to bad condition but not necessarily as a result of the building getting old. Other factors will contribute to this ageing process e.g., vandalism, constant neglect and misuse, fire, flood etc. The model does not however contain feedbacks of this nature.

The number of dwellings falling into bad condition is taken to be a constant proportion of the number of good condition dwellings at any time.

(5) Conversions - Changing Size.

This was the only phenomenon where no guiding data existed. In the event, it was only included towards the end of the calibration process as an aid to matching model output with available data on the levels.

The method used to facilitate the incorporation of this phenomenon was, with hindsight, far from satisfactory.

Thus the structure of The Dwellings Sub-Model is seen to accord well with the reality described in the literature review. Also, it was possible to incorporate to a very large extent the majority of those phenomena seen to affect the numbers of dwellings of different types. All of this was achieved without grossly over simplifying the model.

Thus, unlike with the Households Sub-Model the structure and concepts of dwellings as a system could be incorporated into a model although certain difficulties, as discussed in Section 4.4.3, arose with validating the model with existing data. But as has been seen, sufficient realistic assumptions could be made to render the model operational.

The following Chapter discusses the relationship between Households and Dwellings and how that relationship was modelled.

CHAPTER FIVE

THE RELATIONSHIP BETWEEN DWELLINGS AND HOUSEHOLDS

Having described how the population can be classified into many different and sometimes overlapping groups (See Chapter 3) and also how the almost infinite variation in the housing stock can be reduced to a manageable number of separate dwelling types (See Chapter 4) it is the aim of this Chapter to discuss how and why households occupy the dwelling stock in the manner experienced in England and Wales.

Evidence presented in Chapters 3 and 4 suggest that some of the factors households take into account in deciding where in the housing system they wish to be located are:

> Present and future household needs, aspirations, views on saving, proportion of income prepared to spend on housing, status perceptions, family background, career, social contacts and networks, ability to pay, location, nearness to schools, shops, open spaces.

It is the extent to which these factors can be satisfied that will determine the type and location of the dwelling. It is suggested that the function of mobility, in fact, is to adjust housing to housing needs and desires.

Some of the factors mentioned above have been discussed previously in devising a suitable method of classification of households. Thus it was decided (See Section 3.2) that household 'needs' are reflected by the stage in the family life cycle and that social class is a recognisable indicator of the factors such as aspiration, ability to pay etc., as given above.

Actual location in the system will also depend on the restrictions that are placed on the household obtaining housing of its choice. Households in local authority dwellings must have satisfied certain qualification conditions defined by the authority; these qualifications are quite different from those governing access to mortgage loans; these in turn are different from the diverse and possibly inconsistent rules of eligibility applied by landlords and agents in the privately rented sector. It will be shown that, once again, stage in family life cycle and socio-economic group have a great influence on the ability of the households to gain access to certain parts of the system. Knowledge of a households stage in the family life cycle and socio-economic group makes it possible to infer where in the housing system it is likely to be located. The nature of the restrictions on households access to certain parts of the system can be more fully appreciated by analysing households movement behaviour-why households wish to move in the first place and what determines their final destination. As Grigsby (55) states:

> 'households (are) links between the parts of the housing system. Thus, the number of households moving between dwellings with different characteristics, the number considering such movement, the restrictions on movement, the process of decision making and the characteristics of households who do not move are all indicative of the nature of the housing system and of the processes in it'.

Similarly, Murie (86) contends that:

> 'information concerning movement behaviour is vital for adequate forecasting, planning and policy evaluation. The pattern of linkages together with evidence of preference and satisfaction can suggest how households are allocated to parts of the system; where parts of the system are subject to heavy demand;

> where households of particular types may be in situations of 'no choice', or may be trapped within particular parts of the system... The patterns of linkages can also indicate what impact changes in policy... (for example), changes affecting the choice between buying and renting, are likely to have'.

Thus the following Chapter will begin with a review of where certain households are located; this will be followed by a study of households movement behaviour. The final section will be a description of how these phenomena were incorporated into the model's calculations.

5.1 THE USE OF DWELLINGS

5.1.1. Which dwellings are occupied by which households.

Alan Murie in his study Housing Tenure in Britain 1958-1971 draws on information from several social surveys which have been concerned with housing behaviour. (24,30,31,32,120) These provide considerable evidence on the use of different sectors by households of different types.

The evidence suggests that consistent associations exist between tenure and household characteristics,i.e. socio-economic group, age and stage in the family cycle.

> 'The very consistency of the patterns indicated by the different surveys suggests that the distribution of households between tenures is not in constant flux despite the considerable shuffling process of households on the move'. (91)

The evidence further suggests that a households situation within the system depends largely upon the different eligibility and allocation policies operated by the different tenures. These criteria for access to the different tenures will be discussed in more detail in Section 5.2.3.

Following Murie's method of analysis of how households occupy dwellings,those characteristics considered important in eligibility profiles i.e., age of head of household, household type, household size, social class, will now be discussed.

(a) Age of Head of Household

Evidence suggests that in both owner occupied sectors and the local authority sectors there is a wide range of age groups. Although among outright owners there are markedly more older households than those owning with a mortgage. In the privately rented sector a sharp age distinction exists between the furnished and unfurnished sectors. In the unfurnished sector there has been a consistently high proportion of 'older' households and the furnished sector more 'younger' households. Evidence from the General Household Survey is summarised in Table 5.1.

(b) Household type

The evidence suggests that the local authority sector consistently includes a higher percentage of large families. The privately rented furnished sector caters for a high proportion of individual and small households. The owner occupied caters for a wide range of all household types similar in distribution to the whole household population with slightly fewer one person households and rather more small family households. See Table 5.2.

(c) Household size

The size of households in each tenure is shown in Table 5.3. Comparison of Tables 5.2., and 5.3. shows that, in terms of who lives where, there is a marked correlation between household type and household size. The size distribution of owner occupier households was very similar to that of all households taken together apart from including rather fewer one person households.

TABLE 5.1 Age of Head of Household and Tenure - Great Britain 1971

Tenure	Owner Occupied: Owns Outright(a)	Owner Occupied: With a Mortgage(b)	All Owner Occupied a + b	Rented from LA/New Town/ Housing Associations(c)
Sample No.	2637	3200	5837	3757
Age of Head of Household	%	%	%	%
Less than 25	.3	4.7	2.7	3.0
25 - 29	.8	13.1	7.5	5.7
30 - 44	9.2	46.5	29.6	24.4
All 'Young'	10.3	64.3	39.8	33.1
45 - 59	27.6	29.1	28.4	33.0
60 - 64	17.6	3.9	10.1	10.1
65 - 69	16.3	1.3	8.1	8.8
70 - 79	21.7	1.1	10.4	11.4
80 & over	6.5	.3	3.2	3.6
All Old	89.7	35.7	60.2	66.9

Tenure	Rented Private Unfurnished(d)	Rented Private Furnished(e)	Other(f)	All other (d) + (e) +(f)
Sample No.	1384	318	578	2280
Age of Head of Household	%	%	%	%
Less than 25	6.2	36.5	5.3	10.2
25 - 29	5.6	17.6	10.5	8.5
30 - 44	14.2	23.3	33.8	20.4
All 'Young'	26.0	77.4	49.6	39.1
45 - 59	23.5	10.7	35.7	24.8
60 - 64	11.8	1.6	8.0	9.4
65 - 69	12.2	2.5	4.0	8.8
70 - 79	19.4	6.0	2.6	13.3
80 & over	7.1	1.9	.1	4.6
All Old	74.0	22.6	50.4	60.9

TABLE 5.2. Household Type and Tenure-Great Britain 1971

Household Type	Owner Occupier %	Rented from Local Authority %	Rented Privately %	All Tenures %
Individuals Under 60.	3.9	4.0	11.9	5.0
Small Adult Households.	13.7	11.0	16.8	14.0
Small Families.	26.0	18.0	15.2	22.0
Large Families.	11.5	17.0	5.4	13.0
Large Adult Households.	17.8	21.0	11.9	18.0
Older Smaller Households.	27.1	29.0	38.8	28.0

Source (91)

TABLE 5.3 Size of Households by Tenure.- England and Wales 1971

Number of Persons	Owner Occupied	Rented from LA/ New Town or Housing Association	Rented from Private Landlord	All Tenures
1	13.7	17.6	29.3	17.7
2	33.6	26.9	34.2	31.7
3	20.4	18.7	16.6	18.9
4	19.2	17.2	11.3	17.3
5	8.3	10.0	5.1	8.2
6	3.1	5.3	2.2	3.5
7	1.0	2.3	.7	1.3
8 or more	0.7	2.0	.6	1.0

Source (91)

The local authority sector caters disproportionately for the larger households, for example the proportion of households with six or more persons was nearly twice as great as in the owner occupied sector. The private rented sector caters largely for smaller households with those in unfurnished accommodation being mainly old and those in furnished being mainly younger (Table 5.1.)

(d) Socio-Economic Group

The housing surveys referred to make use of the Registrar General's socio-economic group classifications. Table 5.4 below compares the social class and tenure of households in 1966 and 1971.

TABLE 5.4. Social Class and Tenure 1966-1971 England and Wales

Percentages

Socio-Economic Group	All Households		Owner Occupiers		Local Authority Rented		Privately Rented	
	1966	1971	1966	1971	1966	1971	1966	1971
I	15	19	23	29	4	5	8	11
II	18	20	22	24	12	13	18	22
III	33	33	30	30	40	40	30	28
IV	34	28	25	17	44	42	44	39

Source (91)

The greatest distinction is between the Social Class of households in the owner occupied sector compared with households in the rented sectors. Although both tenure types include the whole range of classes the rented sector has comparatively few households classified in the professional and non-manual groups. Despite the growth of the owner occupied sector the number of owner occupiers from Social Class 4 and 5 has not increased dramatically.

It appears that the privately rented sector has become more Class Specific, that social groups have graduated to owner occupation to different extents and that manual groups have not shared in the expansion of owner occupation to the same extent as other groups. The degree of exclusiveness or minority use of this tenure has been altered by this expansion and may have reduced the diversity of the population in the other sectors.

Some explanation of this may be attributed to the eligibility rules laid down by the various agencies responsible for access to the different tenures, although this applies to all household characteristics and will be discussed in a later Section.

Problems arise when a gap exists between housing need and the availability of dwellings. This gap may be one of a physical shortage - not enough dwellings of a specified standard to accommodate all the households who 'need' them; or it can be due to a shortfall between need and demand - the dwellings physically exist, but are not available to households in need because they cannot make their demand effective. In particular areas one or other factors may be more important. The provision of dwellings is not sufficient to ensure all needs are met; allocation is as important as building. It is the aim of housing policy to ensure that 'needs' are met regardless of the level of effective demand.

Four 'problems' can be identified:

(1) Unnecessarily Vacant Dwellings.
(2) Overcrowding.
(3) Sharing
(4) Homelessness

which will now be discussed separately.

5.1.2. Unnecessarily Vacant Dwellings

Dwellings become vacant for a number of reasons, examples of which are:

(i) The Household voluntarily moves to alternative accommodation.

(ii) The household is evicted.

(iii) The dwelling is compulsorily purchased and the household rehoused.

(iv) The household is dissolved by death.

(v) A dwelling is newly created - by new building or conversion.

The reasons why dwellings remain vacant for extended periods are far less clear. The Government announced their intention to embark upon a sample survey of vacant houses in the Autumn of 1977 to get an up-to-date picture of the situation. The survey will involve a much needed examination of the causes of vacancy and the length of time dwellings remain empty as well as the type and former tenure of the dwellings and their condition.

Until the results of this survey become available the reason for dwellings remaining vacant for long periods is the subject of conjecture.

Three possible reasons for needlessly empty council houses are:

- Short life dwellings acquired for slum clearances or roadworks are often left empty for long periods. Ron Bailey in his book 'The Homeless and the Empty Houses' (11) shows that large numbers of houses get 'lost' or disappear from the statistics for no apparent reason thus leading to gross underestimates of the number involved. He also provides evidence that large numbers of houses are lost or destroyed years in advance of redevelopment plans. The amount of official information available on this subject is extremely limited.
- Dwellings awaiting improvement are often left empty for shorter periods particularly since improvement funds were cut under the Housing Act 1974.
- Delays in purchasing houses, and in letting houses, particularly because of the strict eligibility requirement for houses in new and expanded towns.

In the private sector vacancies may persist as a result of:

- <u>Planning delays.</u>

  Nearly half of all planning applications are taking over the two month statutory period to determine despite the fact that the Department of Environment Circular 9 of 1976 stated that 'almost all' applications should be dealt with within the two-month period.(41)

- Improvement grant delays

  A strong correlation has been found between the number of improvement grants and the number of empty houses and this may partly be explained by the delays of up to a year in obtaining improvement grants. (119)

- Security of Tenure

  It has been argued that landlords leave houses empty because of fear that they will never be able to get rid of the tenants. However, what little evidence there is suggests that it is rent control and increasing wealth that is causing the death of the private rented sector.

- Speculation

  When house prices are rising, speculators buy houses and then sell them a year or two later at the peak of the price boom. Speculators will not let the houses in the meantime partly because any rent is far less important to them than the capital gain to be realised, and partly because the house will sell for less with a sitting tenant.

- Mortgage Restrictions

  Dwellings in inner city areas many of which are old and in need of modernisation are often empty because building societies are unwilling to grant mortgages on such dwellings.

- Tied Accommodation

  Tied accommodation is often left empty awaiting the recruitment of an employee. This is particularly true of police houses.

- Availability of Credit

  During the mortgage famine of 1973 and 1974, for example, the number of vacant dwellings in good condition increased as dwellings built for sale could not be sold. Houses, put up for sale by executors of owner occupiers who had died, or by landlords trying to sell when the tenants had gone could have stayed on the market for extended periods.

To assume that vacancies persist for want of would-be occupiers is an erroneous oversimplification. In some geographical locations this must be the case, but, in general, the problem is much more complex. In London for example, the inner boroughs generally thought of as areas of heavy housing pressures, namely Camden, Islington, Kensington and Chelsea, and Westminster had the highest vacancy rates in Inner London, which had an average of 5.6 per cent of all dwellings vacant in 1971 compared with the national average of 3.2 per cent.

Even the numbers of vacant dwellings is not straightforward to ascertain, because of doubts in some instances about whether a house is truly vacant as distinct from occupied with no-one at home; and ambiguities about where to draw the line between empty houses in poor repair and derelict structures no longer habitable, and between houses that are uninhabitable because they are incomplete and newly built houses that no one has yet moved into.

According to the 1971 Census there were 676,000 dwellings vacant of which 100,000 had not previously been occupied. Applying the findings of the Scottish post-enumeration survey to England and Wales, about 35,000 enumerated vacant dwellings were in reality second homes. (67)

The 1971 House Condition Survey suggests that about one half of the vacant dwellings were either unfit but lacking one or more of the basic amenities, and that the number of fit dwellings with all amenities that were vacant lay in the range 250-300,000, that is about 1.8 per cent of the stock. The total vacancy rate, including new dwellings and second homes, was 4.0 per cent (3.2 per cent excluding).

Since 1971 the number of vacant dwellings and the vacancy rate have risen. A half per cent survey of addresses undertaken in 1975 as a study of the labour force indicated that just over 3.6 per cent of dwellings were vacant (excluding new buildings and second homes).

The first results of the 1976 House Condition Survey do not suggest any major change in the number of vacant dwellings unfit, or fit but lacking one or more of the basic amenities since 1971 thus this increase appears to be of dwellings in good condition. See Table 5.5 below.

TABLE 5.5. Vacant Dwellings in England and Wales.

Thousands.

	1971 Condition			1975 Condition		
	Total	Good	Bad	Total	Good	Bad
Unoccupied Dwellings.	540	265	275	650	375	275
Second Homes.	35	35	-	50*	50	-
Previously Occupied Dwellings.	100	100	-	100	100	-
Total Vacancies.	675	390	275	800	525	275

* Estimated.

Evidence on the former tenure of vacant dwellings is limited to a number of small local surveys mostly carried out by interested pressure groups - tenants associations, community action groups etc.

The Government estimates that there were only 58,000 empty local authority dwellings in England and Wales at the end of 1974 and that there were proportionally four times as many empty private dwellings as empty council dwellings. (58)

Shelter however, (113) consider this a serious underestimate of the number of empty council dwellings and that proportionally the number of vancancies in the local authority sector may be as high as in theprivate sector. This opinion being based on evidence from empty house surveys in Paddington, Wandsworth, Southwark, Southampton, Sheffield. Another critism of these particular Government figures is that they omit dwellings awaiting demolition.

There is no positive evidence to suggest that condition of vacancies in the two sectors differs in any way or that dwellings are distributed by size in any particular manner. On several occasions however local authorities have been known to officially damage dwellings in order to prevent squatters moving in. As well as this official vandalism, empty houses are easy targets for lead thieves, strippers and other vandals.

5.1.3. Households unable to Separately Occupy Dwellings

The progress made in providing sufficient housing space is indicated by changes in overcrowding and sharing.

5.1.3.1. Overcrowding

'In 1935 the Housing Act laid down a definition as a basis for making overcrowding an offence, punishable by a fine and placing a statutory duty on local authorities to take steps to end it. The definition (which still applies) relates to permitted numbers of persons per number of rooms:

One rooms	-	two persons
Two rooms	-	three persons
Three rooms	-	five persons
Four rooms	-	seven and one half persons.
Five rooms or more	-	ten persons plus two for each room in excess of five.

Children aged one to nine count as one half, and babies under one year do not count at all. Rooms under 50 square feet do not count; rooms between 50 and 110 square feet are counted according to a special formula. The standard is a minimum for the protection of health and morals, not of convenience or comfort'. (69)

According to this statutory standard, some 350,000 dwellings were overcrowded in 1936 but this had dropped to 81,000 by 1960. (53)

The number of households living at densities above one and a half persons per room is taken as an indication of the incidence of severe overcrowding. Table 5.6 shows the changes between 1931 and 1971.

TABLE 5.6 Households living at densities above $1\frac{1}{2}$ persons per room, England and Wales; 1931-1971

	Households		Persons	
	Numbers (000)	Proportion of all census enumerated households %	Numbers (000)	Proportion of all persons in Census enumerated private households. %
1931	1174	11.5	7087	18.6
1951	664	5.1	3672	8.8
1961	415	2.8	2367	5.3
1971	226	1.4	1354	2.9

(Source 69)

Crowding has been greatly reduced over the period although the 1971 figure is low in comparison with 1961 andearlier due to the changed criteria for counting kitchens as rooms (See Section 4.2.3). In the same period the proportion of households living at a density of less than 0.5 persons per room rose considerably. All sized household groups have experienced a reduction in average density of occupation though larger households are still the most likely to be overcrowded. (48)

Measures of overcrowding show important variations between tenures. In the privately rented sector furnished accommodation is proportionately more overcrowded than unfurnished; and there is more overcrowding in the privately rented sector than in the public sector; the owner occupied sector is the least overcrowded.

5.1.3.2. <u>Sharing</u>

Difficulties with gaining a true assessment of the sharing situation arise from problems with the definition of a separate household and a separate dwelling as discussed in Sections 3.1. and 4.1 For example, many potential one person households at present live involuntarily with their parents(many more of course are quite happy to do so). As these young single households have been unable to express their demand for housing the demand is assumed not to exist and they are included as part of the family household. Other examples of 'concealed' demand for housing are newly married couples living with in-laws and loneparents living with parents. As with young single housholds not all multi-person households that share do so voluntarily. Some are households who let part of their house to someone else - the two units of accommodation may not be self-contained (each contained behind its own front door) and so the two households will be classed as one. Census estimates of the number of sharing and concealed households is shown below:

TABLE 5.7. Sharing Households by Type: England and Wales 1931-1971.

Thousands.

	Households				
	One Person	Multi-Person	Married Couple Concealed	Lone Parent Concealed	All Sharing
1931	349	1599	(430)	(Not Known)	2400 (Approx)
1951	430	1422	750	185	2787
1961 (1)	303	582	438	164	1487
1971 (2)	270	367	268	158	1063

Source (68)

(1) The number of sharing households in 1961 may have been reduced by some accommodation being incorrectly counted as separate, and there appears to have been some undercounting of oneperson households.

(2) Some 130,000 bedsitting rooms were counted as separate dwellings in 1971, but would have been classified as parts of dwellings in earlier censuses. This definition change affects primarily the oneperson households sharing.

For the reasons outlined above the exact extent of the reduction in the number of households sharing is in doubt. Also it must be remembered that the definition of a household varies slightly from that used in the modelling procedure, hence comparisons with the number of households given in Section 3.4.2.1. will be of limited value only.

Evidence on the distribution of sharing households by type is limited to data involving classifications in the form given in Table 5.7. Some limited distinctions can be made between sharing in different tenures.

Owner occupiers living in shared dwellings are most likely to be householders who have let off parts of their houses. Many tenants renting privately are likely to be renting parts of other people's houses.

Amongst young single households, especially in the large conurbations there has been a growing tendency to combine resources and to rent accommodation as a group - in a certain sense to live communally. In many instances the major incentive for a group to live together under one roof is economic. Restrictions imposed by many building societies on sub-letting mortgaged property means that the phenomena is limited in the owner occupied sector. The majority of local authorities are unwilling to house any young single persons although recently one or two authorities in London have offered flats to small groups of young single households in an attempt to make use of properties which have consistently been refused by other household types. The extent to which this phenomenon is voluntary and increasing is open to conjecture as further information is not at present available.

5.1.3.3. Homelessness

According to the Greve Report 'Homelessness in London' 1971 - (54)

'Nobody knows or has ever known, how many homeless people there are, and there is no agreement about what in fact homelessness is'.

Since 1969 Shelter, the homelessness charity, has argued that any person/household who lives in intolerable conditions is homeless. But only a minority of these are actually houseless. It is the latter group which are generally considered to be statutorily homeless. The houseless fall into a number of categories;

1. people who reside in hostels, 'night shelters', common lodging houses and other such institutions;
2. those who are placed in bed and breakfast establishments by local authorities because there is no alternative available at the time;
3. those who reside in hospitals not because they need to or ought to, but because there is no suitable accommodation available for them in the community;
4. those families that are split up by 'official' action, such as the reception into care (Part III accommodation) of their children, because they are homeless;
5. those who wander from place to place, often sleeping rough, and are totally without shelter;
6. those whose shelter is an unlawful one- i.e. the increasing number of people who 'squat'.

Trying to gauge the extent of homelessness is an almost impossible task. The number of officially defined homeless households is obtained from statistics published annually by the Department of Health and Social Security of those applying for and being admitted to temporary accommodation. Under Part III of the 1948 National Assistance Act local authorities have a legal obligation to provide for the homeless, aged and the sick:

> 'It shall be the duty of every local authority to provide temporary accommodation for persons in urgent need thereof, being need arising in circumstances which could not reasonably have been forseen, or in any other circumstances as the authority may in any particular case determine. ' (95)

Table 5.8 below gives the number of homeless in temporary accommodation from 1966 to 1971.

TABLE 5.8 Homeless families and persons in temporary accommodation - England and Wales, December 31st

	Number of families	Number of persons
1966	2558	13031
1968	3624	18849
1970	4926	24283
1971	5630	26879

These figures only account for those accepted by a local authority. Glastonbury (49) estimates that for every household being accepted at least six are turned away. The number who make no attempt to apply is immeasurable. By either not applying or by being refused help the household will inevitably cease to be homeless - some alternative will be found. It will rarely be a solution, merely an alternative such as sharing with friends or relatives - often creating problems of overcrowding. Other solutions attempted may be living in the back of a car, in a tent, in a caravan, in bed and breakfast accommodation, or in an hotel.

Little information exists on the characteristics of households who become homeless or for what reasons.

Local authorities have strict rules about the type of household they are willing to accommodate. In general they will only provide shelter for families with children, or lone parents, old single persons and occasionally older couples without children. Young single households or young couples without children (even if the wife is pregnant) are most likely to be refused help. Similarly former owner occupiers, irrespective of the reason for becoming homeless will have difficulties in obtaining local authority temporary accommodation.

5.2. HOUSEHOLDS MOVEMENT BEHAVIOUR

It has been estimated that, on average, between seven and twelve per cent of households move each year.(91) It seemslikely that since 1958 this annual rate has increased slightly. Several questions present themselves:

(a) What type of household is most likely to move?

(b) Why do these households wish to leave their homes?

(c) What determines the type of dwelling they are likely to move to?

5.2.1. The Characteristics of Households Most Likely to move.

Some understanding can be gained of the difference between households who move and households who do not move from Table 5.10. This presents data from the West Yorkshire Movers Survey 1969 compared with survey evidence from the West Yorkshire Conurbation Housing Survey carried out at the same time. The West Yorkshire Conurbation Housing Survey was a General household survey in which a sample of 2724 was drawn from local valuation lists.

Although it includes some recent movers (households having moved more than two years before the survey) it is useful in identifying the contrast with moving households in the West Yorkshire Movers Survey.

As the table indicates, non-moving households tend to be small and less likely to have young heads of household.

TABLE 5.10 Characteristics of Movers and Non-Movers

	Movers Sample	General Sample Non-Movers
Household characteristics		
Sample No.	3296	2074
	%	%
Age of head of household:		
<45	63	29
45 and over	37	71
Household Type:		
Married Couple.	76	67
Lone Parent.	5	6
Family.	4	5
One Person.	12	20
Others.	3	3
Socio-Economic Group of Head of Household:		
I	11	13
II	16	14
III	41	38
IV	32	35
Accommodation Characteristics		
Previous Tenure:		
Owner occupied.	37	53
Local Authority Tenant.	23	30
Privately rented and others.	40	17
No. of Bedrooms:		
1	14	10
2	35	41
3	44	43
4 or more	7	6

Source: (93)

Only 29 per cent of heads of household were aged under 45 compared with 63 per cent among mover households. Non-mover households are more likely to consist of one person and include a larger proportion of aged and retired persons. Non-mover households are less likely to be in privately rented accommodation and more likely to be in owner occupied tenures. Households in the privately rented sector are proportionally more likely to move. Their accommodation does not differ markedly in size.

5.2.2. <u>The Reasons for Household Movement</u>.

Murie (93) in his study of Household Movement and Housing Choice draws a distinction between households which are new to the system and continuing households as there is a clear difference both in mover characteristics and in the destination of the two groups. Broadly, a new household is defined as one whose housewife had split off from an established household in which he/she had not been a housewife, had previously lived in non-private housing, or he/she is no longer living with the person who was head of household. The housewife is the person (male or female) who is responsible for most of the domestic arrangements and duties. In a continuing household the nucleus is likely to be the same, although household composition may have changed. New households tend to be younger and to include a higher proportion of small adult households than continuing households. (See Table 5.11. below). New households will also contain a small proportion of older heads of household who are most likely to be single persons or married couples without children.

These older households are more likely to be of lower socio-economic group. As the employers, managers and professional workers and intermediate and junior manual worker groups (SEG I) are more likely to be small adult households with the head of household at work, their incomes will tend to be higher. Although many differences exist between new and continuing households it seems probable that housing behaviour will be similar for groups with the same age, household structure, income or socio-economic characteristics.

Murie hypothesizes that the major reason for movement in new households is directly associated with the formation of thehousehold rather than with changes in employment, housing aspirarions or other factors. (See Table 5.12 and 5.13 below.)

For those households who cited the change of people within the household as the reason for movement, the nature of the change varied according to age. For heads of household under forty-five marriage was the predominant reason for deciding to move. Where the head of household was over 45 death of or separation from a member of the household became a more important reason for causing a move.

Change of employment of a member of the household was given as the reason for moving by under 8 per cent of all respondents.

Behaviour of continuing households is however of greater interest as movement by these households releases accommodation for use by other households. In the West Yorkshire Movers Survey the majority of continuing households were small families where both head of household and wife were under age forty-five. Unlike new households there was a considerable proportion of older smaller households among movers. (See Table 5.11). These older households were more likely to have come from a lower socio-economic group and to have low incomes. Evidence suggests that the movement of continuing households is caused by quite different factors to those causing new households to move. Changes in household composition is stated as the reason for movement in only six per cent of moves with variations in age groups being insignificant (See Table 5.12). Where this reason was important it took a variety of forms. More important is the pattern indicated under which marriage, family growth, household fission and bereavement succeed each other as causes of movement in progressively older households(See Table 5.13). Such a pattern conforms to the theories of the influence of family life cycle on movement and dwelling use. (See Section 3.2.1. for discussion on the importance of family life cycle).

Of seemingly greater importance than household change, but not accounting for the bulk of movement, is movement explained by change of employment. Employment change as a reason for movement decreases with age and increases with sicio-economic group andincome. From this survey it would appear that the majority of movement among continuing households arises for reasons other than family or employment changes. Other reasons cited as important were dwelling condemned or demolished (16 per cent of all households), too large (11 per cent), too small (37 per cent),

TABLE 5.11. Household Characteristics of New and Continuing Household Movers

Age of head of household	Under 45 New	Under 45 Continuing	45 and over New	45 and over Continuing
Sample No.	592	1473	46	1176
	%	%	%	%
Household Type:				
Married Couple	87	87	24	60
Lone Parent	2	6	5	6
Family	2	4	-	5
Single Person	6	2	69	27
Others	3	1	2	2
Socio-Economic Group of Head of Household				
I	10	14	4	8
II	20	16	9	14
III	48	45	39	34
IV	22	35	48	44

TABLE 5.12 Reason for Movement: New and Continuing

Age of Head of Household	Under 45 New	Under 45 Continuing	45 and over New	45 and over Continuing
Sample No.	592	1473	46	1176
	%	%	%	%
Reason for move:				
Change of people in household.	75	6	26	7
Change of Employment.	5	19	9	9
Other	20	75	65	84

TABLE 5.13 Nature of Change of People in Household: New and Continuing Household Moves.

Age of Head of Household	Under 45 New	Under 45 Continuing	45 and over New	45 and over Continuing
Saple No.	448	84	12	74
	%	%	%	%
Nature of Household Change:				
Marriage	93	4	25	11
Birth/Family Growth.	4	51	8	4
Relative added	3	12	17	44
Bereavement/ Separation.	-	33	50	40

Source (93)

dwelling in poor repair (17 per cent), wanted change of tenure (49 per cent), neighbourhood (31 per cent), health of personal reasons (34 per cent).

Many of these 'other' reasons may be explainable in terms of changes in family life cycle or changes in job circumstances not regarded as change in employment. Changing circumstances of these types may increase the opportunity to move even though they may not be perceived by the mover as being the determining factor in the decision to move. For example, a household may give the reason for movement as 'dwelling too small' when in actual fact this situation has arisen due to the children growing up and requiring more living space. Similarly an increase in income due to job promotion may improve the households ability to compete for alternative accommodation in the private sector and hence precipitate a move. Moves may enable adjustments of dwelling characteristics to suit household requirements but they may also anticipate family changes, coincide with them or lag behind. The nature of the coincidence will depend upon the ability to compete in the housing system.

The major function of mobility therefore is to be the process by which households adjust their housing to the housing needs that are generated by the shifts in family composition that accompany life cycle changes. Mobility is greatest when households are experiencing greatest growth. Young families, especially those who have just added to their members are most likely to move. When such families find their housing inadequate for the demands generated by these shifts in composition, they are especially likely to move.

Housing varies to the extent to which it is adjustable to such changing needs. Large units are more flexible than small units. Home owners have more control over their residence than renters and so an owned home can more easily be modified to meet family changes - particularly those which impinge on the dwellings interior characteristics. For these reasons renters living in small dwelling units are particularly inclined towards mobility.

The previous discussion has shown that the household characteristics of movers and non-movers may differ considerably. Also the movement behaviour of movers themselves will depend upon whether the household is newly formed or was established before the desire to move arose.

The chart below indicates in a very broad sense, (as this is all that the surveys allow), the general conclusions concerning the variations in movement behaviour in terms of the household characteristics previously referred to in this study.

TABLE 5.14. General Household Characteristics of Non-movers and Movers (including both new and continuing households).

Household Characteristics	MOVERS New Households	MOVERS Continuing Households	Non-Movers
Age of Head of Household	Young (mainly <45)	Slightly Older (mainly <60)	More evenly Spread (25 - 60)
Household Type	Couples	Small Families	Larger Families Older Couples
Socio-Economic Group	Higher SEG (Especially with higher incomes)	Higher SEG	Lower SEG's Lower Incomes

It will be noted that the previous discussions has drawn on evidence from studies of the characteristics of households who have actually moved. Very few surveys attempt to ascertain a households' intended plans for moving i.e. its potential mobility.

The understanding of the housing system emerging from a consideration of successful movers only may be considerably distorted by the neglect of non-mover groups. At the extremes, immobility may indicate that current housing situations enable satisfaction to be maximised or that current housing situations represent a 'trapped' position which the household is unable to change. Rossi (111) attempted to measure how close a household's potential mobility was related to its actual mobility behaviour. Eight months after an initial interview the interviewers returned to determine whether or not the household had moved. Of those planning to stay where they were 96 per cent had done so but of those planning to move only 80 per cent had been able to do so.

Evidence from surveys on actual mobility may go a long way in attempting to define characteristics of mobile as opposed to stable households but it must be remembered that actual mobility may underestimate the number of households desiring to move.

5.2.3. <u>Factors Affecting the Destination of Movers.</u>

Murie (93) has shown that the highest proportion of moves involve movement within the owner-occupied sector. Twenty-eight per cent of all moves were within this sector and fourteen per cent within the local authority sectors. See Table 5.15 below. Evidence from this survey suggests that the current housing situation i.e. current tenure has a considerable effect on movement behaviour and that households are most likely to move within the same sector.

Movement out of the tenure is likely to follow certain distinct patterns i.e. movement from private rented accommodation to local authority and owner occupied housing (involving 28.7 per cent of all moves). Movement from the local authority to the owner occupied sector appears to have been countered to a certain extent by similar flows in the opposite direction, both flows having increased in importance over time.

TABLE 5.15. Continuing Households: Present and previous Tenure.

Previous Accommodation	Present Accommodation: Owner Occupied	% of all moves	Local Authority Rented	% of all moves	Privately Rented	% of all moves	Total
Owner Occupied	747	28.1	158	6.0	83	3.1	988
Local Authority Rented	171	6.4	359	13.5	88	3.3	618
Privately Rented.	307	11.6	453	17.1	289	10.9	1049
Total.	1225		970		460		2655

From Murie(93)

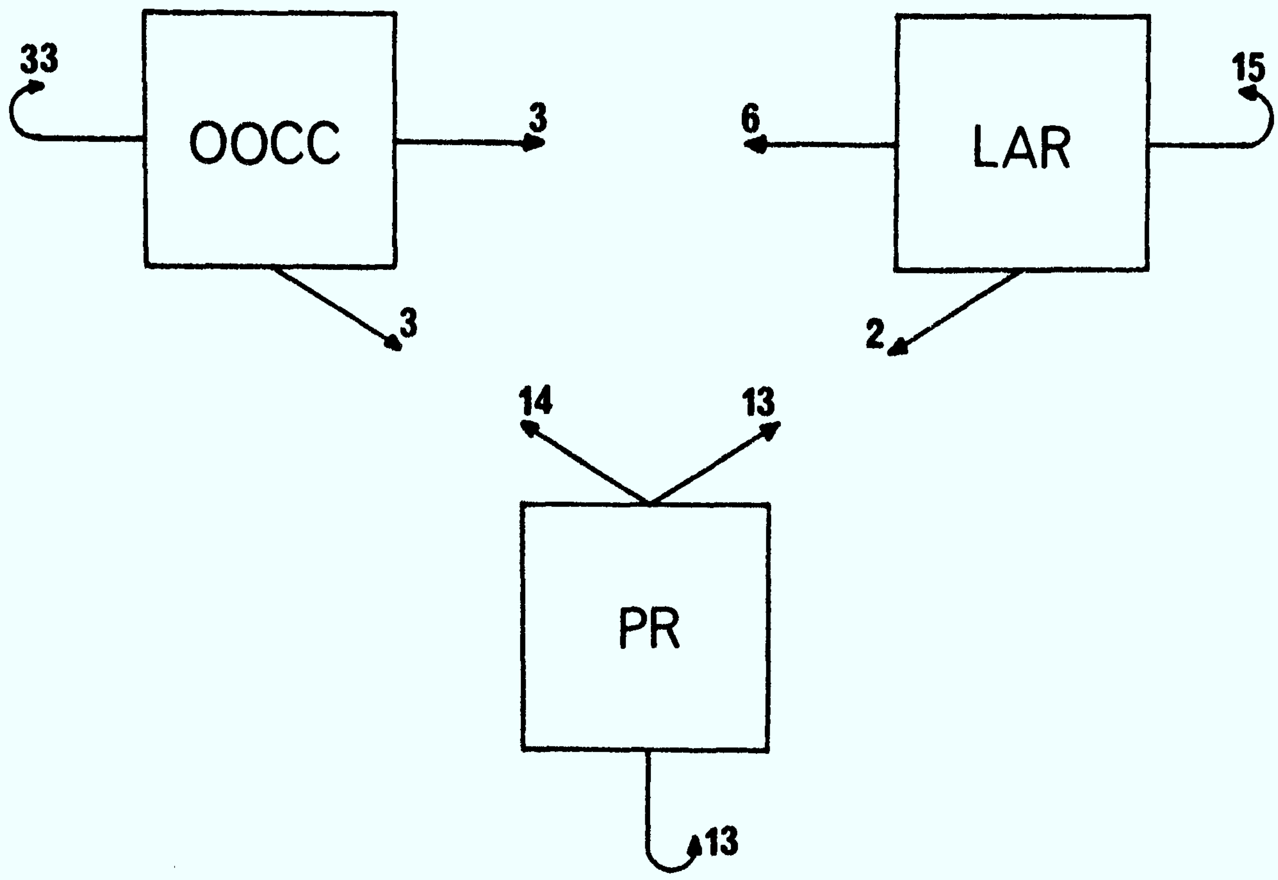
boxes - figures refer to moves within tenures.

Fig. 5.1. presents evidence from the 1972 National Movers Survey (Unpublished) in England and Wales of the pattern of movement between tenures.

This is consistent with previous evidence and also shows the importance of movements which might not have been expected i.e. moves away from owner occupation involve six per cent of all continuing households and moves to the privately rented sector 5 per cent.

Fig. 5.1. Continuing Household Movers: Proportion of all Moves by Tenure Origin and Destination: England and Wales (excluding Greater London) 1970-1-71.

Percentages.



Source: (85)

Table 5.16. indicates the relationship between tenure destination and household characteristics using evidence from the West Yorkshire Movers Survey 1969.

Certain distinctions emerge between the destinations of new and continuing households. New young householders are more likely to become owner occupiers and less likely to become local authority tenants, than continuing households in the same age group. New larger households are more likely to become tenants in the private sector than entering owner occupation. The privately rented sector is used proportionately more by new households than other sectors. Although the privately rented sector appears to cater forthe majority of SEG IV new households, continuing households in this group are much more likely to qualify for a council dwelling. A higher proportion of owner occupiers including both new and continuing households are from higher socio-economic groups. Markedly fewer households, new and continuing, in Socio-Economic Group I enter the local authority sector.

TABLE 5.16. Tenure Destination by Household Characteristics; New and Continuing Households.

Household Characteristic		Owner Occupied	Rented from Local Authority.	Rented Privately
N = New				
C = Continuing.				
Age of Head				
<45	N %	60	15	25
	C %	53	31	16
>44	N %	21	41	28
	C %	37	44	19
Household Type				
Individual <60	N %	11	28	61
	C %	31	33	36
Small Adult Household	N %	74	7	19
	C %	55	24	21
Small Family	N %	48	25	27
	C %	56	29	15
Large Family	N %	20	60	20
	C %	44	32	14
Large Adult Household	N %	23	8	69
	C %	47	36	17
Small Older Household.	N %	30	35	35
	C %	27	55	18
Socio-Economic Group				
I	N %	77	8	15
	C %	81	6	13
II	N %	62	11	27
	C %	61	24	14
III	N %	62	17	21
	C %	46	39	15
IV	N %	33	25	42
	C %	28	50	22

Source: (93)

Some of the differences in movement behaviour can be accounted for by the relative sizes of the tenures. In terms of numbers alone it would appear that access to owner-occupation should be easier to achieve than to the public sector, which in turn should be easier than access to private renting. To a limited extent this is true. But access depends on vacancies arising rather than size of the stock. The National Movers Survey 1972 showed that 38 per cent of continuing households who moved in 1971 (to an address in England and Wales outside Greater London) left an owner occupied house, 23 per cent a public sector dwelling and the remainder left privately rented and other tenure groups. On this measure ease of access to private and other tenancies is much higher than their proportion in the total stock would suggest.

By far the greatest influence on movement behaviour are the eligibility rules operated by the various agencies responsible for access to the different tenures.

In each tenure it is possible to isolate those bodies which regulate supply and demand each having its own terms of reference and its own objectives and interests. In Britain there are over 400 local housing authorities, 24 New Town Development Corporations, The New Town Development Commission, over 2000 housing associations and various government departments all concerned with the provision and management of public sector housing. There are nearly 500 building societies as well as the local authorities, insurance companies, banks and private finance houses providing mortgages; over 70,000 firms in the construction industry, over 25,000 estate agents, valuers and solicitors involved with the building or effecting the sale of a house in owner occupation. The number of individuals or companies who own and let housing is impossible to ascertain. In the owner-occupied sector especially the agents involved with provision and allocation may be quite different thus leading to greater complexity.

The distinction between housing 'need' and housing 'demand' (See Section 3.2.1.) is particularly pertinent when discussing the different criteria operated by agencies in different tenures. In theprivate sector the prime motivation is one of profit hence a household will only be allowed to enter the sector if it has proven ability to pay.

Building Societies (in the UK in 1972 eighty four per cent of all home loans were from a building society) try to minimise their financial risks; hence they are interested in the career prospects of potential borrowers, the stability as well as the level of their earnings, their age, the condition, expected future life of the property being purchased. Private landlords may expect, for example, their tenants not to have children as this may reduce the chance of damage to the property.

The local authority sector, developed in response to the demand for working class housing which could not be provided by theprivate sector at rents households could afford. Current local authority policies show that 'need' is still the main criterion which determines the allocation of council housing. 'Need' is usually defined in terms of housing conditions, overcrowding, underoccupation, lack of self-contained accommodation and ill-health i.e. measurable physical factors, not social aspects. Within limits, local authorities are free to determine their own allocation policies but all authorities must rehouse, or make alternative arrangement, for households made homeless by slum clearance or redevelopment. Since the1977 Housing (Homeless Persons Act) they also have a statutory obligation to provide housing for any homeless person/household providing that need has arisen for 'unforeseen'reasons (Although 'unforeseen'is not clearly defined).

In nearly all local authorities council housing is a scarce resource. The demand for tenancies exceeds the supply of vacancies, authorities therefore impose 'rationing' rules: first limiting those eligible for consideration of a tenancy and then deciding the priority of competing claims among those eligible. A household may not be allowed to register an application unless it has satisfied certain residential qualifications, i.e. lived on the area for a minimum of one year, or may be debarred by age or marital status - very few young single households find it possible to apply for council housing. For households on the waiting list most local authorities operate a 'points' system to define the households actual need. Different authorities will have different systems of priority. For most authorities transfer claims (existing tenants requiring alternative type of dwelling) are given greatest priority in the allocation of houses and bungalows leaving flats and maisonettes (inherently less attractive dwellings) for waiting list applicants. Despite the apparent differences between different local authorities broadly similar categories of households can be identified as being housed by local authorities.

Because of the 'differences' between eligibility rules for the different tenures it is not easy to draw up an accurate hierarchy of ease of access to different tenures. But it is possible to give examples of the characteristics of households that would be likely to enter different tenures. The National Movers Survey of 1972 provides such evidence of continuing household movers whose destination was the tenure in question, but whose origin was some other tenure. Hence internal movers (owner occupied to owner occupied for example) are not considered as tenure entrants. The following three tables deal with the local authority sector, owner occupied sector and privately rented sector separately.

Table 5.17. shows those household types most likely to enter the local authority sector. The relatively large number of young small family entrants arise as applicants can rarely apply for a local authority dwelling until they are married and then they may have to wait a few years to gain 'points' against them - by which time one or more children may have been born. Old age pensioners are eligible to apply for a council tenancy often for reasons of ill-health and poor housing conditions. As mentioned previously councils have a statutory obligation to ensure that accommodation exists for those displaced by clearance or other demolition. Overcrowding and sharing attract the greatest number of points and thus the highest priority in many allocation policies. Applicants lacking any accommodation of their own receive priority (e.g. a married couple living with in-laws would

not be defined as a separate household for survey purposes if housekeeping were communal hence on applying for separate accommodation they would be regarded as a 'new' household.

TABLE 5.17. Entrants to the local authority sector: England and Wales (excluding Greater London) 1970-1971 Comparison with all households: Great Britain 1971

Household Characteristic.	England and Wales excluding Greater London		Great Britain
	Entrants to Local Authority Sector	All Movers	All Households
	1970-71 %	1970-71 %	1971 %
Small Families.	38	34	22
Household head aged 25-29	20	20	7
Small elderly households.	22	15	29
Demolition as reason for move.	26	7	(Not applicable)
Previous density of occupation $1\frac{1}{2}$ or more persons per room.	14	6	1
New households.	28	22	(Not applicable)
Former owner occupiers.	16	37	49
Individuals aged 16-59.	4	5	5
Moved distance over half hour journey from previous address.	32	32	(Not applicable)

Source (87)

Former owner occupiers are often deemed ineligible for a council tenancy. Clearance areas tend to involve rented rather than owner occupied property. Entrants to the public sector are apparently less geographically mobile than all movers.

Table 5.18 shows those household types most likely to enter the owner occupied sector.

TABLE 5.18. Entrants to Owner Occupation: England and Wales 1970-71 (Excluding Greater London) Comparison with All Households: Great Britain 1971.

	England and Wales (excluding Greater London)		Great Britain
	Entrants to owner occupation 1970-1971	All Movers 1970-71	All Households 1971
	%	%	%
Head of Household:			
Annual Income £1560 or more.	51	43	29
Non-Manual Worker.	46	39	39
Unskilled or Semi-skilled Manual Worker.	12	18	26
Aged 45 and over	17	33	62

Source: (88)

The Survey evidence is in line with what would be expected from the policies and rules followed by building societies in allocating mortgage funds to new owner occupiers. House price levels and repayment requirements suggest that those with higher incomes will find it easier to obtain mortgage finance. Non-manual workers will be favoured due to security of earnings and incremental salary scales. Although unskilled workers may command higher wage levels the insecurity of such occupations makes it unlikely that a building society will favour an application from such a worker. Since building societies usually require that a loan be repaid before retirement age and the maximum repayment period is often 25 years a new borrower over aged 45 would be at a disadvantage.

Table 5.19. shows those household types likely to enter the privately rented sector.

TABLE 5.19. Entrants to the Privately Rented Sector: England and Wales (excluding Greater London) 1970-71 Comparison with All Households: Great Britain 1971.

	England and Wales excluding Greater London.		Great Britain
	Entrants to Private Renting 1970-71	All Movers 1970-71	All Households 1971
	%	%	%
Head of Household Annual Income £1560 or more.	27	43	29
Small Families.	26	34	22
Individuals 16-59.	14	5	5
Moved distance over ½ hour journey from previous address.	34	32	(Not applicable)

Source: (89)

Households most likely to become private rented tenants are those who cannot satisfy the eligibility criteria for other tenures, rather than choosing private tenancies in preference. Although, there is a high incidence of single person households under retirement age - out of proportion to all households - who possibly do choose private renting for preference. These households are highly mobile and the relative ease of movement within the sector - or to other sectors - means that the sector is very popular. The implications for this group of a continued decline in the privately rented sector seems particularly serious.

Relatively few households will have average or above average incomes since they would most likely be eligible for a mortgage for entry to owner occupation. Small families, especially those living in poor conditions - will most likely be accepted for a local authority dwelling.

The apparent lack of common eligibility requirements for entry to the privately rented sector make it difficult to predict thetype of household most likely to be found entering this sector.

Another factor influencing a households destination is the extent of knowledge and information. The range of information possessed by, or available to, households and the time available for search are both important. They may depend upon the characteristics of the searcher but they are also linked with the objectives, attitudes and actions of the individuals and agencies which influence or control the flow of information. Variations in the destination of objectively similar households may not be explained by different preferences or the operation of constraints, but by knowledge and attitudes connected with both dwelling and location. Vacant dwellings arise throughout England and Wales; more in certain areas than others. A household's choice of dwelling may be severely restricted by lack of knowledge of what is actually available. Similarly, a household's attitudes to factors such as nearness to place of employment, schools, shops, open spaces etc., will affect the range of choices available.

In conclusion, those factors affecting the destination of household moves are:

(a) Present tenure;

(b) Eligibility criteria;

(c) Search, information and nearness to employment behaviour.

5.3. MODELLING THE RELATIONSHIP BETWEEN DWELLINGS AND HOUSEHOLDS. (THE ALLOCATION SUB-MODEL)

The phenomena described in the first part of this chapter relate to how and why the dwelling stock is occupied by households in the manner observed in England and Wales. The aim of this section of the chapter is to describe how and to what extent these phenomena were incorporated into the model.

As described in Chapter Two this third stage of modelling involved bringing together the households and dwellings sub-models in order to:

(a) reproduce the housing situation i.e., who lives where; and

(b) reproduce the processes involved in the allocation of households to dwellings.

5.3.1. Modelling who lives where

It appears from the literature review, Section 5.1., that, at any point in time, there are several 'locations' in the housing system where households will be found.

There it was shown that there are three major options open to households choosing a place to live:

(i) Occupy a permanent dwelling (as defined in the Census), separately; or,

(ii) Stay in temporary accommodation such as a hostel, hotel, bed and breakfast, hospital etc; or,

(iii) Share a permanent dwelling with one or more other households.

The discussion on homelessness in Section 5.1.3.3. showed that only a very small minority of households officially defined as homeless are in fact houseless. Even the houseless are found or find some temporary solution to their problem.

Section 5.1.3.2. discusses the growing tendency among young single households to combine resources to occupy accommodation as a group - in a sense to live communally. This form of sharing differs substantially from (iii) above in that voluntary sharing amongst YSH is considered to be acceptable whereas sharing of for example, family households is deemed not to be desirable.

Thus, in the model four locations are defined to which households are assigned:

(1) THE OCCUPANCY MATRIX.

This is a matrix of 768 cells (24 x 32) containing the number of households of each type (of which there are 32 i.e., 4 family types, 2 ages, 4 SEG's) who are living separately in dwellings of each type (of which there are 24 i.e., 3 tenures, 2 conditions, 4 sizes) e.g., the number of young family households of SEG I living in good condition, medium sized, owner occupied dwellings.

(2) TEMP

This is a vector (32 x 1) containing the number of households of each type who, having no dwelling of their own nor sharing accommodation, are temporarily staying in either an hotel, hostel, bed and breakfast, hospital, institution or Council Part III accommodation.

(3) SHARING

This is a vector (32 x 1) containing the number of households of each type who have no dwelling of their own and are sharing with friends or relatives. The vector does not include the households with whom they share who will be found in the OCCUPANCY MATRIX. No distinction has been made between households who share voluntarily - for example many 18 year olds still living with parents, or old persons living with their children - and those who share involuntarily. Neither is the dwelling type detailed. Groups such as gypsies, caravan dwellers, permanent inmates of hospitals or institutions, heads of households with residential jobs have not been dealt with explicitly in this model since the accommodation they occupy has not been included in the model classification of dwellings. A caravan, for example, is classified in the Census as a non-permanent dwelling and mental institutions and hospitals as non-residential accommodation. Only permanent, residential dwellings were included in the House Condition Surveys from which the majority of the model input data was obtained. It was decided that the magnitude of the groups involved did not warrant increasing the complexity of the model. In 1971 for example, there were 1.4 million persons living in non-permanent accommodation, representing just under three per cent of the total population.

(4) COMMAC

This is the number of Young Single Households in addition to the head of households who communally share accommodation. The head of the household will be in the OCCUPANCY MATRIX.

In addition, the number of dwellings of each type which remain unoccupied are held in the vector (24 x 1) VACANT. At the end of each iteration the model output will describe:

1. The total number of households of each type (HOUSEHOLDS).
2. The total number of dwellings of each type (DWELLINGS).

3. The number of households of each type living in dwellings of each type (OCCUPANCY MATRIX).

4. The number of households of each type living in temporary accommodation (TEMP).

5. The number of households of each type sharing accommodation (SHARING).

6. The number of extra young single households sharing dwellings communally (COMMAC).

7. The number of dwellings of each type remaining vacant (VACANT).

Information in brackets refers to the matrix/vector in the computer programme, in which the output is held.

The nature of the dwelling stock and the distribution of household types is in a constant state of flux: dwellings age, are modernised, change tenure, are built, are demolished, converted, households age, children are born, children leave home, people die, households migrate, marry, divorce. Even without actual household movement the use of the dwelling stock is continually changing.

Certainly with some moves the need for alternative accommodation will be manifest before the actual movement is carried out. For this reason, in the model, the household and dwelling phenomena above are dealt with before any household movement takes place.

For the purposes of the computer programme the households and dwellings phenomena were further classified in terms of the effect of the phenomenon on the housing system:

(A) Households Change (HHCHANGE)

Some households will change their status

i.e.,	YSTYSPF	OFTOSPF
	YSTYC	OFTOC
	YCTYF	OSPFTOS
	YFTOF	OCTOS
	YSPFTOSPF	
	YCTOC	

(B) New Household (NEWHH)

where NEW means new to the system; not to be confused with the distinction made earlier between new and continuing households.

i.e., CLFH

(C) Household Dissolves (HHDISSOLVE)

Some households will cease to exist rather than change their status.

i.e., YSTYC EYF DOS

(D) Dwellings Change (DWCHANGE)

Some dwellings will change their state i.e., condition or tenure

i.e.,	PRAR	PBBO
	PRMR	OBBP
	OAR	PGBL
	OMR	PBBL
	LAAR	OGBL
	LMR	LGBO
	PGBO	LBBO
	OGBP	OBBL

(E) New Dwelling (NEWDW)

Some dwellings will be entirely new to the system.

i.e.,	NPR	PGFC
	NOOCC	OGFC
	NLAR	LGFC

(F) Demolish Dwellings (DEMDW)

Some dwellings will cease to exist

i.e.,	DPR	OBLC
	DOOCC	OGLC
	DLAR	LBLC
	PBLC	LGLC

HHCHANGE, NEWHH, HHDISSOLVE, DWCHANGE, NEWDW, DEMDW are the names given to the procedures within the computer programme which simulate the effect of these phenomona.

These procedures, which contain several crucial model assumptions, will now be discussed in turn although their full implications for household movement will be dealt with in more depth in Section 5.4.

(A) HHCHANGE.

(i) Data from the Households Submodel used to determine the proportion of each household type changing to all other household types.

(ii) Totals for each household type adjusted by the number changing their state.

(iii) In the OCCUPANCY MATRIX the same proportion of each household type in each dwelling type is transferred to the new household type i.e., it is assumed that households change their state before deciding to move and that they will not move in anticipation of a change.

(iv) The same proportion of each household type is moved within TEMP and SHARING wherever the type of change applies.

(B) NEWHH.

(i) Data from the Households Submodel used to determine the total number of <u>NEW</u> households of each type.

(ii) These numbers added to the totals of existing households of each type.

(iii) The same number added to the SHARING category for each household type i.e., all <u>NEW</u> households share with friends or relatives before looking for their own accommodation.

(C) HHDISSOLVE

(i) Data from the Households Sub-Model is used to determine the proportion of each household type that has dissolved.

(ii) The total number of households of each type is reduced by this proportion.

(iii) Households in each dwelling type (i.e. cells in the OCCUPANCY MATRIX) are reduced by the same proportion for each household type affected.

(iv) The corresponding number is added to VACANT dwellings of each type.

(v) The number of households of each type in TEMP and SHARING is reduced by the same proportion.

N.B. By taking the same proportion it is assumed that the type of dwelling does not affect the rate at which households dissolve.

(D) DWCHANGE

(i) Data from the Dwellings Model is used to determine the proportion of dwellings of each type changing to all other dwelling types.

(ii) The totals for each dwelling type is altered by the number changing their condition or tenure.

(iii) In the OCCUPANCY MATRIX the same proportion of each household type in each dwelling type is transferred to the new dwelling type. i.e. it is assumed that when a dwelling changes type the household remains in situ.

(iv) The same proportion of each VACANT dwelling type is transferred to the new type.

(E) NEWDW

(i) Data from the Dwellings Sub-Model is used to determine the total number of new and converted dwellings.

(ii) These numbers are added to the totals of existing dwellings of each type.

(iii) The same numbers are added to VACANT of each type.

(F) DWDEM

(i) Data from the Dwellings Sub-Model are used to determine the proportion of each dwelling type which are demolished or 'lost' to conversion.

(ii) The total number of dwellings of each type is reduced by this proportion.

(iii) A proportion of each household type in the OCCUPANCY MATRIX (occupying dwellings of the type to be demolished) is moved into TEMP, corresponding to the proportion of each dwelling type demolished.

(iv) The number of VACANT of each type which are to be demolished is reduced by the same proportion.

See Appendix D for a listing of the computer programme including the above procedures.

5.3.2. <u>Modelling Households Movement Behaviour</u>

A households movement behaviour is viewed in two stages:

(1) Movement OUT of dwellings; and
(2) Movement INTO dwellings.

(1) <u>Movement OUT of dwellings</u>

Evidence presented in Section 5.2. indicates that households of different types move OUT of dwellings at different rates. Thus, in the model, each household type occupying each dwelling type is assigned a value corresponding to the average time spent by households of that type living in dwellings of that type before deciding to look for alternative accommodation.

This matrix of values is of the same dimensions as the OCCUPANCY MATRIX, i.e., 768 cells and is called AVSTAY. Similarly, the average length of time spent by households of different types in temporary accommodation before looking for a permanent dwelling is contained in AVSTAYTEMP. The average length of time spent by households of different types sharing dwellings before looking for alternative accommodation is known as AVSTAYSHARE. As a consequence of the problems involved in calibration the concept of Average Stay was later reviewed - See Chapter 6.

The parameters AVSTAY, AVSTAYSHARE, AVSTAYTEMP appear in the programme procedure SHAKEOUT which determines the total number of households looking for alternative accommodation between each iteration.

Thus, $$H_O = \frac{\mathrm{DT} \times \mathrm{OCCUPANCY}\ [\mathrm{SEG,TYPE,AGE,SIZE,TENURE,COND}]}{\mathrm{AVSTAY}\ [\mathrm{SEG,TYPE,AGE,SIZE,TENURE,COND}]}$$

$$H_T = \frac{\mathrm{DT} \times \mathrm{HOMELESS}\ [\mathrm{SEG,TYPE,AGE,TEMP}]}{\mathrm{AVSTAYTEMP}\ [\mathrm{SEG,TYPE,AGE}]}$$

$$H_S = \frac{\mathrm{DT} \times \mathrm{HOMELESS}\ [\mathrm{SEG,TYPE,AGE,SHARING}]}{\mathrm{AVSTAYSHARE}\ [\mathrm{SEG,TYPE,AGE}]}$$

$$H_C = \frac{\mathrm{DT} \times \mathrm{COMACC}\ [\mathrm{SEG}] \times \mathrm{YSROOM}}{\mathrm{AVSTAY}\ [\mathrm{SEG,TYPE,AGE,SIZE,TENURE,COND}]}$$

Where, $H_O + H_T + H_S + H_C = H_M = \mathrm{HOMELESS}\ [\mathrm{SEG,TYPE,AGE,MOVING}]$

H_M represents the total number of households of a particular SEG,TYPE and AGE who decide to look for alternative accommodation.

H_O represents the number of households of a particular SEG, TYPE and AGE who move out of separately occupied dwellings.

H_T represents the number of households of a particular SEG, TYPE and AGE who attempt to move from temporary accommodation.

H_S represents the number of households of a particular SEG, TYPE and AGE who attempt to move from shared accommodation.

H_C represents the number of young single households, apart from the head of household (who is included in H_b), who live communally but wish to move.

OCCUPANCY [SEG, TYPE, AGE, SIZE, TENURE, COND] represents households in each SEG, TYPE and AGE, separately occupying dwellings of each SIZE, TENURE and CONDITION.

HOMELESS [SEG, TYPE, AGE, TEMP] represents households in each SEG, TYPE and AGE living in temporary accommodation.

HOMELESS [SEG, TYPE, AGE, SHARING] represents households in each SEG, TYPE and AGE living in shared accommodation.

COMACC [SEG] represents the 'extra' young single households living communally.

YSROOM represents the average extra number of young single households per dwelling likely to be found living communally with the head of household.

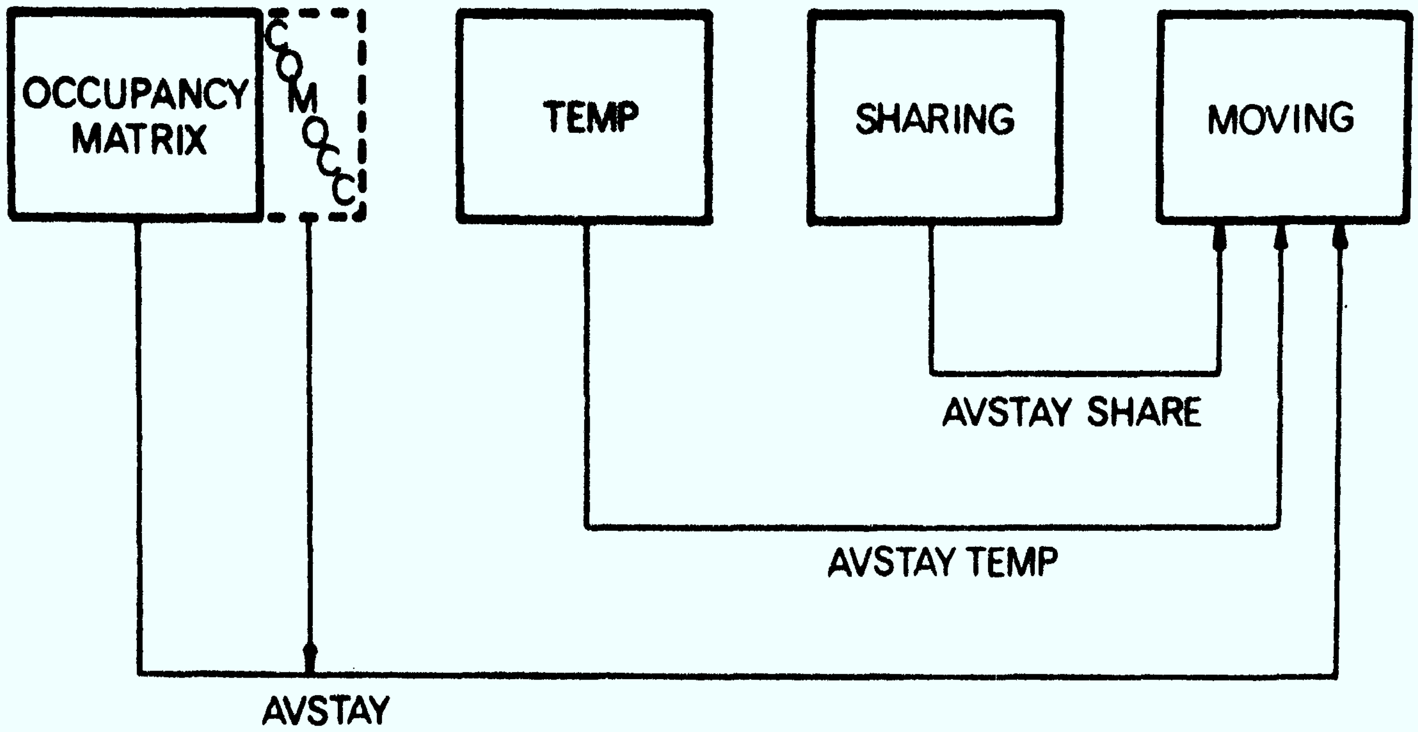
HOMELESS [SEG, TYPE, AGE, MOVING] represents the total number of households in each SEG, TYPE, AGE who wish to move.

DT represents the time step taken.

SEG	= SEG I, SEG II, SEG III, SEG IV.
TYPE	= Single, Couple, Family, Single Parent.
AGE	= Young, Old.
SIZE	= Very Small, Small, Medium, Large.
TENURE	= Owner Occupied, Local Authority Rented, Privately Rented.
COND	= Good Condition, Bad Condition.

For this formula to hold it is assumed that the propensity to move is independent of the length of stay. This appears to be borne out in the Owner Occupied Sector by the data in Table 5.20. However, less confidence can be placed in this assumption in the privately rented and local authority rented sectors.

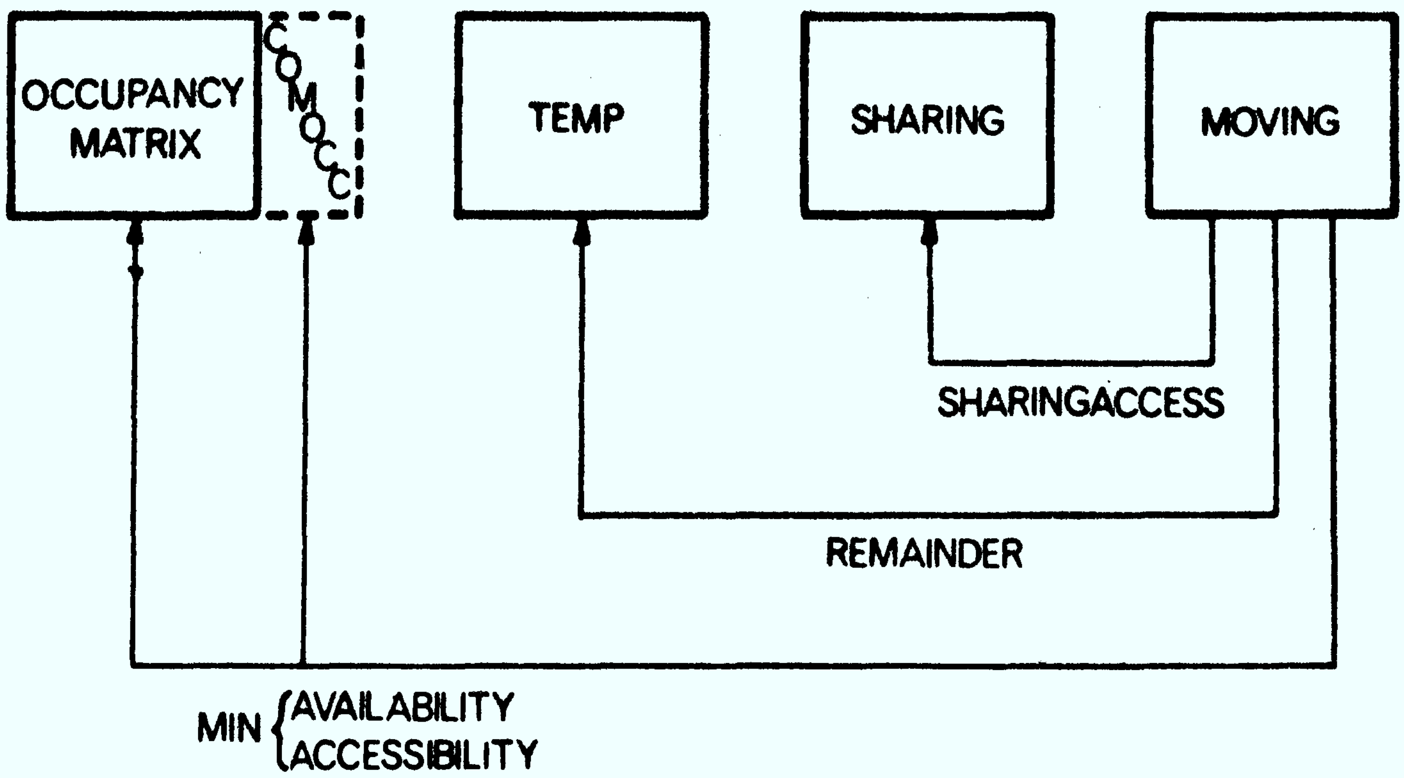
MOVEMENT OUT OF DWELLINGS



Where;
AVSTAY indicates parameter affecting number wishing to move

Fig.5.2

MOVEMENT INTO DWELLINGS



Where;
ACCESSIBILITY indicates parameter affecting number who actually move and their final destination

Fig.5.3

It will be noted that in the model, average stay relates to the concept of potential movers as discussed in Section 5.2.1. Whereas in reality if a potential voluntary mover is unable to find suitable alternative accommodation it will remain in the present dwelling, in the model actual movement out occurs although this may be followed by movement back into exactly the same dwelling. In this sense, the model exaggerates the number of actual movers.

Having determined the total number of households of each type wishing to move, this number is held in a vector/matrix called MOVING - See Figure 5.2. The OCCUPANCY MATRIX,COMACC,TEMP and SHARING being adjusted accordingly.

Having made the decision to look for alternative accommodation, presently occupied dwellings are potentially available for another tenant/occupier. The dwelling of the potential mover is transferred to the vector VACANT thus increasing the supply of dwellings available for occupation.

At this stage a large number of households are looking for alternative accommodation and a similarly large number of dwellings are available for occupation. The modelling of the subsequent.allocation will now be described.

(2) <u>Movement INTO Dwellings</u>

The factors determining movement INTO dwellings have been discussed in Section 5.2.3.

In the model, movement INTO dwellings depends upon the availability of suitable dwellings and the desires, needs and ability to pay of each household type.

Every household type is assigned 24 values representing:

> The proportion of households of that type who wish to move (i.e., held in MOVING) that would move into each dwelling type given an infinite supply of such dwellings.

This parameter, called ACCESSIBILITY acts as a proxy for:

> the ability of the household to gain access to different tenures;
> size of the dwelling in relation to size of the household, i.e., 'needs' of the household;
> condition of the dwelling;
> cost of the dwelling;
> income of the household;
> aspirations of the household.

Thus, for example, proportionately more young family households of SEG I will move to owner occupied, medium sized, good condition dwellings than local authority, good condition, medium sized dwellings i.e., the accessibility of a YFH in SEG I will be higher for the owner occupied sector than the local authority sector.

The 32 sets of accessibility figures - one set for each household type - are entirely independent; no comparisons can be made between the figures for different household types.

In the model, the number of households who would like to move to a particular dwelling type is determined by

$$DT \times ACCESSIBILITY \times H_M$$

The accessibility figures for any particular household type add up to 100 per cent as they are intended to represent a households housing objectives in a situation of plentiful supply. But, household choice is constrained by the availability of vacant dwellings of suitable type, price and location. Thus another concept was introduced into the model. AVAILABILITY is a matrix of numbers representing the proportion of vacant dwellings of each type that can be taken up by households of each type.

In the model, the number of vacant dwellings effectively available for occupation is determined by:

DT x AVAILABILITY x VACANT

ACCESSIBILITY and AVAILABILITY appear in the programme procedure ALLOCATE which assigns households who wish to move to dwellings of each type, to TEMP and to SHARING. The actual number of households of each type who are able to move to dwellings of each type, in order to separately occupy them, is taken as the minimum of either the number of vacant dwellings of each type effectively available to those households or the number of households of each type desiring to move to dwellings of that type.

Thus, H_O = Minimum (AVAILABILITY x VACANT) and ACCESSIBILITY x H_M)

where, H_O represents the number of households of a particular type who move and separately occupy a dwelling of a particular type.

AVAILABILITY represents the availability of that dwelling type to that household type.

VACANT represents the total number of vacant dwellings of that type.

ACCESSIBILITY represents the accessibility of that dwelling type to that household type.

H_M represents the total number of that household type who wish to move.

In its present form the model does not allow households a second choice if their first choice is restricted by availability. Of those households unable to acquire a dwelling of their own a certain proportion will share with friends or relatives; the remainder find temporary accommodation. Households unable to satisfy their objectives are assigned to either SHARING or TEMP.

The number of households of a particular type entering SHARING (M_S) is determined by

$$M_S = (H_M - M_A) \times \text{SHARING ACCESS}$$

where, H_M is defined as previously

M_A represents all households of that type who actually move.

SHARING ACCESS represents the proportion of those households of each type who at the end of each time period have not acquired a dwelling of their own and share with friends or relatives.

The remainder (M_T) are assigned to TEMP

Thus, $M_T = (H_M - M_A - M_S)$

At the end of each time period MOVING is empty. All households are located in some part of the system. One iteration of the dynamic process is completed. See Figure 5.3.

A limitation of the model structure in its present form which is important to note is its ability to cater only for net flows of households. It is not possible to trace the path of individual households. This represents a limitation since, as was discussed in Section 5.2., one of the factors affecting the destination of moves is their original situation.

5.3.2.1. The Pecking Order

Each iteration of the dynamic process is carried out in two stages:

Stage I : Changes to households, dwellings and households occupation of dwellings caused by demographic (births and deaths etc.,) or housing phenomena (new building, modernisation etc., are made effective through procedures NEWHH, HHCHANGE, HHDISSOLVE, NEWDW, DWCHANGE, DEMDW, as discussed in Section 5.3.1.

Stage II : Potential movers are moved OUT of dwellings. They move back INTO dwellings subject to the availability of dwellings. This stage is carried out separately for each household type i.e., the process of movement OUT followed by movement INTO dwellings is carried out thirty two times in each iteration. As discussed in Section 5.2. different households have differing abilities to command housing of their choice. At times of housing shortage it can be said that a 'pecking order' exists for housing facilities which tends to reinforce the eligibility criteria of the various organisations controlling entry to the tenures.

Drawing on evidence presented in Section 5.2., in the model households are ranked in the following order:

Rank.	Household Type	Socio-Economic Group.	Model Symbol
1.	Young Couple	I	YCH(SEG I)
2.	Young Family	I	YFH(SEG I)
3.	Young Couple	II	YCH(SEG II)
4.	Young Family	II	YFH(SEG II)
5.	Old Family	I	OFH(SEG I)
6.	Old Family	II	OFH(SEG II)
7.	Old Couple	I	OCH(SEG I)
8.	Old Single	I	OSH(SEG I)

Rank	Household Type.	Socio-Economic Group.	Model Symbol
9.	Old Couple	II	OCH(SEG II)
10.	Old Single Parent Family	I	OSPFH(SEG I)
11.	Old Single Parent Family	II	OSPFH(SEG II)
12.	Young Family	IV	YFH(SEG IV)
13.	Young Family	III	YFH(SEG III)
14.	Old Family	IV	OFH(SEG IV)
15.	Old Single Parent Family	IV	OSPFH(SEG IV)
16.	Old Family	III	OFH(SEG III)
17.	Old Single Parent Family	III	OSPFH(SEG III)
18.	Old Single	IV	OSH(SEG IV)
19.	Old Single	III	OSH(SEG III)
20.	Old Single	II	OSH(SEG II)
21.	Old Couple	III	OCH(SEG III)
22.	Old Couple	IV	OCH(SEG IV)
23.	Young Single Parent Family	I	YSPFH(SEG I)
24.	Young Single Parent Family	II	YSPFH(SEG II)
25.	Young Single Parent Family	III	YSPFH(SEG III)
26.	Young Single Parent Family	IV	YSPFH(SEG IV)
27.	Young Single	I	YSH(SEG I)
28.	Young Single	II	YSH(SEH II)
29.	Young Couple	III	YCH(SEG III)
30.	Young Couple	IV	YCH(SEG IV)
31.	Young Single	III	YSH(SEG III)
32.	Young Single	IV	YSH(SEG IV)

The first eleven groups represent those household types most eligible for entry to the owner occupied sector. The following eleven groups are household types most likely to enter the local authority rented sector - The final ten groups are most likely to be found in the privately rented sector.

Thus in the second stage of each iteration Young Couple Households in Socio-Economic Group I are moved OUT of dwellings first then moved INTO dwellings of their choice subject to availability. Young Single Households in Socio-Economic Group IV are deemed to be least able to enter the housing system in a location of their choice and are given the final 'peck' at vacant dwellings at each iteration.

A young couple in SEG I where both partners are most likely working and having few other financial commitments would be viewed by Building Societies as favourable candidates for a mortgage. As households age or have children or if their income falls (e.g. at retirement) they will be considered more of a risk and hence are placed lower down the pecking order.

Young family households in SEG IV would most likely satisfy the criterion of need as required for entry to the local authorities sector as would old families and single parent families. Old single households are increasingly being catered for by the local authority.

Each 'peck' will have available to them those dwellings left vacant at the end of the previous 'peck' plus those dwellings vacated by the potential movers of the present 'peck'. The impact of the pecking order can be strengthened or weakened by adjustments to AVAILABILITY since AVAILABILITY affects the number of dwellings which can be taken up at each iteration.

5.3.3. The Use of Data.

In order to render operational the modelling of households movement behaviour certain data are required; the concepts defining those data needs have already been discussed i.e:

1. AVSTAY
2. AVSTAYSHARE
3. AVSTAYTEMP
4. ACCESSIBILITY
5. AVAILABILITY
6. SHARINGACCESS
7. YSROOM

None of these data requirements could directly be satisfied from existing sources of statistics. In all cases 'guesstimates' have been made based on a combination of available related statistics and qualitative evidence drawn from social surveys. The final choice of parameter values being determined via the calibration process. Each data need will be discussed separately:

(1) AVSTAY

In the model, AVSTAY is defined as the average length of time, in years, that a household of a particular type remains in a dwelling of a particular type before deciding to look for alternative accommodation i.e. AVSTAY determines the numbers of potential movers.

768 pieces of data are required for each household type living in different dwelling types to be assigned a unique value.

The General Household Survey provides information on the length of residence of households in the three tenures owner occupied, privately rented and local authority rented. See Table 5.20 below.

TABLE 5.20. Length of Residence by Tenure

	TENURE		
Length of residence in years	Owner Occupied (OOCC)	Privately Rented (PR)	Local Authority Rented (LAR)
< 1	6	15	6
1 -2	6	9	6
2- 3	8	6	8
3- 4	6	5	6
4- 5	6	5	6
5- 6	6	3	6
6-10	20	7	19
11-20	22	14	25
21-30	7	9	10
31-40	8	13	6
41 and over	5	7	3
Median	8	10	8

Source: (47)

As the data was in the form of length of stay rather than time before moving, for the purposes of determining values for AVSTAY, these stay times were extended to allow for those households who would continue to stay in the same dwelling. A simple method was adopted which, for the lack of any better information, was to double the median length of residence.

Hence, in the owner occupied sector, AVSTAY = 16 years
in the privately rented sector, AVSTAY = 20 years
in the local authority sector, AVSTAY = 16 years

Evidence presented in Section 5.2.1. broadly suggests that:

(a) young households move more often than older households.

(b) couple and family households move more often than other household types.

(c) higher SEG's move more often than lower SEG's.

(d) households in privately rented accommodation move more frequently than households in owner occupation who move more often than local authority tenants.

The survey material does not allow more precise conclusions to be drawn.

For model purposes households were assigned values to broadly satisfy the above criteria. For households in SEG I AVSTAY figures ranged from 3 to 12 years; for households in SEG II AVSTAY figures ranged from 4 to 18 years; for households in SEG III AVSTAY figures ranged from 4 to 25 years; and for households in SEG IV AVSTAY figures ranged from 9 to 40 years. The final choice being determined via the 'calibration' process of matching model output to known data. See Appendix B for a sample listing of the final AVSTAY values.

(2) AVSTAYSHARE

In the model, AVSTAYSHARE is defined as the average length of time in years that a household of a particular type remains in shared accommodation before looking for an alternative. As no account is taken of the type of dwelling which is shared, AVSTAYSHARE is a matrix of 32 values - one corresponding to each household type.

At this point in time, March 1978, no statistical evidence has been found on which to base the choice of values entering this matrix. Instead, guesstimates were made of the initial values with the final choice being determined via the calibration process.

It was assumed that the less desirable it were for a particular household type to share the shorter the time the household will wish to spend in shared accommodation. It was further assumed that the household characteristics of movers presented on page 214 equally applies to movers from shared accommodation i.e. :

(a) young households move more often than older households.

(b) couple and family households move more often than other household types.

(c) higher SEG's move more frequently than lower SEG's.

The final choice of AVSTAYSHARE values ranged from 0.5 years to 6 years - see Table 5.21.

TABLE 5.21. AVSTAYSHARE VALUES USED IN THE MODEL

SEG	YSH	OSH	YCH	OCH	YFH	OFH	YSPF	OSPF
I	4.5	1.5	.6	.6	.5	.5	1.0	1.0
II	4.5	1.5	.6	.6	.5	.5	1.0	1.0
III	6.0	2.0	.6	.8	.7	.7	1.5	1.5
IV	6.0	2.0	.6	.8	.7	.7	1.5	1.5

(3) AVSTAYTEMP

In the model, AVSTAYTEMP is defined as the average length of time in years that a household of a particular type remains in temporary accommodation.

At present all household types are assigned the same value for AVSTAYTEMP. The figure is taken to be 0.25 years since this is the average maximum time that local authorities allow households to remain in Part III accommodation.

Facilities exist within the programme to allow each household type to be assigned a different value for AVSTAYTEMP.

(4) ACCESSIBILITY

In the model, ACCESSIBILITY is defined as the proportion of households of each type who wish to move (i.e. in MOVING) that wouldmove to dwellings of each type if an infinite supply of such dwellings existed.

ACCESSIBILITY figures are held in a matrix consisting of 768 cells - a unique value for each household type occupying each dwelling type.

ACCESSIBILITY acts as a proxy for several factors. These include, ability to pay and suitability of the dwelling for the households needs and desires. Since peoples housing expectations tend to vary both with time and also with the changing state of the housing situation, it is unrealistic to apply an array of constants for each households' appraisal of its housing options. A better model would need to take account of this fact. Here however, the limitation has been accepted and constant values of ACCESSIBILITY used.

Once again a combination of common sense and qualitative evidence was used to assign values to the ACCESSIBILITY matrix with the final choice being determined via the calibration process. The most useful source of evidence came from Murie (82) in his study of the eligibility criteria put forward by the various agencies responsiblo for allocating households to dwellings. The results are summarized in Tables 5.17, 5.18 and 5.19. To a certain extent also, the actual mix of households in different dwelling types, as indicated in Section 5.1.1., was taken into account in determining the values for the ACCESSIBILITY matrix even though the concepts of actual occupation and desired occupation do differ slightly.

To take an example, Young Family Households of Socio-Economic Group I were assigned the ACCESSIBILITY figures for each of the dwelling types shown in Table 5.22.

TABLE 5.22. ACCESSIBILITY figures for Young Family Households, SEG I for each dwelling type.

	TENURE AND CONDITION OF DWELLING					
	Owner Occupied.		Privately Rented.		Local Authority.	
Dwelling	Condition		Condition		Condition	
Size	Good	Bad	Good	Bad	Good	Bad
	%	%	%	%	%	%
Very Small.	.1	.1	.4	.1	1.0	.1
Small.	16.8	4.9	1.1	.5	1.8	.2
Medium.	45.8	5.7	1.1	.6	3.8	.2
Large	9.6	5.1	.1	.3	.3	.1

The choice of these figures were based on the following general assumption:

(a) Households in SEG I will most easily gain access to the owner occupied sector as opposed to the local authority sector and will not wish to enter the privately rented sector.

(b) Good condition properties are preferred to bad condition properies despite the extra cost implied.

(c) A young family household will prefer medium sized accommodation.

(d) Young families will choose small dwellings as second best although a large, bad condition, owner occupied dwelling might be preferred given the opportunity to make improvements.

(e) Very small dwellings are the least desired size since a size of dwelling more closely related to the size of household will be able to be afforded.

A sample listing of the matrix of ACCESSIBILITY figures can be found in Appendix B.

(5) AVAILABILITY

In themodel, AVAILABILITY is defined as the proportion of vacant dwellings of each type that can be taken up by households of each type.

Thus it is another matrix of 768 cells. However, at present all cells are assigned the same number. No information was available to aid even a 'guesstimate' of 'AVAILABILITY' to be made. Final choice of the magnitude of the parameter was determined via the calibration process. The range of possible values for AVAILABILITY is dependent upon the value given to DT. DT is the time step taken by each iteration and has been set to 0.25 years. Since in the model AVAILABILITY is multiplied by DT (See Page 238) and the number of dwellings available to households must be positive AVAILABILITY must lie in the range 0 to 4. A value greater than 4 will allow more dwellings to be taken up than are actually available.

The value chosen for AVAILABILITY was 0.5 Thus for each iteration a maximum of one eighth of vacant dwellings can be taken up by each household type. Exploration with different values of AVAILABILITY has shown that this parameter affects the impact of the pecking order. Low values of AVAILABILITY mean few dwellings can be taken up at each iteration and the impact of the pecking order is strengthened.

(6) SHARING ACCESS

In themodel SHARINGACCESS is defined as theproportion of households of each type who at the end of each iteration have not acquired a dwelling of their own and are likely to share with friends or relatives as opposed to entering temporary accommodation (TEMP). SHARINGACCESS is a matrix of 32 values - one corresponding to each household type.

Once again no suitable data exists in the required form. Common sense 'guestimates' were made. It was assumed that different household types have different attitudes to sharing. The vast majority of young single households would choose to share with their parents rather than live in a hostel or an hotel for example. Young families especially those in the lower SEG's who cannot find a suitable dwelling would be more likely to enter Council Part III temporary accommodation than a young couple household for example.

Table 5.23 shows the values for SHARINGACCESS used in the model.

TABLE 5.23 Model values for SHARINGACCESS.

SEG	YSH	OSH	YCH	OCH	YFH	OFH	YSPFH	OSPFH
I	.99	.80	.85	.83	.60	.75	.75	.65
II	.99	.79	.85	.85	.58	.70	.72	.60
III	.99	.78	.85	.87	.55	.65	.68	.58
IV	.99	.75	.85	.92	.5	.60	.62	.55

Thus taking young family households in SEG I for example of those potential movers unable to find suitable accommodation 60 per cent enter SHARING and 40 per cent enter TEMP. For the household type in SEG IV only 50 per cent enter SHARING and 50 per cent enter TEMP.

(7) YSROOM

In the model, YSROOM is defined as the average number of spare rooms available for each dwelling type to be occupied by a young single household where the head of household is also a young single household. YSROOM is a vector of 24 values one for each dwelling type.

Information on young single households living together communally is extremely scarce. Evidence on the space occupied is even more limited. The magnitude of values assigned to the matrix were based on the following assumptions:

(a) Not all single heads of household wish to have other young single households living with them.

(b) Not all dwelling types are suitable/available for communal occupancy e.g., very small dwellings or dwellings in the local authority sectors.

(c) The extra space available is related to the size of the dwelling but may vary according to tenure.

See Table 5.24 for the values chosen:

TABLE 5.24. Model Values for YSROOM

SIZE.	Owner Occupied. Condition Good %	Bad %	Privately Rented. Condition Good %	Bad %	Local Authority. Condition Good %	Bad %
Very Small.	0	0	0	0	0	0
Small.	0.25	0.25	0.25	0.25	0	0.25
Medium.	0.60	0.60	0.75	0.75	0	0.75
Large.	1.00	1.00	1.25	1.25	0	1.25

The model deals with net flows of households and dwellings when considering movement behaviour. YSROOM is applied to the total spare accommodation in dwellings of a particular type not to an individual dwelling. Hence a YSROOM value of 0.25 wouldmean that for every four dwellings where the head of household was young and single one room would be available for occupation by another young single household.

5.3.4. Model Results

At the end of each iteration the following information is output from the model:

(1) The total number of households of each type(HOUSEHOLDS).
(2) The total number of dwellings of each type (DWELLINGS).
(3) The number of households of each type living in dwellings of each type (OCCUPANCY MATRIX).
(4) The number of households of each type living in temporary accommodation (TEMP).
(5) The number of households of each type sharing accommodation (SHARING).
(6) The number of 'extra' young single households sharing dwellings communally (COMACC).
(7) The number of dwellings of each type remaining vacant (VACANT).

Information in brackets refers to the name of the matrix/vector in the computer programme in which the input/output is held.

In order to calibrate the model data is required in this form for at least two dates - preferably for 1967 and 1971 as in the households and dwellings sub-models.

But amongst the 916 output variables which were of interest only about 70 could be fixed from known data at one time. For the HOUSEHOLDS and DWELLING matrices, data availability was satisfactory and has been described in Section 3.4.5. and 4.4.7.

For the OCCUPANCY MATRIX, TEMP, SHARING, COMAAC and VACANT, data either does not exist in the required form or is extremely limited.

It was only possible to obtain twelve summary statistics for the 768 values required for the OCCUPANCY MATRIX for the two dates 1967 and 1971. These were in the form of the proportion of occupiers in each tenure from each socio-economic group and were obtained from the Sample Census 1971. The assumption was made that the situation did not change significantly from 1966 to 1967. The results are shown in Table 5.25. This table is of limited value in terms of its use for calibration, but it was the only information of this nature available and did provide a useful guide to the proportions of households to be expected in each tenure.

Information of the nature required by the model may be collected at the Census. At present it is not published in this form. Obtaining such unpublished data is lengthy and expensive and could not be undertaken during this research programme.

Very limited statistics are available on vacant dwellings as discussed in Section 5.1.2. For calibration purposes as only total numbers of vacant dwellings was known, only a common sense interpretaion of the model results was possible. The distribution of vacant dwellings by type produced by the model were considered acceptable if the proportion of each type of dwelling left vacant broadly agreed with the proportion of all dwellings left vacant.

TABLE 5.25. Tenure by Socio-Economic Group 1966 and 1971. England and Wales.

		Proportions
Socio-Economic Group (SEG)	1966	1971
Owner Occupied	%	%
SEG I	23	29
II	22	24
III	30	30
IV	25	17
Private Tenants		
SEG I	8	11
II	18	22
III	30	28
IV	44	39
Local Authority Tenants		
SEG I	4	5
II	12	13
III	40	40
IV	44	42

Source: (92)

Statistics on SHARING are also extremely limited. Census data on sharing households does not include all model defined household types as discussed in Section 5.1.3.2. The assumption was made that if the model could be calibrated on the OCCUPANCY MATRIX and the total number of vacant dwellings then the number of households found to be sharing must be correct as a logical consequence. The vast majority of model defined sharers will be young single households as a result of their definition.

For TEMP and COMACC no suitable data could be found to even guide guesstimates of their values. It was assumed that previous assumptions about the magnitude of values in SHARINGACCESS and YSROOM would result in acceptable values for TEMP and COMACC.

Ideally, each of the above matrices/vectors are required as input data to provide the initial conditions for the model. As this was not possible a process of initialisation was carried out with the aim of producing an acceptable starting position for 1967.

Initialisation is carried out in two stages:

Stage 1: All households are 'placed' in MOVING.
All dwellings are 'placed' in VACANT.
All other matrices/vectors are empty at the beginning of this stage.

The model was run for one iteration using procedure ALLOCATE only, which assigns households to dwellings. At the end of this iteration over 56 per cent of all households had been allocated to over 80 per cent of dwellings. No movement OUT of dwellings occurred i.e., SHAKEOUT was inoperative. Furthermore, no growth was allowed in either the Dwellings or Households sub-models i.e., the procedures NEWHH, HHCHANGE, HHDISSOLVE, NEWDW, DWCHANGE, DWDEM were not operative.

Stage 2: Further iterations were carried out until the total number of vacant dwellings remaining, reached the required target for 1967 i.e., 600,000. Eight iterations were required to reach this point. Still no growth was allowed but SHAKEOUT was fully operative so that movement

OUT of dwellings took place. Hence some households, once allocated to dwellings, do move out and join all other households in MOVING. However, it is not possible to identify whether households not allocated during the first iteration take second choice in the second iteration etc., as the model only deals with net flows of households.

Initialisation formed part of the calibration process in that model parameters were set to the same values for use before and after 1967. The running of the model for 1967 to 1976 was described in detail in Section 5.3.2. with each iteration corresponding to a three month period. The successes and failures of the calibration will now be discussed.

Fig.5.4. depicts the model output for 1967 to 1976 on a very broad basis. The total number of households has shown only a very minor increase from 23.47 million in 1967 to 23.72 million in 1976. Dwellings have increased at a greater rate from 15.59 million in 1967 to 18.2 million by 1976. In the model this has had the effect of significantly reducing the number of households sharing over this period. Evidence presented in Section 5.1.3.2. on the decline in sharing justifies these model results. Over the period the total number of vacant dwellings has remained fairly static although the rate of increase in the period 1974 to 1976 was slightly higher than in the period up to 1974 reflecting the evidence presented in Section 5.1.2.

In very broad terms, the model is well calibrated, 90 per cent of households (excluding single households) are occupying 98 per cent of the dwelling stock. However,

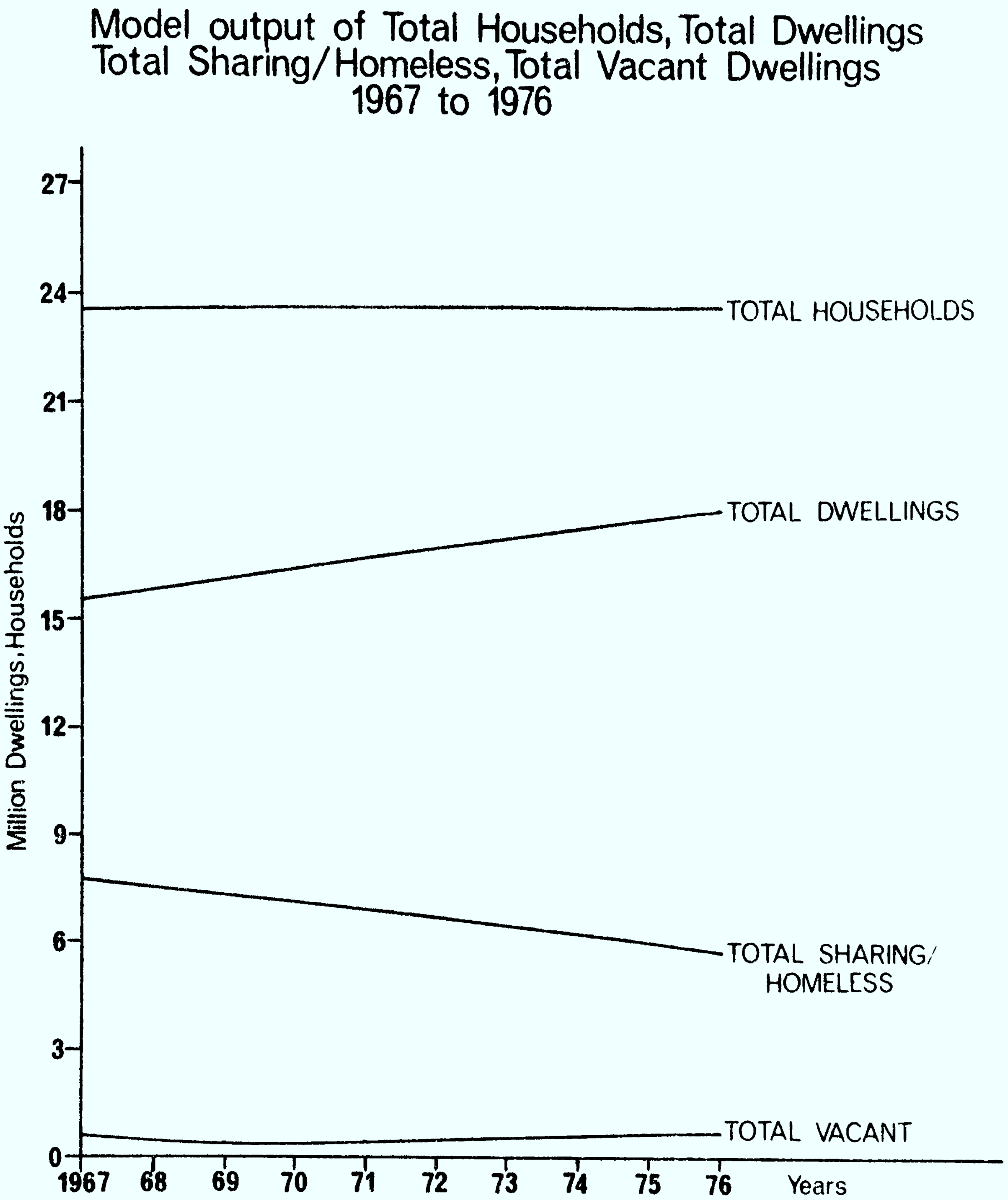

Model output of Total Households, Total Dwellings
Total Sharing/Homeless, Total Vacant Dwellings
1967 to 1976
Million Dwellings, Households
27
24
21
18
15
12
9
6
3
0
TOTAL HOUSEHOLDS
TOTAL DWELLINGS
TOTAL SHARING/
HOMELESS
TOTAL VACANT
1967
68
69
70
71
72
73
74
75
76
Years

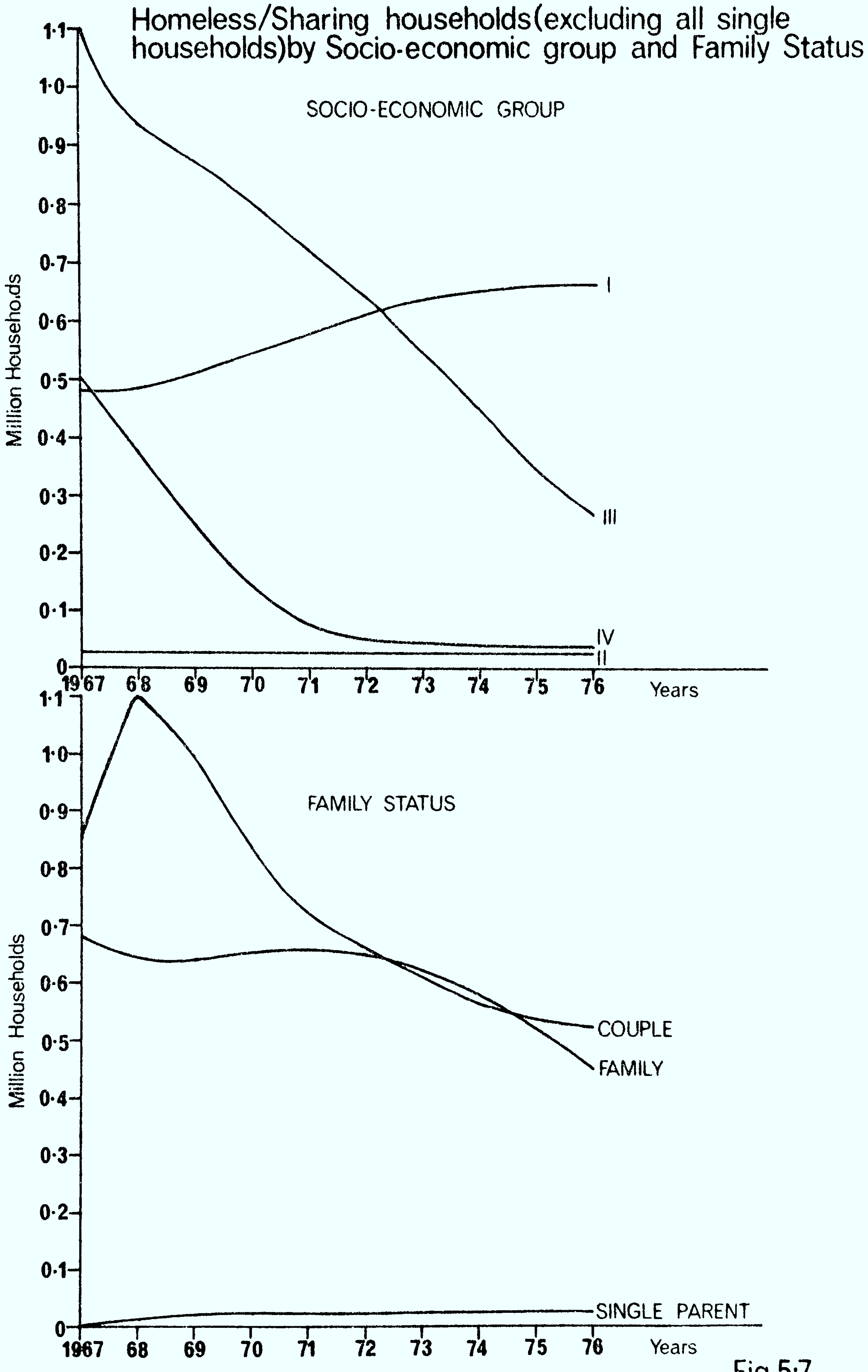
Fig.5·4

closer analysis of the model's output will demonstrate to what extent calibration has been unsuccessful.

Fig.5.5. shows vacant dwellings by tenure and condition. Although there is no evidence to justify these results it seems acceptable that given a known increase in the total number of vacant dwellings which occurred over the period that vacant owner occupied and local authority dwellings should have increased in the manner produced in the model. It is not surprising that the number of vacant privately rented dwellings has declined slightly over the period since the total number of privately rented dwellings has also declined. The reasons why the model causes the number of vacant dwellings in the owner occupied sector to decline for the first three years are not clear although there is no statistical evidence to suggest that this happened. During the second stage of initialisation the total number of vacant dwellings is falling rapidly from iteration to iteration and the model may still be under this influence in the early years.

According to the model's output an increasing proportion of vacant dwellings in all tenures were of good condition over the period 1967 to 1976. There is no evidence to suggest that these results are incorrect. The evidence presented in Section 5.1.2. especially Table 5.5. suggests that, in fact, the total number of good condition vacant dwellings is increasing.

Fig. 5.6. shows vacant good condition local authority and owner occupied dwellings by size. Very small and small



Homeless/Sharing households(excluding all single households)by Socio-economic group and Family Status
SOCIO-ECONOMIC GROUP
Million Households
I
III
IV
II
1967 68 69 70 71 72 73 74 75 76
Years
FAMILY STATUS
Million Households
COUPLE
FAMILY
SINGLE PARENT
1967 68 69 70 71 72 73 74 75 76
Years

Fig.5·7

local authority vacant dwellings and medium and small owner occupied vacant dwellings appear to have increased most dramatically, especially since 1973. These are the dwelling types of which most new building is consisted, and a query arises as to whether the recent building programme has overtaken demand for these particular dwelling types. Again there is no evidence to suggest that the model results are incorrect.

Fig.5.7. shows the number of homeless and sharing households, excluding single households, by SEG and family status. The results for households classified by SEG are dramatic and in conflict with common sense. Their only value being in questioning imperfect modelling. The very dramatic reduction in sharing of households in SEG III and SEG IV is difficult to justify when it appears to have occurred at the expense of households in SEG I where sharing increased over the period. It is feasible that total sharing should fall as the situation changes from one of housing shortage towards a situation of excess, but there is no common sense justification for households in Seg II to be satisfied first followed by SEG IV and SEG III.

In terms of family status the results cannot be clearly interpreted. The model has shown a general improvement for couple and family households after the first few years of the period.

Although not shown on the diagrams the number of sharing households is dominated by single person households. In 1967 for example there were, according to the

OCCUPIERS BY SOCIO-ECONOMIC GROUP

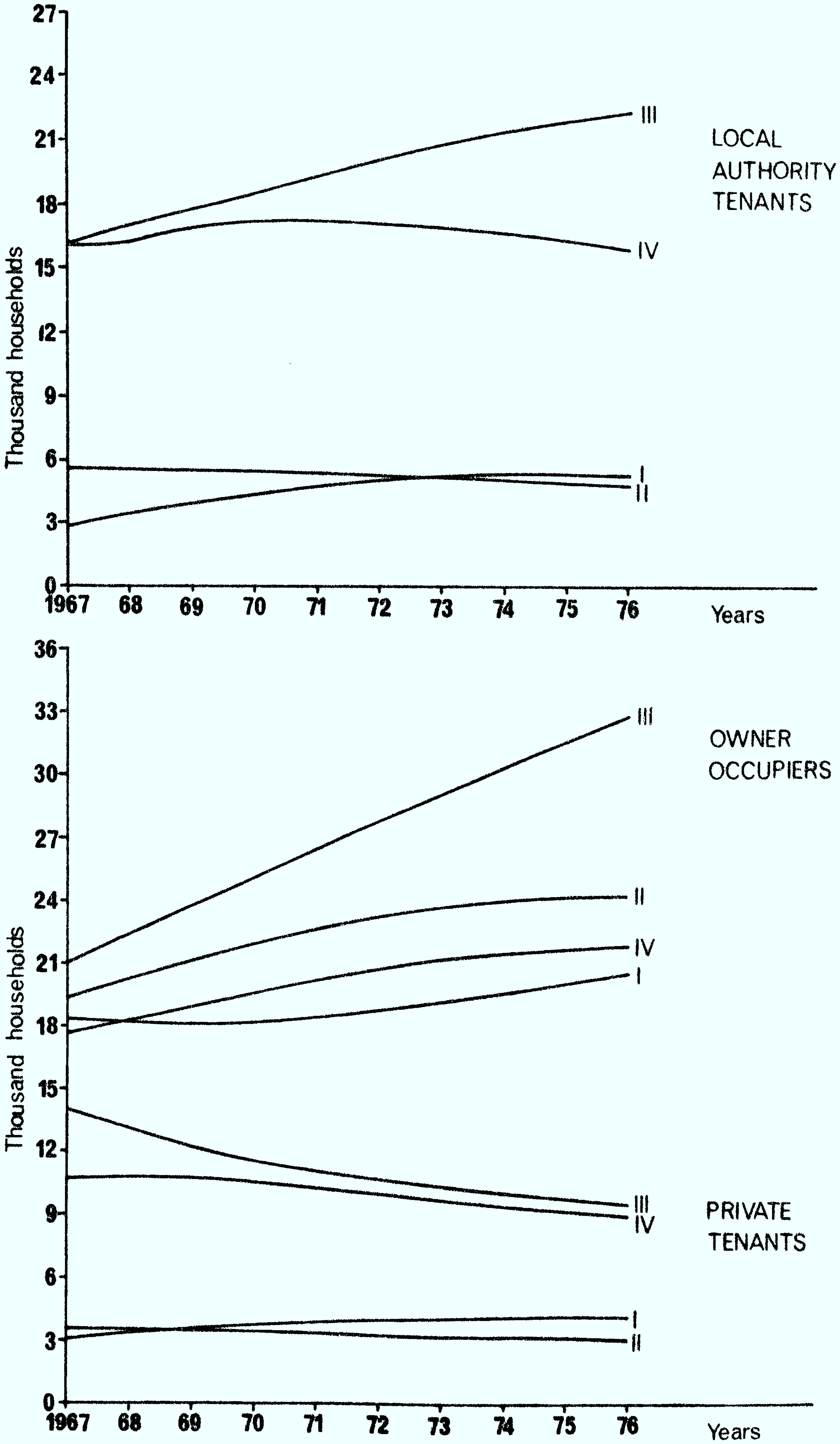


Fig. 5·8

this result is a consequence of the 'problem' in the model of allocating too many SEG I households to the SHARING category. Both results are believed to arise from model failures which have not yet been corrected. Comparing Figs. 5.8 and 5.7 it would appear that the model, in reducing sharing in SEG III, has allocated these households straight into owner occupation. According to the data, Table 5.2.5. the proportion of owner occupiers from SEG III remained at a constant of 30 per cent over the period 1967 to 1976. The model increases the proportion from 27 per cent to 33 per cent.

It is believed that if the problems associated with the model's treatment of households who share could be overcome many of the anomolies within the OCCUPANCY MATRIX would also be solved.

5.4. A REVIEW OF THE ALLOCATION SUB-MODEL

The allocation sub-model is concerned with modelling the way in which households of different types come to occupy dwellings of different types. As with the two other sub-models the methods adopted have not always been capable of modelling all phenomena explicitly. But, as emphasized in Chapter One, the primary function of the research was to provide a learning experience of how to approach the problem of developing an operational model of the housing system.

This section considers the extent to which those concepts discussed in Sections 5.1. and 5.2 of this Chapter have been incorporated into the model. Important facts considered in those sections which are not accommodated by the model design are noted and recorded for the benefit of those who later seek to develop or improve upon the modelling process.

The material presented in this section follows the structure set out in Sections 5.1. and 5.2.

5.4.1. <u>Which dwellings are occupied by which households</u>

The evidence presented in Section 5.1.1. suggested that consistent associations exist between tenure and certain household characteristics i.e., socio-economic group, age and stage in the family life cycle.

In the model the OCCUPANCY MATRIX specifies who lives where. One notable phenomenon which could not be modelled is the sharp age distinction which exists between the type of tenants found in the furnished and unfurnished privately rented sectors. (See Table 5.1.). This is because no distinction is made between furnished and unfurnished tenancies. Size of family is also known to be different in different tenures but, in the model, is only reproduced in crude terms as defined by stage in the family life cycle. Quite clearly single and couple households are synonomous with one and two-person-sized households, but the size distinctions within family and single-parent families are less clear. To an extent the classification young and old helps to provide a further indication of size of the household. A family must age whilst increasing, although once children reach a certain age and start to leave home the family size will decrease as the household ages. Thus age can only provide limited indication of the size of the household.

Table 5.4. compares social class and tenure of households for the years 1966 and 1971 and shows that a clear relationship exists between SEG, and tenure. The extent to which the model results reflect that evidence has been discussed in great detail in the previous section. Here it was stated that some of the results for households classified by SEG are dramatic and in conflict with common sense; their major value being in questioning imperfect modelling. Contrary to the evidence presented in Table 5.4. the model consistently places insufficient households from SEG I in the owner occupied sector and concludes that, in fact, the vast majority of sharing households come from SEG I. This 'problem' of allocating too many SEG I households to SHARING has not been resolved, but it is believed to be a result of the incorrect modelling of the Average Stay concept which is discussed in greater depth in Chapter 6.

It was suggested in Section 5.1.1. that some explanation of why certain households are found in certain parts of the system can be attributed to the eligibility criteria laid down by the various agencies responsible for access to the system. These eligibility rules were modelled via the use of the ACCESSIBILITY matrix but a good deal more specific knowledge is available about the functioning of these rules than could be modelled.

The functioning of ACCESSIBILITY will be discussed later in this Section. Having discussed 'who lives where' it was suggested in Section 5.1.2. that 'problems' arise when a gap exists between housing need and demand and the availability of dwellings. Four conditions were identified:

(1) Unnecessarily vacant dwellings.
(2) Overcrowding.
(3) Sharing.
(4) Homelessness.

The extent to which it was possible to incorporate these concepts into the model structure will now be discussed, and in particular comments will be made on the strengths and weaknesses of the model which has just been described in respect of these phenomena.

5.4.2. Unnecessarily Vacant Dwellings.

In Section 5.1.2. a number of examples of the reasons for dwellings becoming vacant are given. Of these, the majority were easily incorporated explicitly into the model, e.g., (i) A household voluntarily moves - procedure SHAKEOUT comes into operation, the household is moved and a dwelling becomes vacant.

(ii) A household is dissolved by death - procedure HHDISSOLVE reduces the number of households and increases the number of vacant dwellings.

(iii) A new dwelling is created - procedure NEWDW operates to increase the number of vacant dwellings.

There is no explicit treatment of cases such as eviction or compulsory purchase orders, but these could easily be introduced by reducing the AVSTAY figures for the household types most likely to be affected. Similarly, the model is not capable of representing the effect of speculation on the numbers of vacant dwellings. As there is no financial sector, the effect of the availability of mortgages on the numbers of vacant dwellings also cannot be modelled explicitly. Implicitly, however, such an effect could be simulated by adjusting the magnitude of either the relevant AVSTAY or ACCESSIBILITY figures.

As discussed in greater detail in Section 5.1.2 there is little understanding of why some dwellings remain vacant for extended periods. In the model as it now stands there is no monitor on the length of time dwellings remain vacant. However, the mechanism AVAILABILITY affects the number of dwellings occupied each time step and therefore, also the number of dwellings remaining vacant. Due to the use of net flows, it would not be possible to model the length of time individual dwellings remain vacant, but a greater understanding of why and which dwellings remain vacant would enable a more precise definition of AVAILABILITY to be made.

5.4.3. <u>Households Unable to Separately Occupy Dwellings</u>

(a) <u>Overcrowding</u>

Since family (household) size is not explicitly included in the classification of households, difficulties arise in using the model to assess the incidence of overcrowding. As discussed earlier, only a limited indication of household size is possible with the classifications used. An improved model would need to distinguish between small and large families, but the data problems of too many model variables would arise. Overcrowding therefore, is not a factor which has been explicitly examined with this model. It has only been possible to include the effect of overcrowding on the desire to move to a limited extent through the mechanism of AVSTAY, by reducing AVSTAY selectively for those household types living in dwellings where they are likely to be overcrowded e.g., Young Families in small dwellings.

(b) Sharing

An attempt has been made to model the phenomena of sharing so as to include all households who voluntarily or involuntarily share accommodation. The choice of model definition of Young Single Households - to include all eighteen plus year olds - was a deliberate attempt to reduce the number of hidden homeless. The separate category SHARING was defined so as to make clear exactly who are sharers. Unfortunately, in an attempt to reduce the size of the matrices it was not possible to increase the matrix classification to link the sharers with the shared. The model, therefore, is not capable of showing which dwelling types are being shared, nor which households are being shared with. Thus in terms of aiding understanding of the system so as to indicate possible policy proposals, this section of the model only shows who shares. Even if data was available to show where and with whom sharers share then there would need to be an expansion of the model complexity adding a three dimensional matrix 32 x 24 x 32.

(c) Homelessness

As discussed in Section 5.1.3. attempting to gauge the true extent of homelessness is an almost impossible task. But there is general agreement that the number of households who are physically houseless is very small indeed; most people find somewhere to live no matter how unsatisfactory it may be in the long run. A homeless household will, in general, either share with friends or relatives or find some temporary accommodation. The model categories TEMP and SHARING were defined to take account of this. For the purposes of setting up an operational model it was believed unnecessary to introduce a further classification (Houseless) since the added complexity would have involved very small numbers and not necessarily led to any greater understanding of how the system works, nor led to any improvement in the quality of the model output. The media does tend however, to greatly emphasize the importance of this end of the scale of unsatisfactorily housed persons even at the expense of those households sharing or living in overcrowded or bad condition dwellings. Attempting to model this section of the system highlighted again the need for Housing objectives to be clearly defined since media 'noises' cannot replace a more fundamental look at the underlying problems.

5.4.4. Households Movement Behaviour

1. The Characteristics of Households most likely to move

The evidence presented in Section 5.2.1. suggested that certain household types were far more likely to move dwelling than others. The model sets up those conditions likely to induce movement and 'moves' households out of dwellings by means of the matrix AVSTAY (average length of time in years that a household of a particular type remains in a dwelling of a particular type before deciding to look for alternative accommodation). The matrix is of equal size as the OCCUPANCY MATRIX, hence it is possible for each household type in each dwelling type to be assigned a different magnitude for AVSTAY. The model procedure incorporating this concept has been described in great detail in Section 5.3.2. Initial guidance on the magnitude of values in the AVSTAY matrix was provided by information on households length of residence in the three tenures taken from the General Household Survey. Thus an average figure for each tenure was determined (details of which are contained in Section 5.3.3.) This average figure was then adjusted for each household type in each dwelling type to incorporate the qualitative conclusions drawn from the discussion on the reasons for household movement and which households occupy which dwellings as discussed in Section 5.2.2. and 5.1.1. e.g., couples and small families are more likely to move than larger older families.

It is important to note that AVSTAY refers to 'potential' movers i.e., those households who would like to move but not necessarily those who are able to actually move. Most studies concentrate on the number of actual movers and, as mentioned in Section 5.2.2. a danger exists in studying the movement behaviour of actual households only. At the extremes immobility may indicate that current housing situations represent a 'trapped' position which the household is unable to change or that they enable satisfaction to be maximized.

In the model, however, all potential movers are initially 'moved' into the category MOVING although the unsuccessful movers may be returned to exactly the same category of dwelling type from which they were taken. However, this movement back to the same type of dwelling may be reflecting a move to another very similar dwelling in a different location or in fact a non-move i.e., the household wanted to move but was not able to find a suitably alternative dwelling, so remained in exactly the same dwelling. This inability for the model to produce output which distinguishes between actual and potential movers is a considerable disadvantage in aiding understanding of why some households find it easier to move within the system, but is inevitable due to the use of net flows. It appears necessary to trace individual flows in order to overcome the problem.

2. The Reasons for Household Movement.

The literature presented in Section 5.2.2. made great use of the distinction between New and Continuing Households in analysing the reasons why certain households move; the implicit assumption being that the liklihood of moving will depend upon the circumstances surrounding the formulation of the household. These distinctions are not used in the model. Due to the use of net flows all households of a particular type irrespective of how or when they were formed are assumed to have the same propensity to move. As such it has not been possible to model explicitly the reasons why households move.

In Section 5.2.2. on the reasons for household movement the point was made that the need for alternative accommodation would be manifest before actual movement takes place. In fact, even without actual household movement the nature of the dwelling stock and the distribution of household types is in a constant state of flux as dwellings age, are modernized, converted etc., and households age, marry and have children etc.. For this reason, in the model, the households and dwellings phenomena are dealt with before any household movement takes place i.e., before the procedure incorporating AVSTAY is allowed to operate. The procedures used to model these phenomena are:

HHCHANGE, NEWHH, HHDISSOLVE, DWCHANGE, NEWDW, DEMDW.

Some of these procedures model phenomena which could induce a household to move e.g., a young couple have a baby (HHCHANGE); a 'child' leaveshome (NEWHH); a dwelling becomes unfit to live in (DWCHANGE); a dwelling being demolished (DEMDW). The operation of these procedures have been discussed in detail in Section 5.3.1. but the extent to which they replicate the present understanding of the real world needs to be made clear.

HHCHANGE

In the process of households changing their status, not only is it assumed in the model that this status is changed before moving, but also that a high proportion of households do not wish to move as a consequence of their new condition. In the model HHCHANGE causes under 10 per cent of households to change their status. Note also that the model assumes that households in TEMP and SHARING experience the same proportion of HHCHANGE as those separately occupying dwellings. This presumes that these detrimental housing states have no influence on the evolving states of these households. Although no suitable data was found it is generally held that household development is affected by current housing conditions, and therefore several feedback mechanisms are required in the model at this stage. (See Chapter Eight for a discussion of the nature of feedbacks to be incorporated into such a model).

NEWHH

In the model as it now stands the creation of new households is solely represented by the injection into the system of eighteen year old Young Single Households. There is no explicit link in the model between an eighteen year old leaving home, and the affect this may have on the Family household remaining. Once again, due to the use of net flows it is not possible to trace individual flows, therefore all eighteen year olds are assumed to 'appear' as YSH. It is assumed that some of these will be last children leaving home. Therefore, included in the flows OFTOC and OSPFTOS are elements to cover families and single parents reduced to couples and single person-households as a result of the last child leaving home. Once more it would be necessary to add the further variable of family size to link these two phenomena.

DWCHANGE

In the process of DWCHANGE it is assumed that vacant dwellings change their state at the same rate as occupied dwellings. In the case of modernization, for example, it is often argued, as in Section 5.1.2. that dwellings are kept vacant in order that they may be modernized. Without more information on this subject i.e., reasons why vacant dwellings arise, the assumption built into DWCHANGE must remain.

5.4.6. Factors Affecting the Destination of Movers

Section 5.2.3. discusses those factors which affect where a household will move to. In conclusion it was suggested that the three most important factors affecting the destination of household moves are:

(a) Eligibility criteria.
(b) Present Tenure
(c) Search information and nearness to employment behaviour.

Households are moved into dwellings from MOVING by means of the matrix ACCESSIBILITY (The proportion of households of each type who wish to move that would move to dwellings of each type if an infinite supply of such dwellings existed). This matrix, as with AVSTAY, is of equal size as the OCCUPANCY MATRIX hence each household type in each dwelling type is assigned a different value of ACCESSIBILITY. The model procedure for incorporating this concept has been described in great detail in Section 5.3.2.

Figures for the ACCESSIBILITY matrix could not be based on any existing data as information on such a concept is not collected. Subjective consideration of the evidence on who lives where; the characteristics of households most likely to move; and the factors affecting the destination of movers (Sections 5.1.1., 5.2.1., 5.2.3.,) was used to determine the magnitude of the figures in this matrix. An attempt was made for information on the eligibility criteria and allocation policies of the various agencies controlling the different tenure sectors to be embodied in the ACCESSIBILITY figures. Thus, for example, since a YCH in SEG I both assumed to be earning a good income would be highly eligible for a mortgage and conversely would be very unlikely to qualify for a council dwelling, the ACCESSIBILITY figure for YCH's in SEG I wishing to enter the owner occupied sector is far higher than those wishing to enter the local authority sector. (The final figures chosen were 91.7 per cent and 2.2 per cent respectively).

The second conclusion to be drawn from the literature review in Section 5.2.3. i.e., the importance of a household's present 'tenure' in affecting its destination after movement was not able to be incorporated into this model structure. In the present model all households of a particular type who wish to move, irrespective of their original location are transferred to the one category called MOVING. Thus vital information on present tenure is lost. Such a model structure was unavoidable in an attempt to limit its size. However, if data on the likely destination of movers from particular dwellings was available continuous adjustments of ACCESSIBILITY values could be introduced.

Similarly it was not possible to model a households search behaviour except to the extent that households of similar types and SEG's are assumed to behave in broadly similar ways as discussed in Section 3.2.2. and are therefore likely to have similar ACCESSIBILITY figures. Thus ACCESSIBILITY largely reflects only eligibility criteria and allocation policies of the various agencies.

Such is the belief in the strength of these eligibility and allocation policies that a further concept was introduced into the modelling process to enhance the effect of the ACCESSIBILITY matrix. This concept is the Pecking Order. Here, households were ranked according to their ability to gain access to first the owner occupied sector, then the local authority sector, and finally the privately rented sector. Guidance on this ordering was provided by evidence from Murie (93) on the factors affecting the destination of movers. Thus the household type at the top of the list is the household type with the greatest capacity to gain access to the housing system and that at the bottom the least able. The pecking order serves the three-fold purpose of ranking first those with financial power, then those with social power i.e., poor, large, and finally those with little or no financial or social power.

Each of these three groups are assumed, in the model, to be largely interested in different types of dwelling i.e., owner occupied, local authority rented, then privately rented.

Such an ordering is, however, highly dependent upon the availability of all dwellings. If dwellings are in plentiful supply the effect of the Pecking Order will be considerably reduced. The Pecking Order has the strongest effect when there is a shortage of dwellings.

Thus there is a strong link between the effect of the Pecking Order and the magnitude of the parameter AVAILABILITY which restricts the take-up of vacant dwellings at each peck. One of the effects of AVAILABILITY is, in fact, to allow for the differences between supply and demand for dwellings in different parts of the country. Whereas total supply may equal total demand on a national basis total supply may exceed total effective demand if the dwellings are not in the desired location and hence a number of dwellings will remain vacant.

Thus the strengths and weaknesses of the Allocation Section of the model have now been discussed. Chapter Six is concerned with why it is necessary to calibrate a model, some of the problems encountered in attempting to calibrate this model, and the results of running the model forward with the parameters as set for the period 1967 to 1976.

CHAPTER SIX

CALIBRATION AND TESTING

6.1. THE AIMS OF CALIBRATION WITH SOME EXAMPLES OF SUCCESS ACHIEVED.

'Calibration' involves the determination of the best estimates of the parameters of the model, and 'testing' means estimating the goodness of fit of the model when run with the best estimate parameters. If a model is to be used for predictive purposes it is essential that it be calibrated and tested for some historic period in order to have some degree of confidence in its predictions.

Ideally, calibration and testing should be carried out separately. For the Housing Policy Model this would mean defining the parameters over a period such as 1957 to 1966 and testing the model over the period 1967 to 1976. 1977 to 1986 being used as the predictive period.

However, severe problems with lack of historic data prevented such a procedure being employed. The decision was taken to use 1967 (including the initialisation period) to 1976 as both the calibration and testing period combined and in so doing to follow Forresters' example.(45)

The processes of calibration and testing are closely connected. As calibration proceeds it is necessary to adjust appropriate parameters according to some goodness of fit criteria. Inevitably the criteria are relaxed or tightened as success or failure in calibration develops.

The basic principle employed with the calibration and testing of this model consisted of first defining the best values for the input data based as far as possible on existing sources of statistics and both qualitative and quantitative survey results. Second, running the model from 1967 to 1976. Third, adjusting the input data so that results on the model levels agreed with statistics which were available (in this case only for 1967 and 1971). Certain input data was available up to 1976 e.g. marriages and new house building, so the assumption was made that if the model could match 1971 data, the model results could be accepted up to 1976. The criteria for acceptance of model results from 1971 to 1976 being that no violent changes occurred in previous trends. It was believed that model predictions would not be acceptable for longer than a further ten year period. The usefulness of being able to predict only ten years ahead was brought into question when carrying out Experiment 3 and will be discussed in the following Chapter.

Calibration of models of complex systems such as housing is in many ways an incomplete and imperfect process. A compromise must be reached between model complexity and model realism (in terms of its ability to reflect observable phenomena) on the one hand and the quality of the existing available data on the other.

For a simple model with few variables, See Fig. 6.1, existing data may be suitable and easy to obtain and consequently the process of calibration relatively easy. In terms of its usefulness a simple model can give only a limited representation of reality. In efforts to describe the actual world with the model the temptation will be to increase

major problem was lack of suitable data. The extreme complexity of the housing system had long been appreciated. But as a large number of parameters, about 1650, were defined in such a way as to be freely adjustable without external constraint from known data, it was initially assumed that it would be possible to obtain many different solutions thus giving more chance of arriving at the 'correct' solution. But the problem now appears that there is too much freedom to set parameters. So many parameters are completely unknown. Even their original definition has been brought into question. Notably amongst these were AVSTAY, ACCESSIBILITY, SHARINGACCESS, AVSTAYTEMP, AVSTAYSHARE, AVAILABILITY. The chance of simultaneously hitting upon the correct choice of all parameters is extremely small. The experience of attempting such a task has been that as one section of the model, say total vacant dwellings, is brought 'under control' i.e. model results match the data, other previously controllable sections are upset. Correcting one variable has only resulted in the mismatch of others. A simultaneous solution matching all known output variables is necessary - piecemeal attempts so far having been only partially successful.

No systematic approach to calibration has yet been devised and it is not possible to know previously if a model is calibrateable or not. Experience has shown that in attempting calibration of a complex model the researcher requires a certain psychological standpoint to be able to

which were defined in such a way as to be freely adjustable without external constraints from known data. These were AVERAGE STAY, ACCESSIBILITY, AVAILABILITY, AVERAGE STAY SHARING, AVERAGE STAY TEMP, PECKING ORDER, SHARING ACCESS, YSROOM. In the event only the first four parameters were used in the calibration process the remainder being kept at their initial values.

In all, over 100 computer runs were necessary to achieve 'calibration' of the model for the historic period 1967 to 1976.

A discussion of some of the problems arising from attempts at calibration will demonstrate how the model can be used as a learning tool.

In Section 5.3.4. it was shown that the model allocates an unacceptably large number of households in SEG I to the SHARING category at the expense of households in the lower socio-economic groups. The reasons why this situation persisted despite attempts to correct it are not entirely clear. The attempts did reveal that in the model, households sharing behaviour is most sensitive to changes in the parameter AVSTAY. There is clear survey data to show that the four socio-economic groups are likely to have different average stay characteristics. SEG I generally being the most likely group to be moving from dwelling to dwelling. This evidence prompted the use in the model of appropriate average stay figures so that more SEG I households were shaken out at each iteration than other socio-economic groups. Bearing in mind the model's use of a pecking order which would give many of the SEG I households preferential allocation to dwellings the process might have been expected to respond realistically. This has been shown not to be the case.

One modification used to explore this issue involved the convenient step of setting AVSTAY figures for households in SEG I equal to the corresponding values for households in SEG II. Similarly, SEG IV AVSTAY figures were set equal to SEG III figures. Thus the range of AVSTAY values was reduced from between 3 and 40 years to between 4 and 24 years. The distinction between movement characteristics of households of different ages and at different stages in the family life cycle was still preserved as was the ranking of socio-economic groups i.e. higher SEG's still move more frequently than households in lower SEG's.

The effect of this change was to produce a more realistic result in which homelessness and sharing in SEG I was significantly reduced and made smaller than in the other social groups. Households in SEG IV now constituting the majority of sharers.

The results of this modification led to an exploration of the model's treatment of households who move. This in turn led to a more detailed understanding of the phenomenon in reality, and also indicated an area where more data is required.

The model definition of AVSTAY may not correspond with the actual use within the model. The present use of the AVERAGE STAY concept produces potential movers. A potential mover being a household who has made positive efforts to find alternative accommodation. All potential movers unable to find suitable dwellings are allocated to SHARING irrespective of their original situation. In reality, however, the difference between potential movers and actual movers varies between the tenure sectors.

In general, in the owner occupied sector and to a lesser degree in the local authority sector movement out of a dwelling will not take place until a new dwelling has been found to move into and another household found to take over the old dwelling. In reality in both sectors the number of potential movers will be greater than or equal to the number of occupiers who actually move since unsatisfied potential movers will remain in their dwelling if they cannot find a suitable alternative.

For the model to recreate this situation the unsatisfied potential movers from the owner occupied and local authority sectors need to go back into the OCCUPANCY MATRIX.

In the privately rented sector and for households sharing or in temporary accommodation, in reality, movement out of a dwelling whether desired or forced e.g. when a lease expires, does not necessarily result in movement into another dwelling. Movement does not depend upon finding another household to move into the dwelling. As such the number of potential movers will often equal the number of actual movers although some moves may be into shared or temporary accommodation. For these sectors the model allocates households correctly.

In all sectors therefore, in reality, a relationship exists between those decisions and constraints relating to movement out of dwellings and those relating to movement into a dwelling. In addition actual movement depends upon the original situation of the household i.e. the owner occupied sector, the local authority sector, the privately rented sector, temporary accommodation or shared accommodation. In model terms a relationship exists between AVSTAY and ACCESSIBILITY, and varies depending on whether the potential mover is located in a particular sector of the OCCUPANCY MATRIX, in TEMP, or in SHARING.

The model results show that the number of households in SEG I sharing dwellings increases steadily from 1967 onwards implying that the number of households moving INTO dwellings is consistently less than the number of households moving OUT of dwellings. This suggests that the link between the concepts of AVERAGE STAY and ACCESSIBILITY have not been taken account of in the model.

Several requirements must be satisfied before the present model can be improved upon.

Research is necessary to ascertain more about the relationship between the reasons for wishing to move out of dwellings, the ability to actually move into a chosen dwelling, and the constraints to actual movement, for households of different types in different housing situations. In addition data is necessary on the number of succesful movers in relation to the number of potential movers in each sector. In terms of the present research neither time nor resources allowed any further investigations into this area.

Another feature of the model noted in Section 5.3.4.

was the consistent reliability with which some types of household were successfully housed. Closer examination showed that these households tended to be small in number.

The allocation of dwellings to potential movers is based on a minimization process. The number of households to actually move is taken as the minimum of either:

Potential Movers x ACCESSIBILITY or

Vacant Dwellings x AVAILABILITY.

Thus a large group of potential movers will have a greater chance of being constrained by supply whereas small groups will most likely be restrained by demand. It was evident from the model results that the pecking order, designed to reflect the market strengths of the various households was being distorted by the relative sizes of the type of movers.

As an experiment a modification was introduced to the model which adjusted AVAILABILITY depending upon the size of the 'potential mover' group being considered. Although the effect of this change was for the pecking order to function more closely as intended other significant and questionable effects remained. The modification was not used in the standard run but does indicate how AVAILABILITY could be rendered, dynamic and allowed to operate in a manner closer to its original definition. Much more needs to be known about how households attempt to find alternative accommodation and in particular the proportion of all dwellings available that households of different types are prepared to consider.

Thus, 'failure' to calibrate has drawn attention to aspects of the model structure which now appear to be incorrect and in some cases to have 'forced' greater understanding of how the actual system may work. A secondary outcome has been the identification of further research required to facilitate a more appropriate model formulation.

In conclusion, those aspects of the model for which further investigation is necessary are summarized:

(i) Model sensitivity to the average stay phenomena;

(ii) The relationship between the concepts of Average Stay and Accessibility.

(iii) Model treatment of potential movers unable to find suitable alternative accommodation i.e. should they enter SHARING or the OCCUPANCY MATRIX?

6.2. THE STANDARD RUN

The 'standard run' is the term applied to the model results of the predictive period obtained by running forwards from the calibrated historic period. In this model the standard run starts at 1977 and finishes at 1986.

Fig. 6.2. provides a broad view of both the historic and predictive period. The historic period has been discussed at length in Sections 3.4.6., 4.4.7., and 5.3.4. In the standard run no great changes are predicted from those trends experienced from 1967 to 1976.

A steady growth is expected in the total number of households and dwellings; vacant dwellings increasing at a greater rate than in the past ten years. The number of households who are homeless/sharing is expected, in the model, to level out over the next five years, increasing slightly until 1986. The reasons for this are not clear but may be related to the model's treatment of households in SEG I mentioned in the previous section.

Fig. 6.3. shows the dwelling stock by tenure, size

Model output of Total Households, Total Dwellings
Total Sharing/Homeless, Total Vacant Dwellings
1967 to 1986

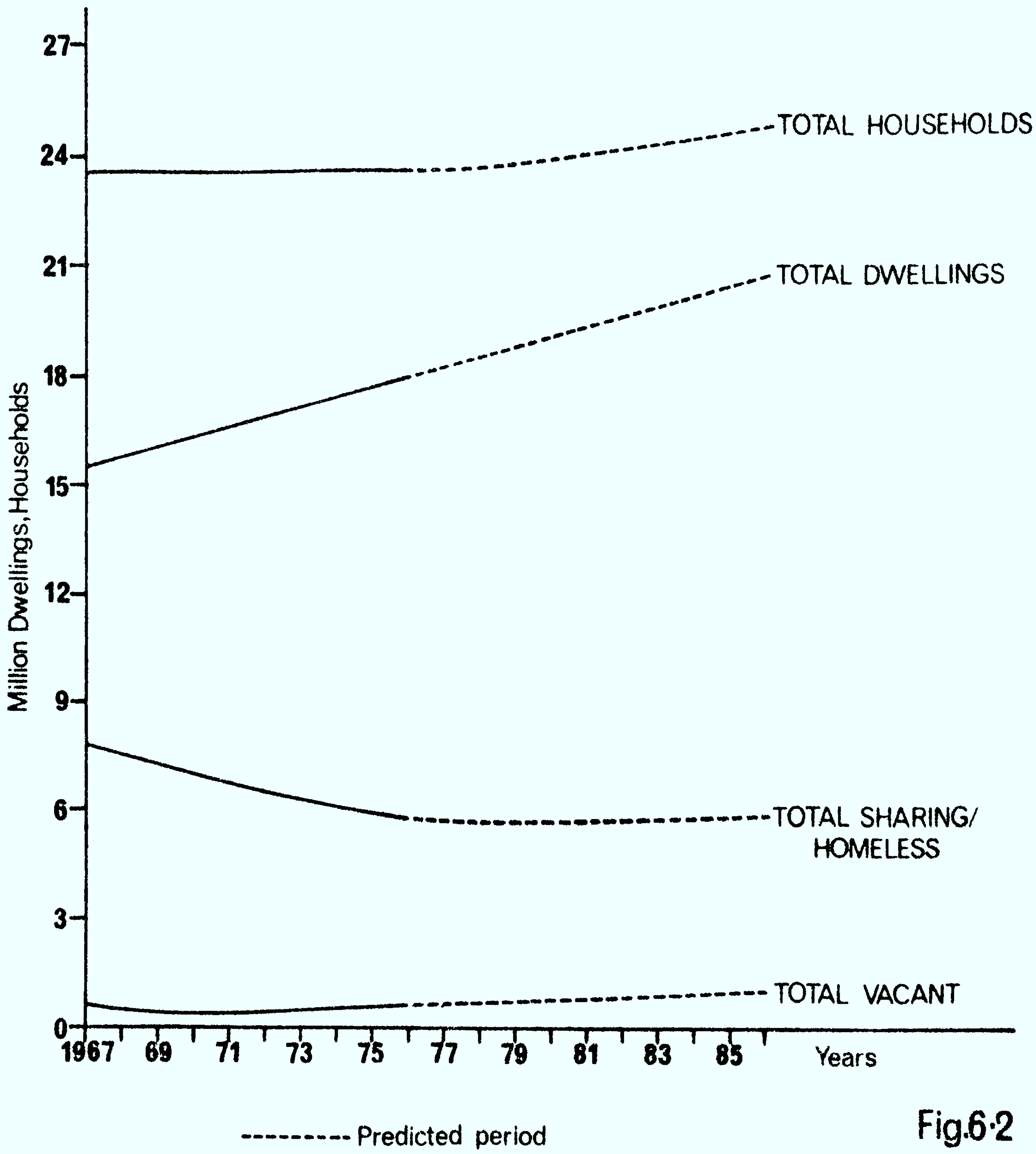


Fig.6·2

MODEL OUTPUT OF DWELLING CHARACTERISTICS

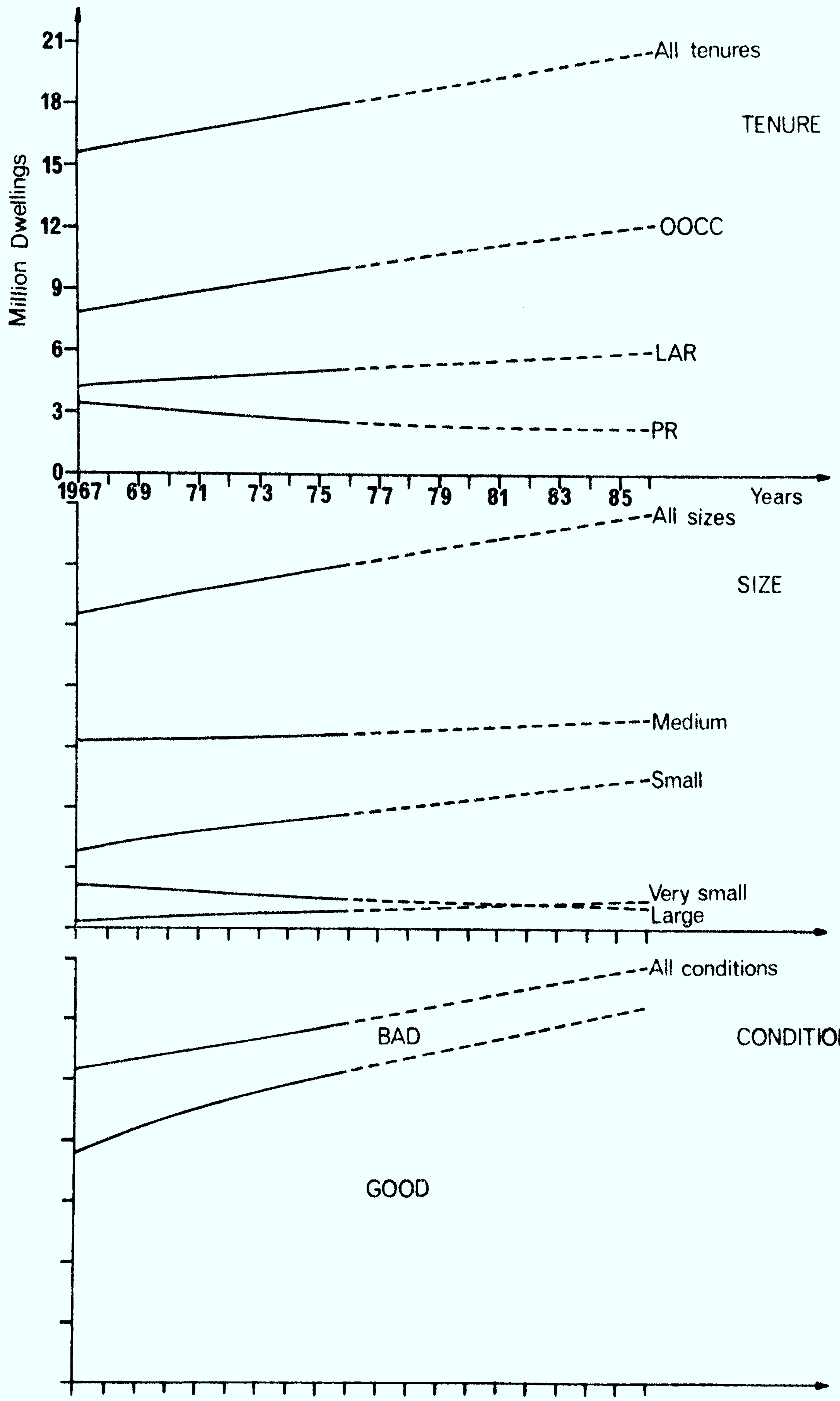


Fig.6·3

and condition. The owner occupied sector is expected to continue to increase as a proportion of all dwellings with the privately rented sector continuing to collapse although the predicted decline is slightly lower than during the previous ten years. This would suggest that there is a level below which this sector will not fall. In terms of size, past trends are expected to continue with small dwellings rapidly increasing in number. By 1986 large dwellings will constitute the smallest proportion of all dwellings. Such trends are not unlikely if present low birth rates continue and family size declines. The general condition of the dwelling stock is expected to improve at a slightly greater rate than during 1967 to 1976.

Figs. 6.4. and 6.5 shows the number of vacant dwellings by tenure size and condition. It is noteworthy that the model produces a remarkable expansion in vacant owner occupied and local authority dwellings; of equal significance is that they are dominated by dwellings in good condition. Such prediction based upon a continuation of the present building programme suggests that demand for housing in the future, at least for these two sectors, will stabilise. These results raise an important query as to the nature of feedbacks which ought to be implemented in a model. In reality such a situation of vast increases in vacant good condition dwellings would undoubtedly cause some governmental reaction. But feedbacks can only satisfactorily be incorporated into a model if there is firm evidence that such a response will be implemented. The query which arises is, 'Should a model assume governmental responses?' .

VACANT DWELLINGS BY TENURE AND CONDITION

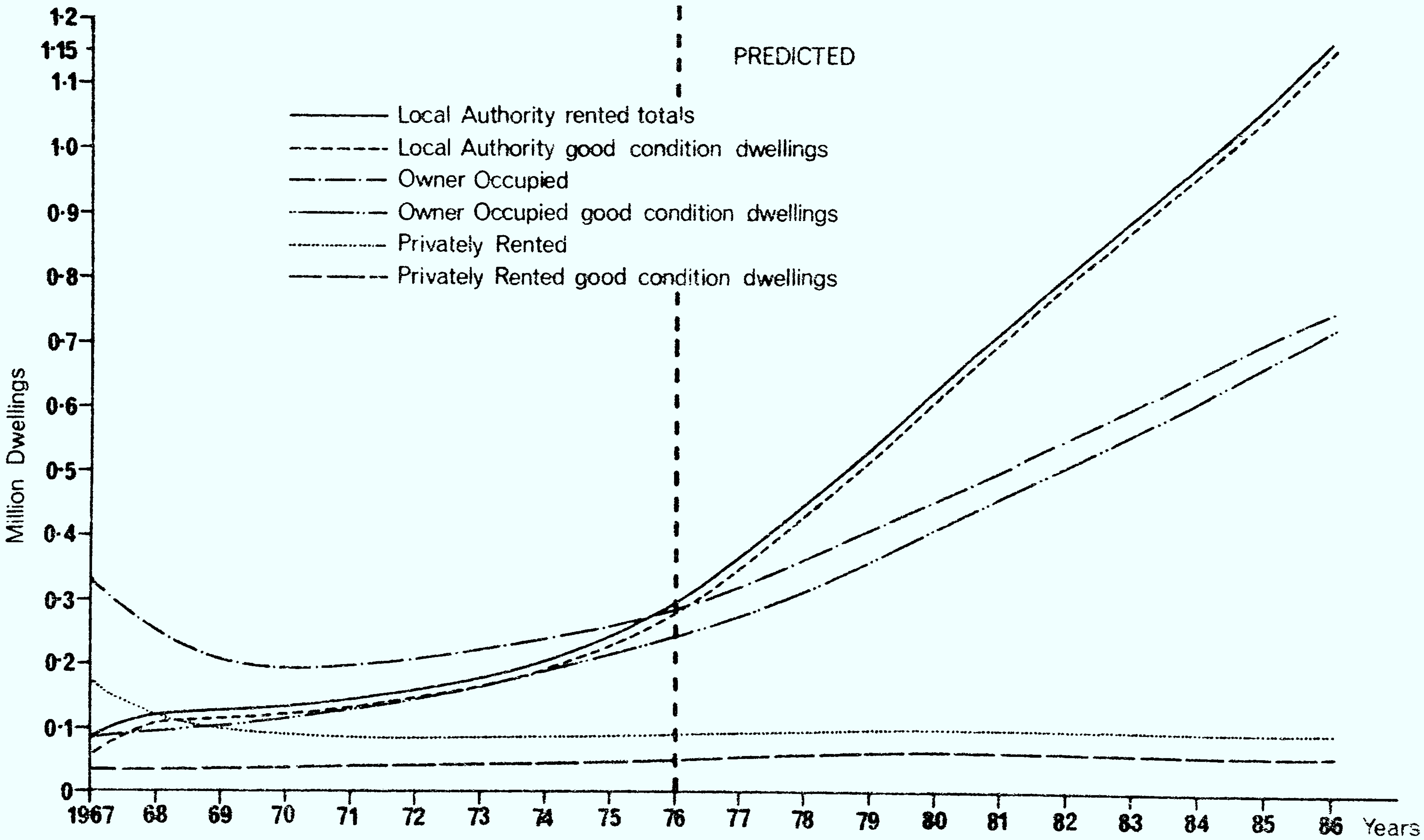


Fig.6·4

According to model predictions only certain sized vacant dwellings are expected to increase at a more rapid rate than the historic period would suggest. In the local authority sector medium sized dwellings are not expected to increase faster than during the previous ten year period. This result is to be expected since local authorities cater primarily for young families who would need this sized dwelling. The dramatic increase expected in very small and small vacant dwellings is somewhat surprising in the light of local authorities changing attitudes towards smaller, especially older, households. In the owner occupied sector there is an expected surplus of medium and small sized vacant dwellings. The number of very small and large sized vacant dwellings is expected to decline further which could suggest a shortage of these sizes in this sector.

That such a situation of rapid increases in vacant dwellings of particular types is predicted by the model could reflect an inadequacy in the concept of ACCESSIBILITY. In reality accessibilities can be expected to reflect to a certain extent the supply of dwellings. Consequently as the supply changes e.g. expansion of small sized dwellings so should the accessibility figures change. At present there is no device within the model to do this.

Fig. 6.6. shows model predictions of the number of households by socio-economic group, family status and age. Again model predictions represent a continuation of past trends with SEG I and SEG II gaining in importance as the upward drift in social class continues. The proportion of households where the head is aged over forty five years is expected to level out in the next ten years as the number

MODEL OUTPUT : HOUSEHOLD CHARACTERISTICS

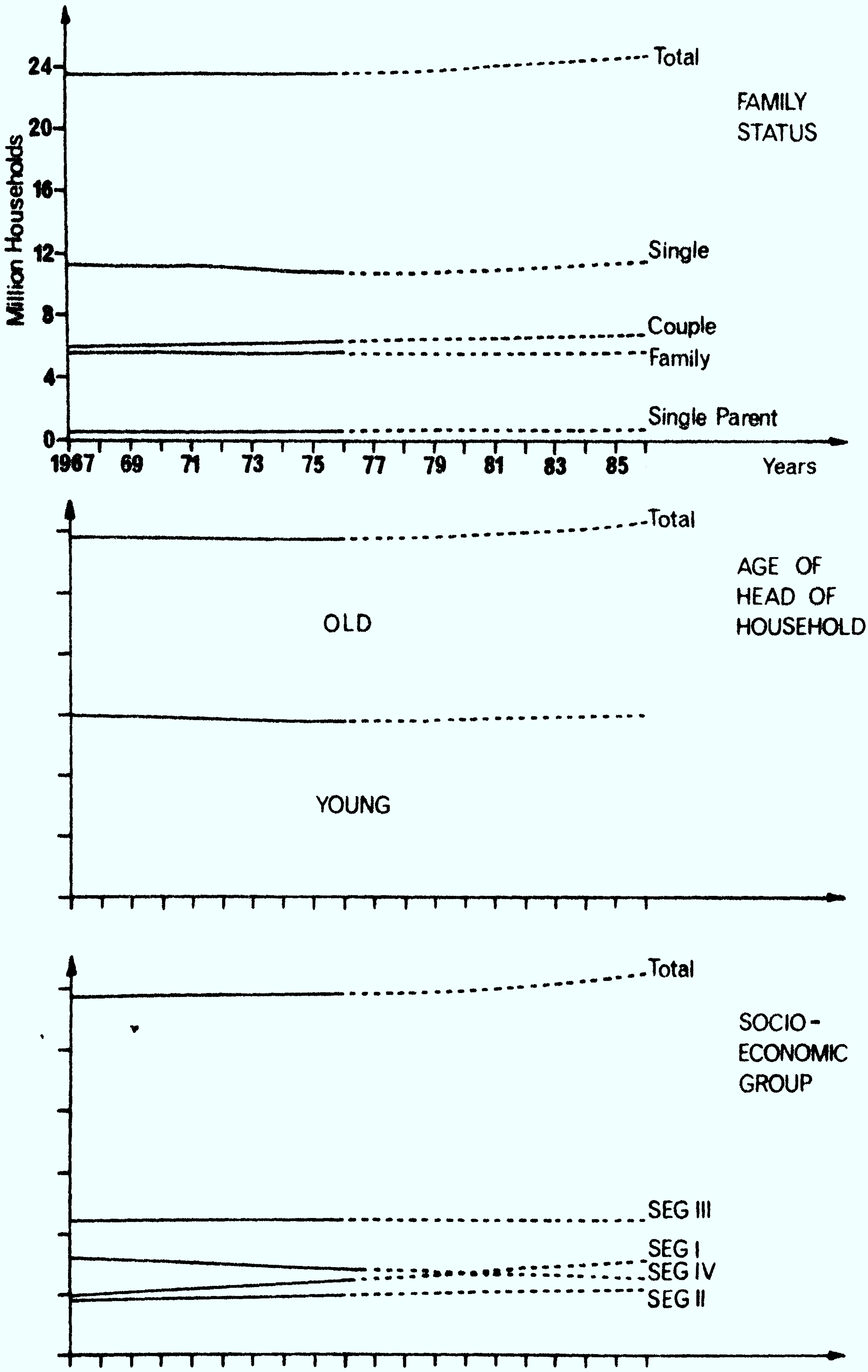


Fig. 6·6

of younger households increases. Single households (as defined in the model) continue to be the dominant family status. The number of childless couples is expected to increase and the number of family households expected to level out as the birth rate remains low.

Fig. 6.7. shows the total number of homeless/sharing couple, family and single parent households. Single households are excluded as in many cases their sharing is voluntary. From 1977 onwards a general improvement is to be expected in the number of households sharing dwellings. The model results for the historic period were discussed in Section 5.4.6. when questions were raised as to their credibility. The results could be feasible - as the dwellings situation has moved from a situation of shortage towards an excess but this does not explain why SEG IV is satisfied first then SEG II then SEG III, with all three tending to stability during the predictive period. No explanation can be given as to why the number of households in SEG I who are sharing is expected to fall quite so dramatically. In a sense the model appears to be 'correcting' the unsatisfactory results of the historic period. These results indicate a model failure - possibly of the nature described in Section 6.1.

Fig. 6.8. shows model output of the number of occupiers in each sector from each socio-economic group. The very rapid increase predicted by the model in the number of households in SEG I in owner occupation is not immediately justifiable and must be associated with the large number of SEG I households predicted to be in SHARING. Both results

Homeless/Sharing households(excluding all single households) by Socio-economic group and Family Status

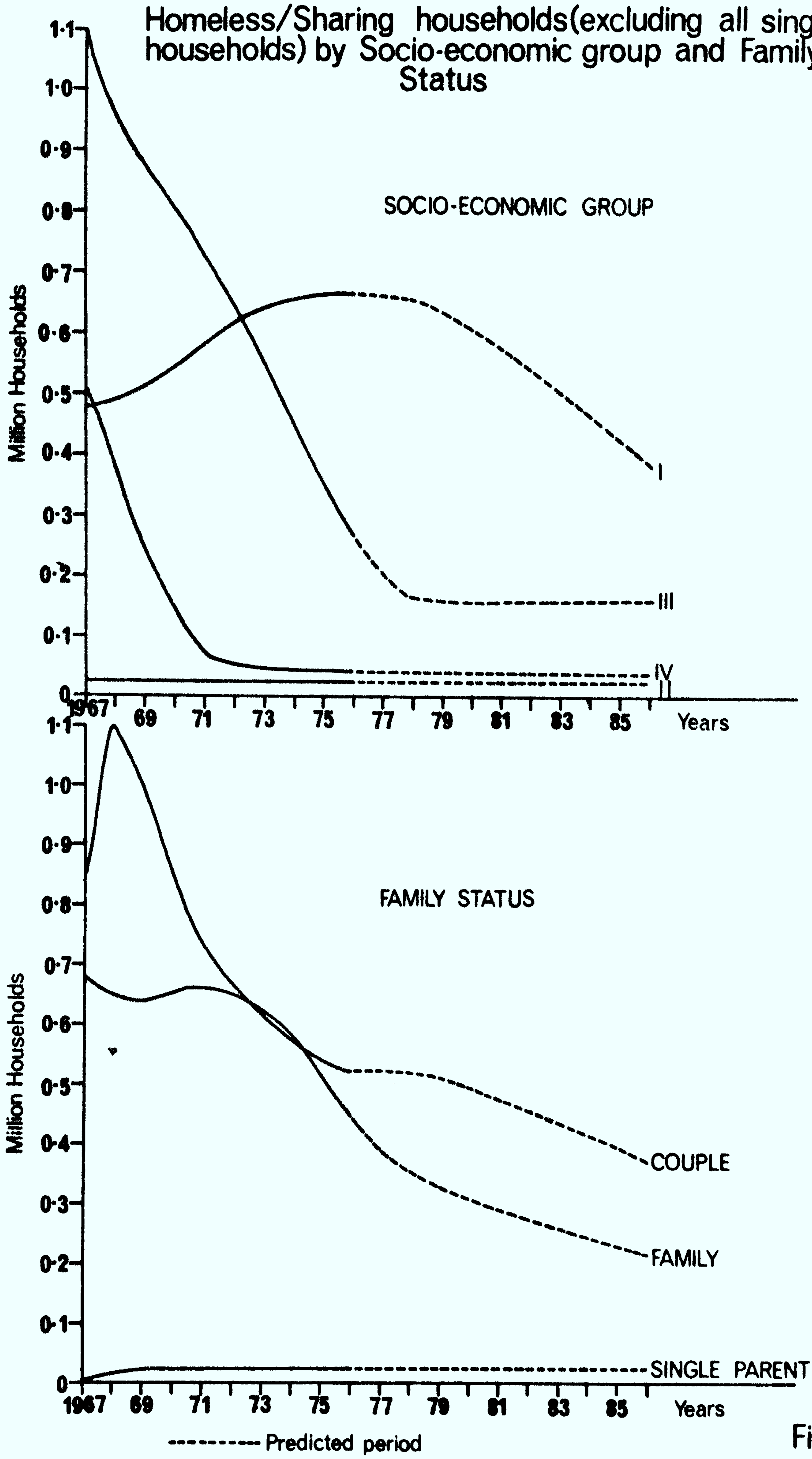


Fig.6·7

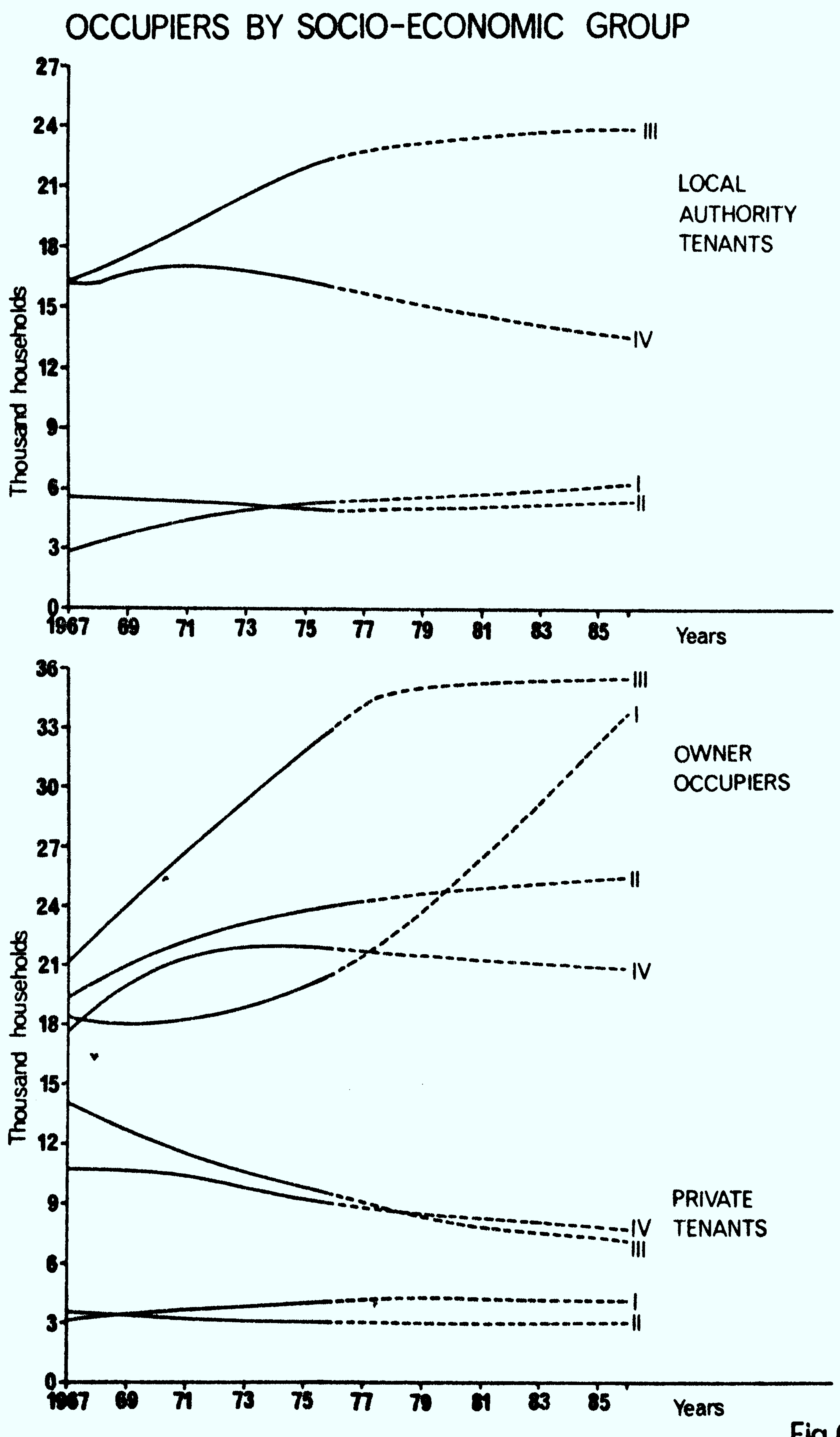

OCCUPIERS BY SOCIO-ECONOMIC GROUP
Thousand households
Years
1967
69
71
73
75
77
79
81
83
85
LOCAL AUTHORITY TENANTS
OWNER OCCUPIERS
PRIVATE TENANTS
I
II
III
IV

Fig.6·8

represent model failures as yet unsolved. The trends predicted for the other socio-economic groups in owner occupation are not unlikely when considering the actual growth in the size of these groups as shown in Fig.6.6. In the local authority sector the situation is expected to stabilize for all SEG's. In the privately rented sector a continued decline in use is predicted for SEG's II, III and IV although households from SEG I are expected to increase slightly in number.

Thus this is the housing situation predicted by the model for the period 1977 to 1986. Despite the inconsistencies with common sense expectations these results were believed to be acceptable for the purposes of showing how such a model could be used for the exploration of policy proposals. This is the aim of Chapter Seven.

CHAPTER SEVEN

THE EXPERIMENTS

There are two justifications for carrying out experiments on a model of this nature:

(i) to demonstrate the model's ability to be used for the exploration of policy proposals, and

(ii) to gain insights into both the real system and the model structure prior to its improvement.

Only limited confidence can be had in the model predictions for 1977 to 1986 and the anomolies have been noted in previous chapters. As such the results of any experiments will be limited. The process of experimentation does however explore in practical terms the role and value which could be expected from a model of this type operating in an environment where more extensive historic data was available and where the technological problems of fitting the model results to that data had been overcome.

Three experiments were carried out on the model and will now be discussed separately.

7.1. Experiment 1.

The first experiment was devised as a result of studying Figures 5.5. and 5.6 on the nature of vacant dwellings predicted for the period 1977 to 1986. The assumption was made that if such a situation were expected with confidence then policy responses would result. One likely response would be to:

Cut new building and conversions to the following dwelling types:

Very Small Local Authority Good Condition Dwellings.
Small Local Authority Good Condition Dwellings.
Small Owner Occupied Good Condition Dwellings.
Medium Owner Occupied Good Condition Dwelling.

Thus the basis of the first experiment was formed. It was decided that new building and conversions to these dwelling types, assumed in the standard run, would be cut by 50 per cent per annum from 1977 onwards.

In very broad terms the general results of this experiment were:

1. Fewer dwellings in total.
2. Fewer vacant dwellings in total
3. More sharing in total.
4. Fewer households in owner occupation.
5. More households in the Local Authority rented sector.
6. No change to households in the privately rented sector.

The greatest decline in dwellings in absolute terms occurred in the owner occupied sector. The cut back in this sector may have been too severe since in any one year only half of the reduction has resulted in a decline in the number of vacant dwellings. It would appear that this sector may require a greater vacancy rate as there are still substantial numbers of vacant properties.

In contrast, in the local authority sector the reduction in total number of dwellings leads to a reduction in the number of vacant dwellings slightly more than the initial reduction. For some reason, this sector appears to have attracted former owner occupiers.

Not all sizes of dwellings are affected, only those where a changed building or conversion programme was introduced. Neither are all household types affected - primarily Old Single Household (OSH), Old Couple Households (OCH), Young Family Households (YFH), and Old Family House-

-holds (OFH) all in SEG I. Examination of the cells of the OCCUPANCY and SHARING matrices reveals that other household types are remarkedly unaffected. The effect on these households in SEG I is to increase the number now sharing although a few enter the local authority sector.

That households in SEG I are again affected by an increase in sharing must be related to the model fault identified in Section 6.1. An observation is made that this defect must be corrected if the model is to be used effectively.

Some interesting discussion points arose out of this experiment. The reaction to the model predictions depicted in Figure 5.5. and 5.6 were that (a) they must be wrong, and (b)this situation would not be accepted. Reducing the number of vacant dwellings may, on paper, produce an apparently more efficient use of the housing stock but may also pose other problems. Not enough is known about the magnitude of the vacancy rate required for dwellings to be used most efficiently e.g. to facilitate adequate mobility (the function of which is to adjust housing to changing needs and desires), to ensure that house prices do not adversely affect mobility, to allow new households to enter the system - their entrance depending upon deaths and emigration of households and the rate of new building and conversion in relation to the rate of demolitions.

The present state of knowledge is geared to understanding a situation of housing shortage. As we move towards a situation of excess new questions need to be answered.

1. What is a 'good' situation to be aiming for - a balance between number of households and number of dwellings or an excess?

2. What level of excess could be tolerated?

3. What are the implications of a surplus of dwellings?

4. Can vacant property be regarded as a social asset?

This model cannot be used to answer such questions. The experiment has provided good evidence of how a model of this type can be used as a tool for identifying areas of incomplete understanding of reality. In addition it has become clear that objectives in housing must be clearly defined if any attempt is to be made at analysing the effect of policy proposals.

7.2. EXPERIMENT 2.

This experiment was devised in response to the current debate on the sale of council houses. The arbitrary decision was taken to increase the transfer of local authority dwellings to the owner occupied sector five-fold. In 1977 this has the effect of increasing the number of dwellings (all sizes) sold from 35,000 to 176,000 representing a dramatic change of policy.

In broad terms the general results of this experiment over the period 1977 to 1986:

(1) The total number of dwellings was virtually unchanged.
(2) Fewer vacant dwellings in total.
(3) Fewer sharing households in total.
(4) More households in owner occupation.
(5) Fewer households in local authority sector.
(6) No change to households in the privately rented sector.

Thus, as a result of selling large numbers of local authority dwellings a general improvement is experienced in the housing situation i.e. more dwellings are occupied and fewer households share.

CHAPTER EIGHT

CONCLUSIONS

The major impetus for this work lay in the belief that one day an 'ideal' model (as defined in Chapter I) of the housing system in England and Wales could, and would, be developed. Such an 'ideal' model, it was thought, could act as a direct aid to the formulation and evaluation of housing policies. As discussed in Chapter I the primary function of this research was to provide a learning experience of how best to approach this task.

The major outcome of the work, however, has been to seriously question both the role of and the ability to ever develop an 'ideal' model as was initially envisaged. The function of this learning model now takes on an importance largely unforeseen at the beginning of the work. The value of this model is now seen in its ability to act as a tool for learning about housing and the housing system itself over and above that of learning how to build an 'ideal' model. Use of the model has provided an important stimulus to our subjective understanding of the functioning of the system, our ability to better define housing objectives, for recognition of data that would be valuable and also for exposing research needs. But significantly only functioning in a very indirect manner in supporting policy evaluation and formulation.

The lessons to be learnt from the experience of using the model will now be discussed under the following six

record. Movement may take place into a shared or temporary dwelling if no other alternative is found.

Thus in the privately rented sector potential movers will most likely equal actual movers. This will be less likely in the owner occupied and local authority sectors. If the trend towards a surplus of dwellings continues then household movement may be seriously restricted in the owner occupied and local authority rented sectors.

Thus attempts at developing the model have forced a new appreciation of the housing system and also indicated an area of incomplete understanding. A useful piece of research to improve the existing weakness in model design would be to study the effects of different vacancy rates on household movement behaviour.

8.1.5. Response Times of the System

The exploration of the effects of a possible further reduction in the birth rate drew attention to the long time scale overwhich some phenomena must be viewed. Demographic phenomena, such as birth rates, require planning horizons in the region of 50 years and hence a model designed to study such situations must be capable of running forward for such a time. Experimentation also showed how some phenomena have relatively short response times e.g., the sale of local authority dwellings will have an immediate impact on the mix of the dwelling stock between tenures - an increase in owner occupation and reduction in the local authority rented sector

Housing policies need to be seen both in the light of the short-term and long-term effects.

ACCESSIBILITY

YOUNG SINGLE HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.009	0.001	0.088	0.073	0.000	0.004
SMALL	0.088	0.031	0.102	0.088	0.000	0.029
MEDIUM	0.073	0.026	0.146	0.088	0.000	0.029
LARGE	0.058	0.003	0.058	0.004	0.000	0.001

OLD SINGLE HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.009	0.001	0.027	0.018	0.011	0.003
SMALL	0.151	0.051	0.012	0.012	0.035	0.012
MEDIUM	0.443	0.049	0.023	0.015	0.035	0.012
LARGE	0.058	0.012	0.001	0.003	0.003	0.001

YOUNG COUPLEHOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.005	0.001	0.005	0.007	0.002	0.002
SMALL	0.202	0.046	0.014	0.009	0.005	0.003
MEDIUM	0.484	0.067	0.016	0.008	0.005	0.002
LARGE	0.061	0.051	0.001	0.002	0.002	0.001

OLD COUPLEHOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.004	0.001	0.001	0.001	0.006	0.004
SMALL	0.204	0.043	0.013	0.003	0.008	0.006
MEDIUM	0.493	0.053	0.028	0.008	0.003	0.004
LARGE	0.102	0.005	0.001	0.004	0.004	0.001

YOUNG FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.001	0.001	0.004	0.001	0.010	0.001
SMALL	0.168	0.049	0.011	0.005	0.018	0.002
MEDIUM	0.458	0.057	0.011	0.006	0.038	0.002
LARGE	0.096	0.051	0.001	0.003	0.003	0.001

OLD FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.001	0.001	0.001	0.001	0.004	0.001
SMALL	0.202	0.070	0.001	0.003	0.014	0.002
MEDIUM	0.449	0.064	0.010	0.007	0.021	0.002
LARGE	0.082	0.055	0.003	0.002	0.002	0.001

YOUNG SINGLE PARENT FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.007	0.001	0.060	0.011	0.019	0.004
SMALL	0.087	0.030	0.050	0.016	0.075	0.011
MEDIUM	0.125	0.010	0.037	0.022	0.374	0.010
LARGE	0.012	0.010	0.020	0.004	0.004	0.001

OLD SINGLE PARENT FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD
V.SMA	0.004	0.002	0.016	0.014	0.011	0.005
SMALL	0.253	0.063	0.018	0.022	0.043	0.014
MEDIUM	0.217	0.060	0.054	0.018	0.072	0.016
LARGE	0.036	0.007	0.040	0.005	0.005	0.002

YOUNG FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD	918765	70893	211580	259272
V.SMA	1917	120	5141	1667	25717	1322				
SMALL	100957	5760	14591	5597	49239	48[illegible]5				
MEDIUM	214376	34326	14613	5219	99860	5592				
LARGE	29520	4746	1196	759	3552	327				

OLD FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD	369826	929	8643	40031
V.SMA	471	86	1116	776	5568	472				
SMALL	71306	5620	2696	1788	14318	1524				
MEDIUM	161057	19308	6248	2832	25686	2029				
LARGE	27706	5025	1321	753	1165	195				

YOUNG SINGLE PARENT FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD	57224	0	3659	7337
V.SMA	336	37	1948	463	1255	188				
SMALL	4217	1102	1780	503	5034	619				
MEDIUM	6102	429	1332	623	24295	689				
LARGE	683	334	659	116	263	38				

OLD SINGLE PARENT FAMILY HOUSEHOLDS OF SEG 1

SIZE	OOCC,GOOD	OOCC,BAD	PR,GOOD	PR,BAD	LAR,GOOD	LAR,BAD	43121	0	256	3693
V.SMA	122	33	628	540	714	166				
SMALL	9038	1587	804	707	2512	5[illegible]8				
MEDIUM	11378	1807	2100	597	5007	556				
LARGE	1870	317	1283	227	208	38				

```
        'BEGIN''INTEGER'CARD;

     'REAL'T,TIME,LENGTH,POUT,PNEXT,DT;
  'PROCEDURE'TEST;

     'BEGIN''INTEGER'J;
     J←READ;
     CARD←CARD+1;NEWLINE(1);PRINT(J,1,0);
    'IF'CARD#J'THEN''BEGIN'WRITETEXT('('DATA%FAILURE%NEAR%LINE')')
                    PRINT(CARD,1,0);PAUSE(99);'END';
      'END';
  'PROCEDURE'READTABLE(Z);'ARRAY'Z;

     'BEGIN''INTEGER'J,K;
     Z[1]←READ;Z[2]←READ;Z[3]←READ;
      Z[0]←(Z[2]-Z[1])/Z[3];
      K←Z[0];
      'FOR'J←4'STEP'1'UNTIL'K+4'DO'Z[J]←READ;
      'FOR'J←1'STEP'1'UNTIL'K+4'DO'PRINT(Z[J],2,3);
     'END';
    'PROCEDURE'AREADTABLE(Z,A);'ARRAY'Z;'INTEGER'A;

    'BEGIN''INTEGER'J,K;
          Z[A,1]←READ;Z[A,2]←READ;Z[A,3]←READ;
          Z[A,0]←(Z[A,2]-Z[A,1])/Z[A,3];
          K←Z[A,0];
         'FOR'J←4'STEP'1'UNTIL'K+4'DO'Z[A,J]←READ;
         'FOR'J←1'STEP'1'UNTIL'K+4'DO'PRINT(Z[A,J],2,3);
         'END';
  'PROCEDURE'IN(Z,P,Q);'REAL'Z;'INTEGER'P,Q;

     'BEGIN'Z←READ;PRINT(Z,P,Q);
     'END';
'REAL''PROCEDURE'TABHL(NAME,X);'ARRAY'NAME;'REAL'X;

         'BEGIN''INTEGER'I,J,K;
      'REAL'DIFF;
       'IF'X'LE'NAME[1]'THEN'TABHL←NAME[4]
         'ELSE''IF'X'GE'NAME[2]'THEN'
                    TABHL←NAME[NAME[0]+4]
    'ELSE'
          'BEGIN'I←ENTIER((X-NAME[1])/NAME[3]);
                J←I+4;K←J+1;
                DIFF←X-NAME[1]-I*NAME[3];
                TABHL←NAME[J]+DIFF*(NAME[K]-NAME[J])/NAME[3];
         'END';
         'END';
```

```
'REAL''PROCEDURE'ATABHL(NAME,A,X);'ARRAY'NAME;'REAL'X;'INTEGER


          'BEGIN''INTEGER'I,J,K;
          'REAL'DIFF;
          'IF'X'LE'NAME[A,1]'THEN'ATABHL←NAME[A,4]
          'ELSE''IF'X'GE'NAME[A,2]'THEN'
      ATABHL←NAME[A,NAME[A,0]+4]
          'ELSE'
          'BEGIN'I←ENTIER((X-NAME[A,1])/NAME[A,3]);
           J←I+4;K←J+1;
           DIFF←X-NAME[A,1]-I*NAME[A,3];
           ATABHL←NAME[A,J]+DIFF*(NAME[A,K]-NAME[A,J])/NAME[A,3];
          'END';
          'END';
'PROCEDURE'SETUP(G);

'ARRAY'G;
      'BEGIN''INTEGER'I,J;
         'FOR'I←1'STEP'1'UNTIL'10'DO'
               'BEGIN'A:G[I,43]←READCH;
                    'IF'G[I,43]=16'OR'G[I,43]=3994'THEN''GOTO'A;
                 'FOR'J←0'STEP'1'UNTIL'42'DO'G[I,J]←0;
          'END';
         G[0,41]←0;
      'END';
'PROCEDURE'SETUPWITHMINMAX(G);'ARRAY'G;

      'BEGIN''INTEGER'I,J;
          SETUP(G);
          'FOR'J←41,42'DO'
            'FOR'I←1'STEP'1'UNTIL'10'DO'G[I,J]←READ;
      'END';
'PROCEDURE'ENTER(G,TIME,P,Q,R,S,T,U,V,W,X,Y);

       'ARRAY'G;'REAL'TIME;
        'REAL'P,Q,R,S,T,U,V,W,X,Y;
       'BEGIN' 'INTEGER'I;
         I←G[0,41];
         'IF'I>40'THEN''GOTO'FIN;
         G[0,41]←I+1;
         G[0,I]←TIME;G[1,I]←P;G[2,I]←0;
         G[3,I]←R;G[4,I]←S;G[5,I]←T;
         G[6,I]←U;G[7,I]←V;G[8,I]←W;
         G[9,I]←X;G[10,I]←Y;
  FIN:'END';
```

```
'PROCEDURE'OUTPUT(G,T);'ARRAY'G;'STRING'T;

      'BEGIN'  'ARRAY'MIN,MAX,D[1:10];
      'INTEGER''ARRAY'E[0:200];
       'INTEGER'I,J,K,L,N;'REAL'M,Z;
        PAPERTHROW;WRITETEXT(T);
       'FOR'I←1'STEP'1'UNTIL'10'DO'
          'IF'G[I,41]=0'AND'G[I,42]=0
               'THEN'MIN[I]←MAX[I]←G[I,0]
               'ELSE''BEGIN'MIN[I]←G[I,41];MAX[I]←G[I,42]'END';
       L←G[0,41]-1;
       'FOR'J←0'STEP'1'UNTIL'L'DO'
          'FOR'I←1'STEP'1'UNTIL'10'DO'
            'IF'G[I,J]<MIN[I]'THEN'MIN[I]←G[I,J]
               'ELSE''IF'G[I,J]>MAX[I]'THEN'MAX[I]←G[I,J];
       'FOR'I←1'STEP'1'UNTIL'10'DO'
          'BEGIN''IF'MAX[I]=MIN[I]'THEN''GOTO'FIN;
               'IF'MIN[I]=G[I,41]'AND'MAX[I]=G[I,42]'THEN''GOTO'F
             M←1;
             'IF'MAX[I]=0'THEN''GOTO'C;
             'IF'MAX[I]<0'THEN''BEGIN'M←-1;MAX[I]←-MAX[I];'END';
            'IF'MAX[I]<1'THEN''GOTO'B;
         A:'IF'MAX[I]<10'THEN''GOTO'C;
            MAX[I]←0.1*MAX[I];M←10*M;
            'GOTO'A;
         B:'IF'MAX[I]>1'THEN''GOTO'C;
            MAX[I]←10*MAX[I];M←0.1*M;
            'GOTO'B;
         C: Z←ENTIER(MAX[I]);
            'IF'Z=MAX[I]'THEN'MAX[I]←Z*M
                        'ELSE''IF'M<0'THEN'MAX[I]←Z*M
                         'ELSE'MAX[I]←(Z+1)*M;
            'IF'M<0'THEN'M←-M;
            Z←ENTIER(MIN[I]/M)*M;
            'IF' Z=0'THEN'MIN[I]←ENTIER(10*MIN[I]/M)*0.1*M
                    'ELSE'MIN[I]←Z;
      FIN:'END';
        NEWLINE(2);
       'FOR'I←1'STEP'1'UNTIL'10'DO'
          'BEGIN'PRINTCH(G[I,43]);
              SPACE(6);
            'IF'MAX[I]=MIN[I]'THEN'
               'BEGIN'WRITETEXT('('CONSTANT:')');
               PRINT(MAX[I],0,5);
               WRITETEXT('('OMITTED%FROM%GRAPH')');G[I,43]←26;
               D[I]←1;'GOTO'FFIN;
               'END';
             D[I]←MAX[I]-MIN[I];
            'FOR'J←0'STEP'1'UNTIL'3'DO'
            'BEGIN'
               PRINT(MIN[I]+J*D[I]/4,0,3);
              'IF'J#3'THEN'SPACE(13);
            'END';
            'IF'(G[I,41]#0'OR'G[I,42]#0)'AND'
                  (MIN[I]#G[I,41]'OR'MAX[I]#G[I,42])
               'THEN'WRITETEXT('('SCALE%CHANGED')')'ELSE'SPACE(13.
             PRINT(MAX[I],0,3);
        FFIN:NEWLINE(1);
          'END';
```

```
      K←0;
    'FOR'I←0'STEP'1'UNTIL'L'DO'
      'BEGIN'NEWLINE(1);
          PRINT(G[0,I],6,0);
         'IF'K=10'THEN'K←0;
         'FOR'J←0'STEP'1'UNTIL'100'DO'
            E[J]←'IF'K=0'THEN'26'ELSE'16;
          K←K+1;
          E[0]←E[25]←E[50]←E[75]←E[100]←26;
         'FOR'J←10'STEP'-1'UNTIL'1'DO'
           'BEGIN'N←100*(G[J,I]-MIN[J])/D[J];
               E[N]←G[J,43];
           'END';
         'FOR'J←0'STEP'1'UNTIL'100'DO'PRINTCH(E[J]);
      'END';
    'END'OF OUTPUT PROCEDURE;
'REAL''PROCEDURE'MAX(P,Q);'REAL'P,Q;
    'BEGIN'
    'IF'P'GE'Q'THEN'MAX←P'ELSE'MAX←Q;
    'END';
'REAL''PROCEDURE'MIN(P,Q);'REAL'P,Q;

    'BEGIN'
    'IF'P'LE'Q'THEN'MIN←P'ELSE'MIN←Q;
    'END';


  'INTEGER'SEG,TYPE,AGE,SH,CH,FH,SPFH,YOUNG,OLD,
    SIZE,TENURE,COND,VS,S,M,L,
    OOCC,PR,LAR,GOOD,BAD,
                INIT,
    STATE,TEMP,SHARING,MOVING;
  'REAL''ARRAY'
     HOUSEHOLD,RANK,SHARINGUTILITY[1:4,1:4,1:2],
         AVSTAYSHARE,AVSTAYTEMP,SHARINGACCESS[1:4,1:4,1:2],
          DWELLING,VACANT,YSROOM[1:4,1:3,1:2],
     HOMELESS[1:4,1:4,1:2,1:3],
     OCCUPANCY,ACCESSIBILITY,AVSTAY,AVAILABILITY,

              CONSTRAINT[1:4,1:4,1:2,1:4,1:3,1:2],
     COMOCC,COMACC[1:4];
  'INTEGER''ARRAY'RANKLIST[1:32,1:3];
   'BOOLEAN'INPUT,OUT;
  'INTEGER'H,D;
  'INTEGER'CONTROL;
  'INTEGER'PART1,PART2;
'ARRAY'RATIO,YSTYSPF,YSTYSPFN,YSTYC,YSTYCN,EYF,EYFN,
   YCTOC,YCTOCN,YFTOF,YFTOFN,YSPFTOSPF,YSPFTOSPFN,
   OSPFTOS,OSPFTOSN,OFTOSPF,OFTOSPFN,OFTOC,OFTOCN,
   OCTOS,OCTOSN,DOS,DOSN[1:4],
   CLFH,YCTYF[1:4],YCTYFN[1:4,1:4],
   MIGFROMSEGN[2:4,1:4];
```

```
'ARRAY'NPR,NPRN,NOOCC,NOOCCN,NLAR,NLARN,DPR,DPRN,DOOCC,DOOC
        DLAR,DLARN,PRAR,PRARN,PRMR,PRMRN,OAR,OARN,OMR,OMRN,L
        LAARN,LMR,LMRM,PGRO,PGBON,OGBP,OGBPN,PBBO,PBBON,PBBL
        PBBLN,OBBP,OBBPN,PGBL,PGBLN,OGBL,OGBLN,LGBO,LGBON,LB
      OGLC,OGLCN,OGFC,OGFCN,OBLC,OBLCN,PBLC,PBLCN,
       PGFC,PGFCN,LBLC,LBLCN,LGFC,LGFCN,LGLC,LGLCN,
            LBBON,OBBLN,OBBL,LC[1:4]:
       'REAL'OLC:
'ARRAY'NPRT,NOOCCT,NLART,PGFCT,OGFCT,LGFCT[1:4,0:25];
```

```
'REAL''PROCEDURE'MINP(P,Q);'REAL'P,Q;

      'BEGIN'
     'IF'P'LE'Q'THEN''BEGIN'
  MINP←P;CONSTRAINT[SEG,TYPE,AGE,SIZE,TENURE,COND]←1'END'
  'ELSE''BEGIN'
  MIND←Q;CONSTRAINT[SEG,TYPE,AGE,SIZE,TENURE,COND]←2'END';
  'END';
```

```
'PROCEDURE'ADD(A)TO:(B); 'REAL'A,B;

      B←B+A:
'PROCEDURE'SUB(A)FROM;(B):'REAL'A,B;

      B←B-A:
'PROCEDURE'MOVE(A)FROM:(B)TO:(C);'VALUE'A;'REAL'A,B,C;

     'BEGIN'C←C+A;B←B-A;'END';
'PROCEDURE'MOVEALL(A)TO:(B);'REAL'A,B;

     'BEGIN'B←B+A;A←0;'END':
'PROCEDURE'MOVEFRAC(FRAC)OF:(A)TO:(B);

     'VALUE'FRAC;'REAL'FRAC,A,B;
     'BEGIN'B←B+FRAC*A;
            A←(1-FRAC)*A;
     'END';
'PROCEDURE'REDUCE(A)BY:(FRAC):'REAL'A,FRAC;

      A←(1-FRAC)*A:
```

```
'PROCEDURE'NEWHH(RATE,SEG,TYPE,AGE);

          'REAL'RATE;'INTEGER'SEG,TYPE,AGE;
     'BEGIN''REAL'NUMBER;
          NUMBER←RATE*DT;
          ADD(NUMBER)TO:(HOUSEHOLD[SEG,TYPE,AGE]);
               'IF'CONTROL#3'THEN'
                    'BEGIN'
          ADD(NUMBER)TO:(HOMELESS[SEG,TYPE,AGE,SHARING]);
                    'END';
     'END' OF NEWHH;
'PROCEDURE'HHDISSOLVE(RATE,SEG,TYPE,AGE);

          'REAL'RATE;'INTEGER'SEG,TYPE,AGE;

     'BEGIN''REAL'NUMBER ,FRAC;
          NUMBER←RATE*DT;
          FRAC←NUMBER/HOUSEHOLD[SEG,TYPE,AGE];
          SUB(NUMBER)FROM:(HOUSEHOLD[SEG,TYPE,AGE]);
               'IF'CONTROL#3'THEN'
                    'BEGIN'
         'FOR'SIZE←VS,S,M,L'DO'
          'FOR'TENURE←OOCC,PR,LAR'DO'
           'FOR'COND←GOOD,BAD'DO'
               MOVEFRAC(FRAC)FROM:
                         (OCCUPANCY[SEG,TYPE,AGE,SIZE,TENURE,COND])
                        TO:(VACANT[SIZE,TENURE,COND]);
          REDUCE(HOMELESS[SEG,TYPE,AGE,TEMP])BY:(FRAC);
          REDUCE(HOMELESS[SEG,TYPE,AGE,SHARING])BY:(FRAC);
         'IF'TYPE=SH'AND'AGE=YOUNG'THEN'
              'BEGIN'
               REDUCE(COMOCC[SEG])BY:(FRAC);
               REDUCE(COMACC[SEG])BY:(FRAC);
              'END';
                    'END';
     'END'OF HHDISSOLVE;
```

```
'PROCEDURE'HHCHANGE(RATE)FROM:(SEG1,TYPE1,AGE1)
                         TO:(SEG2,TYPE2,AGE2);
         'REAL'RATE:
         'INTEGER'SEG1,TYPE1,AGE1,SEG2,TYPE2,AGE2;
    'BEGIN' 'REAL'NUMBER,FRAC;
         NUMBER+RATE*DT:
         FRAC+NUMBER/HOUSEHOLD[SEG1,TYPE1,AGE1];
         MOVE(NUMBER)FROM:(HOUSEHOLD[SEG1,TYPE1,AGE1])
                     TO:(HOUSEHOLD[SEG2,TYPE2,AGE2]);
              'IF'CONTROL#3'THEN'
                   'BEGIN'
         'FOR'SIZE+VS,S,M,L'DO'
          'FOR'TENURE+OOCC,PR,LAR'DO'
           'FOR'COND+GOOD,BAD'DO'
              MOVEFRAC(FRAC)FROM:
                   (OCCUPANCY[SEG1,TYPE1,AGE1,SIZE,TENURE,COND
                TO:(OCCUPANCY[SEG2,TYPE2,AGE2,SIZE,TENURE,COND
         MOVEFRAC(FRAC)FROM:
                   (HOMELESS[SEG1,TYPE1,AGE1,TEMP])
                TO:(HOMELESS[SEG2,TYPE2,AGE2,TEMP]);
         MOVEFRAC(FRAC)FROM:
                   (HOMELESS[SEG1,TYPE1,AGE1,SHARING])
                TO:(HOMELESS[SEG2,TYPE2,AGE2,SHARING]);
         'IF'TYPE1=SH'AND'AGE=YOUNG'THEN'
              'BEGIN'
       REDUCE(COMACC[SEG1])BY:(FRAC);
              MOVEFRAC(FRAC)FROM:(COMOCC[SEG1])
                           TO:(HOMELESS[SEG2,TYPE2,AGE2,
                                    TEMP]);
              'END'
                   'END';
    'END'OF HHCHANGE;


'PROCEDURE'HOUSEHOLDMODEL:




    'BEGIN'SOCIO ECONOMIC GROUP(1);
           SOCIO ECONOMIC GROUP(2);
           SOCIO ECONOMIC GROUP(3);
           SOCIO ECONOMIC GROUP(4);
          MIGRATION ACROSS SEGS;
  'END';
```

```
'PROCEDURE'SOCIO ECONOMIC GROUP(SEG);'INTEGER'SEG;

     'BEGIN''INTEGER'CLIP;
     'IF'TIME#-1'THEN''GOTO'BB;
          'IF'SEG=1'THEN'
       PAPERTHROW;NEWLINE(2);SPACE(5);CARD+0;
          'IF'SEG=1'THEN'
      WRITETEXT('('COPY%OF%DATA%FOR%HOUSEHOLDS%MODEL')');
       NEWLINE(1);SPACE(5);
           WRITETEXT('('SOCIO ECONOMIC GROUP')');PRINT(SEG,1,0);
      TEST;IN(HOUSEHOLD[SEG,SH,YOUNG],0,4);                              1
      TEST;IN(HOUSEHOLD[SEG,CH,YOUNG],0,4);                              2
      TEST;IN(HOUSEHOLD[SEG,FH,YOUNG],0,4);                              3
      TEST;IN(HOUSEHOLD[SEG,SPFH,YOUNG],0,4);                            4
      TEST;IN(HOUSEHOLD[SEG,SH,OLD],0,4);                                5
      TEST;IN(HOUSEHOLD[SEG,CH,OLD],0,4);                                6
      TEST;IN(HOUSEHOLD[SEG,FH,OLD],0,4);                                7
      TEST;IN(HOUSEHOLD[SEG,SPFH,OLD],0,4);                              8
      TEST;IN(YSTYSPFN[SEG],1,4);                                        9
      TEST;IN(YSTYCN[SEG],1,4);                                          10
      TEST;IN(EYFN[SEG],1,4);                                            11
      TEST;IN(YCTOCN[SEG],1,4);                                          12
      TEST;IN(YFTOFN[SEG],1,4);                                          13
      TEST;IN(YSPFTOSPFN[SEG],1,4);                                      14
      TEST;IN(OSPFTOSN[SEG],1,4);                                        15
      TEST;IN(OFTOSPFN[SEG],1,4);                                        16
      TEST;IN(OFTOCN[SEG],1,4);                                          17
      TEST;IN(OCTOSN[SEG],1,4);                                          18
      TEST;IN(DOSN[SEG],1,4);                                            19
      TEST;'FOR'CLIP+1,2,3,4'DO'IN(YCTYFN[SEG,CLIP],1,4);                20
     'IF'SEG=1'THEN'
          'BEGIN'TEST;
               'FOR'CLIP+1,2,3,4'DO'IN(CLFH[CLIP],0,4);                  21
          'END';
     'GOTO'CC;
BB:  'IF'T=TIME'THEN''GOTO'AA;
                       'IF'CONTROL=4'THEN''GOTO'CC;
      CLIP+'IF'TIME<1971'THEN'1'ELSE''IF'TIME<1976'THEN'2
           'ELSE''IF'TIME<1981'THEN'3'ELSE'4;
      NEWHH(RATIO[SEG]*CLFH[CLIP],SEG,SH,YOUNG);
      HHCHANGE(YSTYSPF[SEG])FROM:(SEG,SH,YOUNG)
                              TO:(SEG,SPFH,YOUNG);
      HHCHANGE(0.5*YSTYC[SEG])FROM:(SEG,SH,YOUNG)
                                   TO:(SEG,CH,YOUNG);
      HHDISSOLVE(0.5*YSTYC[SEG],SEG,SH,YOUNG);
      HHCHANGE(YCTYF[SEG])FROM:(SEG,CH,YOUNG)
                              TO:(SEG,FH,YOUNG);
      HHDISSOLVE(EYF[SEG],SEG,FH,YOUNG);
```

```
     HHCHANGE(YCTOC[SEG])FROM:(SEG,CH,YOUNG)
                              TO:(SEG,CH,OLD);
     HHCHANGE(YFTOF[SEG])FROM:(SEG,FH,YOUNG)
                              TO:(SEG,FH,OLD);
     HHCHANGE(YSPFTOSPF[SEG])FROM:(SEG,SPFH,YOUNG)
                                  TO:(SEG,SPFH,OLD);
     HHCHANGE(OFTOSPF[SEG])FROM:(SEG,FH,OLD)
                                TO:(SEG,SPFH,OLD);
     HHCHANGE(OFTOC[SEG])FROM:(SEG,FH,OLD)
                              TO:(SEG,CH,OLD);
     HHCHANGE(OSPFTOS[SEG])FROM:(SEG,SPFH,OLD)
                                TO:(SEG,SH,OLD);
     HHCHANGE(OCTOS[SEG])FROM:(SEG,CH,OLD)
                              TO:(SEG,SH,OLD);
     HHDISSOLVE(DOS[SEG],SEG,SH,OLD);
AA:  CLIP←'IF'TIME<1971'THEN'1'ELSE''IF'TIME<1976'THEN'2
             'ELSE''IF'TIME<1981'THEN'3'ELSE'4;
     RATIO[SEG]←HOUSEHOLD[SEG,SH,YOUNG]/(HOUSEHOLD[1,SH,YOUNG]+
                HOUSEHOLD[2,SH,YOUNG]+HOUSEHOLD[3,SH,YOUNG]
                                     +HOUSEHOLD[4,SH,YOUNG]);
     YCTYF[SEG]←YCTYFN[SEG,CLIP]*HOUSEHOLD[SEG,CH,YOUNG];
     YSTYSPF[SEG]←YSTYSPFN[SEG]*HOUSEHOLD[SEG,SH,YOUNG];
     YSTYC[SEG]←YSTYCN[SEG]*HOUSEHOLD[SEG,SH,YOUNG];
     EYF[SEG]←EYFN[SEG]*HOUSEHOLD[SEG,FH,YOUNG];
     YCTOC[SEG]←YCTOCN[SEG]*HOUSEHOLD[SEG,CH,YOUNG];
     YFTOF[SEG]←YFTOFN[SEG]*HOUSEHOLD[SEG,FH,YOUNG];
     YSPFTOSPF[SEG]←YSPFTOSPFN[SEG]*HOUSEHOLD[SEG,SPFH,YOUNG];
     OSPFTOS[SEG]←OSPFTOSN[SEG]*HOUSEHOLD[SEG,SPFH,OLD];
     OFTOSPF[SEG]←OFTOSPFN[SEG]*HOUSEHOLD[SEG,FH,OLD];
     OFTOC[SEG]←OFTOCN[SEG]*HOUSEHOLD[SEG,FH,OLD];
     OCTOS[SEG]←OCTOSN[SEG]*HOUSEHOLD[SEG,CH,OLD];
     DOS[SEG]←DOSN[SEG]*HOUSEHOLD[SEG,SH,OLD];
CC: 'END':
'PROCEDURE'MIGRATION ACROSS SEGS;

    'BEGIN''INTEGER'CLIP,NEWSEG;
     CARD←O;
    'FOR'SEG←2,3,4'DO'
         'IF'TIME=-1'THEN'
                  'BEGIN'
                  'IF'SEG=2'THEN'
                      'BEGIN'NEWLINE(2);
                       WRITETEXT('('MIGRATION%ACROSS%SEGS')');
                      'END';
              'BEGIN'TEST;
                   'FOR'CLIP←1,2,3,4'DO'IN(MIGFROMSEGN[SEG,CLIP],1,4)
                   'END'
              'END''ELSE'
                     'IF'T#TIME'AND'CONTROL#4'THEN'
              'BEGIN'NEWSEG←SEG-1;
                 CLIP←'IF'TIME<1971'THEN'1'ELSE''IF'TIME<1976'THEN'2
                      'ELSE''IF'TIME<1981'THEN'3'ELSE'4;
               'FOR'AGE←YOUNG,OLD'DO'
                  'FOR'TYPE←SH,CH,FH'DO'
                     'IF'AGE#OLD'OR'TYPE#SH'THEN'
                        HHCHANGE(HOUSEHOLD[SEG,TYPE,AGE]*MIGFROMSEGN
                          [SEG,CLIP])   FROM:(SEG,TYPE,AGE)
                                            TO:(NEWSEG,TYPE,AGE);
              'END';
    'END';
```

```
'PROCEDURE'NEWDW(RATE,SIZE,TENURE,COND);

          'REAL'RATE;'INTEGER'SIZE,TENURE,COND;
     'BEGIN''REAL'NUMBER;
          NUMBER←RATE*DT;
          ADD(NUMBER)TO:(DWELLING[SIZE,TENURE,COND]);
               'IF'CONTROL#4'THEN'
                    'BEGIN'
          ADD(NUMBER)TO:(VACANT[SIZE,TENURE,COND]);
                    'END';
     'END'OF NEWDW;
'PROCEDURE'DEMDW(RATE,SIZE,TENURE,COND);

          'REAL'RATE;'INTEGER'SIZE,TENURE,COND;
     'BEGIN''REAL'NUMBER,FRAC;
          NUMBER←RATE*DT;
          FRAC←NUMBER/DWELLING[SIZE,TENURE,COND];
          SUB(NUMBER)FROM:(DWELLING[SIZE,TENURE,COND]);
               'IF'CONTROL#4'THEN'
                    'BEGIN'
          'FOR'SEG←1,2,3,4'DO'
           'FOR'TYPE←SH,CH,FH,SPFH'DO'
            'FOR'AGE←YOUNG,OLD'DO'
              'BEGIN'
               'IF'TYPE=SH'AND'AGE=YOUNG'THEN'
                   'BEGIN''REAL'LOST;

                    LOST←FRAC*OCCUPANCY[SEG,TYPE,AGE,SIZE,
                         TENURE,COND]*YSROOM[SIZE,TENURE,COND]
                    SUB(LOST)FROM:(COMACC[SEG]);
                    MOVE(LOST)FROM:(COMOCC[SEG])
                        TO:(HOMELESS[SEG,TYPE,AGE,TEMP]);
                   'END';
               MOVEFRAC(FRAC)FROM:
                    (OCCUPANCY[SEG,TYPE,AGE,SIZE,TENURE,COND])
                    TO:(HOMELESS[SEG,TYPE,AGE,TEMP]);
              'END';
               REDUCE(VACANT[SIZE,TENURE,COND]BY:(FRAC);
                    'END';
     'END'OF DEMDW;
```

```
'PROCEDURE'DWCHANGE(RATE)FROM:(SIZE1,TENURE1,COND1)
                          TO:(SIZE2,TENURE2,COND2);
          'REAL'RATE;'INTEGER'SIZE1,TENURE1,COND1,
                          SIZE2,TENURE2,COND2   ;
     'BEGIN''REAL'NUMBER,FRAC;
           NUMBER←RATE*DT;
           FRAC←NUMBER/DWELLING[SIZE1,TENURE1,COND1];
           MOVE(NUMBER)FROM:(DWELLING[SIZE1,TENURE1,COND1])




                       TO:(DWELLING[SIZE2,TENURE2,COND2]);
                'IF'CONTROL#4'THEN'
                     'BEGIN'
           'FOR'SEG←1,2,3,4'DO'
            'FOR'TYPE←SH,CH,FH,SPFH'DO'
             'FOR'AGE←YOUNG,OLD'DO'
               'BEGIN'
               'IF'TYPE=SH'AND'AGE=YOUNG'THEN'
                    'BEGIN''REAL'CHANGE;

                     CHANGE←FRAC*OCCUPANCY[SEG,TYPE,AGE,SIZE1
                                         TENURE1,COND1];
                     SUB(CHANGE*YSROOM[SIZE1,TENURE1,COND1])
                               FROM:(COMACC[SEG]);
                     ADD(CHANGE*YSROOM[SIZE2,TENURE2,COND2])
                               TO:(COMA  CC[SEG]);
               'COMMENT'COMONN UNCHANGED;
                    'END';
           MOVEFRAC(FRAC)FROM:
             (OCCUPANCY[SEG,TYPE,AGE,SIZE1,TENURE1,COND1])
             TO:(OCCUPANCY[SEG,TYPE,AGE,SIZE2,TENURE2,COND2])
          'END';
           MOVEFRAC(FRAC)FROM:
               (VACANT[SIZE1,TENURE1,COND1])
               TO:(VACANT[SIZE2,TENURE2,COND2]);
                     'END';
     'END'OF    DWCHANGE;




'PROCEDURE'DWELLINGMODEL;

     'BEGIN'DWELLING TYPE(VS);
            DWELLING TYPE(S);
            DWELLING TYPE(M);
            DWELLING TYPE(L);
     'END';
```

```
'PROCEDURE'DWELLING TYPE(SIZE);'INTEGER'SIZE;

'BEGIN'
'IF'TIME#-1'THEN''GOTO'BB;
'IF'SIZE=VS'THEN'
 PAPERTHROW;NEWLINE(2);SPACE(5);CARD←0;
'IF'SIZE=VS'THEN'
 WRITETEXT('('COPY%OF%DATA%FOR%DWELLINGS%MODEL%%%%
                [1=VS,2=S,3=M,4=L]')');
 NEWLINE(1);SPACE(5);
 WRITETEXT('('DWELLING%TYPE')');PRINT(SIZE,1,0);
 TEST;IN(DWELLING[SIZE,OOCC,GOOD],0,4);              1
 TEST;IN(DWELLING[SIZE,OOCC,BAD],0,4);               2
 TEST;IN(DWELLING[SIZE,LAR,GOOD],0,4);               3
 TEST;IN(DWELLING[SIZE,LAR,BAD],0,4);                4
 TEST;IN(DWELLING[SIZE,PR,GOOD],0,4);                5
 TEST;IN(DWELLING[SIZE,PR,BAD],0,4);                 6
 TEST;AREADTABLE(NOOCCT,SIZE);                       7
 TEST;AREADTABLE(NLART,SIZE);                        8
 TEST;AREADTABLE(NPRT,SIZE);                         9
 TEST;IN(DOOCCN[SIZE],1,4);                          10


 TEST;IN(DLARN[SIZE],1,4);                           11
 TEST;IN(DPRN[SIZE],1,4);                            12
 TEST;IN(OARN[SIZE],1,4);                            13
 TEST;IN(LAARN[SIZE],1,4);                           14
 TEST;IN(PRARN[SIZE],1,4);                           15
 TEST;IN(OMRN[SIZE],1,4);                            16
 TEST;IN(LMRN[SIZE],1,4);                            17
 TEST;IN(PRMRN[SIZE],1,4);                           18
 TEST;IN(PGBON[SIZE],1,4);                           19
 TEST;IN(OGBPN[SIZE],1,4);                           20
 TEST;IN(PBBON[SIZE],1,4);                           21
 TEST;IN(PBBLN[SIZE],1,4);                           22
 TEST;IN(OBBPN[SIZE],1,4);                           23
 TEST;IN(PGBLN[SIZE],1,4);                           24
 TEST;IN(OGBLN[SIZE],1,4);                           25
 TEST;IN(LGBON[SIZE],1,4);                           26
 TEST;IN(LBBON[SIZE],1,4);                           27
 TEST;IN(OBBLN[SIZE],1,4);                           28
 TEST;AREADTABLE(PGFCT,SIZE);                        29
 TEST;AREADTABLE(OGFCT,SIZE);                        30
 TEST;AREADTABLE(LGFCT,SIZE);                        31
 TEST;IN(PBLCN[SIZE],1,4);                           32
 TEST;IN(OBLCN[SIZE],1,4);                           33
 TEST;IN(OGLCN[SIZE],1,4);                           34
 TEST;IN(LBLCN[SIZE],1,4);                           35
 TEST;IN(LGLCN[SIZE],1,4);                           36
 TEST;IN(LC[SIZE],6,0);                              37
```

```
          NEWLINE(1);
          'GOTO'CC;
BB:       'IF'T=TIME'THEN''GOTO'AA;
                'IF'CONTROL=3'THEN''GOTO'CC;
          NEWDW(NPR[SIZE],SIZE,PR,GOOD);
          NEWDW(NOOCC[SIZE],SIZE,OOCC,GOOD);
          NEWDW(NLAR[SIZE],SIZE,LAR,GOOD);
          DEMDW(DPR[SIZE],SIZE,PR,BAD);
          DEMDW(DOOCC[SIZE],SIZE,OOCC,BAD);
          DEMDW(DLAR[SIZE],SIZE,LAR,BAD);
          DWCHANGE(PRAR[SIZE])FROM:(SIZE,PR,GOOD)TO:(SIZE,PR,BAD);
          DWCHANGE(PRMR[SIZE])FROM:(SIZE,PR,BAD)TO:(SIZE,PR,GOOD);
          DWCHANGE(OAR[SIZE])FROM:(SIZE,OOCC,GOOD)TO:(SIZE,OOCC,BAD);
          DWCHANGE(OMR[SIZE])FROM:(SIZE,OOCC,BAD)TO:(SIZE,OOCC,GOOD);
          DWCHANGE(LAAR[SIZE])FROM:(SIZE,LAR,GOOD)TO:(SIZE,LAR,BAD);
          DWCHANGE(LMR[SIZE])FROM:(SIZE,LAR,BAD)TO:(SIZE,LAR,GOOD);
          DWCHANGE(PGBO[SIZE])FROM:(SIZE,PR,GOOD)TO:(SIZE,OOCC,GOOD);
          DWCHANGE(OGBP[SIZE])FROM:(SIZE,OOCC,GOOD)TO:(SIZE,PR,GOOD);
          DWCHANGE(PBBO[SIZE])FROM:(SIZE,PR,BAD)TO:(SIZE,OOCC,BAD);
          DWCHANGE(OBBP[SIZE])FROM:(SIZE,OOCC,BAD)TO:(SIZE,PR,BAD);
          DWCHANGE(PGBL[SIZE])FROM:(SIZE,PR,GOOD)TO:(SIZE,LAR,GOOD);
          DWCHANGE(PBBL[SIZE])FROM:(SIZE,PR,BAD)TO:(SIZE,LAR,BAD);
          DWCHANGE(OGBL[SIZE])FROM:(SIZE,OOCC,GOOD)TO:(SIZE,LAR,GOOD)
          DWCHANGE(LGBO[SIZE])FROM:(SIZE,LAR,GOOD)TO:(SIZE,OOCC,GOOD)
          DWCHANGE(LBBO[SIZE])FROM:(SIZE,LAR,BAD)TO:(SIZE,OOCC,BAD);
          DWCHANGE(OBBL[SIZE])FROM:(SIZE,OOCC,BAD)TO:(SIZE,LAR,BAD);
          NEWDW(PGFC[SIZE],SIZE,PR,GOOD);
          NEWDW(OGFC[SIZE],SIZE,OOCC,GOOD);
          NEWDW(LGFC[SIZE],SIZE,LAR,GOOD);
          DEMDW(PBLC[SIZE],SIZE,PR,BAD);
          DEMDW(OBLC[SIZE],SIZE,OOCC,BAD);
          DEMDW(OGLC[SIZE],SIZE,OOCC,GOOD);
          DEMDW(LBLC[SIZE],SIZE,LAR,BAD);
          DEMDW(LGLC[SIZE],SIZE,LAR,GOOD);
AA:       NPR[SIZE]←ATABHL(NPRT,SIZE,TIME);
          NOOCC[SIZE]←ATABHL(NOOCCT,SIZE,TIME);
          NLAR[SIZE]←ATABHL(NLART,SIZE,TIME);
          DPR[SIZE]←DPRN[SIZE]*DWELLING[SIZE,PR,BAD];
          DOOCC[SIZE]←DOOCCN[SIZE]*DWELLING[SIZE,OOCC,BAD];
          DLAR[SIZE]←DLARN[SIZE]*DWELLING[SIZE,LAR,BAD];
          PRAR[SIZE]←PRARN[SIZE]*DWELLING[SIZE,PR,GOOD];
          PRMR[SIZE]←PRMRN[SIZE]*DWELLING[SIZE,PR,BAD];
          OAR[SIZE]←OARN[SIZE]*DWELLING[SIZE,OOCC,GOOD];
          OMR[SIZE]←OMRN[SIZE]*DWELLING[SIZE,OOCC,BAD];
          LAAR[SIZE]←LAARN[SIZE]*DWELLING[SIZE,LAR,GOOD];
          LMR[SIZE]←LMRN[SIZE]*DWELLING[SIZE,LAR,BAD];
          PGBO[SIZE]←PGBON[SIZE]*DWELLING[SIZE,PR,GOOD];
          OGBP[SIZE]←OGBPN[SIZE]*DWELLING[SIZE,OOCC,GOOD];
          PBBO[SIZE]←PBBON[SIZE]*DWELLING[SIZE,PR,BAD];
          OBBP[SIZE]←OBBPN[SIZE]*DWELLING[SIZE,OOCC,BAD];
          PGBL[SIZE]←PGBLN[SIZE]*DWELLING[SIZE,PR,GOOD];
          PBBL[SIZE]←PBBLN[SIZE]*DWELLING[SIZE,PR,BAD];
          OGBL[SIZE]←OGBLN[SIZE]*DWELLING[SIZE,OOCC,GOOD];
          LGBO[SIZE]←LGBON[SIZE]*DWELLING[SIZE,LAR,GOOD];
          LBBO[SIZE]←LBBON[SIZE]*DWELLING[SIZE,LAR,BAD];
          OBBL[SIZE]←OBBLN[SIZE]*DWELLING[SIZE,OOCC,BAD];
          'IF'SIZE=VS'THEN'OLC←LC[VS]+LC[S]+LC[M]+LC[L];
          PGFC[SIZE]←ATABHL(PGFCT,SIZE,TIME)*OLC;
          OGFC[SIZE]←ATABHL(OGFCT,SIZE,TIME)*OLC;
          LGFC[SIZE]←ATABHL(LGFCT,SIZE,TIME)*OLC;
          PBLC[SIZE]←PBLCN[SIZE]*DWELLING[SIZE,PR,BAD];
          OBLC[SIZE]←OBLCN[SIZE]*DWELLING[SIZE,OOCC,BAD];
          OGLC[SIZE]←OGLCN[SIZE]*DWELLING[SIZE,OOCC,GOOD];
          LBLC[SIZE]←LBLCN[SIZE]*DWELLING[SIZE,LAR,BAD];
          LGLC[SIZE]←LGLCN[SIZE]*DWELLING[SIZE,LAR,GOOD];
          LC[SIZE]←PBLC[SIZE]+OBLC[SIZE]+OGLC[SIZE]+LBLC[SIZE];
CC:       'END';
```

```
'PROCEDURE'ALLOCATIONMODEL;

      'BEGIN'
       'IF'TIME=-1'THEN'
               DATA INPUT FOR ALLOCATION
              'ELSE'
       'IF'TIME#T'THEN'
              'BEGIN'
                REALLOCATE(1);
              'END';
      'END';
    'PROCEDURE'REALLOCATE(K);'INTEGER'K;

         'BEGIN''INTEGER'I;
                   'IF'CONTROL<3'THEN'
         'FOR'I←1'STEP'1'UNTIL'32'DO'
              'BEGIN'SEG←RANKLIST[I,1];
                     TYPE←RANKLIST[I,2];
                     AGE←RANKLIST[I,3];
                     SHAKEOUT(SEG,TYPE,AGE,K);
                     ALLOCATE(SEG,TYPE,AGE);
              'END';
         'END';
    'PROCEDURE'SHAKEOUT(SEG,TYPE,AGE,K);

              'INTEGER'SEG,TYPE,AGE,K;
       'COMMENT' IF K=0 ONLY HOMELESS H_HOLDS ARE SHAKEN OUT;
         'BEGIN''REAL'NUMBER;
          'IF'INIT=1'THEN''GOTO'PP;
          HOMELESS[SEG,TYPE,AGE,MOVING]←0;
PP:       NUMBER←DT*HOMELESS[SEG,TYPE,AGE,SHARING]/
                         AVSTAYSHARE[SEG,TYPE,AGE];
              MOVE(NUMBER)FROM:(HOMELESS[SEG,TYPE,AGE,SHARING])
                           TO:(HOMELESS[SEG,TYPE,AGE,MOVING]);
              NUMBER←DT*HOMELESS[SEG,TYPE,AGE,TEMP]/
                         AVSTAYTEMP[SEG,TYPE,AGE];
              MOVE(NUMBER)FROM:(HOMELESS[SEG,TYPE,AGE,TEMP])
                           TO:(HOMELESS[SEG,TYPE,AGE,MOVING]);
           'IF'K=1'THEN'
              'FOR'SIZE←VS,S,M,L'DO'
               'FOR'TENURE←OOCC,PR,LAR'DO'
                'FOR'COND←GOOD,BAD'DO'
                   'BEGIN'
                    NUMBER←DT*OCCUPANCY[SEG,TYPE,AGE,SIZE,TENURE,COND]
         (AVSTAY[SEG,TYPE,AGE,SIZE,TENURE,COND]/2.5);
                    MOVE(NUMBER)FROM:
                         (OCCUPANCY[SEG,TYPE,AGE,SIZE,TENURE,COND])
                         TO:(HOMELESS[SEG,TYPE,AGE,MOVING]);
                    ADD(NUMBER)TO:(VACANT[SIZE,TENURE,COND]);
                    IF'TYPE=SH'AND'AGE=YOUNG'THEN'
                         'BEGIN'
                          NUMBER←NUMBER*YSROOM[SIZE,TENURE,COND];
                          MOVE(NUMBER)FROM:(COMOCC[SEG])
                               TO:(HOMELESS[SEG,TYPE,AGE,MOVING]);
                          SUB(NUMBER)FROM:(COMACC[SEG]);
                         'END';
```

```
'PROCEDURE'ALLOCATE(SEG,TYPE,AGE);'INTEGER'SEG,TYPE,AGE;

      'BEGIN''REAL' NUMBER,POOL;
            'BOOLEAN'YSH; YSH←TYPE=SH'AND'AGE=YOUNG;
             POOL←HOMELESS[SEG,TYPE,AGE,MOVING];
            'FOR'SIZE←VS,S,M,L'DO'
             'FOR'TENURE←OOCC,PR,LAR'DO'
              'FOR'COND←GOOD,BAD'DO'
                 'BEGIN'




              NUMBER←MINP(DT*AVAILABILITY[SEG,TYPE,AGE,SIZE,
                         TENURE,COND]*VACANT[SIZE,TENURE,COND]
                     AND:(ACCESSIBILITY[SEG,TYPE,AGE,SIZE,TENURE,COND
                         *POOL/('IF'YSH'THEN'1+YSROOM[SIZE,TENURE,COND
                                        'ELSE'1));
                  MOVE(NUMBER)FROM:(HOMELESS[SEG,TYPE,AGE,MOVING])
                     TO:(OCCUPANCY[SEG,TYPE,AGE,SIZE,TENURE,COND]);
                  SUB(NUMBER)FROM:(VACANT[SIZE,TENURE,COND]);
                 'IF'YSH'THEN'
                      'BEGIN'
                       NUMBER←NUMBER*YSROOM[SIZE,TENURE,COND];
                       ADD(NUMBER)TO:(COMACC[SEG]);
                      'END';
                 'END'OF LOOP;
            'IF'YSH'THEN'
                 'BEGIN'
                  NUMBER←MIN(COMACC[SEG]-COMOCC[SEG])
                          AND:(HOMELESS[SEG,TYPE,AGE,MOVING]);
                  MOVE (NUMBER)FROM:(HOMELESS[SEG,TYPE,AGE,MOVING])
                          TO:(COMOCC[SEG]);
                 'END';
             NUMBER←HOMELESS[SEG,TYPE,AGE,MOVING]*
                          SHARINGACCESS[SEG,TYPE,AGE];
             MOVE(NUMBER)FROM:(HOMELESS[SEG,TYPE,AGE,MOVING])
                        TO:(HOMELESS[SEG,TYPE,AGE,SHARING]);
             MOVEALL(HOMELESS[SEG,TYPE,AGE,MOVING])
                        TO:(HOMELESS[SEG,TYPE,AGE,TEMP]);
         HOMELESS[SEG,TYPE,AGE,MOVING]←POOL;
         'END'OF ALLOCATE;
```

```
'PROCEDURE'DATAINPUTFORALLOCATION;

     'BEGIN'
 PAPERTHROW;
      INPUTRANK;


      INPUTYSROOM;
      INPUTAVSTAY;
      INPUTAVSTAYSHARE;
      INPUTAVSTAYTEMP;
      INPUTAVAILABILITY;
      INPUTSHARINGACCESS;
      INPUTACCESSIBILITY;
                 'IF'CONTROL<3'THEN'
                      'BEGIN'
  'IF'CONTROL#0'THEN'TAPE(INPUT);
'IF'CONTROL=0'OR'CONTROL=2'THEN'
      INITIALISE;
                      'END';
     'END';
'REAL''PROCEDURE'RIN(P,Q);'INTEGER'P,Q;

    'BEGIN''REAL'R;
      R←READ;PRINT(R,P,Q);RIN←R;
     'END';
'PROCEDURE'DBLOCKHEAD;

     'BEGIN'NEWLINE(1);
           WRITETEXT('('SIZE%OOCC,GOOD%%OOCC,BAD
             %%PR,GOOD%%PR,BAD%LAR,GOOD%LAR,BAD')');
     'END';
'PROCEDURE'HBLOCKHEAD;

     'BEGIN'NEWLINE(1);
           WRITETEXT('('SEG%%%SH,YOUNG%%%SH,OLD%CH,YOUNG%%%CH,OL
            %FH,YOUNG%%%FH,OLD%SPFH,YOU%SPFH,OLD')');
     'END';
'PROCEDURE'MAINHEAD;

     'BEGIN'NEWLINE(2);
          'IF'AGE=YOUNG'THEN'WRITETEXT('('YOUNG')')
                     'ELSE'WRITETEXT('('OLD%%')');
          'IF'TYPE=SH'THEN'WRITETEXT('('%SINGLE%')')
               'ELSE''IF'TYPE=CH'THEN'WRITETEXT('('%COUPLE')')
               'ELSE''IF'TYPE=FH'THEN'WRITETEXT('('%FAMILY%')')
               'ELSE'WRITETEXT('('%SINGLE%
                     PARENT%FAMILY%')');
           WRITETEXT('('HOUSEHOLDS%OF%SEG')');
           PRINT(SEG,1,0);
     'END';
```

```
'PROCEDURE'DLINE;

      'BEGIN'NEWLINE(1);
       VS←1;S←2;M←3;
      'IF'SIZE=VS'THEN'WRITETEXT('('V.SMA%')')
           'ELSE''IF'SIZE=S'THEN'WRITETEXT('('SMALL%')')
           'ELSE''IF'SIZE=M'THEN'WRITETEXT('('MEDIUM')')
           'ELSE'WRITETEXT('('LARGE%')');
      'END';
'PROCEDURE'HLINE;

      'BEGIN'NEWLINE(1);
       PRINT(SEG,3,0);
      'END';
'PROCEDURE'  SET3D(A)TO:(B)SUFFICE:(I,J,K)LIMITS:(II,JJ,KK)




                 NEWLINE:(N)HEAD:(T);
                'REAL'A,B;'INTEGER'I,J,K,II,JJ,KK,N,T;
      'BEGIN'
       NEWLINE(N);
      'IF'N#0'THEN''BEGIN'
                   'IF'T=0'THEN'DBLOCKHEAD'ELSE'HBLOCKHEAD;
                   'END';
      'FOR'I←1'STEP'1'UNTIL'II'DO'
         'BEGIN'
           'IF'N#0'THEN''BEGIN'
                            'IF'T=D'THEN'DLINE'ELSE'HLINE;
                          'END';
           'FOR'J←1'STEP'1'UNTIL'JJ'DO'
                'FOR'K ←1'STEP'1'UNTIL          'KK'DO'
                     A←B;
         'END';
      'END';
'PROCEDURE'SET6D(A)TO:(B)SUFFICES:(F,G,H,I,J,K)LIMITS:(FF,GG,HH,II,

       JJ,KK)NEWLINE:(N);
           'REAL'A,B;'INTEGER'F,G,H,I,J,K,N;
             'INTEGER'   FF,GG,HH ,II,JJ,KK;
   'BEGIN''FOR'F ←1'STEP'1'UNTIL'      FF'DO'
              'FOR' G←1'STEP'1'UNTIL' GG'DO'
                'FOR'H←1'STEP'1'UNTIL'HH'DO'
                     'BEGIN''IF'N#0'THEN'MAINHEAD;
                          SET3D(A,B,I,J,K,II,JJ,KK,N,D);
                     'END';
      'END';
```

Procedures INPUTRANK, INPUTYSROOM, INPUTAVSTAY, INPUTAVSTAYSHARE, INPUTAVSTAYTEMP, INPUTAVAILABILITY AND INPUTACCESSIBILITY, are used to read into the computer data on the pecking order, YSROOM, AVSTAY, AVSTAYSHARE, AVSTAYTEMP, AVAILABILITY and ACCESSIBILITY.

```
'PROCEDURE'INPUTRANK;

      'BEGIN'NEWLINE(3);
       WRITETEXT('('RANK%ARRAY%SET%TO:')');
       SET3D(RANK[SEG,TYPE,AGE])TO:(RIN(6,0))SUFFICES:(SEG,TYPE,AGE)
                  LIMITS:(4,4,2)NEWLINE:(1)HEAD:(H);
         'BEGIN''INTEGER'I;

           'FOR'I←1'STEP'1'UNTIL'32'DO'
                'BEGIN'
                'FOR'SEG←1,2,3,4'DO'
                 'FOR'TYPE←SH,CH,FH,SPFH'DO'
                  'FOR'AGE←YOUNG,OLD'DO'
                     'IF'RANK[SEG,TYPE,AGE]=I'THEN''GOTO'NEXT;
                      WRITETEXT('('ERROR%IN%RANK%DATA')');
                      PAUSE(99);
                 NEXT:RANKLIST[I,1]←SEG;
                      RANKLIST[I,2]←TYPE;
                      RANKLIST[I,3]←AGE;
                'END';
          'END';
      'END' ;
'PROCEDURE'INPUTYSROOM;

      'BEGIN'NEWLINE(3);
       WRITETEXT('('YS.ROOM%ARRAY%SET%TO')');
       SET3D(YSROOM[SIZE,TENURE,COND])TO:(RIN(3,2))
                  SUFFICES:(SIZE,TENURE,COND)LIMITS:(4,3,2)
                  NEWLINE:(1)HEAD:(D);
      'END';
   'PROCEDURE'INPUTAVSTAY;


      'BEGIN'
      'REAL'X;
       NEWLINE(3);
       WRITETEXT('('AV.STAY%ARRAY:')');
       SET6D(AVSTAY[SEG,TYPE,AGE,SIZE,TENURE,COND])
         TO:(RIN(4,1))
             SUFFICES:(SEG,TYPE,AGE,SIZE,TENURE,COND)
             LIMITS:(4,4,2,4,3,2)
       NEWLINE:(1);
      'END';
'PROCEDURE'INPUTAVSTAYSHARE;

      'BEGIN'
      'REAL'X;
       NEWLINE(3);
       WRITETEXT('('AV.STAY%SHARE')');
       SET3D(AVSTAYSHARE[SEG,TYPE,AGE])
                       TO:(RIN(3,2))
             SUFFICES:(SEG,TYPE,AGE)LIMITS:(4,4,2)
       NEWLINE:(1)HEAD:(H);
      'END';
```

```
'PROCEDURE'INPUTAVSTAYTEMP;

      'BEGIN'
      'REAL'X;X←READ;
       NEWLINE(3);
       WRITETEXT('('AV%STAY%TEMP')');
       PRINT(X,2,2);
       SET3D(AVSTAYTEMP[SEG,TYPE,AGE])
             TO:(X)
             SUFFICES:(SEG,TYPE,AGE)LIMITS:(4,4,2)
             NEWLINE:(0)HEAD:(H);
      'END';
'PROCEDURE'INPUTAVAILABILITY;

      'BEGIN'
      'REAL'X;X←READ;
       NEWLINE(3);
       WRITETEXT('('AVAILABILITY')');
       PRINT(X,2,2);
       SET6D(AVAILABILITY[SEG,TYPE,AGE,SIZE,TENURE,COND])
             TO:(X)
             SUFFICES:(SEG,TYPE,AGE,SIZE,TENURE,COND)
             LIMITS:(4,4,2,4,3,2)
             NEWLINE:(0);
      'END';
'PROCEDURE'INPUTSHARINGACCESS;

      'BEGIN'
       NEWLINE(3);
       WRITETEXT('('SHARINGACCESS')');
       SET3D(SHARINGACCESS[SEG,TYPE,AGE])TO:(RIN(3,2))
             SUFFICES:(SEG,TYPE,AGE)LIMITS:(4,4,2)
       NEWLINE:(1)HEAD:(H);
      'END';
'PROCEDURE'INPUTACCESSIBILITY;

      'BEGIN''REAL' A;
                  'PROCEDURE'DIV(B)BY:(C);'REAL'B,C; A←B←B/C;
      'REAL'SUM;'BOOLEAN'F;
       NEWLINE(3);WRITETEXT('('ACCESSIBILITY')');
      'FOR'SEG←1,2,3,4'DO'
       'FOR'TYPE←SH,CH,FH,SPFH'DO'
       'FOR'AGE←YOUNG,OLD'DO'
            'BEGIN'SUM←0;
             MAINHEAD;DBLOCKHEAD;
      'FOR'F←'TRUE','FALSE'   'DO'
       'FOR'SIZE←VS,S,M,L'DO'
            'BEGIN'
            'IF''NOT'F'THEN'DLINE;
        'FOR'TENURE←OOCC,PR,LAR'DO'
         'FOR'COND←GOOD,BAD'DO'
            'IF'F'THEN'
                  'BEGIN'
       A←READ;
                   ACCESSIBILITY[SEG,TYPE,AGE,SIZE,TENURE,
                                                     COND]←A;
                   SUM←SUM+A;
                  'END'
                  'ELSE'
                  'BEGIN'
                  DIV(ACCESSIBILITY[SEG,TYPE,AGE,SIZE,
                         TENURE,COND])BY:(SUM);
                    PRINT(A,2,3);
                  'END';
            'END';
            'END';
      'END';
```

Procedure INITIALISE is used for the initiallization process as discussed in Section 5.3.4.

Procedure FULLOUTPUT is used to print out the model results in the form shown in Appendix C.

Procedure TAPE(IN) is used for both reading into the computer data from a papertape and also for producing a papertape of model output.

```
'PROCEDURE'INITIALISE;

        'BEGIN' 'INTEGER'I,J,K,L,M,N;
         'IF'CONTROL=0'THEN'
         'BEGIN'
              'FOR'I←1,2,3,4'DO'
                   'FOR'J←1,2,3'DO'
                    'FOR'K←1,2'DO'
                         VACANT[I,J,K]←DWELLING[I,J,K];
            'FOR'I←1,2,3,4'DO'
             'FOR'J←1,2,3,4'DO'
              'FOR'K←1,2'DO'
                  'BEGIN'
                         HOMELESS[I,J,K,TEMP]
                              ←HOMELESS[I,J,K,SHARING]←0;
                         HOMELESS[I,J,K,MOVING]
                              ←HOUSEHOLD[I,J,K];
                        'FOR'L←1,2,3,4'DO'
                         'FOR'M←1,2,3'DO'
                          'FOR'N←1,2'DO'
                           OCCUPANCY[I,J,K,L,M,N]←0;
                  'END';
            'FOR'I←1,2,3,4'DO'COMOCC[I]←COMACC[I]←0;
         'END';
         I←0;
         'FOR'INIT←1'STEP'1'UNTIL'PART1+PART2'DO'
                  'BEGIN'
         'IF'PART1=0'AND'INIT=1'THEN'
         FULLOUTPUT;
                      REALLOCATE
                  ('IF'INIT'LE'PART1'THEN'0'ELSE'1);
            'IF'INIT=PART1'THEN'
                            'BEGIN'
         PAPERTHROW;
                             WRITETEXT('('AFTER%1ST%PHASE%OF%
                              INITIALISATION;')');
                             FULLOUTPUT;
                             'END';
         'IF'INIT>PART1'THEN'
         'BEGIN''REAL'SUM:SUM←0;

         NEWLINE(2);
         WRITETEXT('('ITERATION:')');
         I←I+1;
         PRINT(I,4,0);
         DBLOCKHEAD;
         'FOR'SIZE←1,2,3,4'DO'
         'BEGIN'NEWLINE(1);
         DLINE;
         'FOR'TENURE←OOCC,PR,LAR'DO'
         'FOR'COND←GOOD,BAD'DO'
         'BEGIN'PRINT(VACANT[SIZE,TENURE,COND],6,0);
         ADD(VACANT[SIZE,TENURE,COND])TO:(SUM);
         'END;
         'END;
         WRITETEXT('('NO%OF%VACANT%DWELLINGS:')');
         PRINT(SUM,8,0);
         'IF'SUM'LE'600000'THEN''GOTO'EXIT;
         'END';
                  'END';
EXIT:    'END' OF INITIALISE;
```

```
'PROCEDURE'FULLOUTPUT;

     'BEGIN''INTEGER'I;
          'ARRAY'SUM[0:5];
           'ARRAY'SPREAD[1:4,1:3];
          'FOR'I←0 'STEP'1'UNTIL'5'DO'SUM[I]←0;
             'IF'TIME#-1'THEN'
                  PAPERTHROW;
           WRITETEXT('('FULL%OUTPUT%AT%TIME=')');
               'IF'TIME#-1'THEN'PRINT(TIME,4,2)
                                        'ELSE'PRINT(T,4,2);
                    'IF'CONTROL#3'THEN'
      'FOR'I←1,2'DO'
               'IF'I=1'OR'CONTROL<3'THEN'
       'BEGIN' NEWLINE(4);
           'IF'I=1'THEN'WRITETEXT('('NUMBER%OF%DWELLINGS:')')
                     'ELSE'WRITETEXT('('NUMBER%VACANT:')');
                    DBLOCKHEAD;
         'FOR'SIZE←VS,S,M,L'DO'
         'BEGIN'NEWLINE(1);
                  DLINE;
            'FOR'TENURE←OOCC,PR,LAR'DO'
              'FOR'COND←GOOD,BAD'DO'
                   'BEGIN'

                PRINT('IF'I=1'THEN'DWELLING[SIZE,TENURE,COND]
            'ELSE'VACANT[SIZE,TENURE,COND],6,0);
                    ADD('IF'I=1'THEN'DWELLING[SIZE,TENURE,COND]
                        'ELSE'VACANT[SIZE,TENURE,COND])TO:(SUM[0]);
              'END';
         END';
         WRITETEXT('('GRAND%TOTAL=')');
         PRINT(SUM[0],8,0);SUM[0]←0;
        'END';
                    'IF'CONTROL#4'THEN'
     'FOR'I←1,2'DO'
               'IF'I=1'OR'CONTROL<3'THEN'
      'BEGIN'NEWLINE(4);
                 'IF'I=1'THEN'WRITETEXT('O'NUMBER%OF%HOUSEHOLDS')')
                     'ELSE'WRITETEXT('('HOMELESS%OR%SHARING%
                              [NOT%IN%COMMUNES]')');
                   HBLOCKHEAD;
        'FOR'SEG←1,2,3,4'DO'
        'BEGIN'NEWLINE(1);
                 HLINE;
           'FOR'TYPE←SH,CH,FH,SPFH'DO'
              'FOR'AGE←YOUNG,OLD'DO'
                  'BEGIN'
                     PRINT('IF'I=1'THEN'HOUSEHOLD[SEG,TYPE,AGE]'ELSE'
                      HOMELESS[SEG,TYPE,AGE,SHARING]
                   +HOMELESS[SEG,TYPE,AGE,TEMP],6,0);
                     ADD('IF'I=1'THEN'HOUSEHOLD[SEG,TYPE,AGE]'ELSE'
                      HOMELESS[SEG,TYPE,AGE,SHARING]
                     +HOMELESS[SEG,TYPE,AGE,TEMP])
                               TO:(SUM[0]);
                  'END';
        'END';
```

```
     WRITETEXT('('GRAND%TOTAL=')');
     PRINT(SUM[0],8,0);SUM[0]←0;
'END';
               'IF'CONTROL<3'THEN'
                    'BEGIN'
     PAPERTHROW;
     'FOR'SEG←1,2,3,4'DO'
     'FOR'TENURE←OOCC,PR,LAR'DO'
     SPREAD[SEG,TENURE]←0;
          WRITETEXT('('OCCUPANCY:')');
          NEWLINE(1);SPACE(59);
          WRITETEXT('('HOUSEHOLDS%%HOMELESS')');SPACE(19);
     WRITETEXT('('COMOCC')');
          NEWLINE(1);SPACE(73);
          WRITETEXT('('TEMP%%SHARING%%%MOVING')');
   'FOR'SEG←1,2,3,4'DO'
        'BEGIN''IF'SEG#1'THEN'PAPERTHROW;
     'FOR'TYPE←SH,CH,FH,SPFH'DO'
      'FOR'AGE←YOUNG,OLD'DO'
         'BEGIN'
               MAINHEAD;OBLOCKHEAD;
               PRINT(HOUSEHOLD[SEG,TYPE,AGE],6,0);
                   ADD(HOUSEHOLD[SEG,TYPE,AGE])TO:(SUM[0]);
         'FOR'STATE←TEMP,SHARING,MOVING'DO'
              'BEGIN'
               PRINT(HOMELESS[SEG,TYPE,AGE,STATE],6,0);
                   ADD(HOMELESS[SEG,TYPE,AGE,STATE])
                                  TO:(SUM[STATE]);

              'END';
              'IF'TYPE=SH'AND'AGE=YOUNG'THEN'
                   'BEGIN'
                    PRINT(COMOCC[SEG],6,0);
     ADD(COMOCC[SEG])TO:(SUM[4]);
                   'END';
         'FOR'SIZE←VS,S,M,L'DO'
                   'BEGIN'DLINE;
           'FOR'TENURE←OOCC,PR,LAR'DO'
            'FOR'COND←GOOD,BAD'DO'
   'BEGIN'


              PRINT(OCCUPANCY[SEG,TYPE,AGE,
                        SIZE,TENURE,COND],6,0);
     ADD(OCCUPANCY[SEG,TYPE,AGE,SIZE,TENURE,COND])TO:
                   (SPREAD[SEG,TENURE]);
   'END';



     'FOR'TENURE←OOCC,PR,LAR'DO'
     'FOR'COND←GOOD,BAD'DO'
       PRINT(CONSTRAINT[SEG,TYPE,AGE,SIZE,TENURE,COND],6,0);
         'END';
         'END';
         'END';
```

```
        NEWLINE(2); SPACE(35);
        WRITETEXT('('GRAND%TOTALS%(ALL%SEG):')');
   'FOR'I+0'STEP'1'UNTIL'4'DO'PRINT(SUM[I],6,0);
      PAPERTHROW;
      WRITETEXT('('TENURE%BY%SOCIOECONOMIC%GROUP')');
      NEWLINE(2);
      WRITETEXT('('SEG%%%%%OOCC%%%%%%%PR%%%%%%%LAR')');
      NEWLINE(2);
      'FOR'SEG+1,2,3,4'DO'
      'BEGIN'
      HLINE;
      'FOR'TENURE+OOCC,PR,LAR'DO'
      PRINT(SPREAD[SEG,TENURE],8,0);
      'END';
      'FOR'TENURE+OOCC,PR,LAR'DO'
      'BEGIN'
       SPACE(6);
      PRINT(SPREAD[1,TENURE]+SPREAD[2,TENURE]+
      SPREAD[3,TENURE]+SPREAD[4,TENURE],8,0);
      'END';
                     'END';
'END'OF FULL OUTPUT;
```

```
'PROCEDURE'TAPE(IN);




BLOCK      60
           'BOOLEAN'IN;
            'BEGIN''BOOLEAN'IB;
              'PROCEDURE'INOUT(X,P,Q);
BLOCK      61
                  'REAL'X;'INTEGER'P,Q;
                  'IF'IN'THEN'X<-READ'ELSE'PRINT(X,P,Q);
              'IF'IN'THEN'SELECTINPUT(3)
                    'ELSE''BEGIN'SELECTOUTPUT(4);RUNOUT;
                      WRITETEXT('('DOC%T-DATA')');NEWLINE(1);'END';
              'FOR'SIZE<-VS,S,M,L'DO'
              'FOR'TENURE<-OOCC,PR,LAR'DO'
              'FOR'COND<-GOOD,BAD'DO'
                INOUT(DWELLING[SIZE,TENURE,COND],6,0);
                'FOR'SIZE<-VS,S,M,L'DO'
                'FOR'TENURE<-OOCC,PR,LAR'DO'
               'FOR'COND<-GOOD,BAD'DO'
                INOUT(VACANT[SIZE,TENURE,COND],6,0);
              'FOR'SEG<-1,2,3,4'DO'
              'FOR'TYPE<-1,2,3,4'DO'
              'FOR'AGE<-1,2'DO'
              'BEGIN'
                 INOUT(HOUSEHOLD[SEG,TYPE,AGE],6,0);
               'FOR'STATE<-TEMP,SHARING,MOVING'DO'
                    INOUT(HOMELESS[SEG,TYPE,AGE,STATE],6,0);
                 'IF'TYPE=SH'AND'AGE=YOUNG'THEN'
                    'BEGIN'
                       INOUT(COMACC[SEG],6,0);
                       INOUT(COMOCC[SEG],6,0);
                    'END';
               'FOR'SIZE<-VS,S,M,L'DO'
             'BEGIN'
                 'FOR'TENURE<-OOCC,PR,LAR'DO'
                 'FOR'COND<-GOOD,BAD'DO'
                   INOUT(OCCUPANCY[SEG,TYPE,AGE,SIZE,TENURE,COND],6,0)
            'FOR'TENURE<-OOCC,PR,LAR'DO'
            'FOR'COND<-GOOD,BAD'DO'
            INOUT(CONSTRAINT[SEG,TYPE,AGE,SIZE,TENURE,COND],6,0);
            'END';
              'END';
                'IF'IN'THEN'
                      'BEGIN'SELECTINPUT(0);PAPERTHROW;
                           WRITETEXT('('CONTINUATION%OF%PREVIOUS%RUN,
                             FROM%FOLLOWING%POSITION;')');
                           NEWLINE(1);
                      'END''ELSE'
                      'BEGIN'WRITETEXT('('****')');
                           RUNOUT;
                           SELECTOUTPUT(0);
                            NEWLINE(1);
                           WRITETEXT('('OUTPUT%OF%FINAL%POSITION%
                                          ON%PAPER%TAPE')');
                      'END';
        'END' OF TAPE;
```

Model calculations are carried out at the equivalent of every three months i.e. DT = 0.25 years.

At each iteration the number of households of each type is determined (procedure HOUSEHOLDMODEL) followed by the number of dwellings of each type procedure DWELLING MODEL). These calculations are followed by the determination of the number of households of each type living in dwellings of each type, of households sharing accommodation or in temporary accommodation and the number of dwellings remaining vacant at the end of each iteration.

```
'COMMENT'MAIN PROGRAM;
       INIT←0;
      CARD←0;
       TEST;IN(TIME,4,0);IN(DT,1,4);IN(LENGTH,4,0);IN(POUT,2,0);
       T←TIME;
      PNEXT←T-0.5*DT;
          INPUT←'TRUE';
          OUT←'FALSE';
         TEMP←1;SHARING←2;MOVING←3;
         GOOD←1;BAD←2;
       L←SPFH←4;
          FH←M←LAR←3;
          CH←OLD←S←PR←2;
          SH←YOUNG←VS←OOCC←1;
          D←1;H←2;
          WRITETEXT('('PAPERTAPEXCONTROL')');
          CONTROL←RIN(1,0);
    'IF'CONTROL=1'OR'CONTROL=2'THEN'
         'BEGIN'PART1←RIN(1,0);
               PART2←RIN(1,0);
         'END';
      'FOR'TIME←-1,T'STEP'DT'UNTIL'LENGTH+0.5*DT'DO'
    'BEGIN'
       HOUSEHOLDMODEL;
       DWELLINGMODEL;
       ALLOCATION MODEL;
       'IF'TIME>PNEXT'THEN'
              'BEGIN'FULLOUTPUT;
                 PNEXT←PNEXT+POUT*DT;
              'END';
    'END';
                    'IF'CONTROL<3'THEN'
     TAPE(OUT);
'END';
```

(63) HOUSING AND CONSTRUCTION STATISTICS,
No.12. HMSO 1974. Table 32.
(64) HOUSING AND CONSTRUCTION STATISTICS,
No.16. HMSO 1975. Table 18.
(65) HOUSING AND CONSTRUCTION STATISTICS,
No.20. HMSO 1976. Supplementary Table III.
(66) HOUSING AND CONSTRUCTION STATISTICS,
ibid. Table 32.
(67) HOUSING POLICY GREEN PAPER,
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(68) HOUSING POLICY GREEN PAPER,
ibid. p.25.
(69) HOUSING POLICY GREEN PAPER,
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Technical Volume. Part III. HMSO 1977.
(71) HOUSING POLICY GREEN PAPER,
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(72) HOUSING STATISTICS GREAT BRITAIN,
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(73) HOUSING STATISTICS GREAT BRITAIN,
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