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I am submitting herewith a dissertation written by Sammie Gatlin Garner entitled "Household Production of Housing Repairs." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Home Economics.

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HOUSEHOLD PRODUCTION OF HOUSING REPAIRS

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ABSTRACT

The purpose of this study was to develop and test a household production model to identify key decision variables associated with home repair. This theoretical model is based on the household production function model and accommodates the dual role of consumers as both producers and consumers of the commodity housing repairs.

The model was tested using a subset from the 1975 Time Use Study, a national probability sample, conducted by the Survey Research Center, Institute for Social Research, University of Michigan. The subset included only homeowners and only respondent data resulting in a subsample of 682 cases.

The statistical procedure used was discriminant analysis which allowed statistical discrimination between two household groups: those who self produce housing repairs and those who contract these repairs. The discriminating variables were: age of respondent, household income, household size, households with teenagers, respondent repair skill, respondent satisfaction in doing repairs, age of housing structure, and use of vacation time.

Because housing repairs were assumed to have different production functions, discriminant functions were derived for nine housing repair categories covered by the survey data: interior painting, exterior painting, papering, plumbing, electrical, carpentry, masonry, television, and other household appliance and equipment repairs.

The analysis portion of the discriminant program indicated that these variables statistically discriminated between the two groups under analysis in the manner predicted by the model and hypotheses: household income, household size, respondent repair skill, respondent satisfaction in doing repairs, and age of housing unit. As these variables increased households were more likely to self produce housing repairs. These variables alter the cost of self producing the commodity housing repairs through their effect on relative time costs, marginal products, and marginal utilities.

The classification aspect of the discriminant program yielded results on the nine repair categories ranging from 66 to 91 percent correctly classified cases. The simpler repairs, interior and exterior painting and papering, were most frequently correctly classified for the self-production group.

The findings of this study could be utilized by those involved in developing housing policy, implementing loans or grants based on self-help housing rehabilitation, or providing education, counseling, or information related to self producing housing repair. Future research ought to focus on extending the analysis to include home improvements, on comparing household repair behavior over time, and on determining what influences repair satisfaction.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	Importance of Housing Repairs	1
	Statement of the Problem	2
	Objectives	3
	Rationale	4
	Definition of Terms	5
	Conceptual Framework	7
	Assumptions	10
II.	REVIEW OF LITERATURE	12
	An Interdisciplinary Problem	12
	Characteristics Approach	14
	Demand Theory	16
	Household Production Model	17
	Housing Quality Change	20
	Empirical Studies of Housing Repairs	23
	Decision Variables Influencing Self Production of Housing Repairs	26
	Summary	36
III.	METHODOLOGY	38
	Procedural Overview	38
	Household Production Model	39
	The Model	39
	Implications of the Model and Related Hypotheses	48
	Sample	52
	Measures	53
	Design	55
	Operational Definitions	56
	Data Analysis	62
	Statistical Analysis	63
IV.	RESULTS	67
	Analytical Approach	67
	Classification Results	77
	Discussion of the Individual Repairs	82
	Discussion of Hypotheses	85
V.	CONCLUSIONS AND IMPLICATIONS	102
	Summary	102
	Conclusions	104
	Implications	112

CHAPTER PAGE

Limitations of the Study 115
Need for Additional Research 118

LIST OF REFERENCES 120

VITA 126

LIST OF TABLES

TABLE		PAGE
1.	Household Position of Respondent.	54
2.	Frequency of Household Income Classes	58
3.	Decade in Which Respondent Housing was Built.	60
4.	Frequency of Respondent Ratings of Satisfaction in Doing Housing Repairs	61
5.	Frequency of Occurrence and Related Costs of Nine Housing Repair Categories	64
6.	Group Means for the Nine Housing Repair Categories.	72
7.	Discriminant Functions at Group Centroids	73
8.	Summary of Significant Variables Affecting Housing Repair Decisions	74
9.	Interior Painting - Variables Selected for the Discriminant Function	76
10.	Classification Results of the Derived Function for Nine Repair Categories	78
11.	Exterior Painting - Variables Selected for the Discriminant Function	83
12.	Papering - Variables Selected for the Discriminant Function.	84
13.	Plumbing Repairs - Variables Selected for the Discriminant Function	86
14.	Electrical Repairs - Variables Selected for the Discriminant Function.	87
15.	Carpentry Repairs - Variables Selected for the Discriminant Function.	88
16.	Masonry Repairs - Variables Selected for the Discriminant Function	89

TABLE PAGE

17. Television Repairs - Variables Selected for the Discriminant Function. 90

18. Other Household Appliance/Equipment Repairs - Variables Selected for the Discriminant Function. 91

CHAPTER I

INTRODUCTION

Importance of Housing Repairs

Housing plays a dominant role in consumer expenditures. The Consumer Price Index allocates the shelter portion of the index (rental and homeowner costs) a weighting of 31.9; the sub-category maintenance and repairs is weighted 3.6 (CPI Detailed Report, 1982). For many families housing represents not only the major monthly expenditure but also the major economic investment over the life cycle. Housing repairs can be viewed not only as a means of protecting this investment but also as a means of improving the flow of housing services derived from the structure for users.

The decision to repair a housing unit can be viewed as a voluntary act, necessary but not usually manditory. Decision alternatives include: do nothing, move to another unit, do it yourself, or contract the work. Because the choices are discretionary, they can be viewed as a utility maximizing choice. These decisions are influenced not only by factors internal to the housing consumer such as age, income, family size and composition, and time use, but also by external factors such as neighborhood quality, market conditions, and government policy.

Housing status is a central component affecting a consumer's perception of well-being (Campbell, 1981). Housing has both material and nonmaterial aspects. It offers a dwelling place, a status symbol,

privacy, comfort and convenience, peer acceptance, and social mobility.

Housing acquisition is a complex process. Housing purchases may be analyzed according to Lancaster's theory of consumer demand (King, 1976). This theory acknowledges that the objects of choice are characteristics of goods rather than the goods themselves (Lancaster, 1966). While housing is initially purchased as a heterogenous bundle of desired characteristics, repairs represent a mechanism allowing marginal adjustments of these characteristics. Families considering home repairs must choose among alternative ways of acquiring them while remaining within their monetary budget. Housing repairs are particularly significant because this category of housing expenditures allows housing consumers to make incremental adjustments in maintaining and adapting the structure, site, or amenities to meet household needs.

Statement of the Problem

Because 97 percent of our nation's housing stock is not new construction (Lindamood and Hanna, 1979), repair of existing units is the major mechanism for satisfying housing needs. Repairs may be done through hired services or through do-it-yourself activity. Determining those factors which distinguish between households who self produce housing repairs versus those who contract such repairs is the focus of the present study. Determining the important factors which influence self-produced housing repairs is merited because it could

enhance understanding of consumer housing decisions and provide a rationale for more effective housing policy and related legislation.

Gronau (1977) emphasized the need for investigation of the interaction between work at home and substitute market services. He describes time budget evidence as "data in search of a theory." Research involving detailed analysis using both time and goods resource combination measurements of housing repairs has been given little attention.

Objectives

The objectives of the present study are to develop a household production model to identify the key economic variables associated with housing repair and to test empirically the model. This procedure will facilitate the determination of the relationship between demand for self production of housing repairs and these variables: age of respondent, income, family size and composition, housing repair skill, satisfaction in doing repairs, age of housing structure, and use of vacation time.

The problem under consideration incorporates these choice variables and allows analysis of factors which distinguish between those households who self produce housing repairs versus those who contract the repairs. There is a need for development and testing of an economic model to explain and predict household behavior relative to the allocation of time and other resources to self-produced housing repairs.

Rationale

During 1980, owner-occupants of one-housing-unit properties spent $31.5 billion for upkeep and improvements of their properties (Construction Reports, 1981). Of this amount, $7.5 billion was spent for maintenance and repair, and $23.9 billion was spent on improvements. These figures do not account for the value of self-produced housing repairs and improvements--"sweat equity"--and thus to a degree understate the total value of this category. Hill (1981) estimates that the nonmarket value of repair and maintenance of major durables in 1975 amounted to about $215 per household, amounting to about $30 billion worth of nonmarket production annually.

Self-produced housing repairs is an alternative which offers household units the opportunity to adjust their respective housing status in an incremental fashion. Participation in self-help housing versus contractual projects can have a differential effect on resulting utility.

Housing represents a stock of existing units which generates a flow of services. Home repairs allow consumers to alter the stock of housing and the concomitant flow of services which leads to an increase in family well-being. Advances in economic theory have created a more realistic way of viewing household decision making, including the decision to repair a housing unit. However, little attention has been given to resource combinations used in self-help housing repairs.

The critical elements of the decision making focus on the use of market goods and time to produce desired commodities. As market

wage rates increase, the opportunity cost of time spent not working also increases. As a limited resource, time is apportioned among competing uses: work in the marketplace, work in the home, or leisure. The opportunity cost of time may be used to account for the value of time used in alternative ways. The degree to which families allocate time and goods to repairs depends on their respective utility function, household production function, wages, and prices. This approach allows for the use of resources--time, money, materials, skills, knowledge, and judgment--to achieve a desired and realistic level of housing consumption. The use of goods and time in combination also allows consumers to adjust their housing environment to meet their own tastes and preferences.

Definition of Terms

Consideration of a household production model of household behavior involves terminology unique to this economic framework. A household unit is a person or group of persons residing at the same address. Household production or self production refers to work done in the home whereby market goods and household time are transformed into commodities which generate utility. Household production functions are the processes whereby a household unit combines market goods and time to produce commodities (e.g., food, appliances, and time to produce meals) resulting in satisfaction (i.e., utility). Resource allocation is the process by which individuals and household units apportion materials, time, and human capacities to competing uses.

A commodity is the output resulting from the household production process using combinations of goods and time and directly providing utility. It is not purchased in the marketplace but is produced as well as consumed by households using market purchases, time, and skill. Examples include children, nutrition, and home repairs. A market good is an item which can be purchased in the marketplace and is used as an input into commodity production within the household.

Housing good (stock of existing units) is the physical dwelling consumers make choices about such as the structure of the house or appliances. Housing services (commodities) are flows of services over a period of time derived from housing goods or related human activities. Examples of housing services include protection from the physical and social environment, privacy, and care of people and their possessions. Opportunity cost is the value of a resource in its best alternative use. Housing satisfaction is the utility or pleasure derived from the housing commodity.

Utility refers to the satisfaction that a consumer receives from whatever commodities the individual consumes. Marginal utility is the change in total utility resulting from an incremental change in a commodity. Marginal product refers to the change in output obtained by an incremental change in an input to the household production function. Marginal cost is the change in total costs resulting from an incremental change in output.

Self-help housing describes a shelter-related good or service provided in part through the home production work of at least one

occupant of the structure. The term repairs includes interior and exterior painting, papering, plumbing repairs, electrical repairs, carpentry repairs, masonry repairs, and television and other household appliance repairs.

Conceptual Framework

Analysis of consumer decisions about housing repairs requires the melding of housing quality change theory and consumer resource allocation theory including the household production function. Over time a housing unit depreciates so that a dwelling unit of a given quality gradually loses its quality or filters down. Filtering theory acknowledges the process of quality change as determined by owner maintenance decisions. This theory does not account for repairs which at least maintain quality and often increase it. Utility maximizing behavior of home owners involves repair strategies based on present and future housing services.

Housing repairs represent a process of continuous adjustment based on an assessment of marginal costs and marginal utility. These trade-offs change over time as market conditions change. Marginal costs may be reduced through use of do-it-yourself labor used in maintaining an owner occupied housing unit. Improvements in the total housing stock result from the aggregated decisions of individual owners to repair or improve existing units.

Self-produced repairs affect utility in a manner distinct from those done on a contractual or hired basis. The satisfaction from

having done the work can be an added benefit for households. Furthermore, owners become more competent to do repairs which may be needed in the future.

Consumers allocate resources with the goal of maximizing satisfaction--to be as well off as possible within their respective time, budget, and production constraints. Consumers show maximizing behavior as they engage in voluntary actions requiring the use of goods and time as inputs in the production of commodities. A household may be viewed as a small business using resource inputs of time, money, and market goods to achieve desired commodities as outputs. The specific objective is to maximize utility which entails minimizing input resource costs. This is similar to the situation facing a business of maximizing profits by minimizing resource costs of producing various levels of output.

The time input is an important aspect of household production; its use and efficiency impact on household welfare. Household production can be construed as combining time and market goods to produce a desired output or commodity (Becker, 1965). Time as an input has a changing value related to its marginal product in alternative activities, the marginal utilities of the commodities, and the market wage. Individuals exhibit maximizing behavior by the choice of input combinations of time and market goods according to their marginal products and how the resulting commodities contribute to utility.

Commodity outputs require varying proportions of time as an input combined with goods. Those requiring a relatively greater proportion

of time as an input are referred to as time intensive commodities, and those with a relatively greater proportion of goods as an input are referred to as goods intensive commodities. Consumers substitute between time and goods as inputs depending on the marginal products and the cost of each. Home owners who decide to have repairs must decide how to produce them. That is, home owners may substitute their own time as input in home repairs to replace some market or contractual goods.

Time allocation as a process within the household production function framework has been further developed to include leisure (Gronau, 1977). Individuals experience trade-offs as they allocate varying amounts of time to work in the home, work in the market, and leisure. Analysis of time budget data permits this further distinction. Socio-economic changes have differing effects on nonmarket time uses: work at home, leisure, and time allocation between spouses (Gronau, 1977).

As families allocate resource combinations to housing repair, the objective is to be as well off as possible. In general, as the wage rises, the opportunity cost of time spent away from work rises, and market goods tend to be substituted for time in home production and leisure. The opportunity cost of not working in the market is determined by the wage which could have been earned. Consequently, as an individual's market wage rate increases, nonmarket time use inputs may decrease. Higher income individuals would be expected to participate less in home production of housing repairs than low income

persons, ceteris paribus. The cost savings of self-help housing repairs will be more important for the low income individual.

Housing repairs can be produced through direct production or can be purchased through the market. Direct production requires skills as well as time and goods. Certain household characteristics appear to enhance self production of housing repairs: skill, family size, home ownership, and age of housing unit. Individuals having requisite skills will be more likely to self produce repairs than unskilled persons because of their higher marginal products. Specialization possibilities may facilitate participation by a larger family depending on both the size of the family and the age distribution of its members. Further, home owners have greater economic incentive to do home repairs than do renters. In addition, older homes are more likely to need repairs than newer homes.

Assumptions

Analysis of home production behavior of household units requires certain assumptions. A household has a fixed set of preferences which determine how commodities generate utility. Because tastes and preferences are inherently individual, allocation of time and money to housing uses will reflect this broad range of preferences. Given that the dwelling unit has been chosen, the problem is when and how to alter the associated service flow. Households are assumed to make rational decisions to maximize utility, including repair of their housing.

Time, abilities of household members, production technologies, and household size and composition are assumed to be fixed for a household at any point. Across households, resources will vary in both qualitative and quantitative aspects. Consequently, the blend of resources used for housing repairs will vary with each household unit. For example, various housing repairs require various levels of knowledge and certain skills, time to do the task, equipment and tools, materials, and usually some money.

CHAPTER II

REVIEW OF LITERATURE

An Interdisciplinary Problem

Many disciplines have been associated with the quest for understanding household production and its effect on well-being. The disciplines of home economics, economics and sociology have been the most important in this effort. The development of theories to explain and predict household production behavior has evolved slowly. More recent efforts have shown the interdisciplinary nature of the task, especially as related to self-produced housing goods and services. Sociology focuses on the process by which households make judgments about their housing according to cultural norms. Economics focuses on the process in which housing demand is part of a constrained utility maximization problem. Home Economics commonly analyzes managerial processes within the household, especially productive work time.

Household production theory has been developed within the last two decades. This approach to the theory of consumer behavior provides a comprehensive analysis of the economic position of a household by including the major constraints confronting a consumer: home production, time, and money. Housing repairs have a considerable impact on the quality of our nation's housing stock over time and on user satisfaction with housing. As consumers attempt to maximize utility, decisions hinge on trade-offs due to the budget, the time, and the production

constraints. With respect to home repair these may be done by members of the household or by external contract. Whichever is pursued depends on the relative prices of the alternatives, how capable household members are in the production of these alternatives, and on the opportunity cost of the household member's time. In studies related to the household production function, researchers analyze the ways in which households combine market goods and time to produce specific commodities such as meals served, child nurturance, clothing maintenance, or changes in the flow of housing services due to repairs.

Home Economics Perspective

Early home economics researchers sought to measure time used for various tasks within the household sector (Warren, 1940; Weigand, 1954; Cowles and Dietz, 1956; and Walker, 1957). The approach was primarily descriptive, and a major deficiency was the lack of a precise model to account for the goods input into the process in addition to time.

Home economics researchers have focused on nonmarket time uses, particularly work within the home. The time budget approach has been used to determine how homemakers spend time on homemaking activities (Cowles and Dietz, 1956; Walker, 1976; and Hall and Schroeder, 1970). Walker (1976) also determined how time use categories of work within the home have changed over time, using a longitudinal time-budget study. These studies aimed to determine the effect of family and household characteristics on time allocated to household tasks. The goods input into the process were not included. None of these researchers

utilized regional or national samples. More recent studies have focused on housing repair behavior of households, but not specifically on both the time and goods inputs.

Sociology Perspective

Researchers in sociology have focused the tools of their discipline on analysis of time uses within the household environment. Households make judgments about their housing according to cultural norms. If housing fails to meet these norms, the household experiences deficits. The character of both the housing unit and the neighborhood influences this process (Morris and Winter, 1978). Households experiencing housing dissatisfaction will usually adjust or adapt resource allocations to correct these perceived deficiencies. Housing adjustment behavior may occur as a result of "strains" leading to overt behaviors such as moving or adapting the existing housing unit through repairs and improvements (Morris and Winter, 1978).

Economics Perspective

Economics deals with the process by which a household maximizes utility subject to constraints. In traditional analysis, utility is a function of market goods. The constraint is that the purchase of goods and services in the market must equal income.

Characteristics Approach

Economists perceive consumer theory of choice as the process by which consumers choose the alternatives they prefer from among those

constrained choices available to them. Lancaster (1966) raised the question as to whether goods or their characteristics are the objects of consumer choice. Each good is presumed to possess several distinct characteristics, and each characteristic may be obtained from more than one good. For example, the repair of a fireplace maintains characteristics such as space heating, status and atmosphere. Space heating as a characteristic is also available through other goods such as furnaces, wood stoves, and solar means. Goods become inputs into a production process; characteristics become outputs.

As a consequence, consumption activity involves consumers specifying a bundle of desired characteristics which may be achieved through actual purchase of a specific combination of goods. The idea of characteristics achieved through goods combinations is closely related to the commodities concept in household production theory (Lancaster, 1977). The characteristics approach is particularly relevant to housing, a highly differentiated good. A housing unit is a distinct product with defined characteristics rather than being homogeneous. Although specifying and measuring these characteristics presents difficulties, the approach is, nonetheless, conceptually appropriate.

Though a housing unit is initially purchased as a single bundle of characteristics, adjustments over time may be made to alter the characteristics provided. Housing repairs and improvements allow households to make marginal adjustments in housing characteristics. Additional space or other desired amenities can be provided in such a manner without the need to purchase a complete new housing unit. The

repair process also allows the household to maintain the quality of characteristics derived from a housing unit.

Demand Theory

Classical demand theory develops a formal theory of choice-making as a constrained maximization problem. The end products of market activity are the goods and services purchased by the household with consumption seen as an instantaneous act. The individual attempts to reach an equilibrium position subject to the expenditures for all goods and services equaling income. A consumer's preferences are represented by a utility function acknowledging the consumer's preferences for alternative combinations of goods. Thus, the dollar values of transactions assume great importance, while the uses to which products are put by households and the time inputs are not considered.

Among the limitations of conventional demand theory are its failure to account for the transformation of market goods into commodities, to account for time as an input with goods, and to account for time as a resource constraint. For example, housing repairs (a commodity) may be achieved with varied input combinations of goods and time. More recently, economists have expanded the theoretical model to include home production and time as additional resource constraint categories.

The household production approach was developed in response to the limitations of conventional demand theory. The seminal paper is that of Becker (1965). Pollak and Wachter (1975) identify three major

advantages of the household production model over the traditional theory of the household. The household production model develops a framework for analyzing the allocation of goods and time within the household. It emphasizes the role of the household's technology and tastes as determinants of behavior. The model also focuses on commodities, the outputs of household technology. Because neither time nor goods are generally useful except in combination, the dual nature of these inputs is demonstrated in the model presented below.

Household Production Model

A prime motivation in the development of home production analysis was the development of a theoretical model incorporating both time and goods as resource inputs (Becker, 1965 and Linder, 1970). In household production literature, the goods traded in markets are treated as inputs to further production processes occurring within the household. Market goods are combined with the time of household members to produce commodities which are the outputs or final products of the model.

The development of the concept of commodities and the recognition of household units as both producers and consumers marks the first major step in the development of this theory. The household production model, developed by Becker (1965), accommodates the dual role of households as both producers and consumers of commodities. Both roles can be viewed as requiring an incremental and pervasive adjusting of resource inputs (combinations of goods and time) carried on by households.

Becker combined both the time constraint and the goods (budget) constraint to show the household's costs of commodities produced for consumption. Households choose the best combination of these commodities in the conventional way of maximizing a utility function. This model incorporates the market price, marginal products, income, and alternative time allocation possibilities between home and market.

Becker (1965 and 1981) develops the analogy of the household as a "small factory" combining capital goods, raw materials, and labor to produce desired commodities. He utilizes the theory of variable proportions whereby households minimize costs by setting the ratio of the marginal product of goods to that of time equal to the ratio of their marginal costs. Households make these marginal adjustments according to the cost minimization rules of the traditional firm. He maintains that time constraints must be integrated with money constraints in order to give a more accurate assessment of the size and allocation of all resources.

Linder (1970) acknowledged that there exists a supply of time and a demand for time, and that the adjustments between the two allow for both consumption and production activities. Utility is derived from commodities generating well-being for the individual. An optimal solution is reached when resources are allocated to give an equal yield on all sectors of use.

The resource adjustment process requires that nonmarket time uses be brought into parity with the yield on market (wage-earning) time use. Current economic growth resulting from increasing market

production efficiency thus results in a relative scarcity of time. Household units may respond by behaviors which make nonmarket time more productive such as do-it-yourself home repairs. The price of home production time goes up in step with the productivity of market (wage earning) time.

Linder (1970) emphasizes the importance of maintenance time in the consumption process. Goods require maintenance, and in some cases, doing-it-yourself is the simpler approach. This notion recognized the problems of proximity (getting the repairman and the item needing repair together), of locating the contracted labor for maintenance, and the possibility that the gains by division of labor in maintenance may be relatively small (Linder, 1970). Transferring maintenance functions from the household sector to the commercial sector depends on what gains are to be made through such specialization which is largely determined by income.

Murphy (1978) extends this idea by noting that the decision by a household to transfer activities to the market depends on the comparative efficiency of home versus market technology and the comparative efficiency of family members in the production of home versus market goods. Household preferences for home versus nonmarket income are related also. Laundry services is an example where home production generally is less costly than the market alternative.

The model is limited by the fact that work at home may produce both direct utility from the product as well as process benefits (Gronau, 1977). The model does not allow for process benefits (Juster, et al.,

1981; Gronau, 1977) nor does it allow for joint production (Pollak and Wachter, 1975). Gronau's refinement of the model builds in wage rates and the shadow price of nonmarket time as components of the model. This elaboration of the basic model incorporates a trichotomy of time use: work in the market, work at home, and leisure. The theoretical model was supported empirically using the Michigan Income Dynamics data (Gronau, 1980).

The development and refinement of the household production model facilitates analysis of productive work within the household sector. Goods and time combinations used to produce housing repairs affect housing quality change. It affects not only user satisfaction but also the quality of our nation's housing stock over time. Thus the development of a precise theoretical model accommodates analysis of how household production of housing repairs directly affects housing quality change.

Housing Quality Change

Over time, all dwellings require repairs to forestall deterioration. Annual maintenance expenditures for owner-occupants of conventional single-family dwellings vary from one to three percent of the current market value of the dwelling unit (Lindamood and Hanna, 1979), a measure not including the labor of home owners. If the home owner does the work, monetary expenditures can be reduced. However, all labor has an opportunity cost.

Housing quality is a flow of services and is derived from the structure itself and related amenities. Deterioration is a decrease in the physical structure resulting from a number of factors including undermaintenance. Evidence indicates that more than half of the housing stock improves with age (Grigsby, 1963). Maintenance serves as a brake on depreciation. Well-built residential structures will remain in good condition indefinitely if properly maintained (Grigsby, et al., 1977; Salins, 1980).

Housing quality change is related not only to age but also to initial design quality and to the level of continuing maintenance. Quality assessments are often determined by the age of the dwelling since materials used, building regulations, and the level of technology will depend on when the unit was built (Botman, 1981). The post construction period accommodates maintenance and structural repair. Generally, the higher the target socioeconomic class of any new dwelling unit, the longer it will survive in the housing stock as a desirable unit (Salins, 1980). Negative changes in housing quality can result from physical deterioration and/or from obsolescence. Physical deterioration is not always inevitable or uncontrollable.

Housing structures generally have a low rate of depreciation. In the medium and upper quality brackets, there is a gradual decline due to deterioration and obsolescence (Grigsby, 1963). Ease of adding innovation features to existing structures and periodic modernization may be preferable and is usually less costly than moving.

On the lower quality end, market decline and supply affect maintenance behaviors. In this instance factors external to the home owner and not under his control may dictate undermaintenance strategies. Grigsby (1977) maintains that housing deteriorates primarily because of obsolescence. In addition, some structures are difficult to alter. However, homeowners are able to do little about locational or site obsolescence. Deterioration may also result from a lower user preference for or valuing of a well maintained residence. Maintenance is subject to compromise.

Census data indicate that the United States has shown a dramatic improvement in housing quality. Less than five percent of all households reside in structures that are in serious violation of local housing codes (Campbell, 1981). Surveys of housing preferences indicate that the proportion of families who are either mildly or seriously dissatisfied with their homes is also low. Both low income and non-low income families alike perceive neighborhood conditions to be much worse than housing conditions (Grigsby, 1977). Neighborhood effects frequently represent factors beyond the control of an individual home owner. Property owners who expect property values to decline have little incentive to maintain or improve their housing unit. Physical deterioration represents a failure to devote adequate resources to maintenance. Housing quality change is affected by the decisions of households to repair and improve their dwellings. This process has been the subject of empirical studies using varied approaches. While

externalities affect whether repairs are done or not, it is deemed not to significantly affect whether the repair is self produced or contracted. This distinction is the focus of the present study and has been studied very little.

Empirical Studies of Housing Repairs

The major research studies dealing with housing repairs analyze both time inputs and goods input measures (Morgan, 1981; Meeks and Firebaugh, 1974; and Hill, 1981), the goods input measures only (Mendolsohn, 1977), or time input measures only (Walker, 1976). The studies to be discussed next were done within a number of disciplines but basically used the conceptual language and methodologies of economics and sociology.

The most comprehensive analysis of variables affecting home production of housing repairs and improvements was reported by Morgan (1981) using the 1979 panel data of the Michigan Study of Income Dynamics. The major variables identified in this study were age, gender, marital status, a working wife, and home ownership. Work on houses was found to be done mainly by the middle aged. Analysis indicated a decline over time in the proportions of people working on their homes perhaps due to a better quality stock of housing, the opportunity cost of time involved, or the ability to hire the work done. Age of respondent was found to be the most significant variable. Home production activities were most often performed by married couples with large

families who lived in single family structures, were well educated, lived in rural areas, and had no children under the age of two years (Morgan, 1981). Morgan's conclusions were based on recall data which may understate the time estimates because estimates were asked regarding time allocated to working on the house rather than time-budget assessments. Specific activities to be included in the category "working on the house" were not defined.

The only studies known to have used time-budget data, goods input measures, and a national sample are the 1965 Multi-national Comparative Time Budget Research (Szalai et al., 1972; Robinson, 1977) and the 1975-76 Time Allocation Study (Hill, 1981). Hill used the 1975-76 Time Allocation Study data to develop a valuation scheme for work done by households themselves regarding home maintenance repairs and improvements including automobiles. Using a LISREL model, estimates were made both for measurement error associated with both recall and time-budget methods of data collection and for the effects of respondent characteristics and their stock of major durables on the true annual amount of time spent on repair and maintenance activities.

The significant variables found to affect self production of household major durables repair were: when the house was built, whether the respondent moved into the house recently, whether the respondent has repair skills, the degree to which the respondent enjoys repair activities, and the age and sex of the respondent. These conclusions were based on both time-budget, recall and demographic survey measurements.

Meeks and Firebaugh (1974) used a systems analysis of maintenance and improvement behavior of owners of single family dwellings. Respondents were male heads of intact families living in small Ohio towns. Analysis of variance revealed the following factors to affect maintenance and improvement behavior: maintenance skill, improvement skill, and time available. Male heads who did not participate in maintenance and improvement activities were excluded from analysis. Data were obtained through an interview. Seventy-four percent of the men interviewed performed maintenance and improvement jobs themselves. For each additional hour worked per week for pay, the number of maintenance jobs performed decreased. The number of improvement jobs performed by the head varied significantly with the improvement skill of the head.

Michelson (1977) analyzed housing behaviors of greater Toronto households who had above average incomes. The study was longitudinal and data collection was done primarily by time budget and personal interview methods. Michelson found that respondents living in houses, particularly older houses, spent more time on repairs and construction than did apartment dwellers. Weekend time was used for repairs more than weekday time. Sixty percent of suburban apartment owners listed their ability to make repairs as a satisfaction compared to only fifteen percent of the renters.

Analyzing census data dollar measures but not time measures regarding housing repairs and improvements, Mendolsohn (1977) also found income, age of resident, and age of structure to be important

variables. The unexplained variation in such expenditures was conjectured to be related to structural characteristics of the dwelling, neighborhood quality, and public services.

Walker (1976) investigated the time inputs into the home production process using time budget data. Goods inputs were not incorporated because the objective was to analyze time inputs in relation to resulting goods and services which are work outputs. Walker also found significant variables related to house maintenance to be nonapartment dwellers and number of children.

A major sociological study using a nationwide sample (Berk and Berk, 1979) included only weekday time for study and, perhaps as a consequence, did not find home repairs to be an important activity. The major research studies just reviewed indicate six major variables affecting home production of housing repairs.

Decision Variables Influencing Self Production of Housing Repairs

Based on the previous review of major studies regarding household production of housing repairs, the most important variables affecting this activity appear to include: housing tenure, income, age of respondent, age of housing structure, family size and composition, skill level, satisfaction, and use of vacation time.

Tenure

Mode of tenure is an important variable influencing quality change of housing units. The present study was limited to owner occupied dwellings. Thus tenure was held constant for purposes of statistical analysis. Since renters need not bear the full cost of failure to preserve what they have, they have weaker incentive to do so. Empirical studies have determined that owner occupied housing units tend to be better maintained than rental units (Grigsby, 1963; Sweeney, 1974). Homeowners spend substantially more than do renters and/or landlords. In 1975 a Census Bureau study of renter housing expenditures (which are otherwise systematically excluded because renters are not usually studied) showed that renters accounted for approximately two percent of all expenditures (Residential Alterations and Repairs, 1981). In 1980 residential property owners spent an estimated $46.3 billion for upkeep and improvement of their properties; 68 percent ($31.5 billion) of this amount was spent by owner occupants of single family, detached housing units (Residential Alterations and Repairs, 1981). Average expenditures per residential property in 1980 was $761.

Part of the difference in expenditures of home owners can be explained by the larger size and value of single family, owner occupied homes. From an economic perspective, housing repairs may be considered luxury goods. Expenditures increase more than proportionately as income increases. Of the $31.5 billion spent on repairs and improvements by owner occupants of single family dwellings in 1980, 94 percent ($29.7

billion) was spent on property valued at $20,000 or more; 80 percent ($25.1 billion) was spent on property valued at $35,000 or more (Residential Alterations and Repairs, 1981). The home owner maintains housing investment and pleasure in occupancy through repairs. It is likely that home owners have a higher marginal utility of housing and will allocate resources to maintain its quality level. The optimal repair strategy for the owner-occupant is determined by the owner's own marginal utility of housing quality relative to its cost compared to the same for other goods and services. Expected tenure is also an important variable in estimating maintenance expenditures (Sweeney, 1974). The fate of the housing stock ultimately rests with the private real estate market and with home owners in particular (Salins, 1980).

Income (Size and Dual Earner)

Higher income home owner households are more likely to do repairs. Of the $31.5 billion spent on this category in 1980, 71 percent ($22.2 billion) was expended by households with incomes of $15,000 or higher (Residential Alterations and Improvements, 1981). Higher income home owners face higher relative time costs and can be expected to contract home repairs. This strategy allows substitution of goods resources for relatively scarce time. Shomrock (1975) found a curvilinear relationship between socioeconomic status and alterations. Middle class occupants were more likely to alter their housing than lower or upper income groups.

Analyzing census data for home repairs and improvements, Mendolsohn (1977) found that higher income home owners were more likely to

hire outside help. They also spent more on maintenance and changes to their housing unit. The tendency for high income home owners to do less work themselves probably reflects their higher wage rate--the opportunity cost of time. Because time is important in home production, marginal costs would be relatively high when the wage rate was relatively high (Ghez and Becker, 1975). In addition, higher income households frequently include two income families. The presence of wage earning spouses may reduce the tendency for families to do home repairs and improvements and increase the willingness to hire others to do the job (Morgan, 1981). A change in income is one of the best predictors of a change in the amount spent for housing (Morris and Winter, 1978; Roistacher, 1974).

The logic of the substitution effect of higher incomes on do-it-yourself behavior includes the opportunity cost of time. Household production theory assumes a smooth trade-off between market participation and home production time. This trade-off holds for self-employed professionals and for wage rate employees who have the choice of working overtime at their own discretion. However, many other workers face a "lumpy" set of choices in market participation. Salaried workers who are not paid overtime and other workers who choose to increase working hours may face second, part-time jobs as an alternative. These workers face an opportunity set that allows discrete changes in wage earning time rather than allowing the smooth incremental adjustment implied by household production theory. Hill and Morgan (1979) reported results

based on a national sample of employed men and women that show that only 37 percent faced the option of more work available on the job and 27 percent could choose less work. Morgan (1981) contends that perhaps the opportunity cost is more closely related to the total time demands on people rather than on their market wage rates. Many people do not have ready choices about the amount of market work they do, so the trade-offs may more readily be between home production and leisure time uses.

Morgan (1981) found that the more hours the head of the household worked in the market, the more that person also worked on the house. Spouses are also involved in doing housing repairs and improvements and may have different opportunity costs.

Despite all the complexities of income and market participation choices, Morgan (1981) found age, gender, marital status, and home ownership to be the most significant variables affecting household production activity. It is probable that the income and substitution effects cancel each other. Higher income also allows household units to opt for new and higher quality housing units likely to require lower maintenance costs.

Housing occupied by low income households is more apt to be older housing and/or poorer quality construction whether rented or owned. Income constraints may allow only the most essential repairs and may preclude major improvements unless external assistance is provided. Incomes may be so low that households cannot handle even the

most essential maintenance. The basic dilemma of low income housing is low income (Grigsby, 1963).

A key factor in engaging in housing repairs relates to the opportunity to do so represented by resource availability. Resources of many kinds tend to be limited for low income families. Opportunity to do home repairs as represented by home ownership, tools, skills, materials as well as time may be available more often to higher income groups. Low income families may have the pressure to do nonmarket work but not the opportunity to do so. Morgan (1981) found that families with the most counter pressures (time, income level, family demands) and the least need for more real income did the most unpaid work.

In a study of repair behavior of low income families, Miller (1975) found that availability of tools and materials were distinguishing considerations affecting commitment to do home repairs. Tool lending services can be provided for self-help repair. Seventy percent of the respondents indicated a desire to learn to do residential repairs.

Low income households may also be faced with problems within the market environment such as redlining either by loan or insurance sources. Private contractors may find higher profit in new construction than in rehabilitating existing structures (Wagstaff, 1979). Salins (1980) identifies social class (determined by income) as the fundamental factor in housing demand.

Age of Respondent

Age has a direct relationship with availability of resources such as income, tools, and skill. These could be expected to increase

with time, although the physical energy to actually do the job might decrease in later years of the life cycle. Some tasks require less physical energy than others. Time pressures are heavier in the beginning stage of the family life cycle, whereas income demands are heaviest during the expanding stage of the cycle (Nickell, Rice and Tucker, 1976). Morgan (1981) found that middle aged people reported higher dollar savings per hour and were also more likely to do work on the house. Other studies have also found a curvilinear relationship between age and alteration activities (Winger, 1973; Yockey, 1976). Higher quality and more expensive housing is prescribed as a household moves through the family cycle (Morris and Winter, 1978).

Age of Housing Structure

Structural deterioration usually becomes more pronounced between the tenth and twentieth years of the age of the house (Grigsby, 1963). Physical deterioration is not inevitable. Households occupying older structures and living in houses rather than apartments spend more time doing housing repairs and improvements (Michelson, 1977). Hill (1981) found that time spent in repair and maintenance activity increases with the age of the structure. Respondents in houses twenty-five years old or older spent almost 16 more hours per year in repair activities than those living in housing structures five years old or younger. The time and goods required to repair and improve a housing unit is related not only to the age of the unit but also to its general construction quality. Analyzing census data regarding home improvement expenditures, Mendolsohn (1977) found that outside help was more frequently employed with

older and higher-valued homes, perhaps reflecting the difficulty and desired quality of needed repairs.

Household Size and Composition

Household size and composition can affect home upkeep decisions in several ways. It may increase the demands on income and housing space. It offers possibilities of specialization and increases the pool of time resources.

Families generally face the maximum need for housing space for both privacy and entertainment of friends during the expanding stage when children are teenagers (Nickell, Rice and Tucker, 1976). Demands on income are also high during this period. If adults or older children can assist in doing the repairs or in caring for younger children while others do the repairs, time can be substituted for relatively scarce income in general. Specialization or division of labor facilitates this strategy. Multiperson households allocate the time of different members according to the relative efficiency of each member (Becker, 1965). The allocation of the time of any member is greatly influenced by the opportunities open to other members. Families with only very young children will likely be constrained by time demands of these children. Morgan (1981) found that the larger the household, the more likely the family was to do some work on the house. However this effect was not significant in the multivariate analysis.

Vacation or Weekend Versus Weekday Time

Home owners may have more unobligated time on vacation or weekends as opposed to weekdays to do home repairs. The value of time used in household production can be approximated in two ways: the market cost of the service and the opportunity cost of such time usage. The rationale behind the latter approach is that individuals allocate their time so that the marginal valuation on the last hour spent is the same whether it is spent on work, leisure, or home production (Murphy, 1978). In equilibrium, the marginal wage rate net of taxes represents the value of time spent in home production.

Linder (1970) acknowledges that maintenance time in consumption varies and output includes both the possible pleasure derived from the process as well as the technical performance of the task. He acknowledges the need for further study of personal (nonmarket) work time where a lot of leisure is spent in strenuous activity including do-it-yourself work in the house, particularly on weekends. Becker (1965) also maintains that the hours used during the day be distinguished from those used at night or weekends. Hill's analysis (1981) of time spent on major durables repair and maintenance activities offers supporting evidence of this contention. Respondents averaged 17.6 minutes per day on Saturday, 13.5 minutes per day on Sundays, and 9.9 minutes per day on weekdays for this type of repair and maintenance activity.

Skill Level

Skill level related to home repairs has the possibility of increasing the marginal product of the time and goods allocated as inputs

into the process. Use of resources is assumed to be subject to diminishing returns. If skill level is sufficient for the task, the individual will be able to widen the advantage between the marginal costs and the marginal benefits. Mendolsohn (1977) hypothesized that owners who were more skillful with repairs would have high productivity and would spend more time doing home repair jobs than other owners. Hill (1981) found that respondents having repair skill increased time allocated to that activity by almost 27 hours per year.

One of the benefits of do-it-yourself activity is the increased skill and knowledge useable for future repairs and improvements. Home owners who directly participate in planning, purchasing and/or actual home repair work gain knowledge and skills that may encourage more effective future maintenance (Wagstaff, 1979; Turner, 1972).

Satisfaction

Households may engage in home production of housing repairs not only for the economic benefits, but also because of the satisfaction, or utility, gained from the process (Sweeney, 1974; Linder, 1970; Becker, 1965; Gronau, 1977). Housing is typically one of the basic components in any attempt to measure an individual's sense of well-being. Housing satisfaction is generally perceived as having both physical and psychological aspects. Owners are more satisfied than renters, even mobile home dwellers (Campbell, 1981). People living in poor housing are not as dissatisfied as might be expected (Campbell, 1981). In fact, dissatisfaction is more commonly related to neighbors and neighborhood than to the housing structure itself. Though psychic income

is an important determinant in the investment of human capital, economists have not been able to isolate and measure this factor (Gronau, 1977).

Summary

A number of disciplines have contributed to the study of home production theory and of household behavior regarding housing repairs. An important step was the development of the household production model which allowed simultaneous consideration of both goods and time constraints.

Empirical studies have used time-budget and recall approaches to measure the time inputs to household production. All have considered housing repairs as a homogeneous category. Personal interviews, telephone interviews, and written questionnaires have been used to collect socio-demographic data measuring the goods input and other relevant information. The household production model allows a conceptual framework for analyzing household production of housing repairs.

The studies reviewed indicate that the following variables appear to be the most important: housing tenure, income, age of respondent, age of housing unit, family size and composition, skill level, use of vacation or weekend time, and satisfaction in doing repairs.

A relatively unexplored area is the detailed economic analysis of household decision making regarding housing repairs using both time

input data and goods (dollar) measurements of inputs into the household production process. The present study as described in the chapter to follow bridges this deficiency in the literature and in the theoretical framework of household production as applied to housing repairs.

CHAPTER III

METHODOLOGY

Procedural Overview

The decision variables indicated by the review of literature include housing tenure, income, age of respondent, age of housing unit, family size and composition, skill level, use of vacation or weekend time, and satisfaction in doing repairs. These variables are incorporated into the model presented in the section below and are also used as the discriminating variables in the statistical testing of the model. The review of literature and the model indicate a number of hypotheses which are identified for testing concurrently with the model. These relationships are discussed in detail in the section regarding implications of the model. The sample used, measures, and statistical procedures define the actual testing of the model and related hypotheses.

Because the purpose of this study is to develop and test a household production model to identify the key decision variables associated with home repair, the first step in this process was the development of a theoretical model. The model was tested using a data set which includes recall measures of time allocated to home production of household repairs. The socio-demographic measures used as discriminating variables were collected through interviews with respondents.

Household Production Model

Analysis of time use data is consistent with the time allocation and monetary opportunity cost of productive activities and the economic functioning of the household as the nation's basic economic unit. The household must decide how to allocate a limited amount of time among various alternatives. Time allocations are a product of both choice and constraint. The household production model, as noted in the previous chapter, allows for a more realistic setting by accommodating the dual role of consumers in an economic system. That is, consumers are both producers and consumers. Households must manage resources as efficiently as possible to achieve the highest feasible well-being.

Following Becker (1965), a household production model of housing repairs was developed. The variation presented below was developed by Dr. David B. Eastwood, Department of Child and Family Studies, The University of Tennessee, Knoxville, June 1982.

The Model

Utility for a representative household is a function of commodities the household produces using goods and time. A commodity is anything which generates utility (U).

$$U = u(Z_1, Z_2, Z_3) \qquad (1)$$

This assumes a fixed set of preferences, diminishing marginal utility (MU), and a one period utility function--i.e., utility is derived only

from commodities produced this period. Market goods must be transformed by the household into desired commodities. The household production model accommodates the dual economic role of consumers. Not only does a household buy market goods and services, but a household also allocates resources, especially time. Household time not spent in the marketplace can be combined with market goods to produce desired commodities. The essential features of the decision making with respect to home repairs can be outlined by assuming a three commodity world.

Z_1 = self-produced repairs

Z_2 = contracted repairs

Z_3 = a composite commodity representing all other commodities which generate utility

Commodities are produced with market goods (X) and household time (t). Time (t_1, t_2, and t_3) and goods inputs (X_1, X_2, and X_3) may be combined to produce commodities (Z_1, Z_2, and Z_3) which appear in the utility function (U) of the household.

Z_3 includes the commodity of leisure. Leisure stems from that portion of nonmarket time not used for work in the home. Leisure is a time intensive commodity, but market goods and time are necessary to produce leisure. Free time is assumed to generate utility if it is combined with some market goods (e.g., stereo, television, or a sporting event).

Basic assumptions of the production processes are as follows. The model assumes constant returns to scale. It also assumes that

individuals are able to make incremental adjustments between market goods and time. A proportionate change in the X_i and t_i inputs leads to the same proportionate change in the Z_i output. There is no joint production; only one output is associated with each input combination. Household production constraints are shown as equations (2) through (4).

$$Z_1 = z_1(X_1, t_1) \tag{2}$$

$$Z_2 = z_2(X_2, t_2) \tag{3}$$

$$Z_3 = z_3(X_3, t_3) \tag{4}$$

The budget (income) constraint is shown as total income (M) being equal to the wage rate (w) times the hours allocated to work in the market (t_4) plus unearned income (V). Total income limits the value of the goods which can be purchased in the market, i.e., the price of each good (P_i) times the quantity purchased (X_i). The income constraint is for one period consumption, because it assumes no borrowing, saving, or investing. Market expenditures are equal to total income.

$$M = wt_4 + V = \sum_{i=1}^{3} P_i X_i \tag{5}$$

The time constraint is

$$T = \sum_{i=1}^{4} t_i \quad \text{where } T = \text{total time.} \tag{6}$$

Total time available to the household (T) is limited by the sum of time allocations to each commodity per time period plus market time. The time constraint acknowledges that time devoted to the production of one commodity (Z) cannot be devoted to another.

The representative household maximizes equation (1) subject to equations (2) through (6). The solution is found through the formation of the Lagrangian expression:

$$\phi = U(Z_1, Z_2, Z_3) + \lambda(M - \sum_{i=1}^{3} P_i X_i) + \eta(T - \sum_{i=1}^{4} t_i) \qquad (7)$$

The decision variables include how much of the market goods to buy and how to allocate time. The model shows how changes in market goods and how time allocation affect the maximization process.

The first order conditions for a maximum are shown below. That is, these relationships must hold whenever there is a maximum. The second order conditions for a maximum are assumed to hold.

$$\frac{\partial \phi}{\partial X_1} = \frac{\partial U}{\partial Z_1} \cdot \frac{\partial Z_1}{\partial X_1} - \lambda P_1 = 0 \qquad (8)$$

$$\frac{\partial \phi}{\partial X_2} = \frac{\partial U}{\partial Z_2} \cdot \frac{\partial Z_2}{\partial X_2} - \lambda P_2 = 0 \qquad (9)$$

$$\frac{\partial \phi}{\partial X_3} = \frac{\partial U}{\partial Z_3} \cdot \frac{\partial Z_3}{\partial X_3} - \lambda P_3 = 0 \qquad (10)$$

$$\frac{\partial \phi}{\partial t_1} = \frac{\partial U}{\partial Z_1} \cdot \frac{\partial Z_1}{\partial t_1} - \eta = 0 \qquad (11)$$

$$\frac{\partial \phi}{\partial t_2} = \frac{\partial U}{\partial Z_2} \cdot \frac{\partial Z_2}{\partial t_2} - \eta = 0 \qquad (12)$$

$$\frac{\partial \phi}{\partial t_3} = \frac{\partial U}{\partial Z_3} \cdot \frac{\partial Z_3}{\partial t_3} - \eta = 0 \qquad (13)$$

$$\frac{\partial \phi}{\partial t_4} = \lambda w - \eta = 0 \tag{14}$$

$$\frac{\partial \phi}{\partial \lambda} = M - \sum_{i=1}^{3} P_i X_i = 0 \tag{15}$$

$$\frac{\partial \phi}{\partial \eta} = T - \sum_{i=1}^{4} t_i = 0 \tag{16}$$

Examination of the first order conditions provides many insights. Interpretation of equations (8), (9), and (10) is as follows: the expression $\frac{\partial U}{\partial Z_i}$ is the marginal utility of Z_i, MU_{Z_i}. This is the effect of a small change in Z_i on utility. The expression $\frac{\partial Z_i}{\partial X_i}$ is the marginal product of X_i, MP_{X_i}, which is the effect of a small change in market good input X_i on the production of Z_i.

Equations (8) through (10) can now be expressed as:

$$MU_{Z_i} \, MP_{X_i} = \lambda P_i \tag{17}$$

A change in X_i affects the production of Z_i, and it is the change in Z_i which affects utility. It is an indirect effect.

Since the household is concerned with trade-offs and the first order conditions must hold simultaneously,

$$\frac{MU_{Z_i} MP_{X_i}}{MU_{Z_j} MP_{X_j}} = \frac{P_i}{P_j} \text{ for } i \neq j$$

or

$$\frac{MU_{Z_i} MP_{X_i}}{P_i} = \frac{MU_{Z_j} MP_{X_j}}{P_j} . \tag{18}$$

The expression $MU_{Z_i} MP_{X_i}$ translates incremental changes in X_i into incremental changes in utility. P_i is the price per unit. The ratio is the value of the last dollar spent.

The same manipulation can be done with equations (11) through (13) to show the equilibrium relationship of uses of time t_i and t_j as inputs into the production of Z_i and $Z_j (i \neq j)$.

$$\frac{\frac{\partial U}{\partial Z_i} \cdot \frac{\partial Z_i}{\partial t_i}}{\frac{\partial U}{\partial Z_j} \cdot \frac{\partial Z_j}{\partial t_j}} = \frac{\eta}{\eta} = 1$$

or

$$MU_{Z_i} MP_{t_i} = MU_{Z_j} MP_{t_j} \tag{19}$$

Since the opportunity cost of time away from work is constant, the decision making for the allocation of home production time focuses on MP_{t_i} and MU_{Z_i}. The expression $\frac{\partial Z_i}{\partial t_i}$ is the marginal product of t_i, MP_{t_i}, which is the effect of a small change in time inputs t_i on the production of Z_i.

The difference in time use comparisons of equation (19) versus those of equation (18) relates to the fact that the opportunity cost of time is the same regardless of nonmarket uses. What matters is how productive time uses are and how the output is valued. The product $MU_{Z_i} MP_{t_i}$ measures how changes in time, t_i, affect utility. It also is an indirect effect. A change in t_i affects the production of Z_i, and it is the change in Z_i which affects utility.

A household must make decisions about time uses versus market goods purchased. This process allows for substitution between time and goods for the same output.

$$\frac{MU_{Z_i} MP_{X_i}}{MU_{Z_i} MP_{t_i}} = \frac{\lambda P_i}{\eta}$$

Using equation (14): $\eta = \lambda w$

$$\frac{MP_{X_i}}{MP_{t_i}} = \frac{P_i}{w}$$

$$\frac{MP_{X_i}}{P_i} = \frac{MP_{t_i}}{w} \qquad (20)$$

Since the above equations are dealing with the same commodity, MU_{Z_i} does not enter into the decision making. The value of the last dollar spent reduces to the ratio of the marginal product to the respective input cost.

Households may also substitute between goods and time for different commodities.

$$\frac{MU_{Z_i} MP_{X_i}}{MU_{Z_j} MP_{t_j}} = \frac{\lambda P_i}{\eta} \quad \text{for } i \neq j.$$

This process of substituting goods and time inputs allows the household to adjust the production process to reach an equilibrium position among commodities.

$$\frac{MU_{Z_i} MP_{X_i}}{P_i} = \frac{MU_{Z_j} MP_{t_j}}{w} \qquad (21)$$

The interpretation is similar to that of equation (18). The expression $MU_{Z_i}MP_{X_i}$ translates the incremental changes in X_i into incremental changes in utility. P_i is the price per unit. This ratio is the value of the last dollar spent. $MU_{Z_j}MP_{t_j}$ translates the incremental changes in t_j into incremental changes in utility. The wage rate for work in the market is the cost per unit of time for household production. If an equality holds, then the first order conditions hold, and the household is at an optimum.

Suppose the first order conditions do not hold. Then equations (18), (19), (20), and (21) would have inequalities instead of equalities. The household should use more of that choice variable which has a greater value of the last dollar spent. For example, if

$$\frac{MU_{Z_i} MP_{X_i}}{P_i} > \frac{MU_{Z_j} MP_{X_j}}{P_j},$$

an adjustment in purchasing of goods X_i and X_j is in order. The household should purchase and use more X_i and less X_j in order to maximize utility. Increasing the use of good X_i will decrease the marginal utility MU_{Z_i} and the marginal product MP_{X_i}. Using less of good X_j will increase the marginal utility MU_{Z_j} and the marginal product MP_{X_j}. These adjustments will bring the use of the two goods into equilibrium, so that the values of the last dollar spent are equal.

Analysis of household production costs can be considered as follows. Assuming constant returns and using Euler's Theorum

$$X_i MP_{X_i} + t_i MP_{t_i} = Z_i$$

i.e., the sum of the marginal product of an input times the respective amount equals the total product (amount produced).

Let π_i be the cost per unit to the household for producing Z_i. Then total cost is

$$\pi_i Z_i = \pi_i MP_{X_i} X_i + \pi_i MP_{t_i} t_i \qquad (22)$$

The total cost is also equal to the unit price of each input multiplied by the number of units

$$\pi_i Z_i = P_i X_i + w t_i \qquad (23)$$

Comparing equations (22) and (23) leads to

$$\pi_i = \frac{P_i}{MP_X} = \frac{w}{MP_{t_i}} \qquad (24)$$

The cost of each commodity Z_i to the household equals the market cost of each X_i relative to how productive it is and the wage relative to how productive the home production time is. For example,

if w = \$10/hour and $MP_{t_1} = 2$, then $\pi_1 = \$10/2 = \$5$.

Thus the wage per hour ($10) divided by the commodity units produced per hour (2) gives the cost per unit ($5). Equation (24) holds for each household and across inputs through varying the amounts of the inputs. Changing the input levels changes the MPs. Given constant returns to scale, the MPs depend on the ratios of the inputs.

Implications of the Model and Related Hypotheses

The higher the wage rate (w) is, the more costly the time input of the commodity produced since w/MP_{t_i} must rise. This condition encourages households to substitute goods for time as income increases. An income effect also is associated with a change in the wage rate. Equation (5) shows that in order to have the same income, M, an increase in w leads to a decrease in t_4, thereby leaving more time for home production. Equation (24) of the model shows that as the wage rate goes up, the cost of the commodity is raised because of the increased cost of the time component involved. Such a situation would encourage households to substitute the cheaper input--goods. Alternatively, we see that if the wage rate goes up, equation (21) becomes an inequality. The left hand side of the equation becomes greater, and households would tend to use more goods inputs. These adjustments suggest the following hypothesis:

> Hypothesis 1. The higher the income the less likely households are to engage in self production of housing repairs, if the substitution effect dominates.

Dual wage-earner households have a higher opportunity cost of self production than a single-earner because there is one more member whose time is allocated to market work.

Hypothesis 1a. Dual income households are less likely to engage in self production of housing repairs.

By the same reasoning, households are apt to substitute relatively less expensive vacation time for weekday time which may be committed to wage earning. This logic indicates that households are likely to minimize production costs by using more time when the wage rate w is close to zero (see equation (24)). A second issue relates to equation (21) and the concept of the value of the last dollar spent. Households adjust production strategies--increasing time inputs or increasing goods inputs--such that the value of the last dollar spent whether on goods or the opportunity cost of time reaches a balance (equilibrium). Vacation days suggest a situation where the wage rate and thus the time input cost is lower and implies

Hypothesis 2. Households are more likely to use vacation time, when time is relatively cheaper, to do home repairs.

The higher the skill level, the higher is the marginal product of time and the lower the cost per unit for the commodity produced. Whenever the MP_{t_i} rises (equation (21)), households are encouraged to substitute more time in the production of the commodity. Households having a member with repair skills have a higher marginal product of time so allocated (the right-hand-side of equation (21)) and are more apt to engage in self-produced home repairs versus contracted repairs. This indicates

Hypothesis 3. Households with requisite skills are more likely to engage in self-produced housing repairs.

MP_t is assumed to be a function of age and is higher for middle aged household members. Thus, when a household has members in this age group, it is more likely that the household would undertake home repairs. Middle aged home owners are assumed to have higher marginal productivity of time, vis a vis older and younger households. High housing repair skill levels on the basis of age suggest:

Hypothesis 4. A nonlinear relationship exists such that home owners who are middle aged, middle income and have needed skills are more likely to engage in self production of housing repairs.

Households whose size and age composition allow for task specialization will be more apt to have a skilled member and/or can afford to have a member devote time to repairs. The larger the household size, the greater the likelihood of someone having a low wage rate w. Teenagers usually have a low w and also possess adequate physical strength. Older teenagers in addition may also have some housing skills. Especially is this likely where the skill requirement is not complex such as in painting. Use of such labor minimizes production costs and encourages such substitution:

Hypothesis 5. Large families are more apt than small families to engage in self production of housing repairs.

Less skilled members can perform alternate tasks such as caring for young children or doing other household tasks, some of which could

free the skilled member's time for repair uses. In particular, families having teenage children have time resource inputs whose opportunity costs may be very low.

Hypothesis 5a. Families with teenage children are more likely to engage in self production of housing repairs.

Whether a housing repair is self produced or contracted, the task is accomplished either way. However, a distinction may occur due to a household member having done the work. The case where household members derive greater satisfaction from doing it themselves suggests that $MU_{Z_1} > MU_{Z_2}$ for a specific repair. Process benefits are a part of Z_1 rather than appearing in the utility function. To the extent that process benefits occur, they are assumed to exist in MU_{Z_1}. These conditions suggest:

Hypothesis 6. Individuals who experience satisfaction in self producing housing repairs are more likely to do self-help repairs.

Age of the dwelling increases the need for repairs and thus increases the opportunity for self production. This increases the supply of houses needing repair. Structural age also increases the possibility of the need for customized repairs. General construction technology and quality are related to age of the structure because of technological change, materials used, and absence, in many cases, of applicable building codes. Homeowners may find that the increased market costs of such customized jobs offer added incentive to self produce such commodities. The higher market cost makes home production more competitive via the left-hand-side of equation (21) becoming less than the right-hand-side.

Hypothesis 7. Individuals who live in older housing structures are more likely to engage in self-produced home repairs than those living in newer homes.

The data set described in the section to follow allows empirical testing of the model and related hypotheses. Although the entire sample is described, a restricted subset representing only home owner households and using only respondent data is actually used to test the model and hypotheses.

Sample

The model developed was tested using recall and survey data gathered by the Survey Research Center of the Institute for Social Research, Ann Arbor, Michigan. A national probability sample of United States households was surveyed based on a microdata perspective. Emphasis was placed on generating accurate estimates of yearly productive uses of time on a household basis. Grant support was from the National Science Foundation and the United States Department of Health, Education, and Welfare.

The sample process involved multistage area sampling. This four-stage process included both urban and nonurban households using both SMSA's (Standard Metropolitan Statistical Area) and counties. Households were represented in the sampling process according to their proportion of the population in each of four major geographic areas of the nation: northeast, north central, south, and west. The sample represents the coterminous United States exclusive of military reservations. There were 74 sample points in 37 states and the District

of Columbia. The intent was to generate about 1,500 interviews at an overall sampling rate of .315/10,080. Probability selection was enforced at all stages of sampling; interviewers had no freedom of choice among household units or respondents.

The data generated were based on 2,406 cases with 1,519 respondents and 887 spouses. The unit of analysis is the respondent whether male or female. Respondents were 18 years of age or older and included those married and not married. Spouses of respondents were also interviewed, although the total number of households in the data set remains at 1,519. The data thus generated may be analyzed using either respondent data or spouse data or both. Time use and personal descriptive data yielded 7,984 variables in the full data set.

The subset of the full sample used for the present study was limited to home owners who reported one or more housing repairs for the year 1975 and used only respondent data. This resulted in a subsample of 682 respondents; 298 males and 384 females. Of the 682 respondents, 681 were either heads of households or spouse of head of household (Table 1).

Measures

Although the data set contained extensive time-budget measures related to housing repairs, this portion of the data set was not useable because it was not possible to exclude automobile repair measures from the housing repairs category. For this reason only recall data regarding housing repairs was used.

TABLE 1

Household Position of Respondent

Position	Absolute Frequency	Relative Frequency
Male head of household	297	43.5
Female head of household	108	15.8
Wife of head of household	276	40.3
Son, step-son	1	0.1

n = 682

Four waves of data sampling were collected: October-November, 1975; February, 1976; May-June, 1976; and September, 1976. Wave 1 data were obtained in the field through personal interviews. Waves 2, 3, and 4 were obtained by telephone. The recall measures of housing repair activity was collected in wave 2, but portions of all four waves are used in the present analysis. The time use data were supplemented by socio-demographic and other household data.

Hill (1981) compared recall measures of time inputs with time-budget measures and found recall measures to be approximately one-half the size of time-budget measures. Correlation between the two measures was low--only .25. It is likely that some major and many minor repairs are under-reported with the recall method (Hill, 1981; Harvey, 1978).

Hill also found that there is a large and significant amount of measurement error in both recall and time-budget measures, both correlating about .5 with the true amount of annual time spent on repair activities. Where measurement error introduces bias, it is likely to result in an under-representation of effects under analysis. Because housing repairs are done on an irregular and infrequent basis, under-reporting is highly probable. However, the extent to which observed measures for such time use reflect the true time use is unknown until it is investigated through direct observation.

Design

Though direct observation may seem the ideal method of gathering time use data, it is expensive for large scale studies and may

change the observed person's behavior causing inaccuracies (Robinson, 1977). Self-reporting by respondents avoids the problem of observer bias. The recall method is "unobtrusive," not systematically biased, to the extent that respondents do not attach any underlying motive to their reporting of repair activity.

The use of personal interviews enhances accuracy and is the most powerful and useful tool of social scientific survey research for obtaining information (Kerlinger, 1973). Survey research has the advantage of wide scope, allowing much information to be collected from a large population. It is accurate. However, interviews require considerable time, money, and skill (Kerlinger, 1973).

Operational Definitions

Data used in the statistical analysis of the present study comes from time recall and survey data given by the respondent during the initial personal interview and subsequent telephone interviews. A respondent is any individual in the sample whose household had one or more housing repairs in 1975 and who was a home owner. Participation in housing repairs refers to whether the household had a housing repair in one or more of the following categories: interior painting, exterior painting, papering, plumbing, electrical, carpentry, masonry, television, and other household appliance and equipment. If the repair was self produced, both the time input measured in number of hours and the goods input measured by cost of materials were recorded. If the repair was contracted, the dollar cost was recorded.

Income is the number of dollars of total annual household income, earned and unearned, reported by respondents. Low income is the household categorization of reported total income according to the Federal Interagency Committee definition used by the Bureau of Census for 1975 income statistics and adjusted according to annual changes in the Consumer Price Index (Current Population Reports, 1977). The low income cutoffs have been adjusted for family size (Current Population Reports, Table A-3, 1977). Category threshholds range from $2,717 annual income for a one-person household to $8,939 annual income for a seven or more person household. Upper income refers to those households whose annual income is in the top quintile (Current Population Reports, Table 13, 1977). Middle income refers to households having total annual income which exceeds the low income thresholds, but is less than the upper quintile representing the upper income category. Income distributions for the subsample are shown in Table 2. About half the households in the subsample were classified as middle income. Dual income indicates whether or not both respondent and spouse were employed, either full-time or part-time.

Age refers to the chronological age in years of the respondent at the time of the initial personal interview. Mean age for the subsample was 43.9 years. Middle age refers to respondents who are between 30 and 50 years of age inclusive. Family size is a continuous variable measured by the actual number of persons permanently residing in the household unit at the time of the personal interview. The mean

TABLE 2

Frequency of Household Income Classes

Income Category	Code	Absolute Frequency	Relative Frequency (Percent)
Low income	1	180	26.4
Middle income	2	337	49.4
Upper income	3	165	24.2

n = 682

household size was 3.1 members. Family composition refers to whether or not there are teenagers between the ages of 13 and 17 residing within the household.

Housing tenure refers to ownership status of the household, whether the housing unit is reported by the respondent to be owned or rented during the time of the personal interview. All respondents in the study were home owners. Age of house refers to the number of years since construction of the house was completed, and was reported in decades by the respondent during wave 4. Decades used were: 1970-76, 1960-69, 1950-59, 1940-49, and before 1940. Table 3 indicates an even distribution over the five decade categories, except for a low in the forties.

Skills is a yes-no determination reported during a telephone interview in wave 2 according to whether the respondent had housing repair skills in any of these categories: carpentry, electrical work, appliance repairs, welding, mechanics, plumbing, woodworking, refinishing furniture, home remodeling, building contractor, carpet laying, or house painting. Only 4.4 percent (30 respondents) reported having housing repair skills. Satisfaction is the utility gained by the respondent from doing housing repairs as measured on a 0 to 10 point rating scale, no satisfaction to high satisfaction. Responses for the variable, respondent satisfaction in doing repairs, showed a common pattern: ratings clustered at the midpoint and the extremes (Table 4). This variable was a general rating of repair satisfaction without any

TABLE 3

Decade in Which Respondent
Housing was Built

Decade	Code	Absolute Frequency	Relative Frequency (Percent)	Adjusted Frequency (Percent)
70's	1	90	13.2	17.3
60's	2	113	16.6	21.7
50's	3	124	18.2	23.8
40's	4	56	8.2	10.7
30's and before	5	138	20.2	26.5
Missing		161	23.6	Missing

n = 682

TABLE 4

Frequency of Respondent Ratings of Satisfaction
in Doing Housing Repairs

Rating	Code	Absolute Frequency	Relative Frequency (Percent)
None	0	137	20.1
	1	8	1.2
	2	30	4.4
	3	28	4.1
	4	28	4.1
	5	164	24.0
	6	58	8.5
	7	65	9.5
	8	48	7.0
	9	26	3.8
Liked	10	89	13.0
Missing		1	

n = 682

reference to a specific repair task. Vacation time refers to work related holidays characterized by leisure or discretionary time.

Data Analysis

Categorization of Variables

The dependent variables for discriminant analysis are whether the household engaged in self-produced housing repair (group 1) versus contractual repair (group 2). The discriminating variables are: age of respondent, income, household size and composition, skills, satisfaction in doing repairs, age of house structure, and vacation time use.

Age of respondent is analyzed both as a continuous variable and as a dichotomous classification: middle age (coded 1) and other age groups younger than 30 or older than 50 (coded 2). Middle income (coded 1) refers to those households whose income is above the Bureau of Census critical value and below the top income quintile as determined by the Bureau of Census. Other income groups (coded 2) include those households categorized as low income or upper income. Dual income households has two categories: single-earner households (coded 1) and dual or two-earner households (coded 2). Household composition is classified as those with one or more teenagers (coded 1) and those with no teenagers, ages 13 to 17 (coded 2).

Skills is a dichotomous variable with no (coded 1) or yes (coded 2) determination of whether the respondent has housing repair skills.

Satisfaction in doing home repairs is a 0 to 10 point rating (coded 0 to 10), no satisfaction to high satisfaction. Age of house is reported in five time period categories related to time of construction: 1970-76 (coded 1), 1960-69 (coded 2), 1950-59 (coded 3), 1940-49 (coded 4), and before 1940 (coded 5). Vacation time use refers to whether vacation time is used for doing things around the house including housing repairs: yes (coded 1) or no (coded 2).

Statistical Analysis

Descriptive: Frequencies, Means

The most frequently occurring repairs reported were interior painting, exterior painting, television, and plumbing repairs (Table 5). Frequencies ranged from a low of 9.4 percent for occurrance of masonry repairs to a high of 48.5 percent for interior painting.

Repairs which were most often self produced were interior painting, papering, and exterior painting. It is noteworthy that these three tasks generally require less technical knowledge and usually a minimum of tools and equipment for accomplishing the task. These tasks also required a fairly low dollar cost for materials ranging from an average of $46.50 for exterior painting materials to $63.97 for papering materials. The average time devoted to these tasks was considerable: 26.88 hours for exterior painting, 24.59 hours for interior painting, and 18.11 hours for papering.

Carpentry repairs was the self-produced task category requiring the heaviest average investment of resources. Of those 165 households

TABLE 5

Frequency of Occurrence and Related Costs of
Nine Housing Repair Categories

Repair Category	Repair Occurrence		Self-Produced Repairs				Contracted Repairs		
	Absolute Frequency	Relative Frequency (Percent)	Absolute Frequency	Adjusted Frequency (Percent)	Materials Cost (Dollars)	Time (hours) Input	Absolute Frequency	Adjusted Frequency (Percent)	Repair Cost (Dollars)
Interior painting	331	48.5	279	83.0	48.75	24.59	48	14.3	209.25
Exterior painting	235	34.5	175	74.8	46.50	26.88	53	22.6	719.42
Papering	134	19.6	110	82.1	63.97	18.11	23	17.2	287.30
Plumbing repairs	301	44.1	148	48.5	80.70	7.17	145	47.5	185.00
Electrical repairs	185	27.1	105	56.5	148.57	18.44	74	39.8	307.01
Carpentry repairs	165	24.2	97	58.1	331.40	79.45	65	38.9	1258.34
Masonry repairs	64	9.4	35	55.6	125.69	10.91	27	42.9	1344.15
Television repairs	261	38.3	25	9.7	63.80	9.12	232	89.6	55.78
Other household appliance and equipment repairs	168	24.6	55	32.4	47.40	6.26	114	67.1	103.26

n = 682

who did this type of repair themselves, the average cost for materials was $331.40 and the average time devoted to the repair was 79.45 hours (Table 5).

The repair categories most often contracted were television repairs, 89.6 percent, and other household appliance and equipment repairs, 67.1 percent (Table 5). The average contracted repair cost was lowest for these two categories: $55.78 for television repairs and $103.26 for other household appliance and equipment repairs. The most expensive average contracted repair costs were for masonry repairs at $1,344.15 and carpentry repairs at $1,258.34.

Inferential: Discriminant Analysis

In order to see if the model can "discriminate," discriminant analysis was used to test for the relationships of independent variables with whether households self produced housing repairs or contracted them. A $p < .05$ was used for all analyses. The results of this analysis are presented in Chapter IV.

The discriminant analysis component in Statistical Package for the Social Sciences, SPSS, was used for the computer programming needed. The use of discriminant analysis was chosen because its functions allow two objectives: analysis and classification (Nie, et al., 1975 and 1981). This approach allows statistical discrimination between two household groups: those who do home repairs themselves and those who contracted such activities. To distinguish between the groups, discriminating variables that measure characteristics on which the two

groups were expected to differ are selected. The hypothesized set of discriminating variables are: income, age of respondent, age of housing unit, family size and composition, skill level, satisfaction in doing repairs, and use of vacation time.

The mathematical objective of discriminant analysis is to weight and linearly combine the discriminating variables such that the groups are forced to be as statistically distinct as the data allows (Nie, et al., 1975 and 1981). The discriminating variables can be entered through stepwise methods which select the "best" set of discriminating variables.

The analysis aspect includes statistical tests which measure the success with which the discriminating variables actually discriminate when combined into a function (linear combination). The discriminant function for a two-group procedure can be plotted as a histogram to show the spatial relationships between groups. The weighting coefficients identify the variables which contribute the most to differentiation. The coefficients are derived such that the discriminant scores are in standard form (Z scores). When the sign is ignored, each coefficient represents the relative contribution of its associated variable to the function (Nie, et al., 1975 and 1981).

The classification aspect allows classification of new cases (households) with unknown group membership. Once a set of variables is found which provides satisfactory discrimination for cases with known group memberships (self produced versus contracted housing repairs), a classification function can be derived permitting such classification.

CHAPTER IV

RESULTS

The presentation of results begins with the rationale for treating housing repairs as separate categories. Interpretation of discriminating variables which comprise the discriminant functions and classification results of the discriminant functions follow. These results allow testing both the housing repair model and related hypotheses presented in Chapter III. Only the statistical results and their interpretation are discussed in the present chapter. Conclusions and implications are reserved for Chapter V. Frequencies and overall sample means were presented in Chapter III.

Analytical Approach

The analysis presented in this chapter examines a subset of the respondent data from the 1975 Time Use Study to test the model of household behavior and related hypotheses presented in Chapter III. Discriminant analysis, a multivariate method available through Statistical Packages for the Social Sciences (SPSS), was used to differentiate the two groups under study.

The conditions necessary for using discriminant analysis are that the discriminating variables are measurements from a random sample, have a multivariate normal distribution, and have equal variance-covariance matrices within each group (Nie, et al., 1975). As a component of the SPSS discriminant package, a test using Box's M shows

evidence that the variance-covariance matrices of the two groups under study are not equal. However, discriminant analysis is considered to be robust in this respect, and these last two assumptions need not be strongly followed (Nie, et al., 1975).

Rationale for the Repair Categories

The nine housing repair types under study were assumed to have different production functions. The skills required for various types of work are quite different, leading to varying marginal products. Market goods used in producing the repairs differ by type of repair. Finally, relative prices vary considerably across the repair categories. For example, most households do interior painting tasks themselves, but most households contract television repairs. These considerations suggest that household repairs should be considered separately by category. Consequently, the nine housing repair types were analyzed by separate discriminant functions.

Statistical accuracy also mandates that the repairs be analyzed separately, if discriminant analysis is to be used. The focus of the study is to distinguish between households who self produce housing repairs and those households who contract housing repairs. These two groups must be defined as mutually exclusive and exhaustive categories. Collapsing the repair tasks into one or more categories precludes this requirements. For example, most households self produce interior painting, whereas they contract television repairs. Even related categories may present this same problem. For example, a household might hang wallpaper themselves, but contract exterior painting.

The data collected allows precise distinction between households who self produce repairs versus those who contract the task, permitting mutually exclusive and exhaustive group division. Nine repair tasks--interior painting, exterior painting, papering, plumbing, electrical repairs, carpentry repairs, masonry repairs, television repairs, and other household appliance and equipment repairs--were analyzed separately producing nine discriminant functions and classification results.

Stepwise Procedure

The discriminant functions reported in this study were generated via Wilks stepwise procedure. This stepwise selection method determined which independent (discriminating) variables were selected for inclusion in the discriminant analysis. The criterion used is the overall multivariate F ratio for the test of differences among the group centroids (means). The variable which maximizes the F ratio is chosen at each successive step in the process. This test allows consideration of the differences between all the group centroids (means) in addition to the homogeneity within the two groups (Nie, et al., 1975). Thus, independent variables are entered into the analysis on the basis of their discriminating power. This procedure of selecting the best variable yielding the highest F value, given the variables already selected, continues until additional variables fail to produce a minimum improvement in the F value. As a consequence, the stepwise procedure allows selection of an optimal set of variables for the given data.

Discriminant analysis also produces classification results which give a test of the discriminating power of the variables selected in the stepwise procedure. This assessment acknowledges whether one group is more accurately predicted than the other group as well as the overall correct prediction rate.

Adjustment for Group Size

Because the groups on each of the tasks were not of equal size, adjustment was made by entering the prior probability as a correction mechanism. This is a Bayesian adjustment made for a priori estimates of group membership.

The consequence of failure to correct for groups which are of grossly different sizes is upward bias in the classification results. By chance there is a .5 probability of being classified in one or the other of two groups. If the groups classified are of unequal size, chance factors favor the larger group classification. Use of a large sample size also helps minimize this problem.

The overall F ratios for each of the nine tasks were significant at the .05 alpha level, supporting the assertions that the two groups under analysis were statistically different. However, the major question becomes whether the observed differences can be analyzed, correctly predicted, and correctly classified.

Discussion of the Results

Discriminant analysis is an attempt to discriminate among groups on the basis of discriminating variables. When the stepwise procedure

indicates that a variable discriminates, assessment of the group means clarifies the distinction. For example, note that age of respondent is consistently higher for group 2, the contracted repairs, than for group 1, those who self produce repairs (Table 6). The same is true for household size. This comparison of means (Table 6) is especially informative in determining the impact of the difference. An assessment of the respective group means lends clarity to interpreting the effect of a discriminating variable.

The groups centroids (means) summarize the group locations according to the discriminant function. This comparison tells us how far apart the groups are along that dimension (Table 7). Self-produced repairs always have larger and positive group centroids; whereas, the contracted repair group always has a negative group centroid.

The direction of the effect of a discriminating variable may be determined by the sign of its respective coefficient in the standardized discriminant function and by recognizing which group has been given higher discriminant scores. The latter is provided by the group centroids. Table 8 summarizes the sign of each discriminating variable. Each discriminating variable makes a positive or negative contribution to its respective discriminant function. A plus sign increases the likelihood of a positive discriminant score which is characteristic of group 1, households who self produce repairs. A minus sign increases the likelihood of a negative discriminant score which is characteristic of group 2, households who contract repairs. For example, note that respondent satisfaction in doing repairs has a positive sign on

TABLE 6

Group Means for the Nine Housing Repair Categories

Repair Category	Group[1]	Group Means[2]										
		TOINCOM	AGER	HSAGE	HSLSIZ	REPSAT	DINCOM	SKILL	VACUSE	MIDAGE	MIDINC	FAMCOM
Interior painting	1	14687.96	41.35	2.42	3.31	5.53	1.40	1.15	.48	1.51	1.47	1.76
	2	13279.40	50.53	2.64	2.68	3.81	1.17	1.17	.26	1.68	1.68	1.77
Exterior painting	1	13703.83	43.68	2.57	3.28	5.48	1.34	1.15	.39	1.50	1.51	1.70
	2	20040.46	46.29	2.32	2.55	3.38	1.38	1.07	.32	1.63	1.63	1.77
Papering	1	16230.31	39.39	2.26	3.60	6.29	1.46	1.13	.58	1.46	1.57	1.76
	2	25987.79	48.17	2.63	2.96	3.63	1.29	1.08	.29	1.46	1.70	1.71
Plumbing repairs	1	14385.77	41.56	2.33	3.35	5.71	1.41	1.24	.51	1.48	1.44	1.71
	2	15032.64	46.65	2.51	2.93	3.85	1.27	1.04	.37	1.63	1.60	1.76
Electrical repairs	1	15215.46	39.62	2.33	3.70	5.70	1.47	1.26	.55	1.42	1.58	1.69
	2	19421.03	46.49	2.61	3.00	4.35	1.33	1.03	.41	1.53	1.60	1.77
Carpentry repairs	1	14058.72	42.99	2.33	3.28	5.91	1.47	1.22	.50	1.51	1.47	1.74
	2	17815.22	48.16	2.77	2.75	4.02	1.31	1.08	.31	1.69	1.58	1.80
Masonry repairs	1	12714.63	43.94	2.74	3.17	5.91	1.46	1.34	.37	1.63	1.49	1.77
	2	25801.74	45.44	2.59	2.89	4.04	1.37	1.00	.37	1.59	1.67	1.74
Television repairs	1	11778.20	36.32	2.20	3.56	6.68	1.36	1.28	.56	1.48	1.48	1.84
	2	14027.84	46.38	2.45	3.16	4.89	1.31	1.11	.37	1.57	1.55	1.72
Household appliance and equip. repairs	1	14968.47	40.00	2.64	3.55	5.60	1.35	1.29	.44	1.38	1.42	1.71
	2	18377.64	45.15	2.41	3.49	4.43	1.29	1.08	.34	1.50	1.61	1.68

[1]Group 1: Households who self produce repairs; Group 2: Households who contract repairs.

[2]Group Means Categories: TOINCOM - total household income; AGER - age of respondent; HSAGE - age of housing unit; HSLSIZ - household size; REPSAT - respondent satisfaction in doing repairs; DINCOM - dual income household; Skill - respondent repair skill; VACUSE - respondent use of vacation time; MIDAGE - middle aged respondent; MIDINC - middle income household; FAMCOM - households with teenagers.

TABLE 7

Discriminant Functions at Group Centroids

Category	Group 1	Group 2
Interior painting	0.14526	-0.87155
Exterior painting	0.25661	-0.80190
Papering	0.24011	-1.10051
Plumbing repairs	0.43178	-0.44977
Electrical repairs	0.43307	-0.61207
Carpentry repairs	0.37836	-0.58528
Masonry repairs	0.45552	-0.59049
Television repairs	0.85980	-0.09108
Other household appliance and equipment repairs	0.50802	-0.24510

n = 682

TABLE 8

Summary of Significant Variables Affecting Housing Repair Decisions

Repair Category	Discriminating Variables											Overall F	Classif. %
	TOINCOM	AGER	HSAGE	HSLSIZ	REPSAT	DINCOM	SKILL	VACUSE	MIDAGE	MIDINC	FAMCOM		
Interior painting		-		+	+	+	-			-	+	5.84*	86.93
Exterior painting	-		+	+	+				-		+	7.75*	81.39
Papering	-	-		+	+	+		+	+		+	4.19*	86.57
Plumbing repairs	-			+	+	+	+		-		+	7.99*	68.03
Electrical repairs	-	-	-	+	+	+	+					6.62*	69.61
Carpentry repairs	-			+	+	+	+		-		+	4.96*	72.39
Masonry repairs					+		+			-		5.37*	66.13
Television repairs	-	-		+	+		+	+			+	2.85*	90.80
Household appliance and equip. repairs	-		+		+		+		-			4.11*	72.19

*Significant at .05 alpha level.

n = 682

all nine functions. This indicates that a higher rating on repair satisfaction increases the likelihood that a respondent is a member of group 1, those households who self produce repairs. Recall that the signs under discussion are related to standardized coefficients which are multiplied by standardized variable measures (Z scores with mean of zero and standard deviation of one).

Observe from Table 8 that total household income has a consistently negative effect, meaning that as income increases, the negative sign of the coefficient has the effect of depressing the score on the discriminant function. A negative discriminant score is more characteristic of the contracted repair group. Higher income households are more likely to contract repairs.

Not only is the sign of the variable important but also the size of its respective coefficient. Each coefficient, or weight, represents that variable's relative contribution to the discriminant score. Any single score represents the number of standard deviations that respondent (household) is away from the mean for all cases on a given discriminant function. Because the coefficients are all based on Z scores, they may be directly compared within each function by dropping the sign. In Table 9, for example, the coefficient for repair satisfaction is twice as large as that of the variable repair skill or the variable households with teenagers. This means that the variable repair satisfaction has twice the impact on the discriminant function of the other two.

TABLE 9

Interior Painting - Variables Selected for the Discriminant Function

Variable	Standardized Discriminant Function Coefficients
Household size	0.41742
Respondent satisfaction in doing repairs	0.55464
Dual income household	0.40361
Respondent skill in doing repairs	-0.27303
Age of respondent	-0.35474
Middle income household	-0.37139
Households with teenagers	0.26816

(Number of steps in stepwise = 7)

n = 329

The analysis of the results shows in general that the strongest overall repair behavior discriminators are repair satisfaction, household size, income, and repair skill. The significance of the variables varies by task. This seems reasonable given the varying complexities of knowledge, repair skill, and time requirement for the various tasks.

Classification Results

The overall multivariate F values for each discriminant function indicates that the two groups for each repair were significantly different in all nine cases. However the F values are not very good indicators of the efficacy with which the independent variables are able to discriminate (Morrison, 1974). With very large samples, even minor differences can be of statistical significance.

Discriminant analysis also involves determining the percentage of cases correctly classified using the discriminant functions previously developed. This classification aspect allows for checking the adequacy of the functions derived. There is upward bias present usually when the classification is based on the same data from which the functions were derived. The present study used the same data both to develop and to classify cases in the analysis. Classification scores for the nine repairs are included in Table 10.

Interior Painting

Of the 329 household discriminant cases who had interior painting done in 1975, 83 percent did it themselves (Table 5, p. 64). The

TABLE 10

Classification Results of the Derived Function
for Nine Repair Categories

Repair Category	Actual Group	Number of Cases	Predicted Group Membership: Group 1-- Self-Produced	Predicted Group Membership: Group 2-- Contracted	Percentage of Cases Classified Correctly
Interior painting	1	282	280 99.3%	2 0.7%	86.93
	2	47	41 87.2%	6 12.8%	
Exterior painting	1	175	168 96.0%	7 4.0%	81.39
	2	56	36 64.3%	20 35.7%	
Papering	1	110	108 98.2%	2 1.8%	86.57
	2	24	16 66.7%	8 33.3%	
Plumbing	1	150	96 64.0%	54 36.0%	68.03
	2	144	40 27.8%	104 72.2%	
Electrical repairs	1	106	83 78.3%	23 21.7%	69.61
	2	75	32 42.7%	43 57.3%	
Carpentry repairs	1	99	81 81.8%	18 18.2%	72.39
	2	64	27 42.2%	37 57.8%	
Masonry repairs	1	35	21 60.0%	14 40.0%	66.13
	2	27	7 25.9%	20 74.1%	
Television repairs	1	25	2 8.0%	23 92.0%	90.80
	2	236	1 0.4%	235 99.6%	
Other household appliance and equip. repairs	1	55	16 29.1%	39 70.9%	72.19
	2	114	8 7.0%	106 93.0%	

Group 1: Self-produced repairs.

Group 2: Contracted repairs.

n = 682

discriminant analysis classification results correctly predicted group membership at the rate of 99.3 percent for group 1 but only 12.8 percent for group 2 (Table 10). This gives an overall percentage of cases classified correctly of 86.93 percent (Table 10). Misclassification most frequently occurred with group 2 where 87.2 percent was incorrectly classified.

Exterior Painting

Of the 231 household discriminant cases who had exterior painting done in 1975, 74.8 percent did the task themselves. The discriminant analysis classification results correctly predicted group membership at the rate of 96 percent for group 1, but only 35.7 percent for group 2 (Table 10). This gives an overall percentage of cases correctly classified of 81.39 percent. Misclassification was most pronounced with group 2 where the rate was 64.3 percent.

Papering

Of the 134 household discriminant cases who had papering done in 1975, 82.1 percent did it themselves. The discriminant analysis classification results correctly predicted group membership 98.2 percent of the time for group 1, but only 33.3 percent for group 2 (Table 10). This gives an overall percentage of cases correctly classified of 86.57 percent. Group 2 was misclassified at the rate of 66.7 percent.

Plumbing Repairs

Of the 294 household discriminant cases who had reported plumbing repairs, 48.5 percent did the task themselves. The discriminant analysis classification results correctly predicted group membership at the rate of 64.0 percent for group 1 and 72.2 percent for group 2 (Table 10). This gives an overall percentage of cases classified correctly of 68.03 percent. Group 1 was misclassified 36.0 percent of the time.

Electrical Repairs

Of the 181 household discriminant cases reporting electrical repairs, 56.5 percent did the repairs themselves. The discriminant analysis classification results correctly predicted group membership at the rate of 78.3 percent for group 1 but only 57.3 percent for group 2 (Table 10). This gives an overall percentage of cases classified correctly of 69.61 percent. Group 2 was misclassified 42.7 percent of the time.

Carpentry Repairs

Of the 163 household discriminant cases reporting carpentry repairs, 58.1 percent did the repairs themselves. The discriminant analysis classification results correctly predicted group membership at the rate of 81.8 percent for group 1, but only 57.8 percent for group 2 (Table 10). This gives an overall percentage of cases classified correctly of 72.39 percent. Group 2 was misclassified 42.2 percent of the time.

Masonry Repairs

Of the 62 household discriminant cases reporting masonry repairs, 55.6 percent did the repairs themselves. The discriminant analysis classification results correctly predicted group membership at the rate of 60.0 percent for group 1 and 74.1 percent for group 2 (Table 10). This gives an overall percentage of cases correctly classified of 66.13 percent. Group 1 was misclassified 40.0 percent of the time.

Television Repairs

Of the 261 household discriminant cases reporting television repairs, only 9.7 percent did the repairs themselves. These results probably reflect the high electronic knowledge and skill required for this task. The discriminant analysis classification results correctly predicted group membership at the rate of 8.0 percent for group 1 and 99.6 percent for group 2 (Table 10). This gives an overall percentage of cases correctly classified of 90.80 percent, the highest in the study. Group 1 was misclassified 92.0 percent of the time.

Other Household Appliance and Equipment Repairs

Of the 169 household discriminant cases reporting household appliance and equipment repairs, only 32.4 percent did the repairs themselves. Here again, the consequences of the need for specialized electrical and mechanical knowledge may be limiting real options to do otherwise. The discriminant analysis classification results correctly predicted 29.1 percent of group 1 and 93.0 percent of group 2

(Table 10). This gives an overall percentage of cases correctly classified of 72.19 percent. Group 1 was misclassified 70.9 percent of the cases.

Classifications Results

These classification results show good predictability in some cases--interior and exterior painting, papering, and television repairs. In other cases the results are marginal--plumbing, electrical, and masonry repairs. These results are good indicators of the accuracy of the discriminant functions. Group 2 was more frequently misclassified with the tasks requiring less skill: interior and exterior painting and papering. Group 1 was more frequently misclassified with the tasks requiring specialized skills: plumbing, masonry, television and other household appliance and equipment repairs. The histograms based on resulting classification show considerable overlap on all nine tasks analyzed. This implies data limitations on measuring appropriate skills as opposed to a problem with the model.

Discussion of the Individual Repairs

Patterns appear within the nine repair task categories relating to a progression of skill levels in the nine tasks. The simpler repairs--interior painting, exterior painting and papering--were correctly predicted only for group 1 (Table 10), self-produced repairs. Household size, repair satisfaction and household income were of major influence in these three tasks (Tables 9, p. 76, 11 and 12).

TABLE 11

Exterior Painting - Variables Selected for the Discriminant Function

Variable	Standardized Discriminant Function Coefficients
Age of housing unit	0.24722
Household size	0.69749
Respondent satisfaction in doing repairs	0.70353
Total household income	-0.60099
Middle aged respondent	-0.24759
Households with teenagers	0.36159

(Number of steps in stepwise = 6)

n = 231

TABLE 12

Papering - Variables Selected for the Discriminant Function

Variable	Standardized Discriminant Function Coefficients
Household size	0.50390
Respondent satisfaction in doing repairs	0.26240
Dual income household	0.29336
Total household income	-0.68899
Respondent age	-0.51953
Respondent use of vacation time	0.33036
Middle aged respondent	0.29980
Households with teenagers	0.30129

(Number of steps in stepwise = 8)

n = 134

The discriminant functions derived for plumbing, electrical, masonry, and carpentry repairs correctly predicted cases for both groups, those households who self produce repairs and those who contract repairs. This overall prediction rate was somewhat lower but more evenly balanced between the two groups. Skill shows up as an important discriminating variable in addition to repair satisfaction and household size. Income in all four tasks has a negative effect, meaning that as income increases, households are less likely to self produce these repairs (Tables 13 through 16).

In the last two tasks, television repairs and other household appliance and equipment repairs, the discriminant functions correctly predicted only for group 2 (Table 10, p. 78), those households who contracted repairs (Tables 17 and 18). Repair skill again appears as a major variable in discriminating between the two groups.

Discussion of Hypotheses

The F ratios for each discriminating variable entering the stepwise procedure employed in the discriminant functions are significant and are within the .05 alpha level by virtue of the statistical requirements for such selection. As a consequence, the absence of a computed discriminant coefficient leads to the inference that the respective variable did not have a significant effect.

Test of Hypothesis 1: Household Income

Household income was measured as a continuous variable. The hypothesis was that the higher the income, the less likely households

TABLE 13

Plumbing Repairs - Variables Selected for the Discriminant Function

Variable	Standardized Discriminant Function Coefficients
Household size	0.37796
Respondent satisfaction in doing repairs	0.51198
Dual income household	0.26815
Respondent repair skills	0.56417
Total household income	-0.30685
Middle aged respondent	-0.27684
Households with teenagers	0.30497

(Number of steps in stepwise = 7)

n = 294

TABLE 14

Electrical Repairs - Variables Selected
for the Discriminant Function

Variable	Standardized Discriminant Function Coefficients
Age of housing unit	-0.16953
Household size	0.39381
Respondent satisfaction in doing repairs	0.23642
Dual income household	0.18615
Respondent repair skill	0.63769
Total household income	-0.45940
Respondent age	-0.38431

(Number of steps in stepwise = 7)

n = 181

TABLE 15

Carpentry Repairs - Variables Selected for the Discriminant Function

Variable	Standardized Discriminant Function Coefficients
Household size	0.41296
Respondent satisfaction in doing repairs	0.58009
Dual income household	0.26067
Respondent repair skill	0.34811
Total household income	-0.57808
Middle aged respondent	-0.59461
Households with teenagers	0.62545

(Number of steps in stepwise = 7)

n = 163

TABLE 16

Masonry Repairs - Variables Selected for the Discriminant Function

Variables	Standardized Discriminant Function Coefficients
Respondent satisfaction in doing repairs	0.34939
Respondent repair skill	0.75505
Middle income household	-0.33522

(Number of steps in stepwise = 3)

n = 62

TABLE 17

Television Repairs - Variables Selected for the Discriminant Function

Variables	Standardized Discriminant Function Coefficients
Household size	0.50975
Respondent satisfaction in doing repairs	0.24363
Respondent repair skill	0.43857
Respondent age	-0.43020
Total household income	-0.37342
Vacation time use	0.25436
Households with teenagers	0.61665

(Number of steps in stepwise = 7)

n = 261

TABLE 18

Other Household Appliance/Equipment Repairs - Variables Selected for the Discriminant Function

Variable	Standardized Discriminant Function Coefficients
Age of housing unit	0.24310
Respondent satisfaction in doing repairs	0.27560
Respondent repair skill	0.73594
Total household income	-0.31555
Middle aged respondent	-0.39562

(Number of steps in stepwise = 5)

n = 169

are to engage in self production of housing repairs. Total income was a discriminating variable on seven of the nine tasks analyzed (Table 8, p. 74). The sign was negative in all seven cases indicating that households with higher incomes were more likely to be members of group 2, those who contracted repairs. Recall that group 2 has negative centroids.

The mean total income for the seven tasks for which total income was a discriminating variable was higher for the contracted repair group, group 2 (Table 6, p. 72). These seven tasks were: exterior painting, papering, plumbing repairs, electrical repairs, carpentry repairs, and other household appliance and equipment repairs. Because each coefficient represents the relative contribution of its associated variable to that function, the relative contribution of each can be compared (Tables 11, p. 83; 12, p. 84; 13, p. 86; 14, p. 87; 15; 17; and 18). Recall that coefficients are in standardized form based on variable Z scores.

The magnitude of the effect of total income varies. It is a major coefficient in the exterior painting, papering, and carpentry repairs and less influential in the discriminant functions for plumbing repairs, electrical repairs, television repairs, and other household appliance and equipment repairs.

The significance of the variable total income supports the model contention that the higher the income, the more costly the time input of self producing these seven housing repairs. Households substitute goods for time by contracting the repair job. As households

seek to maximize utility, goods are substituted for time until an equilibrium is reached.

Test of Hypothesis 1a: Dual Income Households

The variable dual income was a discriminating variable in five of the nine tasks tested (Table 8, p. 74). There was no support for the hypothesis that dual income households are less likely to do housing repairs themselves. The discriminant score is influenced in this case by a positive coefficient which is multiplied by a coding number of two for a dual income household (a one for single income households) which results in a higher positive discriminant score. The group centroids for dual income (Table 7, p. 73) were higher and positive for group 1, those households who self produce housing repairs. As a consequence dual income households are more likely to be members of group 1. Support would have been associated with negative and significant coefficients.

The F ratios required for the inclusion of the variable in the stepwise procedure indicate that the variable dual income is a significant discriminator between the two groups, those who self produce housing repairs and those who contract the task. The sign of the coefficient dual income was positive for all five tasks indicating that dual income households were more likely to be members of group 1, those who self produced housing repairs. The coefficients for dual income households represent a moderate influence for interior painting (Table 9, p. 76) and a minor influence in the discriminant functions for papering, plumbing, electrical, and carpentry repairs (Tables 12, p. 84;

13, p. 86; 14, p. 87; 15, p. 88). These results regarding dual income do not appear to support the model. Despite the higher opportunity cost of time in the present case, dual income households do not seem to be substituting in this manner.

Test of Hypothesis 2: Use of Vacation Time

Households can reduce the time input of commodity production by using relatively less expensive vacation time when the opportunity cost of nonmarket time is lower. The independent variable, respondent use of vacation time, was a discriminating variable in two of the nine tasks analyzed--papering and television repairs (Table 8, p. 74). The F ratios required for the inclusion of the variable in the stepwise procedure for these respective functions reject the null hypothesis that vacation time use is not a discriminating variable for these two tasks for the two groups under study. In both papering and television repairs, the sign of the coefficient was positive indicating that households who use vacation time for housing repairs were more likely to be members of group 2, those households who contract housing repairs. The coefficients for the variable, vacation time use, were of moderate influence on the respective discriminant functions (Tables 12, p. 84; 17).

Test of Hypothesis 3: Repair Skill

The independent variable, skill in doing housing repairs, was a discriminating variable in seven of the nine tasks analyzed: interior painting, plumbing repairs, electrical repairs, carpentry

repairs, masonry repairs, television repairs, and other household appliance and equipment repairs (Table 8, p. 74). Repair skills was the major coefficient in five of these seven tasks: plumbing repairs, electrical repairs, masonry repairs, television repairs, and other household appliance and equipment repairs (Tables 13, p. 86; 14, p. 87; 16, p. 89; 17, p. 90; 18).

The sign of the coefficient, respondent repair skill, was negative for interior painting and positive for the other six repairs: plumbing, electrical, carpentry, masonry, television and other household appliance and equipment. The negative coefficient indicates that households having the skill were more apt to contract interior painting. The positive coefficient leads to the inference that those having the skill were more apt to self produce these six repairs. The coefficients were major in five tasks: plumbing repairs, electrical repairs, masonry repairs, television repairs, and other household appliance and equipment repairs (Tables 13, 14, and 16-18). The F ratios required for the inclusion of the variable in the stepwise procedure for the seven cases reject the null hypothesis that the variable vacation time use does not discriminate between the repair production of those who self produce housing repairs and those who contract these repairs.

These results support the hypothesis that households with requisite skills are more likely to engage in these six self-produced housing repairs. Repair skills have the effect of increasing the

marginal product involved in production of the respective commodity. A higher marginal product encourages respondents and households to substitute more time in the production of the commodity. This reduces the cost of producing the commodity in support of the model.

Test of Hypothesis 4: Middle Income, Middle Age, and Skill

The discriminating variable, middle income household, was a discriminating variable in two of the nine tasks: interior painting and masonry repairs (Table 8, p. 74). The sign of the coefficient was negative in both cases, indicating that middle income households were more likely to be members of group 1, those households who self produce housing repairs, for these two tasks. This indicates that middle income households were more likely to do interior painting and masonry repairs, and that other income groups (lower, upper) are more likely to contract such repairs. The coefficients for the middle income variable in the two respective discriminant functions were of relatively moderate significance (Tables 9, p. 76; 16, p. 89).

The discriminating variable, middle aged respondent, was a discriminator in five of the nine tasks: exterior painting, papering, plumbing repairs, carpentry repairs, and other household appliance and equipment repairs (Table 8). The signs of the coefficients were negative in four cases. Because middle aged respondents were coded a 1 and other age respondents were coded a 2, middle aged respondents were more likely to have a positive discriminant score, characteristic of group 1. This indicates that middle aged respondent households

were more likely to be members of group 1, those households who self produce these four repairs. In the instance of papering, the sign was positive indicating that middle aged respondent households were more likely to be members of group 2, those who contract housing repairs.

Note that respondent age, a continuous variable, was a discriminator in four tasks: interior painting, papering, electrical repairs, and television repairs (Table 8, p. 74). The sign of the coefficient was negative in all four cases indicating that as the age of the respondent increases, households are more likely to be members of group 2, those who contract repairs. The coefficients were of moderate influence in the respective discriminant functions (Tables 9, p. 76; 12, p. 84; 14, p. 87; and 17, p. 90).

Skill level was discussed in the previous section. All three factors--housing repair skill, middle aged respondent, and middle income household--did not appear together as discriminators for any task. There was no supporting evidence to indicate a discrimination for the household characterized by the combination of middle aged, middle income, and skilled respondents as more likely to self produce repairs.

Test of Hypothesis 5: Household Size

The independent variable, household size, was a discriminating variable in seven of the nine tasks: interior painting, exterior painting, papering, plumbing repairs, electrical repairs, carpentry repairs, and television repairs (Table 8). The sign was positive on all seven coefficients indicating that larger households were more

likely to be members of group 1, those who self produce repairs. The F ratios required for the inclusion of the variable in the stepwise procedure refute the null hypothesis that there is no difference in households between those who self produce housing repairs and those who contract such repairs. The coefficients for household size were major in the discriminant function for exterior painting and moderate in those remaining: interior painting, papering, plumbing repairs, electrical repairs, carpentry repairs, and television repairs (Tables 9, p. 76; 11, p. 83; 12, p. 84; 13, p. 86; 14, p. 87; 15, p. 88; 17, p. 90).

These results support the hypothesis that larger households are more likely than smaller households to engage in self production of housing repairs. The possibility of task specialization also supports the model, because the low wage rate of some household members reduces the time cost component, and thus the final cost of the commodity is reduced.

Test of Hypothesis 5a: Households with Teenagers

The independent variable, households with teenagers, was a discriminating variable in six of the nine tasks: interior painting, exterior painting, papering, plumbing repairs, carpentry repairs, and television repairs (Table 8, p. 74). The sign was positive in all six tasks indicating that households with teenagers (coded as a 1) were more likely to be members of group 2, those who contract housing repairs. Households with no teenagers (coded as a 2) were more likely

to be members of group 1, those households who self produce housing repairs. The coefficients for this variable were of relatively moderate influence in the discriminant functions (Tables 9, p. 76; 11, p. 83; 12, p. 84; 13, p. 86; 15, p. 88; and 17, p. 90).

These results fail to support the hypothesis that families with teenage children are more likely to engage in self production of interior and exterior painting, plumbing repairs, and carpentry repairs. The model is not supported for these tasks even though teenagers are more likely to have a low wage rate, potentially reducing commodity production costs.

Test of Hypothesis 6: Repair Satisfaction

The repair satisfaction variable was a discriminator in all nine tasks (Table 8, p. 74). It was the most powerful discriminator analyzed as judged by the stepwise results and the standardized coefficients. In five of these nine tasks, repair satisfaction was a major coefficient in the respective discriminant functions: interior painting, exterior painting, plumbing repairs, electrical repairs, carpentry repairs and television repairs (Tables 9, 11-18). The sign of the coefficient was positive indicating that these households were more likely to be members of group 1, those who self produce these housing repairs.

These results support the hypothesis that individuals who experience satisfaction in self producing repairs are more likely to do all nine repairs themselves versus contracting the tasks. These

results support the model in cases where individuals receive higher marginal utility for having done the tasks themselves. The F ratios required for the inclusion of the variable in the stepwise procedure allow rejecting the null hypothesis that there is no difference between the two groups.

Test of Hypothesis 7: Age of Housing Structure

This variable was a discriminator in three of the nine tasks: exterior painting, electrical repairs, and other household appliance and equipment repairs (Table 8, p. 74). The sign of the coefficients was positive in the instances of exterior painting and other households appliance and equipment repairs, indicating that households in older dwelling units were more likely to be members of group 1, those who self produce repairs. The sign was negative for electrical repairs indicating that these households were more likely to be members of group 2, those who contract electrical repairs (Table 8).

The coefficients for these tasks were of relatively minor influence in the respective discriminant functions (Tables 11, p. 83; 14, p. 87; and 18, p. 91). The F ratio required by the inclusion of the variable in the stepwise procedure rejects the null hypothesis that there is no difference in age of housing structures inhabited by households who do the work themselves and those who contract the task.

These results support the hypothesis for some repairs that individuals who live in older housing structures are more likely to

engage in self-produced housing repairs, specifically exterior painting and other household appliance and equipment repairs. The significant negative coefficient of electrical repairs could be due to older housing structures more frequently having repairs beyond the skill level of the owner to do himself. Recall that skill level was the most discriminating variable in this discriminant function.

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

Summary

The purpose of this study was to develop and test a household production model to identify key decision variables associated with home repair. The theoretical model presented in Chapter III is based on the household production function model. The household repair model developed accommodates the dual role of consumers as both producers and consumers of this commodity. As households seek to maximize utility, time and goods are allocated to housing repairs or to other commodities. Household characteristics are assumed to affect whether housing repair commodities are self produced or contracted.

The data set used to test the model was the 1975 Time Use Study conducted by the Survey Research Center of the Institute for Social Research, University of Michigan, Ann Arbor, Michigan. The full data set was a national probability sample which used multistage area sampling which generated data for 1,519 households via respondent and spouse interviews.

A subset of the full sample was used for the present study and included only homeowners and only respondent data. This resulted in a subsample of 682 respondents of which 681 were either heads of households or spouses of the heads of households.

Variables

The dependent variables used in the discriminant procedure were those households who self produced housing repairs, group 1, and those households who contracted housing repairs, group 2. The review of literature presented in Chapter II identified a number of independent variables which affect household housing repair decisions. These variables were housing tenure which was held constant through sample definition, age of respondent, income, household size and composition, repair skills, satisfaction in doing repairs, age of housing structure, and use of vacation time.

The statistical procedure used was the discriminant analysis component in Statistical Package for the Social Sciences, SPSS. This approach allows statistical discrimination between two household groups: those who do housing repairs themselves and those who contract such activities. The analysis aspect measures the success with which the discriminating variables actually discriminate when combined into a function. The classification aspect allows empirical testing of the adequacy of the functions derived.

Because different housing repairs might have different production functions, the repairs were analyzed separately. Discriminant functions were derived for nine housing repair categories covered by the survey data: interior painting, exterior painting, papering, plumbing, electrical, carpentry, masonry, television, and other household appliance and equipment repairs. Results varied by task complexity.

Conclusions

The repair tasks proved to have differing discriminant functions and, by implication, differing production functions. Housing repair is not a homogeneous category as it is treated in the literature reviewed. Rather, each task studied varies in resource inputs--time, skill, and market goods. Testing of the model presented in this study was successful in identifying major household characteristics which discriminate between those households who self produce housing repairs and those who contract such tasks. The results support the household production function approach. The variables identified by the model can separate the sample into two groups. The direction of the effects is also consistent with the model.

Test of Hypothesis 1: Household Income

Higher income households were found to be more likely to contract housing repairs. Total household income had a significant, negative discriminant coefficient in seven tasks: exterior painting, papering, plumbing repairs, electrical repairs, carpentry repairs, and other household appliance and equipment repairs. The magnitude of the effect of income, vis-a-vis other discriminant variables, changes by repair. As measured by the absolute value of its standardized coefficient, total income is a major discriminant in exterior painting, papering, and carpentry repairs, and less influential in plumbing, electrical, television, and other household appliance and equipment repairs.

Both income and wage rate were used as income measures. For the 357 respondents who were employed, the mean wage rate was $4.75 per hour. Wage rate of the respondent did not prove to be a useful measure of income, perhaps because the income and substitution effects were offsetting.

These results support the model's hypothesis that the higher the income, the more likely households are to contract housing repairs because of the higher opportunity cost of the home production time required. Higher income households substitute goods for time by contracting repairs, and thus minimize the cost of the home repair commodities.

The relationship between income and housing repair decisions are consistent with the household production work of Becker (1965 and 1981) and Gronau (1977 and 1980) which show goods being substituted for time as income increases. The results are also supportive of the research done by Mendolsohn (1977) identifying income as a significant variable affecting whether repairs were self produced or contracted.

Test of Hypothesis 1a: Dual Income Households

Dual income households were found to be more likely to self produce housing repairs in five tasks. It was a moderate, positive influence for interior painting and a minor, positive influence on papering, plumbing repairs, electrical repairs, and carpentry repairs. The direction of the effect of dual income did not show the predicted relationship: that such households would be more likely to contract

repairs because of the relatively higher time cost component of self-produced commodities.

The category, dual income, included earners who were part-time workers. Many women wage earners earn wage rates considerably lower than their spouse and than men in general. One or a combination of several possibilities could be the cause of the failure of dual income to show the predicted relationship. First, the second income could be so relatively small that it makes the repairs possible regardless of how the repair is done--self produced or contracted. Second, the supplemental income is used to purchase other than repair-related goods. Third, the income and substitution effects of the supplemental income offset each other. However, data limitations preclude distinguishing among these possible explanations. These results failed to support either the model or past research (Morgan, 1981) showing that dual income households are more likely to contract repairs.

Test of Hypothesis 2: Vacation Time

Households who use vacation time for housing repairs were found to be more likely to contract interior painting and papering. These two results do not support the model which concluded that vacation time is relatively less expensive and has the effect of reducing the time cost and thus the commodity cost of self-produced interior painting and papering. The variable, vacation time use, had a moderate, positive influence as a discriminator.

Test of Hypothesis 3: Repair Skill

Respondent skill in doing housing repairs was a significant, major discriminator in six cases indicating for the respective repairs that households having a member with such skills are more likely to self produce repairs, specifically: plumbing repairs, electrical repairs, carpentry repairs, masonry repairs, television repairs, and other household appliance and equipment repairs. Repair skill was a major positive influence as a discriminator on these tasks.

Though repair skill was also a significant, negative discriminating variable for interior painting, the effect was reversed. Perhaps this reflects the lower skill required for the task as compared to the skills required for other repairs.

In six instances these results support the model which indicated that repair skill increased the marginal product of time and goods allocated to self production of these repairs. Where skill is sufficient for the task, the individual is able to widen the margin between the marginal costs and the marginal benefits. These conclusions are consistent with the research finding of Mendolsohn (1977) and Hill (1981) who found that skilled individuals do more housing repairs.

Test of Hypothesis 4: Middle Income, Middle Age, and Skill

This combination of factors--middle income, middle age, and housing repair skill--did not appear together as discriminators for any task. There was no evidence to indicate significant discrimination for the household characterized by this combination on any repair.

Middle income households were more likely to self produce interior painting and masonry repairs. Other income groups, low and upper income, were more likely to contract these repairs. This variable had a relatively moderate, negative effect as a discriminator. But they were not significant together in the same repair.

Households, on the basis of middle aged respondents alone, were more likely to self produce exterior painting, plumbing repairs, carpentry repairs, and other household appliance and equipment repairs. The positive coefficient for papering indicates that middle aged households were more likely to contract this repair. Skill was discussed under hypothesis 3.

Test of Hypothesis 5: Household Size

Larger households, those having more members, were more likely to self produce these seven housing repairs: interior painting, exterior painting, papering, plumbing, electrical, carpentry, and television. This variable was a major, positive discriminator between groups for exterior painting and papering and a moderate, positive discriminator in the remaining three. Larger households increase the demand for housing services and make possible task specialization to provide some of these services through self production. This supports the model because it makes possible utilizing the low wage rate of some household members, reducing the time cost component of commodity production. This process can occur in less skilled tasks such as painting and papering. It can also apply to cases where household

tasks can be redistributed freeing time for more skilled members to do tasks requiring more technical expertise.

These results support the research finding of Becker (1965 and 1981) and Morgan (1981) that multi-person households allocate the time of different members according to the relative efficiency of each.

Test of Hypothesis 5a: Households with Teenagers

Households with teenage members were more likely to contract these six housing repairs: interior painting, exterior painting, papering, plumbing, carpentry, and television repairs. The variable had a relatively moderate influence as a discriminator.

These results failed to support the model and the hypothesis even though teenagers are apt to have a very low wage rate and thus low opportunity costs which reduce commodity costs of self producing repairs. It is conceivable that households were responding to the teenagers' preferences for time uses other than repair activity. This may have been to avoid conflict or simply to accede to individual time use preferences. In addition, television repairs represent a task category requiring technical skill which likely precludes self producing repairs for most households.

Test of Hypothesis 6: Repair Satisfaction

Households having a respondent who enjoyed doing housing repairs were more likely to self produce all nine repair categories. Respondent repair satisfaction was a powerful, positive discriminator. In five of these tasks, it was a major influence in discrimination:

interior painting, exterior painting, plumbing repairs, electrical repairs, carpentry repairs, and television repairs. These results support the model acknowledging that households engage in home production of housing repairs not only for the economic benefits which accrue but also the additional utility gained from having done it themselves.

These results support the work of other researchers: Sweeney (1974), Linder (1970), Becker (1965), and Gronau (1977) who acknowledge both product benefits and process benefits of self-produced commodities.

Test of Hypothesis 7: Age of Housing Structure

Households in an older housing structure were more apt to self produce exterior painting and other household appliance and equipment repairs. Households in newer housing structures were more likely to self produce electrical repairs. In all three task categories, this variable exerted a minor influence as a discriminator between the two groups. These mixed results probably are related to the deterioration process of the house itself. Painting and appliance repairs commonly occur with greater frequency with older housing units providing opportunity for and benefits of self producing the task. Electrical repairs may be more readily done on newer houses because the repairs are probably less complex, as opposed to electrical repairs on older houses where upgrading to meet electrical code standards is often a factor. Complex electrical repairs more common with older housing structures might be beyond the skill level of owners to do it themselves.

These results provide general support for research studies by Michelson (1977) and Hill (1981) who found that more time is spent on self-produced repairs done on older homes. However, Mendolsohn (1977) acknowledges that repairs on older and higher-valued homes were more frequently contracted. All three studies considered repairs on a composite rather than disparate categories having different production functions.

The results for all nine repair discriminant functions show in general that the strongest overall repair behavior discriminators are repair satisfaction, household size, income and repair skill. The simpler repairs--interior painting, exterior painting, and papering--were correctly classified only for group 1, those who self produce housing repairs. The major discriminating variables were household size, repair satisfaction, and household income.

The classification results show good predictability for the simpler repairs with overall classification rates ranging from 81.39 to 86.93 percent. Group 1, those who self produce these repairs, had a very high correct classification rate, whereas group 2, those who contract repairs, was frequently misclassified.

The more complex repairs--plumbing, electrical, masonry, and carpentry--were correctly classified for both groups though at a lower overall correct classification rate ranging from 66.13 to 72.39. Skill emerged as an important discriminating variable in addition to repair satisfaction and household size.

Perhaps the most complex repairs--television and other household appliance and equipment--were correctly classified only for group 2, those households who contract repairs with rates of 72.19 and 90.80 respectively. Repair skill was a major discriminating variable reflecting the usually complex and technical skills required. The requisite electrical and mechanical skill required for these repairs may preclude them as self-produced repair options.

Implications

A number of implications emerge as a result of focusing on housing repairs via the household production model. Testing of the housing repair model presented in this study succeeded in identifying significant household characteristics which discriminate between those who self produce housing repairs and those who contract such tasks. An acceptable prediction rate varying from 66 percent to almost 91 percent showed that these decision variables can predict household repair behavior.

The assumption that housing repair categories have different production functions proved valid. All of the research studies reviewed approached housing repairs as a composite category which obscures the variation in resource inputs--time, skill, and market goods.

Because each repair category has its own different production function, programs aimed at encouraging self production of home repairs must acknowledge this diversity. Administrators of education

and of housing policy who may be involved in encouraging home repair behavior among targeted populations should acknowledge possibilities as well as relevant limitations. Since the pattern of discrimination varies depending upon which repair is to be emphasized, different policies should be followed. For example, interior painting could be encouraged via one set of variables and exterior painting by a somewhat different set. This would include programs related to granting loans tied to self-help behavior, disseminating self-help information or counseling, or offering vocational education dealing with housing repair skills.

Information regarding self-produced home repair could be utilized by Community Development Block Grant (CDBG) offices involved in making rehabilitation loans, by regional development districts doing housing planning, and by state housing development agencies. Other organizations which make distinctions in granting loans or funds for contracted jobs or materials for self-help home repair include Community Action agencies (CAC), the National Trust for Historic Preservation and the Farmers Home Administration. Public utilities such as the Tennessee Valley Authority and local utility companies which concern themselves with housing consulting, evaluation, and making loans for housing repairs could also utilize this information. Any redevelopment program like Neighborhood Housing Service which fosters housing repair behavior would be potential users of the results of the present study. Others interested in self-help housing repair distinctions include agencies which give self-help housing information such as

community design centers and the Agricultural Extension Service. The regional board of the Federal Home Loan Bank monitors housing rehabilitation done on a self-help basis.

Because skill emerged as a major discriminator, the teaching of these skills would likely encourage some individuals to undertake certain task categories but not necessarily others. Because repair satisfaction was the most powerful discriminator, factors affecting repair gratification also ought to receive attention.

Household size as a strong discriminator supports the model contention that households do specialize, as does a small factory, to produce commodities using resources in a more efficient manner. This further indicates that research in household behavior ought to focus on the whole unit rather than a single reprsentative.

Household income also constrains behavior. Testing of the model indicates that as the opportunity cost of time increases, households increasingly substitute goods for time. Business firms seeking to assess demand for repair goods and/or services could use these results. Higher income groups are realistic targets for the repairs analyzed except for interior painting. Especially is this true for small households. Lower income groups are better targets for repair goods such as repair tools, equipment and related materials. Especially is this true for larger households whose demand for housing services is greater. However, these results deal with how repairs are accomplished not the demand for the repairs.

Limitations of the Study

The Data Set

Because an existing data set was used for the study, the analysis had to be tailored to mesh with the data as collected and coded. In general, this worked well, although some variables could have been more specific. For example, the variable repair skill was a general measure as discussed in Chapter III. A better alternative would have been to ask for a skill measure for each of the nine repair categories and to ask the question of the household member(s) who actually did the repair. The same argument could be made for measurement of the variable repair satisfaction. This was also asked as a general repair satisfaction rating.

Two variables not measured in the data set were the quality and quantity of capital goods--tools, equipment, and related materials available to the household for doing repairs.

The Method

The accuracy of the results are related to the method of data collection as discussed in Chapter III. The recall method of time input measures and the survey method for socio-demographic data have inherent error rates. Hill (1981) estimates the error rate for recall time measures to be as high as .5 but to be slightly more accurate than time-budget data for measuring infrequently occurring activities. It is likely that some major and many minor repairs are underreported with the recall method. It is therefore highly probable that the

incidence of self-produced housing repairs is much higher than is reported by the present study.

The basic approach used to collect the data was the survey method. The attrition rate was considerable. An original sample of 2,300 was drawn, of which only 1,519 respondents agreed to participate in wave 1. By wave 2 when the housing repairs data was gathered, the number had decreased to 1,147 respondents. The sample may be considered representative of the population to the degree that nonparticipants are similar to those who participated in the study.

The statistical analysis ideally should have used all interval or ratio levels of measurement. Some variables were: income, respondent age, household size. Others were categorical because of the nature of the data. There is risk of bias when the two types are used together in discriminant analysis. As a basis of comparison, the variables were also analyzed as primarily categorical. The resulting classifications were only slightly lower usually one to three percentage points lower than the measurements reported.

Time Period

The results may be generalized to other population groups only by assuming the groups or conditions to be similar. Since 1975, housing costs especially interest rates have risen dramatically, construction of new housing units has been depressed, and unemployment is high. With these conditions, it is probable that self-produced repair activity has increased. Comparison of Census Bureau measures of

housing housing repair costs shows that the dollar costs increased each year until 1980 and showed a decrease in 1981 (Construction Reports, 1981 and 1982). This could mean that housing repairs are being postponed in the short run. However, these figures do not account for the time cost component of self-produced housing repairs which could also be a partial explanation. Maintaining what is owned becomes less costly than moving and protects an investment which is generally expected to appreciate in value.

The Model

The model developed and tested for this study has limitations inherent in the household production function upon which it is based. The model assumes the possibility of incremental adjustments between home production and market participation. However, most households face segmental choices in time spent in employment versus time spent working at home.

The model assumes process benefits to be a part of the marginal utility gained by self producing the commodity housing repairs. Process and product benefits cannot be separated. Individuals are apt to have preferences related to how their time is used in addition to consideration of economic benefits to be gained in self production. The model also assumes no joint production in producing the commodity housing repairs. However, joint production, producing more than one commodity in the same time period, is pervasive in home production. It is probable that individuals are also involved in other activities

such as conversation, listening to music, enjoying the repair process while doing the repair.

Constant returns to scale are assumed for the purpose of analysis; however, adjusting resource inputs of time and goods will show increasing and/or eventually diminishing returns to scale. The model assumes that utility is derived only from commodities currently produced and does not consider the possibility of household borrowing or saving. In practice households routinely derive satisfaction from the productivity of other time periods.

The limitations of the model are inherent to the household production model because of the necessity of holding certain conditions constant in order to allow the respective economic analysis. The model presented in this study proved valid and relevant as shown by the previous discussion of the supporting variables and hypotheses. In those cases where the direction of the variable results was unanticipated, the explanation is more likely due to data limitations or definitions rather than to model failure. These considerations were discussed in the section of this chapter regarding limitations of the data set and in the hypothesis testing section for dual income.

Need for Additional Research

There is a need to extend this analysis to include home improvements. Housing repairs basically maintains a structure as it is, forestalling deterioration. Housing improvements allows housing to be adjusted in an incremental fashion to accommodate changing household needs and preferences. It is a better defense against obsolescence.

There is a need to compare household behavior over time regarding housing repair behavior. Are households doing more or less self production of housing repairs and/or improvements today and what factors influence these behaviors? The present study could be replicated using more recent data to test the model and the discriminant power of the household characteristics identified as variables. A determination could be made of what influences repair satisfaction--social expectations, family behavior patterns, peer influence.

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