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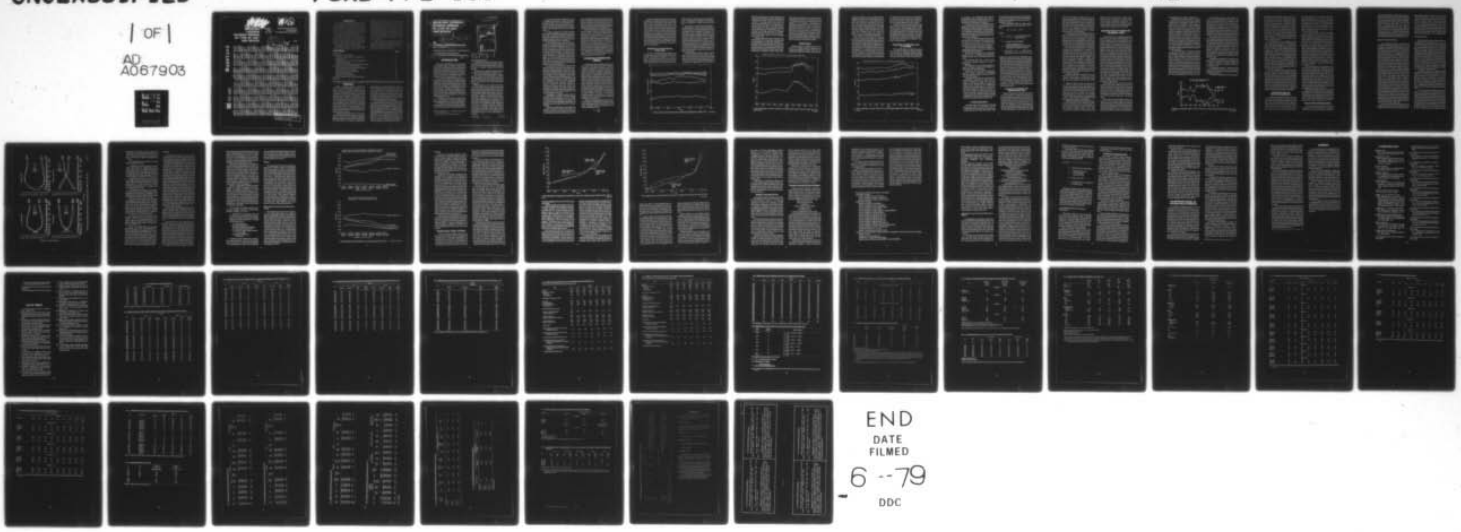

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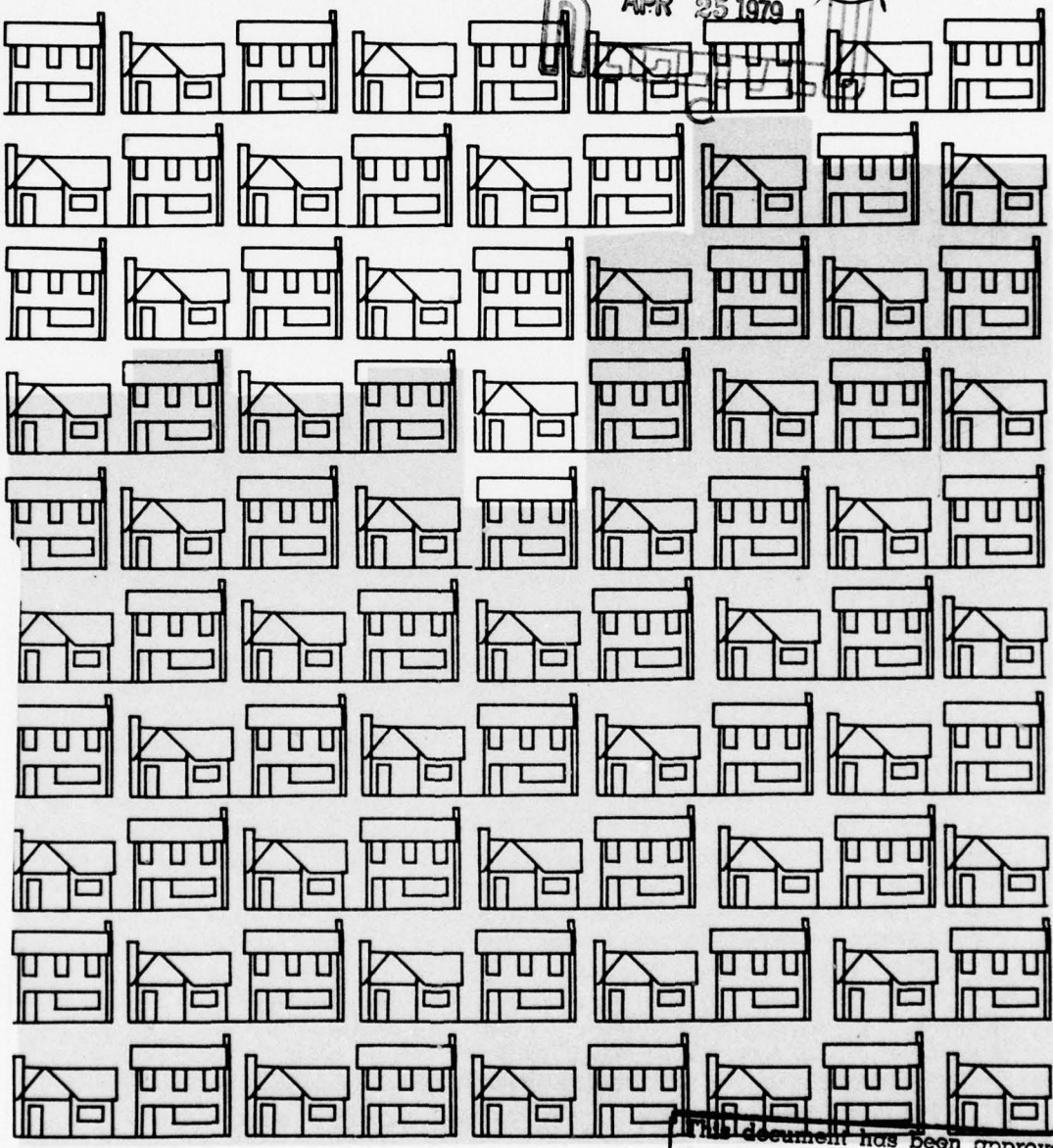
MODELING LONGRUN HOUSING DEMAND BY TYPE OF UNIT AND REGION

Research Paper FPL 308

Forest Products Laboratory
Forest Service
U.S. Department of Agriculture

1978



ABSTRACT

This report summarizes the results of research to develop an improved model of longrun housing demand for projecting future residential construction activity by type of unit and region. Specific submodels have been developed for household formations, type of housing unit occupied, and housing replacement.

Household formations and trends in marital status are discussed. A procedure for estimating a theoretical upper limit to headship is described. Equations for projecting headship by age group are present along with a set of estimated headship rates to the year 2020.

A detailed analysis of factors, determining housing choice between single-family, multifamily, and mobile home housing structures, is presented. Major determinates are: (1) Age of household head, (2) family type, (3) regional location, (4) metropolitan location, (5) household size, (6) income, and (7) the ratio of income to housing expenditures. Three types of models of housing choice are also discussed. They are: (1) Individual household models, (2) aggregate cross-sectional models, and (3) time-series model. Several examples of individual housing models are given.

A discussion of housing replacement and the lack of an adequate data base for statistical analysis is presented. A model based upon estimates of net housing replacement by age of structure and region is examined.

CONTENTS

(Final report on work conducted in cooperation with Oak Ridge National Laboratory, Oak Ridge, Tenn.)

PREFACE

Work on modeling longrun housing demand was originally begun as part of a research effort to project future timber demand for use in long-range planning in forestry. New residential construction accounts for nearly 40 percent of wood products consumption in the United States. In addition, repair and alternation of existing housing units account for over 10 percent of all U.S. wood product consumption. Altogether about one-half of all wood product consumption occurs in the residential construction sector of the economy. Thus, home building is a major determinate of future timber requirements and of the prospects of wood products industry.

Substantial variations occur in the use of wood for different housing types in various regions of the country. It is important to disaggregate the projections of housing demand by type of unit and region. For example, a single-family house uses over 12,000 board feet of lumber in the Northeast while a multifamily unit uses less than one-half that, and a mobile home uses only about a quarter as much. Houses in the South use only about three-fourths the amount of lumber as the Northeast. Long-term population shifts now favor construction in the South and West and of single family houses.

A model was previously formulated to project future residential construction activity and the inventory of housing unit by type of unit and region based upon detailed estimates of population by use and trends in the regional distribution of population. This model was adapted by Oak Ridge National Laboratory for use in the development of a comprehensive model of energy use in the residential sector of the U.S. economy. Partial support was provided by ORNL to improve the model by adding economic variables to the demographic model.

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(6) MODELING LONGRUN HOUSING DEMAND BY TYPE OF UNIT AND REGION

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INTRODUCTION

Research is described here on developing an improved model of long-run housing demand in the United States for projecting future residential construction activity as well as inventorying housing by type of unit and region. The starting point for this research was a previously developed comprehensive demographic model of housing (Marcin, 1972)[2].

This model projects the longrun level of household and housing requirements by housing type and region based upon explicit annual projections of population by age group. The research documented in this paper was directed at examining additional demographic, social, and economic variables to develop an improved model which includes behavioral economic relationships emphasizing measures of housing prices and housing cost. The main goals of study were to:

(1) Develop a data base of relevant economic, demographic, social, and housing statistic variables for use in model development.

(2) Postulate specific economic relationships based upon economic literature and theory and empirically fit econometric equations to them where data permit.

(3) Refine and improve a working model of housing demand by adding economic relationships on an incremental basis beginning with a measure of economic activity and personal income.

(4) Improve and update the model by fitting it to data from the period from 1950 to 1976.

(5) Provide a completed model for projecting the number and characteristics of future housing demand which can be used as a component of a national timber requirements model and as a component of a model of residential energy use.

Reformulation of the model has proven more time-consuming and difficult than originally anticipated in part because of time spent in developing the data base. The process of examining data, testing relationships, and building a model, however, has provided valuable information. Limitation of data has been recognized. New insights into the housing market have been developed, and directions for further research are suggested. Specifically, new information and insights have been developed on trends in household formation relative to marital status, the relationship of family status to the type of housing unit demanded, and the relationship of housing cost and prices to household income; i.e., the "affordability of housing."

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[1] Maintained at Madison, Wis., in cooperation with the University of Wisconsin.

[2] Listed in Literature Cited at the end of this report.

A data base has been established for use in modelling and analysis of housing markets. The base consists of: (1) Computer tapes of individual housing units and household characteristics, and (2) demographic and socioeconomic data collected from various published reports.

A number of specific economic relationships were formulated and examined. Attempts were made to establish statistical relationships using both time-series and cross-sectional regressing analysis. Some of the more important results are discussed later in the paper.

An improved working model has been established. Headship equations which explicitly include personal disposable income and an estimate of maximum headship based upon trends in marital status and living arrangements for adults have been added. A model for determining the type of housing unit demand has been examined on an experimental basis. Estimates of housing replacement requirements based upon a matrix of replacements rates by type of unit, region, and the age of the stucture have also been developed on an experimental basis, but are not reported here.

It is important to discuss the nature of the housing market at this point to better understand the appropriateness of particular socioeconomic variables relative to short- and long-term housing market response and to models of fluctuations in new residential construction versus models of the total housing stock. For a given set of assumptions this model generates an "equilibrium" level of annual residential construction demand. It does not, however, attempt to account for short-term changes in construction activity about this longrun demand level. Therefore, a number of economic variables, such as short-term interest rates and the flow of funds into savings institutions, are not considered in the model.

Demographic variables become particularly important in the longrun. Trends in the age structure of the population, the mix of individual versus family households, the age of the housing stock, and geographic distribution of population are particularly important in longrun analysis.

Housing services flow from the total housing stock of about 80 million units. New construction amounts to only about 2 to 3 percent of the total stock annually. Additionally, conversion of existing structures to more units can expand the number of housing units during periods of shortages. Wide fluctuations can and do occur from annual housing production of different types of housing units without greatly affecting the total flow of housing services.

The development of an improved comprehensive longrun model of housing demand, which projects the regional distribution of households, housing inventory, and housing production by type of unit, is a complex undertaking which requires division into separate research areas. The major areas of research are covered in this paper. They are: (1) An improved model of household formation, (2) an improved model of housing choices, and (3) an improved model of housing replacement. In addition, we have developed specific information on: (a) Measures of housing cost expenditure, value, and price, and (b) historical trends in housing production by type of unit.

HOUSEHOLD FORMATION MODEL

In projecting future household formations in the nation, it is useful to separate movements caused by population changes and those caused by changes in the rate of household occurence for a given population age group. In addition, shifts in the composition of household types between husband-wife families, other families, and nonrelated individuals are also important for determining the type of housing demand. Long-term changes in marital status and living arrangements are important determinates of the total number and kinds of households. Economic factors such as the level of per capita personal disposable income are important in determining the ability of individuals to form separate households. Increased housing costs relative to income or a restricted housing supply as evidenced by low vacancy levels could also reduce the rate of household formations, in the short run.

The effect of population change on household formation is separated from other factors by defining headship (H^i) as the proportion of a given population (Pop^i) for age group i that heads households $(HH^i)_i$ or

$$H^i = \frac{HH^i}{Pop^i}$$

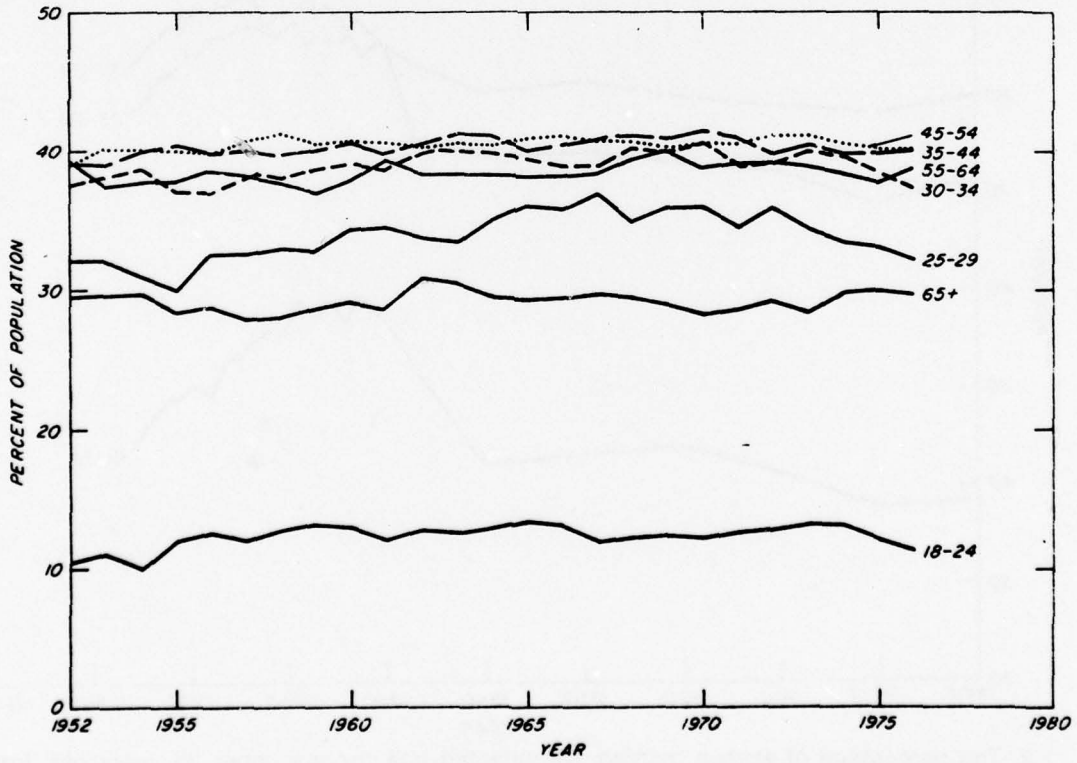
The total number of households is then determined by estimating the level of headship and the future population by age class separately. Seven age classes are used in our model. They are: 18 to 24, 25 to 29, 30 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 years and older. For statistical reasons we have combined our previous 15- to 19- and 20- to 24-year-old age groups into one category of 18 to 24 years old. Virtually all household heads are over 18 years (over 99.9 pct) and this situation is likely to continue. Census population projections are available by age class for alternative fertility, mortality, and immigration assumptions and can be used with this model.

Distribution of Households by Family Type

The mix of household types between traditional husband-wife households, other family groups, and primary individuals (i.e., one or more unrelated persons) is an important factor influencing the future demand for various housing types. The overall mix of household types for all age groups is summarized in table 1. Changes in the age-mix of the population are important in determining the overall mix.

In addition to looking at the distribution of household types, it is also useful to examine occurrence rates, i.e., the percentage of the total population in each category of household. The occurrence rate of husband and wife households has remained relatively steady for all age groups for 1952 to 1976 (fig. 1). The number of married couples living with parents or others has declined substantially since 1950 and has offset the recent decline in marriage rates in younger age groups. The increased proportion of households headed by individuals is largely the result of increased headship among nonmarried individuals, previously members of other households.

There has been a great increase in individual households since the early 1950's, particularly in the under-30 and over-65 age groups (table 2). Family groups not headed by a husband and wife have increased substantially for households in age groups under 45 years of



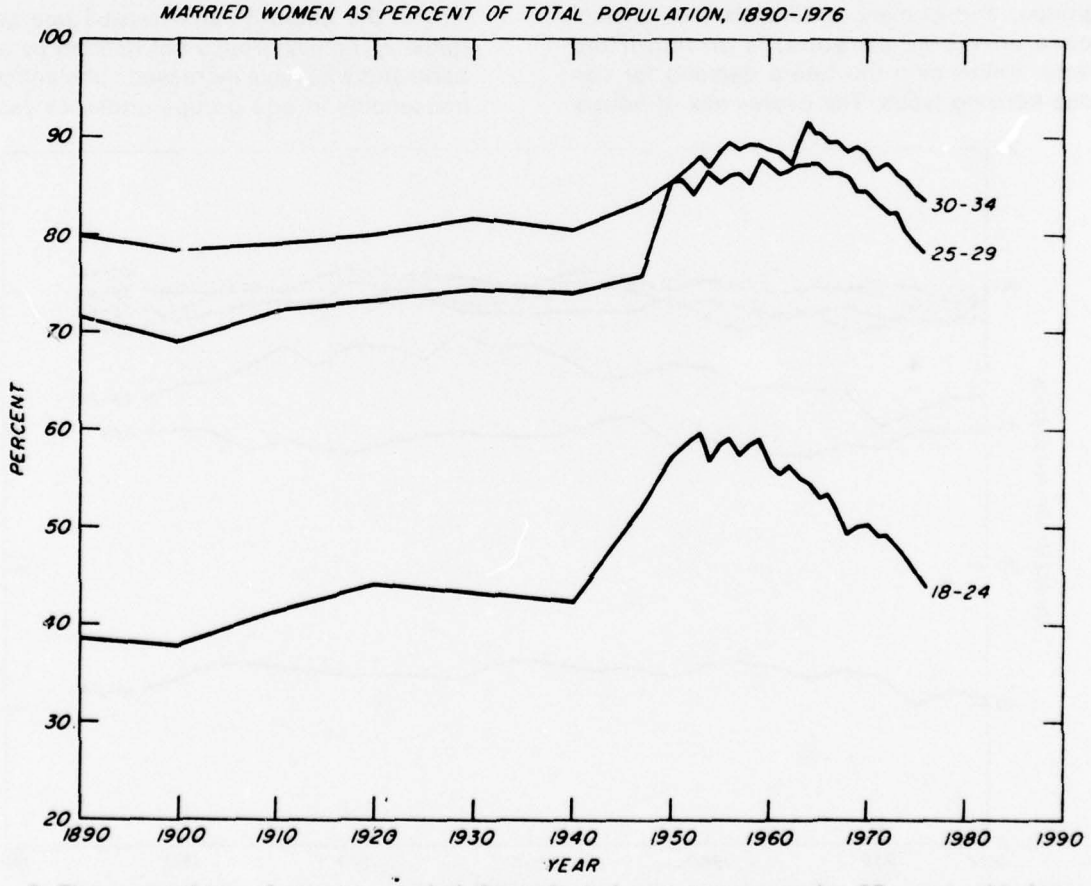
1. The occurrence rate of husband-wife households by age group, 1952 to 1977. M 146 408

age, primarily because of recent high levels of divorce and resultant one-parent families with female heads. This is a result in part of the dissolution of marriages which occurred at extraordinarily high rates and at young ages during the 1940's and 1950's. The rate of occurrence of these other family groups has declined for households in the over-45 age group, reflecting a continued separation of intergenerational families. However, the overall proportion of other family groups has not changed much since 1940.

Headship rates have now increased to the point where nearly all married couples (99 pct) live separately in households. Additional increases in headship must result from increased headship of the remainder of the population not living as couples or from dissolution of existing husband-wife households into two individual or single-parent households. Since each household has only one head, a married couple automatically accounts for two people and results in a maximum headship of 50 percent for that segment of the population. Cohabitation by nonmarried couples also results in a maximum headship of 50 percent for them. Trends in marriage rates and the occurrence of married couples are an important factor for estimating an upper limit to headship. Examination of historical rates of marital status is, therefore, important in determining ultimate headship rates. In addition, the type of housing unit demand is related to the type of household occupied.

Marital Status

Historical data on marital status show the percent of married women by age group remained very stable from 1890 to 1940, then increased dramatically for women under 35 in the



2. The percentage of women married, for selected age groups under 35 years old, from 1890 to 1976.

M 146 406

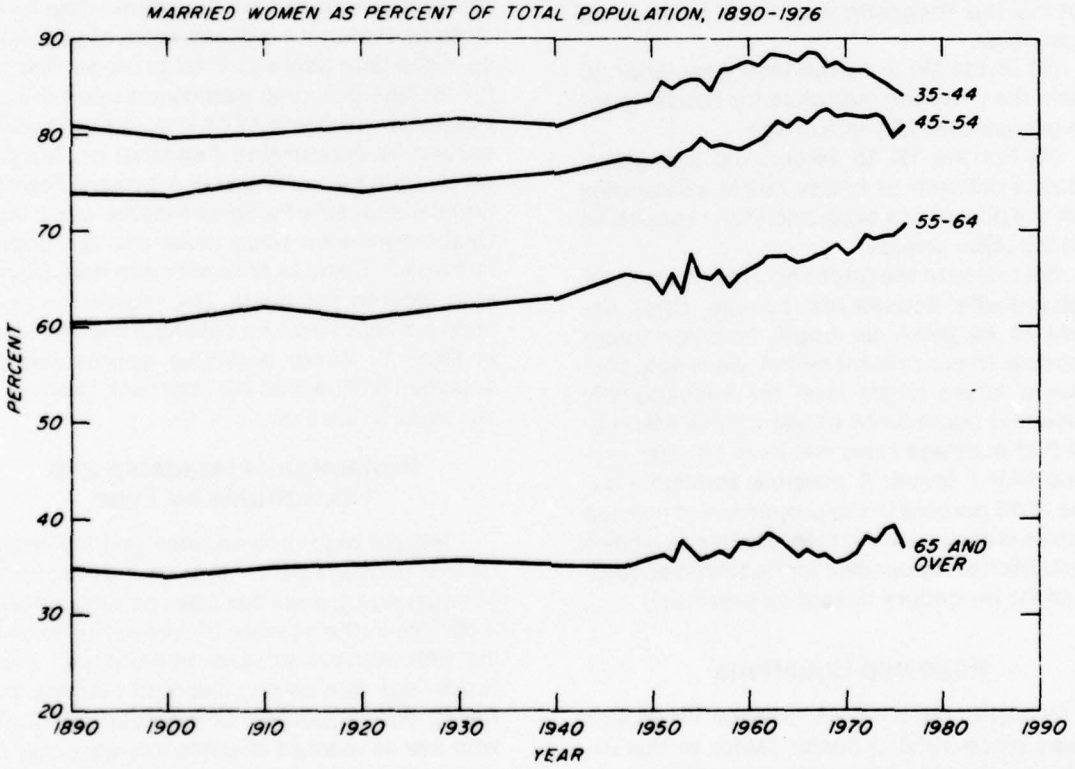
1940s and 1950s (fig. 2). For example, the percentage of women 18 to 24 who were married rose from 42 percent in 1940 to 58 percent in 1960. This level fell to 44 percent in 1976; however, this is still above the level before 1940. The percentage of married women in other age groups remains substantially above the pre-1940 level despite recent declines from abnormally high marriage rates of the 1950s and 1960s. In fact, marriage rates continued to advance for those over 55 years of age (fig. 3).

We view the current decline in marriage among the younger age groups as a return to historical levels from the abnormally high levels of marriage accompanying the baby boom of the 1940s and 1950s. We would expect the current decline in marital status for women not to fall much below the historical levels of the pre-1940 period, i.e., marriage levels of about 40 percent for women 18 to 24 years old, 70 percent for women 25 to 29 years old, 80 percent for women 30 to 44 years old, and 75 percent for the 45- to 54-year-old group. Marriage levels for women 55 to 64 and over 65 are assumed to not fall below 65 and 35 percent, respectively, and in fact are likely to remain above these levels due to better health and rising incomes.

Annual statistics indicate a trend to a high level of divorce. However, since most divorced persons remarry, the aggregate effect is difficult to assess. In addition, high levels of divorce for persons aged 25 to 54 partially reflect the extremely high levels of marriage in the 1950s and 1960s for this age group. More young people may remain single in the future now that it has become more socially acceptable not to marry or have children.

Calculation of a Maximum Limit for Headship

The headship rate for a given age group (i.e., the ratio of household heads to population) will reach a theoretical maximum based upon the number of husband-wife households and the occurrence of other household types.



3. The percentage of women married for selected age groups over 35 years old from 1890 to 1976.

M 146 407

For example, if all households were married couples, the maximum headship rate would be 50 percent since each household has only one head by the Census Bureau's definition.

A theoretic maximum for headship by age group is derived by examining records of marital status and living arrangements (tables 3 and 4). Estimates of total population and population in households by sex and type of household for each age group are used to derive a theoretical maximum of headship. The procedure is as follows for each age group:

(1) Add: (a) male household heads with wife present, and (b) wives of household heads to obtain the population in husband-wife households (note that wife of heads are younger on the average than their spouses).

(2) Subtract No. 1 from the population in households (excluding inmates in institutions and armed forces overseas).

(3) Assume 90 percent of the household population not in husband-wife households could or would want to head separate households.

(4) Add 50 percent of No. 1 to No. 3 to determine the theoretic maximum number of households.

(5) Divide No. 4 by the total population to obtain the theoretic maximum for headship for age groups over 25 years of age.

(6) For the 18- to 24-year-old age group subtract children of heads not in subfamilies from the population basis and then proceed as with the other groups.

Estimates of the future occurrence rate for husband-wife households by age class are made to establish an upper limit for future headship. In our present model, we simply postulate a future target level for husband-wife household occurrence based on the assumption that marriage rates will level off near pre-World War II levels. A possible additional decline of 10 percent in the proportion of married couples is assumed. We then use this as a basis to establish an upper limit for headship according to the procedure described previously.

Headship Equations

Headship rates have increased for all age groups since 1950. A major factor in this increase has been the steady rise in real per capita personal income in the same period. Specific behavioral relationships have been developed for each age group with real disposable personal income per adult 18 and over as an independent variable.

The following functional form was used to estimate headship for each age class i in the year n:

$$\bar{H}^i_n = A + B\,\bar{Y}_{n-1} + C\,\bar{H}^i_{n-1}$$

where

$\bar{H}^i_n = \ln\left(\frac{H^i_n}{a_i - H^i_n}\right)$ or the logistics transformation function

a_i = an upper limit for headship

$\bar{Y} = \frac{\text{real disposable personal income in thousands of 1972 dollars.}}{\text{(Population 18 years and older)}}$

i = age class (i – 1, 2, . . ., 7: 18-24, 25-29, 30-34, 35-44, 45-54, 55-64, 65 and over).

Statistical relationships were developed using data for the period from 1953 to 1976. Headship rates were derived from household data by age class as of March 1 and estimates of population as of the data (table 5). Real personal disposable income per adult was based upon the previous year's income since it would be more important in determining headship on March 1 rather than the current year's income. Total National Disposable Personal Income was divided by the consumer price index and the population aged 18 and over to estimate Real Disposable Income per adult. The regression equations for headship and data sources are shown in table 6. When headship approaches the specified limit, within 0.01 percent, headship is set equal to the limit.

Projection of Headship and Households by Type

Recent high divorce rates and the decline in the proportion of married persons for younger age groups has been partially offset by a decline in the number of married couples living with relatives or other persons and a high remarriage rate among divorced persons. As a result, the proportion of the total population who live as married couples has generally not declined significantly by age group from 1950 to 1976, although this proportion declined

since 1970 for persons under 35, back to the levels of the mid-1950's. In modeling household types, we estimate the occurrence of husband-wife household and other family households by age class. Households headed by individuals are then derived from projections of total headship from our regression equations. Projections of household types are used to estimate the distribution of housing types.

Available evidence indicates that the family type is probably the most important factor in determining housing choice. Most families (over 75 pct) live in single-family housing regardless of income, while slightly over half of all individuals live in multifamily structures. Future research efforts will be directed at developing a model of household formation by family type.

An important improvement in modeling headship is the development of a model to simultaneously determine the occurrence of husband-wife and other household types by age class. We can then take advantage of the fact that headship is by definition limited to 50 percent for couples to derive a realistic upper limit to headship. In addition, a submodel of marital status is also important for determining both the upper limit of headship and the number of husband-wife households. The models of marital status and household occurrence by family type could then be related to social and economic variables wherever possible to project households by type.

Headship rates were projected to the year 2020 using the equation in table 6 for growth rates of 1 and 2 percent annual growth in real per capita disposable income per adult. (table 7).

Headship rates increase in all age groups as income increases. The age groups for household heads over 35 years old begin to approach their theoretic upper limits in the 1990's and alternative assumptions about income have less and less of an effect. For example, headship rates vary from 67.0 to 67.5 percent for the 65 and older age group in the year 2000 and 67.7 to 68.0 percent in the year 2020 for the two assumptions about income growth.

Headship rates vary more widely for the 18-24 and 25-29 age groups in response to alternative assumptions about income growth because they are farther from their upper limits. For example, headship rates for the 18-24 group vary from 23.9 to 25.7 percent in the year 2000 and 25.6 to 28.9 percent in 2020. These headship rates, combined with the Census Bureau's Series II population projections, produce household formation projections which compare fairly closely to Census Bureau's middle and lower projections for households.

AN ANALYSIS OF CHOICE OF HOUSING TYPES

Yearly shifts in new housing production by type of unit can lead to misinterpretations of what is happening to total housing supply; new housing provides only a small fraction of the overall supply of housing services to consumers. Changing economic and demographic factors lead to cycles in housing production for different types of units over time (Campbell, 1966). For example, major apartment booms occurred in the 1920's and from 1960 to 1973. Overall, since 1900 approximately 70 percent of all housing construction has been single-family housing units (including attached units) and 30 percent multiunit. The analysis of housing choice is further complicated by the conversion of existing single-family housing units to multifamily units and the emergence of the mobile home. In the 1960's the mobile home became an alternative supply of housing which provides service in the form of chattel rather than real estate. Many attributes of a mobile home are similar to single-family houses, and they may be considered as another form of single-family housing. (The Census Bureau now reports a combined figure for single-family structures and mobile homes.)

New regulations have brought the mobile home more and more under the control of the institutional forces in the conventional housing market. As such the mobile home is evolving into another form of industrialized housing. In doing so it is losing many of the attributes of a low-priced form of housing exempt from typical community building codes and real estate taxes.

Basic data on the housing inventory by type of unit are available beginning with the 1940 Decennial Census of Housing. In addition to the 1950, 1960, and 1970 Housing Censuses, data are also available from the Annual Housing Surveys begun in 1973. As an overview of housing, we have summarized the distribution

of housing types for 1940 to 1976 (table 8).

Historically, the market share of annual housing production has varied widely between single-family and multifamily housing units. The market share of multifamily units ranged between 20 and 45 percent of nonfarm housing starts from 1900 to 1930. From the early 1930's to 1960, the multiunit market share was abnormally low—between 10 and 20 percent of housing starts—relative to the 30 percent share multiunits had of the total housing inventory in 1940 and 1950 (fig. 4). Conversion of large, single-family houses to apartments, rent controls, the fear of rent control, and the highly successful housing mortgage guarantee programs of the Federal Housing Administration and Veterans Administration contributed to the large market share single-family homes had of the total housing market.

The market share in multiunits increased dramatically in the 1960's, rising from 19.5 percent of housing starts in 1959 to almost 46 percent in 1969. It remained at nearly 45 percent for the period from 1970 to 1973 and then fell to about 24 percent for 1975 and 1976. This increase in apartment construction is less dramatic when mobile home shipments are also included in the housing production base. Including mobile homes, the market share of multiunit structures increased from 18 percent in 1959 to peaks of about 36 percent in 1969, 1971, and 1972. It then fell to about 20 percent in 1975 before rebounding slightly to 21 percent in 1976.

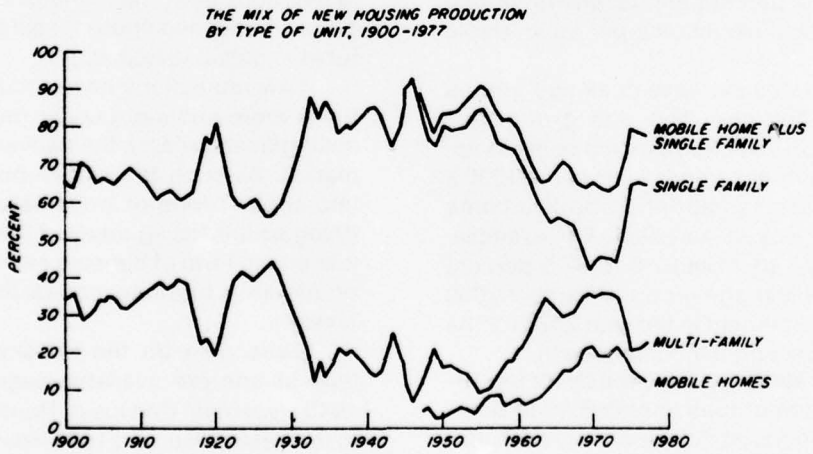
The apartment boom of the 1960's and early 1970's can be largely explained by (1) the age of the apartments stock in 1960 (few new structures of five or more units had been produced since the 1920's), (2) an excess supply of single-family houses, (3) a return of housing production to its long-term share of the total housing inventory of about 28 percent, and (4) demographic factors such as the increase in one-person households and the large increase in the number of young households under 30.

The market share of mobile homes as a percentage of housing starts plus reported mobile home shipments has increased from about 7 percent in the late 1950's to almost 22 percent in 1969. After staying at a plateau of about 20 percent for the period 1970 to 1974, their market share dropped to 15 percent in 1975, 14 percent in 1976, and 12 percent in 1977. This decline resulted in part from overbuilding and repossession of mobile homes, which caused lenders to be much more conservative in extending credit.

The mobile homes share of the year-round occupied housing market has increased from 0.7 percent in 1950 to 1.3 percent in 1960 and 3.1 percent in 1970 to 4.6 percent of the housing stock in 1975.

A substantial share of reported mobile home shipments fail to show up in subsequent counts of mobile homes occupied as primary households (table 9).

A number of explanations for this apparent



4. New housing starts by type of unit from 1900 to 1977, with mobile home shipments from 1947 to 1977.

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discrepancy are possible. First, vacant units and second homes are not included in the census or survey counts. This is particularly important in the 1972 to 1973 period when the mobile home boom may have led to excessive inventory buildup by dealers. Second, placing mobile homes on permanent foundations or the attachment of a porch or room may have led to some counting of mobile homes as single-family houses. Third, there may have been some overreporting of shipment data. On a pragmatic basis we count 75 percent of reported mobile home shipments as a satisfying primary year-round housing demand.

The mobile home has changed significantly over the last 20 years. For example, the first 10-foot-wide models were introduced in 1955; 12-foot-wide models came into mass production in 1962; and 14-foot-wide models were introduced in 1969. Now expandable models, double wide models, and even triple-wide models similar to single-family houses are available. The adoption of a nationwide mobile home standard code by the Department of Housing and Urban Development (HUD) in 1976 is a major milestone in the evolution of mobile homes to another form of manufactured housing. This code dictates 2 by 4 framing, insulation, and fire spread standards similar to conventional construction.

This code, together with government programs to allow long-term mortgage financing on certain types of mobile homes, indicates that the mobile home is now coming under the control of the institutions and regulations of the conventional housing market. As such the mobile home is losing many of the special advantages of being outside the control of the conventional real estate system (Drury 1973). As a sign of the times the Mobile Home Manufacturer's Association has recently changed its name to the Manufactured Housing Institute.

Home Ownership and Rental Housing Markets

In examining historical trends in the type-mix of the housing stock, it is important to look at tenure of home ownership versus rental markets. The home ownership market is generally demand-determined since consumers make a decision to buy or build a house of their choice. Income and consumer assets generally determine the size and value of the housing unit. On the other hand the rental market is generally supply-determined, i.e., the renter accepts what is available on the market and the investors will only supply units which will produce an acceptable rate of return on investment after construction costs, mortgage interest, and operating costs are taken into account. In this case, it is generally more economical to produce multiunit structures

From 1940 to 1960 ownership increased sharply, rising from 43.6 to 62 percent. Since 1960 ownership has continued to increase slowly, reaching 64.8 percent in 1976. Single-family homes have steadfastly maintained the lion share of the ownership market for the last 40 years. The market share of single-family housing in the home ownership market has remained surprisingly constant from 1940 to 1976, varying between 87 and 89 percent of the total owner-occupied housing stock (table 10). Despite extravagant claims of large shifts to condominium apartment ownership, the market share of multifamily units in the ownership market has declined from nearly 11 percent in 1950 and 1960 to less than 6 percent in 1976. Mobile homes share of the ownership market has risen from about 1 percent in 1950 to over 6 percent in 1976.

Trends in the type mix of the rental housing market are quite different. Single-family housing units have declined from 57 to 32.5 percent of the rental housing market from 1940 to 1976. As further evidence of the overbuilding of single-family houses in the 1950's, we note that the single-family unit share of the rental market increased from 44.7 percent in 1950 to 48.2 percent in 1960 despite the long-term decline in rental of single-family homes. (Rental of multiunit structures is generally more economical because operating and maintenance costs can be spread over a number of units.)

Multiunit structures have correspondingly increased their share of the rental housing market except for the 1950's when the oversupply of single-family houses temporarily filled much of the rental demand. Mobile homes are a minor factor in the rental market with a 2.5 percent share of the rental housing market in 1976.

Determinates of Housing Choice

A number of cross tabulations have been prepared which relate the type of housing consumers live in to major household characteris-

tics such as age of head, family type, tenure, income, region of the country, and metropolitan location. At this point, it is useful to examine housing occupancy relative to these characteristics for 1960, 1970, 1973, 1974, and 1975. The cross tabulations were based on 1-in-1,000 public use sample tapes from the 1960 and 1970 censuses and the total survey sample of the 1973, 1974, and 1975 housing survey. Each sample contains over 50,000 households. Age of household head is with each of the other major determinates in the following section since it is a primary determinate of housing choice.

Age of Household Head

The most important factor in determining the type of housing people choose to live in is the age of the household head. By age 30, most household heads live in single-family housing. From ages 35 to 65, nearly over 75 percent of all household heads live in single-family houses (fig. 5). What's more, this relationship has remained virtually constant from 1960 to 1975 despite wide variations in the mix of housing production between houses, apartments, and mobile homes during this period. Household heads over 65 show a strong preference for single-family houses with over 70 percent living in houses. Even households headed by primary individuals (one or more unrelated persons) show a strong age relationship with the majority of middle-age people, where most have determined where they will live, their career, and have married. They prefer the permanence and privacy of a single-family house. In addition, many houses, particularly in rural areas, are simply passed from one generation to the next without ever being sold. From a consumption-saving viewpoint, middle age is the time of capital accumulation for the consumer. Investment in a house provides an excellent way to build equity since home ownership is the only practical tax-sheltered investment available to most people. Home ownership is now viewed as an investment by most people and as a protection against inflation. Thus rising housing prices encourage the preference for single-family home ownership rather than discourage it as conventional economic logic might imply.

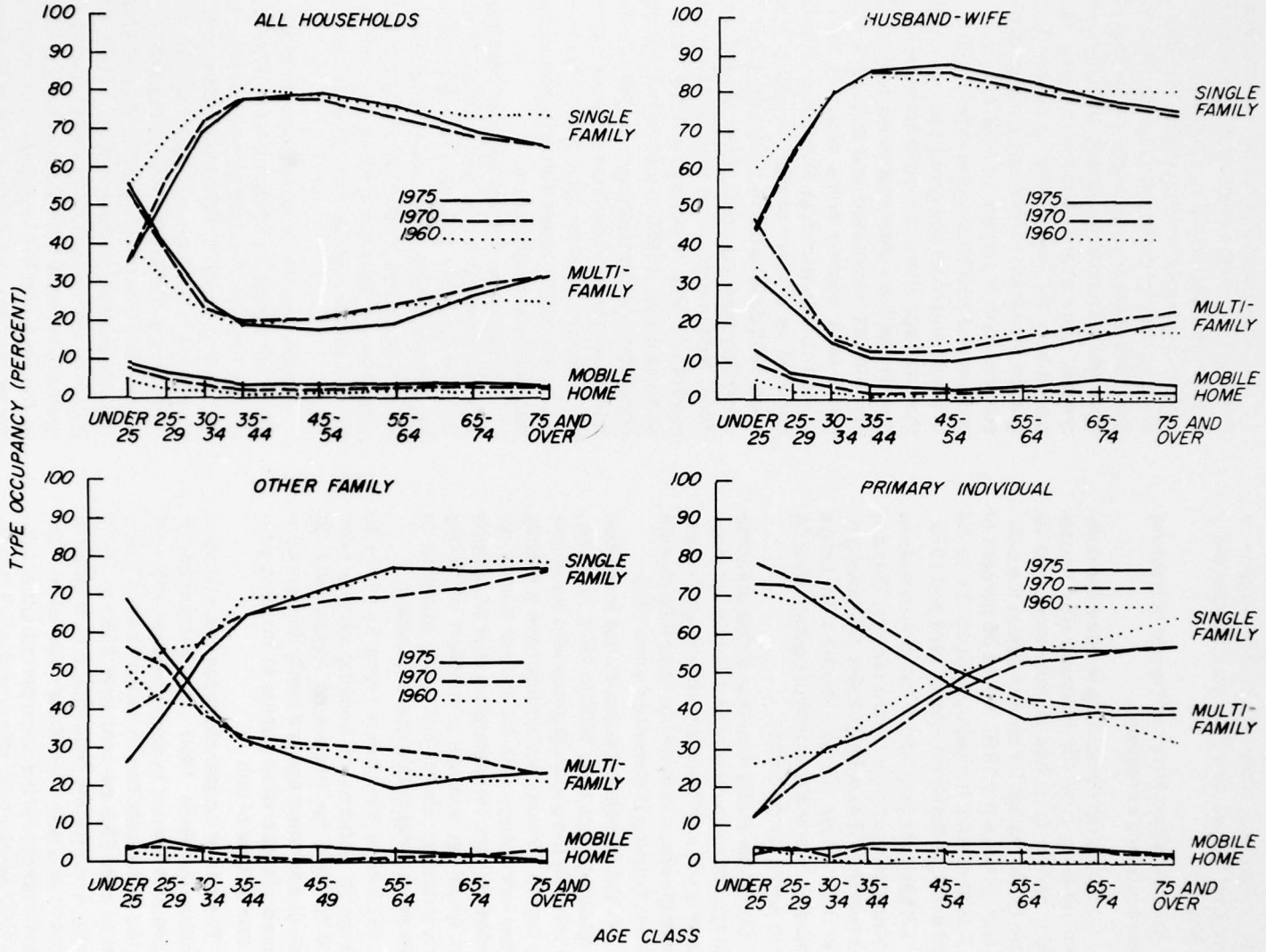
As a measure of the effect of age alone on single-family house choice, we have calculated regression coefficients for housing type occupancy based upon the 1973 and 1974 housing surveys. Multifamily house occupancy was found to decrease for all age groups when the effects of family status, income, household size, and location were accounted for (tables 11 and 12). Regression analysis for 1960, 1970, and 1975 produced similar results. A study by Carliner (1974) on home ownership based upon the 1967 Survey of Economic Opportunity also confirms the age relationship of greater single family housing occupancy with increased age.

Household Type

Household type is also an important factor in determining housing choice. The overwhelming majority of husband-wife households live in single-family houses—overall nearly 80 percent with about 86 percent for household heads 35 to 54 years of age. From 1960 to 1975 there was actually a slight increase in the percentage of married couples over 30 living in single-family houses despite the decline in single-family housing production (fig. 5). Multiunit occupancy on the other hand declined substantially for couples between 30 and 65 years of age and remained about the same for those over 65. Mobile home occupancy increased steadily from 1 to about 3 percent for couples in all age groups with a relatively higher proportion in younger and older groups.

A category called other families largely consists of single-parent households. Female heads are by far the most common. In 1975 about 60 percent of this category lived in single-family homes, 36 percent in multifamily structures, and 4 percent in mobile homes. Single-family occupancy increases with age with over 70 percent of those 45 years and older living in single-family houses. Furthermore, this pattern has remained unchanged from 1960 to 1975.

The third and most rapidly increasing category of household is the primary individual. This group (one-person households and nonrelated individuals living together) is most likely to live in multiunit structures. However, the predominance of apartment living is not as high as one might expect. For 1970 and 1975, about 50 percent of primary individuals lived in multifamily housing units, about 46 percent lived in single-family houses, and 4 percent in mobile homes. Housing occupancy is age-related for



5. Housing occupancy rates by type of unit and family type for 1960, 1970, and 1975.

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this group. For example, nearly 75 percent of individuals under 30 years of age live in multiunit structures while about 55 percent of those over 55 years of age live in single-family houses.

We may summarize our results of housing type occupancy as follows:

(1) Single-family housing remains the dominate housing type for husband-wife households, and in fact, has slightly increased its share of the market for households in the over-30 age group since 1960. About 86 percent of all husband-wife households aged 35 to 54 lived in single-family houses in 1974 and 1975.

(2) Multiunit occupancy has only increased for younger couples who are renters. There is little evidence that older couples are moving to apartments or mobile homes in large numbers—nearly 80 percent of couples over 65 live in single-family homes.

(3) Single-family housing is the predominate type of housing for other families in over-30 age groups and primary individuals in over-55 age groups, and there has been little change in these housing preferences since 1960.

(4) Mobile home occupancy has increased for all age groups from 1960 to 1974; however, it is primarily the under-30 group who live in mobile homes. Primary individuals have a slightly higher occupancy rate for mobile homes regardless of age. Householders over 65 occupy only about an average proportion of mobile homes despite claims that large numbers of them are moving to this type of housing.

(5) There has been remarkably little change in patterns of housing choice from 1960 to 1975 for household heads over 30 years of age, when age and family type are considered, despite wide swings in housing production by type of unit.

The mix of household types has changed significantly since 1950. The proportion of households headed by single persons and nonrelated individuals has increased from 11 percent to over 23.8 percent from 1950 to 1977. Correspondingly the percentage of traditional husband and wife households has fallen from 78 to 64 percent in the same period. Other families now account for 12 percent of all households, up from 11 percent in 1950 but still below the 14 percent level for this category in 1940.

Tenure

An important distinction exists between housing types in the ownership and rental markets. Home ownership is almost synonymous with single-family housing (table 13). This relationship has remained the same for 1960, 1970, and 1975 even though home ownership rates have been increasing. Mobile homes have increased their share of the ownership market particularly for households in under-30 age groups. However, mobile home ownership was still less than 5 percent in 1960 for those age groups over 35 including the elderly. The failure of the 65 and older age groups to show a larger than average share of mobile home ownership may be because older mobile home buyers retain the old homestead and acquire a mobile home as a second home which is then excluded from census data. Multifamily units have declined as a share of the ownership market since 1960 despite the recently publicized condominium housing boom. Even among the elderly, multiunit share of the home ownership market was only 10 percent in 1975, about the same as it was in 1960. It may be that growth in condominium ownership in large apartment buildings is being more than offset by a decline in ownership of older smaller structures—duplex, converted houses with apartments, etc.—particularly in central cities.

Overall home ownership rates have significantly increased for all households 25 to 64 years of age from 1960 to 1975 and remained about the same for those under 25 and over 64. What's more, the proportion of all households who own single-family houses also increased for the middle-age groups since 1960 (table 14).

Over two-thirds of all households and about 80 percent of husband-wife families in the 35- to 64-year-old range owned single-family housing in 1975. Preliminary data indicate that these rates have increased slightly since then. This is in sharp contrast to the widely publicized view that people are being priced out of the single-family housing market. In fact, since 1950 we have had a number of housing programs to increase home ownership. In addition to the FHA and VA mortgage guarantee programs we have recently had the HUD Section 235 housing program to assist moderate-income people to buy houses. Special consider-

ation has also been given minority groups to aid them in buying houses. Women are now being given equal consideration with men in qualification for home mortgages, both as single persons and as joint income earners with their spouses. Those developments increase the potential market for single-family homes.

Multiunit housing's share of the rental market has increased substantially since 1960—rising from 51 to 65 percent in 1975. This increase has occurred in all age classes. However, multiunit housing rental occupancy has not increased as a percentage of all households in those households aged 35 to 64 (table 15). Thus, the increase in rental of multifamily units has been largely concentrated in households under 30 and to a lesser extent in households over 64. Middle-age persons who rent are still more likely to rent a house (table 1).

Rental of single-family houses has fallen sharply since 1960. This reflects in part the increase in ownership by families, i.e., former renters who bought houses. Most new construction for the rental market is multiunit structures, because it is more economical to spread land, construction, and operating cost across multiple units. High interest rates and construction costs make even multiunit construction unprofitable in many areas without government subsidizing or increases in rents of 20 percent or more from 1975 levels.

As a Chicago real estate executive, Lawrence H. Cleland, views the rental market (Professional Bldg., Jan. 1977):

> ". . .Unless there is a turnabout in the cost of building and operating rental apartments or changes in government housing programs, the next generation of renters will face these facts:
>
> (1) Few apartments
> (2) Smaller apartments
> (3) Smaller apartment complexes
> (4) Paying all their utility bills
> (5) A return to basic shelter with few or no amenities
> (6) Greater emphasis on refurbishing."

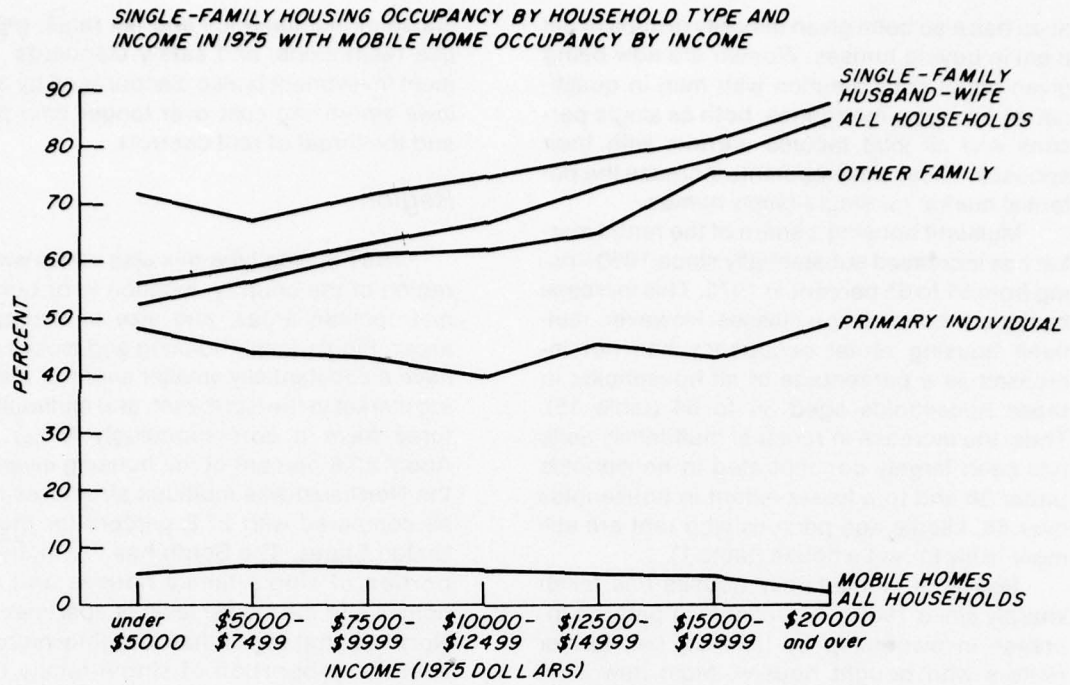
In addition to high interest rates, construction cost, land costs, and rising utility, apartment construction is becoming increasingly more complicated and costly in urban areas because of maintenance and tax rates, new land use restrictions, and safety standards. Apartment investment is also discouraged by new tax laws amortizing cost over longer time periods and the threat of rent controls.

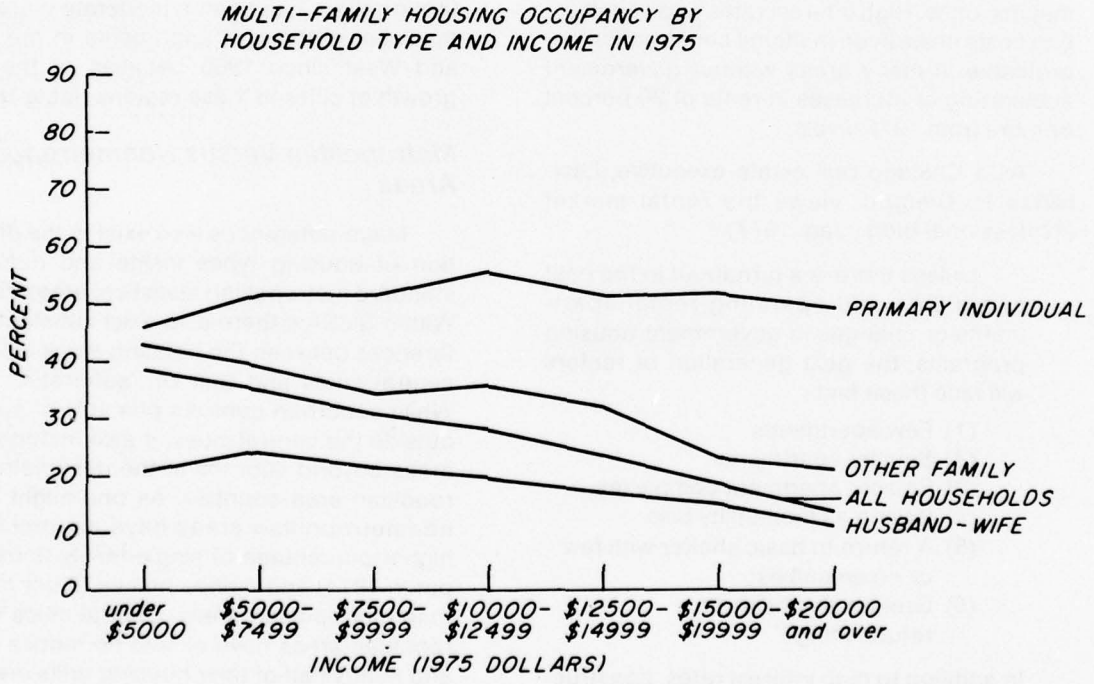
Region

The housing type-mix also varies widely by region of the country, location in or outside of metropolitan areas, and size of metropolitan areas. Single-family housing and mobile homes have a substantially smaller share of the housing market in the Northeast, and multiunit structures have a correspondingly larger share. About 42.6 percent of the housing inventory in the Northeast was multiunit structures in 1975 as compared with 27.8 percent for the entire United States. The South has the highest proportion of single-family houses and mobile homes and the lowest level of apartments. The North Central region has a slightly higher than average proportion of single-family houses while the West has a higher than average share of mobile homes. These regional variations have remained fairly constant since 1940, although there has been a moderate increase in the relative share of apartments in the South and West since 1960 because of the rapid growth of cities in these regions (table 16).

Metropolitan Versus Nonmetropolitan Areas

Major differences also exist in the distribution of housing types inside and outside of standard metropolitan statistical areas (SMSA). Within SMSA's there also exist substantial differences between the housing stock inside the central cities and that of "suburban" areas. While suburban consists primarily of suburbs, outside the central cities, it also includes rural areas beyond suburbs in the designated metropolitan area counties. As one might guess, nonmetropolitan areas have a substantially higher percentage of single-family houses (79 pct in 1974) and mobile homes (9 pct in 1974) than metropolitan areas. Central cities in metropolitan areas have almost no mobile homes and nearly half of their housing units are multifamily. Suburban areas have slightly more single-family housing (72 pct in 1974) than the U.S. share (68 pct in 1974).





6. Housing type occupied relative to income and family type for 1975. M 146 410 M 146 411

Income

Income is an important variable in determining the type of housing people choose to live in. A wider range of housing choices will presumably be available to persons of higher income. In addition, the tax advantages of home ownership are an incentive for higher income households to own homes. And, if lower income people are being priced out of the single-family housing market, then a strong relationship should exist between type of housing occupied and income.

In general, as income increases more households live in single-family houses (fig. 6). However, over 56 percent of all households making less than $5,000 in 1975 still lived in single-family housing. What's more, about 72 percent of all husband-wife households making less than $5,000 in 1975 lived in single-family housing. Housing type occupancy is only moderately related to income when households are separated by family type. Most families, husband-wife, and others live in single-family houses, while the majority of primary individuals live in multifamily housing. In fact, a higher proportion of lower income individuals (mostly older persons and people living in rural areas) live in houses than higher income persons. Mobile home occupancy is highest among households with incomes under $10,000 in 1975—about 6 percent of all households. Multifamily housing occupancy is negatively related to income. However, the income relationship appears to be less important than the influence of age and family type on housing choice.

Income itself varies significantly with age of household head and family type. Income is highest for household heads 35 to 54 years of age. For example, in 1975 these families averaged $19,000 in income as compared to an overall average for families of $14,000. Unrelated individuals had income much lower than families.

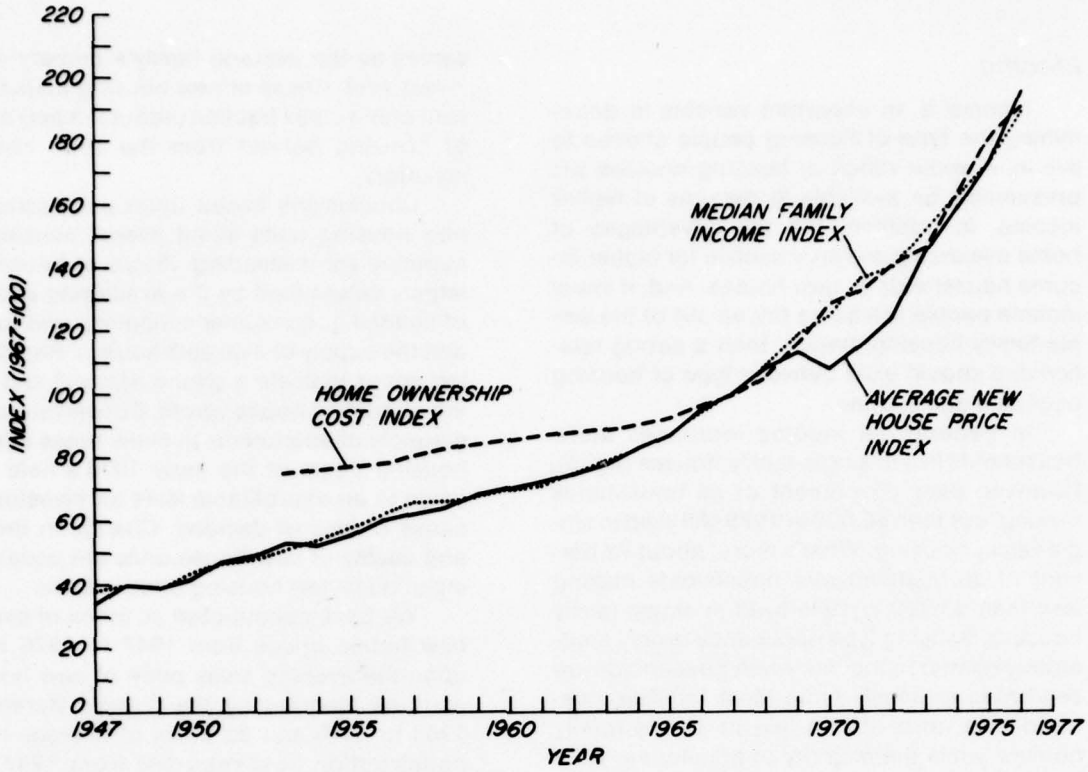
Housing Prices, Values, and Rents

Trends in prices of houses, mobile homes, and rents are important factors in determining housing choice. The exact relationship between the price for different housing types and housing type occupancy by households is complex as most housing services come from the existing housing inventory which also serves as the average family's primary equity investment. Prices of new housing units represent only a small fraction (about 2-3 pct) of flow of housing served from the total housing inventory.

Conclusions based upon price-series for new housing units about overall housing occupancy are misleading. Prices of houses are largely determined by the availability and cost of financing, consumer's incomes and assets, and the supply of available houses. Rapidly rising prices indicate a strong demand and owners of existing houses profit. Conversely, an oversupply of apartments in many areas after the housing boom of the early 1970's held rents down to an unprofitable level for investors because of lack of demand. Change in the size and quality of new house units are usually not included in new housing price indices.

We have constructed an index of average new house prices from 1947 to 1976 based upon the average sales price of new housing units as reported by the Census Bureau for 1963 to 1976 and an index of average house construction cost reported from 1947 until 1971 (U.S. Bureau of Census, 1977; Davidson, 1973). The index of construction cost included only labor and material cost. Our composite index was developed by adding on an allowance of 25 percent for other costs prior to 1963 to the construction cost index. This index shows a very close relationship to an index of family income from 1947 to 1976, except when it was distorted for 1969 to 1973 by housing subsidy programs to provide new housing for low and moderate income people. The index of average housing cost caught up to the family income index after 1973 (figure 7). Thus, in the long run, family income is a major determinate of housing prices (Atkinson, 1966).

Housing is one of the few items which demonstratively establishes social class in America. Consumers generally bid up the price of existing houses in prestigious areas or build expensive large new houses to establish social status. Housing programs which liberalize financial terms or indiscriminately provide more money for housing will increase the nominal price of houses without necessarily increasing the supply of housing service. Programs of housing allowance and subsidies without increase in supply will only raise nominal housing cost and shift housing services in favor of those



7. The relationship of average new housing price, and home ownership cost to family income, 1947 to 1976.

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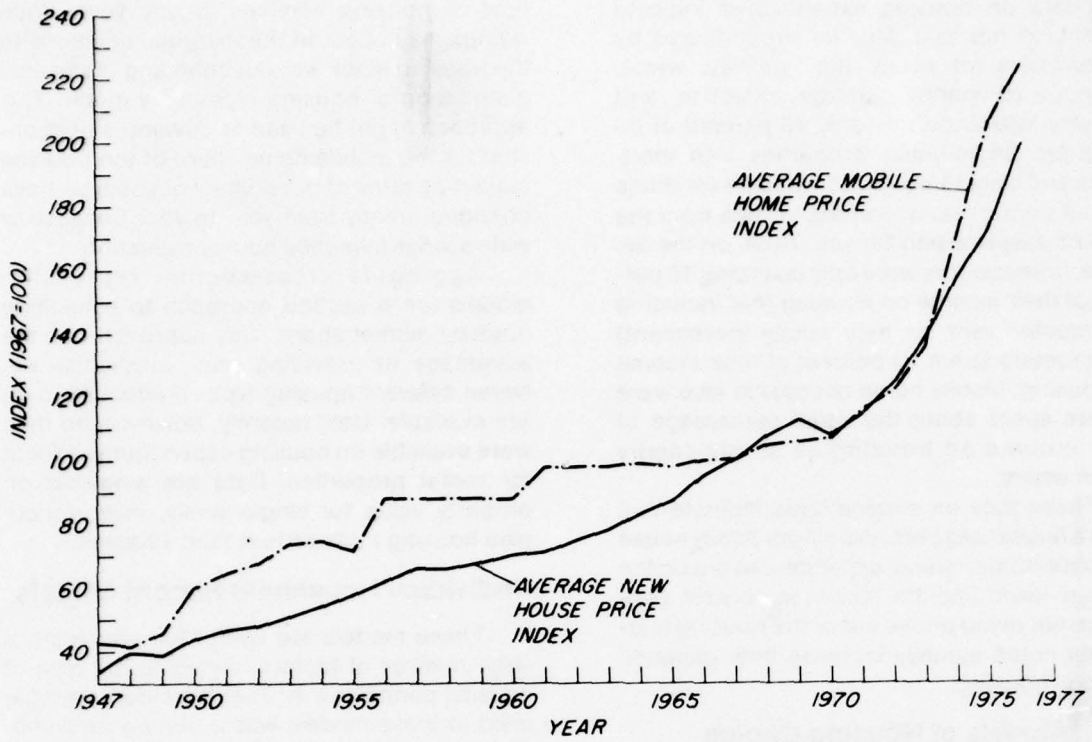
receiving subsidies from the next income class above them.

Another indicator of housing price is property value for single-family houses on less than 10 acres reported in the Decennial Housing Censuses and The Annual Housing Surveys. Median property value has increased from $7,400 in 1950 to $29,500 in 1975—an increase of 392 percent. This compares to an increase of the average new house price from $10,844 in 1950 to $42,900 in 1974—an increase of 396 percent. The median price of new houses was $39,300 in 1975. Thus, we see that average values or prices of all housing are considerably below new housing prices and that people most often buy or exchange used houses.

Housing price indices for multifamily houses and mobile homes are not readily available. An index of rents may serve as a proxy for multifamily housing costs. Two sources of rent information are available: The rent component of the consumer price index (CPI) (U.S. Bureau of Labor Statistics, 1977) and rents paid as reported in the Decennial Census of Housing and The Annual Housing Surveys. The CPI rent index does not fully represent changes in rents since it is based on a standard, moderately priced city apartment (Grebler and Maisel, 1963). The median rent as reported in the Census has increased roughly twice as fast as the rent index since 1940. For example, the median census rent increased 363 percent from 1950 to 1975 while the CPI rent index rose by only 206 percent. The median census rent also corresponds more closely to a Boeckh index of changes in residential construction costs (compiled by the American Appraisal Co., Inc. for typical construction costs in 20 cities) (Construction Review, 1977). Information on mobile home values is available beginning with the 1974 Annual Housing Survey (it was not included in the 1973 survey).

An average price for new mobile homes was estimated based upon industry data for total value and number of shipments. Prices for average mobile homes were constant in the



8. The relationship of average mobile home prices to average new housing prices, 1947 to 1976.

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1950's and 1960's, and they became less expensive relative to new single-family houses. In the 1970's, increased size and quality standards for mobile homes led to doubling of their average price—an increase even greater than average new single-family housing prices (fig. 8).

Another measure of the relative cost of single-family housing is the consumer price index of home ownership cost, which started in 1953. This index is a composite of many factors such as new house prices, taxes, first-mortgage interest, utilities, fuel, and maintenance costs (U.S. Bureau of Labor Statistics, 1977). As such it should measure the relative cost of home ownership for the existing housing stock. When this index is plotted against an index for median family income and all consumer prices, it indicates home ownership was relatively more expensive in the 1950's; home ownership then became cheaper relative to family income until 1967 (our base year) and has remained relatively the same since. What this suggests is that home ownership was relatively cheap as compared to income for the years from 1967 to 1972. Home ownership costs have increased more rapidly than income since 1973, and in 1976 the ratio was about the same as it was in 1967.

Other measures of the relative cost of housing are ratios of housing value to income, rent to income, and housing expenditures to income. In 1960, value-to-income ratio for single-family houses was about 2. By 1970 the overall ratio fell to 1.8—an unusually low level and further evidence of the historical cheapness of single-family housing then. In 1975, the median house value was again about two times the income of its occupant.

Median gross rent as a percentage of current income also fluctuates in a narrow range. Rent expenditures have increased from about 20 percent of income in 1960 to about 23 percent for 1973 to 1975. One might guess that single-family homeowners spend more of their income on housing than renters. However, re-

cent data on housing expenditures indicate that this is not true. Median expenditures by homeowners for taxes, fuel, utilities, water, mortgage payments, garbage collection, and property insurance was only 18 percent of income for single-family properties with mortgages and only 11 percent of income for those without mortgages according to data from the 1975 Annual Housing Survey. Thus, on the average, homeowners were only spending 16 percent of their income on housing (not including the imputed rent for their equity investment) while renters spent 23 percent of their income on housing. Mobile home occupants who were owners spent about the same percentage of their income on housing as single-family homeowners.

These data on expenditures indicate that once a household obtains a single-family house or mobile home, overall expenditures are on the average lower than the renter; in general, people are not being priced out of the housing market but could actually increase their expenditures on housing.

Models of Housing Choice

Three general types of models are possible for the analysis of the type of housing units consumers choose. They are: (1) Individual household cross-section regression models which match housing choice to characteristics of individual households and housing units, (2) aggregate cross-section regression models comparing differences in housing types among states, SMSA's or other geographic subdivisions, and (3) time-series models of the market share of house production for different housing types.

The individual household record model approach is best suited to the data from the annual housing surveys. For the first time, general data on housing expenditures are available from the 1974, 1975, and 1976 annual housing surveys. (This was not included in the 1973 survey.) These models provide predictive equations for determining housing choice by age groups directly from survey data.

Time-series models of housing production are easy to construct because of the availability of data on housing production by type of unit and of numerous time series of economic variables. But new housing production provides only about 2 to 3 percent of the total housing flow of housing services in any year. Wide swings may occur in the marginal additions to the housing stock without changing the overall distribution of housing types very much. This approach might be used to develop a relationship for the mobile home share of the housing market as rates of occupancy of this type have changed greatly from year to year because of wide swings in mobile home production.

Aggregate cross-section regression models are a second approach to estimating housing market share. This approach has the advantage of providing price elasticities between different housing types if adequate data are available. Until recently, however, no data were available on housing expenditures except for rental properties. Data are available on property value for single-family, owner-occupied housing units on less than 10 acres.

Individual Household Record Models

These models are useful for examining a large number of factors related to the type of housing people live in. The dependent variable used in these models was a dummy or dichotomous variable for the probability of a household occupying a particular housing type. The following independent variables were used:

Region of the country
Age of household head
Family type
Location inside/outside SMSA
Household size
Household income
Housing expenditures/income ratio

Dummy variables were used for region, age of household head, family type, and location in SMSA. Results of this analysis have been used on an experimental basis to estimate changes in housing occupancy from 1960 to 2000. This analysis indicates that the market share of single-family housing is negatively affected by current trends toward more individual households, declining household size, and rising housing expenditures as a percentage of income. However, these trends are offset by migration trends away from the Northeast and away from central cities, increased real income, and after 1980, a shift in the age distribution of households away from young households.

These types of models require substantial amounts of information. We must project all independent variables. A model for estimating

multifamily unit occupancy based on 1973 regression equations and estimated changes in housing occupancy by type of unit in 1990 are shown in table 11. This particular model does not include the housing expenditure to income ratio, since housing cost data were not available in 1973.

As a measure of the usefulness of this approach, the estimates indicated in table 17 are made for the percent of multifamily housing from 1960 to 2000.

A second individual household model is a variable for housing expenditures relative to income. Separate equations were developed for single-family, multifamily, and mobile home units with dichotomous dependent variables for the probability of a household occupying a particular housing type. A variable to measure the relative cost of housing was added to the independent variables listed in the previous model. Total housing expenditures (including mortgage payments, taxes, insurance, utilities, fuel, and trash pickup) by consumers was used as the variable for housing cost. A rent value was not inputed to homeowners equity because we feel that most owners view their equity as a tax shelter investment (generally a very profitable one) and not a liability. Gross rent (including utilities, fuel, trash pickup, and parking) was used as the measure of expenditures for renter-occupied units. Single-family units on more than 10 acres, owner-occupied multifamily units, and rental units without cash rent were excluded because no data were collected for them. Total expenditures, including site rental, were used for owner-occupied mobile homes and gross rent was used for rented mobile homes. The expenditure-to-income ratio was used for rented mobile homes. The expenditure-to-income ratio was used for each household as a measure of relative expense of housing. An example of this type of model is presented in table 12.

The following variables were used in the analysis:

Dependent variables:

- Dummy variable for living in multiunit
- Dummy variable for living in mobile home
- Dummy variable for living in one-unit house

Independent variables:

- Number of persons in household
- Dummy variable for living in Northeast
- Dummy variable for living in North Central
- Dummy variable for living in West
- Dummy variable for central cities of 50 largest SMSA's
- Dummy variable for outside SMSA's
- Dummy variable for age group 25 to 29
- Dummy variable for age group 30 to 34
- Dummy variable for age group 35 to 44
- Dummy variable for age group 45 to 54
- Dummy variable for age group 55 to 64
- Dummy variable for age group 65 and over
- Dummy variable for families other than husband-wife
- Dummy variable for individual households
- Household income previous year
- Ratio of housing expenditures to income

The following variables were omitted as reference variables for use with other dummy variables:

- Region—South
- Age group—18 to 24 years old
- Family type—husband-wife households
- SMSA location—suburbs of large SMSA's and small SMSA's

The regression models use weighted observations of 1975 data. Each observation was weighted based upon the sample design of the survey.

All variables appear significant. However, living in the Northeast, in large cities, being a household head over 45 years of age, and heading an individual household are particularly significant.

Another individual household record model was estimated using separate equations for each age of the seven age groups and three housing types. The results of this analysis using 1976 data are summarized in tables 18 to 21. One result of this analysis is the relationship of income and the expenditure-to-income ratio for various age classes for single-family housing occupancy. For age groups under 45 expenditure-to-income ratio coefficient was positive for single-family homeowners and negative thereafter. This suggests that single-family homeownership is viewed as an equity investment by younger households and that consumers use housing as a means to build capital, as might be expected from a consumer's life-cycle of capital saving in middle age for retirement. In addition, income has a strong positive relationship to single-family housing occupancy for the younger households. The relationship progressively weakens until it actually becomes negative for the group over 65. This again illustrates that homeownership is an equity investment with tax shelter advantages which is used to build capital during the consumer's capital-building years. In later years, these relationships dissipate as capital diminishes.

Aggregate Cross-Sectional Regression Model

Two aggregate cross-section models have been constructed. One uses state data from the 1970 Census. The second uses data from 125 standard metropolitan statistical areas obtained from the 1975 Annual Housing Survey. Both models are preliminary. This approach, however, provides some information of interest on the elasticities of demand of various housing types.

In the state model housing cost variables were: (1) Median value of single-family houses, (2) median rent value, and (3) an average mobile home value derived from depreciated values of the existing mobile home stock in 1970. The mobile home cost variable is not adequate because it is not based upon actual market value of mobile homes and does not account for other costs such as site, rent, or property value if the site was owned. Median rent is a proxy for multiunit cost; however, about one-third of all rentals are single-family units. The dependent variables were the proportion of three housing types in the housing stock of the States. Independent variables used were:

Median house value,
Median rent,
Average depreciated mobile home value,
Proportion of population in central cities of SMSA's,
Proportion of population in SMSA's outside central cities,
Proportion of husband-wife families,
Proportion of nonhusband-wife families, and
Average personal income.

A logistic transformation was used with each market share to assure that each market share has been 0 and 1 for any set of independent variables (Lin, Hirst, and Cohn, 1976). Other model formulations were tried; however, the one present here is an illustration of the results (table 22).

The SMSA cross-sectional regression model is based upon expenditure data for single-family houses, multifamily units, and mobile homes. For rental units of all types, gross rent is used as the measure of expenditure. For owner-occupied single-family units and mobile homes, reported housing cost was used as the measure of expenditure. Cost data were not collected for owned multifamily units and units on properties of more than 10 acres, so these units were excluded from the analysis. Expenditure data were summarized by SMSA from the 1975 Annual Housing Survey data tape (data were also summarized for 1974). The proportion of occupied housing types and the level of household income was also summarized for each SMSA. Mobile homes were poorly represented in many SMSA's since they are only a small share of the total housing market and are generally concentrated in rural areas. The ratios of housing expenditures to income by housing type were used as independent variables in the model to measure the relative cost of housing. No cost was inputed to owner equity since it was assumed that most owners only

look at their monthly cost and consider their equity as an investment.

The market share of each housing type was used as the dependent variable. SMSA's without any mobile homes were eliminated. The logistic transformation was used to limit the range of the dependent variable. The following model was estimated (table 23):

$$\ln\left(\frac{S_i}{1-S_i}\right) = \beta_0 + \beta_1 C_1 + \beta_2 C_2 + \beta_3 C_3 + \mu_i$$

S_i = market share of housing type i

C_i = average housing cost of housing type i / average income

μ_i = random error term

i = 1 is single-family, 2 is multifamily, 3 is mobile home

Estimate of interarea price elasticities are summarized in table 24. The elasticity of single-family housing demand was about –0.4 relative to housing expenditures and –0.5 relative to house value. Mobile home elasticity was estimated to be positive at 0.86 and 1.20. This surprising result may reflect the fact that zoning restrictions often relegate mobile homes to low-cost areas; where zoning is more liberal, higher price units are placed on better sites.

Time-Series Models of Housing Production

Time-series models can be constructed from annual data, quarterly data, or monthly data of housing production. Data have been collected on annual housing production by type of unit, including mobile homes, from 1947 to 1977. Monthly and quarterly data are available from 1959 to the present. These data have also been collected and computerized.

Data on economic and demographic variables have also been collected on an annual and quarterly basis. Regression analyses of annual changes in housing production have been conducted. Regression analyses have also been made on a quarterly basis. A monthly summary of housing production and market share by type of unit and region have also been computerized. The results of this work will be summarized later.

Summary of Housing Choice

This section reviewed factors affecting household housing choice between single-family, multifamily, and mobile home housing units and presented several econometric models of the relationship of some of these factors to housing choice. The purpose of this analysis is two-fold: (1) to establish the significance of these factors, and (2) to develop a formal analytic model for projecting housing choice in the housing model.

Age of household head is the most important single determinant affecting the type of unit occupied. This partially is because age is a good proxy for many other factors such as income, assets, marital and family status, career position, and household attitude. Therefore, whenever possible other factors are related to age of household head. Household type is another important demographic variable of housing choice—married couple, other family group, or individual household. Geographic factors of region of the country and location inside or outside metropolitan areas are also important. Economic factors such as household income and housing cost are also considered.

Our housing model is based upon explicit consideration of population, headship, and housing type occupancy rates by age class. We want to retain this structure in developing an analytical model to project the future housing type-mix of the inventory and housing production.

The model best suited for this approach is the individual household record model for each age group reported in tables 18-20. A simulation of housing projection has been conducted using this model; however problems have been arising in application of the model.

Results of the models presented in this paper show that single-family housing occupancy is positively related to income. This relationship will eventually drive single-family housing to an unrealistically high proportion of housing in a model which assumes a constant increase in real family income. In addition cross-sectional models are not particularly good for forecasting time-series relationships. One possible improvement is to reformulate the equations us-

ing income classes rather than a linear continuous income function.

Mobile homes are extremely difficult to model because of the changing characteristics of the mobile home market and the evolution of mobile homes into a form of manufactured house. Mobile home occupancy fits poorly in the simulation based upon historical data. Mobile homes are over-estimated in the period from 1960 to 1970 and decrease rapidly in the period after 1990. Recent experience indicates that this relationship has changed since 1974 and models based upon it will over-predict mobile homes market share.

Simulation results using equations in tables 18-20 will be discussed in a later report. We feel this model with modification can be used for projecting housing types. Limits should be placed upon the housing occupancy rates by age and type of unit to assure the results will be reasonably consistent with past experiences. These should remain near the bounds of housing types defined in figure 6. For example, for the 35-44 and 45-54 age groups the maximum rate of single-family housing occupancy might be 85 percent, while the minimum multifamily rate could be 12 percent and mobile homes 3 percent. In addition, the coefficient for income could be adjusted (arbitrarily for relative other models) to ameliorate the income effect.

AN IMPROVED MODEL OF HOUSING REPLACEMENTS

In the present model, units lost from the housing stock are estimated simply as a percentage of the housing inventory. A distinction is made for the rate of removal of conventional housing units and mobile homes because of the differences in their structure and longevity. Additionally, separate removal rates are estimated for each of the four census regions for conventional units. Thus, in the present model, four regional replacement rates are input for conventional housing units based on external analysis of census data, and one nationwide replacement rate is estimated for mobile homes which is based upon an analysis of changes in the mobile home inventory.

To improve our estimates of housing replacement requirements and to attempt to develop behavioral relationships between the rate of housing removal and economic variables such as economic growth, capital cost, housing prices, and housing operation cost, we attempted to: (1) Develop an annual series of "apparent" housing replacements derived from annual estimates of housing production, net household formations, and vacancy rates; and (2) to examine more closely changes in the housing inventory between past housing censuses to determine rates of replacements of housing units by type of structure and age of housing unit.

A matrix of the housing stock based upon the type and age of housing units was estimated from Census data for 1940 to 1975. Removal rates were estimated for each cell based upon hypothesized average life cycle for each housing type.

It appears that housing replacement demand is related to economic growth; however, it is questionable whether statistically sound econometric relationships can be estimated because of the lack of a primary data series for housing removals. For example, we know that net replacement of housing units was virtually nonexistent during the 1930's when economic growth was low.

In an attempt to establish time-series information, we will derive a series of apparent housing replacements based on the definition that all new housing production must be used for: (1) Additional households, or (2) additional vacancies or to replace units lost to the housing inventory. Apparent replacement will equal housing production minus the net increase in households minus vacancy changes minus a portion of mobile home shipments which are assumed not to be used as primary residences, i.e., as second homes or for nonresidential purposes. Specific series of annual housing replacement have been compiled; however, they have not provided useful information for developing statistical relationships.

Long-term historical data by decade on housing removals from 1890 to 1960 were compiled in "Resources in America's Future" (Landsberg, Fischman, and Fisher, 1963).[3] Specific data on units lost from the housing stock can be found or derived from the Census of Housing for 1956,1960, and 1970. Additional information on units lost from the housing inventory can also be obtained from the 1973 to

3 MATERIAL IS SPECIFICALLY GIVEN IN TABLE A4-5, P. 621.

1975 Annual Housing Surveys. Data on gross housing replacement is also available from the annual housing surveys. General data on housing removals for the periods 1950 to 1956, 1956 to 1960, 1960 to 1970, and 1970 to 1975 have been compiled (table 25).

Estimates of the inventory of housing by age of structure are available beginning with the 1940 Census of Housing. We have compiled a table of reported change by decade from 1940 to 1970 and for 1970 to 1975. An average rate of annual disappearance was calculated based upon the reported change for the United States (table 26).

We have calculated the rate of change of inventory by housing type. Results of this comparison are somewhat erratic. For some periods, units appear to be added from previous reports. Multiunit structures can be added by conversion of existing units to apartments. In addition, errors in reporting age may occur, especially for older structures, The annual housing surveys are not strictly comparable in design to the Censuses, and the use of different weighting systems could distort direct comparison. We have nevertheless developed a set of net replacement rates by type of unit for the United States and the four Census regions. These are based upon reported changes in inventory by year built from 1960 to 1970 and 1970 to 1974. A combination of the rates of change (sometimes positive) were used to derive a composite estimate of removals by age of structure.

These estimates of apparent replacement are then used to develop hypothetical life-cycle replacement curves of housing retirement by type of unit and region. A computer program has been developed to project replacement based upon these curves and to "grow" the housing inventory through time with new additions and removals. This submodel is intended to replace the current simple single replacement rate in the overall housing model. A summary of this program will be provided later after further refinement and it is incorporated into the housing projection model.

SUMMARY

The original model of housing demand was carefully formulated after considering and rejecting a number of economic variables which related to short-term influences on housing production. These factors tended to obscure the impact of basic longrun demographic trends. Thus, the model was made simplistic purposely. Disaggregation of demand projections by housing type and region complicate the addition of economic variables because each factor must be coordinated in the regional and type projections.

We are now reformulating our model. The improvements which have been implemented or are in the experimental state are: (1) New headship equations, (2) new housing choice equations, and (3) housing retirement matrix with age of structure, type of unit, and region.

Specific headship equations have been added. The housing occupancy equations listed in tables 18 to 20 are being programmed into the model for sensitivity testing. Mobile home choice may require an alternative model based upon time-series equations because of the dynamic nature of this market. A housing retirement matrix has been programed on an experimental basis and seems to give satisfactory results. It must still be incorporated into the general model.

Future research areas of importance are the development of: (1) A model to relate housing retirement explicitly to alternative economic growth levels, (2) an explicit model of migration, (3) an improved model of housing size, and (4) a model of marital status and household composition.

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LIST OF TABLES

Table 1.—**U.S. households by type for selected years, 1940 to 1977**

Year	All households	Husband-wife		Other family		Primary individual	
		Number	Percent	Number	Percent	Number	Percent
1940	34,949	26,571	76.0	4,920	14.1	3,458	9.9
1947	39,612	30,612	78.3	4,352	11.1	4,143	10.6
1950	43,554	34,075	78.2	4,763	10.9	4,716	10.8
1955	47,874	36,251	75.7	5,481	11.5	6,142	12.8
1960	52,799	39,254	74.3	5,650	11.8	7,895	16.5
1965	57,436	41,689	72.6	6,149	10.7	9,598	16.7
1970	63,401	44,728	70.5	6,728	10.6	11,945	18.8
1975	71,120	46,951	66.1	8,612	11.9	15,557	22.0
1976	72,867	47,297	64.9	8,759	12.0	16,811	23.1
1977	74,142	47,471	64.0	9,001	12.2	17,669	23.8

Source: U.S. Department of Commerce, Bureau of the Census: *Current Population Report, Series P-20, No. 313.*

Table 2.—**Headship rates and occurrence rates for husband-wife, other family, and primary individual households by age class 1952 to 1976 (percent)**

Year	Age class							
	18-24				25-29			
	Headship	Husband-wife	Other family	Primary individual	Headship	Husband-wife	Other family	Primary individual
1952	12.9	10.7	0.9	1.3	36.0	32.0	2.1	1.8
1953	13.6	11.3	1.0	1.3	36.0	32.0	2.2	1.7
1954	12.8	10.1	.9	1.8	35.0	30.7	2.4	1.9
1955	14.2	12.0	1.1	1.1	34.4	30.0	2.5	2.1
1956	15.1	12.6	1.2	1.3	36.7	32.4	2.3	1.9
1957	15.4	12.3	1.4	1.6	36.8	32.6	2.5	1.7
1958	15.6	12.7	1.3	1.6	37.7	32.9	2.5	2.3
1959	16.0	13.2	1.0	1.8	37.8	32.9	2.6	2.3
1960	15.8	13.0	1.1	1.8	39.2	34.2	2.7	2.4
1961	15.5	12.2	1.3	2.0	39.7	34.3	2.5	2.9
1962	16.3	12.8	1.3	2.2	40.0	33.6	3.1	3.3
1963	15.8	12.6	1.2	2.0	40.1	33.4	3.5	3.2
1964	16.4	12.9	1.5	2.0	40.8	35.0	3.1	2.8
1965	17.0	13.4	1.2	2.4	42.5	36.0	3.3	3.2
1966	16.7	13.1	1.2	2.4	43.1	35.9	3.6	3.7
1967	15.9	12.1	1.2	2.5	44.0	36.9	3.3	3.9
1968	16.7	12.3	1.4	3.1	42.1	35.0	3.3	3.8
1969	17.2	12.4	1.5	3.3	44.5	35.9	4.0	4.7
1970	17.6	12.3	1.8	3.5	44.9	36.2	3.8	5.0
1971	18.4	12.5	1.9	3.9	44.7	34.6	4.4	5.6
1972	19.9	12.8	2.3	4.8	46.2	35.7	4.2	6.3
1973	20.7	13.1	2.6	5.1	46.7	34.4	5.3	6.9
1974	21.7	13.1	2.5	6.1	46.9	33.5	5.2	8.2
1975	21.2	12.2	2.8	6.1	46.8	33.1	5.3	8.4
1976	20.9	11.4	2.8	6.7	47.4	32.2	5.2	10.0

Table 2.—**Headship rates and occurrence rates for husband-wife, other family, and primary individual households by age class 1952 to 1976 (percent)**—continued

Year	Age class							
	30-34				35-44			
	Headship	Husband-wife	Other family	Primary individual	Headship	Husband-wife	Other family	Primary individual
1952	41.5	37.5	2.7	1.3	46.1	39.0	4.3	2.9
1953	42.9	38.0	3.0	1.9	45.8	39.0	3.7	3.1
1954	43.8	38.5	3.2	2.2	47.0	39.8	4.5	2.7
1955	42.1	37.1	3.3	1.7	48.1	40.3	4.9	2.9
1956	41.7	36.8	3.2	1.7	46.9	39.8	4.7	2.5
1957	42.8	38.0	2.9	1.9	46.7	40.1	4.3	2.3
1958	43.2	38.1	3.0	2.1	46.6	39.7	4.2	2.7
1959	44.1	38.6	3.3	2.2	47.2	40.0	4.4	2.8
1960	44.8	39.1	3.3	2.5	47.9	40.5	4.7	2.8
1961	45.2	38.7	3.7	2.8	47.4	39.8	4.6	2.9
1962	46.5	39.6	4.0	2.9	48.1	40.4	4.7	3.0
1963	46.4	40.0	3.9	2.5	48.8	41.2	5.0	2.6
1964	45.9	39.9	3.6	2.4	49.4	41.1	5.3	3.0
1965	46.1	39.4	3.9	2.7	48.9	40.0	5.4	3.5
1966	46.1	39.0	4.0	3.1	48.9	40.4	5.2	3.3
1967	46.2	38.8	4.4	3.1	49.5	40.7	5.4	3.4
1968	47.8	40.2	4.6	3.1	50.2	41.0	5.6	3.6
1969	48.1	40.0	4.4	3.7	50.1	40.9	5.8	3.4
1970	48.3	40.5	4.3	3.5	50.4	41.3	5.5	3.5
1971	48.1	39.0	5.3	3.8	51.0	40.9	6.1	4.0
1972	50.1	39.2	5.6	4.7	50.5	39.9	6.6	4.0
1973	50.9	39.8	6.3	4.6	51.6	40.4	6.8	4.5
1974	51.0	39.5	5.9	5.7	51.4	39.7	7.3	4.4
1975	51.6	38.7	6.5	6.4	52.0	39.7	7.8	4.5
1976	50.9	37.3	7.0	6.6	53.2	40.2	8.0	5.0

Table 2.—**Headship rates and occurrence rates for husband-wife, other family, and primary individual households by age class 1952 to 1976 (percent)**—*continued*

Year	Age class							
	45-54				55-64			
	Headship	Husband-wife	Other family	Primary individual	Headship	Husband-wife	Other family	Primary individual
1952	50.4	38.8	6.2	5.4	55.7	39.1	7.5	9.0
1953	52.1	40.0	6.1	6.0	55.3	37.1	7.6	10.6
1954	51.1	40.0	5.6	5.6	53.9	37.6	7.1	9.2
1955	50.8	40.0	5.9	5.0	54.3	37.7	7.2	9.4
1956	51.3	39.8	6.1	5.4	55.4	38.5	7.1	9.9
1957	52.2	40.8	6.1	5.4	55.2	38.4	6.7	10.1
1958	53.5	41.2	6.4	5.9	54.1	37.2	6.5	10.5
1959	52.9	40.6	6.1	6.3	54.4	36.9	6.3	11.2
1960	52.9	40.9	6.2	5.8	55.1	37.6	6.3	11.2
1961	51.6	40.1	5.9	5.6	56.9	39.0	6.4	11.5
1962	51.7	40.5	5.6	5.6	56.4	38.5	6.4	11.5
1963	51.5	40.3	5.7	5.5	55.8	38.3	6.4	11.1
1964	52.3	40.9	5.8	5.6	56.1	38.4	6.1	11.7
1965	52.4	40.9	6.2	5.4	56.7	38.2	6.2	12.4
1966	52.8	41.1	5.9	5.9	56.3	37.9	5.7	12.6
1967	52.4	40.1	6.2	5.4	56.3	38.2	5.7	12.4
1968	52.4	40.6	6.0	5.8	58.1	39.3	6.0	12.8
1969	52.6	40.3	5.9	6.5	58.3	39.7	5.7	12.9
1970	52.6	40.6	6.0	6.1	58.0	38.8	6.1	13.1
1971	53.5	40.5	6.7	6.3	58.2	39.2	5.8	13.2
1972	54.2	41.2	6.5	6.5	58.5	39.3	6.0	13.2
1973	54.1	41.0	6.5	6.6	58.3	38.9	6.1	13.2
1974	54.4	40.7	6.6	7.2	57.3	38.4	6.0	12.9
1975	54.3	40.1	7.1	7.1	57.4	37.9	6.1	13.4
1976	54.2	40.1	6.8	7.2	58.3	38.7	6.1	13.6

Table 2.—**Headship rates and occurrence rates for husband-wife, other family, and primary individual households by age class 1952 to 1976 (percent)**—continued

Year	Age class			
	65 and older			
	Headship	Husband-wife	Other family	Primary individual
1952	54.3	29.4	9.6	15.0
1953	56.1	29.7	9.7	16.7
1954	54.2	29.7	8.7	15.7
1955	54.7	28.4	9.0	17.3
1956	55.2	28.9	9.1	17.2
1957	54.5	28.1	9.5	16.9
1958	54.8	28.2	8.8	17.9
1959	55.6	28.6	8.7	18.4
1960	56.8	29.1	8.3	19.4
1961	56.2	28.7	8.0	19.5
1962	59.8	30.8	8.1	20.9
1963	60.0	30.4	8.3	21.3
1964	59.7	29.8	8.2	21.7
1965	60.5	29.2	8.0	23.3
1966	61.1	29.6	8.0	23.5
1967	62.1	29.7	8.0	24.4
1968	62.0	29.5	7.6	24.9
1969	62.1	28.9	7.6	25.5
1970	61.5	28.3	7.2	26.0
1971	61.8	28.7	6.5	26.7
1972	63.7	29.3	6.6	27.8
1973	63.5	28.7	7.0	27.7
1974	64.1	29.8	6.6	27.7
1975	64.4	30.1	6.2	28.1
1976	65.0	29.6	6.2	29.2

Source: U.S. Department of Commerce, Bureau of the Census. *Current Population Report, Series* P-20 and P-25, various issues.

Table 3.—Population in various household types by sex and age: 1976 and estimates of alternative potential headship rates

(Thousands excluding inmates in institutions and persons living in group quarters.)

Subject	Age class						
	18-24	25-29	30-34	35-44	45-54	55-64	65 and over
Male, total	13,156	8,465	6,801	11,107	11,296	9,320	8,913
Household head, wife present	3,189	5,641	5,286	9,239	9,496	7,713	6,730
Other family	98	90	85	266	347	238	229
Primary individual	1,064	1,088	635	743	758	849	1,398
Child of head (*not in subfamily*, 18-24 only)	7,486	–	–	–	–	–	–
Female, total	13,780	8,754	7,128	11,712	12,156	10,447	12,749
Wife of household head	5,223	6,246	5,509	9,205	9,361	7,000	4,600
Household head, other family	669	813	903	1,576	1,273	970	1,121
Primary individual	818	667	302	403	945	1,862	5,254
Child of head (*not subfamily*, 18-24 only)	5,415	–	–	–	–	–	–
Population in husband-wife households	8,412	11,887	10,795	18,444	18,857	14,713	11,330
Children of heads (18-24)	12,901	–	–	–	–	–	–
Population in households	26,936	17,219	13,929	22,819	23,452	19,767	21,662
Not married couples or children of head (18-24)	5,623	5,336	3,134	4,375	4,595	5,054	10,332
Husband-wife households	3,189	5,641	5,286	9,239	9,496	7,713	6,730
80 percent of other population	4,498	4,269	2,507	3,500	3,676	4,043	8,266
Total population[1]	27,982	17,509	14,161	22,989	23,670	19,951	22,758
Potential headship, percent, *with 80 percent headship for nonhusband-wife population*	27.5	56.6	55.0	55.4	55.6	58.9	65.9
Potential headship, percent, with 90 percent headship for nonhusband-wife population	29.5	59.6	57.2	57.3	57.6	61.5	70.4
Percent of male household heads with wife present—1976	11.4	32.2	37.3	40.2	40.1	38.7	29.6
Potential headship assuming a 10 percent decline in husband-wife households and 80 percent nonhusband-wife headship	28.2	58.5	57.2	57.8	58.0	61.2	67.7
Potential headship assuming a 10 percent decline in husband-wife households and 90 percent nonhusband-wife headship	30.4	62.2	60.2	60.5	60.8	64.6	72.8

[1]Includes inmates and armed forces overseas.

Table 4.—**Population in various household types by sex and age: 1975 and estimates of alternative potential headship rates**

(Thousands excluding inmates in institutions and persons living in group quarters.)

Subject	Age class						
	18-24	25-29	30-34	35-44	45-54	55-65	65 and over
Male, total	12,833	8,048	6,728	10,992	11,366	9,181	8,722
Household head, wife present	3,352	5,525	5,354	9,060	9,544	7,451	6,656
Other family	237	117	96	279	353	276	267
Primary individual	975	868	572	668	704	770	1,346
Child of head (not in subfamily, 18-24 only)	7,051	–	–	–	–	–	–
Female, total	13,484	8,345	6,971	11,615	12,220	10,305	12,405
Wife of household head	5,367	6,106	5,434	9,207	9,279	6,823	4,589
Household head, other family	685	764	808	1,497	1,326	930	1,107
Primary individual	693	536	308	356	988	1,875	4,884
Child of head (not in subfamily, 18-24 only)	5,367	–	–	–	–	–	–
Population in husband-wife households	8,719	11,631	10,788	18,267	18,823	14,274	11,245
Children of heads (18-24)	12,418	–	–	–	–	–	–
Population in households	26,317	16,393	13,699	22,607	23,586	19,486	21,127
Not married couples or children of head (18-24)	5,180	4,762	2,911	4,340	4,763	5,212	9,882
Husband-wife households	3,352	5,525	5,354	9,060	9,544	7,451	6,056
80 percent of other population	4,144	3,810	2,329	3,472	3,810	4,170	7,906
Total population[1]	27,387	16,705	13,844	22,823	23,787	19,696	22,208
Potential headship, percent, with 80 percent headship for nonhusband-wife population	27.4	55.9	55.5	54.9	56.1	59.0	65.6
Potential headship, percent, with 90 percent headship for nonhusband-wife population	29.3	58.7	57.7	56.8	58.1	61.6	69.9
Percent of male household heads with wife present—1975	*12.2*	*33.1*	*38.7*	*39.7*	40.1	37.8	30.0
Potential headship assuming a 10 percent decline in husband-wife households and 80 percent nonhusband-wife headship	28.1	57.9	57.8	57.3	58.5	61.3	67.5
Potential headship assuming a 10 percent decline in husband-wife households and 90 percent nonhusband-wife headship	30.3	61.5	60.8	59.8	61.3	64.6	72.3

[1] Includes inmates and armed forces overseas.

Table 5.—Headship rates by age class in the United States for 1950, 1954 to 1976, and theoretical upper limit for headship

Year	Age class						
	18-24	25-29	30-34	35-44	45-54	55-64	65 and over
1950	13.1	33.9	39.9	44.8	49.2	52.0	52.8
1954	12.7	35.4	42.7	47.2	51.4	53.7	55.5
1955	14.2	34.8	43.7	48.2	50.8	54.2	54.7
1956	15.1	37.1	42.0	47.1	51.2	53.4	55.2
1957	15.4	37.2	43.0	46.9	52.1	55.2	55.0
1958	15.6	38.1	43.4	47.0	53.6	54.1	54.8
1959	16.0	38.2	44.3	47.3	52.8	54.5	55.6
1960	15.8	39.3	44.9	48.0	53.0	54.7	56.8
1961	15.5	39.6	45.2	47.6	52.3	56.9	56.1
1962	16.3	40.0	46.5	48.0	51.4	56.4	59.7
1963	15.8	40.1	46.4	48.8	51.6	55.8	60.0
1964	16.4	40.9	45.9	49.4	51.5	56.1	59.7
1965	17.0	42.5	46.1	48.9	52.8	56.7	60.5
1966	16.7	43.1	46.1	48.9	52.8	56.5	61.0
1967	15.9	44.0	46.2	49.5	52.4	56.3	61.2
1968	16.7	42.2	48.0	50.3	52.5	58.0	62.4
1969	17.2	43.9	48.3	50.3	52.9	58.3	62.7
1970	17.6	44.5	48.8	50.7	52.7	58.3	62.9
1971	18.3	44.5	48.3	51.4	53.9	58.5	62.3
1972	19.9	44.0	49.5	50.6	54.2	58.5	64.1
1973	20.7	46.0	50.6	51.6	54.1	58.3	64.3
1974	21.7	46.5	51.2	51.1	54.7	57.2	64.3
1975	21.2	46.8	51.6	52.0	54.3	58.4	64.4
1976	20.9	47.4	50.9	53.2	54.2	58.3	65.0
Upper limit	30.0	56.0	56.0	57.0	58.0	60.0	68.0

Source: U.S. Department of Commerce, Bureau of the Census. Current Population Report, Series P-25 and Series P-20, various issues.

Table 6.—Regression equations for relating headship to real per capita personal income by age class using the logistic function

Age class	Headship upper limit	Regression equation [1]
18-24	0.30	$\bar{H}_n = -0.3123 + 0.7350\ \bar{H}_{n-1} + 0.00011\ \bar{Y}_{n-1}$ $R^2 = 0.934$
25-29	.56	$\bar{H}_n = -.9302 + 0.3120\ \bar{H}_{n-1} + .00045\ \bar{Y}_{n-1}$ $R^2 = .965$
30-34	.56	$\bar{H}_n = -.2835 + 0.7257\ \bar{H}_{n-1} + .00020\ \bar{Y}_{n-1}$ $R^2 = .947$
35-44	.57	$\bar{H}_n = -.05910 + .9705\ \bar{H}_{n-1} + .00004\ \bar{Y}_{n-1}$ $R^2 = .886$
45-54	.58	$\bar{H}_n = .3474 + .6402\ \bar{H}_{n-1} + .0013\ \bar{Y}_{n-1}$ $R^2 = .773$
55-64	.60	$\bar{H}_n = .06588 + .4016\ \bar{H}_{n-1} + .00044\ \bar{Y}_{n-1}$ $R^2 = .810$
65 and over	.68	$\bar{H}_n = .4794 + .7270\ \bar{H}_{n-1} + .00029\ \bar{Y}_{n-1}$ $R^2 = .935$

[1] The equations were fit for annual data from 1953 to 1976, where:

$\bar{H} = \ln\left(\frac{H}{a - H_n}\right)$ on the logistic transformation for headship

a = an estimated upper limit for headship

$\bar{Y} = \frac{\text{disposable personal income}}{\text{(consumer price index) (population 18 and older)}}$

Data sources: Headship rates from Economic Report of the President, 1977, table 5; population 18 and older from U.S. Department of Commerce, Bureau of Census, Series P-20.

Table 7.—**Headship rate projections by age class for 1 and 2 percent growth in real disposable personal income (DPI) for 1980 to 2020**

Year	Age class						
	18-24	25-29	30-34	35-44	45-54	55-64	65 and over
	1 PERCENT GROWTH IN REAL DPI PER ADULT						
1980	20.9	47.7	51.2	54.0	54.2	58.4	65.4
1985	21.4	48.8	51.9	54.7	54.5	58.6	65.8
1990	22.0	49.8	52.5	55.3	54.8	58.9	66.3
1995	22.6	50.7	53.1	55.8	55.1	59.1	66.7
2000	23.3	51.5	53.6	56.1	55.3	59.2	67.0
2005	23.9	52.2	54.0	56.4	55.6	59.4	67.3
2010	24.5	52.9	54.4	56.6	55.8	59.5	67.5
2015	25.1	53.5	54.7	56.7	56.1	59.6	67.6
2020	25.6	54.0	55.0	56.8	56.3	59.7	67.7
	2 PERCENT GROWTH IN REAL DPI PER ADULT						
1980	21.1	48.3	51.4	54.0	54.3	58.5	65.5
1985	22.1	50.2	52.6	54.9	54.9	59.0	66.3
1990	23.3	51.9	53.6	55.6	55.4	59.3	67.0
1995	24.5	53.2	54.4	56.1	55.9	59.6	67.5
2000	25.7	54.2	55.0	56.5	56.3	59.7	67.7
2005	26.7	54.9	55.4	56.7	56.7	59.8	67.9
2010	27.6	55.3	55.7	56.9	57.0	59.9	67.9
2015	28.3	55.6	55.8	56.9	57.3	60.0	68.0
2020	28.8	55.8	55.9	57.0	57.5	60.0	68.0

Table 8.—**Distribution of housing inventory by type of unit for 1940, 1950, 1960, 1970, and 1973 to 1976**

Year	Detached houses	One-family unit[1]	Mobile home or trailer	One family plus mobile homes	Multifamily unit
	Pct	Pct	Pct	Pct	Pct
1940	66.7	[2]71.2	[3]0.4	71.6	28.4
1950	64.0	[2]68.5	.7	69.3	29.7
1960	68.8	74.1	1.3	76.3	23.7
1970	66.2	69.1	3.1	72.2	27.8
1973[4]	63.7	68.1	4.4	72.5	27.5
1974[4]	63.6	67.6	4.9	72.5	27.5
1975[4]	64.2	68.3	4.3	72.6	27.4
1976[5]	N.A.	68.0	4.5	72.5	27.4

[1]Includes attached one-unit structures.

[2]Includes two-family side-by-side which are classified as one-unit attached after 1960.

[3]Includes trailers and other miscellaneous temporary housing.

[4]The annual housing includes adjustments of 700,000, 400,000 and 200,000 additional mobile homes for 1973, 1974, and 1975, respectively, because of a lack of a sampling procedure for new mobile home parks. An additional 600,000 conventional units were added to account for units started before January 1, 1970, and not included in the sampling procedure for new permits. For details see the appendix sections of the Annual Housing Reports. While concepts and definition are generally compatible between the 1970 census and the 1973, 1974, and 1975 housing surveys, year-to-year comparison should be made with caution because of differences in sample size and enumeration methods. The 1974 and 1975 questionnaire and sample size differ slightly from 1973's.

[5]Preliminary data.

Source: U.S. Department of Commerce, Bureau of the Census. 1940, 1950, 1960, and 1970 Censuses of Housing; 1973 to 1976 Annual Housing Surveys.

Table 9.—A comparison of reported mobile home shipments, with subsequent inventory counts for 1960, 1970, 1973, and 1975

Year	Mobile home shipments reported	Count of mobile homes occupied as primary households	Primary households as a percent of shipments
		1960 CENSUS	
1955-1958	457	251	54.9
1959-March 1960	132	106	80.3
		1970 CENSUS	
1960-1964	654	469	71.7
1965-1968	990	708	71.5
1969-March 1970	513	335	65.3
		1973 SURVEY	
1960-1964	654	376	57.5
1965-1968	990	646	65.3
1969-June 1973[1]	2,285	1,312	57.4
1969-June 1973[2]	2,285	2,012	88.1
		1975 SURVEY	
1960-1964	654	291	44.5
1965-1968	990	555	56.1
1969-June 1975[3]	2,890	2,153	74.5

[1]Based on unweighted count from public use sample tape of entire survey.
[2]With an arbitrary adjustment of an additional 700,000 mobile homes for assumed undercounting.
[3]With an arbitrary adjustment of an additional 200,000 units for assumed undercounting.

Source: U.S. Department of Commerce, Bureau of the Census. Series C-20; various issues and data compiled from sample survey data tapes.

Table 10.—The occupied housing inventory by tenure and by type of unit for 1940, 1950, 1960, 1970, and 1973 to 1976

Year	Owners	Owner occupied			Renter occupied[1]		
		One-unit	Multiunit	Mobile home	One-unit	Multiunit	Mobile home
	Pct	Pct	Pct	Pct	Pct	Pct	Pct
1940	43.6	89.3	10.3	[2]0.4	56.9	42.6	[2]0.5
1950	55.0	88.1	10.8	1.1	44.7	55.0	.3
1960	62.2	87.2	10.7	2.1	48.2	51.4	.4
1970	62.9	89.0	6.6	4.4	36.2	62.4	1.4
1973	64.4	87.7	6.0	6.3	34.2	63.9	1.9
1974	64.6	87.4	5.7	6.9	33.7	64.1	2.2
1975	64.6	88.2	5.8	6.0	32.9	65.1	2.0
1976	64.8	87.9	5.8	6.3	32.5	65.0	2.5

[1]Includes units with no cash rent.
[2]Includes all other temporary housing.

Source: U.S. Department of Commerce, Bureau of the Census. 1940, 1950, 1960, and 1970 Censuses of Housing; 1973-1976 Annual Housing Surveys.

Table 11.—**Regression analysis of the probability of a household living in an apartment in 1973**[1]

	Regression coefficient[2]	Mean value 1973	Aggregate effect	Mean value 1990	Aggregate effect
Constant	0.6465		0.6465		0.6465
Number of persons	-.0329	2.97	-.0977	2.65	-.0873
Income	-.0000031	11,205	-.0347	14,460	-.0448
Household type					
Husband-wife	-.2010	.6708	-.1348	.5893	-.1184
One parent	-.0978	.1144	-.0112	.1228	-.0120
Primary individual	reference	.2148	–	.2879	–
Region					
Northeast	.2238	.2340	.0524	.2101	.0470
North Central	.0594	.2727	.0162	.2481	.0147
South	reference	.3116	–	.3372	–
West	.0532	.1817	.0096	.2046	.0109
Metropolitan location					
In central city	.2086	.3143	.0656	.2800	.0584
In SMSA-outside city	reference	.3680	–	.3800	–
Country	-.0895	.3177	-.0284	.2400	-.0304
Age class					
18-24	reference	.0817	–	.0653	–
25-29	-.0965	.1042	-.0101	.1114	-.0108
30-34	-.1804	.0950	-.0171	.1200	-.0216
35-44	-.2194	.1733	-.0380	.2210	-.0485
45-54	-.2729	.1857	-.0507	.1492	-.0407
55-64	-.3019	.1671	-.0504	.1297	-.0392
65 and over	-.3086	.1930	-.0596	.2061	-.0636

Probability of living in apartment = 0.2576 in 1973 and 0.2602 in 1990.

Proportion of inventory in multiunit structures[3] = 0.275 in 1973 and 0.277 in 1990.
Multiple correlation coefficient = 0.527.
Coefficient of determination = 0.278.
F ratio = 1200.7 with 15 and 46,790 deg. Freedom. Sign at 0.00001 level.

[1]Single-family house includes attached units while all structures with two or more units as defined by the Census Bureau are considered apartments for this table.
[2]Based on the 1973 Annual Housing Survey. All regression coefficients are significant at 0.00001 level based upon t-value test with 46,790 deg. Freedom.
[3]Estimates of proportion of the housing inventory in multiunit structures differs from estimated relationship for living in an apartment because of exclusion of vacant units from the regression analysis and the use of the unweighted survey data.

Table 12.—**Regression analysis of the probability of living in a single-family house, an apartment, or a mobile home in 1975**

	Independent variable		
	Housing type		
	Mobile home	One-unit house	Apartments, two or more units
Dependent variable			
Constant	0.13936	0.36019	0.50044
Age class			
18-24	reference	reference	reference
25-29	-.02092	.12465	-.10373
30-34	-.01662	.23278	-.21616
35-44	-.02116	.28034	-.25918
45-54	-.03151	.35156	-.32005
55-64	-.02606	.40075	-.37475
65 and over	-.03705	.41486	-.37781
Household type			
Husband-wife	reference	reference	reference
Other family	-.02515	-.09988	.12503
Individuals	-.03577	-.19431	.23008
Region			
Northeast	-.02233	-.14367	.16600
North Central	-.01546	-.01061	.02607
South	reference	reference	reference
West	+.04929	-.05818	.00889
Metropolitan location			
In central cities	-.04850	-.14448	-.19298
In SMSA-outside city	reference	reference	reference
Non-SMSA	.03324	.03976	-.07300
Number of persons	-.01011	.04815	-.03803
Income	-0.1375	.03954	-.02579
Expenditures-to-income	-.00011	-.00176	.00188
Coefficient of determination, R^2	.09	.75	.50

Table 13.—**The distribution of housing types by age class within the home ownership and rental markets for 1960, 1970, and 1973-1975**

(Percent of households.)

Housing type	Age class							
	Under 25	25-29	30-34	35-44	45-54	55-64	65-74	75 and over
				OWNERS—1960				
Single family	0.80	0.92	0.93	0.94	0.93	0.91	0.88	0.88
Multifamily	.04	.03	.04	.04	.06	.08	.10	.10
Mobile home	.16	.05	.03	.01	.01	.01	.01	.02
				OWNERS—1970				
Single family	.70	.84	.92	.93	.92	.89	.86	.84
Multifamily	.05	.05	.03	.04	.06	.08	.10	.13
Mobile home	.26	.11	.05	.03	.02	.03	.04	.03
				OWNERS—1973				
Single family	.66	.84	.90	.94	.93	.88	.87	.86
Multifamily	.06	.05	.04	.03	.04	.07	.08	.10
Mobile home	.28	.11	.06	.03	.03	.04	.05	.04
				OWNERS—1974				
Single family	.59	.82	.89	.92	.91	.88	.85	.84
Multifamily	.04	.05	.03	.04	.04	.07	.09	.11
Mobile home	.37	.14	.08	.05	.04	.05	.06	.05
				OWNERS—1975				
Single family	.63	.83	.90	.92	.92	.88	.86	.84
Multifamily	.04	.05	.03	.04	.04	.07	.08	.11
Mobile home	.32	.12	.07	.04	.04	.05	.05	.05
				RENTALS—1960				
Single family	0.48	0.52	0.53	0.52	0.48	0.42	0.41	0.42
Multifamily	.51	.48	.47	.47	.52	.58	.59	.57
Mobile home	.01	.00	.00	.00	.00	.00	.01	.01
				RENTALS—1970				
Single family	.28	.37	.46	.44	.39	.33	.30	.29
Multifamily	.69	.61	.53	.55	.60	.66	.69	.70
Mobile home	.03	.02	.01	.01	.01	.01	.01	.01
				RENTALS—1973				
Single family	.31	.34	.39	.43	.38	.36	.31	.30
Multifamily	.66	.64	.59	.56	.60	.63	.68	.69
Mobile home	.03	.02	.02	.02	.02	.01	.01	.01
				RENTALS—1974				
Single family	.29	.33	.38	.41	.35	.38	.29	.29
Multifamily	.68	.65	.60	.57	.63	.61	.70	.69
Mobile home	.04	.02	.02	.02	.02	.01	.01	.02
				RENTALS—1975				
Single family	.28	.31	.36	.41	.37	.35	.27	.27
Multifamily	.69	.66	.61	.57	.61	.64	.71	.72
Mobile home	.03	.02	.02	.02	.01	.01	.01	.01

Source: U.S. Bureau of the Census: *One in 1,000 Public Use Sample Tape* from the 1960 and 1970 Census; Public Use Sample Tape from the 1973-1975 Annual Housing Surveys.

Table 14.–**Home ownership by housing type and age class for 1960, 1970, and 1973 to 1975**

(Percent of all households.)

House type	Age class								
	Under 25	25-29	30-34	35-44	45-54	55-64	65-74	75 and over	All households
				OWNERS–1960					
Single family	17.5	35.7	53.0	62.6	63.2	61.6	61.2	60.8	56.9
Multifamily	.9	1.3	2.4	2.8	4.1	5.2	7.0	7.1	3.9
Mobile home	3.5	1.9	1.6	.9	.9	1.0	1.0	1.1	1.2
Total	21.9	38.9	57.0	66.3	68.2	67.8	69.2	69.0	62.0
				OWNERS–1970					
Single family	14.4	35.2	53.7	64.4	67.7	63.7	59.1	55.6	56.1
Multifamily	1.0	2.0	2.0	2.7	4.0	5.5	6.9	8.7	4.1
Mobile home	5.3	4.4	2.9	1.9	1.8	2.3	2.0	2.3	2.7
Total	20.7	41.6	58.6	69.0	73.5	71.6	68.0	66.6	62.8
				OWNERS–1973					
Single family	14.6	36.4	54.8	66.8	71.2	67.4	62.1	57.4	57.9
Multifamily	1.4	2.2	2.2	2.5	3.4	5.5	6.1	6.6	3.6
Mobile home	6.1	5.0	3.5	2.1	2.2	3.3	3.6	2.4	3.2
Total	22.1	43.6	60.5	71.4	76.8	76.2	71.8	66.4	64.6
				OWNERS–1974					
Single family	13.3	35.0	54.6	65.5	69.7	67.3	61.0	55.9	56.5
Multifamily	.8	2.0	2.1	2.6	3.4	5.2	6.2	7.4	3.7
Mobile home	8.4	5.9	4.9	3.5	3.2	3.8	4.4	3.6	4.4
	22.5	42.9	61.6	71.6	76.3	76.3	71.6	66.9	64.6
				OWNERS–1975					
Single family	12.9	35.8	56.0	65.7	70.7	68.1	61.6	56.4	57.0
Multifamily	.9	2.1	1.9	2.6	3.5	5.2	6.4	7.8	3.8
Mobile home	6.6	5.3	4.3	3.2	3.0	3.6	3.9	3.1	3.9
	20.4	43.2	62.3	71.5	77.2	76.9	71.9	67.3	64.7

Source: U.S. Bureau of the Census: One in 1,000 Public Use Sample Tapes from 1960 and 1970 Census; Public Use Sample Tape from 1973-1975 Annual Housing Surveys.

Table 15.—**Renter-occupied housing by type of unit and age class for 1960, 1970, and 1973 to 1975**

(Percent of all households.)

House type	Age class								
	Under 25	25-29	30-34	35-44	45-54	55-64	65-74	75 and over	All households
				RENTERS—1960					
Single family	37.4	31.7	22.8	17.7	15.3	13.4	12.5	13.1	18.3
Multifamily	39.6	29.1	20.0	16.0	16.4	18.7	18.0	17.7	19.2
Mobile home	1.0	.3	.1	.1	.1	.1	.2	.2	.5
Total	78.0	61.1	42.9	33.8	31.8	31.2	30.7	31.0	38.0
				RENTERS—1970					
Single family	22.4	21.7	19.0	13.6	10.3	9.5	9.6	9.8	13.4
Multifamily	54.4	35.8	21.9	17.0	16.0	18.7	22.1	23.3	23.2
Mobile home	2.4	.9	.5	.3	.2	.2	.3	.3	.5
Total	79.2	58.4	41.4	30.9	26.5	28.4	32.0	33.4	37.1
				RENTERS—1973					
Single family	24.2	18.9	15.3	12.2	8.9	8.7	8.8	9.9	12.6
Multifamily	51.0	36.3	23.4	15.9	13.9	14.9	19.6	23.3	22.2
Mobile home	2.6	1.1	.7	.5	.4	.2	.3	.4	.6
Total	78.8	56.3	39.4	28.6	23.2	23.8	28.7	33.6	35.4
				RENTERS—1974					
Single family	22.2	18.6	14.5	11.8	8.3	8.9	8.2	9.7	12.0
Multifamily	52.4	37.3	23.2	16.1	14.9	14.5	19.9	22.9	22.7
Mobile home	3.0	1.3	.7	.5	.4	.3	.3	.5	.8
Total	77.6	57.2	38.4	28.4	23.6	23.7	28.4	33.1	35.5
				RENTERS—1975					
Single family	22.2	17.9	13.9	11.7	8.4	8.0	7.7	8.8	12.3
Multifamily	54.8	37.9	23.1	16.3	14.1	14.6	20.1	23.7	25.6
Mobile home	2.6	1.3	.9	.5	.3	.3	.3	.3	.8
Total	79.6	57.1	37.9	26.5	22.8	22.9	28.1	32.8	38.7

Source: U.S. Bureau of the Census: One in 1,000 Public Use Sample Tapes from 1960 and 1970 Census; Public Use Sample Tape from 1973-1975 Annual Housing Surveys.

Table 16.—**The distribution of the housing inventory by type of unit for the United States and regions for 1940, 1950, 1960, 1970, and 1973 to 1975**

Year	Housing type	Region				
		Northeast	North Central	South	West	United States
		Pct	Pct	Pct	Pct	Pct
1940	Single family	51.7	71.8	85.4	77.6	71.2
1950	Single family	51.9	70.3	80.9	75.6	68.5
1960	Single family	57.8	77.4	86.2	78.6	74.1
1970	Single family	54.2	71.9	77.7	70.0	69.1
1973	Single family	55.3	71.2	75.7	66.7	68.1
1974	Single family	55.4	71.3	74.0	66.1	67.6
1975	Single family	55.5	71.3	74.2	66.8	67.8
1940	Mobile home	.2	.4	.4	1.2	.4
1950	Mobile home	.2	.8	.6	1.6	.7
1960	Mobile home	.7	1.3	1.7	2.7	1.3
1970	Mobile home	1.5	2.7	4.2	3.9	3.1
1973	Mobile home	2.1	3.6	6.2	5.1	4.4
1974	Mobile home	2.2	3.9	7.0	6.1	4.9
1975	Mobile home	1.9	3.5	5.9	5.6	4.3
1940	Multifamily	48.1	27.8	14.2	20.2	28.4
1950	Multifamily	48.9	28.9	18.5	22.8	29.7
1960	Multifamily	41.5	21.3	12.5	18.8	23.7
1970	Multifamily	44.3	25.4	18.1	26.2	27.8
1973	Multifamily	42.6	25.3	18.1	28.2	27.5
1974	Multifamily	42.4	24.8	19.0	27.8	27.5
1975	Multifamily	42.6	25.2	19.8	27.6	27.8

Source: U.S. Department of Commerce, Bureau of the Census. 1940, 1950, and 1960 Census of Housing; 1973-1975 Annual Housing Surveys.

Table 17.—**Percentage of households living in multiunit houses**

Year	Actual	Estimates assuming constant 1973 occupancy rates	1973 regression model[1]
1960	23.7		24.7
1970	27.5	27.4	26.1
1973	26.8	27.9	26.8
1974	26.4	28.0	27.1
1975	26.8	28.2	27.6
1980		28.2	27.8
1990		27.5	27.5
2000		27.0	26.2

[1]Adjusted so regression model equals actual occupancy in 1973.

Table 18.—**Regression coefficients for single-family housing occupancy by age class, 1976**

Age class	Constant	HH size	Income	Expenditure to income	Family type			Region				Metropolitan location			R^2
					Husband-wife (ref)	Other family	Primary individuals	Northeast	North Central	South (ref)	West	Central city	In SMSA outside city (ref)	Non-SMSA	
18-24	-0.01697	0.08370	0.14958	0.00126	–	-0.02812	-0.07216	-0.11895	-0.01692	–	0.02599	-0.05902	–	0.15065	0.4236
25-29	.04411	.09434	.15815	.00432	–	-.20047	-.16018	-.16139	-.00234	–	.03515	-.10059	–	.06624	.6349
30-34	.30144	.05166	.14073	.00399	–	-.15710	-.33258	-.10276	.01809	–	-.02927	-.14151	–	.07150	.7749
35-44	.60132	.03200	.07047	.00196	–	-.13114	-.33176	-.15840	.01083	–	-.01112	-.17321	–	.00195	.8256
45-54	.77674	.03082	.04024	-.00142	–	-.11251	-.27741	-.11190	-.02598	–	-.06169	-.13769	–	.01856	.8419
55-64	.85676	.03807	.01413	-.00420	–	-.02044	-.16537	-.12712	-.00508	–	-.12462	-.12846	–	.04415	.8007
65 and older	.84620	.06383	-.01655	-.00561	–	-.03498	-.11040	-.14826	-.01098	–	-.18112	-.14861	–	.08470	.7179

Table 19.—**Regression coefficients for apartments (two or more units) occupancy by age group, 1976**

Age class	Constant	HH size	Income	Expenditure to income	Family type			Region				Metropolitan location			R^2
					Husband-wife (ref)	Other family	Primary individuals	Northeast	North Central	South (ref)	West	Central city	In SMSA outside city (ref)	Non-SMSA	
18-24	0.81413	-0.07569	-0.13588	-0.00096	–	0.11224	0.15187	0.19711	0.04537	–	0.01447	0.12572	–	-0.19444	0.6712
25-29	.78197	-.08998	-.12614	-.00318	–	.22871	.19868	.21985	.05047	–	.00458	.13130	–	-.15011	.5830
30-34	.54061	-.04260	-.11142	-.00302	–	.17635	.38126	.12418	-.00016	–	-.00085	.18151	–	-.09741	.5125
35-44	.29135	-.03002	-.05062	-.00050	–	.13037	.32119	.17626	-.00207	–	-.02099	.20676	–	-.02980	.4432
45-54	.13071	-.01967	-.03347	.00152	–	.10354	.28130	.13468	.03630	–	.02074	.17290	–	-.04228	.3854
55-64	.02186	-.02329	-.00165	.00420	–	.05413	.19708	.14251	.01899	–	.02532	.18741	–	-.03226	.3777
65 and older	.01267	.04600	.02763	.00546	–	.04682	.15549	.17376	.02105	–	.02968	.24498	–	-.04317	.4687

Table 20.—**Regression coefficients for mobile home occupancy by age class, 1976**

Age class	Constant	HH size	Income	Expenditure to income	Family type			Region				Metropolitan location			R^2
					Husband-wife (ref)	Other family	Primary individuals	North-east	North Central	South (ref)	West	Central city	In SMSA outside city (ref)	Non-SMSA	
18-24	0.20284	-0.00800	-0.01371	-0.00029	–	-0.08411	-0.07972	-0.07817	-0.02845	–	-0.04046	-.06670	–	0.04380	0.1432
25-29	.17393	-.00436	-.03202	-.00114	–	-.02824	-.03849	-.05846	-.04813	–	-.03974	-.03071	–	.08387	.1161
30-34	.15795	-.00906	-.02931	-.00097	–	-.01926	-.04868	-.02142	-.01793	–	.03012	-.04000	–	.02591	.0774
35-44	.10733	-.00198	-.01986	-.00146	–	.00077	.01057	-.01786	-.00875	–	.03210	-.03354	–	.02786	.0700
45-54	.09256	-.01115	-.00677	-.00010	–	.00897	-.00389	-.02278	-.01032	–	.04094	-.03521	–	.02372	.0758
55-64	.12138	-.01478	-.01248	.000001	–	-.03369	-.03171	-.01539	-.01391	–	.09929	-.05895	–	-.01190	.1165
65 and older	.14113	-.01783	-.01108	.00015	–	-.01184	-.04509	-.02550	-.01007	–	.15144	-.09636	–	-.04153	.1676

Table 21.—**Mean values of variables used in housing occupancy regression analysis by age group, 1976**

Age	HH size	Housing type (proportion of housing units)			Income	Expenditure to income	Family type (proportion of households)			Region (proportion of households)				Metropolitan location (proportion of households)		
		Apartment	Mobile home	Single family housing units			Husband-wife	Other family	Primary individual	North-east	North Central	South (ref)	West	Central city	In SMSA outside city (ref)[1]	Non-SMSA
	No.				**$10,000**	**Pct**										
18-24	2.29353	0.56739	0.09368	0.33891	0.96716	28.5445	0.53890	0.13088	0.33022	0.16272	0.28235	0.34278	0.21215	0.27377	0.42810	0.29813
25-29	2.8211	.40737	.62038	.53057	1.35833	23.9026	.66152	.12887	.20961	.20352	.25763	.30002	.20715	.27272	.46788	.25940
30-34	3.5296	.26679	.04159	.69166	1.60125	22.4540	.73423	.13479	.13098	.21544	.24183	.33004	.21269	.24440	.49668	.25892
35-54	4.1209	.19628	.03117	.77255	1.78296	20.8807	.74491	.14823	.10686	.22032	.25529	.31191	.21248	.23579	.50966	.25455
45-54	3.3756	.16456	.03596	.77953	1.8669	18.0335	.73017	.10673	.16310	.23380	.25727	.31372	.19521	.23889	.48982	.27129
55-64	2.3967	.18480	.04331	.77186	1.5105	18.8421	.64980	.07554	.27466	.25683	.24199	.29870	.20248	.25668	.44931	.29401
65 and older	1.7344	.26851	.05623	.67526	.80056	24.9018	.43922	.07290	.48788	.23015	.26611	.31857	.18517	.27276	.38398	.34326

[1]Includes small SMSA's.

Table 22.—**State cross-sectional regression model of housing occupancy, with estimated coefficients, semilog model, 1970**

Dependent variable	Constant	Median house value	Median rent	Average mobile home value	Median household size	Metropolitan location household type				Personal income	R
						Central cities	In SMSA outside central city	Husband wife	Other family		
Single family: $\ln(\frac{S_{sf}}{1 - S_{sf}})$	-0.495860	-0.000093	0.001524	0.000179	-0.366215	-0.081027	0.800511	5.516836	0.325428	-0.000248	0.7334
Multiunit: $\ln(\frac{S_{mu}}{1 - S_{mu}})$	.560350	.000095	-.003958	-.000242	.495225	.207994	-.525552	-6.325805	-1.724540	.000346	.7156
Mobile home: $\ln(\frac{S_{mh}}{1 - S_{mh}})$	.198728	-.000058	.022376	.0003422	-.062354	-.494868	-1.143435	-3.553604	-2.428312	-.000648	.4430

Table 23.—**Cross-sectional SMSA regression model for housing-type occupancy, semilog model, 1975**

Dependent variable	Average expenditure			R
	Single family	Multifamily	Mobile home	
Single family: $\ln(\frac{S_1}{1 - S_1}) = 2.3539$	-10.10823 C_1[1]	+1.59471 C_2	-0.73405 C_3	0.30
Multifamily: $\ln(\frac{S_2}{1 - S_2}) = -2.45149$	+9.48423 C_1[1]	-.28986 C_2	-1.01449 C_3	.22
Mobile home: $\ln(\frac{S_3}{1 - S_3}) = 4.2401$	-1.58547 C_1	-.46384 C_2	+7.90064 C_3	.11

[1] *Significant at 0.01 level.*

Table 24.—**Elasticity of housing types relative to housing costs based upon 1970 state model and 1975 SMSA model**

Market share	Average housing expenditure		
	Single family	Multifamily	Mobile home
	SMSA MODEL		
Single family	-0.54	0.07	-0.03
Multifamily	1.15	-.03	-.08
Mobile home	-.26	-.06	.86
	Median house value	Median rent	Average depreciated mobile home value
	STATE MODEL		
Single family	-0.40	0.03	0.18
Multifamily	1.16	-.25	-.68
Mobile home	-.88	1.75	1.20

Excludes houses on more than 10 acres.

Excludes owned multifamily units.

This value is hypothetical based upon an average depreciated value derived from the age of the stock.

Table 25.—**Annual net replacement rates for conventional housing and all housing including mobile homes in the United States by regions for 1950-1956, 1960-1969, and 1970-1975**

Period	U.S.		Northeast		North Central		South		West	
	Conventional[1]	With mobile homes	Conventional	With mobile homes	Conventional	With mobile homes	Conventional	With mobile homes	Conventional	With mobile homes
	Pct									
1950-1956	0.46	–	0.27	–	0.33	–	0.76	–	0.49	–
1957-1959	.85	–	.48	–	.48	–	1.27	–	1.03	–
1960-1969	.80	0.84	.55	0.57	.57	0.78	1.01	1.03	.92	1.02
1970-1975	.50	.69	.24	.31	.58	.74	.88	1.12	0	.13

[1]Conventional housing refers to all housing units other than mobile homes.

Source: 1950-1969—U.S. Department of Commerce, Bureau of the Census, U.S. Census of Housing 1960, Vol. IV, Component of Inventory Change, U.S. Census of Housing 1970, Vol. IV, Components of Inventory Change, 1973; 1970-1975 derived U.S. Bureau of Census, Current Housing Reports Series H-150-75A, Annual Housing Survey, 1975, 1977.

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Table 26 — **U.S. housing inventory by age of structure (year built) for 1940, 1950, 1960, 1970, and 1975 with estimates of annual disappearance**

(Thousands of units)

Census years	1970-1975	1965-1970	1960-1964	1950-1959	1940-1949	1930-1939	1920-1929	1910-1919	1900-1909	1900 or earlier
1975	11,212	9,831	8,060	13,600	7,974	← 26,877				← earlier
1970	—	8,874	8,082	14,499	8,786	← 27,458				
1960	—	—	—	16,046	8,640	6,512	← 21,121			
1950	—	—	—	—	5,175	5,898	8,894	← 20,264		
1940	—	—	—	—	—	5,528	8,515	6,445	6,117	10,720

PERCENT ANNUAL RATE OF DISAPPEARANCE[1]

1975-1970	—	-2.157	.055	1.240	1.848	←				
1970-1960	—	—	—	.964	.169	←				
1960-1950	—	—	—	—	.583	-1.041	←	2.728	.699	
1950-1940	—	—	—	—	—	.669	-.445	←	1.296	

[1] Negative rates indicate apparent net addition because of conversion or discrepancies in counts.

Source: U.S. Department of Commerce, Bureau of the Census, 1940, 1950, 1960, and 1970 Censuses of Housing; 1975 Annual Housing Surveys.

Appendix

This appendix contains a list of materials previously sent to ORNL related to this study.

Written communications:

October 1976

(1) Preliminary tables on individual household regression model by age of head made from 1960 and 1970 Census data.

October 1977

(2) Analysis of housing choice report.

November 1977

(3) Household formation model report.

Other materials:

October 1977

(1) Data deck of annual time-series variables for housing production by type of unit and related socioeconomic variables for 1947 to 1976.

(2) Computer printout of annual time-series regression equations to determine market share of housing production for single-family, multifamily, and mobile home housing units.

(3) Computer printout of alternative individual regression models of housing choice based on 1975 annual housing survey data.

(4) Computer printout of illustrative projections of housing-type requirements based upon regression equations of housing choice.

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U.S. Forest Products Laboratory.

Modeling longrun housing demand by type of unit and region, by Thomas C. Marcin. Madison, Wis. 1978.

46 p. (Research Paper FPL 308, For. Prod. Lab., For. Serv., U.S. Dept. Agr.)

Summarizes results of research to develop an improved model of longrun housing demand for prejecting future residential construction activity by type of unit and region. Specific submodels have been developed for household formations, type of housing unit occupied, and housing replacement.

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