A STUDY OF THE DEMAND FOR HOUSING IN A METROPOLITAN AREA

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Submitted to the Department of City and Regional Planning on January 13, 1969 in partial fulfillment of the requirement for the degree of Doctor of Philosophy.

This study attempts to synthesize certain aspects of the current theory of the housing market, to formulate specific hypotheses stemming from that theory and to test those hypotheses within the framework of a formal model and by means of regression analysis.

The theoretical discussion emphasizes the heterogeneity of both demand and supply responses in the market for the services of housing. Aspects of special relevance for the subsequent formulation of the model are the role of transaction and other costs in preventing continual adjustment toward an equilibrium level of consumption, and the simultaneity of the transactions representing demand and supply by most of the households in the market.

The model which is formulated for testing the hypotheses consists of two parts: the determination of the value of housing services acquired, whether in fee or rental, by those who move from one dwelling to another; and the determination of the probability of a move in a particular period for all households in existence at the beginning of the period.

The model is tested empirically, employing a large file of household interview data containing information about past moves, incomes and housing values. For the demand function for movers, it is found that level of current income generally yields greater explanation than a measure of long-run or permanent income. A modified permanent income measure which is believed to include the influence of wealth performs even better than the current income measure, however. The level of housing consumption prior to the move, which is taken to represent the effects of accumulated housing experience and taste, adds significantly to the explanatory power of each of the income variables employed. Heterogeneity is investigated within groups of movers, with several

combinations of explanatory variables in the regression equations. Heterogeneity is found to be almost universal, indicating the inadvisability of employing grouped data in predictive models. In addition, comparison of equations estimated with micro and with aggregated data shows a severe upward bias in the coefficients of the income variables and a severe downward bias in the coefficients of the variable representing prior level of housing consumption.

The estimation of the portion of the model dealing with the determinants of the residential move failed to yield significant results, a consequence, it is believed, primarily of the relatively small number of individual observations, since only a portion of the sample households were used for this portion of the analysis.

Thesis Supervisor: Jerome Rothenberg
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The doctoral dissertation is expected to be the fledgling effort of a scholar at substantial and independent research. The independent character of the research is usually qualified, however, by the support of other individuals, if not in the design and analytical elaboration of the work, at least in a variety of ways which facilitate his carrying out that work. This dissertation is not an exception to that generalization. It is with a feeling of much gratitude that I acknowledge the help, and frequently the indulgence, which the following persons and institutions have given me in my efforts. They are, I need hardly state, to be exonerated from any blame for whatever shortcomings this work may display.

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INTRODUCTION

The major objective of this study is to contribute to a greater understanding of the processes at work in the urban housing market. The fulfillment of this objective will in turn, it is hoped, lead to more powerful forecasting procedures for that market. As an approach to this objective, I intend, first, to synthesize and make some modifications to the existing theory of housing demand, paying special attention to the distinction between consumption and market demand, and to the influence upon the desired level of housing consumption of the prior level of housing stock. Second, I shall formulate some specific hypotheses derived from the existing theory and my modifications thereof. Third, I shall examine, within the general framework of regression analysis, the results of various tests of these hypotheses.

The route I have chosen for examining the demand relationships involves treating observations at the household level. There has been considerable dissatisfaction in recent years with the validity of economic relationships established by investigating grouped data. This is especially true in the household sector. In the area of housing demand, the reliance placed upon highly aggregated data has yielded little understanding of the dynamic behavior of households in the marketplace. To date, we have seen some treatments of the long-run aggregate demand function, but we are not likely to get any closer to a satisfactory short-run model until we know more about the varying influence over time of different components of demand, of which there are many. The data which have been employed in this study allow us, perhaps for the first time, to

make an approach to this objective.

The portents for the success of a micro investigation of housing demand are not good, as testified by the gloomy title of one such investigation: "Family Housing Expenditures: Elusive Laws and Intrusive Variances". It may well be, however, that Maisel and Winnick's defeatist conclusions stem from incorrect theory and inadequate data with which to test it. Again, the employment of a micro approach may be at odds with the stated ultimate objective of providing more powerful forecasting tools, since the particular data set with which I shall work is, as far as I know, of a unique type, and is not likely to be duplicated on a national basis in the near future. If forecasting seems destined to be based upon data which are grouped or which pertain only to a single point in time, this investigation may give us a much better idea of the validity of such procedures and also lead to better ones.

CHAPTER I

THEORETICAL SUMMARY

A. Introduction

The literature on housing is very extensive, perhaps more so than that on any other single consumer good. Within this literature there have been a number of attempts at laying a theoretical groundwork for the study of the housing market. It is the purpose of this chapter to present a very brief summary of what I feel to be the most important theoretical aspects of recent writings.

It has frequently been pointed out that the housing market is not in fact a single market, but a series of intermingled markets, and this fact, which creates many analytic problems, will be discussed briefly below. This summary, and indeed the entire study, will be conducted in a framework which focusses upon the transaction in which the services of the housing stock are traded by households, as contrasted with other types of transactions such as those common in the real estate market. While, within this framework, I shall attempt to apply to the market phenomena traditional economic analysis, I shall also lay great emphasis upon those aspects of the housing market which appear to me to require unorthodox or novel treatment. I am convinced that any satisfactory model of this market requires such treatment.

B. The Nature of the Housing Commodity

1. Special characteristics of housing as compared with other types of commodities

As a consumer good, housing is durable, more so than any other

consumer good. It may be conceived of, from the point of view of the household, as of infinite durability. It is essentially fixed in place. It is heterogeneous, consisting of many styles, sizes and environments.

As an investment good, its acquisition and liquidation involve substantial and immediate direct costs. Its purchase frequently involves incurring long-term debt. Its yield of services deteriorates slowly over time. Its services may be consumed directly by the owner or rented to others. For owner occupants, the yield on investment may include significant non-monetary factors.

2. Components of housing

The housing "unit" as it is commonly termed, is identical with the physical structure or portion of the structure occupied by the household. A measure of the amount of housing which the household consumes, therefore, would have to employ as a reference some "unit" which may or may not include a single unit in the orthodox sense, but which would include not only the structure but also the goods and services associated with the structure and normally imputed to land since it is the entire bundle which is purchased or rented in a single transaction.

The structure is distinguished from land in that its yield may be altered, within legal limits, or it may be scrapped. (Both the structure and the land may be converted from or to residential use in whole or in part, however.) In addition, a special form of alteration in yield is deterioration, also specific to the structure. I shall assume that physical deterioration is a function of age alone, and improvements are capital in nature; hence, the yield of services from the structure at some point in time is a function of

a) physical attributes of the house "new", scaled according to price relative to the standard unit in the reference year, b) improvements made during the period of service and c) the ages of each.

The land associated with the housing structure derives its "rent" value (in the Ricardian sense) from competition among (residential) bidders. The flow of services which the individual household derives from the land is a function of its site characteristics and its area, i.e., price is not uniform for the individual parcel but varies, to some extent, with quantity, site characteristics held constant. Site characteristics may in turn be thought of as composed of two main sources, accessibility and neighborhood characteristics. "Accessibility" is a concept which represents the inverse of "costs," largely non-monetary, involved in reaching point spatially distant from, in this instance, the place of residence. This attribute is not entirely specific to the site, but depends also upon the occupant of the site. "Neighborhood characteristics" or "amenity" are similarly conceptual terms, representing the desirability, to the resident, of both the physical features of the immediate surroundings and such subjective attributes as "reputation." In addition, public services vary in quality among sub-areas within the market area, such variations not being matched by variations in costs to residents as among sub-areas. These disparities (perhaps a special case of neighborhood characteristics) also result in variations in value.

Some of the factors mentioned in the discussion of the housing commodity could complicate the analysis, especially the treat-

ment of the structure as yielding an objectively measurable flow of services which obtains a uniform unit price, capitalized in the market price of the property, or in the form of rental payments.

It would perhaps be appropriate to clarify, at this point, the use of the terms "producer" and "consumer" of housing services as used in this paper. The "producer" is the owner of the housing, and therefore the agent who supplies the services directly to the "consumer" or occupant of the dwelling unit. The builder is not the producer but may become one if he subsequently leases the property. The owner-occupant is both producer and consumer of the identical set of housing services.

The first complication is that the producer of housing services must purchase command over the services of the structure and land together which means that he must optimize with respect to both the structure and the land simultaneously. Constraints are likely to exist on the amount of housing obtainable at locations which optimize the land input, e.g., middle-class families with children might find only apartments in areas which optimize location. Obtaining the optimal structure, on the other hand would require sub-optimizing with respect to location. Second, structures possess style characteristics which contribute to their heterogeneity, making substitution more rigid, and which are in the realm of primarily subjective satisfaction. Some households will nevertheless sacrifice consumption of other goods to be able to live in a Victorian gingerbread house while others are willing to pay, i.e., sacrifice other goods, to avoid it. For both of these reasons, there is some element of rent, in the Ricardian sense, included in the value of

the structure, as well as of the land. Both of these factors may be mitigated by inclusion of "neighborhood characteristics" in the determination of land rent, since in general the household is likely to want to be surrounded by housing of the type in which it lives itself and by people with generally similar behavior. The second factor is extremely difficult to account for, however, without a very detailed study of fashions in consumption. On the other hand, it is possible that the bulk of households have no strong preferences with regard to housing style and/or that within a metropolitan area, there is not an appreciable diversity of styles, so that style is not a significant explanatory variable. Nevertheless, these factors may go some way toward explaining the apparent existence of style and quality "sub-markets" within the metropolitan area, i.e., from the point-of-view of the individual household, substitution may be limited to a relatively small segment of the total range of housing opportunities, regardless of income.

C. Micro-Determinants of the Value of Housing

1. Static effects

In a static world, in which adjustments in production and consumption could be made without friction, such adjustments would be made continually and equilibrium would be maintained. In the housing market, even if we view the agents as attempting to adjust continually, such adjustment is hindered by built-in constraints. Primary among these for the owner occupant is transaction costs. In changing residence, or ownership of housing, closing costs and agent's fees, for the seller, moving costs, and

legal and other fees for the buyer, may be substantial. For the renter household transaction costs consist almost entirely of moving costs, hence such a household is relatively unconstrained as compared with an owner. The owner-occupier's behavior has two aspects: as a consumer of services and as an investor in a capital good. At the time of the purchase of the good, his calculation is that of an investor, i.e., he purchases in such a way that the capitalized return on his investment exceeds the cost of the house (including transaction costs). The existence of such "profitable" opportunities does not insure investment, however, this being determined in large measure by family expectations and liquid assets. However, once having made the investment, his power to adjust his housing as a response to changed taste toward housing, increased income or decreased relative housing prices of such improvements is limited by the possibilities of the structure (although such decreased prices are likely to exist only at times when his equity is also decreased through a drop in real estate prices). Such additional investment is also likely to be heavily dependent upon the owner's liquid asset position, especially if favorable debt financing is unavailable. Hence, wide variation in housing consumption during the tenure of a single unit is severely inhibited. Substitution in favor of housing consumption is therefore shifted, in the short run, to non-housing goods, in the strict sense, but goods which are closely associated with housing, especially furnishings of all kinds and transportation. Renters are similarly constrained and have the same type of response, except that speed of adjustment is much more rapid.

Downward adjustment for the owner-occupant is even harder than upward adjustment because deterioration is a slow process, and subdividing may be costly or may be limited by law. Whether he sells in order to move to other housing which is more nearly optimal depends upon 1) movements in relative prices of the housing which he occupies and the housing which he considers occupying (a static factor) and 2) the length of time for which he has remained and is expecting to remain so, if he does not move out of equilibrium (a dynamic factor).

The renter household is less likely than the owner to be able to adjust its housing consumption upward unless it moves to another dwelling; but, on the other hand, it is generally less constrained in such movement, since its principal costs are direct moving costs (unless the move involves a house purchase). Another constraint is the lease, if one exists, but this can be ignored as having relevance only for a short, fixed period. Costs of personal transportation may be an important constraint, however, since there are discontinuities in transportation costs, in a broad sense, from public transportation, to operation of a single automobile, to two or more automobiles, and these costs are frequently associated with type of tenure because of the factors of neighborhood type and location.

The owner-landlord (non-occupant), in contrast with the owner-occupant, is a producer who thinks of the acquisition of housing purely in investment terms, periodically re-appraising the profitability of his investment. He will maintain or improve the property according to the marginal yield. Where he holds several properties, he will invest in that one for which the marginal yield is highest. He is

constrained from increasing his yield through increased rents, where his profit margin falls below returns available in alternative investments, by the strength of the demand in the particular sub-market pertinent to his property. In multi-family housing especially, rents on individual units are constrained from moving downward because of tenant pressures to similarly reduce the rent in all units. Transaction costs are likely to be a negligible factor for this type of producer.

The landlord-occupant is a hybrid. The property is an investment for him, but his own housing consumption is tied directly to it. Furthermore, like the owner-occupant, his asset position in relation to the size of the downpayment is critical in determining whether he purchases. He can put improvements into his own or into rental units, i.e., substitute between the consumer durable and the pure investment good, according as housing prices decrease or increase, respectively. Transaction costs are relatively important compared with the owner-landlord, since this type of owner is generally not so professionalized and does not possess substantial recourse to working funds.

2. Dynamic effects

The prospective owner-occupant invests in housing in which he can gain a surplus in capitalized returns over cost (including transaction cost). We assume that the decision as to whether to own or rent has already been made in favor of the former. Because of the qualitative differences affecting expectations of return, e.g., quality of the neighborhood, different rates of discount will be necessary to make different dwelling units economic. Thus,

investment in housing in a declining neighborhood requires a high rate of discount. Because the amount and kind of investment a household will make depends upon its wealth position, the investment yield motive in house purchase may be less important to wealthier families. The values of high consumption as such, including specific environmental attributes may play a much more important role in level of investment. We should therefore expect to find greater disparity among wealthier households in level of housing investment. Among less wealthy households, however, there is a strong desire for stability of investment. They therefore tend to seek areas of "stable values" at the expense of foregoing a higher level of consumption in housing which involves greater investment risks. The building of equity which is forced upon the homeowner has the effect of providing him with a reserve with which he can overcome transaction and moving costs; hence, he becomes more capable of taking advantage of a rise in the market value of his own housing as equity is enlarged. But the building of equity is probably highly correlated with stage in the life cycle, i.e., the younger family typically has a small equity, whereas the older one is more likely to own the house outright, even if it has made several moves, because it has transferred its equity. Stage in the life cycle is probably one of the principal variables determining both rental-owner split, among movers, the amount of housing purchased and the amount of capital additions to existing housing. But equity tends to be stuck in the house until it is sold, because of costs of re-financing. Hence, as an investment, housing may be substantially out of equilibrium

at any time. Building up equity in the early part of the tenure is a form of saving. For the household with a low rate of discount which, during periods of rising prices buys more housing than otherwise in anticipation of a capital gain, or vice versa in times of falling prices, such enforced saving tends to reinforce this tendency. As tenure proceeds, the homeowner makes adjustments in housing consumption either by capital improvements which reflect a shorter horizon than the original housing investment or which are financed on borrowed funds, keeping payments more in line with consumption over time, or by the acquisition of movable goods.

For (non-occupant) owner-landlords, the rate of return on equity investment is of paramount importance. Financing will be done as much as possible through external borrowing. The purchase price of rental properties is therefore very sensitive to changes in the interest rate, which determines how well real estate is able to compete with other forms of capital investment. Returns from this type of investment can, subject to the constraints mentioned above, be adjusted to correspond with varying opportunity costs; but the output of each dwelling unit is fixed in real terms unless physical alteration or a change in equipment can bring a higher return. There tends to be a lag in such adjustment because of uncertainty about the permanence of rent changes. In the direction of downward rent adjustments, especially, there tend to be rigidities, e.g., overlapping leases, which inhibit such adjustment until the rate of vacancies in the relevant submarket becomes so critical as to force down rents, clearing the

market. Given the mobility of renters, the price per unit of housing service is likely to be relatively uniform throughout the market. A counter-influence, however, is the tendency for many renters, predominantly of low income and living in high density areas, to be constrained in their locational choice, hence in their housing choice, so that the rental for such households may be maintained at an abnormally high level relative to costs and/ or a low level of maintenance and repair becomes a long-term policy. If the latter approach is relied on primarily, it is anticipated that the long-term diminution of operating costs more than offsets the long-term reduction of rents and the reduction in re-sale value. Rising re-use site value would also enhance the latter strategy.

The landlord-occupant, after a prolonged period of high return may sacrifice his own consumption in the structure in part or in whole. In the latter case, he may occupy instead housing in the fee market. An increased yield of services from his property bolsters both his own income and his own consumption, so that if he stays in the house, the landlord is likely to increase his investment in the structure generally.

The structure is conceived of as yielding a flow of services indefinitely. This flow of services may be diminished relative to other housing and through deterioration. The rate of obsolescence is unavoidable and irreversible (or avoidable and reversible only at great cost), e.g., buildings without central heating systems. Change in the value of the house due to obsolescence is a function of certain characteristics of the house in relation to the rest of the housing stock rather than through physical change

in the house itself.

The second source of diminution in the flow of housing services pertains to the physical state of the structure. Deterioration is the reduction of the structure and parts of the structure in their yield of services. The yield can be sustained, however, by maintenance and repairs. "Normal" maintenance is defined as that level of maintenance and repairs which sustains the flow of services at a constant level. It is likely that the "normal" level of maintenance for a house rises over time (possibly to a plateau) since some types of failures develop only over long periods of time.

3. Transactions in the housing market

a. Types of transactions

Transactions in the housing market are of two principal types: 1) transfers of property rights and 2) physical alterations of the stock. The former are observable (though not always documented) transactions involving two parties; the latter are not always observable and sometimes involve only one party, though in two different roles, according to our conception. The specific sources of demand and supply in these categories are shown in the following table:

DEMAND	SUPPLY
. Transfer of Property Rights	
households changing their dwellings--moving in	households changing their dwellings--moving out
households occupying dwellings for the first time	households ceasing to occupy dwellings

Physical Alteration--Existing Units

maintenance, improvement and extension of existing units vs. deterioration

Physical Alteration--Change in Number of Units

new construction vs. demolition

subdivision of units into greater numbers of units vs. merger of units into lesser numbers of units

conversion of units into residential use vs. conversion of units out of residential use

We are concerned both with transactions by which individual households alter their consumption of services and by which they alter the aggregate capacity of the stock to produce services.

b. Transfer of property rights

Over the lifetime of the household, adjustments in the consumption of housing services frequently run in the following sequence: original rental; change of rental dwelling; change from rental to owned dwelling; investment in current dwelling unit (i.e., improvement, etc.); sale of dwelling and purchase of a different one; sale of dwelling and rental of a different one. Some of the intermediate steps in this sequence may be by-passed, e.g., a household may come into existence with the purchase of a house.

It is assumed that, with the exception of investment in the current dwelling, these adjustments in consumption, which involve changing from one dwelling unit to another, are prompted primarily by family expectations, i.e., stage in the life cycle and changes in the location of employment, rather than by changes in income and prices as such, the influences of which are felt in

the determination of housing value and the level of housing consumption. Thus, a homeowner may move from one market area to another, or within the market area if his place of employment is shifted, even though he is not reimbursed for his costs; on the other hand a) in so doing he may adjust his consumption of housing to bring it closer to his desired level, which he was hindered from doing as long as he held his former property (assuming the compensation of better pay, etc., leaves him at least as well off) and b) high transaction costs, including having to sell in a poor market may in some instances work to hinder a move of employment or may force the consumer to commute longer (lower his consumption of accessibility).

The following five sets of alternatives may be open to the household as decision-maker at one time or another, following from the above and including a consideration of both the initial state and the possible states after the decision. Note that, except for 1), the decisions involve the alternative of "staying put", hence not to engage in a transaction of the "visible" type.

1) rent vs. purchase (initial)

2) continue to rent same or different dwelling vs. purchase of different dwelling

3) continue to own same or different dwelling vs. rental of different dwelling

4) continue to own same or different dwelling vs. cease to continue existence as a separate household

5) continue to rent same or different dwelling vs. cease to continue existence as a household

Each of these decisions, and the major factors involved, will be considered in turn.

1) rent vs. purchase (initial)

This decision may involve a person or persons about to form a separate household for the first time or a household which is migrating to the market area (the former are relatively homogeneous with respect to family expectations, but the latter are likely to be heterogeneous, and therefore have different experience with housing). It is assumed that housing prices are not themselves determinants of the rate of household formation or in-migration, and, further, that the decision to occupy a separate housing unit is determined outside the model. The decision between renting and owning is assumed to depend upon asset position and family expectations. The household in this instance compares its potential consumption of owned housing, i.e., pure consumption of housing plus the utility derived from homeownership, with the loss of utility due to decreased liquidity resulting from the downpayment and associated outlays. It may buy a lesser house for a lesser downpayment and monthly payments, gaining liquidity but losing utility in housing consumption. If it rents, intending to purchase later, the delay in ownership (loss of utility of ownership as such) is partly compensated by greater liquidity over that period, but not entirely, since the saving is partly forced. If the capitalized gain in the consumption of housing as such plus ownership does not compensate for the loss in liquidity because of 1) a low preference for home ownership, 2) a high degree of uncertainty about the future, including either conditions external or internal to the household or 3) a low preference for risk, or all three, the household will choose rental;

but if an addition to assets would put it in a position such that it would have chosen ownership, then it will add to savings to accumulate this amount if the capitalized decline in utility from the foregone consumption is less than the discounted increase in utility derived from purchase.

2) continue to rent same or different dwelling vs. purchase of different dwelling

In this case, the decision unit is an existing household which, at the end of the renting period may continue to rent its own dwelling or another yielding more or less service, or it may purchase. Unlike the previous instance, where formation of the new household necessitates, by definition, a transaction in the market, the household may remain in the same dwelling and indeed, it has an incentive in the form of moving costs, although these may be assumed to be of secondary importance compared with the homeowner's costs in selling and re-purchasing or renting. The variables which govern the choice of the newly-formed or in-migrant household also determine the choice between ownership and rental here, although a) the household which has been renting, as compared with the one which is newly-formed (but not in-migrant) is more likely to have acquired liquid assets and b) the renter will compare the other options with remaining in his present dwelling on the basis of relative "values", i.e., price per unit of housing service; in so doing he will be influenced by recent or proposed changes in the rent of his current dwelling.

3) continue to own same or different dwelling vs. rental of different dwelling

This decision involves important considerations not included in the decisions discussed above. The principal factor complicating this decision is that the household is both a consumer of the services of its dwelling and a supplier with an investment in fixed capital. It therefore has the opportunity, not only of entering into transactions in the market for dwelling units, but also of investing (through improvements) or disinvesting (through deterioration) in the unit which it owns, so as to adjust its housing consumption to the optimal level.

There are important constraints which hinder the homeowner from adjusting his consumption through occupying a different unit.

Selling a house and buying another, or even selling and renting another involve substantial transaction costs (as indicated above) such that, if the household moves to a new house which yields the same flow of services, it will have suffered a loss to the full extent of those costs; therefore a household will make such a move only where the capitalized gain in utility from a different housing package equals or exceeds this loss in utility which these transaction costs represent. An alternative to sale of the dwelling in order to achieve equilibrium in consumption would be to alter the dwelling itself, a subject which will be treated below under "production." Ignoring for the time being such adjustments in housing consumption, we would expect to find, in the market involving transactions in dwelling units, that there exist discontinuities in the individual demand curve for housing, i.e.,

only large changes in price would induce the owner-occupant to alter his level of housing consumption.

4) continue to own same or different dwelling vs. cease to continue existence as a separate household

The determinants of household dissolution, like those of household formation, are primarily non-economic in nature, or are otherwise external to the local housing market. These include, inter alia, out-migration and death. Voluntary dissolution of the household, the member(s) remaining in the market area, e.g., family breakup, doubling up, is associated with stage in the life cycle including especially elderly persons forming other households. Unlike new household formation, however, income (including anticipated dissaving) may be a significant factor in such dissolution.

5) continue to rent same or different dwelling vs. cease to continue existence as a household

Again, non-economic and external factors are important. Where dissolution is primarily the result of stage in the life cycle and declining preferences for housing, income and savings prior to dissolution are likely to be more critical than in the case of the homeowner because no equity is liquidated. Depending on the convention we want to use as to continuity of a household, we could include under this heading many households of more-or-less temporary convenience, e.g., several bachelors sharing a dwelling, and doubling up generally, who, upon dispersing are absorbed into several dwellings which collectively yield more

consumption services than the single one did previously. Similarly, a man and woman who each occupy a dwelling will, upon marriage, reduce the number of occupied dwellings, and hence households, by one and probably reduce the amount of housing service consumed.

c. Physical alterations--existing units

For the owner-occupant, and for producers generally, as noted previously, changes in the dwelling unit to alter its flow of services downward are restricted; deterioration is a slow and gradual process, especially if the house is relatively new, so that output cannot quickly be adjusted to equilibrium in this way; similarly, maintenance costs may amount to only a small share of total housing costs compared with contractual and other operating costs, especially if the mortgage is still in force, so that inputs are also sticky. Minor improvements in the dwelling unit, on the other hand, while they are not so restricted, may be very costly relative to their yield because of diseconomies of small-scale production, tending to lead to the substitution of other durables. Major improvements will similarly be restricted because of the real or implicit cost of funds, i.e., high interest payments on borrowed funds or a high subjective rate of time preference on own liquid assets. The decision as to whether the improvement will be made will depend, on the demand side, upon a) the disparity between the household's desired consumption of housing services (from the structure) and its realized consumption, b) the length of its horizon with respect to the improvement, i.e., the extent to which it feels the increase

in its optimal consumption of housing services will be long-lasting and c) price-expectations, e.g., where it foresees re-sale in a rising market, so that the improvement would yield a capital gain. The relative importance of these factors corresponds with the relative strength of consumption vs. investment (for monetary returns) motives. Where the household foresees vacating due to non-market forces or because of a severe disequilibrium or an anticipated disequilibrium due to family expectations, either in the consumption of the services of the structure or the land, investment motives may be paramount.

For landlords, the decision as to whether to sustain an expenditure sufficient to produce normal maintenance depends upon net yield from the property (probably discounted very heavily). Where the return is very thin, he will forego maintenance in part or in whole. Thus, e.g., faced with generally rising expenses on the one hand and a thin market on the other (especially if there are substantial vacancies) he is likely to reduce maintenance in an effort to keep the rent down, although a fluctuation which is thought to be temporary, as when the market is undergoing some short-term adjustment, may have little effect on maintenance. Both possibilities depend upon the landlord's portfolio; hence they are likely to be related to size of enterprise. On the other hand, and especially in low quality rental housing, the landlord may forego maintenance since further deterioration does not greatly lessen yield, i.e., the market is "thick". Above-normal maintenance and improvements result when the landlord foresees a more lucrative market at a somewhat higher level. This typi-

cally happens when ownership changes hands, the former landlord having allowed deterioration over time because of internal financial considerations. A general rise in consumer income can also produce such improvement provided operating costs do not rise proportionately, but with a lag, depending upon mobility and the presence of excess supply in the market into which migration takes place. An important influence here is neighborhood characteristics, i.e., the level of repair tends to approach that of the neighborhood, since a property at a lower level of repair than the neighborhood generally will yield a high marginal return on investment in improvements.

The landlord-occupant is likely to be subject to much the same influences as non-occupant landlords, except that he is more sensitive to fluctuations in yield, on the one hand, but on the other, has direct consumption, including non-market, interests in the property, as do owner-occupants. A poor yield on the property affects his income and, if it persists, his consumption, including consumption of housing, so that his maintenance expenditures for the structure as a whole will decline. A rental income which declines relative to other sources of income may lead the occupant landlord to move out entirely, renting the entire building. If the net yield is sufficiently low in relation to other investments or his liquidity position is bad, it may lead to his selling. An increase in yield from the rental portion of the structure will probably have symmetrical effects.

d. Physical alteration--change in number of units

i. Merger and subdivision

One means by which the homeowner may adjust his consump-

tion of housing downward is by renting all or part of his dwelling. If he rents part of the dwelling, e.g., as a furnished room, he incurs subjective costs, e.g., loss of privacy or prestige. If he rents the house in its entirety, he suffers moving costs. If he makes a capital investment in the form of subdivision of the dwelling (placing himself in the landlord-occupant category) he suffers opportunity costs arising from foregone investment alternatives (in other housing or non-housing goods). In addition, as with all classes of owners, subdivision may be restricted by the character of the house or forbidden by zoning laws, although, in the long run, zoning laws may be modified where pressure exists for such subdivision. Renting, with or without subdivision will take place, however, where the owner household's family size and expectations and income are such that it desires to make a downward adjustment in housing, but transaction costs are large. It is especially likely to happen where rentals are high in relation to fee housing costs due to a short supply of rental units.

The landlord will subdivide or merge units to maximize net yield, and will be influenced either by shifts in demand among submarkets or by the overall strength (or lack of it) of demand for housing which would, in turn, affect different submarkets differently. Thus, e.g., three-bedroom units may remain vacant for a shorter period of time than one bedroom units and command a rent that is sufficiently greater than two one-bedroom apartments to warrant the investment in conversion from the latter to the former if the imbalance is expected to endure for some time. Frequently, no capital costs are involved in such

conversion.

The landlord-occupant is typically faced with restrictions on subdivision similar to those facing the owner occupant: zoning law and the unsuitability of the structure. Probably more than the owner-occupant, however, he has the opportunity to make substitutions between the rental portion of the structure and the portion which he himself occupies. The landlord-occupant with an expanding family, for instance, may incorporate part or all of the rental portion into his own dwelling. Costs involved in such conversion may or may not be capitalized in the value of the house, e.g., as a one-unit house its re-sale value may actually be less than its previous value as a two-unit house; this cost in addition to direct conversion costs and discounted foregone rents would in effect be the cost of increased housing consumption on the part of the owner. Similarly, unless his rental income forms a large part of his total income, present and expected, a falling rental income relative to operating costs may lead to absorbtion of some or all of the rented dwelling space into the landlord's own.

ii. Construction

By construction is meant here, in line with our previous definition of the housing market, additions to the flow of housing services resulting from the provision of totally new housing units. We are not concerned with the volume of construction as such, but with the amount and type of new units being traded at any time and with the contribution to vacancies which newly-constructed but untraded units may make.

The character of new construction as an increment to an existing stock and the length of time involved in bringing a project for constructing a housing unit or units to completion contribute to its extreme volatility and to the lag which characterizes the supply response. Purchasers of new housing bring such housing into the employed stock where equivalent housing in the used stock is 1) more costly or 2) yields a lower return. By "equivalent housing" is meant housing for which the price in a market in equilibrium would be the same. There is implied in this statement the substitutibility of new and used units. As in the case of different units in the used stock, we may assume perfect substitutability with the marginal rate equal to the price-ratio in equilibrium.

Where the costs of production of new housing are equal to or less than the purchase price of equivalent used housing, such production will take place, assuming an available supply of finished housing. This supply is likely to be highly inelastic, however, for some time after the disparity in price arises, so that if demand continues strong in the particular portion of the overall housing market (the value submarket), used house prices may continue to rise. The availability (or cost) of credit determines how rapidly production can be expanded, although other factor scarcities may develop with increasing output which would tend to keep the supply curve relatively inelastic. As newly-constructed units become available, they tend to bring prices of new and used housing toward equilibrium; however, it is not a smooth approach to equilibrium, because of the variation in production costs over

the building cycle. Moreover, the construction industry frequently over-responds, to the point where inventory accumulates and the market can only be cleared by reducing new house prices (fee market) or rents or by renting houses originally intended for the fee market.

An important qualification to the above description is that new housing is in fact not competitive with used housing in a sizeable share of the market, viz., the lower end. In other words, in terms of quantity of housing service per dwelling unit, the supply curve of new housing in this submarket and the demand curve do not intersect in the positive quadrant because the supply curve ceases to exist at some positive level of price and quantity. Hence, for that portion of the market, increases in the stock must come from used housing in other parts of the market through the process of filtering, which is, however, normally a long-term response, through conversion of units within the market and through conversion of non-residential structures.

D. Aggregate Relations in the Market

1. Static effects

The metropolitan housing "market" is a single market only in a limited sense, viz., consumers in selecting their housing limit the alternatives from which they choose to those existing in the area; and the costs and prices which producers face are those specific to the area. More broadly, the housing market consists of a number of sub-markets which, in a static framework, may be thought of as forming a system in equilibrium. For analytic purposes the

following distinctions may be made together with the mechanisms by which adjustments to equilibrium are made.

Fee versus rental: In the fee market, the transaction involves command over the services of a dwelling, normally in perpetuity; in the rental market the transaction involves such command for a specific and finite length of time. Equilibrium is brought about through the equating of capitalized rental payments and fee prices. All dwellings may, in a general sense, be thought of as being involved in both markets (if owner-occupants are viewed as renting dwellings to themselves), while buyers and sellers may be in either (renters, landlords) or both (owner occupants). The observed rental value of units, even in a state of equilibrium, is not the appropriate measure of the value of such services to the occupant in fee because 1) homeownership may in itself be a consumption good and 2) the appropriate rate of capitalization may be different for the landlord and for the owner-occupant.

Standing stock vs. new construction: new construction represents an increment in the stock. The submarket for new construction arises out of an excess of demand for services above the amount of service which can be provided within the existing number of dwellings, taking into account normal vacancy rates.

Two variables are involved: the amount of service and the number of units. The number of households is a lower limit on the number of dwellings which may lead to new construction. Increased aggregate demand for housing services may also lead to new construction. Apart from increased demand for dwellings, the surplus of the capitalized yield over cost of creating new

dwellings in the existing stock has to be compared with the surplus obtained by the creation of dwellings through new construction. For a changed demand for services (number of dwellings unchanged) the comparison is between the improvement of the existing stock and demolition and construction (increased demand) or between deterioration of the existing stock and demolition and construction (decreased demand), the latter being necessarily a long-run alternative. Equilibrium occurs when, for a constant number of households, the ratio of the marginal product of repairs and additions over their price equals the ratio of the marginal product of new construction divided by its price, where this includes the foregone yield of the demolished structures. For an increased demand for dwellings, the marginal product divided by the price of new construction must equal the equivalent ratio for conversion, where factor costs include a sacrifice in consumption due to making the previous dwellings smaller.

Quality distribution within the standing stock: the dwellings in the housing stock form a distribution according to the capitalized flow of services per dwelling. Thus the total stock of housing at any time is proportional to the flow of services. Ideally, we might consider dwellings of different sizes, styles and ages as perfect substitutes (excluding site), with marginal rates of substitution equal to their price ratios. The flow of services from a dwelling is in turn the resultant of a number of elements, or "factors of production" including floor area, heating system, type of construction, facing materials, number of rooms, size and type of garage, size of lot, net of house, type of foun-

dation, electrical system and, perhaps, number of units in the structure. The ratios of the marginal products of pairs of these factors must equal the ratios of their prices. It would be assumed that in a single housing market, the price of any of these factors is uniform.

Location: by contrast with housing structures, the service derived from land which we associate with the term "site value" is actually the opportunity to enjoy other services, i.e., the demand for it is a derived demand. Furthermore, different sites are likely to be less than perfect substitutes. Thus, the number of sites which allow the household to optimize its housing and accessibility-amenity consumption per se are likely to be limited, so that, assuming fairly homogenous tastes, the metropolitan area may be conceived as divided into a number of contiguous submarkets in which demand is relatively inelastic and limited, individually, to narrow ranges.

In addition to sub-markets within the housing market, we shall make an illustrative comparison between the housing market and one of the other markets which have important interactions with it.

Housing market vs. mortgage market: because of the size of the financial commitment in relation to the resources possessed by most purchasers of housing, financing has to be made by means of a mortgage, in which the house is pledged as collateral. The mortgage terms and size of the mortgage in relation to the market value of the house depend upon the riskiness of the housing loan as opposed to the risk in the credit markets. Where credit becomes

scarce in general, mortgagors must compete by offering higher interest rates and greater equity (an indication of decreased risk). This increased cost of purchase depresses the volume of transactions in the fee market. The converse occurs where credit becomes more plentiful. What holds for new construction also holds for major improvements, so that aggregate change in the housing stock is affected.

The mortgage market may also be further subdivided into the portion in which mortgage terms and loan-to-value ratio are relatively free to respond to demand and supply for funds and the "regulated" portion of the market in which mortgages are insured or guaranteed specifically, in the U.S., through V.A. and F.H.A. By decreasing the riskiness of this type of loan, such insurance a) brings more funds into the mortgage market on the whole than there would otherwise be, thus stimulating the volume of transactions and b) places a premium upon loans thus insured in comparison with loans in the conventional part of the market on identical housing, hence terms are more favorable.

Rigidities:

The above description of the submarkets within the housing market and of the markets interdependent with the housing market assumed continuous adjustments at the margin so that such markets are continually in equilibrium. Certain rigidities must be recognized which, even in a static framework, tend to hinder such adjustment. Some of these have been mentioned previously, but a few need further elaboration.

The high opportunity costs involved in the foregone assets resulting from the purchase of a home lead to distortions in current expenditures as a reflection of the desired level of housing consumption. The renter who desires to purchase may forego housing (and other) expenditures in order to save for a downpayment; the owner's expenditures for housing, on the other hand, include investment expenditures which do not move entirely in response to movements in the optimal consumption point; the same is true, conversely, for the owner-occupant's expenditures viewed as investment, e. g., he may hold an expensive house as an investment, and even rent it cheaply if his price expectations are high, but he will not sell his house for investment reasons alone except under severe conditions, i. e., investment motives may make him sell sooner or later than he otherwise would have, but they are not primary in the decision to sell. Capital rationing is aggravated for low-asset households because of institutional practices, i. e., the cost of credit is higher for them.

Substitution between repair and enlargement of the existing stock vs. new construction: there is a great range both in adaptability of housing to change and in the regulations which would allow such change (although regulations are liable to follow economic forces). Aside from this, factor costs may differ in the two industries. This also applies to conversion from non-residential uses. The variation of factor costs even within the new construction industry has often been cited. In a dynamic sense, expectations may differ in the two markets,

e. g., because of the "bandwagon effect."

Components of housing: a deficiency or excess of one or several of the components of the housing package may persist for some time without an adjustment being made by transferring tenancy to another dwelling unit. Where a deficiency exists in the structure or equipment, an adjustment may be made through an improvement or addition. This is more likely to happen in owner-occupied than in rental units. In other words, alterations in housing structures in the fee market indicate an attempt to adjust housing consumption without sale. But it is liable to be a very erratic adjustment, because of legal and structural limitations, as mentioned previously. There is probably also a discontinuity in factor costs, i. e., a small amount of maintenance can be done by the owner cheaply, but major improvements represent a significant postponement of consumption and are expensive. This again raises the question, for homeowners, of running down reserves. Owner-occupants with strong investment motives would have to appraise the improvements according to their costs in relation to their effect on re-sale price. Investors generally, i. e., landlords, would be concerned with assessing the capitalized increase in yield; they may be willing to continue with a lower yield, however, if 1) more profitable investments are available for the additional funds, 2) if residential real estate prices appear to be rising relative to labor costs or 3) there is a stronger, more reliable demand at the lower service level, i. e., that demand at the service level and price of the improved dwelling would be more uncertain because the

dwelling would be moving into a new sub-market. Again, neighborhood effects may aggravate such uncertainties.

2. Dynamic effects

The demand for dwellings being identical with the number of households, we are concerned with the amount of housing service and its value as determined by dynamic forces. In this section, I shall examine separately the effects of changes in income and of migration rates in an idealized setting, tracing its impact and the return of the system to equilibrium.

Assume initially that the number of households remains constant, and assume some vacancies exist, distributed throughout the stock arrayed according to level of service-per-dwelling in the same way as occupied units. Such "normal" vacancies are necessary for movement of households within the stock. A general increase in real income which is expected to be permanent would lead to: occupancy of the vacant units in the top part of the distribution; a relatively small amount of new construction by those moving out of used dwellings at the top; occupancy of the latter dwellings by households just below on the income scale. Those at the top will generally have greater mobility because transaction costs will be partly or wholly cancelled by the price rise due to demand push from below, plus a greater willingness and ability to cope with such costs. On the other hand, the higher on the income scale, the more resistance households have to market forces as opposed to subjective considerations. The influence of family expectations may not be sufficient to make a wealthy, middle-aged household head (wealthy households are

likely to be concentrated in the middle and upper age brackets) move to housing offering less service if he has strong subjective associations with a house or an area. Thus, only a small number of vacancies would be created in this way, so that prices near the top would rise. This would create pressure for new construction at lower levels which would, when built, tend to bring prices for standing stock on the market back to a point where it is competitive with such new construction. The latter is then damped down, but with a lag, so that it overshoots, because of time necessary for incubation, etc., creating new vacancies again. This phenomenon continues down the line, but is gradually damped out by price rises because of 1) increasingly large numbers of households wanting to move up compared with vacancies in the market above them and 2) the decreasing effect of additional income on asset position, associated with the higher marginal propensity to consume, as we go down the income scale. These income-distribution effects will work in the opposite direction from the effects of family expectations assuming that households with expectations of large housing needs due to growing families are disproportionately situated in the lower income categories due to 1) stage in the life cycle (although expected income, given a suitably long horizon, would counteract this) and 2) the propensity of poorer families to have more children. This is especially true in relation to fee vs. rental markets, where households with high family expectations who rent have a motivation to save out of their additional income in order to be able to purchase a house. For the most part, however, increased

income leads to the decision to purchase earlier than otherwise. There will be a relatively large increase in vacancies in the lower quality categories. In the fee market, these low quality dwellings will be reduced in price, but if these fee dwellings attract households from low rent dwellings who have been able to save out of their additional income, their prices may remain at a level at least as high as previously, and the impact of reduced values will be passed on to the low-rent portion of the market, further mitigating upward mobility of residents of the latter dwellings. In the rental market, vacancies will be more general throughout the market than in the fee market because 1) increased income has allowed households to shift to fee housing generally, 2) households with low incomes, expecting their increased incomes to be permanent, tend to want to buy rather than move into more expensive apartments and 3) the tendency of landlords with multi-family structures to keep their rents high and carry vacancies in the short-run throughout the range of rental units. Some single-family rental units will be switched to the fee market, especially in the upper brackets where prices are relatively favorable, however, simultaneously loosening this sub-market and reducing vacancies in the higher quality rental market. In addition, in the lower strata some multi-family units will be converted to non-residential use, and some will be merged into larger units, competing with fee housing, so that vacancies are decreased. Improvement of the existing stock is the second means, besides new construction, by which the consumption of housing service is increased. The effect of increased income does not

damp out as we go down the income scale to the same extent as in the case of new construction. Thus, even where households are overconsuming housing services in relation to their desires in the upper income brackets, the modification of the housing bundle to bring it more into line (insofar as any adjustment is made at all, see above) may be preferable to a move; a fortiori, households whose family expectations are levelling off will tend to alter or improve their property or replace equipment, i.e., bring about quality improvements as the result of their increased incomes, contributing to the increased value of the standing stock. At the lower levels, greater constraint on homeowners to stay put forces an increase in housing consumption to take the form of improvements to a greater extent than in the upper brackets. This is probably true regardless of family expectations, except that there may be a tendency for lower income households to invest in durables with shorter lifetimes, especially in movable items, so that there is a lesser positive effect upon the real output of dwellings in the long run. In the rental market, increased income is likely to be accompanied by increased operating costs, tending to increase rents; but in sections of the rental submarket where the vacancy rate is high, such increase is likely to be repressed. Landlords who are mortgagors are generally better off than those who are not because amortization and interest are smaller in real terms assuming the rise in incomes is accompanied by a moderate price rise. These movements are likely to have little effect upon either the capitalized value or the real flow of services from such properties, however,

interest rates and external effects being much more important.

Assume now that instead of a rise, there is a proportional drop in incomes. There will be considerable rigidity in adjusting housing consumption or the value of housing. First, consumers tend to want to maintain the higher level of expenditures as is true for all consumption expenditures. Second, unlike goods of smaller value and duration, housing cannot be readily adjusted downward 1) for homeowners, because of transaction costs, especially if the expectation is that income will rise once again, 2) even for many renters who are bound by leases, at least in the very short run and 3) because of the rigidity of rents in the downward direction in multi-family housing. Therefore, only tenants of single-family rental housing are likely to be able to adjust their housing outlays in the very short run. The effect of this relative flexibility upon the market as a whole would depend upon the amount of such housing in the stock and on the amount available as vacancies. Whatever new construction had been underway at the time of the income drop would keep coming onto the market as completed, but the tendency of households in existing units to spend out of their savings during the decline, especially those further down in the fee market, will cause them to defer purchase of new or used housing. Most will stay where they are. There may be some minimal shift from owning to renting, but the main effect in this connection is that those who would have purchased will defer it. Renters in this latter category may seek other rentals, especially in single-family housing. Some housing previously offered in fee will be switched to the rental

market. Hence, both demand and supply for dwellings is increased in the rental market; but the demand for services is increased less than proportionately. The supply of services is likely to increase because of transfers from the fee market (with a lag, however, since owners have first to experience difficulty in disposing of their properties) but this is partially offset in the longer run by undermaintenance by the landlords. The houses transferred from the fee market are likely to be better maintained initially, in anticipation of a subsequent upswing, but if this does not materialize, their prices will drop, and they too will be undermaintained as the owner seeks to cut his operating expenses on an unwanted investment.

The net result of the drop in income is that most households will stay where they are, i.e., moves will decrease. Vacant fee units will be lowered in price as a response and some will be transferred to the rental market. New construction will have to compete with these units and will be sharply curtailed. Rental occupancy is likely to rise, on the whole. Maintenance and improvement of owner-occupied housing will be sharply reduced, especially in the lower income strata, but will be initially maintained in the rental sector, but subsequently reduced, especially in the lower income strata, as a reflection of lowered rents.

Assume now a market in which income and the interest rate are stable (the latter at some "normal" level). We allow in-migration and out-migration, however. Let us say that there is

a net in-migration over some period of time, subsequently ceasing, and that the composition of the migrants is identical in income and family characteristics with that of the original population. Assume again that vacancies are distributed proportionately among the housing stock. Finally, assume that vacancies are of the same order of magnitude as the number of households involved in the net in-migration.

Initially, there is a general tightening of the market as vacancies are filled. Rentals and sales prices rise.

Construction is undertaken, initially of housing intended for the fee market and subsequently of rental housing. There is some doubling-up in rental units, especially among non-family households. As migration continues, there will be some subdivision in rental units. In-migrants seeking fee housing will rent temporarily.

Out-migrants and dissolving households leaving fee housing sell in a favorable market. New construction in the upper part of the fee market begins to become available. With the appearance of new vacant units, buying is strong among the temporary renters, including both in-migrants and those previous residents who had sufficient savings and were at the stage of the life cycle where they expected to buy.

Prices remain high, however, but profits dwindle for builders as their costs rise. Buyers in this inflated market will purchase less housing than they would in a stable market.

New apartments begin to appear, but as many households which have sold their dwellings move into apartments, rents

remain high.

Additions to the supply through construction only affect the upper portions of the market directly. In the lower portions, there is much more renting of space and doubling-up in both tenure types and subsequent subdivision.

New construction reaches a state of excess supply, especially in the fee market. Some new fee housing may be shifted to the rental market if rental construction has been slow or small in volume. Prices fall on new units sufficiently to wipe out profits. Builders have to hold these houses until they are gradually absorbed by indigenous household formation or households shifting from rental to fee housing. The latter movement will continue, possibly in combination with additional new rental units in the upper rental categories to cause a loosening of the rental market and a long-term return to lower rentals.

The lower part of the market has remained tight. Where households higher up in the scale have, on balance, moved into new housing, increasing vacancies, households in the lower part of the market will be forced to bid for these in competition with households in the upper groups. Some housing will pass to consumers of lower income and will be maintained at a lower level than previously while others, both rental and fee, will be subdivided.

The net result of these movements is new construction of both fee and rental housing; subdivision of housing in a wide range of value classes, tending to increase the value of the stock but to decrease the value per unit; no demolition at the bottom;

a spread between purchase prices and long-run sale prices, depending upon the stage in the building cycle when they were purchased; and a larger proportion of vacancies in the upper part of the stock than before the in-migration.

In the very long-run, indigenous changes will take over. The vacancies in the upper part of the stock will fall in price or be subdivided and will be occupied; in this way, more units become available for the lower-income households. Eventually, vacancies will be distributed as before.

E. Implications for the Model Formulation

Two major themes have emerged in the preceding discussion. One revolves around the heterogeneity of the housing goods and of the transactions in the market. The other relates to the concept of the household as being, and remaining for protracted periods of time in a state of disequilibrium with respect to its level of desired housing consumption. In the analysis which follows, I shall develop and test a model of housing demand which explicitly accounts for this latter aspect of the market. It does so, basically, by dividing housing demand into two parts: the determinants of the move, which if not the only means, is at least the principal means for adjusting the level of consumption; and the determinants of the value of housing occupied by those households which make a move. Heterogeneity will be tested for in the mover demand equations by a series of formal statistical tests.

It may, of course, be argued that a demand model is inadequate to represent the complex relations which have been verbally

presented here. In defense of my approach I should point out that in spite of the complexities, some modest beginning must be made; and I consider that as an econometric investigation of the housing market of an individual area, this study is indeed path-breaking. Second, it is a peculiar feature of the housing market that the demanders are, to a considerable extent, also the suppliers, and that this combination of roles makes the demand function as defined in this study something more than the conventional demand function. The demand function does have one important failing. It lacks a price variable. Again, I can only plead that this work is a beginning; but more refined work may be built upon it.

CHAPTER II

THE MODEL

A. Some Empirical Problems

Behind the relationships presented in the previous chapter lie a wealth of empirical difficulties for the analyst of housing demand. For the most part these difficulties have been extensively described in the literature.[1] They will merely be reviewed here in summary fashion so that their significance may be evaluated in relation to the objectives of the present study.

The first group of difficulties stems from the nature of the housing commodity itself. Housing is extremely long-lived, so much so that even without a high level of maintenance, the individual structure is likely to extend over the life span of several households. This feature of housing together with the ill-defined and poorly documented role of capital maintenance make the measurement of output of housing as a capital good extremely difficult. Except for the trailer, which still represents a relatively small share of urban housing, the housing structure itself is for practical purposes immobile. This immobility raises the difficulty that on the one hand the household may enter the housing market not because of the existence

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[1] See, e.g., Reid (40), Muth, (38), Grebler and Maisel, (19), and Maisel and Winnick, (34).

Note: Single arabic numbers in parentheses, e.g., (14) refer to items shown in the List of References at the end of this paper. A set of parentheses enclosing two numbers separated by a period, e.g., (2.12) refers to an equation, where the first number is the number of the chapter in which the equation is included.

of a non-zero excess demand but because of the desire for a change in location, e.g., due to a change in place of work. On the other hand, the household wishing to remain in the same location while adjusting its level of housing consumption is usually limited by the structure to small and positive increments in such consumption. Partly as a result of the immobility of the housing structure, the consumption of housing has come to be associated with a bundle of goods. The delineation of this bundle of goods, however, raises additional problems. If at one extreme housing is defined as the housing structure or shell iself, or the services deriving from that shell, then the amount of housing service thus defined can be expected to be influenced to a large extent by significant cross elasticity with some closely associated good, including house furnishings and equipment and the services generally associated with site value, including the lot itself and local public services and neighborhood characteristics. On the other hand, if we group all of these commodities into a single bundle, we are dealing with a very heterogeneous good, the components of which might display very different elasticities with respect to the independent variables of the demand equation.[2] As was indicated in the previous chapter, heterogeneity is a distinct problem even aside from the com-

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[2] Muth, in his study of housing demand, deals mainly with the housing structure, commenting "there is no reason to expect that the income elasticity of demand for housing including land should be the same as that for structures only and, indeed, some reason for thinking that it might be higher. It seems quite possible that as income increases relatively more of the consumer's expenditure for housing, defined to include land, would be channeled towards securing a desirable location as compared with structural features." (38), p. 69.

plexity of the housing bundle. While styles may change in the production of most other kinds of consumer goods, e.g., automobiles, relative homogeneity exists among the different "models" at any given point in time; whereas the housing stock represents the accumulation of generations of housing structures with modifications added on.

Another general set of problems revolves around the subject of the payment for the consumption of housing services. As with most other durable goods, the consumption of the services of the good in the case of home owners is not synchronous with the payment for those services. Rather it is necessary for the home owner to build up equity at the beginning of the homeownership period; whereas at the end of the mortgage term, he is frequently left with a virtually unreduced level of housing consumption and a greatly reduced level of housing payments. Moreover, it is not uncommon for the market value of the house to increase during the tenure of the owner either because of physical improvements or because of increased prices, resulting in a capital gain. The identification of the magnitude and timing over the tenure period of the various sources of capital appreciation and depreciation and, therefore, of changes in the magnitude of the flow of services are virtually impossible with existing data and would in any case be arbitrary because of the lack of a realized market price criterion.

Investigators attempting to assign a value to the output of various kinds of capital goods are fond of pointing out that substantial rental markets for such goods would provide a direct

market measure of such output. This observation suggests a facile means for such imputation in the urban housing market, where one third to one half of households in an urban area typically occupy rental housing. In fact, the portion of the urban housing stock occupied in fee is frequently of a predominantly different character from that occupied by renters, both in its physical characteristics and in its location. Even if the housing bundle is viewed in its narrower sense, i.e., as the shell alone, there is considerable heterogeneity between the two tenure types. If we add to this concept locational considerations, the disparity is even greater. Furthermore, the desire for home ownership likely involves investment motives as well as the desire to provide the services of housing itself. Furthermore, in any short-run comparison the differential effect of institutional constraints such as mortgage requirements may be of considerable importance. In short, a household may perceive of a single house as two distinct goods depending upon the type of tenure arrangement that obtains.

A difficulty underlying all of the above mentioned problems is that the housing good is intimately associated with what might be called the "urban structure", which is not independent of the past but rather is the result of growth in which the relations which characterize the structure have been changing gradually over time. This resultant or conglomerate of structures remains with us, however, and prevents the marginal relationships which are now at work from achieving an equilibrium. Thus while the workings of, say, the wheat market, may be explained by var-

iables which, except for the previous few periods are temporally independent (aside from what might broadly be termed "technology") the workings of the housing market as one of the phenomena involved with the growth of the urban structure depend directly upon decisions made over the course of generations.

After these remarks on the difficulties of defining the housing good, it is perhaps not surprising to find that market relationships are more than usually complex. The flows within the market and the heavily demographic, as contrasted with economic, determinants of those flows have been investigated in the previous chapter. From the point of view of estimating a demand function, two specific problems which this complexity creates may be mentioned here. First, because the individual household makes such adjustments in housing consumption as are observable in the market only sporadically, the composition of demand may fluctuate from one period to the next, i.e., the demand function may be a composite, not of identical individual demand functions but of several possibly internally homogeneous groups of consumers whose relative importance may vary over time. This would suggest distinct investigations of a number of sub-markets defined by the intersection of several classes each of housing type, tenure type, and household type.[3,4]

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[3]For a discussion of such an approach see Grigsby, (20) Ch. II.

[4]On the other hand, in dealing with observations over time, the assumption of successive independent samples becomes more plausible, and serial correlation connected with statistical estimation is therefore less likely.

A second type of heterogeneity has to do with the spatial dimension. The existence of a specific and unmovable arrangement of housing types within a metropolitan area leads to the existence of spatially defined sub-markets. It is conceivable that in a large and diverse metropolitan area differences among the sub-markets for a given point in time may be greater than differences within such sub-areas over extensive periods of time. If there is a significant amount of heterogeneity among sub-areas within the metropolitan housing market, then it holds a fortiori that statistical comparison among metropolitan areas ought to include specific indicators of differences in urban structures.

Next on the list of empirical difficulties is the existence, or rather the non-existence of data on urban housing market demand which could conceivably be used to examine the complex relationships which I have outlined. Probably the most extensive set of data of usefulness in housing demand studies are the construction statistics compiled by the Federal Government; however, these statistics have not been collected on anything near a comprehensive basis until very recent years, and prior to 1960 were of very low reliability. These statistics have been valuable mainly for investigations of housing demand aggregated to the national level, or for the investigation of the contribution of housing investment in GNP.[5] For the purpose of a study at the metropolitan scale, however, available construction statistics are

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[5]Grebler, Blank, and Winnick, (18) and Grebler and Maisel, (19) are good examples of the former. Klein, (27) Duesenberry, (11) and Break (3) are examples of the latter.

of questionable usefulness since they can at best be correlated with household characteristics at only a relatively high level of aggregation, such as the county or SMSA, in which case heterogeneity among areas may become a considerable problem, or at very large observation intervals, especially the ten-year interval of the U. S. Census, in which case only a small number of observations is available and only long-run demand can effectively be estimated. Furthermore, even if improvements and alterations to the existing stock (for which the Federal Government has lately begun compiling partial statistics) are included in this concept of construction, it remains a somewhat erratic and loose response to fluctuations in housing demand and for the most part satisfies directly only that portion of households at the higher end of the income scale.[6] The second major possible source for housing demand data is the information collected decennially as part of the U. S. Census of Population and Housing. As indicated above, an observational time span of this magnitude limits time series analysis because of the problem of simultaneity, not to mention a serious problem in practice of changes in definition from one census to the next. Census data might provide an admirable basis for cross-sectional studies were it not that from the point of view of the present analysis they measure an inappropriate dependent variable, i.e., consumption rather than market demand, which

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[6]See Grigsby, (20), passim.

is what we are interested in.[7] Maisel (33) has demonstrated the disparity between housing consumption as observed in the 1960 Census and housing demand based upon housing values for a sub-sample of recent movers. A similar comparison will be made in Chapter III. Because of the existence of transaction costs, even the acceptance of the level of current housing consumption as representing a long-run optimum must be viewed with grave reservations. A household, e.g., which "over-consumes" housing, in the sense of being in a high percentile relative to other households with similar observable characteristics, may still be enjoying the result of a bargain purchase made in a previous period when housing prices were depressed. The relevant market for such a household is not the current market but some past market.

[7] See Reid, (40), who uses Census data in a variety of ways, including both the conventional type of cross-section and cross-sections of change variables employing 1950 and 1960 Census data.

B. Alternative Models of Housing Demand

Before discussing the specific model of housing demand which I shall employ, I shall mention what appear to me to be the three alternative approaches upon which such a model might be based.

1. The Marginal Model

This model is based upon the familiar theory of consumer demand in which the individual is posited as having a unique set of preferences and a well-defined set of demand functions, such that for given relative prices and a given budget the quantities of individual goods purchased are determined. Alternatively, the individual is said to adjust the relative amounts of goods purchased such that the marginal rate of substitution of any pair of goods equals their price ratio. The expression upon which the estimating equation for the individual unit is based is then of the general form

$$(2.1) \qquad Q_{it} = f_i (Y_t, p_{it}, W, Z_t, \omega_{it})$$

where Q_{it} is the measured quantity of good i consumed at time t, Y_t is the individual's income, p_{it} is the relative price of the good, W represents a series of observable characteristics of the individual which are assumed to be associated with the shape of the preference field, Z_t represents a series of other explanatory variables which may include the relative prices of closely associated goods, lagged values of Y_t or p_{it} or a time trend (in time series analysis) and ω_{it} is a stochastic term representing both errors of measurement in Q_{it} and the effect of other variables

not specifically included in the equation. Among the difficulties of applying this model for the purposes of the present study are (a) that it assumes perfect knowledge on the part of the consumer about the market whereas in the housing market there is widespread ignorance both on the part of buyers and sellers as to prices prevailing in other transactions, so that two housing bundles which might be regarded as perfect substitutes actually sell for different prices on the market; (b) that the consumer is assumed to adjust his consumption of the good at every point in time to the equilibrium level, whereas the existence, in reality, of considerable transaction and moving costs in respect to housing may result in large and continuing disparities between actual and equilibrium levels of consumption; (c) that goods demanded in a period are consumed in the same period; whereas, for owner-occupants, at least, payment for the good is not simultaneous with its consumption, the motivation toward home ownership being at least in part the motivation to capital investment; (d) that the model is static. While most of these defects are not critical in investigations of long-run demand, they suggest that the use of this model to measure dynamic short-run effects is highly questionable.

2. The Portfolio Model

Whereas the traditional consumer demand model deals with a flow of services as the object of consumer satisfaction, the portfolio approach concerns itself with the ownership of stock and goods by the individual who adjusts the relative amounts of

such stocks held according to his expectations of costs and returns from the stocks so as to maximize his net capitalized return. This approach presents the following problems: (a) like the conventional consumer demand theory, it is static and gives very little help in understanding dynamic interaction; (b) it has the same assumption of knowledge of the market; (c) it would appear to be appropriate only for the homeowner portion of the households; (d) at least in empirical studies thus far, which have admittedly been severely restricted by the data available,[8] significant effects of home ownership upon the investment portfolio have been demonstrated; but of much greater interest for the study of housing demand is the complementary influence of the composition of the consumer portfolio as a determinant of the size and timing of house purchase, an influence which this approach has had little success in tracing.

3. The Consumer Durables Model

The consumer durables model, which will be the starting point for my own empirical work, is in fact a variety of approaches to the problem enumerated under the previous two headings. Thus, one of the themes which is found throughout the literature on consumer durable demand analysis is an attempt at a reconciliation between the ideas of consumer satisfaction as deriving on the one hand from the consumption of services flowing from goods and on the other hand from the possession

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[8]See Watts and Tobin (54), Goldsmith and Lipsey (17), and Claycamp (6).

of those goods itself. Stocks have been conceived as yielding a flow of services which is the object of consumption. The volume of this flow is adjusted to the level of desired consumption by altering the amount of stock held. This view was expressed by Suits, who stated, "The service desired is a function of income; the service supplied a function of stocks." (44) At a theoretical level both Theil (cited in (7)) and Chow (5) reformulated classical demand theory so as to include both the consumption of services and the possession of stock converted into flow terms. At the empirical level, this reconciliation has hinged upon some critical assumptions as to the time path of depreciation of the durable good. For instance, Chow in his study of the demand for automobiles treated the basic unit of demand as the amount of capital value "used up" in any given time period as measured by prices in the second-hand market. Unfortunately for the present study, houses do not come in a discrete variety of models as do automobiles, nor is there a "Redbook" for houses even by generalized types and ages because of the sizeable influence on market price of maintenance and alterations. The availability of such data for automobiles may explain the popularity of this good for demand studies. Its non-availability for most other durables makes the computation of an appropriate rate of depreciation highly problematic.[9] In what is probably the best known study of housing demand using the consumer durables approach, Richard

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[9]See Burstein in (21).

Muth (38), p. 32 defines a unit of housing service as the quantity of housing service yielded by one unit of housing stock per unit of time. The price of this service to the consumer is the rent, composed of the net return to the landlord plus an allowance for depreciation. By means of the simplification of making all these rates proportional to the capital value he was able, in the actual estimation equation, to employ capital value as the dependent variable. This value could be taken as representative of the consumption of housing services without making a numerical estimate of the rate of depreciation.

Another question which has frequently been of concern to analysts of consumer durables demand is the distinction between long-run and short-run demand. The statistical identification of long-run and short-run demand elasticities has usually taken one of two forms: either the level of stock at the beginning of the period of observation has been included among the determinants of the level of stock at the end of the period of observation or, where the stocks of goods and services derived from those goods could be separately measured, short-run demand was defined as demand for the flow of services while long-run demand was defined as the demand for the stocks yielding those services. Among the former are studies employing the stock adjustment model, which I shall discuss in more detail, or variations upon that model such as that of Houthakker and Taylor (23). The latter are represented by the studies of demand for electricity by Fisher (13) and for natural gas by Balestra (1).

4. The Stock-Adjustment Model

Dynamic formulations of consumer demand for durable goods have in general relied upon some variation of the familiar stock adjustment model, which may thus be characterised as a particular variant of the consumer durables model. This model, as developed by Metzler and subsequently refined by Nurkse, Goodwin and others, was designed to explain movements in producers' inventories. It was adapted initially by Stone and Rowe for the analogous case of consumer durables. Basically the model postulates a reaction on the part of the consumer to differences between his desired and actual levels of stock. In its simplest version the model can be expressed as

$$(2.2) \quad Q_t - Q_{t-1} = \rho \left(Q^*_t - Q_{t-1} \right)$$

where $Q_t - Q_{t-1}$ represents the change in level of consumer stocks between two successive periods; Q^*_t represents the desired or long-term level of stock ownership; and ρ is a "reaction coefficient" which is stable over time. This model states that the adjustment between desired stocks and the level of stocks actually held is proportional to the gap between the two levels, where the reaction coefficient which is positive with a magnitude less than one, is a measure of the friction which prevents the consumer from making a complete adjustment in each period. Reasons for such friction might include: (1) the assumption on the part of consumers that changes in the relevant variables are only temporary; (2) ignorance of changes in the market due to poor information flow; (3) tem-

porary illiquidity; and (4) shortages of supplies which are not yet reflected in price increases. The variable Q^*_t is not observed, since the consumer (even in the extreme case of the housing commodity) never "comes to rest" in his consumption of a single good relative to a desired level. It is postulated, however, that the determination of this variable can be represented by the equation:

$$(2.3) \qquad Q^*_t = \alpha_o + \alpha_1 Y_t + \alpha_2 p_t$$

where Y_t is some measure of long-run or permanent income and p_t is the relative price of the good. By substitution and some rearrangement, we then obtain the equation:

$$(2.4) \qquad Q_t = \rho\alpha_o + \rho\alpha_1 Y_t + \rho\alpha_2 p_t + (1-\rho)Q_{t-1}$$

where ρ, and hence the α's, can be identified in a regression equation from the coefficient of Q_{t-1}. The equation as written attempts to explain short-run demand with the size of ρ depending upon the length of period chosen for the estimation. In the long-run version of the model ρ is set equal to one, so that the variable Q_{t-1} drops out and the "stock adjustment" feature disappears as consumption is continuously at equilibrium.

The stock adjustment model raises problems at several levels of generality of application, but I shall discuss here only the salient ones as they pertain to the analysis of demand for housing. First, while firms may be thought of as continually varying their level of stock in order to approach or maintain some level conceived as the optimum, or, in terms of the esti-

mating equation, as making such adjustments at short and regular intervals over time, the behavior of the individual household with respect to housing cannot be realistically characterized in this way. Its decision as to the amount by which it wishes to adjust its stock is made at staggered and sometimes very lengthy intervals. This is so because in the great majority of cases it occupies only one dwelling unit at a time and disposes of its entire prior stock at the time of the adjustment. In dealing with aggregates of households we can assume that something approaching such continuous adjustment does in fact take place; however, in each period the adjustment affects different groups of households so that we are not aggregating the behavior of elemental decision units, which would be desirable, but rather are averaging the behavior of households which at any period in time are of two distinct types -- those who make an adjustment and those who do not. It might be possible, of course, to use observation periods which are long in comparison with the lifetime of a household so that all, or nearly all, households would be included in the adjustment process during each of these intervals. Aside from smearing over the short-run adjustment process which it is the object of the stock adjustment model to represent, this alternative would aggravate one of the other shortcomings of the model. Equation (2.3) expresses the desired level of stock as a linear function of income and relative price. As written, it implies that for a given level of prior stock, tastes remain constant. In cross-section, tastes are assumed constant over different types of households with different family characteristics

and different experiences of housing consumption; while in time series the assumption is that tastes are constant over the life cycle of the household. While the effects of heterogeneity can to some extent be mitigated by the addition to equation (2.4) of a series of variables representing family and environmental characteristics,[10] serious problems still remain for both types of estimation. In cross-section it is frequently likely to be the case that households with high prior stock levels are disposed to allocate larger portions of their budget to housing. In time series, and again referring to macro-estimation, it is probable that the differences in types of households which enter the market from one period to the next as influenced by changes in macro-variables, e.g., credit terms, are likely to be accompanied by differences in tastes. Thus mature households with large amounts of housing equity are less likely to be deterred from purchasing in times of tight credit than are younger families with little or no equity.

The two other major difficulties of the stock adjustment model pertain to the adjustment coefficient. This coefficient perhaps more than any other element of the model appears to obscure a considerable amount of heterogeneity. It is implied that the proportion or speed of adjustment to the desired level is symmetrical with respect to upward and downward movements. This assumption appears to be unrealistic for durable goods in general and for housing particularly. The level of housing stock to which the consumer adjusts is likely to be very closely associated with

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[10] See e.g., Fisher (13), p. 78.

the level of stock which he had prior to the adjustment -- this much is expressed in the stock adjustment model. It is likely, however, that the consumer will be much more reluctant to make a downward adjustment in his housing consumption than he would be to make an upward adjustment. This asymmetry has been observed for consumption as a whole and has been the basis for the work of, among others, Duesenberry (11) and T. M. Brown (4) on the consumption function. There are several reasons which could be put forward for this type of behavior in respect to housing. It is one of the more visible elements of consumption and as such is an important symbol of status for the individual in his society. Since the individual frequently must commit himself to a particular level of housing for an extensive period, he is less likely to be able to "do without" his accustomed level of housing consumption in times of temporary financial reverses. The homeowner who changes to another house in fee and who holds substantial equity in his prior housing seems likely to hold constant the absolute level of equity and to want to hold constant or to reduce the ratio of equity to value than he is to increase it, so that barring drastic intertemporal price changes, the value of his new housing is likely to be higher than the value of his old. Where households look forward to a period of prolonged reduction in earning power and hence in mortgage payment ability, this may not be the case; on the other hand, households with older heads, among which such prospects of reduced income are proportionately greatest, are most likely to have completed their mortgage payments so that this exception may not in fact

be statistically important. Finally, it seems not unlikely that the reaction coefficient would vary systematically among different types of households on cross-section and over time with changes in macro-variables. For purchasers of homes, equity and other forms of saving play an important role in relation to the required down payment and hence in the extent to which the household can "react" upward. Renter households are apt to react differently according to whether they are saving for a down-payment on a house or intend to rent for a prolonged period. In the former instance, the household would view a reduction of rent as a means of accumulating savings at a faster rate. In general, the anticipated length of tenure in the housing into which the household is moving is likely to influence the proportion of the gap which is covered by the adjustment. Anticipated changes in household size which are unlikely to be well represented by observable variables, and which in fact would cause differences in the level of desired stock would introduce variance into the estimated coefficient. Since the adjustment in stock level is not smooth and gradual and involves purchasing or contracting for a single dwelling unit with a particular level of housing services, price distortion and shortages or excesses which are not general to the market but peculiar to the portion of the market where the desired level of stock per housing unit is located will cause similar distortions in the amount of adjustment accomplished, e.g., a temporary shortage of $15,000 houses may cause a household to purchase a $13,000 house rather than

one at the higher figure.[11] In time series analysis which, because of the erratic and relatively infrequent adjustment of the individual household in the level of its housing stock, is of necessity analysis of aggregated data, much of this heterogeneity is smoothed over. The simplicity of the form of the model obscures some of the features of demand which are of the most interest, however. Because the explanatory variables pertain to aggregates which would in our case include both those who made positive or negative changes in their stock level and those whose level of stock remained unchanged, the model does not account for changes in the composition of demand over time, i.e., in the characteristics of that portion of the population who do make adjustments. In addition, the model does not identify variations over time in numbers of consumer units making non-zero adjustments, much less their distribution according to the proportion of the "gap" which they make up in each period in which they do make an adjustment. While many of these shortcomings may not be considered serious in a macro-model, they represent considerable weaknesses from the point of view of the purposes of this study, and in a broader view, of any micro-economic study of consumer durables demand.

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[11] If households in such instances tend to invest the additional money in improvements to the house which they do in fact obtain, the stock adjustment model is justified in this regard; however, the measurement of such an effect is not likely to be made with the data which, to my knowledge, now exist.

C. The Present Approach

1. The Model

The problems which have been raised thus far, both of a conceptual and of an empirical nature, do not bode well for the formulation and estimation of a meaningful model of housing demand at the micro level. The task does not appear to be made easier, moreover, by the introduction of non-observable or allegedly invariable factors such as Q^*_t and ρ in the stock adjustment model. Accordingly, the model upon which the present study is based, while including a recognition of the peculiar characteristics of housing as opposed to non-durable consumer goods will represent only modest (but nevertheless novel) deductive elaborations of the traditional optimizing model of consumer behavior as modified in the recent literature of economics. The main thrust of the analysis will be rather upon experimentation with alternative equation forms and definitions of variables. This seems appropriate since the emphasis of this study is not upon theoretical development in the area of housing demand but rather upon the empirical investigation of a previously unexploited set of data.

The structure of the model, which may be briefly presented, consists of two main parts. The first part attempts to explain the probability of an individual's entering into a housing market transaction in a particular period by the generalized expression

$$(2.5) \qquad E(m_i) = f(x_{1i},\ldots,x_{ki}, x_{mi},\ldots,x_{pi}, x_r,\ldots,x_s)$$

where m_i is a dichotomous variable which takes a value of one where the individual "i" makes a move in a given time period and a value of zero if he does not; $x_{1i}, \ldots x_{ki}$ are a series of "state" variables measuring characteristics of the individual and $x_{mi}, \ldots x_{pi}$, $x_r, \ldots x_s$ are a series of variables which represent stimuli which may originate either within or outside the household. Some of these stimuli may be defined as changes in the state variables. The idea here is that the propensity to move varies with the level of certain economic and family characteristics, such as income and family size, and that changes in these variables and/or other variables have a separate and additive influence upon that propensity.

The second part of the model may be summarized in the expression

$$(2.6) \qquad E(Q_i|m_i) = g(Y_{i,t-1}, H_i) \cdot (m_i)$$

The term Q_i represents the level of housing services contracted for, conditional upon entry into the market at a given period, i.e., normally accompanied by a move. This level of housing service may be referred to as either "quantity" or "value", the two concepts being treated as equivalent in this study. The terms in the argument of the first expression on the right-hand side, which will be discussed further below, are, respectively, income, price, level of housing services consumed at the beginning of the period and family characteristics.

The full model involves the multiplicative relation:

$$(2.7) \qquad E(Q_i) = f(x_{1i}, \ldots, x_s) \; ; \; g(Y_i, \; p, \; Q_{i,t-1}, \; H_i)$$

where the dependent variable is the expected value of housing services by all households, regardless of whether they participate in the market during the period. The expected value of demand is, therefore, an average of the positive level of demand by movers and the zero-level demand of non-movers. The measure of demand, however, is the amount of housing service actually purchased in the market by those who move. In this study, therefore, two types of functions will be estimated: one based upon the entire population of households (the probability of a move measured as a proportion) and the other based upon those households which move.

It should be noted first that the concept of demand employed here is one of gross market demand, i.e., aggregating the demand functions would yield the total amount of housing purchased or leased rather than the change in overall consumption. On the other hand, and leaving aside problems such as households leaving the market entirely, the empirical treatment of which is beyond the scope of this study, the inclusion of starting stock on the right-hand side of the expression implies that net demand, or change in level of consumption may be calculated by summing the individual differences. Second, the distribution of characteristics of movers is not predicted from the characteristics of the population in this model, and as such is an important missing link in the predictive chain.

The quantity-determining portion of the equation may be interpreted as the long-run demand function while the resultant of the

multiplication of this long-run demand function and the function predicting probability of market transaction constitutes the short-run demand function. It is assumed that when a household enters into a market transaction for housing it is able to make a complete adjustment to the level of housing consumption appropriate to its individual horizon; hence, its observed level of purchase is a long-term level. In this construction, short-run demand cannot be measured for the individual. Viewing (2.7) as a continuous function, short-run behavior on the part of the individual may then be interpreted as a potential. Where observations are taken across households, however, this potential becomes the observed market demand.

This model, while it by no means provides a solution for all of the problems raised in the prior discussion, has some important advantages. First, it is flexible, in that it captures, in a likelihood sense, the variation and frequency with which households establish their level of housing consumption as well as the determination of that level so that the cause of variations in aggregate demand can be more precisely analyzed. Second, it deals with market demand, which we can meaningfully discuss as a periodic phenomenon rather than with consumption which, at any point in time, is a cumulative result of past demand decisions. Its chief disadvantage is that the estimation of an equation corresponding to (2.5) involves a dependent variable which can vary only between zero and one. This problem will be discussed below under Section C.3.

2. Determinants of the quantity of housing demanded

The cross-section regression equation for (2.6) is

$$(2.8) \qquad Q_i = a_o + a_1 Y_i + a_2 Q_{i,t-1} + a_3 A_i + a_4 N_i$$

where A_i, the age of the head of household and N_i, the number of members in the household, represent the family characteristics previously symbolized by H_i. Observations are taken only on movers, for whom m_i equals one.

Taking the variables of (2.8) in order, the dependent variable represents the stock of housing purchased or rented in current market transactions. For single family fee housing this value is simply the value stated on the interview questionnaire. For rental housing it is necessary to make some conversion from rent level to equivalent stock value. One possible basis for such a conversion would be the definition of Muth referred to previously, i.e., that "the price per unit of housing service, or rent, is the price paid by consumers for the flow of services from one standard house per unit of time". This definition could be given operational content by calculating the familiar "gross rent multiplier" which results from the capitalization of the expected stream of returns to the owner of rental housing and which can be quantified by observing sales prices and rent yields on such housing. If an objective of this study were an investigation of the implications of changes in housing demand upon the stock of housing as one component of the conventionally measured stock of capital goods, such a conversion would be appropriate. Since our interest in the stock of housing is in its

role as a consumption good, however, it seems more appropriate to convert the level of rent which a household is observed to pay to the level of the value of housing which the same household would be expected to own if it did, in fact, own its housing. Operationally this conversion involves comparing fee and rental levels for similar households. This conversion, unlike the "gross rent multiplier" recognizes that a single housing unit represents to the consumer two different goods depending upon whether the unit is owned or rented and that these two goods are only imperfect substitutes. Ownership involves investment considerations which renting does not, so that imputing a capital stock to renters equivalent to the size of the stock as valued by landlords obscures this distinction. Of course, if the housing market were entirely without rigidities, if each housing unit could feasibly be shifted between the fee and rental markets, according to the one in which it obtained the higher price, if there were no downpayment requirements, and if there were no transaction costs, then the two types of equivalence would be equal. But because physical rigidities and other types of frictions do in fact exist, the two will, in general, be different. Perhaps the most obvious objection which might be raised to this particular type of equivalence is that owners as a class may have different tastes from renters. Specifically, ownership would appear to be prima facie evidence for a relatively strong preference for housing as opposed to other types of consumption, or at least to particular types of physical configurations of the housing bundle. Part of this apparent difference is probably due to the kinds of friction which I have just mentioned; but, even

assuming it to be a valid objection, it will be shown in Chapter IV that the employment of a simple equivalence in pooling the two groups is at least no worse than treating purchasers and renters separately but ignoring their tenure type prior to the transaction.

Interest in the income variable in this study will be centered around an investigation as to which of several definitions of permanent income yields the greatest amount of explanatory power and whether any or all of these variations are superior to the current income measure. If (2.8) is a legitimate long-run demand equation, then it would be expected that some measure of income which reflects the consumer's expectations over at least several years would be superior to a measure, a substantial proportion of which includes a transitory effect. A number of techniques have been proposed, by Friedman and by others, for deriving measures of income which minimize this transitory effect. Several of these measures will be employed as appropriate, according to the particular hypothesis under investigation.

The prior stock variable may appear to be out of place in what is asserted to be a long-run demand function.[12] The prior

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[12] In other studies the prior stock variable is typically eliminated by some variation of the following means. An equation equivalent to (2.8) is transformed to a form such as (2.9) $Q_i - Q_{i,t-1} = a_o + a_1 Y_i + (a_2 - 1)Q_{t-1} + \ldots + \varepsilon_{il}$. If the left hand side is set equal to zero, implying that the level of the stock remains constant over time, i.e., equilibrium level, then (2.9) becomes

(2.10) $0 = a_o + a_1 Y_i + (a_2 - 1)Q^* + \ldots + \varepsilon_{il}$

(cont.)

stock level is investigated in this study, not simply as a constraint upon the achievement of an optimal level of stock, although this aspect must be considered, but as perhaps the single most important variable representing individual household tastes. As such, it is expected to be an important determinant in the explanation of level of stock purchased in the market since, judging by the experience of prior studies relying upon cross-sectional micro estimation of demand for individual commodities, the proportion of the variance of the dependent variables which income alone can be expected to explain would probably be small.

There are two aspects of household tastes as they affect the level of housing demand which I shall attempt explicitly to account for in the present analysis. One aspect which the level of prior stock is intended to represent may be called the "habit formation" effect. This effect results from the household's experience of housing consumption over the prior course of its existence. It is asserted here that the household builds up its level of housing stock relative to its income over the course of its existence and that the level of stock which the household attains at any point in time depends to a considerable extent on the previous time path of housing stock level. Accordingly, if we had observations of the level of housing stock and the other pertinent

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12 (cont.)
where Q^* is the long-term or "desired" level of stock and the parameters of the long-run equation can be estimated indirectly as

$$(2.11) \qquad Q^* = \frac{a_o}{(a_{2-1})} + \frac{a_1 Y_i}{(a_{2-1})} + \ldots \quad .$$

variables for a household over time together with some appropriate discounting formula for past experience we should be able to account for this aspect of the household's tastes. The higher the discounted level of prior housing stock for a given household compared with another with the same characteristics, the more it would be expected that the former household would purchase in the way of housing stock in the transaction. The level of stock which is held just prior to the transaction is suggested here as a gross measure of the different housing consumption experience among various households with similar income and family characteristics. The relation of this level of housing stock held just prior to the transaction to the hypothetical, discounted level of housing stock, and hence to the level of housing consumption tastes will, it would be expected, vary according to the frequency of adjustment in the past and to variations in income and in family size over the relevant previous period. If the suggested retrospective rate of time discount is very high, however, as we might expect, then the prior stock level may be very important in accounting for this aspect of taste. Specifically, in the context of the "building-up-stock" hypothesis, it would be expected that only in the presence of a severe income decline would the level of housing stock following the transaction be lower than the level previous to the transaction. In this connection, the constraining influence of the level of prior stock, which is so much stressed in the stock-adjustment model, acts counter to this taste effect where the "gap" between desired and currently-held stock levels is positive. If this constraint is small relative to the taste effect,

then the coefficient of $Q_{i,t-1}$ in (2.8) may be large, even greater than one, which would be a result contrary to the stock-adjustment model. If the constraint is of comparable importance with the taste effect, however, then the coefficient might well be insignificant. On the other hand, the taste effect, which inhibits the formation of a negative gap, would be reinforced by the prior stock constraint where income and other variables indicate a downward adjustment. In such a case, we should expect that the coefficient of prior stock would be large and significant, while income would be a relative unimportant explanatory variable.

The second aspect of taste can be accounted for only in observing discrepancies in behavior among households when all of their relevant observable properties have been accounted for. Thus, given two households with identical housing consumption histories and identical family and income characteristics, the problem is then to account for discrepancies in amount of housing service contracted for in a transaction, assuming that the most important relevant observable properties of that household have been included among the explanatory variables. This discrepancy is a problem concomitant with the traditional type of cross-section analysis. In the present study the existence of data on individual households for prior periods presents us with an opportunity to account for these individual household differences in taste. Specifically, where a household has reported moves both in the cross-section year and in some prior year, the level of housing stock contracted for in the next previous individual housing market transaction, adjusted for the family and income characteristics at the time of

that transaction, may be introduced in addition to the explanatory variables of the cross-section year.

The approach may be summarized as follows: Given the traditional cross-sectional demand model for the individual household

$$(2.12) \qquad Q_i = \alpha_o + \alpha_1 Y_i + \omega_i$$

the error term, ω_i, may be partitioned into two components which I shall specify as being independent as follows:

$$(2.13) \qquad \omega_i = \gamma_k + \lambda_i$$

where γ_k represents the effect of prior housing consumption, this effect being constant over all households with similar housing histories (index k) and λ_i represents the residual or "pure" household effect which is constant for the individual household over time but varies among households in cross-section. In the analysis which follows, attempts will be made to reduce the variance attributable to both of these error components, both individually and simultaneously. While it is possible to define these two effects as being orthogonal, it is another matter to represent them empirically. The level of prior stock has been suggested as the best single representation of the former component.

Some of the variance attributable to λ_i may be reduced in accordance with the regression equation

$$(2.14) \qquad Q_i = a_o + a_1 Y_i + a_2 (Q_{i,t-m} - a_o - a_1 Y_{i,t-m})$$

where t-m refers to the period in which the previous housing transaction of the household was made, but where the parameters a_o, a_1 are as estimated on the cross-section year variables exclusive of these lagged values.

The validity of introducing, simultaneously, the two variables proposed as being representative of the two parts of the partitioned error term of (2.13) depends upon their lack of correlation; but it would not be surprising to find that they are in fact highly and positively correlated,[13] since e.g., "high" housing consumers would have enjoyed a higher level of housing consumption over the past, ceteris paribus, than "low" consumers, and therefore would come to the market with a higher level of prior stock. On the other hand, if the magnitude of the pure household effect has been small by comparison with variations in income or liquidity over time, then the correlation might be expected to be very low. The validity of the partition is therefore likely to be enhanced where the household has experienced wide fluctuation in such variables over time. Furthermore, we might expect λ_i to be larger, relative to ω_i, for high income households than for low income households if the proposition of Chapter I is correct, namely that low income households are more constrained, relative to their incomes, in the range of housing which they may consume than are high income households. Consequently, λ_i would be expected to be larger, in absolute size, on the average

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[13] In that case, the coefficient of the prior stock variable would be reduced.

for high income than for low income households, i.e., in statistical terms, the relation may be heteroscedastic. The introduction of the correction represented in (2.14) may help to alleviate this condition.

The age-of-head variable is of considerable interest in view of the model presented here. If the model is correct, it would be anticipated that, assuming age of head is highly correlated with the number of years for which the household itself has existed, the coefficient of this variable would be positive where the prior stock variable is not included among the determinants, i.e., as the household ages and enters into successive transactions, its stock level grows and this, in turn, begets still higher stock levels in succeeding transactions. With the inclusion of the prior stock variable, however, the sign of the coefficient of the age variable would be expected to be negative or insignificant since the increment in its housing stock, while it may remain non-negative, will probably diminish as the household ages and achieves its plateau, implying non-linearity. One counterinfluence here is that equity in housing and other forms of saving increase with age so that the household with an older head is more likely to be able to increase its level of housing stock by a large amount, especially through the reduction of his equity-to-capital-value ratio, than is the younger household with an equal level of income. On the other hand, if this increased level of saving with age has an effect at all on housing stock level, it is likely to come in the ownership market. Since in this study both rental and ownership markets are for the most part treated

jointly and since for any specified period the number of households moving into rental housing greatly exceeds the number moving into fee housing, such an effect, if it exists, is not expected to have important statistical consequences.

There are obvious intuitive reasons for including household size since it would be expected that increasing size would lead to greater consumption of housing services. Previous empirical studies leave some doubt about the validity of this assumption, however, depending upon the definition of the unit of housing employed. Martin David (9), for instance, has shown that with increasing family size the size of the housing unit measured in terms of numbers of rooms increases, but that this effect is outweighed by a decreasing ratio of value per room so that the net effect is a decline in expenditures with household size. Although he worked with a sample of households which were expected to be close to their equilibrium level, David nevertheless measured consumption rather than market demand. For households involved in the market, however, the results may be considerably different. No hypothesis will be offered in this study, however, which would imply a priori expectation of one sign or another. The variable will be retained or not depending upon its significance in the estimated equations.

3. Determinants of the Probability of Moving

Before proceeding to a formulation of a regression equation suitable for the prediction of the probability of a household move, we must deal with the problem frequently met in studies of owner-

ship of, as contrasted with demand for, consumer durables. The problem is that at the micro level the observed value of the dependent variable in (2.5) is either zero or one, i.e., the unit owns or does not own or, in the present analysis, moves or does not move in the relevant period. The problem results from the assumption in the classical linear regression model that the dependent variable can take on any value between plus infinity and minus infinity. In the so-called "linear dependent" model an ordinary least squares equation is fitted to a hypothesized relationship with the observed values of the dependent variable limited to either zero or one. Unfortunately, in such an application the classical assumption of constant variance of the error terms is inappropriate.[14] In addition, the predicted group average value for the dependent variable may fall outside the range of zero to one.

The second approach is the use of discriminant analysis, a technique designed to distinguish between (in its most common form) two sub-groups within a population on the basis of a vector combination of the characteristics of each member of the population. While a number of the results produced by the discriminant model are equivalent to those of the "linear dependent" model,[15] the former has the advantage that all units are classified

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[14]For a discussion of most of the models mentioned in this section, see Goldberger, (16), pp. 248-255.

[15]Similarities and differences between the two methods are explored in a recent article by Ladd, (30).

as being in either one sub-population or the other up to a given level of confidence so that the total of, say, movers and non-movers would always be 100 °/o. On the other hand, discriminant analysis is based on a different model from that of classical regression analysis in that it is assumed that the independent variables come from two normal populations with a common covariance matrix but with different means, whereas the regression model makes no assumptions about the distribution of the independent variable.

In the present analysis neither of the above two approaches will be used, the reason being that since in the quantity determination portion of the model we are relying upon classical regression methods, it would seem appropriate to employ the same model in the other half of the computation. The method to be used here is simply to group the observations, assuming that the proportion of movers observed in each cell is equivalent to the average probability for that cell. The resultant loss in information due to grouping may be partially compensated by making adjustments for differences in distribution.

While grouping overcomes the specific cause of heteroscedasticity found in the linear dependent model, it leaves us with the problem that the predicted value of the depen dent variable may fall outside the interval between zero and one, which is a nonsense result in terms of the definition of the dependent variables. In order to circumvent this problem, I shall draw upon the so-called probit analysis model which has long been

used in biometric research.[16] The essence of the model may be briefly explained. Let the individual be subjected to some stimulus r_i and assume that the individual has a critical threshold level r_i^*. If

$$r_i > r_i^*, \; m_i = 1$$
$$r_i < r_i^*, \; m_i = 0$$

Let a large population of individuals be exposed to a uniform level of dosage or intensity of stimulus r^o. If the density function for the probability of an individual value of y being one is given by f(r), i.e.,

$$(2.15) \qquad E(m_i|r) = Pr(m_i = 1|r) = f(r)$$

then for the entire population the expected proportion of response to that level of stimulus is given by

$$(2.16) \qquad Pr = \int_o^{r_i^o} f(r)dr = F(r^o)$$

In biological assays, e.g., of the effects of insecticides upon flies, randomly selected groups of individuals are exposed to different levels of dosage. It is generally assumed that the tolerance levels of the individual are distributed either normally or log-normally, so that Pr is a function either of the dosage or the logarithm of the dosage. The response rate can be fitted to the model (2.16) where $F(r^o)$ is the value of the standard cumula-

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[16] See Finney (12) for a detailed exposition. Tobin (48), Warner (53), and Cramer (7) have discussed applications of this model in analyses of consumer behavior.

tive normal distribution at r^{o}. Expression (2.16) implies a non-linear regression; however, we can avoid the computational difficulties involved in such a regression by an approximation recommended by Berkson (2). He suggested that the probability, Pr, of a positive response may be given by a logistic function which has the same general shape as a cumulative normal curve. The probability would then be represented by the expression

$$(2.17) \qquad Pr = \frac{1}{1 + e^{\alpha_o + \alpha_1 x_j}}$$

which may be transformed into the expression

$$(2.18) \qquad \ln [p/(1-p)] = \alpha_o + \alpha_1 x_j$$

where x_j is the level of dosage in cell "j" and p is the proportion of response in that cell, where the proportion is substituted for the true probability.[17]

The adaptation of the probit model for the purposes of the present study raises several difficulties which are not encountered in the application of the basic model to the kind of experimental problem for which it was derived. In the classical biological experiment the dosage of a single agent could be varied and the proportions of responses observed where a number of agents are involved. The well-known factorial design could be employed wherein one agent is varied while the

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[17]This substitution is accurate for large numbers of observations. Berkson suggests, however, that each observation be weighted by $[n\hat{p}(1-\hat{p})]$, where "n" is the number of individuals in each group and $\hat{p}$ is the observed value of the dependent variable.

others are held constant. Where the cells in which we are interested are geographically defined and where the number of observations within cells are variable and frequently small, this type of procedure becomes difficult, if not impossible. In this connection we can think of three types of models for the case of several agents or variables acting simultaneously. Let us say, still employing the language of biology, we are interested in the toxic action of a drug or poison.[18] The three types are (1) independent joint action, in which the response to the mixture can be predicted from the response curves for the individual constituents acting alone with an adjustment for the correlation in susceptibility to the two constituents; (2) similar joint action in which the constituents may be substituted in constant proportion for one another, the response to the mixture being predictable directly from that of the constituents if the relative proportions are known; and (3) synergistic action in which the response to the mixture cannot be predicted from the individual components acting alone. In the present study the second model, that of similar joint action will be adopted. This model is the one which involves the greatest amount of simplification. It is typical, however, of econometric models in which the explanatory variables are generally taken as being additive and independent. Another problem is that whereas in the biological experiment the level of dosage in each cell is uniform, in our analysis all of the explanatory variables may take on a range of values within each cell, implying at the very least

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[18]These three types of action in relation to probit analysis were first discussed systematically by Bliss (cited in Finney (12), pp. 122-124.)

a need for some adjustment for differences in distribution. Still another difference between our analysis and that conducted in the laboratory environment is that the level of stimuli or explanatory variables not only varies within each cell, but is at a zero level for many of the individuals, i.e., they are subjected to no stimulus whatever. This might appear to put us back where we started when we began the consideration of the present model. The difference is that we are now considering as a dependent variable a proportion rather than an absolute value. It should be noted before we discuss the particular version of the probit model which will be used in this study, that previous econometric applications of the model[19] have relied upon a series of "state" variables, e.g., income or net worth. An index, corresponding to "I" in (2.26) below was constructed as a linear combination of these explanatory variables. This treatment is appropriate for the analysis of the ownership of consumer durables (in which those investigators were interested) rather than their purchase. The resulting index represents susceptibility, where the level of stimulus is assumed constant. In the present study, however, we are interested primarily in the effects of variations in the stimuli. In this respect, our model is more in the spirit of the original biometric application than are the formulations of the previous econometric studies in which it has been employed.

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[19] See, e.g., Dernburg (10); the study of Tobin (47), which has also been mentioned in several other works, is very inaccessible.

In the present version of the model we assume that the magnitude of the response of an individual "i" is given by

(2.19) $R_i = K\ln(r_i / r_i^*)$

the Weber-Fechner Law of psychophysics[20], where r_i^* is the critical threshold level and K a constant of proportionality, and assume

(2.20) $r_i^* = \overline{r^*} + \omega_i \qquad \omega_i \sim N(0, \sigma^2)$ [21]

then

(2.21) $R_i = K\ln r_i - K\ln(\overline{r^*} + \omega_i)$

using a Taylor's Series expansion, dropping the higher order terms and normalizing, we get

(2.22) $R'_i = K'\ln r_i - K'\ln\overline{r^*} + \omega'_i \qquad \omega'_i \sim N(0, 1)$

if the right-hand side is positive and $R_i = 0$ if it is negative. This leads directly to

(2.23) $Pr(m_i = 1) = f(R_i)$

which is identical to (2.15).

If we assume that a combination of stimuli will be additive in

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[20] See Torgerson (49), pp. 149-150.

[21] This assumption is actually unnecessary in deriving the aggregative model, and is employed only by way of analogy.

their effects, we can construct an index for the individual over s stimuli defined as

$$(2.24) \qquad I_i = K_1 \ln r_{1i} + K_2 \ln r_{2i} + , \ldots , + K_s \ln r_{si}$$

where $Pr(m_i = 1)$ now depends upon I_i being greater than some threshold level I_i^*.

If the population is divided into a number of cells, which may contain varying numbers of individuals with differing distributions of the explanatory variables, we want to construct an index I_i for each cell such that

$$(2.25) \qquad \hat{m}_j = F(I_i) = F(\underline{x}_j \underline{b})$$

where the vector $\underline{x}_j$ is constructed from the individual x_{ij}'s. Assuming additivity among individuals, as well as independence, i.e., lack of a "demonstration effect", let

$$(2.26) \qquad I_j = \frac{K_s}{n_j} \sum_s \sum_{i=1}^{m_{sj}} \ln r_{sij}$$

where m_{sj} represents the number of individuals in cell j who are exposed to the stimulus s, and n_j is the total number of individuals in the cell. The regression equation equivalent to (2.18) becomes

$$(2.27) \qquad x_j = \ln[p/(1-p)] = b_o + b_1 \frac{m_{ij}}{n_j} \overline{\ln r_{1j}} + b_2 \frac{m_{2j}}{n_j} \overline{\ln r_{2j}} + \ldots$$

where $\overline{\ln r_{sj}}$ is the logarithm of the stimulus averaged over the number of individuals exposed to the stimulus. The index is constructed of the sum of the proportions of exposed individuals weighted by the average value of the stimulus. The term b_o may be interpreted as a "background level" of stimulus which is the level of response, i.e., moves, even where there is no specific stimulus to account for such response. For computational purposes, (2.27) may be simplified to the form

$$(2.28) \qquad \ln[p/(1-p)] = b_o + b_1 \frac{1}{n_j} \sum_{m_{1j}} \ln r_{1j} + b_2 \frac{1}{n_j} \sum_{m_{2j}} \ln r_{2j} + \ldots$$

One major disadvantage of the model as presented here is that it makes no allowance either for differences within cells in the correlation of stimuli or of indicators of susceptibility among individuals.

The basic equation to be estimated is as follows:

$$(2.29) \qquad X = b_o + b_1 AY + b_2 TS + b_3 VH + b_4 VL + b_5 C + b_6 DTT + b_7 DTT_{-1}$$

where[22]

X = proportion of movers in a period

AY = proportion of households with heads under 30 years of age

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[22]The variables are presented here in a generalized form. their specific construction is elaborated in Chapter IV.

TS = proportion of households who moved into their present home in the recent past

VH = proportion of households with high housing values relative to their incomes

VL = proportion of households with low housing values relative to their incomes

C = proportion of households increasing through the addition of children in the recent past

DTT = proportion of households whose heads experienced an increase in their travel time to place of work

DTT_{-1} = proportion with increased travel times in previous period.

Of the variables listed, the first four have the character of levels of susceptibility while the last three are meant to represent a dynamic change which can be more properly identified as a stimulus. This distinction suggests a stratification by combinations of level of susceptibility and the measurement of the effects of variations in level of stimulus upon the various strata. Such an experiment is beyond the scope of the present research however.

Most of the variables in (2.29) need little explanation. On the basis of past empirical research, households with heads in the youngest age group have considerably higher mobility than those in the older groups. Households with very high or very low value relative to income are motivated to move to housing which brings their consumption closer into line with income. Households in the child-bearing stage of life frequently move in order to acquire housing with more space. The variables DTT and DTT_{-1} provide the basis for an analysis of the dynamic effects of changes in travel time upon relocation within the metropolitan area. The variable TS which is a measure of the propor-

tional importance of new movers in the area needs some more detailed discussion. A pair of hypotheses is offered here as alternative explanations of the behavior of households with regard to their susceptibility to moving with the passage of time since a prior move. On the one hand it is conceivable that following the move the household seeks to amortize its transaction costs and its susceptibility to a move is low in the early period following the previous move. With the passage of time its susceptibility rises but then after a very long period of time the psychological costs involved in moving lower the susceptibility level once again. In an alternative model, households may be thought of as ranged along a scale of footlooseness, their position being determined by individual tastes. Having observed that a household has moved in the recent past, we would therefore attach a high probability to its moving again in the near future and conversely with households which have not changed their place of residence for a long time. Alternatively, we could state the latter model as follows: The length of the household's horizon with respect to housing depends upon its stage in the life cycle. The terminal year of each stage marks the end of the horizon, e.g., the household head of age 30 with very young children may plan on the basis of the time span which extends up to the point where the youngest child will cease to be permanent resident in the household, say when the head reaches age 48; but his horizon does not recede as he progresses through middle age. Therefore if the household moves at the time the head is age 30 and if its appraisal of its

equilibrium level of housing consumption for the relevant period changes soon after it has made the move, it may incur the transaction costs involved in making an adjustment in order to achieve that equilibrium even though it has incurred similar costs in the recent past rather than continue throughout the nearly eighteen year period in a state of disequilibrium. As time passes, however, the adjustment becomes less worthwhile, i.e., the gain in utility decreases and the household's susceptibility to a move becomes less. These two alternative models would lead us to expect different aggregate behavior when viewing sub-areas within the metropolitan area. If the former model is more accurate we would expect that a large amount of recent in-migration into such a sub-area resulting in a high proportion of households with short tenure periods would lead to a low incidence of out-movers in the subsequent period. If the latter model is more accurate, however, we would expect to find that, having taken account of other influences, some areas appear to be high mobility areas while others are low mobility areas, i.e., areas having consistently high or low rates of both in-migration and out-migration over time.

CHAPTER III

THE DATA AND THEIR TREATMENT

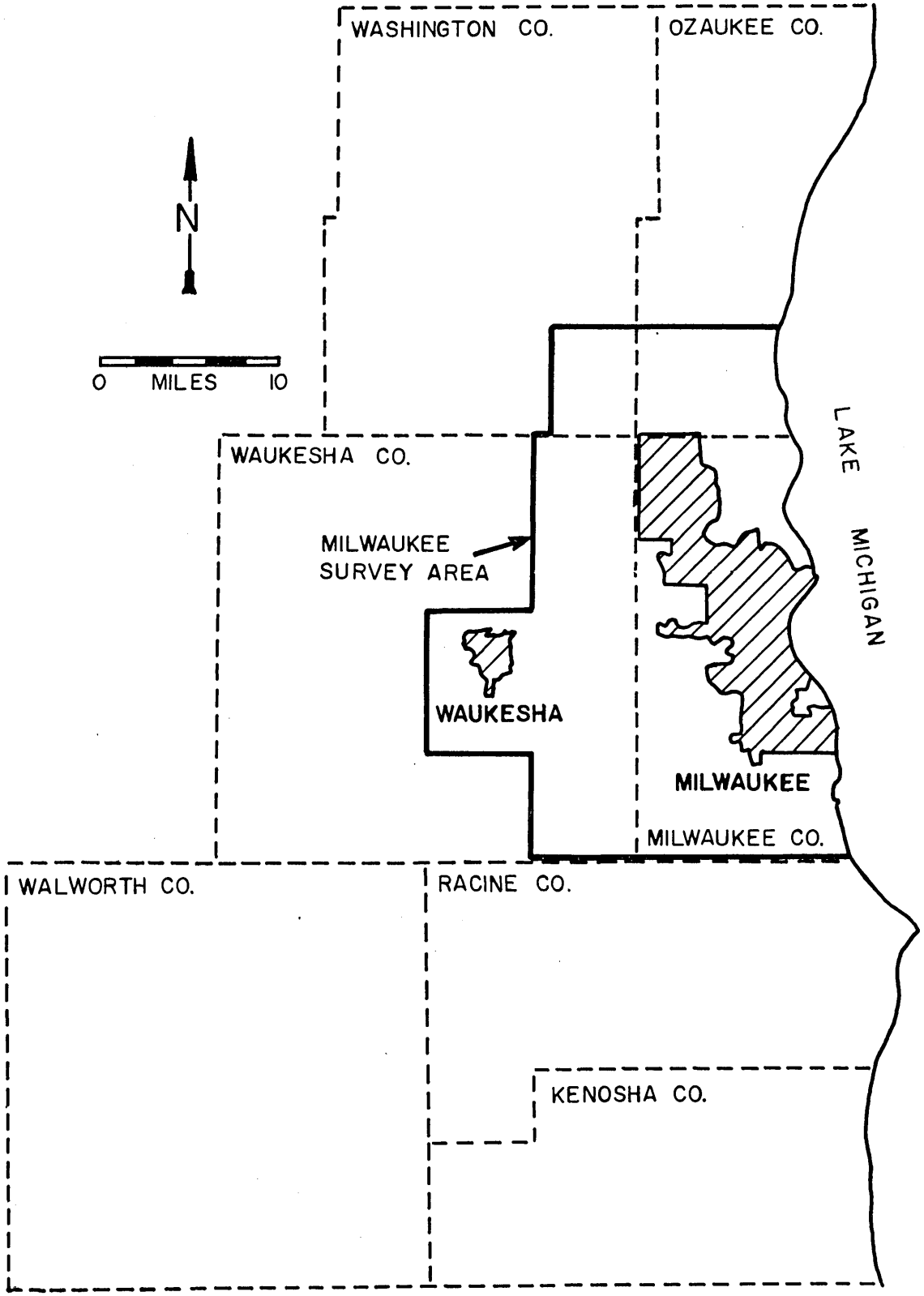
A. The Survey

The data which form the basis for the empirical work in the present study come from a survey of about 17,000 households in the southeastern Wisconsin area which was conducted as part of the work of the Southeastern Wisconsin Regional Planning Commission, in the spring of 1963. As such, it was one component of a wider survey which was conducted with the general objective of creating an inventory of transportation facilities and travel behavior, both on the part of households and businesses. The household interview portion of the survey had as its objective not only the documenting of the existing travel habits of members of households, but also the collection of a range of socioeconomic data which might be used in forecasting future growth patterns in residential locations and traffic flows within the region in the context of a series of land use-transportation simulation models (41), (42), (43). While such surveys have been conducted in recent years in every major metropolitan area of the country, the SEWRPC survey was the only one, as far as I know, to include for every household interviewed a questionnaire soliciting socioeconomic and housing information for both the current year and a number of years prior to the year of interview.

The survey included three "urbanizing areas," i.e., centers of intense urban development together with those peripheral areas

FIGURE 1

THE SOUTHEASTERN WISCONSIN REGION



undergoing rapid change from a rural to an urban environment.[1] These were the Milwaukee area, in which a three per cent sample yielded about 10,000 households, and the Racine and Kenosha areas, in each of which 10 per cent samples yielded about 3,500 households each.

The portions of the survey for which data were supplied to the present study in the form of three data files on magnetic tape included: a summary of household characteristics as of the year 1963, including, e.g., size of household, number of auto available, current income, occupation and industry; travel characteristics for the weekday prior to day of interview, including origins and destinations of trips for all members of the household over five years of age, trip purpose, mode of travel, and starting and finishing time of each trip; and a household history for the period 1950-1963 showing, for even-numbered years and for 1963, the geographic location of residence and the workplace of the head of the household, and, when the location of the residence or workplace was changed between any two years, the rental or fee value of housing, income, and the reason for the move. The sample selection was random within each geographic area. The sample frame was created from a listing of electric meters in service obtained from the electric power company serving the region. While an expansion factor was attached to each household

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[1] These areas are almost identical with the "urbanized areas" defined for each of these areas by the U.S. Bureau of the Census and employed for statistical purposes in the 1960 Census of Population and Housing.

in these files to account both for different sample rates in different parts of the region and for different proportions of uncompleted interviews in different areas, these were not used in the present study as it is not an objective of this study to explain global variations but only those specific to the sample; however, where household records have been deleted as part of the present analysis, either because of non-response to particular questions or because of assumed non-homogeneity relative to the main portion of the sample, it may be of some interest to know or to estimate how such selection influences the distribution of characteristics in the remaining households. The criteria by which sub-samples of households are taken and the resulting influence on the distributions will be discussed in Section III C.

In the initial phases of the survey, questionnaires were sent to households by mail, filled in by the householders themselves, and picked up subsequently by representatives of the SEWRPC. This proved so unsuccessful, however, because of the high rate of refusal, that the procedure was changed, and subsequently the householder was interviewed by a representative of the Commission. This revised procedure produced a response rate of about 85 per cent.

In spite of several limitations which I shall discuss in the succeeding section, the household history portion of the survey, the portion upon which I shall rely most heavily, presents a body of data which as far as I know is of a unique type and is especially well suited to the purposes of this analysis. Other micro survey data, such as that of the decennial U. S. Census, are available only

on a national basis with at best some regional designation. If the data are available on a metropolitan area basis, they are grouped. The Survey of Consumer Finances conducted annually by the University of Michigan Survey Research Center is similarly a national sample. Reinterview data are being collected on a panel of households as a part of this survey; however, when a household moves its place of residence, it is dropped from the panel. It is therefore impossible to include, for instance, the value of previous housing owned or rented as an explanatory variable for level of current housing consumption.[2] Other surveys have been conducted on a very small scale or have included only a particular type of household, e.g., homeowners (35).

Because of my desire, for reasons stated in the Introduction to employ data which are disaggregated to the household level and which are specific to a single metropolitan area, data from such surveys are at best of limited usefulness in exploring the relationships which are the subject of this study. The historic data included in the SEWRPC survey are not only extensive, allowing a considerable sub-setting of households by particular characteristics for particular purposes, and detailed, allowing a rich variety of variables, but are also supplemented by a volume of ancillary data, mainly gathered by the Study Commission as part of the over-all survey which makes possible the indirect estimation of additional historic variables.

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[2] For the application of Census micro data in a housing demand study see Maisel (33); Survey of Consumer Finances data have been used by Morgan (37) and by Lee (31).

B. Problems Inherent in the Data

While the data which form the basis for this analysis can be made to yield some information unique to housing market studies, they have a number of shortcomings both of coverage and accuracy which need to be discussed explicitly. While some of these effects are unavoidable in a survey in which householders are asked to give information about themselves for previous years, for the most part they are concerned with this particular set of data.

There is probably no need to elaborate on the supposition that there exists a substantial degree of distortion, in part non-random, due to respondents' willful or unwitting misstatements. Such inaccuracies, which are difficult to minimize in any interview survey are compounded in this case by several peculiarities in the survey procedure. First, because of the large size of the survey and the fact that it was being run only once by the Study Commission and because of the pressure of time (parts of the survey were inputs to other steps in the plan-making procedure), the interviewers did not receive extensive training nor did they have prior interviewing experience. The questionnaires were not structured in such a way as to allow interaction between interviewer and respondent in order either to show up inconsistencies in the responses or to aid the respondent in recalling information about the past. Considering these limitations the high rate of completed interviews is impressive. On the other hand, in view of the nature of the questionnaire the high rate of non-response to particular questions within completed interviews is not at all

surprising. Many of the questions asked for information which the householder could reasonably have been expected long since to have forgotten no matter how good his intentions. This problem is compounded by the questions referring to the head of the household where typically the interview was conducted with a housewife whose husband was not at home at the time of the interview so that males who married during the historical period covered by the questionnaire would be likely to have their data on questions such as place of employment and earnings truncated at that point in time. In addition, it is unlikely that for certain types of questions, e.g., income level, the household head himself would have a clear recollection for points in time as much as thirteen years previous. Accordingly, memory questions show the highest rates of non-response and, by implication, the greatest amount of inaccuracy.

In order to gain some idea of response rates, I took a sample of somewhat less than two per cent of the total households in the survey and separated these into two groups according to a sorting device which was built into the records. Households which failed to respond to less than five questions were grouped separately from those with five or more non-responses.[3] Fifty-eight per

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[3]The distinguishing criterion was even more restrictive than the nominal distinction above would indicate, e.g., if all questions but one were answered in an interview and the household head had not moved either his place of residence or place of employment over the historical period covered by the questionnaire, then the non-response to that single question would have been recorded for each of the seven previous years counting for a total of eight non-responses.

cent of the households in this sub-sample were in the former category against 42 per cent in the latter. For most items of information, percentage distribution among classes were nearly identical for the two groups; however, renters, especially those with low incomes living in low-value housing, had a disproportionately high representation among the high non-response group, as did the elderly. Low-income renters can be expected to have a higher rate of residential and job mobility than most other groups so that, because of the way the questionnaire was designed, they would have had to answer a greater number of specific questions about previous history than would less mobile households. There would therefore have been a greater opportunity for non-response to specific questions. Households with elderly heads have a high proportion of widows who would not have a clear recollection of the prior history of their deceased husbands. In addition, the elderly are less likely to be able to answer memory questions for purely physiological reasons. As for individual questions about information pertaining to the interview year, 1963, there were relatively high rates of non-response to the income question (eight per cent), the value of housing question (five per cent), and the education of head of household question (four per cent). As might have been expected, the rates of non-response to these individual questions were much higher among the high non-response group than among the low non-response group, indicating disproportionately high rates of non-response to these questions from low-income groups, and by implication, relatively low reliability where there was a

response. These results are not surprising given the nature of the survey.[4] The number of households at the opposite end of the income scale was so small that it was difficult to estimate their relative rate of response. Previous survey research indicates that they have a relatively low rate of response.[5]

On the other side of this discussion of the reliability of responses and of response rates, it should be pointed out that most of the questions on the survey pertained to matters of great importance to the household or are otherwise of the type which is relatively easy for the householder to remember, at least within the broad classes included on the questionnaire, e.g., location of residence or type of tenure, whereas questions about the consumption of goods less durable and individually less important than housing in a similar survey for a similar historical period would be virtually futile. Kish and Lansing (26) analyzed the results of a quality check of answers to the housing value question in the 1950 Survey of Consumer Finances. Responses by homeowners were compared with estimates of current market values made by professional appraisers on over 500 properties. The conclusions were that while only a small proportion (37 per cent) of the estimates of respondents were within 10 per cent of the appraised value, the errors tended to cancel out within each value category (similar to those used in this study), although the dispersion increased with increasing

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[4]See (41), passim.

[5]See (8).

value.[6] Response to the rent level question is likely to be at least as accurate, since this is a recurring payment.

Of greater concern than random variance are systematic biases in responses, especially in connection with memory questions. Kosobud and Morgan (28), have compared the results of questions about income in surveys made at annual intervals on a continuous panel of households with those households' recollection of both income and the direction of income change in the previous year. Their conclusions are

> .....the broader such questions are, the more likely the "no change" response. Indeed, validity studies have shown a tendency for people to remember the past as more like the present than it really was. Memory questions about short run changes will elicit "no change" responses from one fourth to one third of the respondents whereas computations based on two interviews with the same people show only one sixth or one seventh with income changes of less than five per cent. In addition, for a substantial number of respondents (more than a tenth) a comparison of the two interviews reveals disagreement even about the direction of the change.

These findings pertain to income changes over a period of two years; implying that the Southeastern Wisconsin data which covered a much longer historic period may be expected to contain substantial bias toward minimizing the change in income and by implication also the change in value of housing. On the

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[6]Investigations of coding errors, which Kish and Lansing undertook in their own study, and of interviewers' errors, which they did not, are by now unavailable to investigators wishing to use the SEWRPC data. The conclusion of Kish and Lansing as to the former source of error is that while it accounts for a large proportion of the very lowest value category, it makes very little difference in the overall distribution.

other hand, this bias may be somewhat mitigated by the relative specificity of the questions, i.e., their division into numerical interval categories rather than the relative categories of "more than," "less than" and "no change." Another bias in memory questions is that respondents tend to place past events closer to the date of interview than the date when they actually occurred. Both of these effects, if they exist in the present data, would influence change variables, but in opposite directions, so that it might be expected that they would cancel one another. On the other hand, the foreshortening phenomenon would not be counteracted insofar as it affects the variable of length of tenure. There is some evidence that this effect may be quite large. Of a subsample of households consisting of those who moved between January 1, 1962 and the survey date, 49 per cent had made at least one additional move within the period 1950 to 1962. Of the latter, 59 per cent reported the next prior move as having taken place in the later years, i.e., 1960 and 1958, with the proportion dropping off rapidly until no first prior moves were reported for 1950. This distribution might be explained by generally high mobility; yet, the households which moved at least once in addition to the move in 1962-63 represented only about one-half of the households which moved between 1962 and 1963, so that we would have expected substantial numbers of less mobile households to have reported a prior move in the early 1950's.

In considering the validity of the data for time series or other dynamic analysis, it is necessary to recognize a source

of non-representativeness which is practically impossible to avoid in surveys of this type. This source of bias results from the fact that the respondents represented only those households which were resident in the area at the time of the survey, in the spring of 1963. The survey accounts for those households which were resident in the area throughout the historic period, which migrated into the area within the historic period and remained, or which were formed in the area in the historic period and remained. Not included in the survey, however, are those households which were dissolved or merged into other households or which migrated from the area during the period 1950-1963. The non-representativeness becomes aggravated as we go back in time from the survey date, since the numbers of households which were present at the beginning of the period and which disappeared during the period cumulates. The sample is thus somewhat depleted relative to the universe as we go back in time from 1963 to 1950. The groups which suffer most from this attrition are of two types: first, those which remain in an area as households for relatively short periods of time, including highly mobile households and households of temporary convenience, e.g., two or more unrelated persons sharing a rented apartment; second, households headed by the elderly whichtend in disproportionate numbers to dissolve by reason of death of the head or to merge with other households. As a result the very young and the very old among household heads are underrepresented as we go backward in time.

The value categories for housing on the questionnaire were

very rough. For owned housing these categories were in $5,000 increments up to an open-ended category at $25,000 and over. The rental categories were even grosser, including only three categories, plus an open-ended category starting at $150. It is believed that the grossness of these breakdowns greatly increases the variances from the fitted regressions.

The Value of Housing variable includes both structure and land. This implies that we must consider the whole bundle of services purchased or leased with housing as one composite good. Externalities such as the level of public services associated with a particular location may raise or lower the market value of the entire bundle of housing services compared with a physically identical housing unit on the same amount of land in another location. In conventional location theory, e.g., Hoover (22), the increment in value is attributed to the land[7]; but here we have to assume that the consumption represented by our dependent variable in the value equation is composed of something more than shelter. Muth (38), p. 69, has pointed out that, at least for owner-occupied housing, it is probable that the income elasticity of the demand for land as such and for the services imputed to the site is larger than the income elasticity of the demand for shelter.[8]

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[7]Turvey (50) disputes this distinction.

[8]Grebler, Blank and Winnick (18), p. 125, corroborate this view in a footnote. Muth excluded land value in his study, while GBW included it. These respective procedures were appropriate since it was desired to test the hypothesis of high income elasticity in the former study and low income elasticity in the latter.

Where households reported a change in place of residence at least once during the historical period, no attempt was made to distinguish the value of previous housing at the beginning of each tenure period from its value at the end of such period. Rather the questionnaire asked simply where the household head had lived and worked on January 1 of each even-numbered year between 1962 and 1950. Where no change in residence or work place was reported for a two-year period, the value of housing was simply copied from the preceding entry. Assuming householders' recollections of value to be correct in some sense, one of three types of value was probably given as a response: the value stated was the purchase or initial rental level; it was the price at which the householder sold the residence when he left it or it was the last rental he paid; or it was some average of the two. I would suggest that either the first or the third is more likely than the second because the owner or tenant is likely to forget variations during the tenure period whereas he would have a clearer recollection of the value at the time of a transaction. Unfortunately there is no way of knowing which of the two possibilities I have suggested as the more likely was actually prevalent, much less what the variation in value or rental over the tenure period may have been. I am therefore forced to treat the value as the same in current dollars at the time of moving out as it had been at the time of moving in. For brief tenures this assumption does not cause much distortion, especially because of the grossness of the value categories which I have mentioned. With gradually rising current

prices, however, the problem becomes increasingly severe, with increasing lengths of tenure. Specifically, with the price index of housing tending monotonically upward as in 1950-63, householders will always be reckoned as moving out of housing with a lower deflated value than it had when they moved in regardless of the real course of the market price of housing.[9] If the value given on the questionnaires tends to be the move-out price or rental, applying that same figure to the earlier move-in year and inflating will cause the dependent variable in the value equation to be inflated. The degree of this inflation will vary with the length of the tenure period. Accordingly, the coefficients of the explanatory variable will be increased algebraically, where those variables are positively correlated with the length of the tenure period subsequent to the transaction being considered. If the value cited tends to be the move-in value, this problem does not arise with respect to the value of the dependent variable; however, the value of stock held prior to the transaction, which I have suggested as an explanatory variable, would be biased downward, the degree of bias being positively correlated with the length of the tenure period prior to the transaction. If there did exist a tendency toward one or the other type of response, the resulting bias would not be a problem in time series analysis since the

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[9]The one exception would be if the householder had changed jobs during his tenure. He would then have had the opportunity to "revalue" his previous housing according to the estimated change in market value during the tenure period for the purpose of the questionnaire. It is doubtful that this was actually done, however, and even if it were the broad categories of value employed in the questionnaire are not likely to have captured most of such adjustment.

dependent variable or the prior stock variable would be consistently higher or lower than the true value but its variation would be in proportion. For cross sections for each of the historical years, however, such bias could cause considerable distortion. Such distortion would be minimized, however, by taking a sub-sample of households which moved in the period immediately preceding the date of interview. In general, of course, one would expect that in this type of survey, data for the survey year would be considerably more reliable than for the historical period.

Aside from the survey year, household income was recorded only for those prior years when the household had moved its place of residence or place of work. It is therefore impossible to derive an aggregate income figure on a time series basis for all of the households in the sample or for any grouping of households within the sample other than movers. For the estimation of the value equations which are specific to movers, we are able to circumvent this shortcoming to some extent. The scope of the analysis is very much curtailed by this lack of information, however. It is impossible, except for a small sub-sample of households, to approximate long-run or permanent income as a weighted average of past incomes as is frequently done in consumption studies. For the equations explaining the probability of the move, this lack of data is even more restrictive since their estimation implies the observation of some measure or measures of differences between movers and non-movers, e.g., the proportion of all households having some characteristic which is taken as "triggering" a move.

For renters the rental value recorded may be either net or gross rent, i.e., the rental payment may include shelter only or it may also include some or all utilities; and it may or may not include furnishings or certain types of equipment such as a refrigerator. This ambiguity in the definition of the housing variable for renters is not a problem in time series analysis but it is for estimation on cross sections. Two types of problems arise. First, assuming that in all cases contract rather than gross rent is recorded in the survey, if contract rent is a nearly constant proportion of gross rent for all types of housing and if contract rent includes utilities and possibly also some furnishings, demand elasticity might be quite different from what it would be if such "extras" were not included. Reid (40), pp. 46-47, shows an income elasticity of outlays on fuel, light and refrigeration by owner occupants of 0.8 which is lower than comparable estimates for housing as a whole. Lippitt (32), p. 227, shows the ratio of expenditures on home furnishings as declining with increasing income and remaining constant with increasing age of head and family size. This problem is similar to the problem of the inclusion of land in the value of housing except that we know that land is always included whereas the incidence of other non-shelter services is difficult to measure. The second problem lies in the possibility that the ratio of contract to gross rent changes systematically with level of housing value. It is not uncommon for low-rent housing units to include both utilities and furnishings while rental payment for high-value units rarely includes either. This difference could bias parameters and elasticities downward by comparison with the demand for shelter.

C. Treatment of the Data

The specific form which the empirical work to follow has to take was dictated on the one hand by the objectives outlined in the Introduction and by the particular model which it was desired to test and which was discussed in Chapter II, and on the other hand by the limitations of the data described in this chapter. In designing the empirical work two major criteria were used for guidance. First, it was felt that greatest reliance should be placed upon those items of data which appeared to have the greatest degree of reliability. This criterion led to the decision to rely upon cross-sectional estimates. Information supplied by respondents specific to the survey year and years in the very recent past was expected to be relatively reliable. Except for errors by interviewers and coders, which affect all the data, certain items of information, such as location and type of housing are unequivocal for the survey year, but not for earlier years. The second major criterion was that heterogeneity in the sample should be reduced as much as possible while still allowing sufficient degrees of freedom to make the estimates which were planned. With reference to the objectives enunciated in the Introduction, this decision was in favor of the hypothesis-testing approach and tended to get the study further away from the construction of a forecasting model. In view of the multifarious relationships described in Chapter I, it is clear that a single demand function estimated on the entire metropolitan population of households would not only display a high variance but would likely also be unstable. The approach taken with this

problem was to select from the original sample those households which represented a relatively homogeneous sub-set. The assumption was made that the households which would subsequently be filtered out of the analysis due to non-response to particular questions not only yielded less reliable information but were probably more heterogeneous in their behavior. The specific criteria for deletion of households from the sub-sample will be listed below. As for heterogeneity within the remaining sub-sample, this will be given specific treatment in Chapter IV. The problem of systematic bias which has entered several times in the discussion of the preceding section is met only in part by the use of survey year cross-sectional data. Where remedies are attempted they will be discussed in connection with particular steps in the following analysis.

In order to obtain a sub-sample of households for the micro estimation of the value equations, the original set of sample households had to pass a series of requirements. While the primary motive for this sieving procedure was to obtain a greater degree of homogeneity so that the households which remained in the sample could be expected to conform in their behavior as nearly as possible to a single model, it was at the same time desired to obtain a sufficiently large sample to allow for estimation within sub-sets while still retaining a large number of degrees of freedom. Because of a limitation of the ADMINS system employed for manipulating the data, it was believed that dealing with much more than 3,000 records --the record in this case pertaining to the contents of a single punched card, of which there were about 120,000

in the household history file-- would greatly complicate the processing of the data prior to regression. I had originally intended to apply a very severe set of criteria for screening out households which might be expected to have anomalous behavior. It soon became apparent, however, that not the upper limit of system capacity, but rather the lower limit of degrees of freedom was the critical constraint because of high mortality in sub-setting as a result of non-response to particular questions, especially those referring to years prior to the survey year. It is one of the advantages of the ADMINS system that an optimal sample can be obtained with relative facility. Aside from non-response, there were several other criteria which remained in force, however, in the selection of a sub-sample, because of their overriding importance.

Since it was one of the purposes of this study to examine housing demand within a single market area and since the survey covered three metropolitan areas, the urbanized portions of which are not contiguous, it was clearly desirable to choose one of these areas for analysis. The area chosen was Milwaukee. Households living in Racine and Kenosha in 1963 were deleted and no analysis was performed on them. Racine and Kenosha had the advantage of larger sampling rates, but this feature was felt to be secondary and the resulting sample size was larger for the Milwaukee area in any case. It was also felt that conditions in the Milwaukee housing market and in the Milwaukee economy in general have much more influence upon the behavior of the Racine and Kenosha housing markets

than vice versa. In addition, the Kenosha area is within commuting distance of the Chicago metropolitan area and in fact the survey showed heavy commuting from the Kenosha area to northern Illinois, so that the "chain of substitutions" used by Grebler to characterize and delineate the housing market laps over in this case from one metropolitan area to another. It was also felt that because of the smaller scale and finer grain of the smaller metropolitan areas it would be more difficult to make meaningful delineations along geographic lines without a more detailed knowledge of the areas. The larger area is also more likely to be more variegated in terms of household and housing types and incomes which means in statistical terms larger variances in the observations, a desirable property. Racine and Kenosha's renters, for instance, are nearly all at the low end of the income and rental scale according to the 1960 Census. The deletion of the Racine and Kenosha areas cuts down the sample size from about 17,000 to about 10,000 households.

For the portion of the analysis dealing with the determination of the quantity of housing rented or purchased by movers, households which occupied multi-family housing which they also owned (50 households, representing four per cent of movers) were deleted, since their estimates of value pertained to the entire structure. Households with unemployed heads would have given unrepresentative income figures and were deleted. Of the 1320 Milwaukee survey households which were movers and responded to the question on occupation, 171, or 13 per cent had a retired head, a head who was temporarily unemployed, were headed by

a housewife, or fell into the miscellaneous category. Small numbers of households supplied answers about education and occupation of the head which were considered improbable combinations, e.g., laborers with college completed. These were also deleted.

It had initially been intended to delete also households with non-white heads because of the abnormal conditions of the submarket in which they purchase housing, and households which migrated to the area during the year preceding the survey, because of price heterogeneity in their previous stock and because of their initial expressed demand upon arriving in the local area might be atypical. The former group, while considered to be too small and too unreliable in its response[10] to allow extensive analysis, was felt nevertheless to be of special interest and were included in the sample for possible subsequent examination. The latter group was found to comprise such a large share of the sub-sample of movers that its exclusion would greatly hinder certain parts of the analysis. Consequently, both groups were left in the sample and, where appropriate, were examined separately.

For the analysis of the propensity to move the sieving criteria were less stringent. Because this part of the analysis was conducted on grouped data, I assumed that individuals with

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[10]See (24) for some of the problems involved in interviewing the non-white population. No special provision was made in this survey, as far as I know, to overcome these difficulties.

anomalous behavior would tend to cancel out, and that non-response was random, so that, in effect, non-respondents could be assigned the mean values of respondents in their groups. Numbers of within-area movers had been calculated as a by-product of the estimation of the equations. It was therefore a relatively simple matter to arrive at a figure for the dependent variable of the propensity-to-move equation, i.e., proportion of within-area movers to total households. This variable was calculated as the ratio of the total number of within-area movers, except those who formed new households, who reported residence in some area in the year prior to the survey to the total number of households which reported residence in the same area in the prior year. Owner-occupants of multi-family housing were subtracted from both numerator and denominator.

Because of the requirements of the various regressions, five principal sub-samples were created from the original sample of 17,000 households residing in the southeastern Wisconsin survey area. The six sub-samples and the criteria used for their selection are as follows:

I. Households which moved their place of residence in the approximately 15-month period from January 1, 1962 to the survey date, and which at the time of the survey resided in the Milwaukee survey area -- 1321 households.

II. A sub-set of the previous sample which at the time of the survey either rented their dwellings or owned one-family houses and which had a head, either male

or female, whose combination of occupation, industry and education placed him in a group with at least three other household heads and for which there were responses to the questions of income, age of head and number in household -- 952 households.

III. A sub-set of the previous group consisting of households which supplied information about housing value and place of residence as of January 1, 1962, except those who were owner-occupants of multi-family housing and those with heads who lived with their parents prior to the move -- 563 households.

IV. A sub-set of III which reported income and prior stock level for a housing market transaction in some period prior to 1962 -- 128 households.

V. A random group of households from among those which reported an address within the Milwaukee survey area as of January 1, 1962, regardless of whether a move was reported at any time -- 1000 households.

Some of the more important differences in distributions, among the sub-samples, of values of the variables used in the subsequent analysis are displayed in Table A. 2 of Appendix II. Briefly, the effect of treating mover households separately from all households is to create a sample in which households with very young heads and renter households are disproportionately represented.

D. Characteristics of the Market Area

In order better to understand systematic differences of behavior among sample households, a brief resume of some of the major structural features of the Milwaukee housing market appears to be in order.[11]

The population of the survey area was estimated at 1.271 million in 1963 --taking the counties of Milwaukee and Waukesha as approximating the survey area-- compared with 957,000 at the time of the 1955 Census. Of this increase, 225,000 was due to natural increase compared with 88,000 by net migration. These two sources of growth have very different effects upon the demand for housing. As in most of the U. S., the growth rate of the Milwaukee area rose very rapidly during the 1940's and 1950's, but then fell back again to a rate slightly below that of 1950 by 1963. This growth was the chief reason for a marked shift in the age pyramid in favor of the extremities, i.e., under 15 years and over 65 years. Similarly, the rate of net migration grew rapidly during the post-World War II period, but then dropped off again shortly before the survey date and is believed to have been close to zero during the period 1960-1963. Natural increase reinforced by in-migration led to a large increase in numbers of children during the 1950's; but even though in-migration also favored those in their twenties, this group as a whole remained

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[11] Principal sources for the non-sample data in this section include an SEWRPC planning report on the inventory findings (41), the FHA analysis of the local housing market (49), and special tabulations from the 1960 Census published by the S. J. Tesauro Co. (45).

almost constant in absolute numbers because of the effect of the earlier depression on the native population. The difference between the two sources of trends in population growth has an important effect upon household characteristics and hence on housing demand. An expansion of the very young portion of the population through natural increase leads to pressure on the existing households to find more spacious dwellings, but this is a very loose kind of causality because many families plan for expansion. At any rate, the response is likely to follow irregularly and at some length of time after the event. An increase in absolute numbers in the oldest age brackets by survival does not indicate of itself an increase in the utilization of the stock. In fact, it probably has a depressing effect upon turnover; a proportional increase in the elderly accompanied by generally rising incomes nationally has contributed to a lower utilization of the stock on the average. Migration, on the other hand, has an immediate impact on housing turnover. The generally available published figures on net migration have two major disadvantages: first, they only show the resultant of two migration streams, in-migration and out-migration, so that even a zero net migration can correspond with substantial population movements;[12] population is not synonymous

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[12] Census figures do throw some light on gross migration flows, however. According to the publication, Mobility for Metropolitan Areas (51), the number of persons five years old and over living in the Milwaukee metropolitan area in 1960 who had resided in other metropolitan areas of over 250,000 population amounted to 52,700, a figure which is 22 per cent of the estimated total increase in population in the area in that same period. The corresponding figure for Milwaukee County for all persons whose residence in 1955 had been outside the County was 97,600 compared with the total growth of 165,000, a 59 per cent share.

with numbers of households which are the principal micro-units of interest in housing studies, and this one in particular. This discrepancy obscures especially the effects of migration in the portion of the population aged 20-29 who are, as stated, the most mobile portion of the population. Much of such in-migration corresponds to the formation of new households in the recipient area, either as families headed by these persons or as individuals, although there is considerable doubling-up in this group. The out-migration of this age group, on the other hand, is likely to contain a large proportion (especially in the younger 20's) of persons leaving their parents' homes.

Economic activity in the region is heavily concentrated in manufacturing, amounting to 43 per cent of employment in 1963 compared with less than 26 per cent nationally and 29 per cent in all metropolitan areas. Because of this concentration of employment in manufacturing and within the manufacturing sector in capital goods-producing industries, fluctuations in the numbers of jobs in the region have been synchronous with, but somewhat greater proportionately than in the nation as a whole. A rapid rise in the 1950's was followed by a sharp downturn in 1958. From 1958 to 1960 there was another rapid rise followed by a sharp drop --much more severe than the national decline-- in 1961. From 1961 to 1963 there was a moderate but steady increase to a level of 502,000 in 1963 compared with 459,000 in 1955 and 417,000 in 1950.[13] Throughout the period unemploy-

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[13]The 1950 figures are not directly comparable because they are figures for employment rather than jobs.

ment rates have been below the national rate, probably reflecting the high proportions of skilled and semi-skilled blue-collar workers. In 1959, the year for which incomes were reported in the 1960 Census, there may have been disproportionately large numbers of households with negative "transitory incomes" because the regional economy was just beginning to recover from a downturn. By 1963, however, incomes probably tended to be much closer to their "normal" levels following nearly two years of recovery.

Commenting upon the growth of urbanization in the Milwaukee area, a SEWRPC report (41), p. 82, states that the investigation of historic development:

> .....does not reveal the same marked influence of transportation routes on urban development patterns that have been identified.....in other large metropolitan regions; and urban growth appears to have occurred more by accretion than by axial expansion .....The 1920 growth ring for the Milwaukee urban area.....still approximates the outer limits of the then existing local street railway network and still approximates the outer limits of the highest population densities (however) the 13-year period from 1950 to 1963 shows the most dramatic increase in urban development. The pattern of development occurring around the existing communities of the region during this period is quite descriptively referred to as "urban sprawl." While the regional population increased 35 per cent during this period, land devoted to urban use increased by 146 per cent.

This rapid change and expansion in the pattern of urban development in the region has brought with it dynamic changes in relationships among geographically-defined housing submarkets. Milwaukee, the central city, contains the bulk of population and jobs within the area; but its share has been dropping markedly since the end of World War II. An apparent growth of the city between 1950 and 1960 from 635,400 to 741,300, an annual rate

of growth of 1.5 per cent, is due entirely to the annexation of areas in suburban Milwaukee County containing 124,000 people in 1960. Within the 1950 boundaries population actually decreased by nearly 20,000. Suburban Milwaukee County on the other hand grew at an average annual rate of 2.3 per cent even without adjustment for a substantial proportion lost through annexation to Milwaukee City. Waukesha County demonstrates even more clearly the shift in regional population to the suburbs. Its population growth during the 1950's was 72,000, an average annual rate of over 6.1 per cent. Ozaukee County also had some suburban development in the area contiguous with the northern boundary of Milwaukee County which, while small in absolute numbers, nevertheless represented a growth rate of about five per cent annually.

Again, differences in the sources of population growth are interesting: for all of Milwaukee County, including Milwaukee City and the suburban portions, the net natural increase of 150,000 is supplemented by net in-migration of 15,000 or 9 per cent of total growth, while in Waukesha County 53,000 out of an increase of 72,000, 73 per cent, was due to migration. The bulk of this migration was accounted for by movement outward from Milwaukee County. One aspect of migration into the area from the outside which has important implications for activity in submarkets within the area is that 27,200 persons, or 44 per cent of net in-migrants during the 1950's have been non-white. As in most other large northern metropolitan areas which have experienced such in-migration, the migrants have

been confined to a relatively well-defined area of the central city. It is possible that in connection with the investigation of the determinants of the probability of moving, "flight" by white households may play some role and may therefore distort the relationships, at least where individual sub-areas are investigated. There is very little evidence at present as to how important quantitatively this phenomenon is in Milwaukee and in other areas, especially since the areas most immediately concerned are likely to contain substantial shares of households which are otherwise inclined to move to the suburbs.

The movement of households parallels the movement in population, but because household size was decreasing during the 1950's in the central city, with large proportions of non-family households, while increasing in the suburbs, with large proportions of families with children, the shift in numbers of households was somewhat less sharp.[14] For the city a rise from 186,000 to 231,000 between 1950 and 1960 was again mainly due to annexation; within the 1950 boundaries the number of households actually declined by about 3 per cent. For the County of Milwaukee there was an increase of nearly 66,000 from 249,000 to nearly 315,000. In the suburban counties, both Ozaukee and Waukesha had high growth rates. The former went from 6600 to 10,400, an annual rate of 4.5 per cent while Waukesha went from 23,500 to 42,400, a rate of 5.9 per

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[14]This difference is difficult to document exactly because of the change in census definition from dwelling unit to housing unit, but the author of the FHA survey (52) feels that these trends were present even with a correction for definitions. In this discussion the figures for number of households are based upon the definition as of the year to which the figures pertain.

cent. During the early 1960's, however, the rate is believed to have been much slower.

The incomes of households which have migrated to the suburbs, as is typical for metropolitan areas throughout the country, has tended to be higher than the average for the area, while the replacements in the central city have tended to be much lower. By 1963 the predominant features of the pattern of distribution of households by income and consequently of housing by value were as follows: the area in and around downtown Milwaukee was predominantly low income, with average incomes increasing with distance from the central business district; starting at a distance of about five miles directly west of the Milwaukee CBD in western Milwaukee County and eastern Waukesha County, there were major concentrations of higher income households; a second major concentration was located along the north shore in a sector shape from within about two miles of downtown Milwaukee and extending well into Ozaukee County.

A shift in the geographic distribution of jobs has paralleled the shift in residence. In 1955, when the suburbanization of employment was just beginning, Milwaukee County had 440,000 jobs, a figure which rose only slightly to 466,000 in 1960 and 468,000 in 1963. Ozaukee County grew from 7900 to 10,700 in the same eight-year period. Waukesha County grew from 18,000 in 1955 to 29,000 in 1960, and actually grew faster in absolute numbers in the early 1960's than the much larger Milwaukee County, from 29,000 to 33,000. The long-run trend of trips into the central area of Milwaukee was reversed during

this period. Trip-making became more diversified geographically and more dependent on the automobile. This means that the choice of area of residence and of the whole bundle of housing services was starting to become less dependent upon job location.

CHAPTER IV

THE RESULTS

A. Determinants of Value of Housing Purchased

1. Introductory note

The major part of the following discussion, specifically Sections 2-10, pertains to that part of the model previously referred to as the "value determining" function. As such, it is based upon the several subsamples of that portion of the interview population composed of persons who moved in the period prior to the interview date. The regressions, unless otherwise specifically indicated, are based upon individual household observations. This fact should be kept in mind in examining this analysis. In addition, since households purchasing fee housing and households renting dwellings are frequently pooled in the regressions, terms such as "value of housing purchased" should be taken as generic, rather than as specifying a particular tenure type.

2. Preliminary investigation

Before proceeding to the regressions which form the main results of the present investigation, two preliminary analyses need to be made. The first of these pertains to the equivalence between the housing values of owners and renters; the second has to do with the broadness of the value groupings included in the survey questionnaire. Both of these problems have been mentioned in previous chapters.

Since we would like to estimate the parameters of demand

functions of the most general validity, it becomes desirable also to be able to treat the observed housing value measures, i.e., rent and fee value, as equivalent by means of some conversion factor. For reasons explained in Chapter II, the conversion employed in the present analysis imputes to renters a level of housing stock which it is asserted they would occupy if they were indeed owners. It might be helpful to think of a bundle of goods including the rental dwelling and associated substitutes for that aspect of owner housing which might be termed "satisfaction derived from homeownership". Taken as a whole, this bundle might be seen as comprising the equivalent, in terms of consumer satisfaction, of owner-occupied housing. This convention is not one with which I am comfortable; however, a more agreeable solution must remain beyond the present work.

Two alternative computations were made which were felt to embody this approach. The decision between the two was made entirely on grounds of the plausibility of the result. The subsequent results appear to have borne out the soundness of the decision. While the derivation of the equivalence factor is admittedly conceptually crude, it does not appear to be of a greater degree of imprecision than the fitted equations themselves. Both alternatives employed separate regressions for owner-movers and renter-movers of housing value upon current income. Housing value was as reported for the interview date on the survey questionnaire, i.e., capital value for owners of single-family houses and monthly rental value for renters. In the first approach (which would have been preferred if it had

yielded results similar to the second approach), the regression line of the renters was mapped onto that of the owners. This approach implies that there is one linear relationship between housing value "purchased" and household income for both types of tenure. The second approach was to force the regression lines of the two tenure types to cross at the point of mean income of the pooled populations. This latter approach preserves the individual income elasticities of the two groups while bringing the predicted values of the dependent variable close together generally. The derivation of the alternative conversion factors is elaborated further in Appendix I. The second alternative, which involves a simple multiple of the rental value to obtain the equivalent capital value, was chosen. Its value, which was used throughout the study, is 195.4. This value is considerably above the range of values generally employed for the gross rent multiplier, the latter tending to be around 100. In view of the different connotations of the two types of equivalence, however, such a disparity is not surprising.

The particular problem which I shall investigate in connection with the grossness of housing value groupings is whether these groupings are so broad in relation to the mobility of households among value categories that the introduction of the prior stock variable might be sufficient to take up nearly all the variation in the dependent variable --the level of the housing moved into.[1]

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[1] The representative values for several of the individual value categories were actually slightly different for the pre-move compared with the post-move distribution, reflecting the upward shift of the distribution.

A cross-tabulation was made for subsample III, described in Section III. C. The cross-tabulation is shown in Table IV. 1. We are chiefly interested in the upper-left and lower-right portions of the matrix of Table IV. 1., i. e., those portions representing movers who did not change their tenure type and for whom the value categories are directly comparable. Application of the previously-derived rental-value equivalence also gives us a basis for comparing prior and post-move values for movers who changed tenure type. The approximate equivalent capital value classes are shown in the table in parentheses below the rental figures. By examining the diagonal running from the upper-left to the lower-right corner of the matrix, we obtain an impression of the extent to which movers are "trapped" in the same broad value category in which they were situated before the move. For owners, who form a minority of the sample, only the open-ended category shows a very large share of households on the diagonal; but the number of such households is very small. Among renters, the problem is more important. Fully thirty-eight per cent of the total sample consists of renters who remained in the same value category. The inclusion on the questionnaire of all renters paying from $60 to $100 in a single category is especially unfortunate for our purposes. On the other hand, the great majority of the sample households are scattered among cells other than those along the diagonal, indicating that household mobility between value levels is high enough to overcome the gross classification to a considerable extent.

A second interesting observation which Table IV. 1. suggests

TABLE IV. 1

HOUSING VALUE BEFORE AND AFTER THE MOVE

(Percent of Total Sample)
(Percent of Row Total)

Pre-Move Value or Rent	Post-Move Value of Owner-Occupied Single-Family Units ($000)					
	0-5	5-10	10-15	15-20	20-25	Over 25
Owner Value ($)						
0-5,000	0	0	0	0	0	0
	0	0	50	0	0	0
5-10,000	0	0	1	1	0	0
	0	0	21	29	0	0
10-15,000	0	0	1	2	2	0
	0	0	7	24	22	3
15-20,000	0	0	0	0	1	0
	0	0	0	4	35	9
20-25,000	0	0	0	0	1	1
	0	0	0	0	25	31
Over 25,000	0	0	0	0	0	0
	0	0	0	0	0	49
Rental Payment ($)						
0-60	0	1	1	1	0	0
(0-12,000)	0	4	4	7	2	0
60-100	0	1	3	7	2	1
(12-20,000)	0	2	6	15	5	3
100-150	0	0	1	2	1	1
(20-30,000)	0	0	7	18	9	6
Over 150	0	0	0	1	0	0
(Over 30,000)	0	0	0	38	0	13

TABLE IV. 1 (Continued)

HOUSING VALUE BEFORE AND AFTER THE MOVE

(Percent of Total Sample)
(Percent of Row Total)

Pre-Move Value or Rent	Post-Move Monthly Payment on Rental Units ($)			
	0-60 (0-12,000)	60-100 (12-20,000)	100-150 (20-30,000)	Over 150 (Over 30,000)
Owner Value ($)				
0-5,000	0	0	0	0
	0	25	25	0
5-10,000	0	1	0	0
	7	36	7	0
10-15,000	0	2	1	0
	2	27	15	0
15-20,000	0	1	1	0
	9	22	17	4
20-25,000	0	0	1	0
	0	0	44	0
Over 25,000	0	0	0	0
	13	0	13	25
Rental Payment ($)				
0-60	6	9	1	0
(0-12,000)	33	46	5	0
60-100	2	27	6	0
(12-20,000)	4	54	11	0
100-150	0	2	4	1
(20-30,000)	1	19	33	6
Over 150	0	0	0	1
(Over 30,000)	0	13	0	38

is that the overwhelming share of households move to housing which is in the same or higher value class. This phenomenon is especially evident among households which own both before and after the move. Only renters moving to fee housing seem to run counter to this tendency, and even there, the cells around the lower-left corner of the corresponding field of the matrix have no entries. This observation tends to confirm the hypothesis stated in Chapter II --that households have a strong tendency to maintain their level of housing consumption, and that downward adjustments in that level are likely to occur only in extreme cases. Upward adjustments, on the other hand, are much more common under normal circumstances.

3. Current income and permanent income

Leaving aside consideration of the effects of the prior stock level for the moment, we examine the regression results in Table IV.2. The principal purpose in performing these regressions is to examine the performance of a measure of long-run or permanent income in comparison with the more conventional current income. The measure of permanent income employed in these regressions, and the measure which I shall apply most frequently in this study, will be referred to as Permanent Income (I). The construction of this type of measure was first suggested, in general terms, by Jean Crockett in (15), pp. 220-221 and has since been employed by Crockett and Friend (8). It is asserted that if consumers are grouped according to family characteristics such as education and occupation, the mean income of all the consumers in each such group may serve to represent the permanent component of income,

assuming that the variables used for grouping affect the level of consumption only through their influence upon income. The notion underlying this suggestion is that consumers with similar family characteristics will tend to cluster around some income level which, both in terms of expectations and, for the group as a whole, in terms of achievement, is held to be "normal". In the present analysis, the grouping variables used were occupation (five categories), education (five categories) and industry (four categories). Age has been suggested by other investigators as a suitable variable where the dependent variable is consumption of all goods. Since it is desired, in the present study, to investigate the effects of age upon income, age was not used as a grouping variable.[2] The resulting measure, since it does not include age, must be viewed as a very long-range version of permanent income. The implied long horizon seems appropriate, however, where the good under discussion is housing, which is likely to have the longest horizon of any single good. The procedure employed for assigning a value of Permanent Income (I) to individual households was to construct a three-dimensional matrix having one hundred cells. Where four or more households reporting information on income and on each of the grouping variables were included in a single cell, their

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[2]Education level and occupation type very likely also affect level of housing services demanded, independently of their relation to income. Again, a compromise with reality was necessary, since this area has had insufficient exploration which would be useful in providing us with more satisfactory grouping variables, even assuming such variables were available in this particular data set.

current income levels were averaged to obtain the desired measure.[3] Ideally, each cell should contain some minimum number of households which is large, so that the effects of peculiar individuals is mitigated. Clearly, however, with a sample of the order of one thousand, as in this case, large cell size could have been obtained only at the expense of either still grosser classifications in the grouping variables or a much reduced sample size.

The initial set of regression results is shown in Table IV.2. The overall fit of the various equations, indicated by the coefficient of determination, R^2, is very low compared with typical regressions using grouped data; however, they are not extraordinarily low for micro-estimation, and in all cases R^2 is highly significant when account is taken of the large number of degrees of freedom. Each equation of Table IV.2 is shown twice; once with the age variable alone and once with the addition of a quadratic term. The latter is included in order to examine the possibility of non-linearity. This is a common procedure in the estimation of demand equations. It should be clear from the preceding discussion why we should expect the age effect to enter non-linearly; early in the life cycle, other types of durable goods and savings compete more successfully against housing in the budget; subsequently, with the desire for space and social status growing, housing comes to be more important; later in life, if the hypothesis of this study is valid, and if the appropriate income measure is employed, housing consumption will remain high. The result is that a curvilinear

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[3]For a cross-tabulation of Current Income vs. Permanent Income (I) for a sample of movers, see Table A.1.

TABLE IV.2

EFFECTS OF CURRENT INCOME AND PERMANENT INCOME

Variable						
Constant	9558*** (587)	8307*** (1488)	6334*** (851)	1151 (1660)	6811*** (780)	5431*** (1566)
Current Income	.9344*** (.0509)	.9219*** (.0524)	---	---	.7843*** (.0576)	.7713*** (.0590)
Permanent Income (I)	---	---	1.165*** (.093)	1.130*** (.093)	.5135*** (.0974)	.5150*** (.0974)
Number in Household	239.7** (81.7)	215.7* (85.8)	466.1*** (86.1)	355.1*** (91.7)	272.5*** (80.9)	246.4*** (84.9)
Age of Head	17.10 (12.59)	96.97 (88.14)	44.44** (13.53)	374.0*** (91.9)	23.7 (12.5)	111.3** (87.0)
$(\text{Age})^2$	---	-1.024 (1.118)	---	-4.241*** (1.170)	---	-1.122 (1.104)
R^2	.2859***	.2865***	.1704***	.1817***	.3062***	.3070***
Degrees of Freedom	948	948	948	947	947	946

* Significant at .05 level ** Significant at .01 level *** Significant at .001 level

regression line with a negative curvature and positive slope is likely to yield a better fit than a straight line. It is seen that Current Income is highly significant, with Number in Household also significant, but at lower levels, both with and without the quadratic term in age. Both Age and $(Age)^2$ are non-significant, however, although both terms have the expected signs. Permanent Income (I) is also highly significant. Its substitution for Current Income, furthermore, makes both Age and $(Age)^2$ highly significant. Possibly because of its own greater variance, Current Income far overshadows Age, leaving it little further explanatory power; whereas in combination with the more sluggish Permanent Income (I), the individual family characteristics come into their own. As expected, the permanent income measure has a larger positive coefficient than Current Income when they appear in separate equations.[4] In terms of overall fit, however, the equations containing Current Income are superior to those containing Permanent Income (I) as the only income measure. Current Income must therefore be judged the superior variable. That both current income and permanent income should be represented in the explanatory equation, and that their effects are distinct, is demonstrated in the last two sets of coefficients of Table IV. 2. Specifically, the equations represented, which include both income measures, are related to the model

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[4]The elasticity is also larger, since the mean of the current income variable is slightly larger than that of the permanent income variable.

(4.1) $Q = \alpha(YC - YP) + \beta YP$

where Q is value of housing purchased, YC is current income, YP is the permanent component of income, and (YC - YP) is therefore the transitory component of income. Equation (4.1) can simply be transposed to

(4.2) $Q = \alpha YC + (\beta - \alpha)YP$

which, with the addition of family characteristics, is represented in the last two sets of coefficients. It is desired to learn whether the coefficient of transitory income is significantly different from that of permanent income. If it is not, then there is no need to distinguish between the two, and current income alone need be represented. The results show that the coefficient of Permanent Income (I), which represents the difference between the two, is significantly non-zero. We conclude, therefore, that consumers spend the permanent component of income differently, and marginally to a greater extent, on housing than they do the transitory component. Again, in terms of overall fit, the inclusion of Current Income nearly doubles the share of variance explained.

4. Inclusion of the prior stock variable

The influence of the level of housing stock held prior to the market transaction is shown in Table IV.3. The regressions are based upon a smaller sample than those of the previous section, due to non-response to the question of prior value. Some of the equations of that section have therefore been re-

estimated for the smaller numbers, in order to yield a more direct comparison. It will be seen, however, that the results are approximately the same, except that Number in Household becomes insignificant throughout and $(Age)^2$ becomes positive and significant in the equations testing for the transitory income effect. These differences are somewhat aside from our main interest in the present section, however. What is of most importance here is that the coefficient of Prior Stock is highly significant, and that the introduction of this variable leads, in every case, to a large increase in explained variance. As was the case with family characteristics, the influence of the addition of this variable is greatest in the equation containing Permanent Income (I). Unlike the other variables, however, Prior Stock is also highly significant in both the equation containing Current Income and that containing Current Income and Permanent Income (I). As expected, the level of prior stock plays a major and distinct role in explaining the level of housing stock purchased in the transaction.

5. Alternative measures of income

The data upon which the present study is based allow more dynamic representations of the permanent component of income than that of Permanent Income (I) which is a static, lifetime measure. While most investigators are constrained to use such measures, we have an advantage in the historical nature of the data, which, furthermore, we can relate specifically to movers. The disadvantages of the data base in this connection are twofold:

TABLE IV.3

EFFECT OF PRIOR STOCK

Variable						
Constant	9558** (587)	4808* (2078)	-3025 (2425)	-2336 (2206)	3328* (1380)	899.1 (1323.9)
Current Income	.9550*** (.0688)	.7294*** (.0699)	---	---	.7443*** (.0770)	.5197*** (.0766)
Permanent Income (I)	---	---	1.315*** (.132)	1.012*** (.123)	.5697*** (.1385)	.4957*** (.1302)
Number in Household	48.83 (122.56)	41.56 (115.3)	194.0 (130.8)	145.3 (118.9)	85.46 (116.3)	45.32 (109.2)
Age of Head	233.4 (128.0)	137.3 (121.0)	567.8*** (132.3)	340.2** (122.2)	24.83 (17.62)	9.130 (16.62)
$(Age)^2$	-2.675 (1.608)	-1.643 (1.518)	-6.583*** (1.668)	-4.022** (1.535)	.5736** (.1753)	.6241*** (.1645)
Prior Stock	---	.3223*** (.0367)	---	.4008*** (.0369)	---	.3205*** (.0365)
R^2	.2993***	.3809***	.2008***	.3403***	.3357***	.4166***
Degrees of Freedom	558	557	558	557	557	556

* Significant at .05 level ** Significant at .01 level *** Significant at .001 level

first, the more information we attempt to include for individual households for prior years, the smaller must our sample become, because of non-response; second, we are limited, for distinct information, to those years prior to the interview date in which a move was made. We can, nevertheless, make an approximation to the notion presented by Friedman (14), when he pictured the consumer as extrapolating his past income experience to some future horizon. I have constructed such a measure of permanent income as follows. For a subsample of the population of interviewed households reporting a prior move of residence, and, for the year of prior move, reporting current income, I have calculated the annual rate of change of income, where the income of the survey year is entered in the denominator. I then added one to this rate of change and multiplied the resulting factor against the current income of the survey year. The resulting measure might be interpreted as a one-year extrapolation of income change. I refer to it by the term Permanent Income (II). In addition, I have calculated an alternative measure which is derived by dividing, rather than multiplying, current income in the survey year by the change factor. I refer to this measure as Permanent Income (III). This measure is also consistent with the permanent income hypothesis. It emphasizes the role of wealth as a part of permanent income. Thus, given two consumers with identical current incomes and differing positive rates of change of income, the one with the lesser rate of change is predicted to have a greater accumulation of savings, hence a higher rate of

consumption. In the downward direction, the consumer with the larger absolute rate of change (smaller algebraic rate) will have the higher rate of consumption because of a greater accumulation of wealth. The results of the regressions including these two alternative measures are presented in Table IV. 4, in addition to which regressions containing Current Income are included for comparison.

All of the coefficients in all of the regressions are significant, but the projected income change variable reduces the overall explanatory power compared with Current Income, both with and without inclusion of the prior stock variable. The discounted income change variable, on the other hand, increases the fit in either case. This result emphasizes the role of assets in the determination of housing demand level. It gives further support to the asserted importance of lump-sum costs associated with the transaction, since these costs are likely to draw primarily upon accumulated assets.

An additional hypothesis may be suggested to explain the results of IV. 4. Since the sample includes both households with rising and falling incomes, and since our prior assertion is that there is extreme rigidity in the downward direction in the demand for housing it is conceivable that the behavior of households with downward-tending income predominates in the sample as a whole. The households in the sample, as we shall see, are about equally divided into those with rising and those with falling incomes, and it is not improbable that the effect of rigidity in the downward direction is much stronger than the extrapolation of rising income.

TABLE IV.4

PROJECTED VS. DISCOUNTED CHANGE IN CURRENT INCOME:
RISING AND FALLING CURRENT INCOMES POOLED

Variable						
Constant	11604*** (1026)	8835*** (1215)	11604*** (1026)	9417*** (1211)	10205*** (1076)	8360*** (1221)
Current Income	.9473*** (.1337)	.7346*** (.1571)	---	---	---	---
Permanent Income (II)	---	---	.7956*** (.1337)	.5855*** (.1454)	---	---
Permanent Income (III)	---	---	---	---	1.0603*** (.1517)	.8459*** (.1646)
Prior Stock	---	.2176** (.0736)	---	.2367** (.0751)	---	.2105** (.0720)
R^2	.2561***	.3047***	.2194***	.2768***	.2794***	.3255***
Degrees of Freedom	126	125	126	125	126	125

* Significant at .05 level ** Significant at .01 level *** Significant at .001 level

This hypothesis may be tested by dividing the sample into two parts: those households with rising, and those with falling incomes.

Tables IV. 5 and IV. 6 present the results for the two groups, of sizes 66 and 62, respectively. For households with rising income, the equation containing Permanent Income (II) is again inferior to that containing Current Income in explanatory power, while the fit is best of all with Permanent Income (III). The hypothesis of the importance of wealth again prevails. Furthermore, when the change factor is given increasing weight in the two alternative income measures, i. e., when the rate of change is successively multiplied by larger and larger integers, the fit worsens for Permanent Income (II), but improves with Permanent Income (III) up to a weighting of seven.[5] This last result is also presented in IV. 5 where the corresponding variable is labelled as Permanent Income (III7). For households with falling income, there is little difference in explanatory power among the equations employing the alternative income measures, and further weighting of Permanent Income (II) and Permanent Income (III) only reduces the fit.

The second important result which appears in IV. 5 and IV. 6 is that, for households with rising incomes, the income measure, however defined, is of supreme importance, while Prior Stock

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[5]This procedure was also performed for the sample upon which Table IV. 4 is based, i. e., including households with both rising and falling income. The result, as might be expected from the separate analyses, was that the fit gradually worsened for both types of income measure with increasing weighting.

TABLE IV.5

PROJECTED VS. DISCOUNTED CHANGE IN CURRENT INCOME: RISING CURRENT INCOMES

Variable								
Constant	11021*** (1552)	10165*** (1797)	11794*** (1587)	10766*** (1838)	10541*** (1498)	9752*** (1750)	10561*** (1310)	9478*** (1630)
Current Income	.9037*** (.1913)	.8203*** (.2107)	---	---	---	---	---	---
Permanent Income (II)	---	---	.7448*** (.1815)	.6507** (.2002)	---	---	---	---
Permanent Income (III)	---	---	---	---	1.0382*** (.1981)	.9614*** (.2170)	---	---
Permanent Income (III7)	---	---	---	---	---	---	1.401*** (.231)	1.310*** (.245)
Prior Stock	---	.0918 (.0969)	---	.1108 (.1003)	---	.0821 (.0936)	---	.0960 (.0862)
R^2	.2586***	.2690***	.2083***	.2233***	.3002***	.3086***	.3647***	.3770***
Degrees of Freedom	64	63	64	63	64	63	64	63

TABLE IV.6

PROJECTED VS. DISCOUNTED CHANGE IN CURRENT INCOME: FALLING CURRENT INCOMES

Variable						
Constant	10118*** (1628)	6323*** (1696)	10393*** (1589)	6468*** (1680)	9994*** (1660)	6214*** (1713)
Current Income	1.064*** (.253)	.5182* (.2581)	---	---	---	---
Permanent Income (IIa)	---	---	1.037*** (.250)	.4937 (.2553)	---	---
Permanent Income (III)	---	---	---	---	1.037*** (.2534)	.5245* (.2569)
Prior Stock	---	.4800*** (.1136)	---	.4838*** (.1139)	---	.4805*** (.1130)
R^2	.2279***	.4072***	.2225***	.4045***	.2271***	.4085***
Degrees of Freedom	60	59	60	59	60	59

* Significant at .05 level ** Significant at .01 level *** Significant at .001 level

is insignificant. For households with falling incomes, on the other hand, income by itself is significant, but its influence is overwhelmed with the introduction of Prior Stock. This finding may be explained by our previous reasoning of Section II, C. 2, especially p. 71, where it was suggested that the level of stock held prior to the transaction acts as a floor to the range of levels from which the household makes its selection. Two influences were asserted as being subsumed under the variable Prior Stock, viz., a taste effect and a constraining effect. In line with the prior argument, if the two effects are about equal in magnitude, the coefficient of Prior Stock is insignificant and the income measure carries the bulk of the explanatory power. The superior performance of Prior Stock for observations on households with declining income is due to the parallel influence of the two effects for such households.

6. Inclusion of information on previous transaction

There was some discussion in Chapter II of the desirability of including in the demand equation as a specific variable some measure of individual household taste based upon previous behavior. The variable which I suggested is expressed in (2.14). It is the residual derived from the values of the variables observed in the next previous housing transaction of each household, multiplied by the parameters of the demand equation, as estimated for the survey year. The reasoning is that if household tastes with respect to housing persist, then households with relatively high demand levels in the past will continue to demand a higher

level than would be predicted by the relation fitted to all households, and vice versa. Consequently, we would expect the taste variable to be positively correlated with the level of housing purchased.

This hypothesis has been tested, with the result shown in Table IV. 7. The explanatory variables shown in (2. 14) have been supplemented by the prior stock variable, both for the interview year transaction, and, as part of the taste variable, for the previous transaction.

TABLE IV. 7

EFFECT OF TASTE VARIABLE

Constant	3324 (2635)
Current Income	.4664* (.1920)
Prior Stock	.6737** (.2075)
Taste	-.4793* (.2043)
R^2	.3342***
Degrees of Freedom	124

* Significant at .05 level
** Significant at .01 level
*** Significant at .001 level

Taste is significant, but the sign of the coefficient is negative---the opposite of what we should have expected. On the other hand, Taste and Prior Stock are only moderately correlated, indicating that they are explaining different aspects of the variance of the

dependent variable. One possible, though not very satisfactory explanation is as follows. Current income tends to fluctuate relatively much more widely over time than does level of housing demand, as expressed in intermittent housing transactions. A household with a housing demand level which is high, relative to income and other explanatory variables, at the time of one transaction will again demand about the same level of housing in the succeeding transaction, even though its income, etc., have risen. As a result, the difference between the level of its purchase and the level predicted by the regression equation (the residual) will be much smaller than previously, or perhaps even negative. This hypothesis might be termed a taste effect also, but in this case the effect is one of a stable level of taste. It would lead to a negative sign on the coefficient of the taste variable if the situation were such that there were a high positive correlation between Taste and the rate of change of income. The simple correlation of .3740 indicates that this hypothesis may be valid as a partial explanation.

7. Stratification by age

Because of the emphasis which I have placed upon behavior of households over the course of their lifetime, it seemed appropriate to examine the performance of the several equation forms in relation to age of the household head. In order to make such an examination, I stratified the sample (sub-sample III) into six age classes. See Table IV. 8. The object of this analysis is to examine the significance of individual coefficients and over-all

fit, rather than differences in the size of slope coefficients, which is reserved for the formal analysis of covariance in Section IV. A. 9.[4]

The current income variable alone performs well for all age strata, but is slightly less significant for the very youngest and very oldest groups. Prior Stock, when included in the equation, is also significant for all groups, but the level of significance grows from the younger groups to the middle-aged and older groups, and also slightly reduces the significance of Current Income for the younger groups, as well as for the oldest two groups. This pattern is in agreement with our anticipations, since we expect that the younger household is more likely to be far away from its long-term housing level, and there are therefore likely to be wide variations in adjustment. In addition, the younger household will, on the average, have a lower wealth level than the older one. This condition will act as a constraint, as brought out in Section IV. A. 5, upon the extent to which such households may adjust to their desired levels. For the same reasons, level of Prior Stock is likely to have less relevance for the decision as to level of housing purchased. For households at the high end of the age scale, Prior Stock comes to have relatively more explanatory power than Current Income, since

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[4]It would be a highly questionable procedure to test, successively, alternative grouping variables for their effects upon the size of coefficients. At the very least, it can be said that conventional test statistics, such as the F-statistic, which I shall employ extensively in Section IV. A. 9, would lose their validity in such an instance.

TABLE IV.8

STRATIFICATION BY AGE

Variable	Age Class 20-24	25-29	30-34	35-44	45-54	55+
Constant	11192*** (1620)	13127*** (844)	10672*** (1110)	8884*** (1211)	12506*** (1662)	11143*** (1866)
Current Income	.7677** (.2742)	.5400*** (.1216)	1.047*** (.1416)	1.240*** (.1358)	.7825*** (.2107)	.8473** (.3061)
R^2	.0892**	.1249***	.3578***	.3816***	.1772***	.1754**
Degrees of Freedom	80	138	98	135	64	36
Constant	8900*** (1937)	11374*** (991.8)	5923*** (1442)	6201*** (1407)	7671*** (1867)	3513 (2652)
Current Income	.6701* (.2729)	.3968** (.1264)	.8452*** (.1360)	.9841*** (.1509)	.4630* (.2020)	.7256* (.2668)
Prior Stock	.2137* (.1033)	.1930** (.0616)	.3992*** (.0864)	.2855*** (.0838)	.4573*** (.1079)	.5712*** (.1575)
R^2	.1359**	.1834***	.4735***	.4308***	.3597***	.4005***
Degrees of Freedom	79	137	97	134	63	35

TABLE IV.8 (Continued)

Variable	Age Class 20-24	25-29	30-34	35-44	45-54	55+
Constant	12239*** (2620)	14083*** (1268)	6435** (2007)	6087** (2001)	7641* (3174)	4137 (4002)
Permanent Income (I)	.5212 (.4052)	.3802 (.1814)	1.766*** (.2920)	1.880*** (.2789)	1.600** (.4732)	1.900** (.6361)
R^2	.0202	.0308*	.2717***	.2516***	.1515**	.1986**
Degrees of Freedom	80	138	98	135	64	36
Constant	9571* (2794)	10824*** (1409)	2443 (2003)	2028 (1976)	4286 (2881)	-1677 (3889)
Permanent Income (I)	.4257 (.3966)	.3347 (.1709)	1.356*** (.2782)	1.4353*** (.2676)	.9819* (.4371)	1.552** (.5662)
Prior Stock	.2459* (.1054)	.2558*** (.0587)	.4332*** (.0913)	.4250*** (.0797)	.4751*** (.1056)	.5476** (.1586)
R^2	.0834*	.1486***	.4088***	.3826***	.3577***	.4022***
Degrees of Freedom	79	137	97	134	63	35

TABLE IV.8 (Continued)

Variable	Age Class 20-24	25-29	30-34	35-44	45-54	55+
Constant	10100*** (2677)	12334*** (1286)	5577** (1792)	5186** (1781)	8303** (3103)	3804 (3878)
Current Income	.7231* (.2889)	.5060*** (.1286)	.7919*** (.1524)	.9863*** (.1611)	.5471** (.2552)	.5863 (.3168)
Permanent Income (I)	.2115 (.4116)	.1492 (.1822)	1.0365*** (.2952)	.8341** (.3007)	.9007 (.5643)	1.4225* (.6676)
R^2	.0922*	.1292***	.4302***	.4152***	.2091***	.2700**
Degrees of Freedom	79	137	97	134	63	35
Constant	8064** (2810)	10357*** (1390)	2468 (1820)	2760 (1861)	4909 (2904)	-1782 (3752)
Current Income	.6360* (.2865)	.3518** (.1335)	.6683*** (.1442)	.7502*** (.1702)	.3101 (.2360)	.5263 (.2771)
Permanent Income (I)	.1667 (.4043)	.1846 (.1768)	.8173** (.2783)	.7952** (.2899)	.6313 (.5099)	1.1347 (.5888)
Prior Stock	.2114* (.1040)	.1970** (.0617)	.3520*** (.0848)	.2765*** (.0819)	.4399*** (.1083)	.5294** (.1533)
R^2	.3712**	.1899***	.5169***	.4613***	.6125***	.4595***
Degrees of Freedom	78	136	96	133	62	34

* Significant at .05 level ** Significant at .01 level *** Significant at .001 level

the absolute level of housing demand is relatively firmly set by the prior level of housing consumption.

Permanent Income (I) performs nearly as well as Current Income for the middle age groups, slightly better for the oldest group, and distinctly worse for the younger groups. Again, this result has a fairly simple explanation. The younger age groups are still relatively mobile with respect to their occupational expectations, so that Permanent Income (I) is a relatively less valid measure for them than for the older groups. In addition, there are the same reasons for greater dispersion among the younger groups as were advanced in connection with the Current Income equations. That Permanent Income (I) retains a significant level of explanatory power for the oldest age groups indicates that, faced with a declining level of Current Income, households tend to rely upon some type of accumulated status in deciding upon the appropriate level of purchase. That Permanent Income (I) yields little more explanatory power than Current Income for the oldest age group can perhaps be explained by the greater probability of the consonance of Current Income with the appropriate long-run income measure for the older groups than for the younger. This consonance seems likely because the older groups' Current Income has had a longer time to stabilize, and therefore is more in accord with long-run expectations. It must also be kept in mind, not only in connection with this section, but wherever Permanent Income (I) is applied to small sub-samples, that the construction of this measure of permanent income is such that we ought not to expect great precision in distinguishing among

income levels for small groups of households, where outliers may be relatively numerous. The performance of Permanent Income (I) in this instance is therefore encouraging. It does lead us to conclude that some measure of long-run income expectations is appropriate in the housing demand function. The introduction of Prior Stock in addition to Permanent Income (I) has much the same effect as its inclusion with Current Income. The result is of interest mainly because it demonstrates that Prior Stock has some effect separate from that of the long-run income measure, and that this is true at all age levels.

When Current Income and Permanent Income (I) are included in the same equation, transitory income effects can be observed in the households with middle-aged heads, where, because of relative stability of their income, Permanent Income (I) is probably most valid as a measure of the true long-run income, and where the divergence between Current Income and this measure is likely to have a small coefficient --"α" in (4.1)-- compared with that of Permanent Income (I) --"β" in (4.1). This is indeed the interpretation we may place upon the results of Table IV.8 in accordance with the previous discussion of Section IV.A.3.

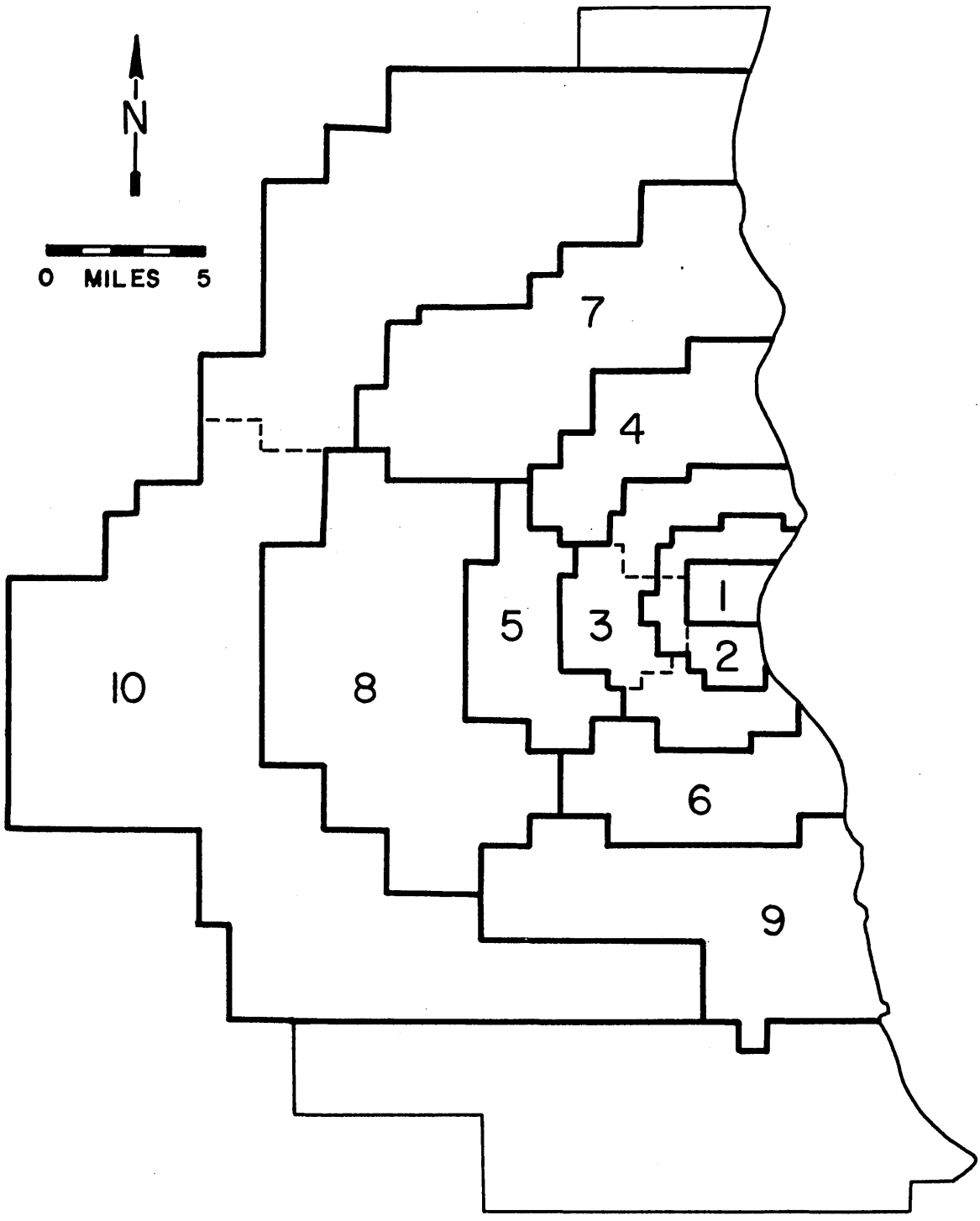
8. Individual groups

There has been considerable discussion thus far in the study of sources of heterogeneity in the housing market and, in particular, in connection with the estimation of a demand function. In this section and the next, I shall examine the extent to which such

heterogeneity exists, where the grouping variables are tenure type and geographic location pairs. Specifically, sub-sample III, which contains information on both type of tenure and geographic location before and after the move (made between January 1, 1962 and the interview date) was divided into groups according to tenure type at "origin" and at "destination" of the move. In addition, the sub-sample was broken down according to general location of "origin" and "destination." These locations were of three types: the core of the metropolitan area; the suburbs; and all points outside the area. In creating these groups, it was desired to obtain, on the one hand, as fine a geographic-pair disaggregation as possible, while on the other hand retaining large numbers of households in each cell. In order to achieve a compromise which allowed a meaningful analysis, each tenure-pair group was arrayed in a cross-tabulation according to Analysis Area of origin and of destination. These Analysis Areas are shown in Figure 2. The cross-tabulations are presented in Appendix II. The groupings which were derived, using the Analysis Areas as basic units, are felt to be reasonable. In terms of geographic breakdown, the core area includes the City of Milwaukee and immediately adjacent communities --Analysis Areas 1-3, with the remainder of the Analysis Areas within the larger area allocated to the Suburbs. Among tenure-type-pairs, the geographic groups are very gross for households which owned their own homes prior to the move, while those who rented, being much more mobile, are a sufficiently large group so that finer disaggre-

FIGURE 2

ANALYSIS AREAS



gation could be made. The resulting groups are as follows:

1. Owner-owners moving within the area;
2. Owner-owners migrating to the area;
3. Owner-renters moving within the area;
4. Owner-renters migrating to the area;
5. Renter-renters moving within the core;
6. Renter-renters moving within the suburbs;
7. Renter-renters moving from the core to the suburbs;
8. Renter-renters moving from the suburbs to the core;
9. Renter-renters migrating to the core from outside the area;
10. Renter-renters migrating to the suburbs from outside the area;
11. Renter-owners moving to and within the core (including in-migrants)[5];
12. Renter-owners moving within the suburbs;
13. Renter-owners moving to the suburbs (including in-migrants)[5].

In creating these groupings it must be recognized that at least three major sources of heterogeneity exist, which regressions based upon the individual groups should reveal. Unfortunately, and with one partial exception which will be discussed in Section IV. A. 8, as far as I can ascertain there is no way in which the available data can be used to isolate these individual effects. There are: first, differences underlying the behavior

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[5]In-migrants were included in these groups because they were so small in number that no separate analysis could be performed on them. Since they are so few, they are not excluded in those tests in Section II. A. 9 which otherwise exclude in-migrants.

of the households in the various groups and which would fall under the general heading of differences in taste, which in this instance are revealed by their choice of location and tenure type both before and after the move; second, differences in prices among sub-areas of the region, the lack of representation of which as a specific variable I have previously commented upon; and third, the rental-fee conversion which has been applied to obtain a single measure of housing demand for both tenure types. It is, of course, the first of these which we should like to extricate from the simultaneous effects of the others.

Regressions have been run on each of the thirteen groups, with Current Income and Permanent Income (I) separately, with and without the inclusion of Prior Stock. The results are shown in Table IV. 9. Regressions on equations containing both income measures were also run, but in all cases Permanent Income (I) was non-significant. The reader is again reminded of the grossness of this measure in small samples. The results of these latter regressions are not shown.

In general the use of Current Income yields superior results, in Table IV. 9, to Permanent Income (I), although, with the inclusion of Prior Stock they are more nearly equal in significance. Prior Stock seems to be non-significant most commonly for those groups wherein households experience a change in tenure type as the result of the move. This may be explained as the change in tenure representing an important change in life style for such groups, a change which displays itself in important measure in a change in housing consumption. Another possible cause relates

to wealth and its relationship to the down-payment and to transaction costs. For different prior owners holding the same level of Prior Stock, wealth levels might be quite different. In moving to rental housing, these varying wealth levels, in combination with either income measure, would result in varying levels of rental payment chosen; whereas those moving from one owned dwelling to another would have a greater tendency to occupy the same level of housing as it did previously, the level being adjusted in relation to the appropriate income measure. For renters moving to fee housing, the level of housing purchased may depend to a considerable extent upon the amount which can be paid as a down-payment, and this variation may not be reflected in the amount of rent paid in the prior dwelling. Indeed, many households may have a tendency to pay a lower rent than they otherwise would in order to be able to save for the down-payment.

9. Covariance analysis

To investigate, in a more formal way, whether there exists within the sample used in the preceding section heterogeneity, and whether this heterogeneity can be explained by logical groupings of the individual thirteen groups, I have employed the technique of covariance analysis. This procedure has been developed by Mood (36), and by Kendall (25). I have drawn upon the presentation of Kuh (29). Briefly, the test consists of three parts, the last containing two steps, which are carried out sequentially. The first part is a test for the over-all homogeneity of the regressions

TABLE IV.9

INDIVIDUAL GROUPS

Variable	Group No. 1 O.O. within Area	2 O.O. In-Migrants	3 O.R. within Area	4 O.R. In-Migrants	5 R.R. within Core	6 R.R. within Suburbs	7 R.R. Out-Movers
Constant	12266*** (3091)	9150* (3551)	1254*** (2205)	13774*** (2921)	11515*** (1051)	12687*** (1495)	13992*** (1210)
Current Income	1.0197** (.3736)	1.4498*** (.3033)	.7365* (.3011)	.7869* (.3362)	.6706*** (.1851)	.7717*** (.2054)	.4045* (.1805)
R^2	.1603**	.6372***	.2063*	.1923*	.0978***	.1739***	.1253*
Degrees of Freedom	39	13	23	23	121	67	35

Variable	Group No. 8 R.R. In-Movers	9 R.R. In-Migrants to Core	10 R.R. In-Migrants to Suburbs	11 R.O. to and within Core (Incl. In-Migrants)	12 R.O. within Suburbs	13 R.O. to Suburbs (Incl. In-Migrants)
Constant	11630*** (1254)	6095** (1805)	13050*** (2027)	8143*** (1534)	11439*** (2084)	9540*** (1754)
Current Income	.5913** (.1750)	1.6916*** (.2594)	.7389** (.2334)	.7332*** (.1860)	1.0371*** (.2637)	1.0970*** (.2028)
R^2	.2512**	.6694***	.2225**	.3832***	.2327***	.3690***
Degrees of Freedom	34	21	35	25	51	50

TABLE IV.9 (Cont.)

Variable	Group No. 1	2	3	4	5	6	7
Constant	6642** (2205)	8608* (3817)	11622*** (2411)	12642*** (3110)	6651*** (1134)	6232** (1886)	11542*** (1645)
Current Income	.3239 (.2674)	1.2810* (.4613)	.5268 (.3726)	.4285 (.4798)	.3744* (.1627)	.5157** (.1869)	.4493* (.1737)
Prior Stock	.8040*** (.1136)	.1281 (.2575)	.1516 (.1581)	.2657 (.2543)	.4677*** (.0674)	.5274*** (.1115)	.1480* (.0707)
R^2	.6376***	.6446**	.2382	.2305	.3561***	.3829***	.2251*
Degrees of Freedom	38	12	22	22	120	66	34

Variable	Group No. 8	9	10	11	12	13
Constant	7884*** (1600)	4067 (2183)	8796*** (1709)	8063*** (1910)	11309*** (2816)	6210* (2581)
Current Income	.3619* (.1701)	1.5163*** (.2754)	.2925 (.1932)	.7204** (.2565)	1.0292*** (.2897)	1.0303*** (.2026)
Prior Stock	.3454** (.1064)	.2475 (.1596)	.5198*** (.0970)	.0111 (.1504)	.0106 (.1526)	.2551 (.1471)
R^2	.4323***	.7048***	.5785***	.3833**	.2328**	.4054***
Degrees of Freedom	33	20	34	24	50	49

TABLE IV.9 (Cont.)

Variable	Group No.						
	1	2	3	4	5	6	7
Constant	9296* (3851)	14135 (8377)	14644*** (3631)	7753 (6920)	11677*** (1660)	9170*** (2320)	13526*** (2956)
Permanent Income (I)	1.5932** (.5405)	1.2993 (.9576)	.4686 (.5464)	1.7009 (.9527)	.5646* (.2672)	1.3692*** (.3526)	.4894 (.4687)
R^2	.1821*	.1240	.0309	.1217	.0355*	.1836***	.0302
Degrees of Freedom	39	13	23	23	121	67	35

Variable	Group No.					
	8	9	10	11	12	13
Constant	9723*** (2648)	1153 (3069)	16024*** (3533)	9869 (4064)	6845 (3862)	13536*** (3329)
Permanent Income (I)	.8808* (.3924	2.3812*** (.4467)	.4137 (.4759)	.5832 (.6151)	1.6923** (.5212)	.6903 (.4534)
R^2	.1290*	.5749***	.0211	.0347	.1712**	.0443
Degrees of Freedom	34	21	35	25	51	50

TABLE IV. 9 (Cont.)

Variable	Group No. 1	2	3	4	5	6	7
Constant	4225 (2608)	9760 (7237)	11274*** (3790)	5274 (6565)	7407*** (1509)	2215 (2350)	10681** (3242)
Permanent Income (I)	.7523* (.3711)	.4762 (.8663)	.3282 (.5173)	1.2794 (.9116)	.1361 (.2314)	1.1093*** (.3010)	.6158 (.4582)
Prior Stock	.7871*** (.1076)	.6051* (.2380)	.2715 (.1337)	.3730* (.1777)	.4981*** (.0686)	.5544*** (.1040)	.1406 (.0757)
R^2	.6604***	.4306*	.1839	.2681*	.3296***	.4291***	.1195
Degrees of Freedom	38	12	22	22	120	66	34

Variable	Group No. 8	9	10	11	12	13
Constant	5500* (2453)	-3179 (2927)	11068*** (2547)	7489 (3967)	2429 (4622)	9648*** (3811)
Permanent Income (I)	.5946 (.3354)	2.1598*** (.3819)	-.1417 (.3380)	.2630 (.5954)	1.7168** (.5124)	.4861 (.4537)
Prior Stock	.4010*** (.1010)	.4553** (.1457)	.5933*** (.0933)	.2804* (.1320)	.2377 (.1419)	.3525 (.1818)
R^2	.4106***	.7143***	.5524***	.1873	.2152**	.1124
Degrees of Freedom	33	20	34	24	50	49

* Significant at .05 level ** Significant at .01 level *** Significant at .001 level

for the individual tenure-pair area-pair groups within the larger groupings being tested; the second part is a test for the homogeneity of the slope coefficient or coefficients, ignoring the intercept term; the third, which can be carried out only if the second test does not reject the homogeneity hypothesis[6] is for equality of intercept terms among the individual groups. The first part of the last-named test is for linearity of means among individual groups; if this linearity hypothesis is not rejected, then the second part tests for the homogeneity of the intercept term directly. The individual tests employ the well-known F-statistic, and the individual steps are therefore labeled F_1 - F_4, respectively. It might be noted that the tests in fact involve rejecting the hypothesis of heterogeneity, if the F-statistic is significant, so that a successful test depends upon non-significance.[7]

What the covariance analysis seeks to establish is whether a single equation may suitably be used to predict the demand of all of the individual groups (as defined in the previous section) within the larger grouping, which we would conclude if all three steps were successful; whether a single equation including some type of dummy variable to allow for differences in height of the individual regression lines would suffice, where F_2 is successful but F_3 or F_4 fails; or whether it is in fact necessary to employ

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[6] It would, of course, not make sense to test for the homogeneity of intercepts after the slopes had been shown to be heterogeneous.

[7] This involves some conceptual difficulties which I shall not discuss at this point. The reader is referred to Fisher (13), p. 38n.

different predictive equations, one for each of the individual groups. In addition, this analysis has relevance for the problem of aggregation, which I shall discuss also in Section IV. A. 10. If the test is successful in all three parts, then we would expect data aggregated by individual groups to provide unbiased estimates.

Seven sets of tests were made in all, involving: all tenure-pair area-pair groups; groups containing households which owned before the move (regardless of tenure following the move); groups containing households which rented before the move; groups which owned after the move; groups which rented after the move; groups which owned prior to the move, excluding in-migrants; and groups which rented prior to the move, excluding in-migrants. The latter two groups are of special significance in the analysis of the determinants of the move which follows in Section IV. B.

The results of the tests are shown in Table IV. 10. For all thirteen groups taken as a whole, heterogeneity exists in all four equations tested. This is a discouraging finding for anybody hoping to construct a simple predictive model of housing demand by movers, or of being able to employ grouped data in doing so. It indicates that information about tenure type and/ or location, possibly both before and after the move must be supplied or generated within such a model. Only Permanent Income (I) taken alone even yields a homogeneous slope coefficient; but this may well be because this measure has little discriminating power within small groups.

Where households are grouped by tenure type before the move and by tenure type after the move, the results improve, but only

slightly. For pre-move owners, over-all homogeneity is established, but none of the other tests is entirely successful. In general, Prior Stock introduces heterogeneity where added to Current Income or to Permanent Income (I). Some suggestions as to the sources of heterogeneity where Prior Stock is included have been made in the previous section.

One of the sources of heterogeneity which might affect the regressions of Part A can be tested for (though not conclusively) by the results of Parts B and C. That source is the rental-fee conversion which I have been employing as a convention. Since pre-move renters may "purchase" either fee or rental housing, this potential source of heterogeneity is included, even where there is no prior stock variable included. Post-move renters, on the other hand, since they all purchase, by definition, housing of the same tenure type are not subjected to this source of heterogeneity; the conversion is a simple multiple of rent, which would merely alter the size of coefficients and intercepts in all cells by the same multiple. Comparing the Current Income and the Permanent Income (I) equations (labelled 1 and 3, respectively, in the table) for the two groups shows the tests to be almost exactly alike. We may therefore tentatively conclude that the rental-fee conversion is at least no worse than the other approximations and omissions which we have had to tolerate.

The last two sets of tests, for households which were resident in the area prior to the move (F and G) show no important improvement over the previous four sets, where in-migrants were included.

TABLE IV. 10
COVARIANCE ANALYSIS

A. All Groups

	Variance Ratio	Degrees of Freedom		Approximate Significance Points on Null Hypothesis*
1. Current Income				
	$F_1 = 3.590$	24,	537	$F_{.001} = 2.40$
	$F_2 = 1.857$	12,	537	$F_{.05} = 1.83$
	Homogeneity hypothesis rejected.			
2. Current Income, Prior Stock				
	$F_1 = 4.506$	36,	536	$F_{.001} = 2.17$
	$F_2 = 2.745$	24,	536	$F_{.001} = 2.40$
	Homogeneity hypothesis rejected.			
3. Permanent Income (I)				
	$F_1 = 4.397$	24,	537	$F_{.001} = 2.40$
	$F_2 = 1.563$	12,	537	$F_{.25} = 1.26$
	$F_3 = 3.460$	11,	537	$F_{.001} = 3.13$
	Homogeneity hypothesis not rejected as to slope coefficient; rejected as to intercept on basis of overall test.			

*Significance points were obtained from Pearson and Hartley, Biometrika Tables for Statisticians, v. I, t. 18. Linear interpolation was employed except that where degrees of freedom exceeded 120, the statistic for 120 degrees of freedom is employed directly. The approximation error is negligible. Where the level of significance is less than .25, the statistic for $F_{.25}$ is shown.

TABLE IV. 10 (Cont.)

A. All Groups (Cont.)

	Variance Ratio	Degrees of Freedom		Approximate Significance Points on Null Hypothesis
4. Permanent Income (I), Prior Stock				
	$F_1 = 4.564$	36,	536	$F_{.001} = 2.17$
	$F_2 = 2.357$	24,	536	$F_{.005} = 2.09$
	Homogeneity hypothesis rejected.			

B. Pre-Move Owners

1. Current Income

$F_1 = 1.011$	6,	98	$F_{.25} = 1.33$
$F_2 = 1.126$	3,	98	$F_{.25} = 1.39$
$F_3 = .341$	2,	98	$F_{.25} = 1.34$
$F_4 = 3.005$	1,	98	$F_{.10} = 2.78$

Homogeneity hypothesis not rejected, either as to slope coefficient or as to intercept.

2. Current Income, Prior Stock

$F_1 = 2.68$	9,	94	$F_{.01} = 2.64$
$F_2 = 2.47$	6,	94	$F_{.05} = 2.21$

Homogeneity hypothesis rejected.

3. Permanent Income

$F_1 = 1.221$	6,	98	$F_{.25} = 1.34$
$F_2 = 0.478$	3,	98	$F_{.25} = 1.40$
$F_3 = 0.471$	2,	98	$F_{.25} = 1.40$
$F_4 = 4.949$	1,	98	$F_{.05} = 3.95$

Homogeneity hypothesis not rejected as to slope coefficient; specific test rejects homogeneity hypothesis as to intercept, but overall test fails to reject hypothesis.

TABLE IV. 10 (Cont.)

	Variance Ratio	Degrees of Freedom		Approximate Significance Points on Null Hypothesis
B. Pre-Move Owners (Cont.)				
4. Permanent Income, Prior Stock				
	F_1=2.000	9,	94	$F_{.05}$=2.00
	F_2=1.391	6,	94	$F_{.25}$=1.34
	F_3=0.745	2,	94	$F_{.25}$=1.41
	F_4=4.469	2,	94	$F_{.025}$=3.84
	Homogeneity hypothesis not rejected as to slope coefficient; homogeneity hypothesis rejected as to intercept on basis both of specific and overall tests.			
C. Pre-Move Renters				
1. Current Income				
	F_1=3.880	16,	439	$F_{.001}$=2.73
	F_2=1.771	8,	439	$F_{.10}$=1.72
	F_3=6.620	7,	439	$F_{.001}$=3.77
	Homogeneity hypothesis not rejected as to slope coefficients; rejected as to intercept on basis of overall test.			
2. Current Income, Prior Stock				
	F_1=5.130	24,	430	$F_{.001}$=2.40
	F_2=2.795	16,	430	$F_{.001}$=2.73
	Homogeneity hypothesis rejected.			
3. Permanent Income				
	F_1=3.995	16,	439	$F_{.001}$=2.73
	F_2=2.124	8,	439	$F_{.05}$=2.02
	Homogeneity hypothesis rejected.			

TABLE IV. 10 (Cont.)

	Variance Ratio	Degrees of Freedom		Approximate Significance Points on Null Hypothesis
C. Pre-Move Renters (Cont.)				
4. Permanent Income, Prior Stock				
	F_1=4.019	24,	430	$F_{.001}$=2.40
	F_2=2.763	16,	430	$F_{.001}$=2.73
	Homogeneity hypothesis rejected.			
D. Post-Move Owners				
1. Current Income				
	F_1=5.299	8,	178	$F_{.001}$=3.55
	F_2=0.732	4,	178	$F_{.25}$=1.37
	F_3=11.275	3,	178	$F_{.001}$=5.79
	Homogeneity hypothesis not rejected as to slope coefficient; rejected as to intercept on basis of overall test.			
2. Current Income, Prior Stock				
	F_1=6.451	12,	173	$F_{.001}$=3.02
	F_2=3.457	8,	173	$F_{.005}$=2.93
	Homogeneity hypothesis rejected.			
3. Permanent Income				
	F_1=4.545	8,	178	$F_{.001}$=3.55
	F_2=0.827	4,	178	$F_{.25}$=1.37
	F_3=4.593	3,	178	$F_{.005}$=4.50
	Homogeneity hypothesis not rejected as to slope coefficient; rejected as to intercept on basis of overall test.			

TABLE IV.10 (Cont.)

	Variance Ratio	Degrees of Freedom		Approximate Significance Points on Null Hypothesis
D. Post-Move Owners, (Cont.)				
4. Permanent Income, Prior Stock				
	F_1=5.263	12,	173	$F_{.001}$=3.02
	F_2=2.103	8,	173	$F_{.05}$=2.02
	Homogeneity hypothesis rejected.			
E. Post-Move Renters				
1. Current Income				
	F_1=2.229	14,	359	$F_{.01}$=2.23
	F_2=1.652	7,	359	$F_{.25}$=1.31
	F_3=1.510	6,	359	$F_{.25}$=1.33
	F_4=11.580	1,	359	$F_{.005}$=8.28
	Homogeneity hypothesis not rejected as to slope coefficient; homogeneity hypothesis rejected as to intercept on basis of both specific and overall bests.			
2. Current Income, Prior Stock				
	F_1=2.756	21,	351	$F_{.001}$=2.50
	F_2=1.891	14,	351	$F_{.05}$=1.79
	Homogeneity hypothesis rejected.			
3. Permanent Income				
	F_1=3.551	14,	359	$F_{.001}$=2.94
	F_2=2.303	7,	359	$F_{.05}$=2.09
	Homogeneity hypothesis rejected.			

TABLE IV. 10 (Cont.)

	Variance Ratio	Degrees of Freedom		Approximate Significance Points on Null Hypothesis
E. Post-Move Renters (Cont.)				
4. Permanent Income, Prior Stock				
	F_1=4.792	21,	351	$F_{.001}$=2.50
	F_2=2.720	14,	351	$F_{.005}$=2.42
	Homogeneity hypothesis rejected.			
F. Pre-Move Resident Owners				
1. Current Income				
	F_1=1.1161	2,	62	$F_{.25}$=1.42
	F_2=0.2599	1,	62	$F_{.25}$=1.35
	Homogeneity hypothesis not rejected as to slope coefficient; insufficient degrees of freedom for specific test on intercept, but overall test shows homogeneity.			
2. Current Income (I), Prior Stock				
	F_1=8.573	3,	60	$F_{.001}$=6.17
	F_2=6.182	2,	60	$F_{.01}$=4.98
	Homogeneity hypothesis rejected.			
3. Permanent Income (I)				
	F_1=2.188	2,	62	$F_{.25}$=1.42
	F_2=1.6061	1,	62	$F_{.25}$=1.35
	Homogeneity hypothesis not rejected as to slope coefficient; insufficient degrees of freedom for specific test on intercept, but overall test fails to reject hypothesis.			
4. Permanent Income (I), Prior Stock				
	F_1=8.152	3,	60	$F_{.001}$=6.17
	F_2=3.405	2,	60	$F_{.05}$=3.15
	Homogeneity hypothesis rejected.			

TABLE IV.10 (Cont.)

	Variance Ratio	Degrees of Freedom		Approximate Significance Points on Null Hypothesis
G. Pre-Move Resident Renters				
1. Current Income				
	$F_1 = 4.359$	12,	383	$F_{.001} = 3.02$
	$F_2 = 0.9497$	6,	383	$F_{.25} = 1.26$
	$F_3 = 9.481$	5,	383	$F_{.001} = 4.42$
	Homogeneity hypothesis not rejected as to slope coefficient; rejected as to intercept on basis of overall test.			
2. Current Income, Prior Stock				
	$F_1 = 4.305$	18,	376	$F_{.001} = 2.65$
	$F_2 = 2.523$	12,	376	$F_{.01} = 2.34$
	Homogeneity hypothesis rejected.			
3. Permanent Income (I)				
	$F_1 = 4.028$	12,	383	$F_{.001} = 3.02$
	$F_2 = 1.082$	6,	383	$F_{.25} = 1.33$
	$F_3 = 7.109$	5,	383	$F_{.001} = 4.42$
	Homogeneity hypothesis not rejected as to slope coefficient; homogeneity hypothesis rejected as to intercept on basis both of specific and overall tests.			
4. Permanent Income (I), Prior Stock				
	$F_1 = 3.749$	18,	376	$F_{.001} = 2.65$
	$F_2 = 2.047$	12,	376	$F_{.05} = 1.83$
	Homogeneity hypothesis rejected.			

10. Aggregation bias

Since we have available in this study micro data, it is possible to compare the results of estimates based upon these individual household observations with those which the same data would yield if the investigator could observe them only in grouped form. Presumably, the former type of estimate is superior to the latter, since it provides more information; it is unnecessary, in using micro data, to resort to such expedients as averaging within groups.

In his classic work on aggregation, Henri Theil (46) has suggested a measure of aggregation bias which would be constructed as the difference between the slopes estimated from aggregate data and the unbiased estimate or average of the corresponding micro parameters. This measure has been calculated for the thirteen groups of the preceding two sections compared with the individual households within those groups. The results are shown in Table IV, 11, where the equations for this purpose are numbered as follows, according to the explanatory variables:

1. Current Income
2. Current Income, Prior Stock
3. Permanent Income (I)
4. Permanent Income (I), Prior Stock

Both for Current Income and for Permanent Income (I), the slopes are biased drastically upward by aggregation, more so for the latter. The inclusion of Prior Stock aggravates this distortion; while the Prior Stock slope itself is biased downward. While this study has not concerned itself with the considerable literature on

the size of the income elasticity of housing, the results of this section should serve to illustrate how misleading findings based upon aggregated data may be as an indication of this size, and of the difference in elasticities between current and permanent income measures. On the other hand, the size of the prior stock influence would be greatly underestimated. These observations, I must hasten to add, apply to cross sections. Time series analyses based upon aggregated data may be much more valid. Unfortunately, as I have previously implied, there is no realistic micro version of time series analysis for housing demand as defined here, since households do not move at regular periodic intervals.

TABLE IV.11

AGGREGATION BIAS

Equation	Aggregate Estimate (1)	Micro Estimate Average (2)	Aggregation Bias (3)=(1)-(2)	Relative Aggregation Bias (4)=(3)÷(2)
		Current Income Slope		
1.	1.7734	.9022	.8712	.9656
2.	1.9124	.6809	1.2315	1.8086
		Permanent Income (I) Slope		
3.	4.0034	1.0867	2.9167	2.6840
4.	4.4428	.7520	3.6908	4.9080
		Prior Stock Slope		
2.	-.1708	.2986	-.4694	-1.5720
4.	-.2562	.4269	-.6831	-1.6001

B. Determinants of the Move

For the portion of the analysis in which the dependent variable represents the probability of a move in a particular period,[8] it had originally been hoped to utilize the full sample of 10,000 households --less those which were not in the area in the prior year-- for the Milwaukee Area. Unfortunately, the costs of computation and of human time involved were felt, after an initial run, to be too great. As a result, this section is based upon a sub-sample of 1000 households, which I consider to be very limiting, since it reduces the numbers of movers, as well as numbers of households having positive values of certain of the explanatory variables to very small magnitudes. Indeed, since owners and renters in general have very disparate rates of mobility, it was felt to be essential that they be treated separately. Because of the relatively low mobility rate of owners, there were only seven owner households out of the 1000 which both resided in the area one year prior to the interview and moved within the area between then and the survey date. As a result, owners had to be dropped, and I was left with a sample of 359 households which rented as of January 1, 1962, of which 85 were subsequent movers.

The construction of the variables employed in the analysis of this section, and which were listed in a generalized way in Chapter II, is shown in Table IV.12. Each variable has two parts which are multiplicative, as indicated in the development

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[8]With some transposition --see Chapter II.

TABLE IV.12

CONSTRUCTION OF VARIABLES: PROBABILITY OF A MOVE

Symbol	Variable Construction	Criterion for Inclusion of Households
AY	100 - age of head	heads less than 30 years old
TS	1962 - year of move	moved to present* home within previous 12 years
VH	Value - 11025 -.8534 Income	positive residuals from regression of value on Current Income
VL	Same	negative residuals from same
C	$\frac{\text{No. of children-No. in household}}{\text{No. in household}}$	1 or more children 5 years old or less
DTT	Time (63) - Time (62)	positive change in travel time to work, 1962-63
DTT_{-1}	Time (62) - Time (60)	Same, 1960-62

*In the actual computations, one minus this proportion was employed.

of the model and expressed in (2.27). These are the proportion of households within a cell who are "exposed to a stimulus" of a particular type, and the level of the stimulus. Only the sums of the stimulus values for those households included in each variable in each cell were actually needed, but numbers of households were also calculated in order to measure the relative effects of proportions weighted and unweighted by average values of the stimuli. The change-in-travel-time variable was not included in the data as such. Rather, only travel times for the interview date were available. From these latter data, which were accompanied by traffic districts of origin and destination, it was possible to construct a matrix of average travel times based upon 5000 trips from residence to workplace. This matrix was applied to trips for all three years, i.e., 1960, 1962 and 1963. Considerable proportions of households with heads who increased their travel times during one or both of the two intervening periods fell in one of the vacant cells of this matrix or did not respond to the question of location of residence or workplace where a change, whether positive or negative, was indicated. It was therefore necessary to apply an inflator in each cell which, in effect, added those households lacking information in the same proportions as those with information. A similar inflator was necessary for the value-residual variable, due to high non-response rates on the value and income questions. In addition to the version shown in Table IV.12, the travel time increase variables were divided by travel time at the start of the period to put them in relative terms. Logarithmic

transformations were applied to equations containing each alternative. A fifth equation, composed simply of the proportions of households in each cell which fell within the criterion for having received a stimulus was also estimated, but without the increase in travel time consideration. This last omission is due to the fact that half of the cells contained no households which fell under this heading for either of the two periods. The cells used for these regressions are the same as those referred to as Analysis Areas in Figure 2, except that, in view of the large concentrations of renters in the inner rings, Analysis Areas 2 and 3 were each divided into three segments, while the outermost ring, because it is so extensive, was divided into two parts.

The results of the five regressions are shown in Table IV. 13. They are resoundingly non-significant. This result is not entirely surprising, given the number of observations which, for this type of model, is almost ludicrously small. Even with much larger numbers, however, it must be borne in mind that the likely determinants of a move are multitudinous and complex, and even if individual coefficients had been found to be significant, we should not have expected the over-all explanatory power to have been great. A further reason for this negative expectation is that the amount of simplification involved, while practically necessary, is large.

Even though the explanatory equations are not themselves significant, an examination of the residuals may be of some interest. These are presented for Equation 3 (logarithmic) in

TABLE IV. 13

DETERMINANTS OF THE MOVE

	1	2	3	4	5
Constant	457.1**	458.2**	400.5**	535.9**	362.2
	(86.8)	(85.2)	(103.5)	(123.6)	(108.0)
Age Less Than 30	.2322	.0049	.0231	.5028	171.6
	(3.1220)	(3.1505)	(.5325)	(.5888)	(147.6)
Increase in Family Size	.3852	.7448	.3703	-.1096	-95.54
	(5.5974)	(5.6480)	(.4518)	(.4626)	(134.2)
Years Since Prior Move	-34.28	-34.34	-1.1649	-2.739	-18.69
	(28.46)	(27.95)	(1.4542)	(1.693)	(159.8)
Positive Residual	.0024	.0024	-.0069	.0384	-.178
	(.0058)	(.0057)	(.0455)	(.0310)	(16.52)
Negative Residual	-.0099	-.0102	-.0285	-.0442	-30.09
	(.0061)	(.0061)	(.0297)	(.0251)	(20.53)
Increase in Travel Time 1960-62	-8.707	-1.651	1.947	-.6127	---
	(7.551)	(1.383)	(3.554)	(.4620)	
Increase in Travel Time 1962-63	-13.68	-3.371	-2.718	-1.348	---
	(20.71)	(4.632)	(3.392)	(1.312)	
R^2	.5598	.5683	.4753	.5645	.3836
Degrees of Freedom	7	7	7	7	9

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* Significant at .05 level
** Significant at .01 level
*** Significant at .001 level

TABLE IV. 14

DETERMINANTS OF THE MOVE:
SCHEMATIC GEOGRAPHIC DISTRIBUTION OF RESIDUALS
(Normalized)

	Sector		
Ring	1	2	3
0		.2063	
1	.6989	.2219	.2229
2	-.6098	-.0088	-1.25131
3	.1640	-.5055	- .7343
4	.0546	-.6683	1.72360
5	.05312	.43273	

a schematic geographical layout in Table IV.14. Ring 0 refers to Analysis Area 1 and the ring numbers ascend moving outward. Sector 1 is the northern sector, etc. Areas very close and very far from Downtown tend to have positive residuals, while those in between (Rings 2 and 3) have negative residuals. These latter are, in terms of physical development, transition rings between the high density city and the lower density suburbs. The close-in areas generally contain relatively large numbers of households which do not have firm connections with the surrounding neighborhood in the form of associations with relatives and other groups. Renters living in the suburbs, on the other hand, frequently do so in anticipation of acquiring title to a house in the same general area, which accounts for the relatively large share of renter-owner moves within the suburbs --about 40 per cent of renters' moves within the suburbs were to fee housing.

C. Summary and Conclusions

1. Introduction

In this chapter, the reader has been led through a series of detailed tests of hypotheses and of the properties of particular combinations of explanatory variables and equation forms. It would appear appropriate, at this point, to try and gain some perspective as to the relevance of the findings for housing market theory and for future housing market research. This discussion consists of two parts: first, a brief summary of the findings made within the framework of the particular model selected for use in this study; and second, a discussion of what we have learned from these results about the realism of the theoretical structure.

2. Summary of Findings

An attempt was made to compare the explanatory power of several measures of income in the demand equations for those households in selected sub-samples of the survey population who moved in the period prior to the survey. It was found that current income generally yields a better fit than a measure of long-run income defined by the household's occupation, industry and level of education. A more dynamic formulation of the long-run income variable, which is asserted to represent the effects of the liquid asset level yields better explanation than current income. The effects of permanent and transitory components of income are found to have significantly different effects upon the level of housing purchased or rented, with a

much lower elasticity with respect to transitory income.

The inclusion of the level of housing stock occupied prior to the move adds greatly to the explanatory power of the demand equations, especially for older households, which are believed to have reached a plateau in housing consumption from which it is difficult to depart; and for households with falling incomes generally, for whom the effects of the constraining influence of the prior stock level and the taste or habit effects represented by that level reinforce one another.

By examining the relative fit of variously specified demand equations among different age groups, it was shown that stage in the life cycle has an important influence upon housing demand behavior. For households with very young and very old heads, the two principal forms of the income variable used in this study showed less significance than they did for those of middle age.

The sample of movers was disaggregated into groups by their location and tenure type before and after the move. The purpose was to examine the stability of the equation parameters and to determine, as a result, whether a single model type fits all the groups, i.e., whether their housing demand behavior can be explained by the same variables and if so, whether the response to these variables is of the same magnitude. The results, with one exception, indicate heterogeneity. This heterogeneity is believed to stem only in part from underlying differences in behavior among the sub-groups. In addition, it is felt that imbalances between market value and the real flow of services from a housing unit may also be important in explaining

this heterogeneity.

Various of the tests had the objective, either directly or indirectly, of showing whether aggregation is appropriate for the demand equations considered. An explicit test for aggregation bias indicated that such bias, at least in cross-section estimation, is substantial, with income, and especially the permanent-income measure, having a much higher slope coefficient in the aggregated version compared with the micro estimates, while the prior stock level has a much lower coefficient which also tends to become insignificant.

The tests of the part of the model designed to explain the probability of moving yielded no significant fits or parameter estimates. Because of various constraints, the observations included in this part of the analysis had to be limited to a number which was far smaller than that originally planned. The relatively small number of observations may account in part for the lack of significance.

3. Implications of the findings for housing market theory

In the initial chapter of this study, I presented what I believe to be an appropriate framework for the study of the major relationships in the market for housing services and of the study of demand in that market. From that broad perspective, I have focussed upon a specific model which has allowed me to discriminate between explicit hypotheses. The analysis described in this chapter has been concerned, then, with supplying some empirical clothing to the largely deductive

corpus of theory represented in Chapter I. The value of the results which have been summarized above may be appraised, then, by the extent to which they tend either to verify or to dispute the appropriateness of the theoretical structure. The question which this analysis should help to answer is whether we should be concerned about many of the complicating factors which were described in Chapter I or whether a simpler, or at least a different model will suffice to explain the mechanisms of the market so that reliable predictions of behavior can be derived. In this section, I shall compare the experimental results with the principal features of the theoretical outline in order to make such an appraisal. At the same time, I shall indicate some of the ways in which the analysis may be extended to tell us even more about housing market theory as I have presented it.

One of the main themes of the theoretical outline centered around the heterogeneity of the housing good. This heterogeneity was attributed mainly to differences in housing styles and to neighborhood effects. In this study, I have used a simple measure of housing consumption, i.e., value of owned housing or rent level. Although it was represented as a measure of housing stock, the dependent variable was probably more like a housing expenditure than a quantity variable, due to this heterogeneity and to supposed price distortions within the market. I have shown, nevertheless, that in spite of this simplification it is possible, at the metropolitan level, to establish significant relationships and to discriminate between hypotheses. On the

other hand, the heterogeneity which is brought to light as the result of disaggregation by tenure type and location is not explicable by any obvious behavioral hypotheses. This suggests that, given the desire to establish statistical relations which account for underlying regularities of behavior among apparently disparate groups, it will at least be necessary to identify a more satisfactory measure of the quantity of housing consumed. This will involve both measuring the distinct sources of utility derived from the housing bundle and attaching to them some measure representing price. A less satisfactory alternative, which may nevertheless be necessary, would be greater disaggregation. This might lead, however, to a predictive model which is very cumbersome. Furthermore, even if it were based upon a very large sample, or indeed upon the universe of metropolitan households, the necessary degrees of freedom might be quickly exhausted, since the set of market participants is itself only a fractional part of all households.

The theoretical discussion has stressed not only the heterogeneity of the housing good, but also the diversity of motives, resources and experience on the part of the market participants. The many experiments with the income variable have shown that no single measure is satisfactory for all groups, i.e., that the heterogeneity of motives, etc., finds its expression in variations in the demand function. Since it is likely that variations in macro variables will lead to instability in the distributions of characteristics among the mover sub-population over time, the result to be anticipated is an apparently erratic market response where

such variations are not taken into account. One of the principal correlates of this heterogeneity of consumers which was brought out in Chapter I was stage in the life cycle. The empirical results on differences in the fit of demand functions by age group therefore bear very directly upon this theme. Similarly, the analysis of groups relatively homogeneous with respect to pre-move housing location (representing neighborhood effects) and tenure type (representing investment and ownership utility considerations) in both principal sections of the empirical work is an attempt, among other things, to adjust for the effects of qualitative variations in housing experience. Both types of tests indicated the importance of these variations.

The dynamics of the adjustment process on the part of the consumer which were discussed in Chapter I have been transformed, in Chapter II, into a specific model. Three aspects of the empirical work are of particular relevance to that part of the theoretical discussion. For households adjusting their housing consumption by transfer of property rights, i.e., by entering into the market for housing services, the importance of the characterization of households as making a quantum change from some existing level is embodied in the tests of significance of the prior stock variable. This variable is found to make an important contribution to explanatory power in most instances. This is an additional result which militates against simple aggregation which would ignore pre-move differences. The characterization of households as basing their behavior in the market upon the consideration of an alternative housing arrangement to that which

they occupy at the beginning of each period is exemplified by the separate examination of groups according to pre-move and post-move tenure. The evidence is that where the move involves a change in tenure type, demand estimation is further complicated. The variety of non-economic motives which have been mentioned in Chapter I as stimulating the move are given empirical content in the list of explanatory variables in the determinants-of-move equation. The fact that neither they nor the variable representing the imbalance between the actual and the predicted levels of housing consumption were significant enhances the assertion that the determinants of this dynamic process are highly diffuse. While the regressions in the section of this study on the determinants of the move obviously need to be re-estimated with larger numbers of observations, it is nevertheless to be anticipated that the high degree of simplification of the model, contrasted with the large amount of "noise" which is expected to underly this relationship, will result in substantial unexplained variation. This conclusion, combined with the results of the specific tests for heterogeneity of the value-of-purchase equation indicate that a more elaborate statistical model is in order. A start in this direction might be made by employing some devices which would give us a better feeling for the underlying distributions in the data. These might include simple cross-tabulations to show difference in expenditure levels by various groups of movers and contingency tables or discriminant analysis to show differences among movers and non-movers, i.e., determinants of threshold levels.

The analysis contained in this study derives its particular form from the approach of Chapter I which argues that the demand for housing is complicated by the considerable costs which a household must incur in changing its housing situation. Consequently, in any one period, many households are likely to occupy dwellings yielding a level of service which diverges widely from that which they would choose if they were to express their choice in the market. In fact, only a minority of households enters the market in each period. Because of limitations of the data, I have not been able to treat the behavior or changes in the characteristics of the households which do not move during the period, and which represent a majority of the population. This limitation is unfortunate, since demand analysis is directed at characterizing the behavior of the entire population. I believe the choice mechanisms of movers resemble those of non-movers. If this assertion is correct, then the types of alternatives which were discussed in Chapter I may be conceived as facing all households in each period, with only some households exceeding the threshold level relevant to a move. This view was embodied, to a limited extent, in the determinants-of-move portion of the analysis. Two important qualifications must be made to this view, however, which would result in apparent differences in the two sub-populations. First, high transaction and moving costs result in dissatisfaction among non-movers which movers, having cleared this barrier, do not suffer. Second, movers may systematically differ from non-movers in tastes.

The specific model formulated in Chapter II contains a multiplicative relation between independently distributed values of probability of move and of value of housing demanded, resulting in an expected value of housing demand. The ensuing two-part analysis should not be construed as an explicit test of this model as a forecasting device, however, since the measurable determinants of the move and of the value of housing demanded are almost certainly highly correlated. The model, in other words, is a theoretical one. The empirical analysis, on the other hand, is limited to exploring behavior accountable within a given data framework which does not allow parallel treatment of movers and non-movers.

If the transaction thresholds separating the two groups were substantial, while their tastes were largely similar, my results on value demand could be interpreted as reflecting a kind of long-run housing demand for the entire population, since they presumably represent closer adaptation of housing characteristics to income and family variables than among the non-movers. The inconclusive results obtained in the determinants-of-move analysis require that such an interpretation be advanced only tentatively.

The empirical part of the study, while it has dealt only tentatively or not at all with some of the specific dynamic features which were discussed within the theoretical framework, gives some indication as to their relevance. It would be desirable, in extending the work begun in this study, to deal more explicitly with these factors. In part, this additional analysis could be done in the context of the existing model; in part it would require

additional equations. At the micro level, the discussion of the adjustment in housing consumption listed and discussed the options under two headings: transfer of property rights and physical alteration. Only the former was dealt with in the formal model. Inclusion of the latter would involve investigation into the supply side, both for households remaining in a unit but making alterations or allowing deterioration, and for firms (including households) altering the number of units. Such elaboration would require data supplementary to those used in this study. At the macro level, it would be desirable to trace the effects of changes over time in variables such as mortgage terms upon both turnover and amount of housing purchased. An initial investigation along these lines might include an examination of the stability over time of the parameters of the two equations of the model.

In addition, the discussion of the effects upon various segments of the housing stock to exogenous shocks includes, perhaps more explicitly than any other portion of this study, an important emphasis upon fluctuations in price, not only for the market as a whole but differentially among the individual submarkets. The construction of a set of price indices would therefore seem imperative for a dynamic analysis. This might be constructed fairly readily by tracing vacancy rates as a proxy, e.g., from newspaper advertisements, or, with somewhat more effort, by examining price changes of individual properties.

I began this study with the hope that it would contribute to a greater understanding of the processes of the urban housing market. The form which the subsequent analysis took resulted

from my anticipation that if significant improvements in such understanding were to come about, especially in connection with short-term phenomena, it would be as a result of a series of studies at the scale of the individual urban area and based upon micro data. The complexity of relations and the interactiveness of variables brought out in this study seem to confirm my prior anticipation as to the necessity for such an approach. Beyond exposing these complexities, it is hoped that the present analysis marks the beginning of a fresh line of inquiry into the processes of the housing market. I have suggested here only the initial extensions.

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APPENDIX I

CONSTRUCTION OF RENTAL-FEE EQUIVALENCE

The intercept and slope coefficient values, respectively, are estimated as

purchasers of single-family housing: 9813, 1.112

renters: 57.5, .0046

Assume

$$V_r^* = KV_r$$

where V_r^* is the equivalent fee value of rental housing, V_r is the rent level as measured, and K is a constant of proportionality.

1. Assume the regression lines of value on current income are superimposed upon one another, or

$$V_o = \alpha_1 + \beta_1 Y = V_r^*$$

$$V_r = \alpha_2 + \beta_2 Y$$

Let

$$V_r^* = \gamma + \lambda V_r$$

$$V_r = \frac{\alpha_1}{\lambda} + \frac{\beta_1 Y}{\lambda} - \frac{\gamma}{\lambda}$$

$$\alpha_2 = \frac{\alpha_1 - \gamma}{\lambda} \quad ; \quad \beta_2 = \frac{\beta_1}{\lambda}$$

$$\lambda = 1.112/.0046 = 241.7$$

$$\gamma = (57.5)(241.7) - 9813$$

$$= 4085$$

$$V_r^* = 4085 + 241.7V_r$$

2. Assume the regression lines for value of housing in fee on current income and of equivalent fee value on current income cross at the point of mean income for the population, which is here $6,619.

Let $(V_r)_{\overline{Y}}$ be the predicted rental value at the mean income level, and $(V_o)_{\overline{Y}}$ be the predicted fee at that same level.

$$(V_r)_{\overline{Y}} = 57.5 + (.0046)(6619) = 87.9$$

$$(V_o)_{\overline{Y}} = 9813 + (1.112)(6619) = 17173$$

$$K = 17173/87.9 = 195.4$$

APPENDIX II

TABLES

TABLE A.1

CURRENT INCOME VS. PERMANENT INCOME (I)

(N=952)

Current Income (Dollars)	Permanent Income (I)* (Dollars) $2-4,000	$4-6,000	$6-8,000	$8-10,000	$10-12,000	Total
$ 0-2,000	4	17	2	1	1	25
2-4,000	8	57	34	7	0	106
4-6,000	6	147	158	20	1	332
6-8,000	1	79	132	36	4	252
8-10,000	0	31	63	31	10	135
10-12,000	0	9	22	21	5	57
12-14,000	0	6	5	8	4	23
14-16,000	0	1	4	9	0	14
16-20,000	0	0	2	5	1	8
20,000 & over	0	0	0	0	0	0
Total	19	347	422	138	26	

* There were no households with Permanent Income (I) greater than $12,000 or less than $2,000.

TABLE A.2

DISTRIBUTIONS OF HOUSEHOLDS WITHIN SUBSAMPLES

(Percent)

	Subsample				
	I*	II	III	IV	V+
Current Income					
$0-2,000	12	3	2	2	11
2-4,000	12	11	10	8	11
4-6,000	31	35	35	34	22
6-8,000	23	26	28	30	27
8-10,000	12	14	14	15	16
10-12,000	5	6	6	6	7
12-14,000	2	2	3	4	2
14-16,000	1	1	1	1	1
16-20,000	1	1	1	1	1
20,000 and over	1	0	0	0	2
Total	100	100	100	100	100

* Non-respondents (8 p.c.) excluded from denominator.

\+ Income in year prior to survey for households which moved residence or workplace in the intervening period (18 p.c.)

TABLE A.2 (Cont.)

DISTRIBUTIONS OF HOUSEHOLDS WITHIN SUBSAMPLES
(Percent of Subsample)
(Percent of Tenure Type within Subsamples)

Value or Rental of Housing	Subsample I*	II	III	IV	V+
Owners					
$0-5,000	0	0	0	0	0
	1	0	0	0	0
5-10,000	1	1	2	2	5
	6	4	5	5	8
10-15,000	5	5	6	11	20
	20	19	19	24	31
15-20,000	10	11	14	21	18
	37	43	41	47	29
20-25,000	5	6	8	6	11
	21	24	23	14	17
25,000 & over	4	3	4	5	10
	15	10	12	10	15
Total	25	26	34	45	64
	100	100	100	100	100
Renters					
$0-60	13	9	9	7	8
	17	12	14	13	22
60-100	45	48	41	34	22
	61	64	63	62	61
100-150	15	15	14	14	6
	20	20	21	25	16
150 & over	2	2	2	0	0
	2	2	2	0	1
Total	75	74	66	55	36
	100	100	100	100	100

* Includes 50 owner-occupants (3 p.c.) of multi-family housing; non-respondents (=7 p.c.) excluded from denominator.
+ Value in year prior to survey for households which moved residence or workplace in intervening period (18 p.c.).

TABLE A.2 (Cont.)

DISTRIBUTIONS OF HOUSEHOLDS WITHIN SUBSAMPLES

(Percent)

	Subsample				
	I	II	III	IV	V
Age of Head					
15-19	0	1	0	0	0
20-24	19	20	15	4	4
25-29	23	25	25	28	9
30-34	15	16	17	26	12
35-44	20	21	24	32	22
45-54	11	11	12	6	19
55-64	6	5	6	4	15
65 & over	6	1	1	0	19
Total	100	100	100	100	100

TABLE A.3

ORIGINS AND DESTINATIONS OF MOVERS

Analysis Area-Pre-Move	Analysis Area - Post-Move																					
	Owner-Owners (N=56)											Owner-Renters (N=50)										
		1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10
	Total	0	1	4	11	10	9	1	6	2	12	Total	2	4	12	7	7	8	0	3	0	7
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3	0	1	1	1	0	0	0	0	0	0	3	0	0	2	0	0	1	0	0	0	0
3	14	0	0	2	3	6	2	0	1	0	0	5	0	1	0	1	1	2	0	0	0	0
4	4	0	0	0	2	0	0	0	0	0	2	2	0	0	1	1	0	0	0	0	0	0
5	4	0	0	0	0	2	0	0	2	0	0	5	0	1	2	0	1	1	0	0	0	0
6	3	0	0	0	0	0	2	0	0	1	0	2	0	1	1	0	0	0	0	0	0	0
7	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	3	0	0	0	0	0	1	0	1	0	1	3	0	0	0	1	2	0	0	0	0	0
9	2	0	0	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
10	7	0	0	0	0	1	0	0	0	0	6	4	1	0	0	1	0	0	0	0	0	2
Outside Area	15	0	0	0	4	1	3	1	2	1	3	25	0	1	6	3	3	4	0	3	0	5

TABLE A.3 (Cont.)

Analysis Area-Pre-Move	Analysis Area - Post-Move																					
	Renter-Renters (N=325)											Renter-Owners (N=132)										
		1	2	3	4	5	6	7	8	9	10		1	2	3	4	5	6	7	8	9	10
	Total	10	68	104	42	33	12	21	5	8	22	Total	1	6	20	19	14	19	17	13	7	16
1	15	4	7	0	2	0	0	2	0	0	0	2	1	0	1	0	0	0	0	0	0	0
2	79	4	34	27	9	4	1	0	0	0	0	20	0	4	6	3	3	2	1	0	1	0
3	66	1	12	34	5	3	4	6	0	0	1	46	0	1	7	8	3	11	6	4	4	2
4	32	1	1	12	12	2	0	4	0	0	0	24	0	0	2	7	1	0	6	3	1	4
5	21	0	1	8	2	8	0	0	1	1	0	11	0	0	1	1	4	1	1	2	0	1
6	16	0	3	2	0	4	4	0	0	2	1	5	0	0	0	0	1	2	0	1	1	0
7	9	0	0	5	1	1	0	2	0	0	0	4	0	0	0	0	0	0	3	1	0	0
8	3	0	0	1	0	0	0	0	1	1	0	4	0	0	0	0	1	0	0	2	0	1
9	5	0	0	0	0	0	1	0	0	4	0	3	0	1	0	0	0	2	0	0	0	0
10	19	0	1	1	0	2	0	1	0	0	14	6	0	0	0	0	0	0	0	0	0	6
Outside Area	60	0	9	14	11	9	2	6	3	0	6	7	0	0	3	0	1	1	0	0	0	2

TABLE A.4

INDIVIDUAL GROUPS: AVERAGE VALUES

Group No.	Current Income	Permanent Income	Number in Household	Age of Head	$(\text{Age})^2$	Value of Housing	Value of Prior Stock
1	$ 7926	$ 6937	4.4	42	1876	$ 20349	$ 13854
2	11107	8557	4.2	37	1421	25253	18867
3	6988	6510	3.8	41	1715	17696	15780
4	7724	7114	4.2	38	1517	19853	14680
5	5339	6056	3.15	34.9	1382	15097	13781
6	6818	6411	3.57	32.2	1133	17949	15547
7	6418	6257	3.30	33.3	1221	16588	14602
8	6639	6623	3.19	32.5	1149	15556	15252
9	6426	6640	3.96	27.7	802	16966	12743
10	8061	7209	3.38	31.4	1051	19007	15104
11	7507	6479	4.22	39.1	1665	13648	15885
12	7444	7277	4.02	32.9	1155	19160	17826
13	8153	7169	3.98	34.2	1237	18485	15181

Biographical Note

Irving Silver was born in Portland, Maine on May 1, 1934. He was an undergraduate at M. I. T. between 1952 and 1956, and received the S. B. in Metallurgy in June, 1956. His thesis topic was on certain properties of high-purity aluminum under stress at elevated temperatures. From 1956 to 1958 he was a National Science Foundation Fellow at Cambridge University, where he was a Research Student in the History of Science, specializing in the study of British science in the early and middle Nineteenth Century. From 1958 to 1960, he was enrolled in the graduate program of the City and Regional Planning Department at the University of California, Berkeley. He received the M. C. P. in June, 1960. He spent the following academic year studying German planning and housing policy at the University of Cologne as a Fulbright Student. Between 1961 and 1965, he was employed in city and regional planning, working on an inventory study of the Mid-Coastal Area of the State of Maine and on various studies with the Boston Regional Planning Project. In 1965, he enrolled as a doctoral student in the Department of City and Regional Planning, M. I. T. He married Gabriele Schroder in March, 1965, and now has two children.