A THEORY OF INTRAURBAN RESIDENTIAL MOBILITY BEHAVIOUR

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ABSTRACT

The purpose of this study is to develop and test a model of the intraurban residential mobility behaviour of individual households. Intraurban residential mobility is the relocation of households from one residence to another within an urban area.

The model is based on a number of theoretical concepts developed in previous studies of household mobility behaviour. Three concepts are particularly important: place utility, aspirations, and locational stress. Unlike earlier studies, however, these concepts are defined within a comprehensive general model of evaluation and choice. The framework adopted is that provided by the theory of consumer behaviour. Developing the mobility model within this framework permits explicit definition of concepts and clear specification of interrelationships.

The basic idea of the model is that mobility is the result of perceived differences between what a household has and what a household believes it could have elsewhere. The household, through its preferences, is able to evaluate and assign relative values to residences. The relative value attached to a particular residence is defined as place utility. Particularly important is the relative value attached to a household's present residence, defined as experienced place utility, and the relative value attached to the best residence the household believes is attainable elsewhere, defined as aspiration place utility. The difference between

these values is defined as residential stress and constitutes the basic decision variable. When residential stress exceeds a certain stress threshold, the household decides to seek a new residence. This decision is followed by a search process in which aspiration place utility functions as a goal.

Of particular importance in this conceptualization is the idea that aspirations are related to what is attainable. Decisions are the result of both preferences and constraints. Specific constraints included in the model are income and needs. The latter are hypothesized to be related to life cycle stage. Changes in these constraints affect experienced and aspiration place utility, and hence, residential stress. Such changes, therefore, are of major significance in understanding mobility.

The model is empirically tested by examining a number of hypotheses derived from the theoretical analysis. Of major importance is the relationship between residential stress and mobility. A measure of residential stress is developed by using a method of conjoint analysis, termed tradeoff analysis, to construct utility scales for individual households. These scales permit measures of experienced place utility, aspiration place utility and thus residential stress to be derived. Tradeoff analysis is particularly appropriate in this context because 1) the type of choice required by respondents is consistent with the evaluation process of the model, 2) the method is designed for the analysis of complex stimuli, such as residences, composed of a number of individual attributes, and 3) the resulting utility scale has interval scale properties as required by the definition of residential stress. No previous study has attempted to measure these concepts at this scale.

Other hypotheses analyzed concern the relationships between income and aspiration place utility, income and experienced place utility, income changes and mobility, and life cycle stage and mobility. Mobility is defined both in terms of intended mobility behaviour and actual mobility behaviour. The results support the hypotheses in all cases, although to varying degrees. Overall, the empirical analysis provides considerable support for the theoretical model of mobility behaviour.

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CHAPTER 1

INTRODUCTION

1.1 Problem and Objectives

An important problem in urban studies is to understand intraurban residential mobility -- the relocation of households from one residence to another within the urban area. One approach to this problem is to attempt to understand the behaviour of individual households. Such an approach raises a number of interesting questions: Why and how does a household decide to move? What factors influence this decision? How does a household identify and search for vacancies? How does a household evaluate residences or decide to select a particular residence? Under what conditions does a household not move? Essentially, such questions are concerned with the household decision-making process. Thus, to answer these questions systematically, requires the development of a model of the way households evaluate and make decisions about residential alternatives. The problem, then, in understanding mobility behaviour, is to develop a model of the household evaluation and decision process which explains such behaviour. Developing such a model is the primary objective of this thesis.

The basis for developing such a model is provided by a number of recent studies of intraurban mobility behaviour (Wolpert, 1965, 1966; Brown and Moore, 1970; Moore, 1972; Clark and Cadwallader, 1973). The objective of these studies has been to develop a general conceptual framework for the analysis of mobility decisions. The subjective nature of the decision situation has been emphasized; individuals are viewed as decision-makers who respond not to objective reality, but to their subjective conceptions of reality. Consequently, attention has been directed toward understanding the subjective processes of cognition and evaluation which precede the household's decisions, first, to seek a new residence and second, to select a particular residence. Such efforts have resulted in the development of a number of important theoretical concepts. These include such concepts as place utility, aspirations, needs and locational stress, which may be contrasted with such operational terms as life cycle stage, income and social status. Whereas operational terms are defined by empirical terms, theoretical concepts are entities or processes which are not directly observed and which involve terms not wholly reducible to empirical terms (MacCorquodale and Meehl, quoted in Turner, 1967, p. 259). Theoretical concepts are particularly important in developing scientific explanations. And since the objective of this thesis is to provide an explanation of mobility behaviour, theoretical concepts are vital.

The development of these theoretical concepts has contributed greatly to our understanding of mobility behaviour and represents a significant step in constructing a formal theory of mobility. However, they do not constitute such a theory. As Quigley and Wienberg (1976, p.12) have recently noted, "implicit in most of these behavioural descriptions of the household's decision to move is only a loose theoretical perspective on the decision-making process". Three general difficulties may be recognized. First, definitions of several of the theoretical concepts are vague. This follows in part, from lack of a formal theoretical framework. We are caught, therefore, in what Kaplan (1964, p.53) calls the paradox of conceptualization: "proper concepts are needed to formulate a good theory, but we need a good theory to arrive at the proper concepts".

Second, interrelationships among some of these concepts are unclear or unspecified. No effort has been made to fully interrelate these concepts within a single conceptual framework. Particularly striking are the different concepts developed to explain the two phases of the decision process, namely, the decision to seek a new residence and the decision to select a particular residence. Brown and Moore (1970), for example, emphasize the role of stress in the decision to seek a new residence, and the role of aspirations, specifically the aspiration region, in the decision to select a new residence, but they do not specify the relationship between the two. The different treatment of the two decisions is seemingly supported by empirical findings (Rossi, 1955). The problem, however, is a failure to distinguish between significant factors and significant differences. The decision to seek a new residence, for example, may be prompted by inadequate internal space, a difference between actual space and needed space. In choosing a new residence, however, the crucial distinction in a given choice may be a difference in neighbourhood. The response by the household that the deciding factor was the neighbourhood obscures the fact that all residences actively considered had adequate internal space. A fully comprehensive theory should be able to explain both decision phases within the same conceptual framework, for it appears reasonable that the cognition and evaluation processes are the same.

Finally, a third difficulty with these behavioural studies has been the lack of empirical analysis. Few studies have attempted either to develop measures of basic concepts which could be related to observed behaviour, or to examine the implications of the conceptualizations at an aggregate level. Exceptions include, respectively, the work of Clark and Cadwallader (1973) and Brown and Longbrake (1970). The empirical validation of models, however, represents an important aspect in the development of social science theory. Since a theory is designed to explain a range of empirical phenomena, there must be evidence that the a priori reasoning incorporated in the model does indeed explain the phenomena.

These difficulties may be overcome through the development of a formal model of mobility decisions. The significance of a formal model is that it provides a precise and concise statement of concepts and relationships. This enhances critical analysis and ultimately the development of more comprehensive general theories. Moreover, the development of models and theories is important in empirical analysis. Such models serve to identify significant empirical questions, to determine appropriate methods of analysis and to interpret results. Models, in other words, help to focus and coordinate empirical analysis.

The specific objectives of the thesis, therefore, may be stated as follows:

1. to provide a comprehensive, formal model of individual mobility decisions, and

2. to provide a method for examining the empirical validity of the model, and a preliminary analysis of such an examination.

1.2 Approach to the First Objective

The first objective is to develop a model of the household mobility decision process. The basic approach is to apply a general model of evaluation and choice to the specific problem of residential mobility. In the present case, the general model of evaluation and choice contained in the theory of consumer behaviour is used to provide the basic framework for the model of household mobility decisions. Given this framework, specific content is provided by introducing the concepts of place utility, aspirations, needs and locational stress, developed in previous studies of mobility behaviour, into the model.

In the mobility model, however, the interpretation of the choice process is somewhat different than that in the theory of consumer behaviour. Particularly, perfect rationality is not assumed. Since only individual households are considered, there are no aggregation problems. All individuals need not have the same choice (i.e., knowledge of alternatives) so that the assumption of perfect rationality is not required. Instead households are assumed to be intendedly rational (Wolpert, 1965). This suggests that individuals seek to make optimal choices but may fail to do so as a result of certain imperfections such as inaccurate and/or inadequate information about opportunities. Essentially this says that individuals choose that alternative which they think is best.

The basic idea of the model is that households are motivated to action by relative differences. In the decision to seek a new residence households are thought to compare the residence the household occupies at the moment (i.e., present residence) with the residence the household thinks it could afford to occupy (i.e., attainable opportunities). In the decision to select a particular residence households are thought to compare a number of attainable opportunities.

Decisions, however, are not simply a function of objective differences such as number of bedrooms, lot sizes, etc., but reflect the values or preferences of individuals for various aspects of housing. The value or preference strength associated with a given residence by a household is defined as place utility. The value associated with the household's present residence is defined as experienced place utility. Place utility is a relative concept being relative both to the household and the set of other opportunities in the area with which the household is familiar (i.e., action space). The level of place utility, however, depends not only on the household's preferences and the level of attributes of the residential environment itself, but also on the level of other goods consumed by the household. As an extreme example, a starving household puts a low value on a highly desirable but costly residence. In turn, the level of consumption of these "other" goods depends on the prices of these goods, the costs associated with the residence and the household's income. Thus, these economic factors are also important in determining place utility. Finally, as this example suggests, needs defined as minimum or maximum levels for certain goods or attributes, by either physical and/or social limits, may also affect place utility.

Given this evaluation process, the household is thought to compare experienced place utility with the place utility of other known and/or believed available opportunities elsewhere. The utility level associated with that residence which is believed to be the best attainable elsewhere is defined as the household's aspiration utility. The difference between aspiration utility and experienced place utility is defined as residential stress. This is the crucial decision variable: high levels of residential stress are associated with the positive decision to seek a new residence, and low levels are associated with the negative decision.

The actual decision, however, also depends on the household's stress tolerance threshold. This threshold is related to the financial and psychic costs of moving. The anticipated gains of moving must exceed these anticipated losses. Therefore, before action is initiated, residential stress must exceed this threshold.

In the model, these ideas are developed within a formal framework. Such a development permits the concepts of place utility, stress, needs and residential stress to be explicitly defined and their interrelationships clarified. At least four significant aspects of this development may be noted. First, within the model framework the concept of place utility is given a richer meaning; it is defined not simply in relation to housing attributes but also in relation to other goods consumed by a household. Second, the concept of aspirations is defined within the household's preference structure; aspiration levels are not assumed to be exogenously given but are determined within the model as part of the evaluation process dependent on the household's preferences. Third, needs are clearly specified and distinguished from preferences. Thus, the independent impact of needs on mobility decisions may be examined -- a point argued by Golant (1973). Finally, a fourth aspect of the model is that since the evaluation process is clearly specified the framework may be used to examine both decision situations; namely the decision to seek a new residence, and the decision to select a particular residence. In this thesis, however, analysis of the decision to seek a new residence is emphasized.

The development of such a model also permits the examination of factors which influence the level of residential stress over time. Changes in the residential environment, for example, involving both physical and social factors, may affect residential stress. In general, "residential environment" or simply "residence" is conceptualized to include aspects of the dwelling, lot, neighbourhood and relative location, any of which may change over time. Moreover, changes in the parameters of the decision situation may affect residential stress. Within the model these decision parameters include the levels of income, prices, and household needs and the household's preference structure (i.e., relative value of attributes). The effect of changes in these parameters, all of which vary over time, is examined within the model in a type of comparative statics approach.[1] In this way, although the decision model is static, certain of the dynamic aspects of the problem are examined.

The analysis emphasizes the view that mobility is the product of change. Particularly, it is changes in the parameters which describe the household-environment situation which leads to mobility and not the level of parameters themselves. It is not, for example, the level of income but changes in the level of income which are important in altering residential stress and prompting relocation. It is recognized within the analysis, therefore, that mobility constitutes a discrete adjustment in a continuous dynamic process.

An important related question concerns the role and interpretation of life cycle factors in the mobility decision. A mobility decision model should be able to explain the well documented relationship between mobility and life cycle stage. Rossi (1955) first suggested that the role of life cycle <u>changes</u> is to affect households needs, thereby stimulating relocation. This hypothesis has been incorporated in the model. Further, it may be hypothesized that life cycle changes affect household preferences. Within the model such preference changes affect residential stress, and thus may stimulate relocation. A further point however requires consideration. Rossi's (1955) interpretation is that mobility is the result of changes, i.e., life cycle changes affect needs leading to mobility. The empirical support, however, relates life cycle

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[1] A rigorous comparative statics analysis is not performed.

stages to mobility. Is it jumps between stages or continuous changes during any given life cycle stage which are important? In view of the emphasis on continuous change, it is suggested, as an alternative hypothesis, that life cycle stages may be thought of not as a series of steps but as a series of slopes, each slope indicating a different rate of change during that period. This seems to be appropriate with respect to preference changes which likely change more or less smoothly, but less so with needs which may indeed change in jumps. The issue is not decided here but it is suggested that the interpretation of life cycle stage be carefully reexamined.

1.3 Approach to the Second Objective

The second objective of the research is to develop a method for empirically examining the model and to provide preliminary results of such an examination. Four basic hypotheses are formulated and examined.

The fundamental hypothesis of the model is that a relationship exists between residential stress and mobility behaviour. Residential stress is defined as the difference between aspiration utility and experienced place utility. It is recognized as the crucial decision variable: high levels of residential stress lead to the decision to move. This relationship is formulated as Hypothesis 1. Examination of this relationship constitutes the most basic tenet of the model and is the most difficult to perform.

To examine Hypothesis 1 requires developing a method to measure residential stress. In turn this requires a method for measuring experienced place utility and aspiration utility.

A method to provide these measurements is developed which consists essentially of a special form of conjoint analysis termed <u>tradeoff analysis</u>. Tradeoff analysis is a method for deriving a utility scale, with interval scale properties, defined over discrete levels of different attributes. The method is particularly suitable for analyzing situations in which individual decisions involve comparisons of complex multi-attribute objects, such as residential environments, and where each attribute may take on one of several values. Data consist of preference comparisons by an individual of different combinations of the levels of different attributes. Such a comparison process essentially involves tradeoffs between differences on one attribute with respect to differences on another in a manner consistent with the comparison process conceptualized in the mobility decision model. With these data and an assumption of additive separability, a utility scale is constructed by selecting (utility) values for each level of each attribute which reproduce the system of preference comparisons as closely as possible.

Application of this method to the present problem yields utility values for each of a number of levels of each attribute of a residential environment. The specific attributes are selected on the basis of previous studies. The utility values are then used, along with information on the level of attributes for the individual's present and aspiration residence, to determine measures of experienced place utility and aspiration utility. From these, a measure of residential stress is obtained by subtraction.

An important aspect of this method is that all values and measures refer to a single individual. No previous research has attempted to provide measures of either place utility or aspiration utility at this scale. A significant aspect of the research, therefore, is the development of a method for estimating these measures at the level of the individual.

Whereas Hypothesis 1 is concerned with the basic assumption of the model, Hypotheses 2, 3 and 4 are concerned with three implications of the model. Hypothesis 2 concerns the relationship between the level of income and levels of experienced place utility and aspiration utility, respectively. It is anticipated that income is positively related to both of these. Hypothesis 3 is concerned with the relationship between income changes and mobility behaviour. Hypothesis 4 is concerned with the relationship between life cycle stages and mobility. Whereas Hypothesis 1 is concerned with the relationship between residential stress and mobility, Hypotheses 3 and 4 may be recognized as being concerned with factors which affect the level of residential stress over time, and hence mobility. Both of these hypotheses are examined using information on intended and actual mobility behaviour. Hypothesis 4 is also examined using the intermediate variable, residential stress, i.e., the relationship between life cycle stages and residential stress. Hypothesis 3 is not examined in this way due to an inadequate number of respondents.

1.4 Outline of the Thesis

The first objective, consisting of the theoretical development of the model, is undertaken in Chapters 2, 3 and 4. Chapter 2 involves a brief discussion of the general conceptual framework of behaviour on which this study is based. Particularly, the relationships among the concepts of cognition, evaluation and decision are clarified by outlining a simple paradigm of individual behaviour. Chapter 3 involves a critical discussion and review of theoretical concepts developed in previous research. Attention is focused primarily on three concepts; place utility, aspirations and locational stress. The discussion provides a foundation for Chapter 4 in which the model is developed. Chapter 4 is composed, essentially, of two parts. First the decision model is developed; second, the effect of certain parameter changes are analyzed.

The second objective, consisting of the empirical analysis, is undertaken in Chapters 5, 6 and 7. In Chapter 5, the four hypotheses which are to be empirically analyzed are presented first. Then, the method for obtaining measures of experienced place utility, aspiration utility and residential stress is developed. Following this, Chapter 6 discusses the data collection methods and Chapter 7 presents the analysis of the four hypotheses introduced in Chapter 5. Finally, Chapter 8 provides a brief conclusion.

CHAPTER 2

CONCEPTUAL FRAMEWORK

2.1 A Simple Behavioural Paradigm

The thesis is concerned with explaining individual behaviour. Hence, it is important at the outset to clarify the perspective in which such behaviour is viewed and particularly to clarify the relationships among the concepts of cognition, evaluation and decision which precede behaviour. These relationships are clarified in the simple behavioural paradigm outlined schematically in Fig. 2.1.

This paradigm reflects what has been termed the cognitive-behavioural approach to understanding (spatial) behaviour. The basic tenet of such an approach is that individual behaviour is a response, not to objective reality, but to the subjective interpretation and evaluation of that reality. Brookfield (1969, p.53), for example, states the proposition as follows:

> Decision-makers operating in an environment base their decisions on the environment as they perceive it, not as it is.

Recently a number of writers have attempted to clarify the subjective processes involved by distinguishing between cognition and evaluation (Demko and Briggs, 1970; Burnett, 1973; Downs, 1970; Lloyd, 1974; Brummell and Harman, 1974). Such a distinction is maintained here. A more complex paradigm, involving feedback effects, may be found in Lloyd (1976).

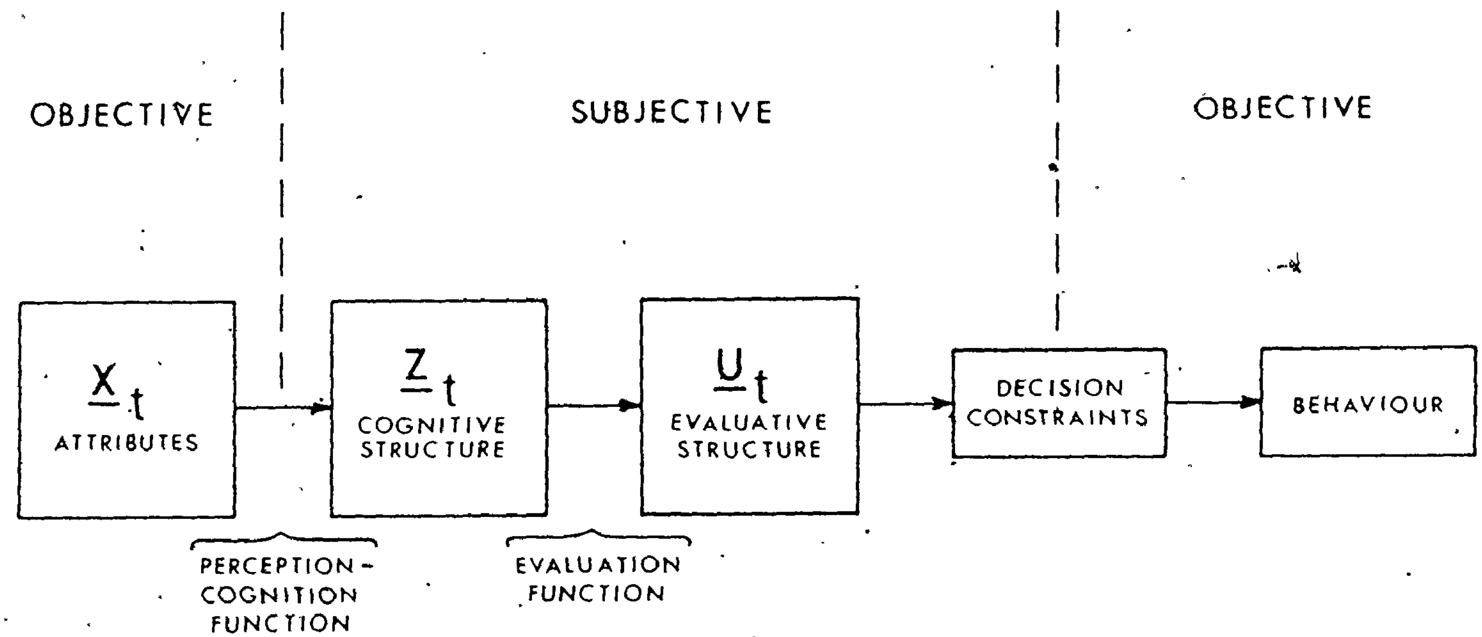

Figure 2.1 Schematic Outline of Behavioural Paradigm

In Figure 2.1, $\underline{X}_t$ denotes a vector representing a description of objective reality at a given time t. Each $x_{it} \varepsilon \underline{X}_t$, i=1,..., n; represents the level of a particular attribute i. This objective reality is then transformed through the processes of perception and cognition into a cognitive reality. $\underline{Z}_t$ denotes a vector describing the cognitive structure for a single individual. Each $z_{jt} \varepsilon \underline{Z}_t$, j=1,..., m; represents the level of characteristic j.[1] Usually cognition is thought to be a process of organization and simplification, hence m<n. This transformation, $\underline{X}_t \rightarrow \underline{Z}_t$, has been, to date, the major focus of research in behavioural geography. (Little effort, however, has been made to relate $\underline{Z}_t$ and behaviour. Cadwallader (1975) provides a recent exception). The cognitive structure provides a basis for evaluations of potential courses of action. $\underline{U}_t$ denotes a vector describing the evaluative structure or relative values placed on a set of behavioural alternatives. The mapping $\underline{Z}_t \rightarrow \underline{U}_t$ is identified here as the evaluation function but has also been referred to as the subjective preference function (Demko and Briggs, 1970). More simply, this mapping may be thought to represent the individual's preferences or preference structure in that the relative weights attached to the cognitive characteristics reflect the individual's preferences. The terms preferences and preference structure will be used frequently. In general they refer to the system of relationships which permit an

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1 Other terms include construct, concept, dimension, factor and component. Some of these terms are associated with a particular structure, e.g., metric space. This is not implied here in the term characteristic.

individual to determine the relative values of a set of behavioural alternatives.

Having evaluated the alternatives the individual must make a decision within the constraints of the situation. Whereas $\underline{U}_t$ represents the positive determinants of behaviour, the constraints represent the 'negative determinants' of behaviour. Anderson (1971) calls these "the outer limits within which behaviour can take place". It is important to distinguish between positive and negative determinants and to recognize that behaviour is a product of both.

An important aspect of this paradigm is that behaviour is purposive. Purposive behaviour is behaviour which is preceded by an active process of evaluation. Evaluation is stimulated by the anticipated need to make a decision and is usually associated with a problem solving situation. This seems appropriate in the context of mobility behaviour where the decision to relocate (or not) is an important one and thus likely preceded by a careful evaluation process. It is less appropriate for situations in which the decisions are less significant or easily corrected if in error. Such behaviours require a consideration of feed-back or learning effects which need not be considered here (see Lloyd, 1976). In the model which is developed, consistent with this paradigm, individuals are assumed to be able to, and to make, careful evaluations of alternatives.

The paradigm also recognizes that changes in behaviour may occur over time. Changes may occur either through changes in the environment, or through changes in the individual. These changes may be seen more

more clearly by expressing the above relationships in functional form:

$$\underline{Z}_t = Z^t(\underline{X}_t) \quad (2.1)$$

$$\underline{U}_t = U^t(\underline{Z}_t) \quad (2.2)$$

Clearly, a change in objective reality, $\underline{X}_t$, will affect the cognitive structure, $\underline{Z}_t$, and in turn the set of relative values, $\underline{U}_t$. In the context of an individual examining a residential environment, these changes might involve changes in the dwelling, e.g., physical deterioration or rebuilt basement, in the lot, e.g., new landscaping or reduced size through sales or annexation etc., in the neighbourhood, e.g., new neighbours or new park, or in relative location, e.g., new expressway or new shopping centre.

Changes may also occur in the individual. These are reflected in changes in either the cognition function, Z^t, or in the evaluation function, U^t, i.e., preference changes. Why such changes may occur is open to speculation. Certainly one possibility is that the way an individual looks at and evaluates his/her environment is affected by life cycle factors. Nevertheless, recognizing that changes in these functions may occur emphasizes the dynamic nature of decision situations, a point which is significant in the model analysis of Chapter 4.

In general the paradigm emphasizes the subjective role of the individual in understanding behaviour. Both the subjective processes of cognition and evaluation are seen as influential in determining behaviour. In the present study, however, the process of cognition and its effects on behaviour are not emphasized. Attention is focused on the evaluation process. This stems from the fact that, despite considerable research on individuals' cognitive structures in a variety of contexts, little is known, in general, about these structures.[1] Hence, little is known about the general properties of the cognition function or the evaluation function.[2] Little more can be stated than that expressed in equations (2.1) and (2.2). These imply that,

$$\underline{U}_t = U^t(Z^t(X_t)) \quad (2.3)$$

which may be expressed as

$$\underline{U}_t = V^t(\underline{X}_t). \quad (2.4)$$

V^t refers to the composite of the functions U^t and Z^t. This states simply that an individual's evaluative structure and hence behaviour is a function of objective reality. Notice however that the function V still depends on the individual so that the subjective nature of the decision process is maintained.

In the theoretical model it is this simpler relationship which is used. The addition of a cognition function, at this initial stage and with our limited knowledge of its properties, would only complicate the analysis. In the empirical analysis, however, the role of cognition is recognized. Studies concerned with the way individuals cognitively organize housing attributes are used as a basis for selecting variables

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1 For a review of cognitive studies see Downs (1970); also the readings in Downs and Stea (1973). A number of general results have been obtained with respect to cognitive distance.

2 Studies concerned with the relationship between cognition and evaluation include those by Klahr (1969), Demko and Briggs (1970), Demko (1974) and Lloyd (1974). See also Burnett (1973).

in the empirical analysis. Cognition, therefore, is recognized as a significant aspect in understanding behaviour, but due to our limited knowledge of cognitive structures and the complication of including a cognition function, it is not treated explicitly in the model. The possibility of incorporating such a function is examined briefly in Chapter 8.

Finally, although this discussion has emphasized the individual as a basic decision unit, in developing the model the household is substituted. This recognizes that the entire household is affected in relocation decisions but ignores the way in which such decisions are reached within the household. It is assumed therefore that the household operates as if it were a single individual. The term individual, therefore, will be understood to represent household.

CHAPTER 3

REVIEW OF MOBILITY CONCEPTS

The purpose of this chapter is to critically review a number of studies concerned with developing a conceptual framework for the analysis of intraurban mobility behaviour. Such studies emphasize the need to understand the evaluation and decision processes of the individual household. To this end a number of theoretical concepts have been proposed to describe this process. The discussion focuses on those theoretical concepts developed to explain why and how households decide to move, and how they select a particular residence. These include place utility, aspirations, and locational stress. These concepts are utilized in Chapter 4 to develop the theoretical model of mobility behaviour.

3.1 Basic Perspective

Following Rossi (1955), studies of intraurban mobility behaviour have adopted a common view of the underlying process: mobility is viewed as a type of adjustment process in which a household alters its residential location in an attempt to attain a residential environment which more adequately accommodates its needs and desires. The basic idea is that of disharmony between a household and its residential environment. Mobility is a particular response to that disharmony. It is only one response, however (Brown and Moore, 1970). A household may, for example, take action to alter its environment, or simply reevaluate its needs and desires.

The degree of disharmony depends on the needs and wants of the household, the household's evaluation of the residential environment, and the residential environment itself. Changes in any of these over time influence the degree of disharmony.

Rossi (1955) has emphasized that the degree of disharmony is strongly affected by changes in the family life cycle. Changes in family life cycle create changes in household needs which affect the degree of disharmony. Expanding families, for example, have increasing needs for space not easily accommodated in a given structure and thus are induced to adjust by moving to a new residence.

The importance of life cycle factors in mobility decisions has been confirmed in a wide range of empirical studies (e.g., Butler _et. al._, 1969; Speare, 1970; Long, 1973; see Shaw, 1975, for a comprehensive review). The results have been so consistent that the relationship has now taken on the status of an empirical law. The life cycle hypothesis, however, emphasizes the effect of needs on the degree of disharmony at the household's present site. As such, attention is focused on push factors.

A different emphasis is suggested by the work of Leslie and Richardson (1961). They argue that the degree of disharmony is affected by occupational advancement. Occupational advancement leads to an increase in desired social status, which in turn increases disharmony. In this approach the role of desires in evaluating different housing opportunities is emphasized. As such, attention is focused on pull factors, specifically the relative attractiveness of other places.

In general, disharmony is a relative concept. It is relative to the individual household, in that changing household circumstances affect needs and desires which influence the degree of disharmony, and it is relative to the environment in that both the household's present residential environment and the set of alternative residential environments affect the degree of disharmony.

Within this general view a number of studies have attempted to specify the mobility evaluation-decision process in more detail (Wolpert, 1965; Brown and Moore, 1970; Moore, 1972). Their approach has been to reconstruct the process from the perspective of the individual household. As a result, a number of theoretical concepts have been proposed to provide a general structure for the evaluation-decision process, pertinent at the level of the individual household. Three of these concepts are particularly important: aspirations, place utility, and stress. The remainder of this chapter is devoted to discussing these concepts.

3.2 Aspirations

The concept of aspirations, as well as that of place utility was introduced by Wolpert (1965). His extremely insightful discussion of the mobility process represents the first effort to develop a theoretical basis for understanding mobility decisions. The approach is behavioural: individuals respond not to the environment but to their evaluation of the environment.

Wolpert's work is based on a particular view of the household as an intendedly rational decision-maker. Intended rationality is a variation of bounded rationality. The concept of bounded rationality emphasizes the limited nature of human decision-making. Specifically, individuals in complex decision situations are bounded, or prevented from making optimal decisions by imperfect knowledge about alternatives and consequences, imperfect foresight about consequences, and imperfect powers of computation of relative values (Simon, 1957; 1972). The concept of intended rationality, as set out by Wolpert, recognizes that individuals are bounded by imperfect knowledge and foresight, but suggests that decision-makers still strive for optimality. Moreover, the decision-maker is thought to possess considerable computational ability. Wolpert (1965, p.161).states:

> We begin with the concept of "intendedly rational" man, who, although limited to finite ability to perceive, calculate and predict and to an otherwise imperfect knowledge of environment, still differentiates between alternative courses of action according to their relative utility or expected utility. Man responds to the perception of unequal utility....

Implicit in this view is the idea that mobility decisions are purposive and goal-directed. As Wolpert says somewhat later "all moves are purposeful, for an evaluation process precedes them".

With this perspective Wolpert defines the concept of aspirations Aspirations represent attainable levels of achievement, which function primarily as standards of comparison. Aspirations are similar to that of satisfactory thresholds in models of satisficing behaviour. In satisficing models, however, the aspiration levels function not only as standards of comparison but also as specific "satisfactory" goals or objectives. Then the evaluation process is a simple binary one: either an alternative exceeds all the aspiration levels, and thus is satisfactory, or does not exceed all aspiration levels and is unsatisfactory. For Wolpert, consistent with his definition of intended rationality, a more complex evaluation process occurs in which differences from the aspiration level are evaluated. Differences normally have no meaning in a satisficing approach. Aspiration levels then, reflect a level of attainable satisfaction, but not necessarily a satisfactory level.

Specifically, Wolpert (1965) defines the concept of an aspiration level in the following way:

> The individual has a threshold of net utility or an aspiration level that adjusts itself on the basis of experience. This subjectively determined threshold is a weighted composite of yardsticks for achievement ...(Wolpert, 1965, pp.161, 162).

The role of aspirations in evaluation is specified:

> The threshold functions as an evaluative mechanism for distinguishing in a binary sense, between success or failure, or between positive or negative net utilities. (Wolpert, 1965, p.162).

And the factors which influence aspirations are outlined, namely past experience and life cycle stage which influences the households needs and desires:

> The process is self-adjusting because aspirations tend to adjust to the attainable. (Wolpert, 1965, p.162).

And

> His accumulated needs, drives, and abilities define his aspirations....aspirations require the fulfillment of many needs. (Wolpert, 1965, p.165).

A relationship between needs and aspirations has been suggested by Simon (1957), although in the context of a satisficing model, and the relationship between needs and life cycle has been suggested by Rossi (1955).

One difficulty in this discussion is the implicit distinction between an aggregate aspiration level (i.e., "weighted composite") and a set of aspiration levels (i.e., "yardsticks"). It is unclear how an aggregate aspiration index would be defined by an individual who evaluates perceived differences. Moreover it appears to be neither necessary in, nor consistent with, the definition of place utility, which will be discussed below. We shall return to this point in the discussion of the evaluation process.

A second difficulty is that intuitively there seems to be a contradiction in defining aspiration levels with respect to needs. Needs usually refer to minimum levels, aspirations to maximum or at least desired levels. In satisficing models, satisfactory levels function as needs as well as goals in that alternatives not exceeding all levels are unsatisfactory and rejected. These need levels are inviolate. In Wolpert's conception, however, these aspiration levels are not inviolate. They function as standards of comparison which define negative as well as positive net utilities. Thus they seem to function more as desires than as needs. Golant (1973) argues that needs and desires have qualitatively different impacts on the mobility decision, particularly on the household's commitment to moving, and thus should be carefully distinguished.

Brown and Moore (1970) have attempted to extend the concept of aspirations by introducing the concept of an aspiration region. They suggest that households may define upper and lower limits to their needs. For example, a household may reject either too little or too much space. Characterizing needs as an n-dimensional space, Brown and Moore, define a lower aspiration vector, $\underline{X}(t) = \{\overleftarrow{x}_i(t);\ i=1,\ldots,n\}$, and an upper aspiration vector, $\overline{X}(t) = \{\vec{x}_i(t);\ i=1,\ldots,n\}$, representing lower and upper need limits respectively. These vectors delimit an acceptable region. Residences which do not fall completely within this region are not acceptable. The limits may vary over time, particularly as life cycle changes occur over an intermediate time period and as sequences of unsatisfactory vacancies occur in the search process over a short time period.

The use of the term aspirations again seems undesirable. Within this view, however, needs and desires may be distinguished. The lower aspiration vector may be associated with minimum need levels; the upper aspiration vector with maximum need levels. Values inside this region meet the household's needs and may differ in desirability. Thus, the aspiration region defines a set of ranges over which "desires", or preferences, operate.

Within this framework, Wolpert's idea of attainable aspirations may be defined. Whereas upper and lower aspirations (needs) reflect only the household's situation, attainable aspirations should also reflect the opportunities in the action space.[1] Thus attainable aspirations are determined by the household's desires within the constraints of both the household's situation (i.e., aspiration region) and the set of opportunities. Attainable aspirations are analogous to what Kennedy (1975) has referred to as expectations. Expectations are immediately attainable goals, or short term objectives "constrained by a household's ability to attain a particular type of residence site". These are important in any single move. They may be contrasted with ideals which are unconstrained, and which function as long term goals, not presently attainable. Each move, then, is a step toward the ideal, forming a sequence of moves over the life-span. For a single move, however, the concept of attainable aspirations or expectations is more relevant.

To summarize, the concept of an aspiration region, may be used to define two need vectors and an (attainable) aspiration vector. $\underline{X}(t)$ refers to minimum need levels. These may be socioeconomically rather than physically determined; some may be zero, and some may vary with life cycle. $\underline{\vec{X}}(t)$ refers to maximum need levels, again socioeconomically determined and sensitive to life cycle changes. For some needs, upper limits may not exist -- more always being better. For others, all values $x_i > \vec{x}_i$ may be completely unacceptable or at least beyond evaluation. $\underline{X}^*(t)$ refers to attainable aspirations or expectations, dependent on the

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1 Action space is that limited area about which the household has sufficient information to be able to assign place utilities. It may be recognized as a spatial expression of the limited knowledge possessed by an intendedly rational decision-maker (Wolpert, 1965).

household's desires or preferences and the set of perceived opportunities in the action space. Notice that whereas need levels are reasonably considered to be exogenously determined, aspirations are endogenously determined since they depend on the household's preferences. Thus, while the vectors $\underline{\bar{X}}(t)$ and $\underline{\hat{X}}(t)$ may be considered unique, $\underline{X}^*(t)$ may not be unique depending on the postulated evaluation process, and the nature of the attributes. In other words there may be several attainable aspiration vectors equally desirable.

3.3 Place Utility

Place utility is a measure of relative value attached to a particular residence (place) by a particular household. It is defined in relation to the household's aspirations. Thus, it may be thought of as a measure of how adequately a particular place meets a particular household's aspirations. Wolpert (1965, p.162) states:

> Place utility, then, refers to the net composite of utilities which are derived from the individual's integration at some position in space. The threshold reference point (i.e., aspiration level) is also a relevant criterion for evaluating the individual's place utility...Thus, place utility may be expressed as a positive or negative quantity, expressing respectively the individual's satisfaction or dissatisfaction with respect to that place.

Although the term "integration" suggests that place utility is confined to the household's present residence, other places in the household's action space may be assigned place utilities. However, there is clearly a qualitative difference between a household's present place, about which it has first-hand experience and other places about which it has limited, indirect, knowledge. Brown and Longbrake (1969), therefore, distinguish between "experienced place utility", and the place utility of other places. The place utility of other places have an anticipated value or expected utility.

Other definitions of place utility have been suggested. Simmons (1968) suggests, quite simply, that place utility is a "measure of the attractiveness or unattractiveness of an area, relative to alternative locations as perceived by the individual decision-maker". Brown and Longbrake (1970) suggest that place utility is a measure of relative value which depends both on the household's past experience and attainments, and on future expectations. These expectations or aspirations provide a standard of comparison. They state:

> The degree to which (expectations) are satisfied at a particular residential site is one measure of the utility of that place (location).

And,

> To measure place utility the aspirations of the household in terms of residential environment and the environment of its present (or prospective) residence(s) should be considered.

The basic idea of these definitions is that place utility is a relative measure of satisfaction. It is relative both to the household's aspirations and to other places in the action space.

The difficulty with the idea of place utility is the question of <u>how</u> it is measured by the individual. Or specifically, how does the evaluation process operate? In Wolpert's (1965) framework, the aspiration level functions as a standard of comparison for evaluating place utility.

But as noted previously, there is an ambiguity as to how this comparison is performed. This stems from a vagueness in distinguishing between an aggregate aspiration threshold and a set of aspiration levels. Although Wolpert's discussion focuses on <u>the</u> (aggregate) aspiration threshold, his definition of place utility refers to a "net composite of utilities".

One approach to specifying the evaluation process is to focus on the idea of a set of aspirations. In this case we may consider a residence to be a bundle of attributes, so that a particular residence may be defined by a vector $\underline{X}$, where each element $x_i \epsilon \underline{X}$; $i=1,\ldots, n$, represents a level of a particular attribute. The household may then define aspiration levels on each of these attributes. This set of aspirations may be denoted by a vector $\underline{X}^*$, where $x_i^* \epsilon \underline{X}^*$; $i=1,\ldots, n$, represents an attainable threshold level for attribute i. Then these aspiration quantities of attributes may be compared to the actual quantities of attributes of a particular residence and these <u>differences</u> evaluated to yield a measure of place utility. In this way, place utility is, as Wolpert suggested, a "composite of utilities". The major weakness of this approach, however, is that no mechanism is specified as to how the set of aspirations is determined. As noted previously, aspirations should be determined endogenously as part of the evaluation process.

A somewhat different approach to defining place utility and aspirations has been developed by Moore (1972). He suggests that households may be thought to possess a set of basic values. These values permit a household to perform three operations:

1. to provide a set of expectations specifying the level of each residence attribute which is deemed acceptable ,

2. to provide a valuation of the household's present residence, i.e., experienced place utility, and

3. to provide valuations of specific alternatives, i.e., place utilities of other residences in the action space, which leads to a preference ordering of those alternatives.

This approach differs in at least two important ways. First, place utility is defined in relation to a basic set of values, and not specifically in relation to aspirations. Thus, place utility is not a measure of how adequately a residence meets a household's aspirations, but is a measure of value defined by the household's set of basic values, and relative to other places in the action space. Second, the set of aspirations are also defined by the household's basic set of values, which means they may be determined within the household's evaluation system. This is advantageous. However, the criterion by which a household determines these aspiration quantities is not clearly specified; the idea of "acceptable" is vague.

A further aspect of this framework is that since the set of aspirations refer to levels of residence attributes and since a household is able to determine the relative value of a residence, then the household may also calculate the utility or value associated with the set of aspirations. This utility level may be defined as the aspiration place utility, or simply aspiration utility. Perhaps this was the intention of Wolpert's aggregate aspiration threshold. Clearly, what is desired is a framework in which the evaluation process is unambiguously specified such that both place utility and aspirations are meaningfully determined.

3.4 Stress

The concept of stress was first applied to the problem of mobility by Wolpert (1966). He viewed stress as the composite result of a number of stressors defined as "potentially noxious environmental forces pressing on the individual". Stress was then transformed into strain, a measure of the strength of stress as perceived and evaluated by the household. With different levels of strain the household could adopt different coping responses, one of which was relocation.

The distinction between stress and strain, however, does not appear to be significant since stress is not independent of the perceiving individual. Thus Brown and Moore (1970) dispense with the concept of strain, recognizing stress as a measure of the strength of a set of stressors relative to the household. They state:

> Stressors relevant to migration behaviour derive from disparity between the collective needs of the household and the characteristics of its environment.

Thus stress is a measure of disparity or disharmony between a household and its environment. Such a definition suggests that stress for a given household depends only on the local environment operating as a push factor in mobility. But stress may also depend on the relative attractiveness of opportunities in the action space.

Clark and Cadwallader (1973) and Clark (1975) recognize stress as a measure of disparity, but between satisfaction at the present location and the potential satisfaction elsewhere. They define locational stress as:

> the gap between satisfaction at one location and that potentially possible at another...(it is) the difference between an individual household's present level of satisfaction and the level of satisfaction it believes may be attained elsewhere. (Clark, 1975, p.168)

Of course satisfaction depends on the degree to which needs and desires are accommodated at a particular place. Thus, this definition of stress may be recognized as incorporating both push and pull factors.

This idea of stress forms the basis of the concept of residential stress developed in the model in the following chapter. If we recognize that satisfaction at the household's present residence is analogous to experienced place utility, and that satisfaction believed attainable elsewhere is analogous to aspiration utility, then locational stress is simply the difference between experienced place utility and aspiration utility. To emphasize the more general concept of place utility proposed in the model, namely that place utility depends not only on aspects of the residence including location but also on the consumption of other goods, this concept of stress is referred to as residential stress.

CHAPTER 4

THE THEORETICAL MODEL

4.1 Introduction

The objective of this chapter is to develop and analyze a model of the mobility decisions of households. In the first part of the chapter (section 4.2) the model is developed. In the second part of the chapter (section 4.3) the effects of certain changes are analyzed. This analysis provides the basis for a number of empirically testable hypotheses which are developed in Chapter 5.

The model is based on the concepts of place utility, attainable aspirations and stress. These concepts are explicitly defined in the model. Particularly, the concept of attainable aspirations is specified within the model as part of the evaluation process; aspirations are not assumed to exist independent of the evaluation process. The relationships among these concepts are also specified. Residential stress is defined as the difference between aspiration utility and experienced place utility.

These ideas are developed within the framework of the theory of consumer behaviour. In this approach a consumer is thought to possess a set of preferences for different combinations of quantities of commodities. These preferences determine the consumer's behaviour. Faced with a choice among a set of available alternatives, i.e., commodity bundles, the consumer selects that alternative which is most preferred. Such behaviour is termed rational. The ability to make such choices implies that the consumer has information about, and is able to evaluate, alternatives. Not all alternatives, however, may be feasible since the cost of purchasing and consuming certain bundles of commodities may exceed the consumer's budget or income.

Under certain conditions, the consumer's preferences may be represented by a utility function (see Green, 1971). A utility function is a mapping which associates with each commodity bundle, a unique number such that if the bundle $\underline{Z}^i$ is preferred to the bundle $\underline{Z}^j$, then the number associated with $\underline{Z}^i$, namely $U(\underline{Z}^i)$, is greater than the number associated with $\underline{Z}^j$, namely $U(\underline{Z}^i)$. Stated more succinctly:

$$\underline{Z}^i \text{ preferred to } \underline{Z}^j \Leftrightarrow U(\underline{Z}^i) > U(\underline{Z}^j).$$

The advantage of assuming the existence of a utility function is that it permits the problem faced by the consumer to be formulated as a mathematical problem, namely a constrained optimization problem and analyzed using known mathematical concepts.

Normally in consumer theory, a utility function is recognized as being unique only up to an ordinal transformation. In other words the utility function conveys information only about the relative ranking of alternatives. In the present model, however, the utility function will be assumed to be unique up to a linear transformation. That is, the utility function maps out an interval scale in which not only the rankings but the relative utility differences have meaning. This assumes that the utility values express preference intensities.

In the present model the range of commodities is partitioned into two sets relating to housing and all other goods. Housing is recognized as a multidimensional commodity. A residence or residential environment (the terms will be used synonymously), represents a bundle of "attributes". These include aspects of the dwelling and lot, such as the amount of internal and external space, aspects of the neighbourhood, both physical and social, and aspects of relative location such as the distances to work, shop, or friends.

The model also specifically includes economic constraints, namely household income and housing costs. Clark (1976) has recently argued that the behavioural approach, focusing on preferences, has neglected the economic constraints affecting mobility behaviour. He provides evidence of the validity of using simple economic variables in predicting intra-urban migration behaviour. The present model incorporates these constraints in explaining mobility behaviour.

Finally, the model adopts the view of the household as an intendedly rational decision-maker. This interpretation is consistent with the theory of consumer behaviour. It recognizes, however, that decision-makers are not omniscient but have limited information about alternatives and consequences; choices are made from this more limited set. Intendedly rational behaviour therefore, following Wolpert (1965) emphasizes that households have limited knowledge and predictive ability, but considerable powers of computation. This last assumption does not appear particularly restrictive given the nature of the problem situation. Relocation usually is of major significance to a household and thus subject to considerable effort and consideration. Consequently, we would expect a detailed evaluation process.[1]

4.2 The Model

The individual household is assumed to have a preference structure which may be represented by a utility function;

$$U_t = V^t(\underline{X}_t, \underline{Z}_t) \tag{4.1}$$

U_t is the utility at time t, $\underline{X}_t$ is the vector of attributes of a residential environment, $\underline{Z}_t$ is the vector of attributes of all other goods, and V^t is the specific preference mapping, or utility function, all identified at time t. The attributes of a residential environment may include aspects of the site, neighbourhood, and relative location. For a particular residential environment, $x_{it} \epsilon \underline{X}_t$; i=1,..., n, is the level of attribute i at time t; $z_{jt} \epsilon \underline{Z}_t$; j=1,..., m, is the level of "other good" j consumed by the household at time t. The fact that the utility function, V^t, is indexed by time indicates that the household's preference structure may change over time. Occasionally, the time index will be dropped with the understanding that the situation refers to a specific point or short period in time.

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1 We should also recognize that a model represents both an approximation to reality and a tool for analysis. Thus unrealistic assumptions must be evaluated on the basis of their impact on the conclusions, and whether any results at all can be obtained without those assumptions. Of course, one advantage of a formal approach is that it promotes explicit consideration of assumptions and avoids implicit assumptions of which one is not aware. Implicit assumptions may be more damaging since their impact is unrecognized.

The utility function is assumed to have two properties; that it is differentiable and quasiconcave. Differentiability implies that V^t is smoothly continuous, and may be recognized as an approximation to reality. It is adopted to permit easier exposition of certain concepts.[1] Quasiconcavity, which includes concavity as a special case, implies that V^t is non-decreasing over some range, and then non-increasing over some range. For example, a bell shape is quasiconcave. This represents a very weak assumption, permitting for example, increasing marginal utilities, "flat portions" and satiation points.

The household is also assumed to be faced with three types of constraints. First, the household is assumed to have a set of minimum need levels which may represent physical subsistence levels or socio-economically determined need levels. These are denoted by the vectors, $\underline{\bar{Z}}(t)$, $\underline{\bar{X}}(t)$. Some $\bar{z}_j(t)\epsilon\underline{\bar{Z}}(t)$; $j=1,\ldots, m$ and $\bar{x}_i(t)\epsilon\bar{X}(t)$; $i=1,\ldots, n$, may be zero. These minimum need levels correspond to Brown and Moore's (1970) lower aspiration limits. They may be interpreted as attribute levels below which tradeoffs are meaningless. That is analogous to satisficing models, if say, $x_i<\bar{x}_i$, then the household cannot be compensated by increases in another (or several) attributes, say x_k, regardless of how much x_k is increased. The vectors $\underline{\bar{Z}}(t)$, $\underline{\bar{X}}(t)$, which define the household's set of minimum needs may change over time. Particularly,

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[1] For an interesting analysis of a situation in which some goods are recognized not to be continuous but to occur in a number of discrete quality levels, see Sweeney (1974).

they would appear to be sensitive to life cycle changes.

Second, the household is assumed to have a set of upper need levels denoted by the vectors $\vec{\underline{Z}}(t)$, $\vec{\underline{X}}(t)$. These correspond to Brown and Moore's (1970) upper aspiration limits. They specify a point beyond which the household is unable to make evaluations; tradeoffs are meaningless. For example, the consumption of food over a given time period is limited at some point. For some commodities, however, upper need limits may not exist, i.e., $\vec{z}_j(t)=\infty$; $\vec{x}_i(t)=\infty$, where $\vec{z}_j(t)\epsilon\vec{\underline{Z}}(t)$ and $\vec{x}_i(t)\epsilon\vec{\underline{X}}(t)$. Further, for some goods, upper need levels may change over time: too much space for a household at one point in time may not be too much at a later point in time, particularly if household size has increased.

Third, the household has a limited income, Y(t). This is defined as the household's permanent or normal income which, in turn, is defined as the long run expected income free of transitory or short run income fluctuations. The household, then, is thought to base decisions on stable income expectations. This, of course, depends on past and present income flows. This definition is adopted here since it has been shown to be an appropriate measure of income in analyzing household consumption patterns, particularly housing consumption (Reid, 1962).

With this view of the household, experienced place utility may be defined:

$$U_t^o=V^t(\underline{Z}_t^o, \underline{X}_t^o) \qquad (4.2)$$

U_t^o refers to a particular household's experienced place utility; $\underline{X}_t^o$ refers to the attribute levels of that household's residential environment; and $\underline{Z}_t^o$ refers to the levels of all other goods consumed, all at time t.

Since the attributes of a household's residence are fixed at a given time t, i.e., $\underline{X}_t^o$ is fixed, the vector $\underline{Z}_t^o$ is defined as the solution to the following problem:

$$\begin{aligned} \text{Max} \quad & U_t = V^t(\underline{X}_t^o, \underline{Z}_t) \\ \text{s.t.} \quad & R(\underline{X}_t^o, t) + \underline{P}(t)\ \underline{Z}_t \leq Y(t) \\ & \underline{Z}_t - \bar{\underline{Z}}(t) \leq 0 \\ & \underline{X}_t^o - \bar{\underline{X}}(t) \leq 0 \\ & \underset{\sim}{\underline{Z}}(t) - \underline{Z}_t \leq 0 \\ & \underset{\sim}{\underline{X}}(t) - \underline{X}_t^o \leq 0 \end{aligned} \tag{4.3}$$

where $\underline{P}(t)$ refers to the known vector of prices associated with goods $\underline{Z}$, and $R(\underline{X}_t^o, t)$ refers to the known costs associated with the household's residence at time t, i.e., the household's present residence.[1] Having determined $\underline{Z}_t^o$, the utility level, U_t^o is also determined.

Problem (4.3) may be interpreted in the following way. The household, as an intendedly rational decision-maker, seeks to maximise its utility. It does so by allocating its income to housing and other goods in a manner consistent with its preferences, but in the present case,

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1. A solution to this problem is guaranteed to exist if the feasible region is nonempty and R is linear, along with the previous assumption that V^t is quasiconcave. This has been shown by Kanaroglou (1976). For a discussion of conditions necessary and sufficient for solution without upper limits, see Chiang (1974; Chapter 20). Numerous studies have been devoted to empirically examining the relationship between housing attributes and price: These studies have generally found a linear relationship to provide high levels of statistical explanation. See, for example, Berry and Bednarz (1974); Kain and Quigley (1970); Apps (1971); or Little (1976).

the household's housing, i.e., residence, $\underline{X}_t^o$, and housing cost, $R(\underline{X},t)=R(\underline{X}_t^o,t)$, are fixed. Thus the household seeks to allocate its remaining income, after housing costs, optimally to the purchase and consumption of other goods, $\underline{Z}$. This consumption of other goods which is associated with the household's residence at time t, is denoted by $\underline{Z}_t^o$. The formulation may be extended to define the place utility of other places in the household's action space by replacing $\underline{X}_t^o$ and $R(\underline{X}_t^o,t)$ by $\underline{X}_t'$ and $R(\underline{X}_t',t)$ where the prime denotes a <u>particular</u> residence other than the household's present residence.

In a similar manner, attainable aspirations and aspiration place utility may also be defined. Aspiration place utility, U_t^*, is the utility level associated with the household's attainable aspirations, denoted by the vectors, $\underline{X}_t^*$, $\underline{Z}_t^*$, i.e.,

$$U_t^*=V^t(\underline{X}_t^*,\ \underline{Z}_t^*). \tag{4.4}$$

The vectors $\underline{X}_t^*$, and $\underline{Z}_t^*$, are defined by the following problem:

$$\begin{aligned} \text{Max}\quad & U_t=V^t(\underline{X}_t,\ \underline{Z}_t) \\ \text{s.t.}\quad & R(\underline{X}_t;t) + \underline{P}(t)\ \underline{Z}_t \leq Y(t) \\ & \underline{X}_t-\underline{\bar{X}}(t)\leq 0 \\ & \underline{Z}_t-\underline{\bar{Z}}(t)\leq 0 \\ & \underline{\tilde{X}}(t)-\underline{X}_t\leq 0 \\ & \underline{\tilde{Z}}(t)-\underline{Z}_t\leq 0 \end{aligned} \tag{4.5}$$

where housing prices, $R(\underline{X},t)$ and other goods prices $\underline{P}(t)$, are known. Solution of this problem yields $\underline{Z}_t^*$, $\underline{X}_t^*$, and by (4.4), U_t^*. Notice that the basic distinction between problems (4.3) and (4.5) is that in the former case residential attribute levels are fixed; they refer to the household's present specific residence, whereas in the latter case, residential attribute levels are not fixed as the household considers a range of possible residential accommodations.

The evaluation process described by problem (4.5) may be interpreted in the following way. The household is thought to possess information about other residential environments in the urban area. This information is accumulated through casual contact with friends, relatives, business associates, etc. and through the mass media. These sources are important in influencing the household's knowledge of the range of opportunities in the action space and particularly their prices reflected in the term $R(\underline{X},t)$ which varies over space. The household, therefore, develops an expectation of prices at each location in the action space; i.e., $R(\underline{X},t)$ is known, or at least, believed known by the household.[1] With this information, and given its preferences, needs, and income, the household is able to determine the optimal combination of housing and other goods at each location, and hence the attainable level of utility at each location. The optimal consumption bundle at each location, however, represents a hypothetical combination and does not necessarily refer to a specific residence. In performing these calculations, the household maps out what may be thought of as a utility aspiration surface (Fig. 4.1). The highest point on this surface represents the household's

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1 Location need not refer to a point but may refer to a small area or neighbourhood.

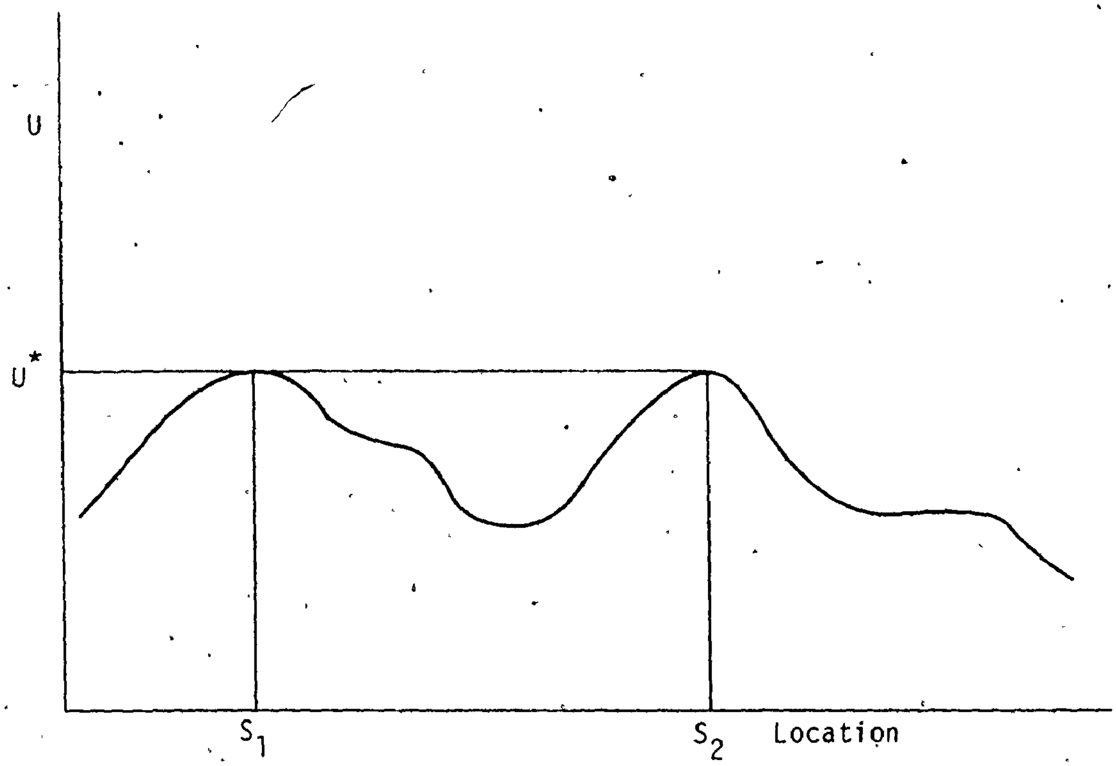

Figure 4.1 Cross-Section of an Aspiration Utility Surface

aspiration place utility. The vectors $\underline{Z}^*$, $\underline{X}^*$ which correspond to that optimal point represent the household's aspirations.[1] There may, however, be a number of locations which achieve the same optimal aspiration utility, U^*, as shown in Fig. 4.1. Corresponding to these points will be different aspirations vectors, i.e., different quantities of $\underline{Z}$ and $\underline{X}$ may yield the same level of utility. This arises from the fact that $R(\underline{X},t)$ is composed of a number of separate costs which may vary differently over space. This leads to different tradeoffs among the elements of $\underline{Z}$ and $\underline{X}$. Thus, while the level of aspiration utility, U^*, will be unique at any one time, the household's aspirations ($\underline{Z}^*$, $\underline{X}^*$) need not be unique. Nevertheless, for simplicity, we shall often speak of aspirations as if they were unique.

Given these concepts, we may formalize the concept of residential stress, S, as the difference between aspiration utility and experienced place utility:

$$S=U_t^*-U_t^o \qquad (4.6)$$

This may be interpreted as follows. At any point in time a household's relative satisfaction with a given situation depends not only on what the household has, but also on what the household thinks it could have.

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1 Notice that there is a relationship between this model of residential evaluation and that developed by Alonso (1964). In the present model the household develops expectations of prices which permits it to calculate U* and hence an aspiration utility surface. In Alonso's model the reverse occurs. The household determines the price it is willing to pay to achieve a given level of utility. Over space this maps out a bid-rent curve. Different bid-rent curves correspond to different utility levels. Similarly, in the present model, different aspiration utility surfaces correspond to different price expectations.

The difference between these is a measure of relative dissatisfaction, or in this case, residential stress. Over time, this difference may change so that the present situation becomes either less, or more, satisfactory. If stress associated with that residential environment increases, the household may decide to seek a new residence.

At low levels of stress, however, the household is not likely to contemplate moving. Instead, the household may adopt other behavioural responses to reduce S (Brown and Moore, 1970). For example, the household may modify its present residence, thereby increasing U_t^0 and reducing S. At high levels of residential stress, however, the household may take the more drastic action of deciding to seek a new residence.

These different responses may be thought to correspond to different stress threshold levels (Wolpert, 1966). Particularly, one stress threshold level, $\alpha(t)$, may be associated with the following simple relocation decision rule: if S exceeds $\alpha(t)$, i.e. $S>\alpha(t)$, then the household decides to seek a new residence. Within the model, $\alpha(t)$ may be interpreted as the anticipated disutility associated with the effort required to relocate. This is consistent with the fact that since $\alpha(t)$ is being compared to a utility measure, (S), it also must represent a utility measure.[1] The factors affecting $\alpha(t)$ may include money costs

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[1] Since $\alpha(t)$ represents a utility measure it could be incorporated into the calculation of aspiration utility. This might be appropriate to the extent that relocation costs may vary with potential destinations. On the other hand, these costs represent a one time cost which appears to be more appropriately considered as an impediment to relocation rather than an aspect of attainable aspirations.

associated with searching and moving as well as psychic costs.[1] These psychic costs, however, include not only the discomfort of actually moving but also the loss of social and psychological ties with the present residence. Thus $\alpha(t)$ represents an inertia factor analogous to that utilized in semi-markov models of mobility where the probability of moving from place i to place j at time t depends on the length of residence at i prior to t (Ginsberg, 1971; for a review see Shaw, 1975). This inertia effect is supported by empirical evidence: as the length of residence increases, the probability of moving decreases (Land, 1969; Morrison, 1967; Speare, 1970). The effect is known as the duration of stay effect or law of cumulative inertia and is explained by the increased social and psychological ties in an area which a household develops over time. Thus, the residential stress threshold, $\alpha(t)$, may be interpreted as a disutility measure associated with the economic, social and psychological costs of moving which increases with time at a particular residence.

To summarize, the basic idea of the model is that a household compares what it has, i.e., experienced place utility (U^O), with what it believes it could have, i.e., aspiration utility (U^*). The difference between these is a measure of relative dissatisfaction or residential stress (S). If residential stress exceeds the household's stress threshold

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1 Simmons (1968) has suggested that moving costs may be as high as 10% of the value of the residence.

level, $\alpha(t)$, then the household decides to seek a new residence; otherwise the household decides to continue living at its present residence.

In relation to previous studies, a number of aspects of this model are important. At least five points may be emphasized. First, place utility is unique to the individual household, at least to the extent that the household's preferences, V^t, and income, $Y(t)$, are unique. Thus it follows from this model that attempts to define aggregate place utility measures for urban sub-areas (e.g., Brown and Longbrake, 1970), must implicitly assume that all households have the same preference structure and income. Even if a number of income-life cycle groups can be defined with similar preference structures within groups, but varying between groups, then not one, but several place utility measures for a single area should be calculated before the concept of place utility is used in aggregate analyses of intraurban migration flows. Of course, the extent to which individuals can be aggregated into a limited number of homogeneous preference groups is an empirical question. The problem of aggregating individuals is discussed briefly in Chapter 8.

Second, place utility depends not only on the consumption of housing, i.e., the nature of the residence attributes, but also on the consumption of other goods. This reflects the simple observation that a poor household will not be happy in a house, regardless of how attractive it is, if they have no money left to buy food. Place utility defined only in terms of housing attributes implicitly assumes that the utility associated with the residential environment can be separated from the utility associated with the consumption of other goods. That is, the utility associated with a given residence is independent of the levels of consumption of other goods. This is invalid. The present definition of experienced place utility, therefore, differs from previous definitions in that U^{o} is defined to <u>include</u> place attributes rather than being defined <u>only</u> with respect to place attributes.

Third, in the present model, aspirations and aspiration place utility follow from an evaluation process. Aspirations are seen to depend on the household's preferences, the household's constraints of needs and income, and the constraints of the market situation, i.e., the set of opportunities and their prices. In this formulation, therefore, aspirations are endogenously determined and not exogenously given as in most earlier formulations.

Fourth, aspiration utility and place utility vary over time. That place utility changes over time has not been emphasized in previous studies. In the present model, however, changes may occur in the parameters of income, $Y(t)$, prices of other goods, $\underline{P}(t)$, housing costs, $R(\underline{X},t)$, upper need limits, $\overset{*}{\underline{X}}(t)$, $\overset{*}{\underline{Z}}(t)$, and minimum need limits, $\overset{+}{\underline{X}}(t)$, $\overset{+}{\underline{Z}}(t)$, all of which may affect place utility. Moreover, changes may occur in the attribute levels of the residential environment itself; for example, the social characteristics of the neighbourhood may change, or changes may occur in the household's preference structure affecting the place utility of a given residence relative to other places in the household's action space, i.e., changes may occur in the parameters of the function V^t.[1] Such changes are vital to an understanding of mobility behaviour. As a result, the effects of these parameter changes on aspiration utility, experienced place utility and, hence, residential stress are discussed more fully in section 4.3, below.

Finally, a fifth aspect of the model concerns the role of opportunities in the decision to seek a new residence. The set of opportunities, real or perceived, influence the household's expectations of housing prices, or, put differently, the types of residences which may be purchased at various prices. These price expectations affect the household's aspirations, aspiration utility, and hence, residential stress. Thus, the attractiveness of the set of opportunities is important in determining the level of dissatisfaction or residential stress which a household feels at its present residence. In previous studies this relationship between opportunities and dissatisfaction has not been emphasized. Instead dissatisfaction has been viewed as the result of inadequacies with the household's present residence. Opportunities and dissatisfaction, however, cannot be separated.

Given that a household has decided to seek a new residence, the

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[1] Changes in utility levels always reflect relative changes. Henceforth, we shall speak of increases or decreases in, for example, experienced place utility as if these were absolute changes, but shall mean relative changes. For example, if we say place utility has increased, this shall be interpreted as increased relative to the place utility levels of other residences in the action space unless explicitly specified to the contrary.

next phase in the mobility sequence involves a process of search and evaluation leading to the decision to select a specific residence. With respect to the present formulation, three questions may be considered. First, what is the role of aspiration utility in the search and evaluation process? Second, how do aspirations and aspiration utility change during search? And third, what factors influence the length of search?

In the process of search, aspiration utility may function as a goal, both in a spatial and psychological context. Spatially, U^* is associated, via the aspiration utility surface, with a limited number of locations. In search these locations will be examined first. Thus, U^* will guide the spatial sequence of search. More generally, however, U^* functions as a psychological goal. In this respect, U^* may operate as a goal in a satisficing manner. For example, the household may select the first residence, say, $\underline{X}'$, whose place utility reaches or exceeds the aspiration utility, i.e., $U' = V^t(\underline{Z}', \underline{X}') \geq U^*$. Unlike a typical satisficing model, however, not all initial attainable aspirations need be satisfied. Some attribute levels may exceed the attainable aspiration level and compensate for other attribute levels below the attainable aspiration levels. It is the place utility of the residence which must exceed (or equal) the aspiration utility, i.e., $U' \geq U^*$, and not the individual aspiration levels.

The household, however, may not immediately choose a residence whose place utility exceeds its aspiration utility because in encountering such a vacancy, the household's aspiration utility may change. For example, if $U' \geq U^*$ and $(\underline{X}', \underline{Z}') \neq (\underline{X}^*, Z^*)$, then the household's original price expectations must have been incorrect; otherwise residence $\underline{X}'$ would not be attainable. In this case, the household may alter its expectations and hence U^*. This may be clarified with reference to Fig. 4.2. This shows a household's choice set for the simple case where there are only two choice attributes, X and Z. The household's initial price expectations are reflected in the budget line Y_0. The households aspirations then will be (X_0^*, Z_0^*) and aspiration utility U_0^*. If the household, however, identifies the vacancy (X', Z') which is economically feasible, then the household may alter its expectations. This is reflected in the new budget constraint Y. The new aspirations would be (X^*, Z^*) and new aspiration utility would be U^*. With this new aspiration utility, what had been an acceptable residence, would now be rejected and search would continue. In this way, changes in price expectations, which in turn affect aspiration utility, explain why a household may not immediately select an acceptable residence in search and why, if U^* later falls, such a residence may be subsequently chosen.

Aspiration utility may fall if the household encounters repeated failures in search. This may result in the household deciding either to remain in its present residence, and thus end search, or reconsidering previously unacceptable residences encountered in search. However, even if U^* falls to the point that residential stress is less than the original stress threshold, the household may still move, if $\alpha(t)$ has also decreased. $\alpha(t)$ may decrease in search as more and more of the original expected costs of relocation are foregone. Thus, at some time after

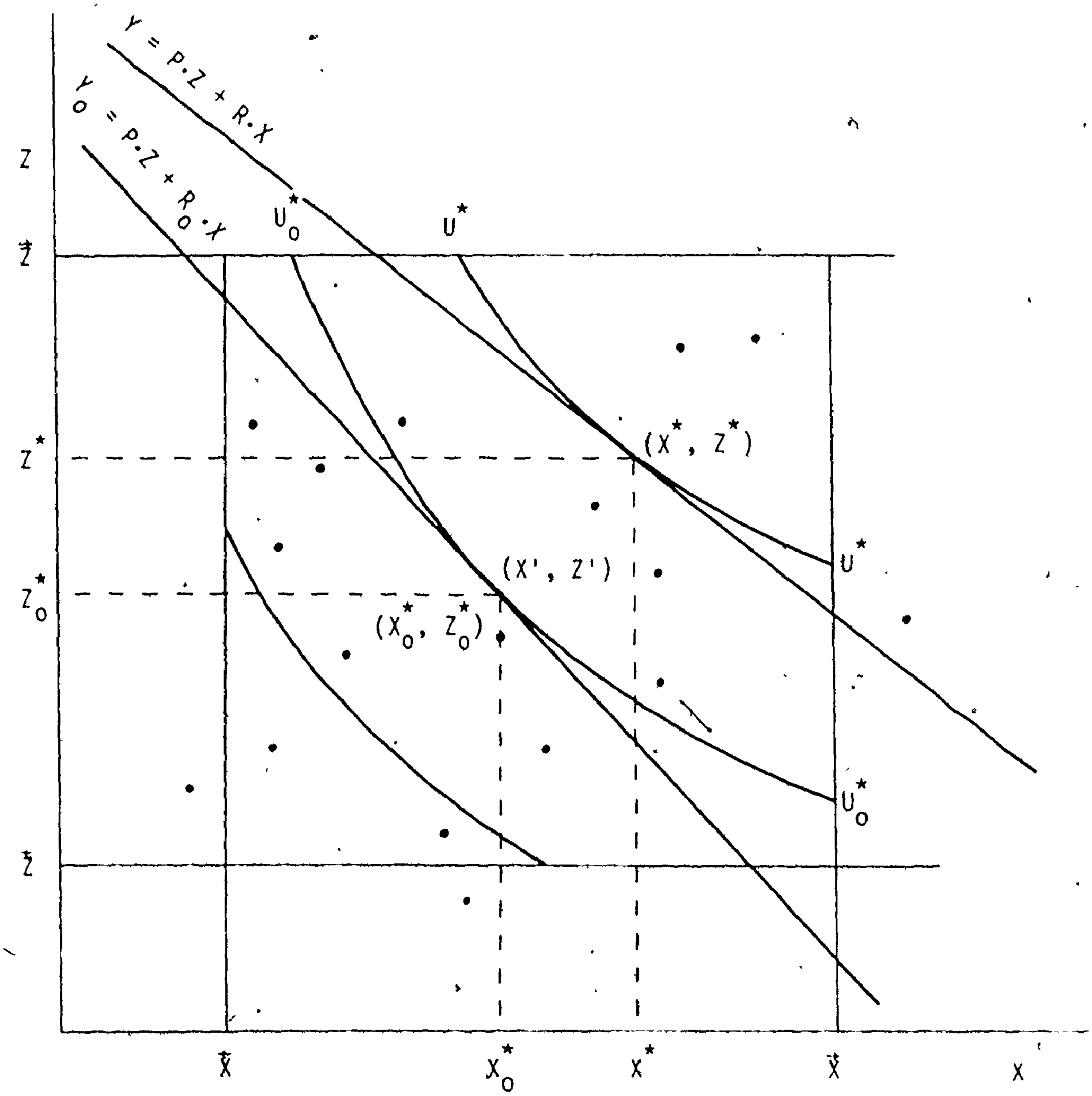

Figure 4.2 A Household's Choice Set in Theory and Reality

search is initiated, the inertia barrier will be less although it will never be zero. In this way a household may decide to relocate even though the selected residence does not reach its original aspiration utility level.

In general, we may expect the household to recognize the incompleteness of its information. The household may, for example, have expectations about either the length of time required in search, or the number of vacancies which should be examined before there is enough information to make a decision.[1] In any case, the household is not likely to select a particular residence until its aspirations have stabilized. When this will occur, i.e., the length of time in search, will depend on the original accuracy of the household's aspiration as well as the sequence of vacancies identified in search.

Finally, an important question for subsequent analysis is the relationship between aspiration utility and experienced place utility, immediately after a household moves. This requires a consideration of optimal utility in theory, and optimal utility in reality.

As emphasized above, when search begins a household's expectation

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1 An alternative way of formulating this might be to introduce a subjective probability function as suggested by Brown and Moore (1970). This function would define the probability of finding a vacancy for each utility level. U* would define a situation in which the probability of finding a vacancy, $\underline{X}'$, such that $V(X', \underline{Z}') \geq U^*$ was very high but the probability of finding a vacancy such that $V(\underline{X}', \underline{Z}') > U^*$ was low. This function would be important in defining the a priori expectations with regard to the number of vacancies to be examined and the length of search.

of prices and opportunities is likely incorrect. Thus there is a discrepancy between what the household believes is attainable and what is actually attainable. This discrepancy arises from the fact that the household does not have perfect information either about the actual set of opportunities or their actual prices. This does not affect the household's decision to seek a new residence, for it is what the household believes is attainable which is important in that decision.

Once this decision is made, however, and search actively begins, then the increase in information which follows will lead to changes in expectations. These changes should reduce the discrepancy between what is believed attainable and what is actually attainable. Ultimately, as information accumulates, what is believed attainable should correspond with what is actually attainable. Whether such a correspondence occurs, however, is unimportant. What is important is that the household believes such a correspondence has occurred. At this point the household may decide not to move. Alternatively, the household may decide to move to a new residence. In this case, the new residence will represent the best residence the household believes is attainable. Consequently, immediately upon relocation, the household's experienced place utility will equal the household's aspiration place utility, i.e., $U^{*}=U^{0}$. In theory, therefore, the household may achieve the optimal level of utility, U^{*}.

In reality, however, U^{*} may not be achievable for two reasons. First, the actual number of opportunities which are available in a finite space and which can be identified in a finite time, is limited. Thus, there is a discrepancy between what is actually available and what is potentially available. Second, some variables (residence attributes) are not continuous, as assumed in theory, but discrete. Thus some combinations are not potentially available.

These discrepancies may be clarified with reference, once more, to Fig. 4.2. Assume that the budget line, Y, is believed to be accurate. Then in theory, aspiration utility is U^* and aspirations are (X^*, Z^*).

In reality, however, there is a limited number of opportunities, shown by the set of dots. The best residence available is the one identified by the point (X', Z'). The optimal level of utility in reality, therefore, is not U^* but the level associated with the point (X', Z'). Notice that this may occur even if the combination (X^*, Z^*) is potentially possible in reality. Indeed, such a combination may exist but not be vacant at that time.

Moreover, there are certain indivisibilities in reality which prevent the household from obtaining the theoretical level of aspiration utility. One indivisibility is that some attributes are not continuous so that <u>certain levels</u> of these attributes may not occur in reality. A second indivisibility is that certain <u>combinations</u> of attribute levels may not occur in reality. For example, large lots are usually incompatible with downtown locations. Thus, the aspiration levels defined in theory by trading off smaller and smaller quantities until marginal utilities are equal may not exist in reality. In Fig. 4.2, indivisibilities may lead to the result that the combination (X^*, Z^*) is not possible, not even potentially, in reality.

The result of these limitations is that a household may attain the optimal level of utility in reality but not the optimal level in theory. This poses no great difficulty in the analysis. It does imply, however, that immediately upon relocation, even after an extensive process of information accumulation in search, that aspiration utility need not be equal to experienced place utility. This can complicate the discussion. Hence, in subsequent analysis we shall assume that upon relocation, experienced and aspiration place utility levels are equal.

4.3 Factors Affecting the Level of Residential Stress Over Time

The purpose of this section is to analyze, within the framework of the model, those factors which may change over time and affect the level of residential stress. Three types of factors may be identified. Changes may occur in 1) the residential environment, i.e., changes in $\underline{X}_t^o$ or $\underline{X}_t^*$, 2) the constraints of the decision situation, i.e., changes in the market situation, $(\underline{P}, R)$, in household income (Y), and in needs $(\underline{\overset{\uparrow}{X}}_t, \underline{\overset{\uparrow}{Z}}_t, \underline{\overset{\downarrow}{X}}_t, \underline{\overset{\downarrow}{Z}}_t)$ and 3) the household's preference structure, i.e., the parameters of the utility function, V^t.

Changes in the residential environment are easily understood. These reflect the physical and social changes constantly occurring in the city. Some changes focus on the household's present residential environment such as changes in the site e.g., new landscaping or an alteration to the layout, etc., changes in the neighbourhood, e.g., a new highrise, new park or new neighbours, and changes in relative location, e.g., new shopping centre. These changes tend to have a greater impact on experienced place utility than on aspiration utility, thereby affecting residential stress. In contrast some changes affect the set of opportunities in the residential environment and thereby affect aspiration utility. The construction of a new subdivision for example may have such an impact. In general, changes in urban structure may affect the level of residential stress of individual households, at least to the extent that such changes have a differential impact on experienced place utility as opposed to aspiration utility.

Of more interest are changes in the constraints of the decision situation and changes in the preference structure. In the following section the effect of changes in the market situation are examined. This includes, first, a discussion of the effects of changes in the prices of other goods, i.e., changes in $\underline{P}$, and second a discussion of the effects of changes in housing costs, i.e., changes in R.

Then in successive sections the effects of changes in income, needs and preferences are discussed.

4.3.1 Changes in the Market Situation

Changes in the market situation are reflected in changes in the relative prices of other goods, $\underline{P}$, and in the relative price (or cost) of housing R. We shall consider these in turn.

Since the prices of other goods, $\underline{P}$, enter the budget constraint in both problems (4.3) and (4.5), changes in $\underline{P}$ may affect both U^o and U^*, and hence, residential stress. Since both are affected in the same direction, however, it is not immediately apparent how S is affected. For example, assuming that neither upper nor lower constraints are met as equalities but that the income constraint _is_ met as an equality, then an increase in some price, $P_i \epsilon \underline{P}$, will reduce both U^o and U^*. Conversely, a decrease in P_i will increase both U^o and U^*. What is of interest however is the differential impact on U^o and U^*, i.e., the impact on S. The strategy for analyzing this will be to examine graphically the simplest possible situation in which there are only two composite goods, Z and Y, representing other goods and housing respectively. This will provide considerable insight into the problem but no effort will be made to extend the argument to the much more difficult general case.

Consider the situation in which a household has just relocated at time t=0: place utility will be equal to aspiration utility, i.e., $U^o_o=U^*_o$; $Z^o_o=Z^*_o$; $X^o_o=X^*_o$; $S_o=0$.[1] This information may be represented on an indifference map as in Fig. 4.3. In that diagram, the actual and optimal consumption levels (at t=0), are determined by the point of tangency between the indifference curve and the budget line YY. Lower but not upper need levels have been included; the latter have been excluded for simplicity.

Now consider the effect of a price decrease for Z at t=1. The budget line will shift to YY_1. This will define a new set of aspirations,

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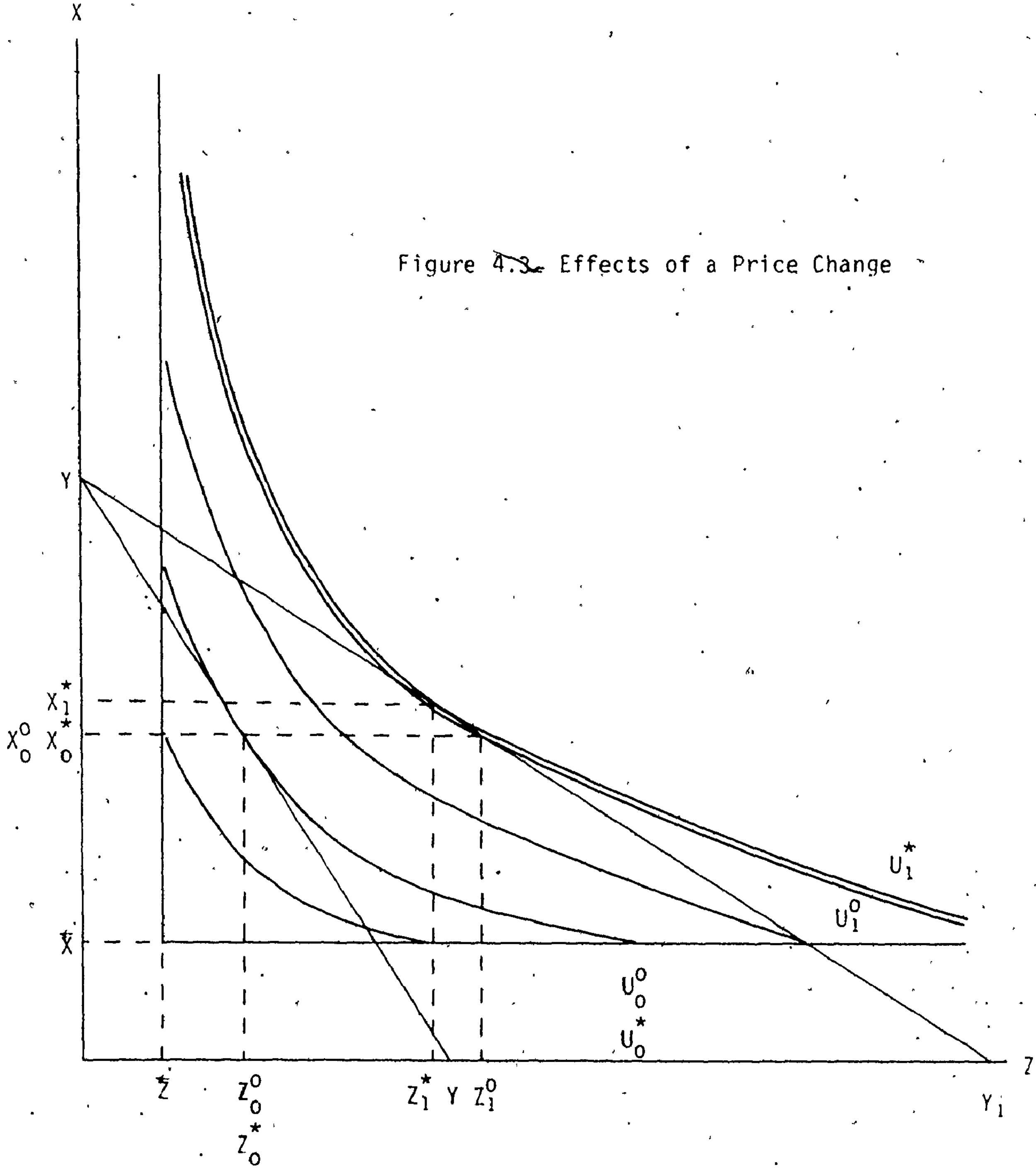
1 See the relevant discussion on pages 55 and 56.

Figure 4.3 Effects of a Price Change



(Z_1^*, X_1^*), and aspiration place utility, U_1^*. Specifically, depending on the household's preference structure, the desired level of housing, X^*, will increase, decrease, or remain the same. The latter case is unlikely.[1] And either an increase or decrease in the desired level of housing, which cannot be accommodated at the present residence will lead to an increase in residential stress.

Figure 4.3 is an example of the situation in which the desired level of housing increases as a result of the decrease in the price of Z. The utility increase is shown by the fact that the new budget line is tangent to -- the household could achieve -- a higher indifference curve. If the household does not move, however, then its consumption of housing is fixed, although its purchase of Z is increased due to the lower price. The household would be able to purchase up to quantity Z_1^o and achieve utility level U_1^o. This new level of experienced place utility is higher than before, but less than the level of aspiration utility, U_1^*, i.e., U_1^o is a lower indifference curve than U_1^*.[2] A similar diagram may be constructed for the situation when desired housing consumption falls. The result is the same: desired and present housing consumption diverge and residential stress increases. Therefore, in general, <u>the decrease</u>

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1 The desired level of X^* could remain the same after the fall in the price of Z only if the price elasticity of demand for Z was exactly Unity.

2 Fig. 4.3 is drawn showing strictly convex indifference curves. Under the assumption of quasi-concavity of the utility function this need not be the case. It is possible therefore, for U_1^o to equal U_1^* but not $U_1^o > U_1^*$.

in the price of other good Z leads to a greater increase in U^* than in U^0 so that residential stress is increased.

Intuitively, this result may be interpreted in the following way. With the price decrease the household would like to reorganize its consumption pattern. It would like to purchase more of the cheaper good Z, and at the same time would like to alter its consumption of housing, X, which can be achieved only through relocation. With respect to aspirations, then, the household can consider purchasing more of good Z and different amounts of X and achieve utility level U_1^*. With respect to the household's present residence, housing is fixed so that utility can be increased only by purchasing more Z. In other words, at its present residence the household has less freedom of choice. The consumption of Z will increase and experienced place utility will increase but in general an optimal consumption pattern will not be achieved.[1] Thus $U^* > U^0$ and residential stress is no longer zero. A similar analysis may be performed for the situation in which the initial price change is an increase. As before, the household will have less freedom in adjusting its consumption pattern at its present residence so that in general U^0 and U^* will diverge and residential stress will increase.

This analysis suggests the following conclusion: after relocation, an increase or decrease in the price of goods other than housing will increase residential stress.

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1. The present residence will provide an optimal consumption pattern only if Z is unit elastic.

A similar analysis may be used to examine the effects of changes in the cost of housing, i.e., changes in R. These might include changes in utility costs, taxes, mortgage rates etc. Consider the simplest situation in which housing and other goods are represented by the composite goods X and Z respectively and that upon relocating to the present residence the household had achieved zero stress.

Now assume that an increase in housing costs occurs. An example of the effects of such a change are presented in Figure 4.4. Initially the household is at (Z_0, X_0) and has achieved utility level $U_0^*=U_0^0$. After the cost change the budget line shifts from Y_0Y to Y_1Y and the household's desired consumption levels of Z and X will change to (Z_1^*, X_1^*). Such a consumption bundle would yield utility level U_1^*. Adjusting housing consumption, however, requires relocation.[1] If the household does not relocate the most advantageous consumption bundle is (Z_1^0, X^0) yielding utility level U_1^0. Clearly $U_1^0 < U_0^*$, so that residential stress is no longer zero.

In general, an increase in housing costs affects the household's desired level of housing. With an increase in housing costs, the desired level of housing consumption may decrease, remain the same, or increase. The latter two possibilities, however, are extremely unlikely: they would

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1 In some cases, it is possible for the household to alter its present residence, e.g., add a room.

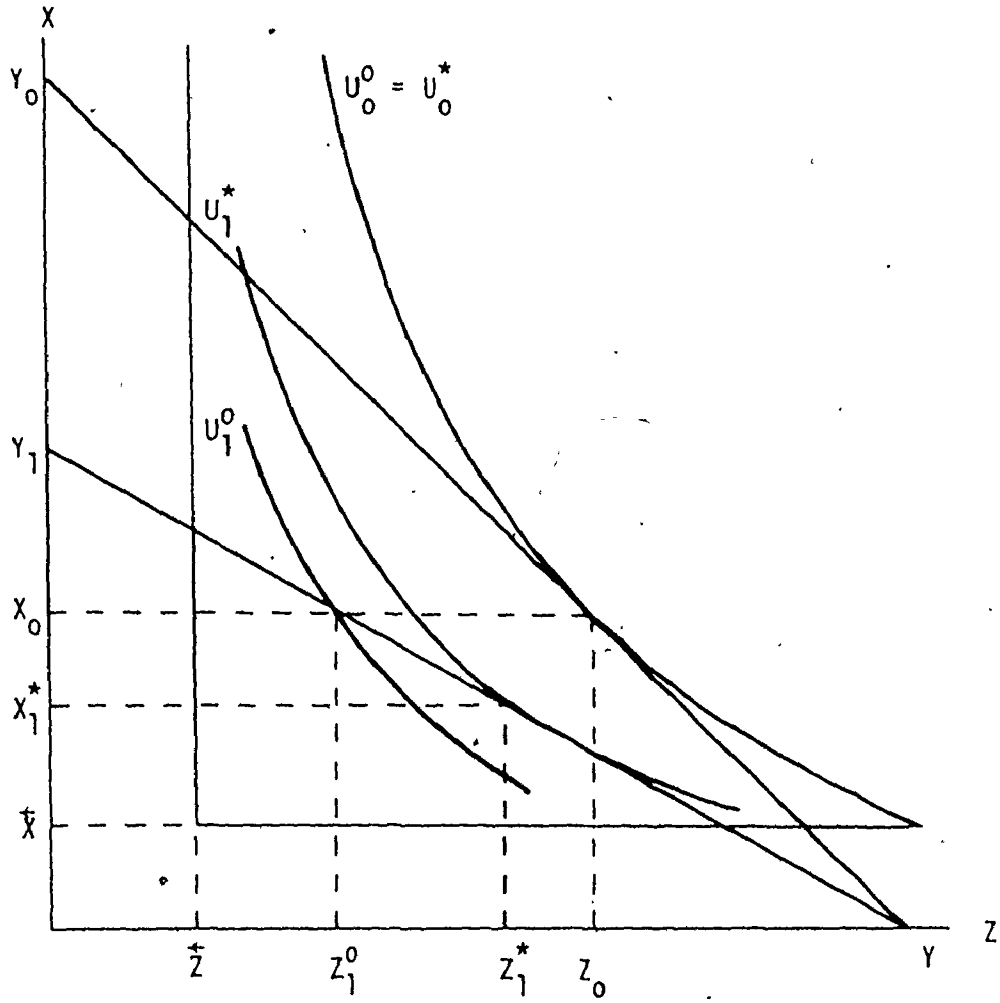

Figure 4.4 Effects of Changes in Housing Costs

imply that housing must be an inferior good.[1] Empirical analyses, however, have provided considerable evidence that housing is a normal good.[2] Consequently, we may conclude that following relocation an increase in housing costs decreases the desired level of housing consumption and increases residential stress. Similarly a decrease in housing costs following relocation increases the desired level of housing and also increases residential stress.

This result, of course, is similar to the result of changes in the price of other goods examined above. In the present case, however, the direction of change in desired housing consumption with changes in housing costs can be specified: increases in housing costs decrease the desired level of housing; decreases in costs increase the desired level of housing. Thus, in general, changes in housing costs following relocation increase residential stress.

Considering changes in housing costs, however, may not be the

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1 The effect on the desired level of housing of a change in housing costs may be examined via the Slutsky equation which partitions the effects into an income effect and a substitution effect (See Chiang, 1974, p.400):

$$\frac{\partial X^*}{\partial R} = -\frac{\partial X^*}{\partial Y} \cdot X^* + \frac{\partial X^*}{\partial R} \quad \text{(compensated)}$$

The second term on the right hand side is the substitution effect which is negative. The first term is the income effect of the cost change and can be positive only if $\partial X^*/\partial Y$ is negative, i.e., an inferior good. Housing, however, is a normal good so that $\partial X^*/\partial Y$ is positive, the first term then is negative and $\partial X^*/\partial R$ must be negative. Thus a housing cost increase must decrease the desired level of housing; a cost decrease must increase the desired level of housing.

2 See Reid (1962).

most interesting question in considering the influence of market factors in mobility. More interesting is the question of whether or not increases in the market prices of housing affect mobility. The problem in this case is to examine the effects of capital gains, such gains represent an important distinction between owners and renters.

Consider the situation for owners and let us begin with the special situation where a household has just moved at time t. Then $U_t^o = U_t^*$, $\underline{X}_t^o = \underline{X}_t^*$, $\underline{Z}_t^o = Z_t^*$. This assumes that the household has adjusted its aspirations while in search process. Now immediately following the move, house prices increase. If the household were to sell its present residence the capital gains received would permit, ignoring transaction costs, the household to just repurchase that house. However, the household could be better off by adjusting its consumption of housing, i.e., by substituting other goods for housing which has become relatively more expensive. Therefore, as a result of the price increase, residential stress has increased. Similarly, a price decline will also increase S.

More general is the situation in which $S = U_t^* - U_t^o \neq 0$; $\underline{X}_t^o \neq \underline{X}_t^*$, $\underline{Z}_t^o \neq \underline{Z}_t^*$. Assume that $\underline{X}_t^* > \underline{X}_t^o$, and that a proportional value increase in housing occurs at t+1, so that the money increase in the price of residence $\underline{X}_t^*$ is greater than the increase for $\underline{X}_t^o$. Now the capital gains will not permit the purchase of the commodity bundle $(\underline{X}_t^*, \underline{Z}_t^*)$ at time t+1. Since U^o is constant, S depends on the change in U^*. But the change in U^* depends on whether the substitution effect resulting from the price change is sufficient to overcome the capital gains shortfall, which is essentially an income effect. Thus the impact on S depends on the utility function and without more specific information, the direction of the change in S cannot be determined. We might note, however, that for people with strong housing preferences S is likely reduced while for consumer oriented households S is likely increased.

Now assume the converse, that $\underline{X}_t^* < \underline{X}_t^o$. The capital gains accruing to the owner will more than offset the increase in price for the residence, $\underline{X}_t^*$. Thus the household would still be able to purchase the commodity bundle $(\underline{X}_t^*, \underline{Z}_t^*)$ under the new prices. Therefore, after substitution as a result of the new prices, aspiration utility will increase, $U_{t+1}^* > U_t^*$ and S will increase.

Similar arguments may be developed for the corresponding situations when house prices decline.[1]

In general, if $\underline{X}^o = \underline{X}^*$, then a change in housing prices increases residential stress for owners. If $\underline{X}^* > \underline{X}^o$, a housing price increase may or may not affect S, depending on the household's preference structure, but a decrease in price will increase S. If $\underline{X}^* < \underline{X}^o$, a housing price increase will increase S while a housing price decrease may or may not affect S, again depending on the household's preference structure. Repeated price changes in one direction, however, will ultimately increase residential stress.

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[1] The effect of changes in the prices of particular housing attributes may be examined, for example, changing land values. The cases then refer to the relative magnitudes of the specific elements of vectors X^* and $\underline{X}^o$, i.e., whether $x_i^o \lesseqgtr x_i^*$. The analysis is complex and adds little to the conclusions.

With renters, of course, increases in house prices do not result in capital gains. Consequently, for renters who aspire to owned housing, housing price increases deter or at least delay mobility plans.

4.3.2 Changes in Income

A household's real income fluctuates over time. Given that the household's income is fully expended in problem (4.5), then an increase in income increases aspiration utility, U^*.[1] But an income increase also increases experienced place utility, U^0, again under the assumption that

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[1] The condition must also hold that at least one $x^*_{it} \epsilon \underline{X}^*_t$, or one $z^*_{jt} \epsilon \underline{Z}_t$ is within the constraint region (i.e., not on the boundary), and $\frac{\partial U^*}{\partial x^*_{it}} \cdot \frac{\partial x^*_{it}}{\partial Y} \neq 0$ or $\frac{\partial U^*}{\partial z^*_{jt}} \cdot \frac{\partial z^*_{jt}}{\partial Y} \neq 0$ (i.e., $\frac{\partial U^*}{\partial Y} \neq 0$). Alternatively, if the solution to problem (4.5) is unique and interior to the constraint region, then the income constraint is met as an equality. Notice that in this formulation a household may attain an optimal consumption pattern without fully expending income. An unconstrained optimum may occur within the constraint region, or the upper need limits may fully define the optimal solution. This latter case, however, assumes all $\vec{x}_i(t)$ are finite.

income is fully expended in problem (4.3). Thus the effect on residential stress is not immediately apparent. Similarly, a decrease in income reduces both U^* and U^0. Thus the problem in understanding the effect of income changes on residential stress is to determine the differential impact on U^* and U^0 of changes in income.

The analysis is essentially the same as in the case of a change in housing prices. The change in residential stress with a change in income depends on the relative locations of the vectors $\underline{Z}^0$ and $\underline{Z}^*$ and the vectors $\underline{X}^0$ and $\underline{X}^*$. Changes in income which induce these pairs of vectors to come together, reduce S; changes which induce these pairs to move farther apart increase S. When one pair moves together while the other moves apart, the effect on residential stress is ambiguous and depends on the household's utility function.

We shall show that this general result holds in the important special case in which the household has just relocated at time t, and income changes at time t+1. At time t, assume that $U_t^0 = U_t^*$; $\underline{X}_t^0 = \underline{X}_t^*$; $\underline{Z}_t^0 = Z_t^*$; and S=0. Consider the effect of an income increase, i.e., $Y(t) < Y(t+1)$. Experienced place utility will increase through the increased consumption of other goods, $\underline{Z}$. However, housing consumption is fixed. This does not represent an optimal solution with respect to both other goods and housing. U_{t+1}^* represents the optimal solution. Therefore $U_{t+1}^* > U_{t+1}^0$; residential stress has increased. Notice, however, that since full income increase is used to increase consumption of other goods in the experienced place utility case, whereas the income increase is used to increase consumption of both other goods and housing in the aspiration utility case, then $\underline{Z}^o_{t+1} > \underline{Z}^*_{t+1}$ and $\underline{X}^o_{t+1} < \underline{X}^*_{t+1}$.[1] Further income increases then will increase this disparity and further increase S. Similarly, repeated income decreases will increase residential stress.

We may conclude, therefore, that in any single time period, the effect of income changes on residential stress depends on the sequence of changes, whether income or other types of changes, which have occurred prior to that time period and extending to the time the household first occupied that residence, and that, over a length of time a sequence of repeated income increases or income decreases will ultimately increase residential stress.

4.3.3 Changes in Needs

Residential stress may be affected by changes in either minimum need levels $\overleftarrow{\underline{Z}}(t)$, $\overleftarrow{\underline{X}}(t)$, or maximum levels, $\overrightarrow{\underline{Z}}(t)$, $\overrightarrow{\underline{X}}(t)$. Both physical and socio-economic need levels may change over time. Again these are likely sensitive to life cycle changes. When minimum need levels increase over time the possibility exists of these levels exceeding attribute levels associated with the household's residence, i.e., some $x_i^o < \overleftarrow{x}_1$, or $z_j^o < \overleftarrow{z}_j$. In this situation the household may relocate, i.e., adjust its housing, or alter its present residence, e.g., rennovate

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[1] This assumes that all $Z_i \epsilon \underline{Z}$ and $X_i \epsilon \underline{X}$ are normal goods over the appropriate range, i.e., $\partial Z_i/\partial Y \geq 0$; $\partial X_i/\partial Y \geq 0$. If some goods are inferior, then $\underline{Z}^o_{t+1} \neq \underline{Z}^*_{t+1}$ and $\underline{X}^*_{t+1} < \underline{X}^*_{t+1}$, but the general argument will still be valid.

the dwelling, or adjust its needs (Brown and Moore, 1970). If the particular housing need or needs not accommodated represent a physical need then relocation or active altering of the environment is required. However, if the particular need is socio-economically determined, then the needs may be altered. This may, however, be particularly painful, representing a deviation from a peer group norm. It may be necessitated, however, by the situation where no better housing is economically feasible. This may reflect normal economic constraints, such as income, or social and institutional constraints. The latter constraints, however, often operate through economic constraints, e.g., mortgage availability. This situation would seem to characterize many low income households in very poor residential accommodations, who are clearly dissatisfied but do not move. In the present model, such households are characterized as having low residential stress. However, using a broader interpretation of stress, these households are clearly in very stressful situations stemming from a disparity between what the household has and what the household believes it should have, (Gurr, 1970). Such disparities, however, are not alleviated by relocation, since nothing better is attainable.

In a similar manner, a household's upper needs may change, particularly through life cycle changes and socio-economic changes. A common situation in which upper needs may change occurs when a household decides to have their first child. The three bedrooms which were previously excessive, are now not the case. Similarly, toward the end of the life cycle, the death of one spouse may render the current dwelling excessive and lead to relocation.

4.3.4 Changes in Preferences

Changes may occur in the household's preferences, that is, in the parameters of the utility function. The effect of these changes on residential stress at any given time cannot be determined since both U^0 and U^* will be affected. Thus, although changes in preferences will affect S, the magnitude and direction of these changes cannot be determined without further assumptions.

We may recognize, however, in the present context, that preference changes may be associated with life cycle changes and socio-economic changes.[1] For example, as household size increases the relative value (i.e., desire, not necessarily need) for internal and external space may increase. Such a change would tend to decrease experienced place utility more than aspiration utility, since with the present residence internal and external space is fixed and cannot be increased by consuming less of other residential or other goods attributes. This restriction does not apply in determining aspiration utility. Thus S would increase. Similarly, changes in socio-economic status may affect preferences. We may recognize, therefore, that if preferences are affected by life cycle and socio-economic status changes, then households undergoing these

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1 Apps (1971), for example, has used such an hypothesis to develop a model of urban housing demand. Her empirical evidence however is inconclusive.

changes are more likely to be undergoing changes in residential stress and hence relocation. Thus, the empirical results of, for example, Rossi (1955) and Leslie and Richardson (1961) that mobility is related to life cycle changes and socio-economic status changes respectively, follows from the effects of these changes in preferences. Notice this follows independently of needs.

CHAPTER 5

THE EMPIRICAL MODEL

5.1 Introduction

The purpose of the remainder of this thesis is to examine the empirical validity of the theoretical model developed in Chapter 4. This examination consists of testing four hypothesis derived from the model. The basic empirical problem in testing these hypotheses is to develop a method for measuring residential stress. Since residential stress, S, is the difference between aspiration utility, U^*, and experienced place utility, U^o, the problem is to measure U^* and U^o. These represent two specific values of the utility function, $V(\underline{Z},\underline{X})$, which in turn represents a household's system of preferences for consumption bundles $(\underline{Z},\underline{X})$. Thus, measures of U^* and U^o may be determined if a scale V can be constructed to represent the household's system of preferences for consumption bundles such that the two values, U^* and U^o, corresponding to the specific consumption bundles, $(\underline{Z}^*,\underline{X}^*)$ and $(\underline{Z}^o,\underline{X}^o)$, respectively, can be located on the scale. The basic empirical problem, therefore, is to construct such a scale.

In section 5.2, the four hypothesis which form the basis of the empirical analysis are presented. In section 5.3, a method of constructing the utility scale is discussed. This may be thought of as an empirical model of household choice which is used to obtain measures of residential stress. In section 5.4, an important assumption of the model, namely that the utility function is additively separable, is discussed. Finally, in section 5.5, the variables used to operationalize the model, in the present context, are presented.

In the following chapters, the data are discussed (Chapter 6), and the analyses of the hypotheses are presented (Chapter 7).

5.2 Empirical Hypotheses

From the model of household mobility decisions developed in Chapter 4 a number of hypotheses may be derived. Four such hypotheses form the basis of the empirical analysis. These are:

> Hypothesis 1: Mobility behaviour is related to the level of residential stress; movers are associated with high levels of residential stress, and stayers are associated with low levels of residential stress.
>
> Hypothesis 2: Aspiration utility levels and experienced place utility levels are directly related to the level of income.
>
> Hypothesis 3: Mobility behaviour is related to income changes; households experiencing income increases or decreases are more likely to be movers than stayers.
>
> Hypothesis 4: Mobility behaviour is related to life cycle stage.

Hypothesis 1 represents the basic concept of the model, namely, that as residential stress increases, the household is more likely to decide to seek a new residence and ultimately move.

Hypothesis 2 follows from problems (4.3) and (4.5) examined in section 4.2. As the income constraint in problems (4.3) and (4.5) is relaxed, i.e., as the household's income level increases, ceteris paribus, experienced place utility and aspiration utility increase. Thus, in general U^o and U^* should increase as household income increases.

Hypotheses 3 and 4 are concerned with factors which affect residential stress levels, and hence mobility, over time. Hypothesis 3 follows from the analysis of the effects of income changes on residential stress in section 4.3.2. There the level of residential stress was shown to depend on the accumulated income changes which have occurred since the household first occupied its present residence. Hence, given Hypothesis 1, that mobility behaviour is related to residential stress, and that residential stress is related to income changes, then mobility behaviour is related to income changes. A corollary of this is that mobility behaviour is not related to the level of income at any given time (Hypothesis 3). Residential stress, and hence mobility decisions, depend on the difference between what a household has obtained, i.e., its experienced place utility, U^o, and what the household believes it could obtain elsewhere, i.e., its aspiration utility, U^*, which is essentially a comparison made within a household; residential stress does not depend on inter-household income comparisons.

Hypothesis 4 follows either from the postulated connection between household needs and life cycle changes or from the postulated connection between preferences and life cycle stage. Either or both of these relationships provide an explanation within the structure of the model for the well documented relationship between mobility and life cycle stage. These relationships may well hold at the individual level but may not show any systematic relationship at an aggregate level. That is, individual preferences may change but the nature of these changes may vary between individuals. The question of systematic changes in preferences with life cycle stages is briefly discussed in Chapter 8.

These hypotheses are not exhaustive of those which might be examined. For example, the effects of changing house prices and/or mortgage rates on mobility could be examined. Or the effect of relative changes in the prices of other goods might be examined. These four major hypotheses, however, appear to provide a significant test of the validity of the model

The basic empirical difficulty in analyzing these hypotheses is to develop a method for measuring residential stress. This requires a method for constructing a utility scale. Such a method is the subject of the following section.

5.3 Tradeoff Analysis

The approach adopted to construct the required utility scale consists of a type of conjoint analysis termed tradeoff analysis developed by Johnson (1972; 1973). The method has been used to analyze multi-attribute choice problems in a number of areas. It is particularly appropriate for problems of the type considered here in which the value of specific combinations of attribute levels is to be estimated. Fiedler (1972) for example, used tradeoff analysis to analyze the demand for different types of condominium units which varied on such attributes as price, space, view and floor level. Davidson (1973) used tradeoff analysis to predict demand for a new transport service which incorporated novel attributes. And in the area of residential choice, Knight and Menchik (1974) used tradeoff analysis to predict demand for novel types of residential land use patterns. Harman (1975) also, has used the method to analyze preference strengths for different aspects of residences among a group of households actively searching for a new house.

Tradeoff analysis is a relatively simple method of conjoint analysis. Methods of conjoint analysis provide measures of the relative values of specific attributes of complex stimuli from data relating to combinations of these attributes. The specific attributes may be thought of as independent variables, and the complex combinations as the dependent variable. For example, data might be collected on the rank order preferences of a set of consumption bundles which vary on the levels of a number of attributes. Then the problem, known as the conjoint measurement problem, is to estimate measures for the various levels of each independent attribute such that when they are combined according to some function, the values associated with the attribute levels will account for the observed order of preferences for complex combinations (the dependent variable). In other words, the derived values of the dependent variable must match the order of observed preferences.[1]

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1 For an excellent discussion of the conjoint measurement problem, see Tversky (1967).

A general method for solving this problem, termed polynomial conjoint analysis, has been developed by Young (1972). The method is general in that any conjoint measurement model, i.e., combination rule, may be specified. The method suffers, however, from a practical viewpoint: the judgement task required of the respondent is extremely difficult.

In that approach information is required on the individual's preferences for a number of complex stimuli. In the present case these complex stimuli would refer to a number of hypothetical consumption bundles. To adequately describe these consumption bundles, however, we may recognize that a relatively large number of attributes would be required. And, although the approach requires only a ranking of these stimuli, an individual's ability to comprehend complex information of this type, and make comparisons is limited (Miller, 1956). Moreover, to adequately estimate even a relatively simple conjoint measurement model, a large number of judgements would be required. That is, a large number of complex consumption bundles would need to be compared. The judgement task then, would be extremely difficult.

A less general, but simplified approach to the conjoint measurement problem is provided by tradeoff analysis. The approach is less general in that an additive combination rule is specified in which no interaction is permitted between the independent variables. This is the assumption, discussed in section 5.4, that the utility function is additively separable. Although restrictive, this assumption greatly simplifies the judgement task for the respondent. Instead of requiring judgements on stimuli in which all attributes may vary simultaneously, judgements are made on stimuli composed of different combinations of different levels of only two attributes. For example, a respondent might be asked to rank nine stimuli composed from the various combinations of two attributes each taking on one of three possible values. This ranking is assumed to depend on the individual's utility values for the levels of these two attributes and not to depend on the levels of other attributes. Thus, although the number of attribute pairs considered may be large, individual judgements are simple. Tradeoff analysis, then, represents a compromise between generality and practicality.

The name, tradeoff analysis, stems from the type of judgements required which are, in effect, tradeoffs between quantities of different variables. For example, the respondent may be asked to choose between a residence with two bedrooms and a backyard 60 feet deep, or three bedrooms and a backyard 20 feet deep. The choice involves trading internal space for external space or vice versa. To the respondent, such judgements are simple binary preference choices where the two alternatives are well defined.

A sequence of such choices results in a preference ranking of the different combinations of variable levels for that pair of variables. Such a ranking may be obtained quite simply by presenting the various combinations of the pair of attributes in the form of a matrix, termed a tradeoff matrix, and by asking the respondent to rank the cells. An

FIGURE 5.1 EXAMPLE OF A TRADEOFF MATRIX

OCCUPANCY - BUILDING TYPE	SIZE OF DWELLING (number of bedrooms)			
	1 bedroom	2 bedrooms	3 bedrooms	4 bedrooms
single family house	13	5	2	1
attached house (townhouse or duplex)	14	6	4	3
multiple family (divided house or low-rise)	15	11	8	7
multiple family (high-rise; elevator)	16	12	10	9

example is provided in Figure 5.1. A number of rankings may be obtained by selecting different pairs of attributes. With K variables there is a total of K(K-1)/2 distinct pairs for which preference rankings may be obtained. Not all rankings are required, however, to estimate the utility scale, i.e., the values for each level of each attribute.

The significance of this type of information for scaling is that each choice provides information on relative differences. For example, if X_{i1} is preferred to X_{i2} (different levels of attribute i), and X_{j1} is preferred to X_{j2} and the combination (X_{i1}, X_{j2}) is preferred to (X_{i2}, X_{j1}) then the (utility) difference between X_{i1} and X_{i2} is greater than the (utility) difference between X_{j1} and X_{j2}. Each judgement therefore represents an inequality constraint on the differences between scale values. This restricts the admissable locations of the scale values, i.e., $V(X_{i1})$, $V(X_{i2})$, $V(X_{j1})$, $V(X_{j2})$. As the number of inequality constraints increases, the freedom in locating the scale value decreases, so that in the limit an interval scale is produced (Shepard, 1966).

The scaling problem, therefore, in tradeoff analysis is to obtain a set of numbers, $V(X_{ij})$, where X_{ij} is the jth level of the ith attribute, such that all the inequality constraints are satisfied. In other words, the problem is to obtain a set of numbers $V(X_{ij})$ such that for each trade-off matrix for which there is information, when the appropriate $V(X_{ij})$ values are added together, their rankings will match the original preference rankings of the respondent. An algorithm to solve this type of problem has been developed by Johnson (1972, 1973). Details of the method are presented in Appendix A.

With respect to the present application, three aspects of the method are particularly important. First, the derived scale has interval scale properties. An interval scale is one in which differences between scale values are meaningful. That is, the distances between scale values or the magnitudes of the intervals are meaningful and may be compared.

The significance of this interval scale property with respect to choice problems is emphasized by Knight and Menchik (1974):

> The conjoint procedure (tradeoff analysis) used here is most useful for metric preference measures, giving more information than just orderings. It is not surprising that people prefer a large backyard to a small one, and a view of woods to others' backyards. It is the magnitude of these preferences that is necessary to indicate real-world choices....

This property is particularly important in the present case since residential stress is defined as the magnitude of the difference, $U^{*}-U^{O}$. For residential stress to be meaningfully measured, the utility scale must be an interval scale.

A second related aspect of the method which is important is that it is consistent with the utility framework of consumer choice theory. The cornerstone of the utility framework is that individuals make choices by trading off quantities of one commodity for another. This is exactly the type of choice used in tradeoff analysis. Knight and Menchik (1974) clarify this point:

> In consumer theory one does not simply prefer one good to another; inter-commodity preference comparisons are made only between specified changes in the quantities of two commodities....The simple question as to whether

> a person considers the quality of the front view more important than backyard size...is meaningless. This is because the result of any specific comparison of residential bundles depends on the "quantities" of view quality and backyard space being exchanged.... One cannot compare whole attributes, only specified changes in attribute levels.

A third aspect of tradeoff analysis is that choices are made between discrete levels of the variables. This is not inconsistent with the assumption of continuity in the theoretical model. In an empirical analysis, however, it is apparent that certain variables are not only not perfectly divisible but may not have any "natural" metric. Some variables are measured only at a categorical level, such as tenure status or dwelling type. Tradeoff analysis permits the analysis of such nominal variables. A corollary of this is that no functional form need be specified for the component utility scales. This point is clarified below.

5.4 A Simplified Preference Structure

A major assumption of tradeoff analysis is that the utility function is additively separable. This places certain limitations on the variables which may be used in the empirical analysis. Consequently, in this section the implications of the assumption are discussed. In the following section the operational variables selected for the analysis are outlined.

The general form of the utility function is:

$$U=V(\underline{X},\underline{Z}). \tag{5.1}$$

In this form, few restrictions are placed on the preference structure (Green, 1971). No limitations, for example, are placed on how the elements of $\underline{X}$ and $\underline{Z}$ are combined to yield the overall utility value, U, except that such a function, V, exists.

However, if we assume that the utility function is (weakly) separable into two groups of commodities, e.g., housing and other goods, then (5.1) may be written as:

$$U=V(U_1(\underline{X}),\ U_2(\underline{Z})). \qquad (5.2)$$

This implies that the total utility U is composed of some combination of the independent part-utilities of housing and other goods. Independence in this case means that the part-utilities depend only on the quantities of commodities within that group and not on the quantities in the other group.[1] More specifically, weak separability implies that the marginal rate of substitution, i.e., tradeoffs, between two commodities within one group is independent of the quantities of commodities in the other group (Gorman, 1959).

If we then assume that the M attributes of housing, and the N other goods, can be partitioned into k and h separate groups respectively, and that the utility function is additively separable, then (5.2) may be written as

$$U=U_1(X_1) + U_2(X_2) + \ldots + U_k(X_k) + U_{k+1}(Z_1) + \ldots + U_{k+h}(Z_h) \qquad (5.3)$$

---

1 Note that in general there may be more than two groups.

In this case total utility, U, is a simple additive combination of the independent part utilities. Notice, however, that while U is defined as a linear combination of the part-utilities, the part-utility functions themselves are not necessarily linear. No precise form is specified for the component utility functions.

More specifically, additive or strong separability implies that the marginal rate of substitution between commodities from different groups is independent of the quantity of any commodity from a third group (Gorman, 1959). In other words, the tradeoffs between say, internal and external space are independent of the type of dwelling unit.[1] Of course, in reality this may not be the case. The amount of internal space someone is willing to give up for a given amount of external space may well depend on whether one is considering a detached house or a town-house. Nevertheless, the assumption of additive separability excludes this type of interdependence, and as such represents the major limitation of the assumption. What this means for selecting variables to represent groups in the empirical analysis is that variables should be chosen which are independent. This is the most important criterion for selecting variables discussed in the following section.

A second disadvantage of additive separability is that the part-utilities are additively combined and additive utility functions have empirically undesirable properties. Particularly, in dealing with

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[1] We are assuming these are from separate groups.

individual goods rather than groups, if all goods have positive marginal utilities then an additive utility function implies all goods must be normal (Green, 1961; 1971). This is not consistent with empirical observation. The problem is less important, however, when considering separable groups. Nevertheless, since the empirical operationalization uses individual variables to represent the basic groups, a second criterion, for selecting variables is that variables should be chosen which are "normal goods".

The significant advantage of additive separability is that the preference structure is greatly simplified which makes the problem of empirical estimation much more tractable. As noted above, this simplification is not without cost. But as Strotz (1957; 1959) and Gorman (1959) both stress, the stringent requirements of additive separability may be thought of as a good thing since the empirical conditions for rejecting the assumption may be specified.

In the present study the adequacy of the assumption is examined by asking two questions. First, under the assumption of additive separability, can a set of utility values be selected which will reproduce the original preference rankings? In other words, can tradeoff analysis provide "good" solutions? "Goodness-of-fit" measures calculated in the algorithm suggest that in most cases good solutions can be obtained. Second, can these utility values, obtained by comparing pairs of attributes, be used to predict rankings of complex stimuli varying on several attributes? This is a crucial test of separability, and again, in most cases good predictions obtain. A full description of these tests is presented in Appendix B. Thus the assumption of additive separability appears to be adequate in the present analysis. More important perhaps, is the fact that individuals whose preferences cannot be represented in this form can be identified and excluded from further analysis.

5.5 Selection of Variables

5.5.1 Nature of the Problem

The basic empirical problem in applying tradeoff analysis in the present situation is to select operational variables to represent the vectors $\underline{Z}$ and $\underline{X}$ which describe "other goods" and residences respectively. A large number of variables might immediately come to mind. The selection, however, is constrained by two factors. First, the variables should be salient to the individual. That is, the variables should not be irrelevant to a household in evaluating alternatives. Second, under the assumption of separability, the variables should be "normal" and independent.

5.5.2 A Variable to Represent Z

Considering the range of goods other than housing consumed by a household the problem of selecting variables to represent $\underline{Z}$ is extremely difficult; some simplification is required.

Consider an individual household's aspiration utility level, U^*, which is defined as a function of housing attributes and other goods, i.e.,

$$U^{*}=V(\underline{Z}^{*},\underline{X}^{*}) \qquad (5.4)$$

The vector $\underline{Z}^{*}$ is defined by problem (4.5). Through this maximization process, $\underline{Z}^{*}$ is a function of the parameters, Y, $\underline{P}$ and R, namely income, prices of other goods, and housing cost respectively. Thus,

$$\underline{Z}^{*}=Z^{*}(Y,\underline{P},R) \qquad (5.5)$$

In other words, the consumption of other goods depends on the prices of those goods, the price of housing and the household's income. If we assume that in evaluating a set of opportunities at a given moment in time the household's income is fixed, and that the price of other goods is fixed, then (5.5) may be rewritten as,

$$\underline{Z}^{*}=Z^{*}(R;\ \bar{Y},\underline{\bar{P}}). \qquad (5.6)$$

The upper bar indicates a fixed quantity. Thus, with income and other prices fixed, the consumption of other goods is determined by the cost of housing. Substituting (5.6) into (5.4) yields,

$$U^{*}=V(Z^{*}(R;\ \bar{Y},\underline{\bar{P}}),\ \underline{X}^{*}) \qquad (5.7)$$

which may be rewritten as,

$$U^{*}=V(R,\underline{X}^{*};\ \bar{Y},\underline{\bar{P}}) \qquad (5.8)$$

Intuitively, this says that as the cost of housing increases the money available to purchase other goods decreases, which in turn, affects the utility level. A similar reasoning may be used to show that experienced place utility depends on housing cost, i.e.,

$$U^{o}=V(R,\underline{X}^{o};\ \bar{Y},\underline{\bar{P}}) \qquad (5.9)$$

In other words, if the housing costs of the household's present residence increases then the place utility declines, less money being available for purchasing other goods.

The important point is that rather than attempt to represent the vector $\underline{Z}$ by a variety of goods, $\underline{Z}$'s influence on U may be represented by R, i.e., housing cost, assuming $\underline{P}$ and Y constant. Housing cost is an easily understood variable which intuitively represents a significant aspect in evaluating housing opportunities.

5.5.3 Variables to Represent X

The variables used in the present study to describe housing are based on the work of Harman (1975). Her study was designed to identify the subjective concepts people use to distinguish and evaluate urban dwellings. She employed the method of eliciting constructs based on Personal Construct Theory (Kelly, 1955; Bannister and Mair, 1968). Harman's (1975) study is particularly appropriate to the problem considered here for at least two reasons. First, the method of personal construct theory permits respondents to identify the salient dimensions of discrimination in their own terms.[1] Respondents do not choose from a predetermined set but articulate the reasons for their answers in a free-response format. The elicited constructs, then, are those which are salient to the individual, not those salient to the researcher. Second, the respondent group surveyed consisted of households active in the mobility process; they were already searching for a new residence and thus

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1 These dimensions of discrimination, i.e., cognition, may or may not be important in evaluation. However, whether or not a dimension is preference neutral, it may still be considered a dimension of evaluation.

sensitive to housing conditions. A limitation of this group, however, was that all the respondents were seeking single family detached homes to own. This provides little information, for example, on the important aspects of rented accommodations or multiple family dwelling types. Nevertheless, this study provides considerable insight into the way individuals cognitively organize attributes of housing and thus is used here as a basis for selecting variables to represent residence attributes.

Personal construct theory is based on the idea that individuals cognize and evaluate reality along a number of bi-polar constructs. These constructs form a hierarchy with a number of subordinate or primary constructs related to each superordinate or secondary construct. Harman (1975) was able to obtain an average of more than 10 primary constructs per respondent, which were classified into 25 broad categories. From the frequency of response, 10 main primary constructs were identified. Harman (1975) was also able to identify 3 main clusters of interrelated primary constructs which were interpreted as secondary constructs. The main primary and secondary constructs were:

Primary Constructs

1. dwelling size, especially the number of bedrooms,
2. dwelling age, maintenance and related concerns,
3. lot size,
4. external privacy and separation from neighbours,
5. trees and landscaping of the lot,
6. parking,
7. accessibilities,
8. degree of perceived urbanism ("urban", "suburban", "rural"),
9. local suburbs or sub-areas designated by place name,
10. financial concerns.

Secondary Constructs

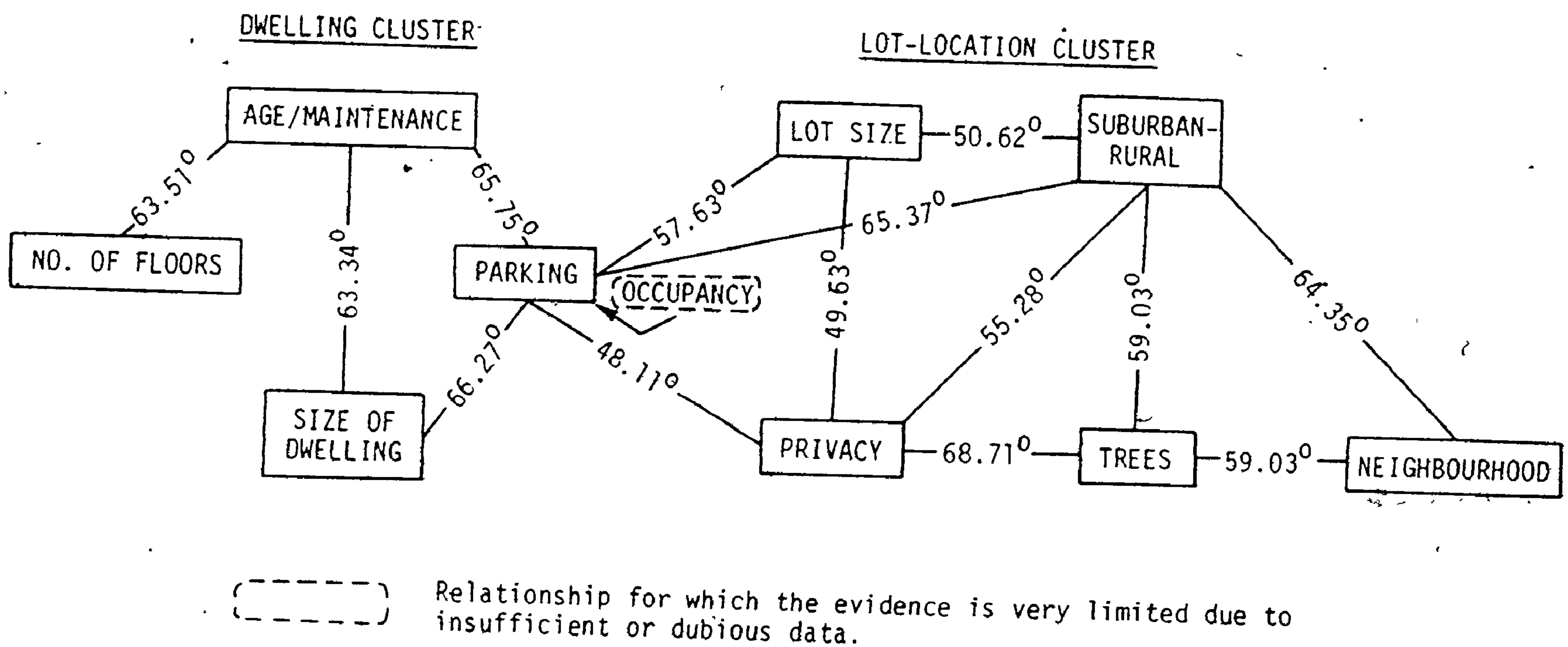
1. the dwelling,
2. lot and location,
3. accessibilities.

The system of interrelationships among the primary constructs serving to identify the secondary constructs of dwelling and lot-location are outlined in Fig. 5.2. Accessibilities was relatively independent of the other two secondary constructs.

Based on these results, a total of 11 variables were selected in the present study to represent the vectors $\underline{X}$ and $\underline{Z}$. Ten of the variables refer specifically to attributes of the residence. The eleventh variable is housing cost, used as a measure of "other goods" foregone. The list of variables, their operational definitions and discrete levels selected for tradeoff analysis are presented in Table 5.1.

Several aspects of this selection might be noted. First, examination of the list of variables selected reveals that, according to Harman's analysis several of the variables are related (e.g., see Fig. 5.2), contrary to the separability requirement of the empirical model. It was felt, however, that it would be advantageous to have as complete a description of housing as possible and that given the limited information available on the interrelationships among cognitive constructs and the relations to objective attributes it would be premature to greatly limit the number of attributes utilized. Evidence presented in Appendix B suggests that the assumption of additive separability was not severely violated by the respondents, at least over this choice of variables and range of variable levels.

Figure 5.2 Association Among Primary Constructs for Dwelling and Lot-Location Secondary Constructs



Relationship for which the evidence is very limited due to insufficient or dubious data.

Numbers refer to the mean angle between construct types. A mean angle of 0° would indicate a perfect association between types; a mean angle of 90° would indicate a complete lack of association, i.e., independence between types.

Source: Harman (1975), Fig. 4.

TABLE 5.1

SELECTION OF VARIABLES AND DISCRETE VARIABLE LEVELS

	VARIABLE	OPERATIONAL DESCRIPTION	DISCRETE LEVELS* SELECTED
1.	Occupancy - Building Type	Occupancy - Building Type	- Single family house - Attached house (duplex, townhouse) - Multiple family (low-rise or divided house) - Multiple family (high rise; elevator)
2.	Tenure	Tenure	- Owned - Rented
3.	Dwelling Size	Number of Bedrooms	- 1 Bedroom - 2 Bedrooms - 3 Bedrooms - 4 Bedrooms
4.	Lot Size	Backyard Space (Depth from back of dwelling to back of lot)	- No backyard - 20 feet - 40 feet - 60 feet
5.	Privacy	Privacy	- Very private, never feel intrusion from neighbours - Quite private, occasionally feel intrusion from neighbours - Not very private, often feel intrusion from neighbours
6.	Neighbourhood	Neighbourhood	- Buildings well kept, streets quiet, people friendly - Buildings well kept, streets noisy, people friendly - Buildings need repair, streets noisy, people friendly - Buildings well kept, streets quiet, people not very friendly
7.	Parking	Parking	- Private covered parking (garage or underground) - Private off-street parking - No private off-street parking
8.	Dwelling Age and Maintenance	Age-Maintenance	- Less than 4 years old, well maintained - 15 years old, well maintained - Over 40 years old, well maintained
9.	Accessibilities	Location (time from downtown by car)	- 5 minutes - 15 minutes - 25 minutes - 35 minutes
10.	Trees and Landscaping	Green Space	- shade tree on property - no shade tree on property
11.	Housing Cost	Cost Per Month (including rent and utilities, or mortgage, taxes and utilities)	- $170 - $225 - $300 - $400

* The total number of discrete levels across all variables is 37.

Second, all of the variables refer to objective attributes of housing except for privacy. Further work on the meaning of privacy has been undertaken by Harman and Betak (1975). The most important objective attribute related to privacy seems to be separation from neighbours. Early efforts to utilize this description in place of privacy proved inadequate. Respondents tended to relate to separation between buildings rather than neighbours. These may be synonymous with single family detached houses, but not so with multiple family dwellings. Consequently the three categories of privacy shown in Table 5.1 were adopted.

Third, in Harman's (1975) list the construct of neighbourhood is not included. This stemmed from the fact that the data were insufficient to adequately define what neighbourhood concerns actually referred to. It was not that neighbourhood concerns were not mentioned, but that the data did not support the conclusion that this "type" represented a single construct. Instead, neighbourhood seemed to refer to a number of other more subordinate constructs which could not be clearly identified, given the data. Consequently, we have attempted to incorporate the concept of neighbourhood using three separate neighbourhood concerns, namely, the degree of physical repair and up-keep of the building, the amount of noise, and the friendliness of the neighbours. That neighbourhoods seem to be defined on the bases of physical as well as social aspects has been suggested by a number of researchers. Lee (1968), for example, found neighbourhoods defined in terms of dwelling types and "people like ourselves". Tuite and Betak (1974) found high traffic streets with associated noise were important in defining neighbourhood boundaries. And Butler et al. (1969) found that safety was an important aspect of neighbourhoods often cited by individuals.

Fourth, Harman (1975) found that the idea of accessibilities and location were composed of a number of constructs such as degree of urbanism, sub-area place names, and distances to a variety of activities such as work, shopping, school, etc.. This has been summarized with the single measure of time to downtown. It was impractical to utilize several measures of distance such as distance to work, shop, etc. and at the same time it was felt that a standard comparison would be most appropriate. Hence, distance to work was not chosen. Almost all individuals utilize the downtown to some degree; either to shop, or to work. A number of respondents, however, suggested that time to work was indeed more relevant. Others were clearly using time to downtown as a surrogate for degree of urbanism. This highlights once more, the complex nature both of individuals cognition and evaluation of residential environments as well as the complex meaning of relative location, a point strongly emphasized by Harman (1975).

CHAPTER 6

THE DATA

The purpose of this chapter is to outline the data and data collection methods used in the research (section 6.1) and to sketch the procedure used to calculate residential stress measures from the data (section 6.2).

6.1 The Questionnaire and Survey Method

The questionnaire was designed to collect basically four types of information: 1) socio-economic data, 2) mobility data, 3) data on the household's present and aspiration residences, and 4) preference data on residence attributes.

The socio-economic data included information on age, education, occupation, number and ages of children, household income and income changes. Information on income changes consisted of the respondent estimating whether household income over the past year increased less than inflation, equal to inflation, or greater than inflation (approximately 10% per annum at the time) and whether expected household income over the next year would increase less than inflation, equal to inflation, or greater than inflation. This approach was intended to provide a rough estimate of real income changes.

The mobility data consisted of information on both the household's previous mobility experience and future mobility intentions. With respect to moving intentions, households were asked whether they planned to move in the next year, and could respond, "yes", "maybe", or "no". Evidence that responses to such a question provide a good indication of future behaviour is provided by Sabagh et al. (1968). More recent results by Duncan and Newman (1976), however, cast some doubt on the predictiveness of moving intentions with respect to actual behaviour. In the present study a follow-up survey was conducted, approximately one year after the original interview.[1] A total of 83 of the original 87 households were contacted. Of the 83 households 56 were intended stayers, 11 were possible movers or possible stayers and 16 were intended movers. Only 1 of the 56 intended stayers had moved; 11 of the 16 <u>intended</u> movers had moved; and 3 of the 11 <u>possible</u> movers had moved. These results provide general support for the validity of moving intentions as a measure of mobility behaviour.

Information on the respondent's present and aspiration or "future possible" residences was collected. The respondent first described his/her present residence on the basis of the eleven variables previously selected. Then the respondent was asked to describe the kind of residence he/she would move to if they moved with the next year. An effort was made to

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[1] Respondents were contacted by telephone to determine whether or not they had moved.

encourage the respondent to provide realistic descriptions. The question was phrased:

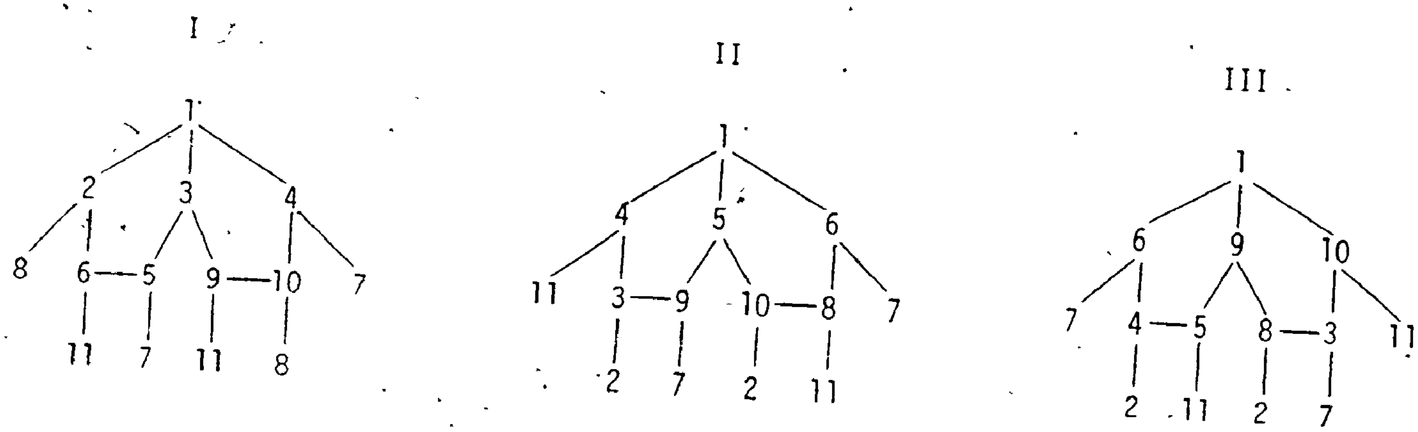
> We would like you to pretend you will have to move from here within say, 1 year. Considering your expected family and financial situation, could you describe the kind of home you would realistically hope to obtain.

On completing this description the respondent was asked whether he/she would be able to afford the residence described and whether the residence would be difficult to find. If the reply was either "NO" to the first question or "YES" to the second, the respondent was encouraged to reexamine the description of their "future possible" residence.

Preference data on residence attributes were collected in a form suitable for tradeoff analysis. The eleven variables, defined into discrete levels as indicated in Table 5.1, were used to form tradeoff matrices (e.g., Fig. 5.1). Each respondent completed 15 matrices so that all attributes appeared at least twice; most were matched with other attributes three times. Three structures of attribute pairings were used (Fig. 6.1) so that all respondents did not complete the same 15 matrices. Also the order of matrices were varied, the positions (row, or column) of attributes were varied, and the order of attribute levels were varied to prevent any order effects.

The survey included 116 interviews representing 87 households. The study was conducted in the Hamilton, Ontario, region. Households were contacted in all parts of the metropolitan area, including the communities of Dundas, Burlington, Stoney Creek and Grimsby, as well as the city of Hamilton. The total population of the area is about 500,000.

Figure 6.1 Three Structures of Attribute Pairings Used in the Questionnaire



Each line connecting two numbers indicates that the attributes represented by those numbers were paired on a single tradeoff matrix. Each structure represents a total of 15 tradeoff matrices.

CODE:

1. Occupancy - Building Type
2. Tenure
3. Number of Bedrooms
4. Backyard Space
5. Privacy
6. Neighbourhood
7. Parking
8. Age - Maintenance
9. Location
10. Cost
11. Trees - Landscaping

Respondents were contacted on a chain basis: each respondent suggested two or three friends who might participate. In some cases the chain of contacts extended to as many as 6 links. This approach provided the advantage of an initial screening in terms of location and household type, i.e., life cycle stage, and permitted a relatively simple introduction process. In fact the respondent would often already know of the interview. As a result only three households contacted refused to participate.

The greatest restriction in this approach, other than the fact that the procedure clearly does not yield a random sample, is that the socio-economic range of the respondents is confined. This seems to have been the case here: 23 households had a total gross income of less than $15,000, 64 households exceeded this. The average household income in Ontario in 1971 was $10,519.[1] It should be noted however, that the survey was restricted to "families", that is, single adult households were excluded which increases the average income. With education, however, a similar result occurs: for 60 of the 87 households at least one member had undertaken some post-secondary education. These facts suggest that these respondents represent largely a middle class group. While recognizing this bias, it is not felt to be particularly restrictive for at least two reasons. First, the question of socio-economic differences in behaviour or preferences is not of primary concern here. Second, the empirical research is, at this stage, both preliminary and focused on a

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1 Statistics Canada: Census Tract Bulletin, Series B, 1974.

particular research problem. The objective is not to test a broad range of hypotheses, but to provide a preliminary examination of a few specific hypotheses. With this objective the importance of large random samples is reduced.

With respect to life cycle stages, however, there is a need for a sufficient number of respondents in each category so that testing of the relevant hypotheses is possible. An effort was made, with the screening possible in the chain approach, to obtain sufficiently large numbers of respondents in each life cycle category. Even so, the emphasis is on providing a preliminary examination of hypotheses relevant to the present study and not test a large number of relationships associated with life cycle stages in the larger population.

6.2 Calculating Residential Stress Measures

The input to tradeoff analysis consists of the preference rankings of the combinations of attribute levels on the tradeoff matrices. The problem is to obtain numbers for each level of each attribute such that when the appropriate numbers are added together the order of the derived sums match, as closely as possible, the original preference ordering of the combinations of attribute levels. The output, from tradeoff analysis, therefore, consists of a set of scale values corresponding to the discrete levels of the selected variables. The 11 variables or attributes selected each with 2 to 4 discrete levels provide a total of 37 scale values for each individual. These values are interpreted as utility values; the scale as an interval scale. These scale values may be used in conjunction with the description of the household's present residence, obtained in the interview in terms of the 11 pre-selected variables, to calculate a measure of the household's experienced place utility.[1]

For those variables with a natural metric, such as backyard size and cost, utility values for intermediate levels of the variable were obtained by interpolation. For example, a 50 feet deep backyard would be assigned the utility value of the average of the utility value associated with a 40 feet deep backyard and the utility value associated with a 60 feet deep backyard. Simple linear interpolation, such as this, was the easiest to calculate and made use of what seemed to be the most relevant information. Fitting a curve through the entire set of points for a given variable, for example, would require a priori assumptions about the form of the utility function, since with only 4 data points there was little freedom to determine the form a posteriori. This also would have created certain anomolies in that the estimate for, say, a 50 feet deep backyard could exceed the original estimate for a 60 feet deep backyard, depending on the position of the other points. Hence, linear interpolation, using only two points was used. For further simplification with respect to the two variables backyard size and costs per month, only a limited number of discrete values were used, each

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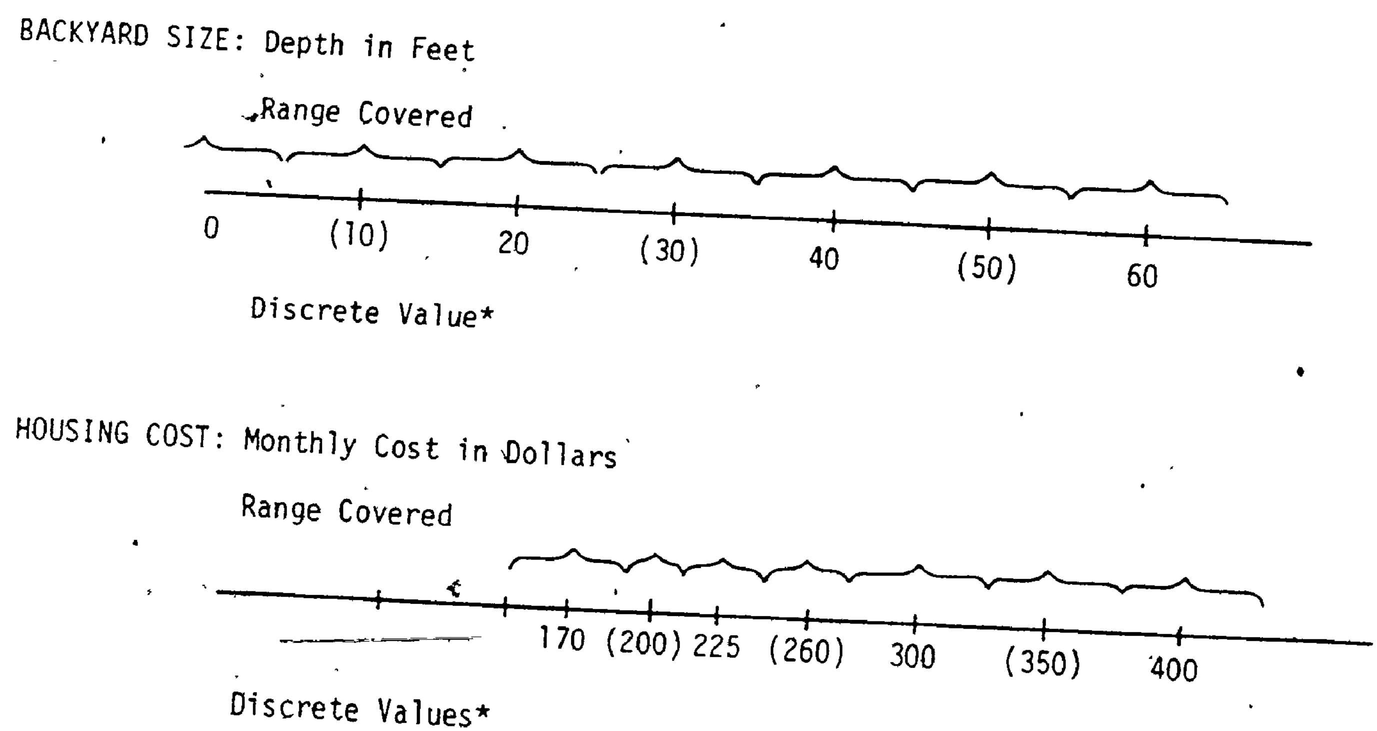
1 If only one member of the household was interviewed, this respondent constituted the household representative. If two members of a household were interviewed, the respondent with the smaller theta value (measure of "fit"; Appendix A) in the tradeoff analysis was designated the household representative.

Figure 6.2 Discrete Values Used to Represent Ranges of Backyard Size and Housing Cost



* Brackets indicate interpolated value.

discrete value representing a range of backyard size or cost. These are presented in Fig. 6.2. This further simplified the calculations and seemed appropriate given the accuracy of the original estimates and the calculated utility measures.

For variables without a natural metric, the original variable levels were selected so that an exhaustive set of categories was provided. Thus, for all categories, utility measures were obtained directly. An exception to this was the neighbourhood category. Respondents were provided with a set of 5 rating scales on which to describe their present and future neighbourhood. From these ratings, 8 rather than 4 neighbourhood types were determined. The rating scales and neighbourhood types including the method of categorization are shown in Fig. 6.3. Utility values were determined by examining utility differences with respect to different neighbourhood types. For example, the utility difference between a well kept, quiet, friendly neighbourhood and a well kept, noisy, friendly neighbourhood reflects the difference between "quiet" and "noisy". Then to obtain the utility value for a neighbourhood described as well kept, noisy, not very friendly, the calculated utility difference may be subtracted from the utility estimate for the neighbourhood type well kept, quiet, not very friendly which had been obtained directly. This assumes separability between the three aspects of neighbourhoods used here.

Having determined the utility values for each variable for the respondent's present residence, these were added to provide a measure of

FIGURE 6.3 DETERMINATION OF NEIGHBOURHOOD TYPES

A. Neighbourhood Rating Scales From Questionnaire

streets very quiet	___	___	___	___	___	streets very noisy
very clean	___	___	___	___	___	very untidy
old	___	___	___	___	___	new
buildings well kept	___	___	___	___	___	buildings rundown
people very friendly	___	___	___	___	___	people not friendly

B. Scales and Categories Used to Determine Neighbourhood Types

buildings well kept	___	___	___	___	___	buildings run down
streets very quiet	___	___	___	___	___	streets very noisy
people very friendly	___	___	___	___	___	people not friendly

C. Neighbourhood Types [1]

1. well kept, quiet and friendly
2. well kept, noisy and friendly
3. needs repair, noisy and friendly
4. well kept, quiet and not friendly

(5) well kept, noisy and not friendly
(6) needs repair, quiet and friendly
(7) needs repair, quiet and not friendly
(8) needs repair, noisy and not friendly

---

[1] ( ) indicate that the utility value for that neighbourhood type was not obtained directly, but through subtraction.

experienced place utility, U^o. Similarly, calculations, using the household's description of its "future possible residence", were made to obtain the household's aspiration utility level, U^*. Residential stress was then obtained by subtraction, i.e., $S=U^*-U^o$.

In this way residential stress could be calculated for a single household. These stress measures, however, are not comparable between households, since the original scale values are not comparable. To permit comparability of the stress measures, respondent's utility scales were standardized in the following way. The utility value for "2 bedrooms" was assigned the value of 0.0, and the utility difference between "1 bedroom" and "2 bedrooms" was assigned the value of 1.0. The remaining 35 values were adjusted using the following formula:

$$v_i = \frac{u_i - u(2\ \text{bedrooms})}{u(2\ \text{bedrooms}) - u(1\ \text{bedroom})}$$

where v_i is the transformed utility value, u_i is the original utility value, u(2 bedrooms) is the original utility value for "2 bedrooms", and u(1 bedroom) is the original utility value for "1 bedroom". This constitutes an increasing linear transformation. This procedure provides each scale with a common anchor point and unit of measure. In this case the unit of measure is the difference in utility between 1 and 2 bedrooms. These particular attribute levels were selected because all respondents agreed that "2 bedrooms" was preferable to "1 bedroom". As a consequence all scales had the common values of -1.0 for "1 bedroom" and 0.0 for "2 bedrooms". Notice, that using a zero value has no particular significance; another value could be used. Also, with an additive utility function negative values are acceptable. In this way, therefore, comparable residential stress measures could be calculated for each household.

Stress measures, however, could not be calculated for all 87 households. As a result of a change in the variable descriptions with respect to privacy (see section 5.4.3), 2 households did not provide comparable tradeoff data and were excluded. For 2 other households, high theta values (exceeding .09), indicated the assumption of additive separability was inappropriate and these were excluded in the residential stress calculations.

Of the remaining 83 households a further 38 had to be excluded due to an oversight in the selection of attribute levels for the two attributes backyard size and monthly costs. For these households, either their present residence or aspiration residence had backyards or monthly costs outside the range of attribute levels selected, i.e., costs in excess of $450 per month or less than $150 per month, or backyards exceeding 80 feet deep. Original intentions to extrapolate in these cases was subsequently deemed invalid. The number of assumptions required, and calculation difficulties with only 4 points, make this approach suspect. Residential stress, therefore, was calculated for 45 households. Of these households 11 had attribute values outside the acceptable range on at least one attribute. However, with these house holds, those values outside the range were the same for both present residence and aspiration residence and consequently those variables do not contribute to residential stress. The distribution of residential stress values is presented in Figure 6.4.

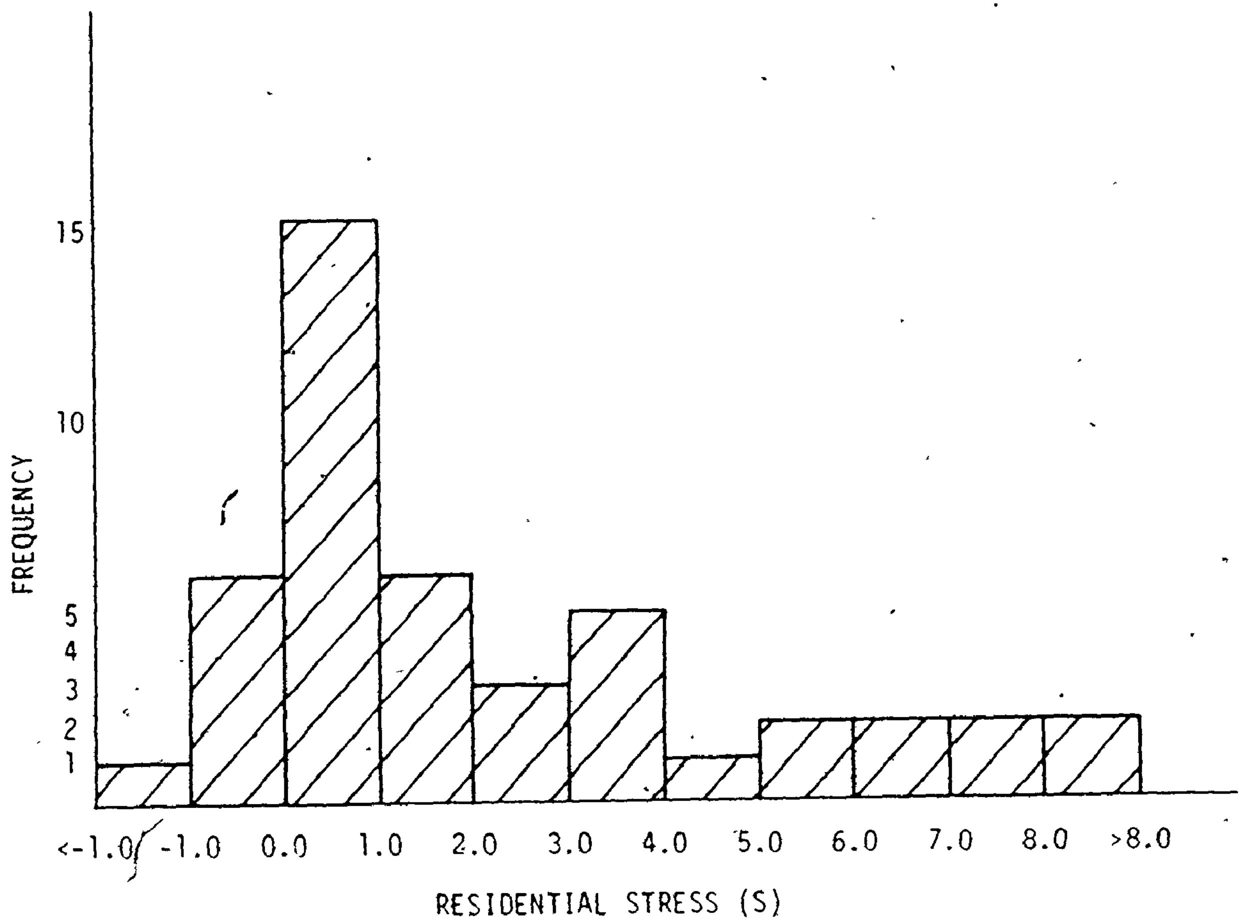


Figure 6.4 Frequency Distribution of Residential Stress Values (N=45)

CHAPTER 7

EMPIRICAL ANALYSIS

The purpose of this chapter is to present the results of the analysis of the four hypotheses outlined in Chapter 5. Each hypothesis is examined in turn. Conclusions with respect to individual hypotheses are presented following each analysis. An overall summary is presented in section 7.5.

7.1 Hypothesis 1: Mobility Behaviour and Residential Stress

The fundamental concept of the model is that residential stress, as a measure of the disparity between what a household has and what a household could have through relocating, is the basic decision variable for a household in deciding either to move or to stay. Whether a single household decides to move, of course, depends on whether the level of residential stress exceeds α, the household's stress threshold level. Although α varies between households, for a number of households the decision to move will be associated with relatively high levels of residential stress, and the decision to stay will be associated with low levels of residential stress.

Hence:

Hypothesis 1: Mobility behaviour is related to residential stress: movers are associated with high levels of residential stress; stayers are associated with low levels of residential stress.

To examine this hypothesis data are required on household residential stress levels and mobility behaviour. A measure of residential stress is available for 45 households, as outlined in the previous chapter (section 6.2). Two measures of mobility are available corresponding to each household's stated moving intentions and actual behaviour. Recall that households were asked whether they planned to move in the next year, and could respond "yes", "maybe" or "no". On the basis of these responses, three mobility intention categories may be distinguished: <u>intended movers</u>, <u>possible movers</u> (or possible stayers) and <u>intended stayers</u>. Also, recall that a follow-up survey was conducted, about one year after the original survey, to identify those who had actually moved in the interim. These data, relevant for testing Hypothesis 1 are included in Table 7.1.

Corresponding to these two measures of mobility, i.e., intended and actual behaviour, two forms of Hypothesis 1 may be examined. These are examined by analyses of variance under the null hypothesis of no difference in residential stress levels between mobility groups.

The results of the analysis with respect to intended mobility behaviour are provided in Table 7.2. The null hypothesis may be rejected at the .01 level of significance, providing support for Hypothesis 1. Further support is provided by an examination of mobility group means.

TABLE 7.1 DATA

HHLD. No.	ASPIRATION UTILITY (U*)[1]	PLACE UTILITY (U°)[1]	RESIDENTIAL STRESS (S)	MOBILITY[2] INTENTIONS	ACTUAL	LIFE CYCLE STAGE[3]	INCOME CATEGORY[4]
2	.3971	-.9739	1.3710	S	SS	1	4
9	3.2083	1.3387	1.8696	S	SS	1	1
14	(8.5192)	(6 9447)	1.5747	S	SS	2	2
17	-1.8823	-1.4233	-.4590	S	SS	2	2
18	(.4471)	(.3010)	.1461	S	SS	2	2
19	1.2302	.7935	.4367	S	SS	1	3
20	7.8255	4.2911	3.5344	S	SS	1	3
21	-2.5772	-2.8727	.2955	S	SS	4	2
22	(6.4334)	(5.9267)	.5047	S	SS	3	3
23	(7.3344)	(7.2670)	.0674	S	SS	3	3
26	.2409	-.1397	.3806	S	SS	3	3
27	9.2477	1.6068	7.6409	S	MM	1	4
28	(-.0391)	(-9.3708)	9.3317	S	SS	4	4
30	6.5014	6.8764	-.3732	S	(NA)	3	3
33	-1.9148	-2.0829	.1680	S	SS	3	3
40	(11.4297)	(11.4297)	.0000	S	SS	3	6
43	(6.0958)	(3.7281)	2.3678	S	SS	4	1
44	(15.1923)	(14.5768)	.6155	S	SS	4	4
49	3.4289	7.7716	-4.3428	S	SS	3	3
53	(4.9664)	(4.4317)	.5347	S	SS	4	1
55	3.3815	1.4397	1.9419	S	(NA)	1	3
56	-6.0489	-6.0489	.0000	S	SS	4	4
59	1.6145	-1.4655	3.0800	S	SS	1	5
64	11.5539	11.6027	-.0488	S	SS	3	6
67	4.5421	2.4039	2.1382	S	SS	4	4
68	1.7995	1.7953	.0042	S	SS	4	5
69	2.1217	2.4342	-.3125	S	SS	3	4
71	(5.2782)	(4.2367)	1.0415	S	SS	2	4
73	12.9998	12.8596	.1402	S	SS	4	5
77	9.7210	8.4864	1.2347	S	SS	3	5
78	10.4748	10.4428	.0320	S	SS	4	3
79	22.6605	17.4293	5.2312	S	SS	3	6
1	-.2273	.0340	-.2613	P	SS	3	3
5	2.9418	-.1054	3.0473	P	MM	1	1
7	6.6672	5.8452	.8219	P	SS	2	4
12	7.2210	3.6134	3.6075	P	MM	2	2
31	(12.4068)	(11.8915)	.5153	P	SS	3	5
52	11.0285	4.2447	6.7838	P	SS	1	3
80	3.8269	-3.8366	7.6635	P	SS	1	2
13	10.3082	3.7635	6.5447	M	MM	1	1
25	4.4171	1.4757	2.9413	M	SS	2	2
50	2.9374	-2.9237	5.8611	M	SS	1	6
54	.0984	-3.7416	3.8400	M	MM	2	5
61	11.5354	-1.5297	13.0651	M	MM	2	2
75	5.3893	1.1664	4.2229	M	SS	1	3

1. Brackets indicate estimate based on values outside measurement range (see section 6.2). Values not used in analysis of Hypothesis 2.

2. S - Intended Stayers
   P - Possible Mover
   M - Intended Mover
   SS - Actual Stayer
   MM - Actual Mover
   NA - Not Available

3. 1 - Young (under 40), no children
   2 - 1 or more children < 6
   3 - 1 or more children between 6 and 17
   4 - old (over 40), no children < 18

4. See Table 7.5.

TABLE 7.2 Analysis of Variance: Hypothesis 1 - Intended Mobility

SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F RATIO
Treatment (Mobility)	125.45382	2	62.72691	8.3704**
Error	314.74527	42	7.49394	
Total	440.19909	44		

Mobility Group	Means ($\bar{T}_i$)	Number (n_i)
Intended Stayers	1.25459	32
Possible Movers	3.16830	7
Intended Movers	6.07921	6

** Significant at .01 level

The order of the mean levels of S for the mobility groups is in accordance with the hypothesis.

Further, the group means may be examined to determine which differences are significant in contributing to the observed F value. The Sheffé method of simultaneously comparing (contrasting) treatment means is utilized (Sheffé, 1959, Ch. 3; also Winer, 1971, Ch. 3). This method has the advantage that the level of significance (.01 in this case) is determined for all possible comparisons and not simply comparisons involving only two means. In other words, the probability of a Type 1 error is at most .01 for any of the possible comparisons, and not .01 for each specific comparison. The method involves calculating a confidence interval for the comparison. If zero is not included in the interval, the null hypothesis of no difference between treatment means may be rejected. The results of five comparisons examining the different combinations of the mobility groups are presented in Table 7.3. The analysis indicates that intended movers have significantly higher residential stress levels than intended stayers; possible movers (or possible stayers) have intermediate levels of residential stress, which are not significantly different from either intended movers or intended stayers, and that while intended movers are not significantly different from possible and intended stayers, intended and possible movers <u>are significantly different from intended stayers</u>. On the basis of this statistical analysis, therefore, respondents indicating that they might relocate may be grouped with intended movers. On a logical basis, this

TABLE 7.3 Comparison of Treatment Means: Hypothesis 1

COMPARISON DESCRIPTION	FORM	CONFIDENCE INTERVAL (99%)	$H_0: C_j = 0$
C_1: Intended Movers/ Intended Stayers	$C_1 = \bar{T}_1 - \bar{T}_3$	$-8.745 < C_1 < -.905$	Reject
C_2: Intended Movers/ Possible Movers	$C_2 = \bar{T}_2 - \bar{T}_3$	$-6.782 < C_2 < .960$	Accept
C_3: Intended Stayers/ Possible Movers	$C_3 = \bar{T}_1 - \bar{T}_2$	$-5.590 < C_3 < 1.763$	Accept
C_4: Intended Stayers/ Possible and Intended Movers	$C_4 = 2\bar{T}_1 - \bar{T}_2 - \bar{T}_3$	$-12.547 < C_4 < -.930$	Reject
C_5: Intended Movers/ Possible and Intended Stayers	$C_5 = \bar{T}_1 + \bar{T}_2 - 2\bar{T}_3$	$-15.815 < C_5 < .344$	Accept

General Form of Comparison:

$$C_j = \sum_i^k c_i \beta_i \quad \text{where } \sum_i^k c_i = 0;\ k = \text{no. of groups}$$

Calculation of Confidence Intervals:

$$\hat{C}_j - S\hat{\sigma}_{\hat{C}_j} \leq C_j \leq \hat{C}_j + S\hat{\sigma}_{\hat{C}_j}$$

where

$$\hat{C}_j = \sum_i c_i \bar{T}_i \qquad s = \sqrt{MS_{error}}$$

$$\hat{\sigma}_{\hat{C}_j} = s \sum_i (c_i^2 / n_i) \qquad S = \sqrt{(k-1)F_{\alpha:k-1;\ N-k}}$$

also appears reasonable, for although possible movers have not made plans to move in the near future, they have expressed a certain committment to moving. Consequently, in subsequent analysis, intended and possible movers will frequently be grouped together. This appears to be a relatively conservative approach and necessary due to the small number of respondents. In general, however, the important result of these analyses is that Hypothesis 1 is supported.

Hypothesis 1 may be further examined using the data on actual mobility behaviour obtained in the follow-up survey. Of the 32 intended stayers, 30 were contacted and only 1 had moved. Of the 7 possible movers or stayers, all were contacted and 2 households had moved. Of the 6 intended movers, all were contacted and 3 had moved (see Table 7.1). The results of the analysis of variance using these data are presented in Table 7.4. The null hypothesis can again be rejected at the .01 level, consistent with Hypothesis 1.

These analyses, therefore, strongly support Hypothesis 1, and hence the basic postulate of the residential mobility model.

7.2 Hypothesis 2: Experienced Place Utility, Aspiration Utility and Income

Experienced place utility and aspiration utility are defined through problems (4.3) and (4.5) respectively. The household is conceptualized as attempting to maximize utility subject to upper and lower need constraints and income. Given that households exhaust their income, then experienced place utility and aspiration utility should

TABLE 7.4 Analysis of Variance: Hypothesis 1 - Actual Mobility

SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE (MS)	F RATIO
Treatment (Mobility)	113.93245	1	113.93245	14.5275**
Error	321.54440	41	7.84255	
Total	435.47686	42		

Mobility Group	Means ($\bar{T}_i$)	Number (n_i)
Stayers	1.59305	37
Movers	6.29093	6

** Significant at .01 level

increase as income increases. Thus,

Hypothesis 2: Experienced place utility and aspiration utility are positively related to household income.

This hypothesis may be examined by examining the relationship between experienced place utility, U^{o}, and income (H2.1), and the relationship between aspiration utility, U^{*}, and income (H2.2), separately.

To examine H2.1 requires information on U^{o} and income. Estimates of U^{o} are available for 34 households (Table 7.1). As well the income category for each household is known (Table 7.5). To examine this relationship, each household was assigned to the mid-point of their respective income category and a linear regression performed. To remove any correlation between the estimated slope and intercept coefficients, for the independent variable, income, deviations from the mean were used rather than raw values. The resulting slope coefficient, b=.26992 (t = 2.172) was significantly larger than zero at the .025 level (one-tail test), thereby supporting Hypothesis 2.

Hypothesis 2.2 was examined in a similar manner. In this case the slope coefficient, b = .22868 (t = 1.660) was significantly larger than zero at the .05 level (one-tail test), again supporting Hypothesis 2.

The results of the two tests support the basic hypothesis. With H2.1, the hypothesis is strongly supported. With H2.2, however, the result is less convincing; the coefficient is barely significant at the .05 level. The difference in these results may be explained by the fact that aspirations represent a more nebulous concept than a household's present residence and thus subject to greater variation.

TABLE 7.5 Income Categories

1) less than $12,000
2) $12,000 to $14,999
3) $15,000 to $19,999
4) $20,000 to $24,999
5) $25,000 to $30,000
6) greater than $30,000

A further aspect of these results is that they lend support to the validity of the method of measuring experienced and aspiration utility. Hypothesis 2 is intuitively so attractive that if a positive trend had not been identified then not only would the definitions of U^o and U^*, and thus the model, be suspect but also the method of calculating U^o and U^*. The present results, therefore, lend support to the validity of the method as well as the model.

7.3 Hypothesis 3: Mobility Behaviour and Income Changes

Whereas Hypothesis 1 was concerned with the basic relationship between residential stress and mobility, Hypotheses 3 and 4 are concerned with factors which influence the level of residential stress over time, and hence mobility. Hypothesis 3 is concerned with the effects of income changes; Hypothesis 4 is concerned with the effects of life cycle changes. The latter will be discussed in section 7.4.

The theoretical relationship between residential stress and income changes has been examined in Chapter 4. S was shown to be related to the accumulated changes in (household) income from the time the household first moved into its present place. Accumulated changes in either direction, i.e., either increases or decreases, increase residential stress, and thus increase the liklihood of a household deciding to relocate. Hence:

Hypothesis 3: Mobility behaviour is related to income changes; households experiencing income increases or decreases are more likely to be movers than households not experiencing these changes.

To examine hypothesis 3 requires data on both mobility behaviour and income changes. As before mobility behaviour may be represented by mobility intentions, i.e., intended movers, possible movers, and intended stayers, or by actual mobility behaviour as indicated from the follow-up survey. Now, however, a third alternative may be included: households who had moved in the 6 months prior to the original interview may be classified as "movers", regardless of whether they intended to move again, or stay in the following year. These recent movers could not be included as movers in the analysis of Hypothesis 1 since residential stress referred to their present residence. Income changes, however, do not depend on the household's residence.

The appropriate measure for income changes would be the accumulated change in real income since the time the household first entered its present residence. The difficulty in discounting income change over a long period, as well as the fact that the recall accuracy of income levels over a long period is not likely to be reliable, prevented the use of this measure. Instead, households were asked to indicate whether their income increased less than, equal to, or more than inflation over the previous year, and to predict whether their income over the next year would increase less than, equal to, or more than, inflation in the next year. With three categories for both past and future income changes, 9 patterns of income change are defined. With the mobility categories these data may be represented in the form of a 3-way contingency table.

Corresponding to the different measures of mobility behaviour three forms of the relationship between income changes and mobility behaviour may be examined. In each case two mobility categories are used due to the small number of respondents. First, mobility intentions are used with stayers being distinguished from possible and intended movers. Second, recent movers are distinguished and included in the mover category. Third, actual mobility behaviour is used with both recent and subsequent movers combined. With these categories the data may be represented as a 2x3x3 contingency table. The method of analysis is to examine the inter-dependencies in the data by the use of the minimum discrimination information statistic, $2\hat{I}$, developed, and applied to the analysis of contingency tables by Kullback (1968).

With a 3-way contingency table the analysis proceeds in 3 stages. First, the 3-way dependence is examined. In this case the dependencies among mobility behaviour (M), past income changes (ΔY_p) and future income changes (ΔY_f) are examined, i.e., $M \times \Delta Y_p \times \Delta Y_f$. Second, the 3-way dependence is partitioned into a) the relationship between income changes ($\Delta Y_p \times \Delta Y_f$), and b) the relationship between mobility and the combined income changes ($M \times (\Delta Y_p \times \Delta Y_f)$). Third, the conditional dependencies are examined: a) the relationship between mobility and past income changes, given future changes, i.e., $(M/\Delta Y_f) \times (\Delta Y_p/\Delta Y_f)$, and b) the relationship between mobility and future income changes given past income changes, i.e., $(M/\Delta Y_p) \times (\Delta Y_f/\Delta Y_p)$.

7.3.1 Mobility Intentions

The appropriate 3-way contingency table corresponding to the case in which the mobility categories refer to intended stayers and possible and intended movers is shown in Table 7.6.

The first step is to examine the 3-way dependencies. Under the null hypothesis of independence among the row, column and depth categories, the formula for calculating the statistic, $2\hat{I}$, given by Kullback (1968, Ch. 8), is:

$$2\hat{I} = 2 \sum_{i=1}^{r} \sum_{j=1}^{c} \sum_{k=1}^{d} X_{ijk} \log \frac{N^2 X_{ijk}}{X_{i..} X_{.j.} X_{..k}} \qquad (7.1)$$

The row category refers to mobility (M), r=2; the column category refers to past income change (ΔY_p), c=3; and the depth category refers to future income change (ΔY_f), d=3. N is the total number of observations. The calculated value of $2\hat{I}$ is 30.492. Ku (1963) however, has suggested that when one or more of the cell frequencies are zero, the calculated $2\hat{I}$ statistic is somewhat inflated. Consequently he suggests subtracting a value of 1.0 for each zero cell frequency. The corrected value for $2\hat{I}$ therefore, is 28.492. Kullback (1968) has shown that the statistic $2\hat{I}$ is distributed as chi-square (χ^2). Since $\chi^2_{.01;\ 12d.f.} = 26.217$, the null hypothesis of 3-way independence may be rejected in this case.

The second step is to examine the sources of the dependencies. The 3-way independence statistic, $2\hat{I}$, may be partitioned into two additive components, reflecting the fact that the 3 classifications are independent if and only if the row classification is independent of the other two classifications and they are independent of each other. That is, $H_0(M \times \Delta Y_p \times \Delta Y_f) \Leftrightarrow H_0(M \times (\Delta Y_p, \Delta Y_f)) \cap H_0(\Delta Y_p \times \Delta Y_f)$, where H_0 refers to the null hypothesis of independence. The results of the partitioning procedure

TABLE 7.6 Contingency Table: Mobility Intentions

ΔY_p	1			0			-1			
ΔY_f	1	0	-1	1	0	-1	1	0	-1	
Stayers	4	10	1	5	12	4	3	10	10	59
Movers	5	6	0	1	4	0	4	2	6	28
	9	16	1	6	16	4	7	12	16	87

ΔY_p - past income change

ΔY_f - future income change

1 - change greater than inflation

0 - change equal to inflation

-1 - change less than inflation

are presented in Table 7.7. The formulae for calculating the appropriate information statistics are given by Kullback (1968, p. 165). Under the null hypothesis of independence between column and depth categories, i.e., $H_o(\Delta Y_p x \Delta Y_f)$, the appropriate information statistic is:

$$2\hat{I} = 2 \sum_{j=1}^{c} \sum_{k=1}^{d} X_{.jk} \log \frac{N X_{.jk}}{X_{.j.} X_{..k}} \tag{7.2}$$

Under the null hypothesis of independence between row and column-depth categories, i.e., $H_o(M \times (\Delta Y_p, \Delta Y_f)$, the information statistic is:

$$2\hat{I} = 2 \sum_{i=1}^{r} \sum_{j=1}^{c} \sum_{k=1}^{d} X_{ijk} \log \frac{N X_{ijk}}{X_{i..} X_{.jk}} \tag{7.3}$$

The bracketed values in Table 7.7 indicate the uncorrected values. Ku (1963) does not specify how the correction factor, necessary when zero entries occur, should be partitioned in the present type of analysis. Comparing (7.2) and (7.3), however, indicates that in calculating (7.3) two of the terms in the summation will be zero corresponding to the two X_{ijk} values which are zero. There will be no such terms in (7.2). Hence, the information statistic corresponding to (7.2) was not corrected. whereas the information statistic corresponding to (7.3) was reduced by a value of 2.0.

From Table 7.7 the results indicate that the null hypothesis of independence between past and future income changes may be rejected. But the null hypothesis of independence between mobility behaviour and income changes cannot be rejected, contrary to hypothesis 3.

The relationship between mobility behaviour and income changes may be explored further, however, by examining the conditional dependencies.

TABLE 7.7 Partitioning of 3-way Independence: Mobility Intentions

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(\Delta Y_p x \Delta Y_f)$	19.658**	4
$H_o(Mx(\Delta Y_p, \Delta Y_f))$	8.834 n.s. (10.834)	8
$H_o(Mx\Delta Y_p x \Delta Y_f)$	28.492** (30.492)	12

** significant at .01 level

n.s. not significant

Step 3 involves partitioning the component due to $Mx(\Delta Y_p, \Delta Y_f)$ into the two additive components, $Mx\Delta Y_f$ and $(M/\Delta Y_f) \times (\Delta Y_p/\Delta Y_f)$, and then into the two components, $Mx\Delta Y_p$ and $(M/\Delta Y_p) \times (\Delta Y_f/\Delta Y_p)$. In other words, is there a relationship between mobility and past income change when future income changes are held constant, and/or is there a relationship between mobility and future income change when past income change is held constant? The formulae, given by Kullback (1968), for the information statistics corresponding to the hypothese $H_0(Mx\Delta Y_f)$ and $H_0(M/\Delta Y_f \times \Delta Y_p/\Delta Y_f)$ are respectively:

$$2\hat{I} = 2 \sum_{i=1}^{r} \sum_{k=1}^{d} X_{i.k} \log \frac{NX_{i.k}}{X_{i..} X_{..k}} \qquad (7.4)$$

$$2\hat{I} = 2 \sum_{i=1}^{r} \sum_{j=1}^{c} \sum_{k=1}^{d} X_{ijk} \log \frac{X_{ijk}}{\frac{X_{i.k} X_{.jk}}{X_{..k}}} \qquad (7.5)$$

Formulae for the hypotheses $H_0(Mx\Delta Y_p)$ and $H_0(M/\Delta Y_p \times \Delta Y_f/\Delta Y_p)$ may be determined by simply rearranging the j's and k's.

The results of these analyses are presented in Tables 7.8 and 7.9. Under no situation can the null hypothesis of independence be rejected.

In conclusion, given this definition of mobility behaviour, there is no significant relationship between mobility and income changes nor are there significant relationships between mobility and past income change and between mobility and future income change. Thus, the results of the analysis of mobility intentions <u>do not support</u> Hypothesis 3.

TABLE 7.8 Conditional Independence of Mobility and Past Income Change: Mobility Intentions

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(M \times \Delta Y_f)$	2.308 n.s.	2
$H_o(M/\Delta Y_f \times \Delta Y_p/\Delta Y_f)$	6.526 n.s. (8.526)	6
$H_o(M \times \Delta Y_p \times \Delta Y_f)$	8.834 n.s. (10.834)	8

TABLE 7.9 Conditional Independence of Mobility and Future Income Change: Mobility Intentions

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(M \times \Delta Y_p)$	3.429 n.s.	2
$H_o(M/\Delta Y_p \times \Delta Y_f/\Delta Y_p)$	5.405 n.s. (7.405)	6
$H_o(M \times \Delta Y_p \times \Delta Y_f)$	8.834 n.s. (10.834)	8

7.3.2 Recent Movers

The appropriate 3-way contingency table corresponding to the case in which the mobility categories refer to intended stayers and possible, intended and recent movers is shown in Table 7.10. Intended stayers who had moved in the 6 months prior to the first interview are now reclassified as movers.

The analysis proceeds as before. The value of the information statistic calculated under the hypothesis of 3-way independence, i.e., $H_0(MxY_pxY_f)$, and corrected for the two zero entries in the contingency table is 36.340, which is significant beyond the .01 level.

The sources of the dependencies are analyzed and the results are presented in Table 7.11. The null hypotheses of independence between past and future income changes and between mobility behaviour and income changes may be rejected both at the .01 level of significance. The latter result differs from the previous case for mobility intentions. The present result is consistent with Hypothesis 3.

The results of the analyses of the conditional dependencies are presented in Tables 7.12 and 7.13. The null hypothesis of independence between mobility and past income changes, future income changes held constant, is rejected. But the null hypothesis of independence between mobility and future income change, past income changes held constant, is not rejected. Thus, given this definition of mobility, there is a significant relationship between mobility behaviour and past income changes, in agreement with Hypothesis 3. But there is not a significant relationship between mobility behaviour and future income changes, contrary

TABLE 7.10 Contingency Table: Recent Movers

ΔY_p	1			0			-1			
ΔY_f	1	0	-1	1	0	-1	1	0	-1	
Stayers	3	5	1	4	12	4	2	10	10	51
Movers	6	11	0	2	4	0	5	2	6	36
	9	16	1	6	16	4	7	12	16	87

ΔY_p - past income changes

ΔY_f - future income changes

1 - income change greater than inflation

0 - income change equal with inflation

-1 - income change less than inflation

TABLE 7.11 Partitioning of 3-way Independence: Recent Movers

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(\Delta Y_p x \Delta Y_f)$	17.634**	4
$H_o(M \times (\Delta Y_p, \Delta Y_f))$	18.706** (20.706)	8
$H_o(M \times \Delta Y_p \times \Delta Y_f)$	36.340** (38.340)	12

** significant at .01 level

TABLE 7.12 Conditional Independence of Mobility and Past Income Changes: Recent Movers

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(M \times \Delta Y_f)$	1.030 n.s.	2
$H_o(M/\Delta Y_f \times \Delta Y_p/\Delta Y_f)$	17.676** (19.676)	6
$H_o(M \times (\Delta Y_p, \Delta Y_f))$	18.706** (20.706)	8

TABLE 7.13 Conditional Independence of Mobility and Future Income Changes: Recent Movers

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(M \times \Delta Y_p)$	10.196**	2
$H_o(M/\Delta Y_p \times \Delta Y_f/\Delta Y_p)$	8.510 n.s. (10.510)	6
$H_o(M \times (\Delta Y_p, \Delta Y_f))$	18.706** (20.706)	8

to Hypothesis 3.

7.3.3 Actual Mobility

The appropriate 3-way contingency table corresponding to the case in which the mobility categories refer to stayers and recent and subsequent movers is shown in Table 7.14. Subsequent movers refer to households who had moved in the 12 months following the initial interview.

Once more the analysis proceeds in three stages. The results of the first 2 steps are presented in Table 7.15. The null hypothesis of 3-way independence may be rejected as well as the null hypotheses of independence between past and future income changes and between mobility behaviour and income changes. All are significant beyond the .01 level.

The results of the analysis of the conditional dependencies are presented in Tables 7.16 and 7.17. The null hypothesis of independence between mobility behaviour and past income changes, future income changes held constant, may be rejected at the .01 level of significance. And the null hypothesis of independence between mobility behaviour and future income changes, past income changes held constant, may be rejected at the .05 level of significance. Thus, with this definition of mobility, there is a significant relationship between mobility behaviour and past income changes, and a significant relationship between mobility behaviour and future income changes. This latter result should be qualified, however, with the observation that these "future" income changes may already have occurred. Nevertheless, these results provide considerable support for Hypothesis 3.

TABLE 7.14 Contingency Table: Actual Mobility

ΔY_p	1			0			-1			
ΔY_f	1	0	-1	1	0	-1	1	0	-1	
Stayers	5	6	1	4	14	4	2	10	12	58
Movers	4	9	0	2	1	0	5	1	4	26
	9	15	1	6	15	4	7	11	16	84

ΔY_p - past income change

ΔY_f - future income change

1 - change greater than inflation

0 - change equal to inflation

-1 - change less than inflation

TABLE 7.15 Partitioning of 3-way Independence: Actual Mobility

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(\Delta Y_p \times \Delta Y_f)$	17.6522**	4
$H_o(M \times (\Delta Y_p, \Delta Y_f)$	21.3306** (23.3306)	8
$H_o(M \times \Delta Y_p \times \Delta Y_f)$	38.9828** (40.9828)	12

TABLE 7.16 Conditional Independence of Mobility and Past Income Changes: Actual Mobility

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(M \times \Delta Y_f)$	5.3087 n.s.	2
$H_o(M/\Delta Y_f \times \Delta Y_p/\Delta Y_f)$	16.0219** (18.0219)	6
$H_o(M \times (\Delta Y_p, \Delta Y_f)$	21.3306** (23.3306)	8

TABLE 7.17 Conditional Independence of Mobility and Future Income Changes: Actual Mobility

COMPONENT DUE TO	INFORMATION	DEGREES OF FREEDOM
$H_o(M \times \Delta Y_p)$	8.3164*	2
$H_o(M/\Delta Y_p \times \Delta Y_f/\Delta Y_p)$	13.0142* (15.0142)	6
$H_o(M \times (\Delta Y_p, \Delta Y_f)$	21.3306** (23.3306)	8

* significant at .05 level

** significant at .01 level

n.s. not significant

An interesting aspect of these analyses is that there seems to be a lag between income changes and adjustments in normal income. When mobility is defined only on the basis of intentions, there is no significant relationship between mobility and income changes. When recent movers are differentiated, however, a significant relationship between mobility and past income change is identified. This suggests that mobility decisions depend more on changes that have already occurred than on anticipated changes. And when recent and subsequent movers are identified, both past income changes and future income changes are significantly related to mobility. In this last case, however, many future changes have already been realized at the time of the actual move. In other words, the results suggest that experienced changes are much more important in influencing relocation decisions than anticipated changes. Of course, anticipated changes actually fulfilled may be the most influential. Nevertheless, these results suggest that people react to, rather than anticipate change.

7.3.4 Income and Mobility

An important corollary of the model is that while U^o and U^* depend on the level of income, residential stress, and hence mobility, do not depend on the level of household income at any given moment in time. This relationship may be examined using the six income categories recorded in Table 7.5 and the three definitions of mobility employed above. These data may be used to form three contingency tables as in Table 7.18. A

TABLE 7.18 Mobility and Income

a) Mobility Intentions

Income Categories*

	1	2	3	4	5	6	
Stayers	3 (4.75)	8 (10.85)	19 (17.63)	18 (14.24)	5 (6.78)	6 (4.75)	59
Movers	4 (2.25)	8 (5.15)	7 (8.37)	3 (6.76)	5 (3.22)	1 (2.25)	28
	7	16	26	21	10	7	87

$X^2 = 10.220$ $X^2_{.05,\ 5df.} = 11.070$

b) Recent Movers Included

Income Categories

	1	2	3	4	5	6	
Stayers	3 (4.10)	8 (9.38)	15 (15.24)	16 (12.31)	3 (5.86)	6 (4.10)	51
Movers	4 (2.90)	8 (6.62)	11 (10.76)	5 (8.69)	7 (4.14)	1 (2.90)	36
	7	16	26	21	10	7	87

$X^2 = 9.385$ $X^2_{.05,\ 5df.} = 11.070$

c) Actual Mobility

Income Categories

	1	2	3	4	5	6	
Stayers	3 (4.83)	11 (11.05)	16 (17.26)	15 (13.12)	6 (6.91)	7 (4.83)	58
Movers	4 (2.17)	5 (4.95)	9 (7.74)	4 (5.88)	4 (3.09)	0 (2.17)	28
	7	16	25	19	10	7	84

$X^2 = 6.949$ $X^2_{.05,\ 5df.} = 11.070$

* For Income Categories see Table 7.5.

chi-square test was performed on each matrix and in none of the cases could the null hypothesis be rejected. Combining either categories 5 and 6 or 1 and 2 did not affect the results. There is no evidence, therefore, that mobility behaviour is related to the level of income. This result is consistent with the model.

7.4 Hypothesis 4: Mobility Behaviour and Life Cycle Stage

A second factor affecting the level of residential stress, and hence mobility, is life cycle change. As discussed in section 5.2, life cycle factors may affect residential stress in two ways. First, household needs may be related to life cycle factors such as age and number of children. Thus, changes in life cycle factors may affect needs and in turn U^*, U^o and S. Second, household preferences may be related to life cycle factors. Thus, changes in life cycle factors may lead to new evaluations of the household's present residence as well as other residences, thereby affecting S. Notice that it is not necessary that households experience similar changes in needs and/or preferences, but that they experience these changes at similar life cycle stages.

As discussed briefly in Chapter 1, life cycle stage may be interpreted somewhat differently than that originally implied by Rossi (1955). Instead of interpreting life cycle stages as periods when needs and preferences are relatively stable, life cycle stages may be viewed as periods in which needs and preferences undergo different rates of change. If life cycle stages are interpreted as periods of stability then relocation should be associated with changes between stages and not with stages. In contrast, if life cycle stages are interpreted as periods with differing rates of change then relocation should be associated with life cycle stages. With this interpretation the following is suggested:

Hypothesis 4: Mobility behaviour is related to life cycle stage.

This hypothesis may be examined using the three definitions of mobility employed previously: 1) intended mobility, 2) recent mobility, and 3) actual mobility. Life cycle stages may be defined using data on the number and ages of children and the ages of adults in the household. Four life cycle categories are identified: 1) young (under forty), no children, 2) one or more children all under 6 years old, 3) one or more children between the ages of 6 and 17, 4) old (over forty), no children or youngest aged 18 or over.

The data for the analysis of Hypothesis 4, are presented in Table 7.19. The three contengency tables correspond to the three different definitions of mobility. Chi-square statistics have been calculated as shown and the results indicate that in each case the null hypothesis of independence may be rejected at the .005 level of significance. This provides strong support for Hypothesis 4.

7.4.1 Residential Stress and Life Cycle Stage

The influence of life cycle changes on mobility decisions may be further examined by analyzing the relationship between life cycle stage

TABLE 7.19 Mobility and Life Cycle Stage

a) Intended Mobility

Life Cycle Stages

	1	2	3	4	
Stayers	14 (19.67)	14 (15.60)	17 (14.24)	14 (9.49)	59
Movers	15 (9.33)	9 (7.40)	4 (6.76)	0 (4.51)	28
	29	23	21	14	87

$X^2 = 13.885$ $X^2_{.005,\ 3df.} = 12.838$

b) Recent Mobility

Life Cycle Stages

	1	2	3	4	
Stayers	11 (17.00)	11 (13.48)	15 (12.31)	14 (8.21)	51
Movers	18 (12.00)	12 (9.52)	6 (8.69)	0 (5.79)	36
	29	23	21	14	87

$X^2 = 17.525$ $X^2_{.005,\ 3df.} = 12.838$

c) Actual Mobility

Life Cycle Stage

	1	2	3	4	
Stayers	12 (17.95)	13 (15.88)	19 (14.50)	14 (9.67)	58
Movers	14 (8.05)	10 (7.12)	2 (6.50)	0 (4.33)	26
	26	23	21	14	84

$X^2 = 18.851$ $X^2_{.005,\ 3df.} = 12.838$

and residential stress.[1] Changes in preferences and/or needs associated with life cycle factors should affect the intermediate variable of residential stress. Thus,

Hypothesis 4*: Residential stress is related to the household's life cycle stage.

Since residential stress is an interval scaled variable, this relationship may be examined by means of an analysis of variance. The relevant data are included in Table 7.1. The results of such an analysis are presented in Table 7.20. The null hypothesis of no differences in residential stress among life cycle groups is rejected at the .01 significance level.

Further analysis of the differences among treatment means may be undertaken by Sheffé's method of simultaneous comparisons (Sheffé, 1959). The results of six such comparisons are presented in Table 7.21. They indicate that there are significant differences (95% confidence level) between life cycle group 1 (young, no children) and life cycle group 3 (old, one or more children between 6 and 17), and between the combined life cycle 1 and 2 group and the combined life cycle 3 and 4 group. The other comparisons do not lead to significant differences. The essential distinction identified in these analyses seems to be the difference between young households and older households. The latter have

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1 The large number of categories associated with income changes with the small number of respondents for which residential stress measures were available, precluded the analysis of a similar type of hypothesis with respect to hypothesis 3.

TABLE 7.20 Analysis of Variance of Hypothesis 4*: Residential Stress and Life Cycle Stage

SOURCE	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE	F RATIO
Treatment (Life Cycle)	110.3514	3	36.7838	4.572**
Error	329.8477	41	8.0451	
Total	440.1991	44		

Life Cycle	Means ($\bar{T}_i$)	Numbers (n_i)
1	4.1537	13
2	2.9532	9
3	.2126	13
4	1.5460	10

TABLE 7.21 Comparison of Treatment Means: Hypothesis 4*

COMPARISON DESCRIPTION	FORM	CONFIDENCE INTERVAL (95%)	$H_o: C_j=0$
C_1: Life Cycle Group 1/ Life Cycle Group 3	$C_1=\bar{T}_1-\bar{T}_3$	$.6938 < C_1 < 7.1884$	Reject
C_2: Life Cycle Group 1/ Life Cycle Group 4	$C_2=\bar{T}_1-\bar{T}_4$	$-.8747 < C_2 < 6.0901$	Accept
C_3: Life Cycle Groups 1 and 2/ Life Cycle Groups 3 and 4	$C_3=\bar{T}_1+\bar{T}_2-\bar{T}_3-\bar{T}_4$	$.3467 < C_3 < 10.3499$	Reject
C_4: Life Cycle Group 1/ Life Cycle Groups 2, 3 and 4	$C_4=3\bar{T}_1-\bar{T}_2-\bar{T}_3-\bar{T}_4$	$-.4481 < C_4 < 15.9467$	Accept
C_5: Life Cycle Groups 1 and 4/ Life Cycle Groups 2 and 3	$C_5=\bar{T}_1+\bar{T}_4-\bar{T}_2-\bar{T}_3$	$-2.4677 < C_5 < 7.5355$	Accept
C_6: Life Cycle Group 3/ Life Cycle Groups 1, 2 and 4	$C_6=\bar{T}_1+\bar{T}_2+\bar{T}_4-3\bar{T}_3$	$-.1823 < C_6 < 16.2125$	Accept

Note: For general form of comparison see Table 7.3.

significantly lower levels of residential stress. This distinction is also evident in the contingency tables (Table 7.19) in which the relative number of movers is distinctly smaller for life cycle groups 3 and 4 compared to groups 1 and 2. These findings are consistent with previous empirical research on the relationship between life cycle stage and mobility (e.g., Rossi, 1955; Long, 1973; Shaw, 1975).

An interesting aspect of the present results, however, is the finding that the mean residential stress level is lower for households in life cycle stage 3 than households in life cycle stage 4, while at the same time mobility is greater for life cycle group 3. This is contrary to the basic hypothesis of the model. At least three factors may be suggested to account for this.

First, from a statistical viewpoint, life cycle group 3 may have greater variability in residential stress levels. A number of very low values may depress the mean. In examining the distribution of values for life cycle group 3, this certainly seems to have some validity. A number of residential stress values are negative, contrary to the theory. Why this should occur more with this particular group, however, is a matter of speculation.

A second factor which might explain this result is simply that life cycle group 4 households have higher tolerance levels, i.e., α values. On average, this group has lived longer in their present residence and hence may have built up greater sentimental attachements.

A third factor might be that life cycle group 3 is experiencing changes in needs which prompt relocation. These changes may be relatively sudden and not reflected in a gradual increase in residential stress.

In conclusion, this analysis of Hypothesis 4* may be related to the question of how life cycle stages should be interpreted. If life cycle stages are interpreted as a series of discrete steps then mobility should occur when a household jumps from one step to the next. There should be a relationship between <u>changes</u> in life cycle stage and mobility but not life cycle stage and mobility. Since there is a significant relationship, however, then life cycle stage must be either re-interpreted or some other variable must be considered to explain the result. Within the theoretical model suggested here, mobility occurs when residential stress exceeds the household's tolerance level, α. One possibility, then is that α varies with life cycle stage. Particularly, α might be expected to increase with life cycle stage so that, all else being equal, the average level of residential stress would tend to <u>increase</u> with life cycle stage, i.e., higher levels of S could occur without relocating. The present results suggest however that residential stress <u>decreases</u> with life cycle stage. Thus, while α may vary with life cycle stage it does not appear to explain the observed relationship between residential stress and life cycle stage.

Alternatively, we may recognize that the factors which affect the level of residential stress, which are directly related to the household, are changes in income, changes in needs and changes in preferences.

Income changes are not likely related to life cycle jumps.

Changes in needs and preferences, however, may be related to changes in life cycle stage, i.e., jumps from one stage to the next. This, however, does not explain the relationship between residential stress and life cycle stage, unless there is a lag between life cycle stage changes and preference and needs changes. This is possible. It would suggest, however, that residential stress levels should on average, obtain a maximum shortly after the life cycle change.

This may be contrasted with the interpretation of life cycle stages as periods of different rates of change. Particularly, preferences and needs may vary during different periods. Similarly, income changes (as well as income levels) may be correlated with life cycle factors, particularly age.[1] This interpretation would suggest that residential stress levels should, on average, reach a maximum late in that life cycle period.

These two interpretations could, therefore, be examined empirically, given sufficient data to be able to examine how residential stress levels vary within given life cycle stages. This is not possible here. The second interpretation, however, is advanced in this thesis, first, to emphasize the need to more carefully examine the rationale underlying the relationship between mobility and life cycle stages, and second, since it seems more plausible that needs and particularly preferences are undergoing continual change rather than a series of discrete changes.

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1 Income may also be important as a variable in a household's decision concerning the number and timing of children.

7.5 Conclusion

The important general conclusion of Chapter 7 is that the results of the analyses provide considerable support for the validity of the proposed model. The four hypotheses examined are all supported by the evidence, although to varying degrees. In particular, Hypothesis 1, which forms the basic concept of the model, is strongly supported by the analysis.

Similarly Hypothesis 3, concerned with the effects of income changes on mobility, and Hypothesis 4 concerned with the effects of life cycle changes on mobility, are supported by the data. With Hypothesis 3 however, the results depend on the definition of mobility: no significant relationship exists when intended mobility is used but a highly significant relationship exists when actual mobility is used.

Future research might extend the analyses in this chapter in several ways. First, with a larger number of respondents the relationships expressed in Hypotheses 3 and 4 could be examined controlling for the other variable, e.g., the effects of income change with life cycle change held constant. Second, the relationship between residential stress and income change could be examined. Third, the effects of different definitions of mobility, life cycle stage and particularly income change could be explored. Finally, different methods of measuring residential stress could be developed. For example, the method of measuring locational stress suggested by Clark and Cadwallader (1973) could be extended, or some form of magnitude estimation as demonstrated by Shinn (1971), could be employed. Particularly, the present results would be strengthened if several measures of residential stress could be shown to provide similar results.

CHAPTER 8

CONCLUSION

The purpose of this thesis has been to develop and empirically test a model of household mobility decisions. It has been argued that the concepts previously proposed to explain mobility behaviour, namely, place utility, aspirations and (residential) stress, can be explicitly defined and their interrelationships clarified within the framework of consumer behaviour theory.

The theory of consumer behaviour provides a comprehensive and consistent general model of the individual's evaluation and choice process. It can, therefore, be applied to other spatial choice problems. Such an approach can not only provide insight into the choice problem, but also lead to important new conclusions about behaviour which may be empirically testable. Moreover, the development of such a theory is important in selecting appropriate empirical methods of analysis. In the present case, for example, the type of choice required in tradeoff analysis is consistent with the type of choice postulated in the theory.

A significant aspect of this framework is that choice is seen to depend on both <u>preferences</u> and <u>constraints</u>. This is extremely simple but of great significance. It emphasizes that to understand behaviour requires an understanding of the limits of choice, i.e., what the constraints are and how they operate. Identifying constraints can greatly clar`fy the choice process. For example, in an individual's choice of residential location, distance from work has often been treated as a continuous choice variable. It may, however, be considered as a constraint so that choice would not depend on distance within a certain limit. Or, perhaps, distance has both upper and lower limits. In the present context of mobility the role of constraints is vital to understanding decisions. Changes in the household's income and needs, i.e., constraints, are seen to be major factors in the decision to move. In general, the simple distinction between preferences and constraints, emphasized in this framework is useful in clarifying the role various factors may play in spatial choice problems.

One shortcoming of the present application of this framework, however, is that the role subjective cognition plays in mobility behaviour is not fully accounted for. The theoretical analysis, for example, would be enhanced if a cognition function were introduced. One approach is provided by Lancaster (1971) who suggests that it is not goods themselves, but the characteristics which goods possess, which are valued. He introduces an objective mapping from goods to characteristics which describes the technological relationship between the two. At the level of the individual this mapping may be interpreted as a subjective cognition function; characteristics, thereby, represent the individual's cognition structure. In this initial analysis incorporating such a function would seem to add to the complexity without greatly altering the results.

Moreover, this specific approach has the weakness that the relationship between goods (i.e., the objective environment) and characteristics (i.e., the subjective environment) is assumed to be linear. Nevertheless, future work might examine this approach. One important aspect of this may relate to the interpretation of upper need limits. An important result of Lancaster's (1971) analysis is that certain goods may have upper limits of demand even though characteristics do not. It may be, therefore, that within the model upper need limits may be interpreted as these upper demand limits for goods -- a result which would seem to suggest the importance of exploring the implications of incorporating a cognition function in the analysis.

The second objective of the thesis has been to provide an empirical test of the theoretical model. In the present case, two approaches to testing the model have been undertaken. One approach attempts to examine the basic assumption of the model, namely, that residential stress is the important decision variable related to mobility behaviour. This requires a method of estimating utility scales for individuals so that measures of residential stress may be obtained. Tradeoff analysis is used for this purpose because 1) the type of choice required of respondents is consistent with the theory, 2) the resulting utility scale is an interval scale as required and 3) it is relatively easy to administer. The method requires, however, the assumption of an additively separable utility function, which is restrictive. Nevertheless, the results of the empirical analysis support the basic hypothesis of the model.

The other approach to testing the model is to examine three <u>implications</u> of the model. These are: 1) that experienced and aspiration place utility levels are positively related to income, 2) that mobility is related to income changes, and 3) that mobility is related to life cycle factors. Each of these hypotheses is supported, although to varying degrees, by the empirical analysis. In total, the empirical analysis provides considerable support for the validity of the theoretical model.

Other implications of the model not empirically examined focus on the effects of changes in market prices on mobility. In today's inflationary age, analysis of these factors would seem to be important and worthy of future research.

A further extension of this work is to examine the homogeneity of preferences within the social and demographic groups traditionally considered in mobility studies, particularly social class and life cycle groups. Generally, the question is: can groups of individuals be identified who have similar preferences? The question is of significance in the context of aggregation. Models designed to explain aggregate patterns are often based on models of individual behaviour which assume homogeneous preferences. The extent to which this assumption may be violated, however, is an empirical question which has received little attention. This is largely due to the lack of interval scaled preference data which limits the statistical techniques suitable for analysis. Tradeoff analysis, however, yields for each individual, a utility scale with interval scale properties. It offers, therefore, a method for quantifying preferences which would be useful in analyzing group preference structures.

With the data collected in this study a preliminary examination of the relationship between preferences and stage in the life cycle was undertaken. Two forms of analysis were used. First, the matrix of utility values obtained through tradeoff analysis were collapsed via a principal axis factor analysis into eight new variables. These were input to a discriminant analysis to determine whether significant differences in preferences existed among life cycle groups. There was weak evidence that life cycle stage was a significant discriminator of preferences. A large number of households, however, appeared to be misplaced.

Second, differences among life cycle groups for each of the 35 specific attribute levels were examined using analysis of variance. For only 5 attributes, related to certain aspects of neighbourhoods, backyard size, and dwelling type, were the differences statistically significant. Limitations in the size and composition of the sample preclude generalizing from these results. They do, however, suggest that further analysis of the relationship between life cycle stage and preference structure with a larger group is merited. Furthermore, the analysis could be extended to examine the preferences of groups defined on the basis of other social and demographic variables.

These possible extensions aside, however, the research described in this thesis has succeeded in meeting the major objectives established at the outset, namely, the development and empirical testing of a theoretical model of residential mobility behaviour. As such, this work represents a significant advance on previous research in this area which has suffered from a lack of the type of theoretical foundation that this thesis has sought to establish.

APPENDIX A

THE ALGORITHM

The purpose of this appendix is to outline the algorithm used to solve the conjoint measurement problem considered in tradeoff analysis. The algorithm, developed by Johnson (1973), is primarily designed to analyze non-metric regression problems, but may be applied to the scaling problem in tradeoff analysis.[1]

Non-metric regression is appropriate in the situation where one is interested in relating a number of independent variables to a dependent variable, as in typical multiple regression, but where data on the dependent variable is available only in ordinal form, e.g., a preference ranking. The problem is to determine coefficients for the independent variables which when combined in a prespecified way yield a ranking which matches the ranking of the dependent variable as closely as possible. In the present case an additive function is specified.

Specifically, let $\underline{Q}$ be an nxp matrix containing values for n objects on p independent variables. Let $\underline{U}$ be a vector containing a ranking of the n objects. Then the problem is to find a vector $\underline{W}$ such

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[1] The present discussion is taken largely from Johnson (1973).

that,

$$\underline{Q} \cdot \underline{W} = \underline{V} \qquad \text{(A1)}$$

where the ranking $\underline{V}$ matches $\underline{U}$ as closely as possible. The technical problem is two fold. First is the problem to provide a measure of fit between the ranking $\underline{V}$ and the ranking $\underline{U}$, and second is the problem to provide a solution method for determining $\underline{W}$. Unlike typical least-squares multiple regression, a single optimal solution cannot be analytically determined. Instead, an iterative approach is utilized.

To measure the fit between $\underline{V}$ and $\underline{U}$, Johnson (1973) defines a statistic θ^2,

$$\theta^2 = \frac{\sum_{ij} \delta_{ij} (V_i - V_j)^2}{\sum_{ij} (V_i - V_j)} \qquad \text{(A2)}$$

where $\delta_{ij} = \begin{cases} 1 & \text{if sign } (V_i - V_j) \neq \text{sign } (u_i - u_j) \\ 0 & \text{otherwise} \end{cases}$

θ_2 is a badness of fit measure which focuses on predicted values (i.e., V_i's), which are "in the wrong order". It may be interpreted as "the percentage of the variation among the V's which is "inconsistent" with the U's. θ^2 ranges from 0, a perfect fit, to 1.0, a perfect inverse ranking. The non-metric regression problem now reduces to the problem of determinging a set of w_i's ($\underline{W} = \{w_i, i=1,\ldots,p\}$), which minimize θ^2. This may be accomplished by starting with an initial arbitrary solution (i.e., an initial $\underline{W}$), and modifying it in small steps in the direction specified by the gradient of θ^2 with respect to $\underline{W}$ (i.e., the vector of partial derivatives of θ^2 with respect to the elements of W). The gradient vector is proportional to:

$$G = \sum_i\sum_j \delta_{ij}(v_i - v_j)'(q_i - q_j) - \theta^2 \sum_i\sum_j (v_i - v_j)(q_i - q_j) \quad \text{(A3)}$$

where q_i and q_j are vectors consisting of the i^{th} row and j^{th} rows of $\underline{Q}$ (Johnson, 1973). The size of θ may be used to determine the size of the step, decreasing as θ decreases, e.g.,

$$\underline{W}_{m+1} = \underline{W}_m + \theta_m \underline{G}_m \quad \text{(A4)}$$

where m refers to the interation step and $\underline{G}$ is the gradient. In this way the algorithm proceeds towards a "best-fit" solution. In practice a solution is reached either after a pre-specified number of iterations or when a pre-specified acceptably low level of θ is obtained.

An important aspect of Johnson's (1973) specific algorithm is that it can accommodate blocks of data. The same set of variables may give rise, in different circumstances, to different rankings. Then not one, but a set of rankings will occur. The algorithm accommodates this situation by performing order comparisons only within blocks, i.e., within single matrices $\underline{Q}$, but calculates an aggregate θ^2 from which a single best fit $\underline{W}$ for all blocks is computed. In other words, a single solution $\underline{W}$ is obtained over all blocks.

This algorithm may be applied to the problem considered in tradeoff analysis. The basic data consist of a number of tradeoff matrices, each matrix representing the combinations of variable levels for a pair of variables, over which a preference ranking is defined. Across all matrices there is a total of L variables each of which may take on one of k values (assume k constant across variables) so that there is a total of kL distinct attribute levels, i.e., the set $Q = \{q_i^h, i=1,\ldots, L; h=1,\ldots, k\}$. Within a tradeoff matrix a single cell represents a particular combination of attribute levels, i.e., a pair (q_i^g, q_j^h), $i \neq j$. This information may be represented by a vector of length kL in which all elements are zero except those two cells corresponding to q_i^g which are given the value 1.0. Essentially this is a dummy variable approach with the 1.0's identifying the level of an attribute present in a given cell. In a 4x4 tradeoff matrix there will be 16 such vectors describing the attribute levels corresponding to each cell. These vectors form a matrix which corresponds to the $\underline{Q}$ matrix in the non-metric regression algorithm. For each cell there is also a preference rank. In a 4x4 tradeoff matrix this ranking may be represented by a vector of length 16. This corresponds to the $\underline{U}$ vector in the non-metric regression algorithm. With the data in this form we may solve for $\underline{W}$ using the non-metric regression algorithm. Notice that each tradeoff matrix will be represented as a single block of data in the algorithm, and comparisons will be made only within blocks as desired, but $\underline{W}$ will be calculated across all blocks.

In this approach the elements of $\underline{W}$ may be interpreted as utility values for attribute levels. For non-metric regression problems in which the independent variables are interval scaled, the absolute value of the variables may be entered in the cells of the matrix $\underline{Q}$. Then the vector $\underline{W}$ represents a set of "coefficients" or weights which may be interpreted as in conventional regression analyses. In the present case, however, $\underline{Q}$ consists only of 1's and 0's indicating the presence or absence of a particular attribute level. The "coefficients" then represent the values of attribute levels, i.e., $U_i(q_i^h)$.

APPENDIX B

EXAMINATION OF THE ASSUMPTION OF ADDITIVE SEPARABILITY

The purpose of this appendix is to examine the extent to which the basic assumption of additive separability, required in the empirical model, is valid in describing the preference structure of respondents. Two types of data are examined. First, summary measures of goodness-of-fit, provided by the algorithm, are examined. These measure the degree to which a respondent's preferences are accounted for by the empirical model. Second, values for attribute levels are used to predict the respondent's ranking of a number of complex descriptions obtained separately in the survey. The degree to which these may be predicted indicates the validity of the assumption.

Goodness-of-Fit Measures

The algorithm computes two measures of goodness-of-fit. Both compare the respondent's original preferences to that derived from the algorithm solution. Both measures are essentially rank-order correlation statistics in that comparisons are made on the basis of order and not on the basis of magnitude. The two measures are 1) theta (Θ), a goodness-of-fit measure used to guide the iterative procedure within the algorithm (described in Appendix A), and 2) tau (τ), a measure of rank-order correlation developed by Kendall (1948). For theta, values may vary between 0.0 and 1.0; 0.0 constitutes a perfect fit. For tau, as in other correlation coefficients, values may vary between -1.0 and 1.0. In the present case we expect only positive correlations; negative correlations would indicate that attribute levels rated highly by the respondent are receiving low values in the solution.

The distribution of theta values for 113 respondents is given in Figure B1.[1] As noted previously, theta is essentially a badness-of-fit measure; hence small values indicate a better fit. How small a value is significant, however, cannot be determined since there is no developed theory on the distribution of theta. In the present case, examination of the results suggests the following rule of thumb: values of theta less than .05 are extremely good; values between .05 and .09 are moderately good to acceptable; values greater than .09 are unacceptable.[2] In those cases in which theta is less than .05 (53 respondents) there are virtually no interaction effects. In contrast, in those cases in which theta exceeds .09 (8 respondents) a large number of variable interactions occur. An example of interaction between attributes (i.e., not separable) is presented in Figure B2. The ranking indicates that tenure and

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1 For 3 respondents comparable tradeoff analyses could not be performed because, following these interviews, one of the selected variables was altered.

2 Theta values vary with the number of variables and attribute levels. These rules of thumb, therefore, may not be applicable in other analyses.

Figure B 1 Frequency Distribution of Theta Values

Total number of respondents: 113

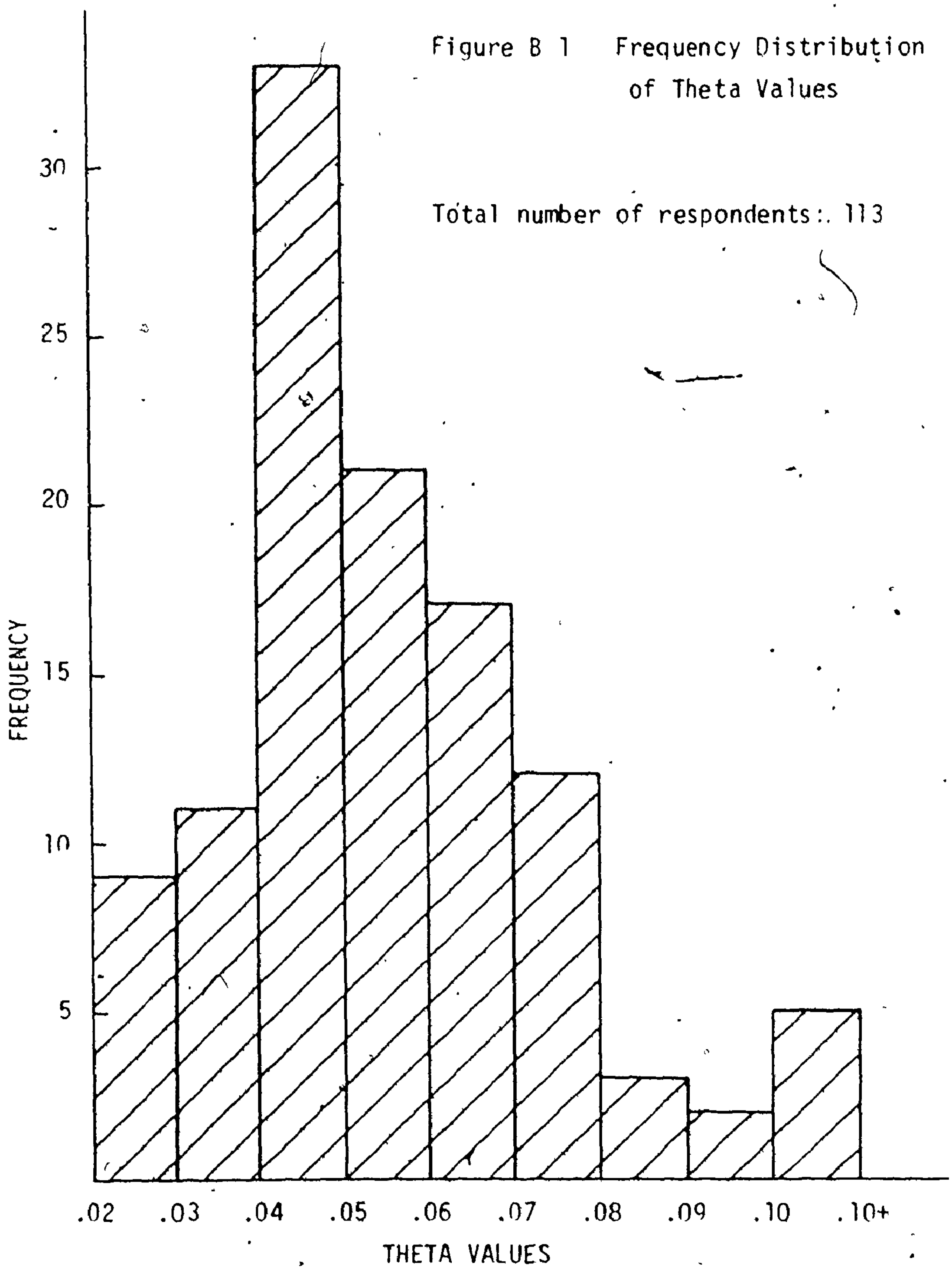

FIGURE B2

EXAMPLE OF ATTRIBUTE INTERACTIONS

TENURE	OCCUPANCY - BUILDING TYPE			
	Single Family House	Attached House (townhouse or duplex)	Multiple Family (divided house or low-rise)	Multiple Family (high-rise; elevator)
Owned	1	2	5	8
Rented	7	6	3	4

occupancy/building type are not independent: a set of numbers cannot be provided for the attribute levels which when added together reproduce the ranking indicated. In other words, this ranking cannot be represented by an additively separable utility function. For the respondent who provided this example, with a theta value of .132, it is evident that the assumption of added separability is incorrect. Such respondents may be (and have been) excluded from further analysis. For a majority of respondents, however, the assumption of additive separability does not appear unduly restrictive.

Further support for this conclusion is provided by an examination of the distribution of tau values (Figure B3). Tau measures the correspondence between the original rankings provided by a respondent on the tradeoff matrices, and the rankings derived from the algorithm solution. In this case almost all respondents had extremely good fits between observed and predicted. Only 13 respondents (8.7%) had tau values less than 0.80. To gauge the relevance of this, we may note that individual values in excess of 0.76 would be statistically significant at the .05 level. These results, therefore, provide support for the conclusion that the assumption of an additively separable utility is adequate in representing the preferences of a majority of respondents.

Predictability

A second method of examining the validity of the assumption of additive separability is to compare actual and predicted rankings for a number of complex stimuli. In the interview, respondents were presented

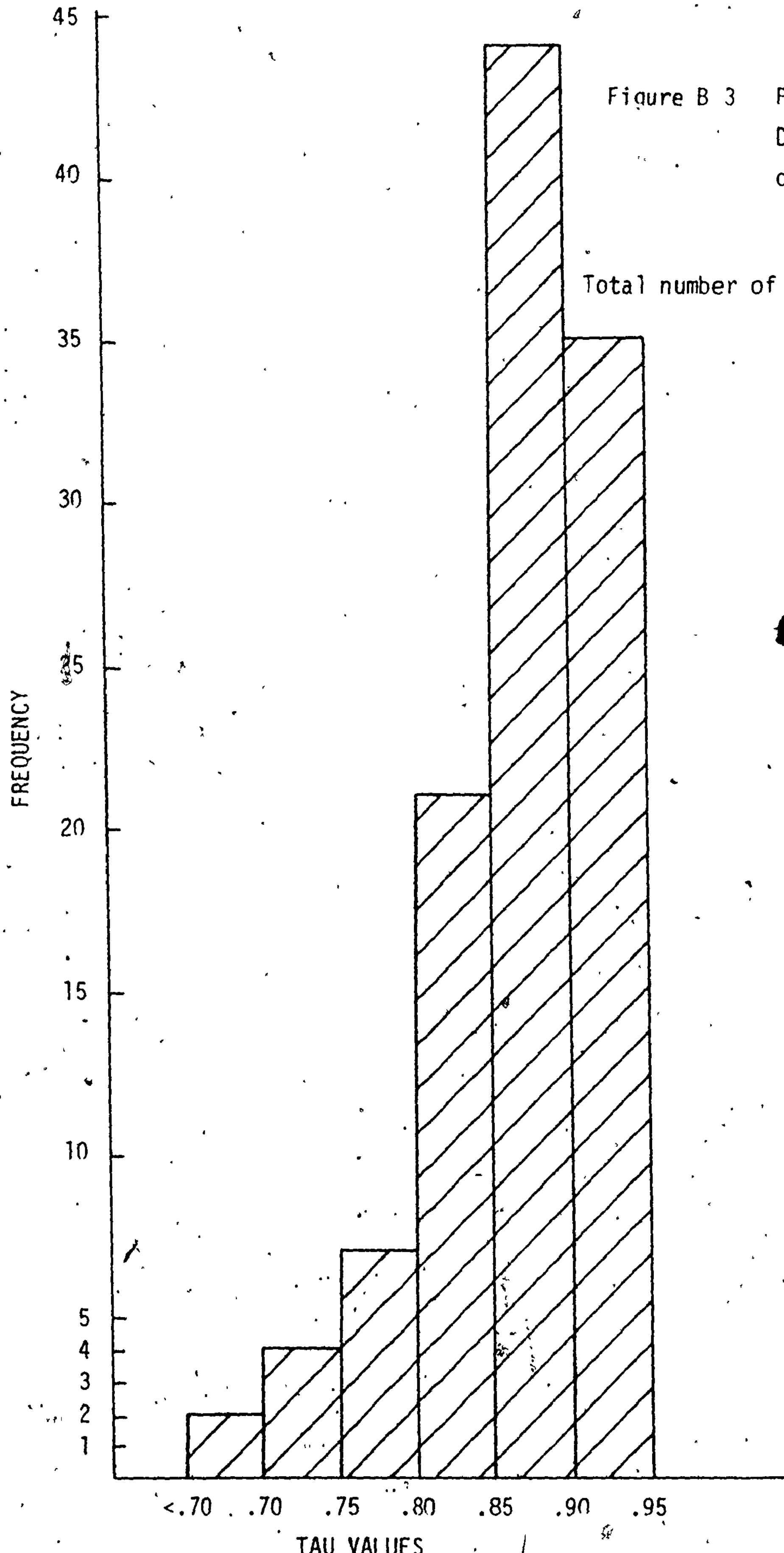

Figure B 3 Frequency Distribution of Tau Values

Total number of respondents: 113

(on cards) with 12 descriptions of residences which varied on the levels of each of the 11 attributes used in the study (see Figure B4), and asked to rank these according to preference. 10 of these descriptions involved only attribute levels within the range of levels used in the tradeoff analysis. The ranking of these 10 descriptions, therefore, may be compared to that predicted using the utility values obtained from the tradeoff analysis. The utility values, obtained in the analysis under the assumption of additive separability, may be added together in the appropriate combinations to obtain aggregate utility values for each of the 10 descriptions. These may then be ranked and compared to the respondents actual ranking. In other words, the question being asked is: Can the results obtained from tradeoff analysis based on data obtained when only pairs of variables are considered at a time (i.e., the assumption of separability) be used to predict the rankings of the complex descriptions when all variables are considered simultaneously? If such prediction is possible, this provides strong support for the assumption of additive separability.

The predicted and actual rankings of the complex stimuli may be compared for 83 households.[1] The comparison was performed by calculating a Spearman rank-order correlation coefficient for each household. The distribution of results is presented in Figure B5. Of the 83 households,

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1 Of the total of 87 households, 2 households did not complete comparable tradeoff matrices and 2 households did not complete the complex rankings.

FIGURE B4

EXAMPLES OF COMPLEX DESCRIPTIONS

Example 1. 1 bedroom unit in multiple family building (high-rise), well maintained, less than 4 years old;

no backyard space;

not very private; often feel intrusion from neighbours;

located 15 minutes from downtown (by car);

neighbourhood: well kept buildings, quiet streets, not very friendly people;

rented for $170 per month (including utilities);

private covered parking in underground garage.

Example 2. 2 bedroom single family house, well maintained, 15 years old;

backyard: 20 feet deep;

quite private; occasionally feel intrusion from neighbours;

located 25 minutes from downtown (by car);

neighbourhood: buildings need repair, noisy streets, people friendly;

owned for $225 per month (including mortgage, taxes & utilities);

private off-street parking.

Example 3. 4 bedroom attached house (duplex), well maintained, 15 years old;

backyard: 60 feet deep with a shade tree;

quite private; occasionally feel intrusion from neighbours;

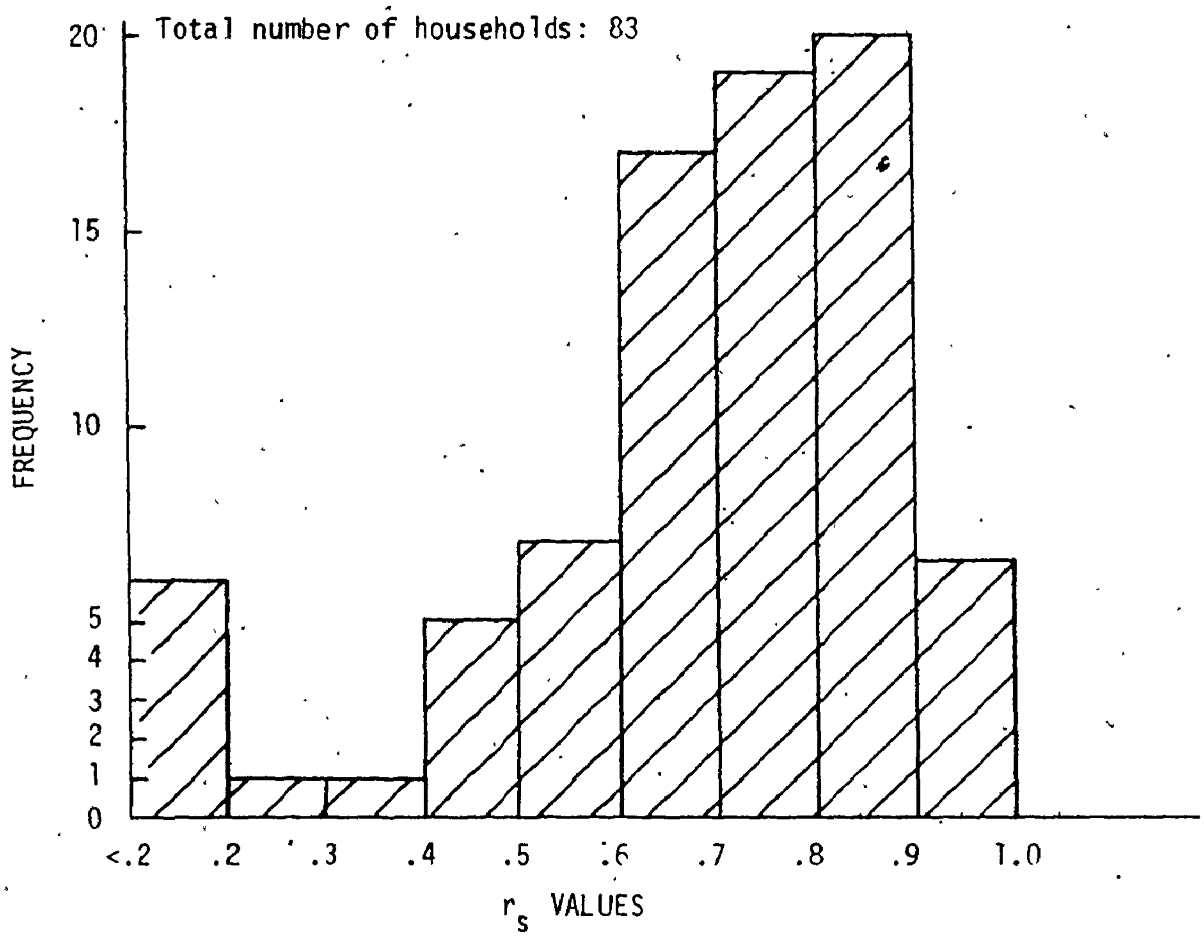
located 35 minutes from downtown (by car);

neighbourhood: well kept buildings, noisy streets, friendly people;

owned for $400 per month (including mortgage, taxes & utilities);

private covered parking in a garage.

Figure B 5 Frequency Distribution of Spearman Correlation Coefficients between Predicted and Observed Complex Rankings



63 households (76%) have correlation coefficients exceeding 0.60. To gauge the relevance of this we may note that with 10 stimuli an individual coefficient value of 0.564 would be statistically significant at the .05 level. The results suggest, therefore, that the assumption of additive separability has not been severely violated by a majority of respondents.

APPENDIX C

QUESTIONNAIRE

HOUSING SURVEY : McMASTER UNIVERSITY

Introduction: "As indicated over the telephone we are conducting research in the geography department at McMaster University about peoples preferences toward certain aspects of housing - what they like and dislike in various hypothetical situations. There are no right or wrong answers; we are interested in your personal choices. If you feel any questions infringe on your privacy please do not feel obliged to answer. All information, however, will be strictly confidential and used only for educational purposes.

Also, please feel free to end the interview if we are taking too much of your time. We sincerely appreciate your cooperation."

Respondents Address: ______________________________

____

1.

	Age	Education Completed	Occupation	Job Location
Respondent				
Spouse (H or W)				
Children at home 1				
2				
3				
4				

Education code:

Never attended ...1	Completed Secondary...5
Some Elementary...2	Some Post-secondary...6
Completed " ...3	Completed " " ...7
Some Secondary ...4	Graduate or Professional ...8

2. "We would like to get a description of your present home by having you fill out this sheet". (Give respondent sheet A). "Could you describe your present situation using column 1".

3. (After column 1, sheet A completed). "Now we would like you to pretend that you will have to move from here in, say, 1 year. Considering your expected family and financial situation, could you describe the kind of home you would realistically hope to obtain. Please use column 2 on sheet A".

   (If respondent hesitates, indicate that they should consider changes they might like to make in present home, neighbourhood and location, and cost of changes.)

4. (After column 2, sheet A completed).
   a) "Do you think you could afford a home like this?" Yes ☐ No ☐

   b) "Do you think a home like this would be difficult to find?" Yes ☐ No ☐
   (Encourage respondent to change estimates.)

5. Tradeoffs:

"What I am going to give you is a series of hypothetical situations and ask you to make a choice. All you have to do is indicate which situation you prefer".

(Give respondent sheet B and explain what is required. Ask respondent to complete sheet B. Then give respondent sheets C through R.

EMPHASIZE:
(1) That respondent is to consider only 2 aspects at a time. All other aspects are assumed the same for each choice.
(2) That some combinations may be unrealistic, but they should pretend that such situations could arise.
(3) That the best choice is not always in the upper left corner so that they should examine all combinations before making a first choice.
(4) "Please fill in all cells").

6. "We would like to ask you some questions about previous places you have lived".

a)

	Date Moved In	Address	Owned or Rented	Dwelling Type	No. of Bedrooms	Main Reason for Moving From
		Present				
01						
02						
03						

b) "How many times have you moved since you were married?"
0 1 2 3 4 5 6 7 8

7. "Do you like living here more or less than the last place you lived?"
more ☐ less ☐ same ☐

8. "If we let '10' stand for being extremely satisfied with your present home, '5' stand for being neither satisfied nor dissatisfied and '0' stand for being extremely dissatisfied, can you give us a number to indiate your feelings about your present home?" __________

9. a) "Have any improvements or major repairs been made since you moved here?" Yes ☐ No ☐

9.a) Continued...

(If yes, "What were these?"): 01

02

b) "Do you anticipate any improvements being done in the near future?"

Yes No

(If yes, "What improvements do you expect?"):

01

02

10.a) (Give respondent 12 cards describing hypothetical situations, and cards representing present home and future possible home, as described on Sheet A. Ask respondent to sort the 14 cards into 3 piles based on relative desirability and then to rank from most to least desirable.)

Ranking:

1. ____	4. ____	7. ____	11. ____
2. ____	5. ____	8. ____	12. ____
3. ____	6. ____	9. ____	13. ____
		10. ____	14. ____

b) (Give respondent sheet S1 and standard card D, which is given a rating of 100 on a desirability scale. Ask respondent to provide numbers to represent the relative desirability of the other 13 previously ranked situations. Low numbers mean less desirable, high numbers mean more desirable. Proceed by successive comparison (e.g., compare D to next less desirable situation; then that situation to next less desirable, etc.).

11. (Questions 12 to 14 may be asked prior to 11). (Give respondent Sheet S and repeat procedure of Qt. 10b for sets 1 through 7.)

12. "Do you plan to move from here within the next year?"

Yes Maybe No Don't know

If yes: "Why?" ______________________________

If no: "Have you ever seriously considered moving from here?" Yes No

If yes: "Why did you consider moving then?" ______________________________

"Why didn't you move?" ______________________________

13. a) "Have you (or your husband/wife) changed jobs in the past year?"
Yes ☐ No ☐

If yes: "Did this involve a promotion or a change in place of work?"
Promotion ☐ Change of place ☐

b) "Do you expect to change jobs in the next year or so?" Yes ☐ No ☐

If yes: "Do you think this will be a promotion or will you be changing your place of work?" Promotion ☐ Change of place ☐

14. "Now, if you are willing we would like to ask you some questions on your income. Of course, this information will be strictly private and confidential. Would that be alright?"

If no, skip to question 15).

a) "Would you say your income over the past year has increased:

More than inflation ☐

Equal with inflation ☐

Less than inflation?" ☐

b) "Do you think your income over the next year will increase:

More than inflation ☐

Equal with inflation ☐

Less than inflation?" ☐

c) "Could you indicate your family income from all members of the family, before taxes, by circling the appropriate category on this chart?" (Give respondent sheet T).

d) "Could you indicate which income category you were in when you first moved here, by marking an X beside the category?"

15. "Could you give us the names of one or two married friends whom we might contact who might be willing to do an interview like this?"

01 Name ______________________
Address ______________________________

02 Name ______________________
Address ______________________________

"Thank you very much for your time and cooperation".

SHEET A: HOUSING DESCRIPTION

Column
1 2

Dwelling type: Single Family House ....
Attached House (Duplex, Townhouse)..................
Multiple Family (Low-Rise)........................
Multiple Family (High-rise) ....

Owned/Rented..

Number of bedrooms..

Depth of backyard (in feet - approximately)......................

Privacy: Very private (never feel intrusion from neighbours).........
Quite private (occasionally feel intrusion from neighbours...
Not very private (often feel intrusion from neighbours).....

Shade tree on property (Yes or No)...............................

Private parking space (or driveway) (Yes or No)....................

With garage (Yes or No)...................................

Age of building (approximately)...................................

Time to downtown (by car, in minutes)..............................

Financial cost (rent, mortgage, taxes, utilities,etc. per month)......

How would you evaluate each of the following aspects of your neighbourhood? Please check the appropriate space.

streets very quiet	___	___	___	___	___	streets very noisy
very clean	___	___	___	___	___	very untidy
old	___	___	___	___	___	new
buildings well kept	___	___	___	___	___	buildings rundown
people very friendly	___	___	___	___	___	people not friendly

SIZE OF DWELLING (Number of Bedrooms)

OCCUPANCY - BUILDING TYPE	1 bedroom	2 bedrooms	3 bedrooms	4 bedrooms
single family house				
attached house (townhouse or duplex)				
multiple family (divided house or low-rise)				
multiple family (high-rise; elevator)				

SAMPLE: Sheets B through R

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