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Consumer Expenditures
for Durable Goods

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This paper presents the findings of research on the demand for consumer durables, using cross-sectional data from the Survey of Consumer Finances. The annual surveys, conducted by the Survey Research Center at the University of Michigan, of 1960, 1961, and 1962 contained a reinterview (panel) sample of 1059 households.[1] The data are analyzed by the Sonquist-Morgan Automatic Interaction Detector (AID) program,[2] developed for the IBM 7090 computer. Essentially, this is a method for searching a large body of data for important relationships. It differs from most research procedures in that it seeks out the most important variables without having them prespecified. The program is discussed in section I.

Section II presents an application of the AID program to consumer investment decisions. The program is used to examine the characteristics that distinguished households who subsequently buy a specific durable from those that do not. The individual durables studied are television sets, refrigerators, washers, furniture, and automobiles.

Since automobiles are the major component of consumer durable expenditure, the phenomenon of the two-car family has special implications for the industry and the national economy. In section III, the program is used to study multiple-car ownership.

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[1] The 1960–62 panel and its characteristics are discussed in R. Kosobud and J. Morgan, *Consumer Behavior of Individual Families over Two and Three Years,* Survey Research Center, 1964.

[2] John Sonquist and James Morgan, *The Detection of Interaction Effects,* Monograph No. 35, Survey Research Center, 1964.

I. The Method of Analysis

Regression and related techniques are often used to analyze cross-section data, but the diversity of individual consumer behavior and the complex intercorrelations and interactions preclude a straightforward linear regression. Cross tabulations often provide a better profile of consumer behavior, but still require the analyst to select the "control" variables in advance. As a practical matter, however, he rarely knows all the important variables, especially where complex interactions are involved. The Automatic Interaction Detector (AID) program provides an alternative by which the data can be scanned to identify the most important variables and their interactions.

The program is essentially a way of partitioning the total sample of observations by a sequence of dichotomies. At each stage the computer attempts to use the variables to divide the existing subsets. Each subset is partitioned by the variable yielding the maximum R^2. The procedure terminates when individual subsets are either sufficiently homogeneous or contain a minimum number of observations. Upon completion, the computer output specifies a "tree" of two-way splits, providing a picture of the relationship by defining a series of increasingly complex interactions.

At each step the program scans several variables, but selects only one of them. An important feature of the program is its ability to allow every variable the chance to become a predictor at each stage. In any split, some variables may be highly correlated with the partitioning variable, but not sufficiently powerful to make the split. A highly correlated variable at one stage may return to partition a group later in the tree. Information about the status of all variables is contained in the printed output of the program. In particular, the relative discriminating power of each variable is shown at every stage of the program, making it possible to compare the one ultimately chosen with all alternatives. This contributes to an understanding of why one variable appears rather than another, and how great the difference between them was. Any interpretation of the tree must be supported by an analysis of the splits that "almost" occurred.

If the program is allowed to run without constraint, it may split off a very small group. These splits must be recognized for their extreme variation, but disregarded in the final analysis.

Each variable appearing in the tree makes a contribution to the explanation of the dependent variable. Its relative strength is indicated by a "partial R^2." The total of all these "partial R^2's" is equal to the proportion of the total variation "explained" by the splits in the tree.

TABLE 1

List of Variables Used in Panel Analysis

Variables	Code Categories
Dependent[a]:	
Whether purchased TV	Purchased; did not purchase
Whether purchased refrigerator	Purchased; did not purchase
Whether purchased washer	Purchased; did not purchase
Whether purchased furniture	Purchased; did not purchase
Whether purchased automobile	Purchased; did not purchase
Independent:	
Better or worse off than year ago	Better; same; worse; uncertain
Expect to be better off year from now	Better; same; worse; uncertain
Size of place	Central cities; urban places; rural places
Age of head	18-24; 25-34; 35-44; 45-54; 55-64; 65-
Number of adults	0; 1; 2; 3; 4; 5; 6; 7; 8 or more
Number of children under 18	0; 1; 2; 3; 4; 5; 6; 7; 8 or more
Age of youngest child under 18	2-3; 3-4; 4-5; 5-6; 6-9; 9-14; 14-18
Age of oldest child under 18	2-3; 3-4; 4-5; 5-6; 6-9; 9-14; 14-18
Marital status	Married; single; widow; divorced; separated
Length of marriage	0-1; 2; 3; 4; 5-9; 10-20; over 20 years
Date residence established	Pre-1939; 1940-49; 1950-54; 1955-56; 1957; 1958; 1959; 1960
Housing status	Owner; renter
Whether head employed now	Employed; unemployed; retired
Number of weeks head worked	13 or less; 14-26; 27-39; 40-47; 48-49; 50-52
Number of weeks wife worked	13 or less; 14-26; 27-39; 40-47; 48-49; 50-52
Wife's employment status	Worked 2 years ago; worked last year
AIDPR/disposable income	Percentage scale
Disposable income	Dollar scale
Percentage of income received by wife	Percentage scale
Remaining instalment debt on A/R	Dollar scale
Remaining instalment debt on cars	Dollar scale
Remaining instalment debt on durables	Dollar scale
Remaining instalment debt on other	Dollar scale
Whether expect to buy TV	Definitely; probably; undecided
Whether expect to buy refrigerator	Definitely; probably; undecided
Whether expect to buy washer	Definitely; probably; undecided
Whether expect to buy furniture	Definitely; probably; undecided
Whether expect to buy automobile	Definitely; probably; undecided

[a] These variables are part of the independent variables unless they are the dependent variable in a particular run.

Consumer Assets

FIGURE 1

Factors Related to Purchase of a Television Set
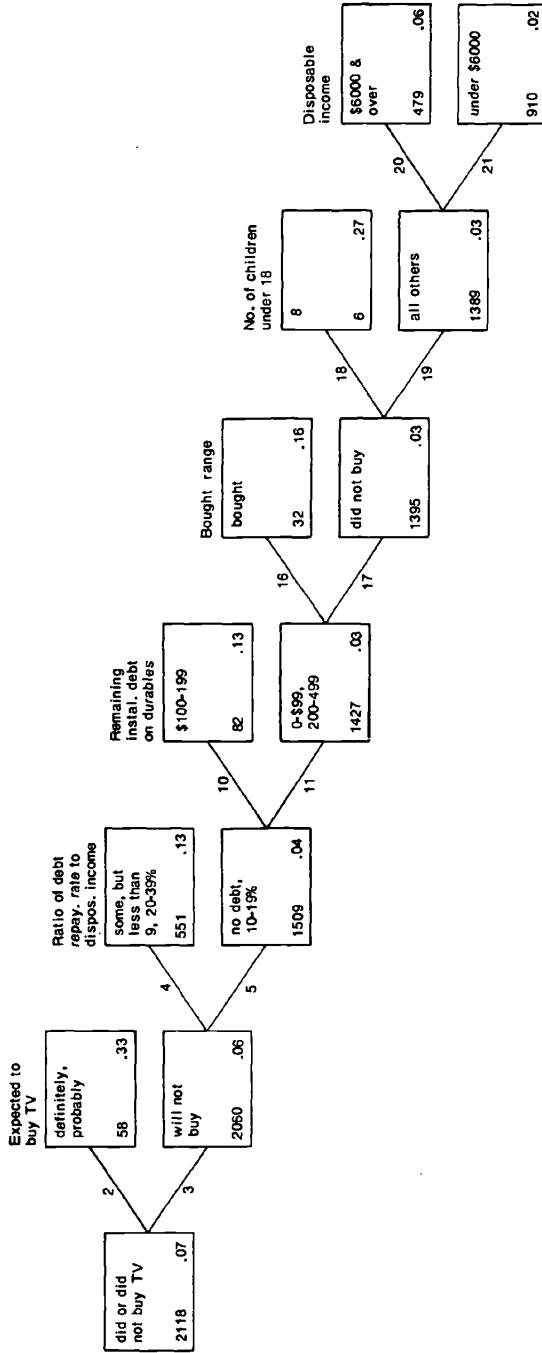
Variation explained: 15 per cent.
Source: 1960-62 Survey of Consumer Finances. N-1059.

II. Purchase of Durables

The AID program is used in this section to study the purchase of con-
sumer durables. The Survey of Consumer Finances, conducted by the
Survey Research Center, contains information on the purchase of tele-
vision sets, refrigerators, washers, furniture, and automobiles, together
with extensive attitudinal, demographic, and economic data. The
1960–62 Surveys contained a panel of 1059 households, each of which
was interviewed three times. Information is available describing the
position of the family at each interview, and its purchase behavior dur-
ing the past year. For each durable, the attempt was made to relate the
characteristics of the family at one interview to its subsequent purchas-
ing behavior as determined from the following interview. Since three
interviews were conducted, two observations were available for each
household. The complete data set used in this analysis consists of 2118
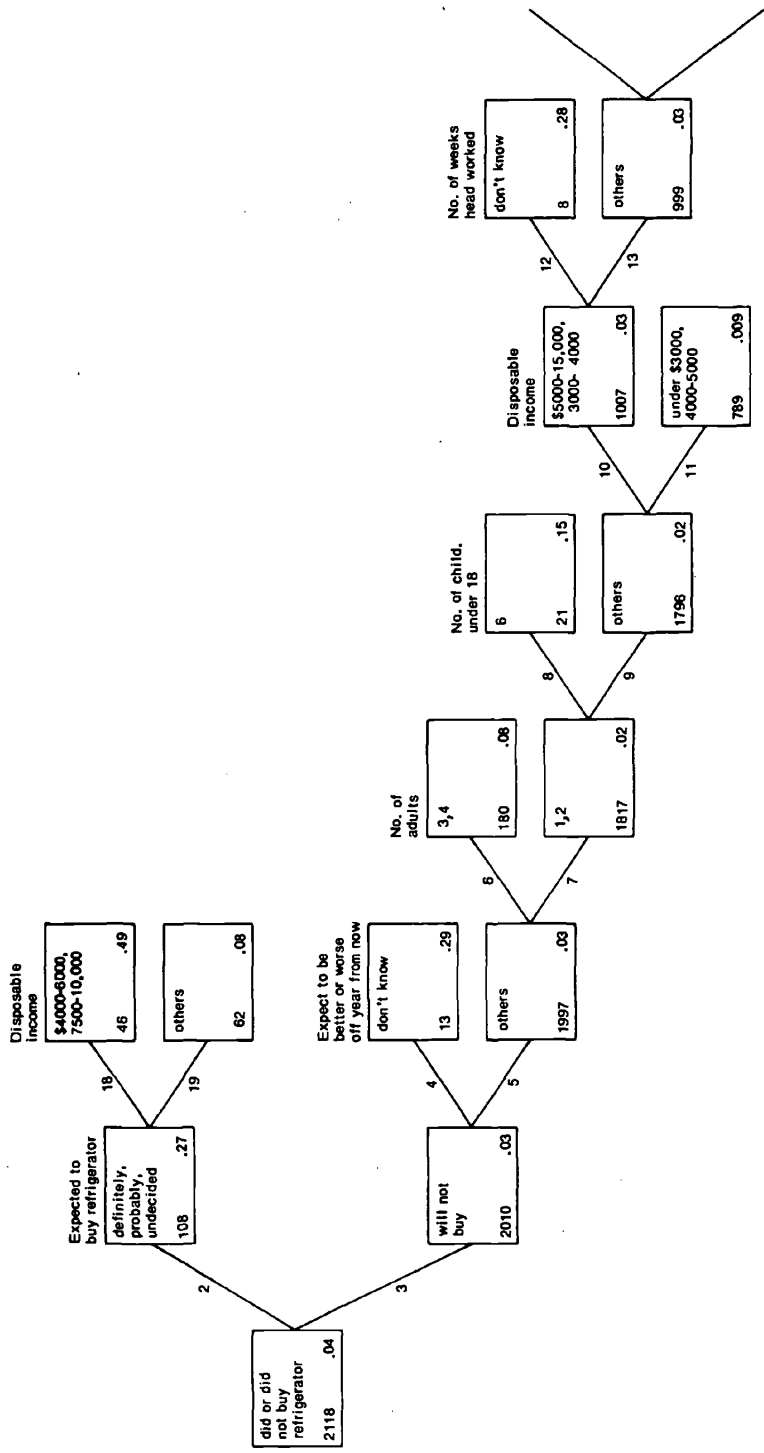observations.

Specifically, the data were arranged in the following way. A particular
durable was selected and the value 1 assigned to a household if it pur-
chased the durable between 1960 and 1961. Otherwise, the household
was assigned the value 0. Corresponding data for the independent vari-
ables were compiled as of January 1960. This yields 1059 households,
each of which is known either to have purchased or not to have pur-
chased the durable between January 1960 and January 1961. All data
for these households were obtained at most one year prior to the actual
purchase.

The procedure was repeated for the same households, but using
purchase behavior of the period 1961–62. The data for the independent
variables were compiled as of January 1961, yielding an additional 1059
observations. All data for these households are, likewise, no later than
one year prior to the actual purchase behavior.

Combining the two groups of data produces the data set of 2118 obser-
vations. The several variables used in the study are listed in Table 1.

The relationship of the independent variables to the purchase of a
television set is shown in Figure 1. The first box shows that, of the 2118
interviews, 7 per cent were followed by the purchase of a television set.
The first branch of the tree shows that "plans to buy a TV" is the most
important information distinguishing purchasers from nonpurchasers.
Among households with expressed intentions to buy, 33 per cent
bought, compared with only 6 per cent of those who did not plan to buy.
Although two-thirds of families "planning to buy" actually failed to do
so, the group was too small to be split again.

FIGURE 2

Factors Related to Purchase of Refrigerator

Disposable income
$4000-6000, 7500-10,000   46   .49
others   62   .08

Expected to buy refrigerator
definitely, probably, undecided   108   .27

did or did not buy refrigerator   2118   .04

Expect to be better or worse off year from now
don't know   13   .29
others   1997   .03

will not buy   2010   .03

No. of adults
3,4   180   .08
1,2   1817   .02

No. of child. under 18
6   21   .15
others   1796   .02

Disposable income
$5000-15,000, 3000- 4000   1007   .03
under $3000, 4000-5000   789   .009

No. of weeks head worked
don't know   8   .28
others   999   .03

Variation explained: 23 per cent.
Source: 1960-62 Survey of Consumer Finances. N-1059.

FIGURE 2 (concluded)
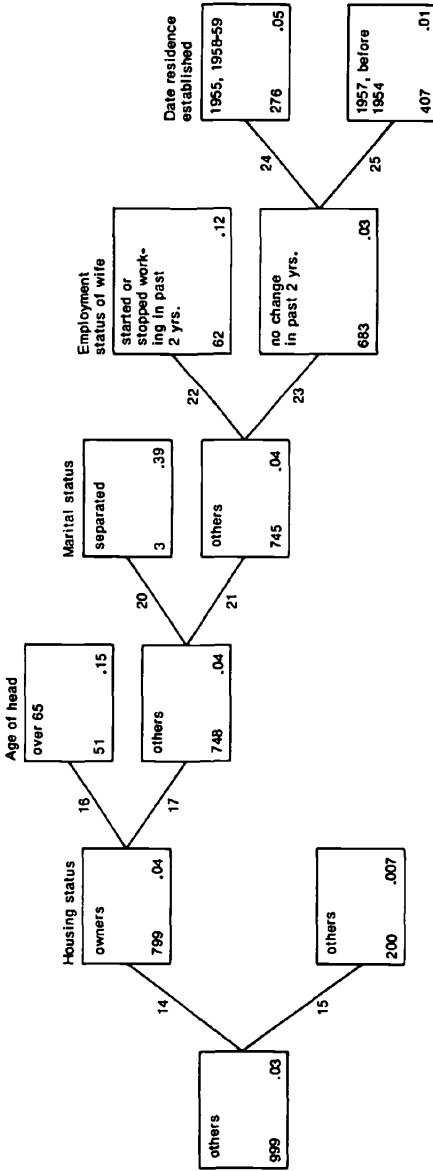
The next branch of the tree shows the importance of the annual repayment rate of consumer debt in distinguishing purchasers from non-purchasers.[3] Among households expressing no intention to buy, a large number of purchases (13 per cent) was made by households whose debt repayment rate as a percentage of income was either very low or very high. Fewer purchases are found among households with a moderate debt repayment to income ratio. Among the latter, families with moderate amounts of instalment debt bought television sets.

The final branches of the tree show the influence of "buying a range," the "number of children under 18," and "disposable income." Neither the purchase of a range nor the number of children under 18 provide useful information. The number of observations in these two splits is thirty-two for the former, and six for the latter. After taking account of all the other influences, however, disposable income still produces a difference in behavior.

Figure 2 displays the AID tree purchases of a refrigerator. Forty-nine per cent of the households planning to buy, and having income in the $4,000–$6,000 and $7,500–$10,000 range, actually bought a refrigerator. The lengthy series of splits on the bottom of the tree shows that extreme variability, arising for a number of reasons, will produce many small partitions. An interpretation must be selective. Splits 7, 10, 14, and 24 highlight the characteristics of households with no prior intentions of buying a refrigerator. Households of one or two adults (split 7), with middle to high income (split 10), who are homeowners (split 14), and recently established (split 24), are more likely to buy refrigerators than households without these attributes. Results for washers, furniture, and automobiles are similar and are shown in Figures 3, 4, and 5.

The purchasing behavior shown by the five trees exhibits a number of important common elements. In every case, expressed purchase intentions are the first criterion for identifying eventual buyers. Nevertheless, less than half of those households planning to buy will carry out their intentions. Other characteristics separate buyers from nonbuyers.[4] These usually include debt position and disposable income. In no case did the two general attitudinal variables ("better off than a year ago," "expect

[3] George Katona, *The Powerful Consumer*, New York, 1960, pp. 186 ff.

[4] Buying intentions and their fulfillment are discussed in *1962 Survey of Consumer Finances*, Survey Research Center, 1963, Ch. 8.

FIGURE 5

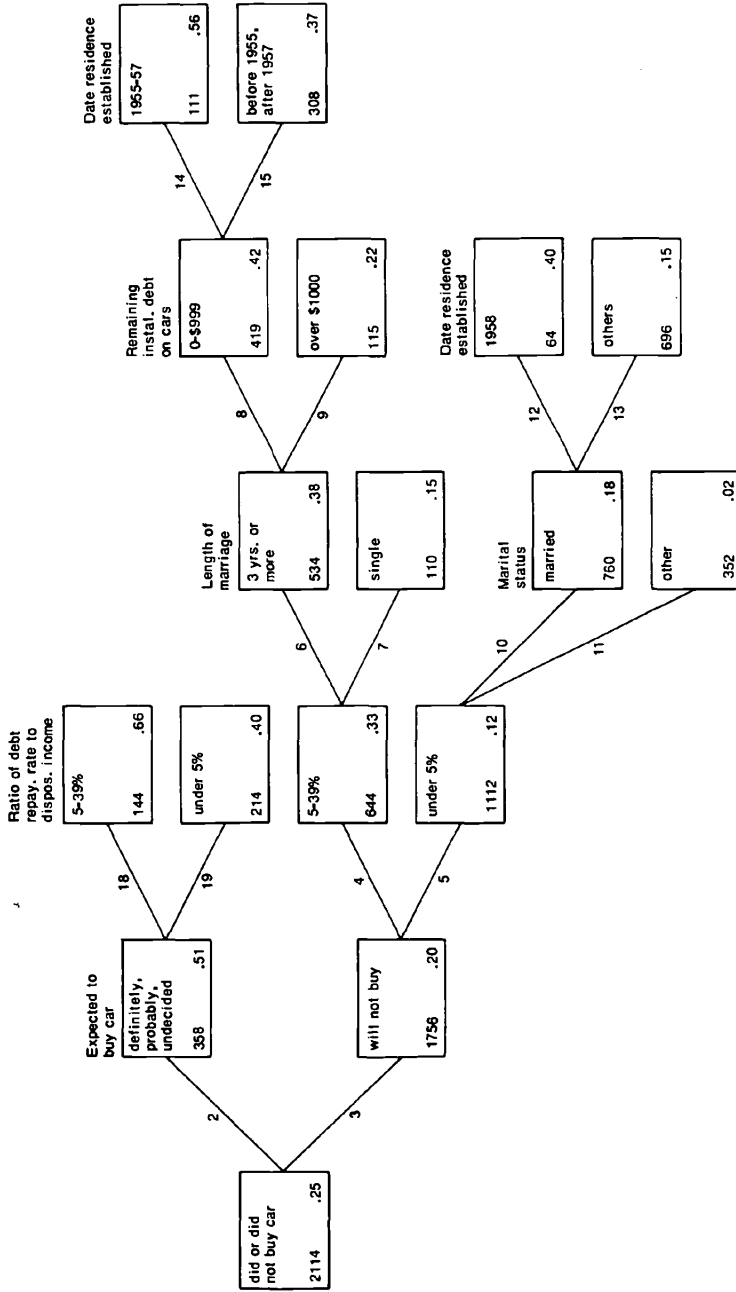*Factors Related to Purchase of Washer*
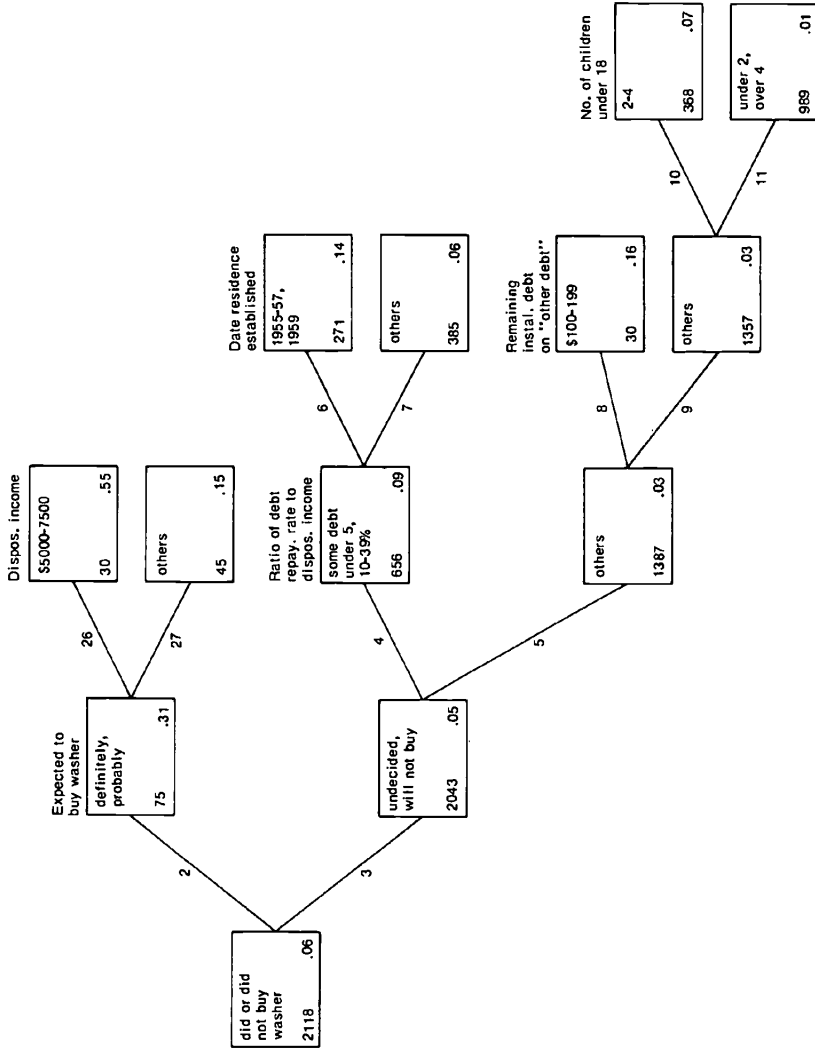
Variation explained: 15 per cent.
Source: 1960-62 Survey of Consumer Finances. N-1059.

FIGURE 4

Factors Related to Purchase of Furniture
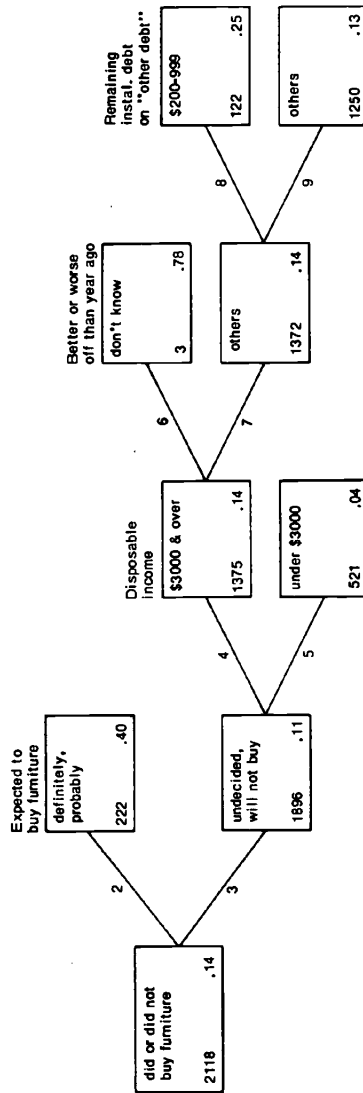
Variation explained: 16 per cent.
Source: 1960-62 Survey of Consumer Finances. N-1059.

FIGURE 5

Factors Related to Purchase of Car

Variation explained: 28 per cent.
Source: 1960-62 Survey of Consumer Finances. N-1059.

TABLE 2

Multiple-Car Ownership Among All Spending Units[a]

| Year	Percentage of Spending Units Owning More Than One Car
1963	18.5
1962	18.5
1961	14.3
1960	14.4
1959	12.3
1958	11.8
1957	10.4
1956	9.6
1955	8.8
1954	7.6
1953	7.7

Source: *Survey of Consumer Finances.*

[a] A spending unit is defined as all related persons living together who pool their incomes. Husband, wife, and children under 18 living at home are members of the same spending unit.

to be better off a year from now") contribute to an understanding of the specific purchase behavior.[5]

The possible complementarity or substitutability of durable purchases was studied by including among the independent variables explaining the purchase behavior with regard to any one good the observed purchase behavior with regard to each of the others. For example, in attempting to distinguish buyers of television sets from nonbuyers, the AID program considered whether the household bought, say, an automobile during the same period. If purchases of automobiles and tele-

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[5] There is a considerable literature on the role of "buying intentions," "attitudes," and consumer demand. Substantive issues are represented, in part, by the following publications: J. Tobin, "On the Predictive Value of Consumer Intentions and Attitudes," *Review of Economics and Statistics,* February 1959, pp. 1–11; Eva Mueller, "Consumer Attitudes: Their Influence and Forecasting Value," in *The Quality and Economic Significance of Anticipations Data,* Princeton for National Bureau of Economic Research, 1960, pp. 149–174; Eva Mueller, "Ten Years of Attitude Surveys: Their Forecasting Record," *Journal of the American Statistical Association,* December 1963, pp. 899–917.

FIGURE 6

Percentage of Spending Units Owning More Than One Car
and New U.S. Passenger Car Registrations, 1953-63
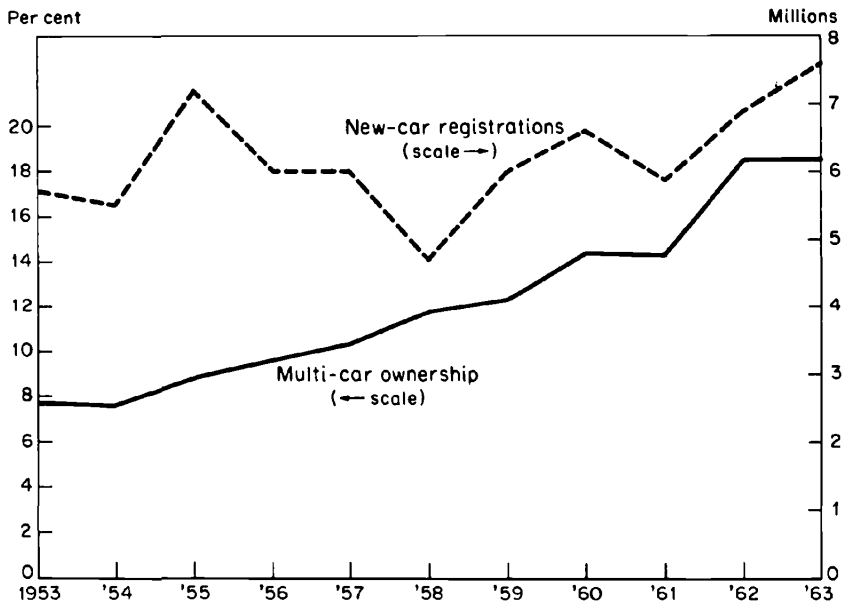
Source: *Ward's Automotive Yearbook;* Survey of Consumer Finances.
Note: A spending unit consists of all related persons living together who pool their incomes.

vision sets are complementary, we should expect known purchases of one to be frequently accompanied by purchase of the other. If the two purchases are substitutes, known purchase of one should be frequently accompanied by failure to purchase the other. In either case, known purchase of the one good should show up as a discriminator. The general failure to do so suggests that the purchases are not generally related in either fashion.

The foregoing analysis highlights the vast complexity of consumer behavior. If we imagine the trees to be employed to predict the behavior of families, it is clear that, regardless of our information, the best bet is that any given family will *not* purchase the durable in question. The rare exceptions are those like the subsample of families who both expect to purchase a washer and whose income is in the $5,000–$7,500 bracket. Since 55 per cent of such families went on to buy a washer, the odds

TABLE 3

Variable List Used in 1957 and 1962-63
Multiple-Ownership Study

| Variables	Code Categories
Dependent:	
Whether family owns more than one car	Multiple owner; not multiple owner
Independent:	
Age of head	18-24; 25-34; 35-44; 45-54; 55-64; 65-
Number of children under 18	1; 2; 3; 4; 5; 6; 7; 8 or more
Number of adults	1; 2; 3; 4; 5; 6; 7; 8 or more
Age of the youngest child	Under 2; 2-3; 3-4; 4-5; 5-6; 6-9; 9-14; 14-18
Age of the oldest child	Under 2; 2-3; 3-4; 4-5; 5-6; 6-9; 9-14; 14-18
Number of dependents not living in	0; 1; 2; 3 or more
Marital status	Married; not married
Home owner status	Owner; renter
Head self-employed or not	Self-employed; works for someone else
Disposable income	Dollar scale
Percentage income received by wife	Percentage scale
Place of residence	Central cities; urban; rural

of identifying a buyer among them are slightly better than even. The real power of the method lies in its ability to help identify the complex of factors associated with consumer behavior, even though their combined influence is small compared with the total of other things.

III. *Multiple-Car Ownership*

This section of the paper is an investigation of the phenomenon of the multiple-car-owning family.[6] As shown in Table 2, the percentage of families owning more than one car has more than doubled in the last decade, rising from 7.7 per cent in 1953 to 18.5 per cent in 1963.
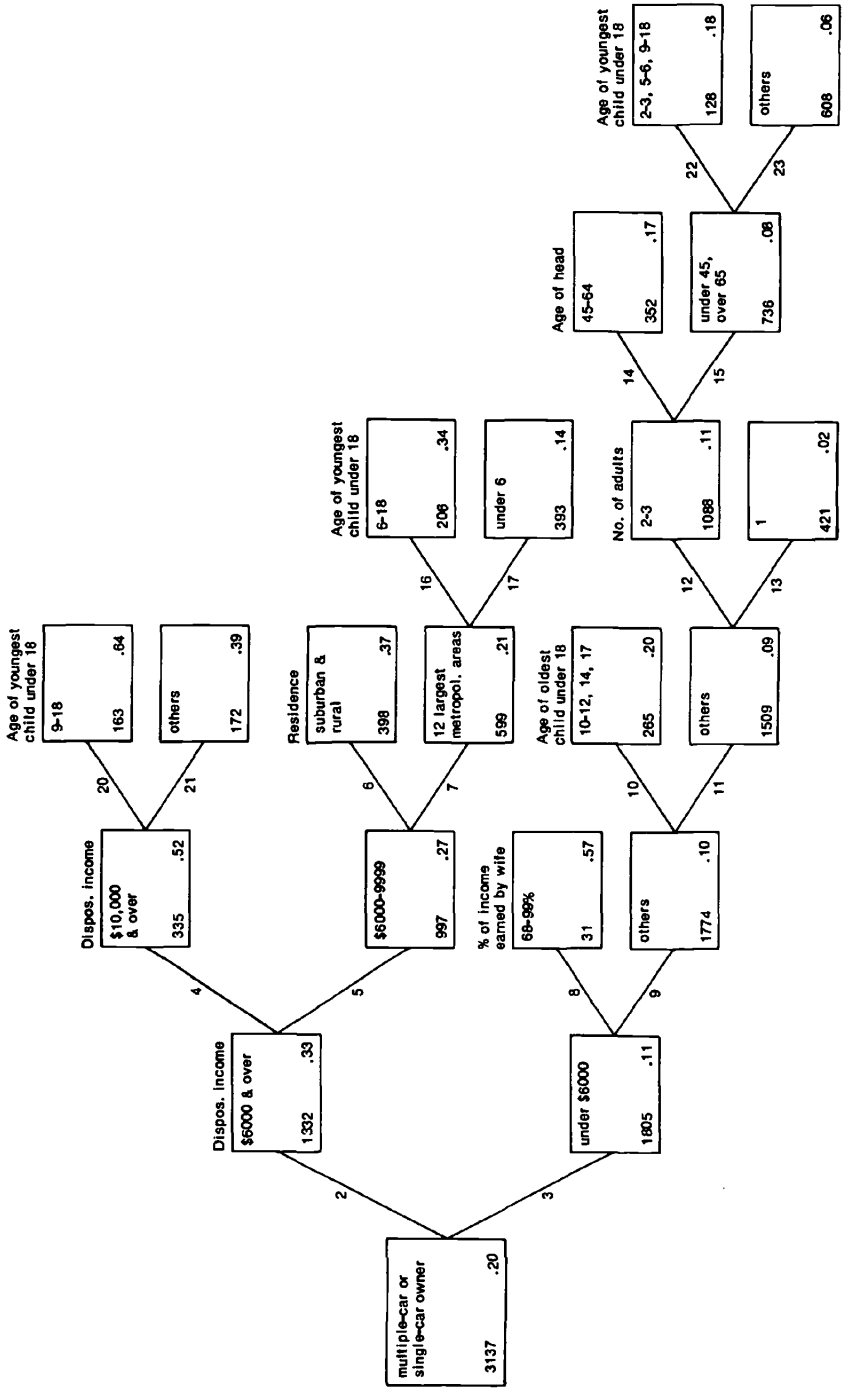
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[6] There has been survey work done on multiple-car ownership. See Mordechai Kreinin, "Analysis of Used Car Purchases," *Review of Economics and Statistics,* November 1959, pp. 419–425; Mordechai Kreinin and Charles Lininger, "Ownership and Purchases of New Cars in the United States," *International Economic Review,* September 1963, pp. 310–324; John Lansing and Nancy Barth, *Residential Location and Urban Mobility: A Multivariate Analysis,* Survey Research Center, December 1964. Also, see the annual issues of the *Survey of Consumer Finances,* Survey Research Center.

FIGURE 7
Cross-Sectional Characteristics of Multiple-Car Ownership, 1957
(nonowners excluded)
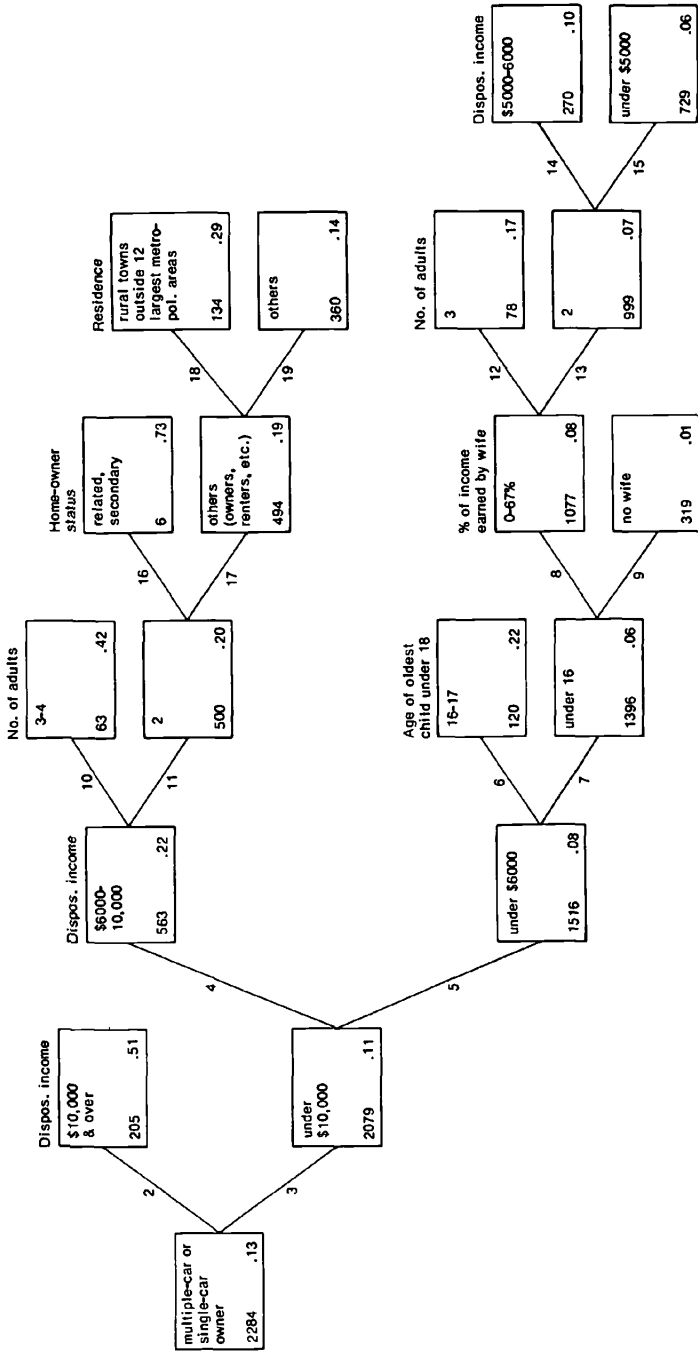
Variation explained: 27 per cent.
Source: 1957 Survey of Consumer Finances. N-3041.

FIGURE 8

Cross-Sectional Characteristics of Multiple-Car Ownership, 1962-63
(nonowners excluded)

multiple-car or single-car owner — 3137 — .20

2 Dispos. income $6000 & over — 1332 — .33

3 under $6000 — 1805 — .11

4 Dispos. income $10,000 & over — 335 — .52

5 $6000-9999 — 997 — .27

8 68-99% — 31 — .57

9 others — 1774 — .10

20 Age of youngest child under 18, 9-18 — 163 — .64

21 others — 172 — .39

6 Residence, suburban & rural — 398 — .37

7 12 largest metropol. areas — 599 — .21

% of income earned by wife

10 Age of oldest child under 18, 10-12, 14, 17 — 265 — .20

11 others — 1509 — .09

16 Age of youngest child under 18, 6-18 — 206 — .34

17 under 6 — 393 — .14

12 No. of adults, 2-3 — 1088 — .11

13 1 — 421 — .02

14 Age of head, 45-64 — 352 — .17

15 under 45, over 65 — 736 — .08

22 Age of youngest child under 18, 2-3, 5-6, 9-18 — 126 — .18

23 others — 608 — .06

Variation explained: 35 per cent.
Source: 1962-63 Survey of Consumer Finances. N (1962)-2117. N (1963)-2036.

Figure 6 shows the growth in multiple-car-owning families in relation to total new automobile demand.

AID runs were designed to study the cross-sectional characteristics of multiple-car-owning families. The data are from the 1957 Survey of Consumer Finances and the 1962 and 1963 Surveys of Consumer Finances. One AID run was made on the 1957 data. Another, with identical variables, was made on the 1962–63 data. The list of variables is given in Table 3. The runs were designed to study multiple owner-ship among car owners. Therefore, all households that did not own cars (i.e., nonowners) have been excluded from these two runs. The 1957 multiple ownership AID run is in Figure 7. The 1962–63 AID run is in Figure 8.

Both the 1957 and the 1962–63 trees separate households into three income groups: under $6,000, $6,000–$10,000, and $10,000 and over.

## TABLE 4

Proportion of Variation Explained by Each Variable in
1957 and 1962 - 63 Multiple-Ownership Study

(per cent)

	1957	1962-63
Age of head	2.1	1.1
Number of children under 18	1.1	4.0
Number of adults	1.5	2.4
Age of youngest child	2.3	5.1
Age of oldest child	2.2	3.4
Number of dependents not living in	.3	.7
Marital status	.3	—
Home-ownership status	.9	1.2
Head self-employed or not	.2	.3
Disposable income	13.0	10.6
Percentage of income received by wife	1.1	3.4
Place of residence	2.5	2.5
Total explained variation	27.3	34.6

Note: Detail may not add to total because of rounding.

[a] *TSS (I)/TSS (T)* = Percentage of "explained variation" attributable to each predictor (*I*).

FIGURE 9
Cross-Sectional Characteristics of Multiple-Car Ownership, 1957
(single-car owners excluded)
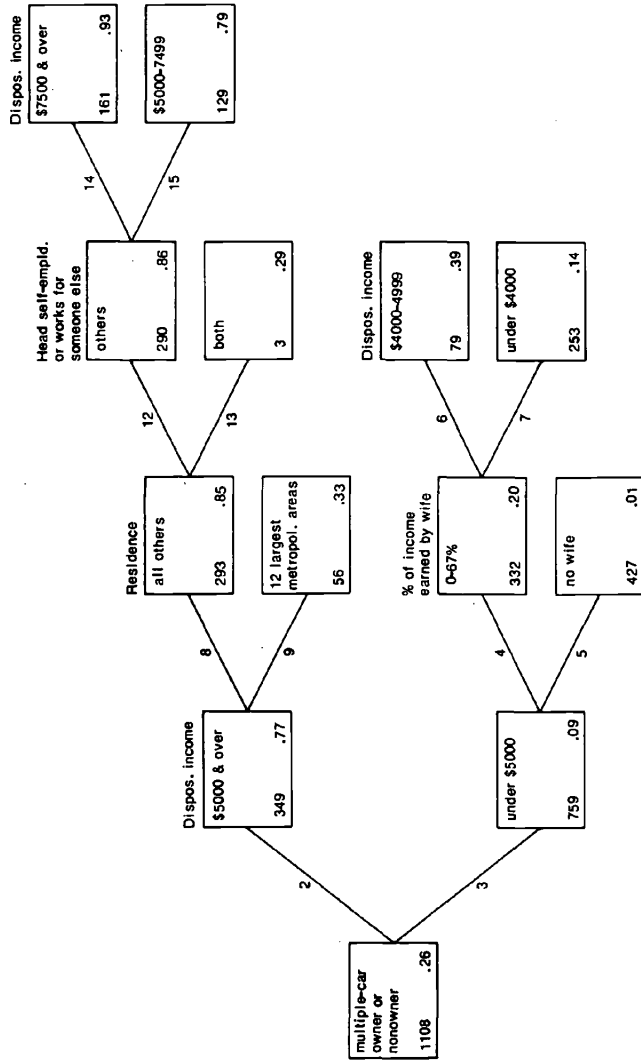
Variation explained: 71 per cent.
Source: 1957 Survey of Consumer Finances. N-3041.

FIGURE 10

Cross-Sectional Characteristics of Multiple-Car Ownership, 1962-63
(single-car owners excluded)
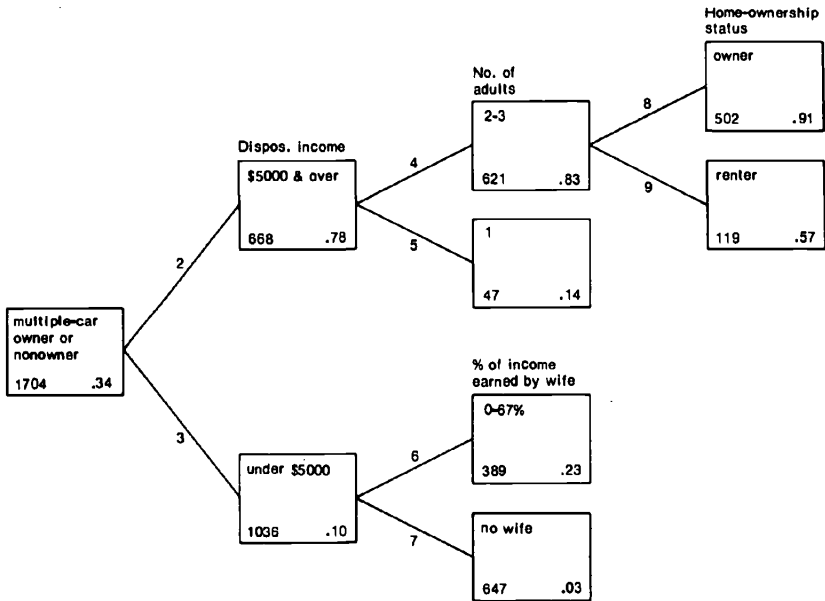
Variation explained: 74 per cent.
Source: 1962-63 Survey of Consumer Finances. N (1962)-2117. N (1963)-2036.

Multiple ownership among low-income families in 1957 is strongly influenced by older children and working wives. The impact of older children is the only major influence on low-income families in 1962–63.

Multiple-car ownership among middle-income families is explained by place of residence in both periods. Disregarding the minor splits in 1957, urban cities outside the twelve largest metropolitan areas and rural towns are the best discriminators. Middle-income households in the central cities are unlikely to be multiple owners. The pattern appears to be stable between 1957 and 1962–63.

Among upper-income groups, the age of older children is important in the 1962–63 tree. The upper-income group is not split in 1957.

The broad characteristics of the AID trees in these two periods are primarily captured by the division of multiple owners into three distinct income classes. In addition, the discriminating features of the three groups are somewhat different. Residence seems to influence middle-income families more than either of the two other income groups, but

the impact of children, especially in the teen-age groups, appears in various guises in all income groups. In the 1957 tree, only low-income multiple owners were characterized by children in certain age groups. By 1962–63, the influence of older children was diffused throughout the separate income groups. One way or another, the variables explaining multiple ownership in terms of family composition were more important in 1962–63.

Table 4 shows the partial R^2's, calculated from the two AID trees. These statistics show the relative strength of the variables. A comparison of the variables over time indicates their changing importance. While disposable income is seen to be the single most important factor, it declined in importance between 1957 and 1962–63. The combined set of variables measuring the number and ages of children under 18 rank second to income, and have risen in importance. The wife's contribution to household income has also become more important in distinguishing two-car owners.

As a supplement to the analysis of the distinction between single- and multiple-car owners, it is useful to explore the distinction between multiple-car owners and those households with no car at all. Again, AID trees were created for the two periods, 1957 and 1962–63, with the dependent variable being ownership of more than one car or of no cars. The variables and data were identical to those used in the runs described above. The resulting trees are in Figures 9 and 10.

The remarkable feature of these two trees is the amount of variation explained by the selected predictors: 71 per cent of the variation is explained in 1957, and 74 per cent in 1962–63, percentages that are extremely high for survey data.

Both trees show that approximately 20 per cent of low-income families with working wives are multiple-car owners. There is virtually no multiple-car ownership among low-income families when the wife does not work. Among middle- and upper-income groups, multiple ownership appears to be associated with residence outside the largest metropolitan areas in 1957, but with home ownership in 1962, 1963. Actually, the statistics from the print-out show that the 1957 sample "almost" split on home ownership, which was nearly as powerful as residence with which it is, in any case, highly correlated. Thus, the residence variable masked the influence of home ownership. In the 1962–63 sample, home ownership was sufficiently powerful to cause the split, with place of residence not even "close"; 91 per cent of home-owners in the middle- and upper-income group were multiple-car owners.

FIGURE 11

Factors Related to Becoming a Multiple-Car Owner
(nonowners excluded)
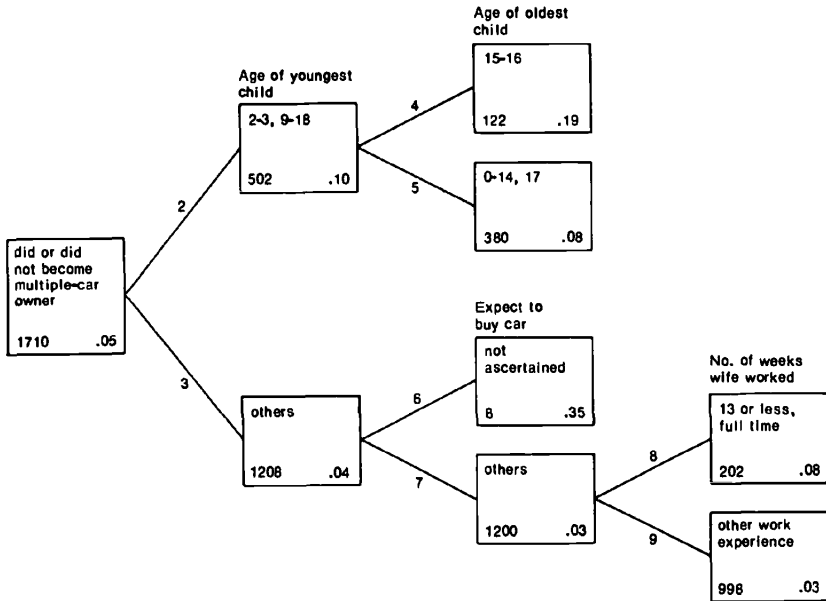

Variation explained: 18 per cent.
Source: 1960-62 Survey of Consumer Finances. N-1059.

The two preceding analyses represent attempts to distinguish the auto-
mobile ownership *status* of households. The reinterview character of the
1962–63 survey, however, further permits us to observe eighty-six
households in the act of becoming multiple-car owners. Although this is
a very small sample of occurrences, it reinforces some of the earlier
findings. The analysis is carried out by treating the acquisition of a
second car exactly as we did the purchase of a durable in section II
above, using the same independent variables. The resulting tree, shown
in Figure 11, differs from the other trees in this section in the failure
of income, place of residence, and home-ownership status to appear.
The only two important factors that seem to distinguish families about
to become multiple-car owners from others are the ages of the children
and the wife's work status.

This has important consequences for the future of the automobile
market. The sharp rise in the teen-age percentage of total population

experienced in recent years has been an important factor in the growing proportion of families who are multiple-car owners. This percentage has now almost reached its peak and is no longer making a strong contribution to the growth in multiple-car ownership. On the other hand, the proportion of married women who are employed will doubtless continue to rise for some time and will continue to exert an upward influence on the multiple-car component of total automobile demand. (See Figures 12 and 13.)

FIGURE 12

Percentage of U.S. Population in 10-19 Age Bracket, 1950-75
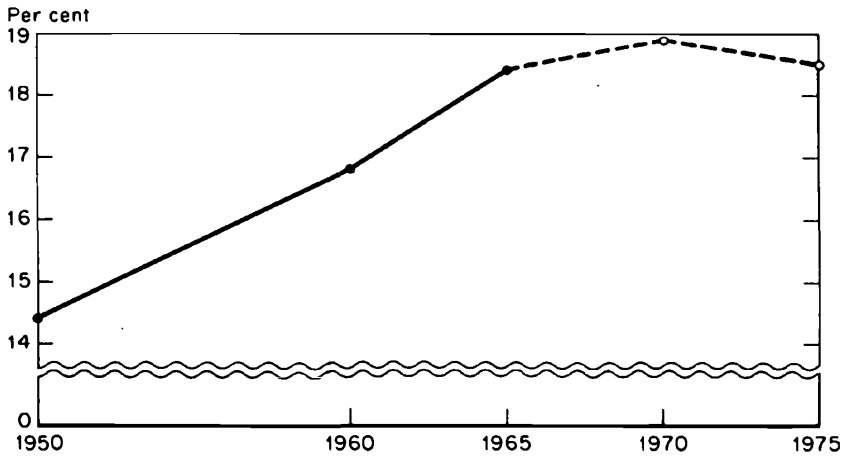
Source: *Current Population Report,* Department of Commerce.

FIGURE 13

Percentage of Married Women in Labor Force, 1950-64
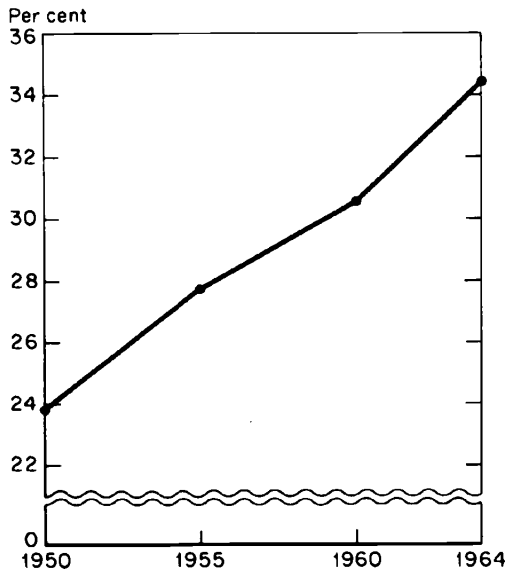
Source: *Manpower Report of the President,* Department of Labor.