Volume Title: Economic Forecasts and Expectations: Analysis of Forecasting Behavior and Performance

Volume Author/Editor: Jacob A. Mincer, editor

Volume Publisher: NBER

Volume ISBN: 0-870-14202-X

Volume URL: http://www.nber.org/books/minc69-1

Publication Date: 1969

Chapter Title: Consumer Anticipations and Models of Durable Goods Demand

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Chapter URL: http://www.nber.org/chapters/c1218

Chapter pages in book: (p. 167 - 242)

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Consumer Anticipations and Models of Durable Goods Demand

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I. INTRODUCTION AND SUMMARY

The contribution of consumer anticipations surveys to models of durable goods demand has been studied since the late 1940's, when data of this kind first appeared. One group of studies [4, 8, 10, 14] has concentrated on analysis of cross-section data, relating differences in anticipations among individual consumer units to differences in purchases during a single time interval. A second group [3, 11, 12, 13] has emphasized time-series analysis, relating average or aggregate anticipations observed at different points of time to the corresponding average or aggregate purchase rates.

The data obtained from anticipations surveys consist of intentions or plans to buy specific consumer products (usually durables, such as automobiles, houses, and major appliances) and general economic attitudes designed to measure the state of optimism or pessimism among

NOTE: Figures in brackets refer to bibliographic references at the end of this essay.

consumers.[1] However, survey data of this sort need not be interpreted literally. For example, intentions can be viewed as one among many dimensions of optimism or as probabilistic statements of future actions, while attitudes can be viewed as the fundamental psychological determinant of behavior or as one among many determinants of intentions.

Surveys of consumer anticipations cover relatively short time spans, and the earliest ones are irregularly spaced within the span covered. Intentions surveys were taken annually by the Survey Research Center at the University of Michigan (SRC) from about 1946 to 1952. After 1952, SRC intentions surveys were conducted several times a year until 1961, and have been on a systematic quarterly basis since. An alternative intentions survey was begun in 1959 by the United States Bureau of the Census and has been available quarterly since its inception.[2] Attitude surveys have been taken since about 1952 by the SRC, at irregular intervals until 1961 and quarterly thereafter. A private survey, covering only buying intentions at first and later including some attitude measures, has been taken by the Albert Sindlinger Co.

[1] Intentions surveys usually ask "Do you expect (plan, intend) to buy X within the next Y months?" Responses are then coded into categories such as, yes-definitely, yes-probably, yes-maybe, and so forth.

The attitude survey conducted by the Survey Research Center at the University of Michigan comprises a set of six questions which yield three-point responses (up, down, no change, or the equivalent) to questions about personal financial attitudes, attitudes towards business conditions, and attitudes towards market conditions. The variables included in the index measure whether people (1) report being better or worse off than a year ago; (2) expect to be better or worse off a year from now; (3) expect business conditions to be better or worse during the next year; (4) expect business conditions to be better or worse during the next five years; (5) think that this is a bad or good time to purchase durable goods; (6) expect prices to be higher or lower next year and view these expectations as "to the good" or "to the bad."

Responses to the component questions are summarized in the form of an index number—per cent reporting up (better, etc.) less per cent reporting down, plus 100. The separate index numbers are then averaged.

An alternative version of the Consumer Attitude Index includes the six measures above plus a measure of intentions to buy new cars during the next twelve months and a measure of intentions to purchase houses during the next twelve months.

In recent years, the SRC Index has been revised to exclude responses to the question about price expectations (no. 6 above). The revised five-question index has roughly the same cyclical movement as the original, but it shows a perceptible upward trend while the other did not.

[2] Both SRC and Census intentions surveys were taken in cooperation with the Federal Reserve Board during their formative years. Differences between the two relate primarily to sample size, sample composition, and regularity of interview. Both have essentially the same design, since the Census survey (QSI) is based on SRC meth-

since the mid-1950's. The lack of sufficient publicly available information makes it difficult to evaluate the Sindlinger data, and the analysis in this paper considers only the SRC and Census surveys.

For consumer anticipations to have demonstrable value in durable goods demand models, it is necessary to show either that anticipations variables make a significant marginal contribution to the explanation of purchases, or that anticipations are about as good as other variables and are in addition less expensive to obtain or more quickly available. This paper examines the question of marginal contribution. It is focused more on the question of the marginal contribution and optimum specification of alternative anticipatory variables than on the question of the marginal contribution of anticipatory variables relative to other variables. The latter question has been extensively examined elsewhere [3, 11, 13] and the present paper adopts the working assumption that the results of these studies are broadly correct.

The test of significant marginal contribution is, of course, appropriate for analysis of both time-series and cross-section data. The empirical analysis in this paper is concerned entirely with time series, although the results of existing cross-section studies are drawn upon as needed.

TIME-SERIES DEMAND MODELS AND CONSUMER ANTICIPATIONS: A BRIEF REVIEW OF FINDINGS

A number of recent studies have concluded that data on consumer anticipations are an indispensable ingredient in short-run demand models for the household sector, especially for the automobile component which accounts for much of the variability in consumer expenditures. The alternative types of anticipations data have not been found to be equally valuable, however. Consumer attitudes generally play an important role in these models, along with nonsurvey variables like income and durable goods stocks, but consumer buying intentions have tended to be of little or no use.

After examining the relation between durables purchases and a variety of other variables, including past and current income, in-

odology. The Census survey is based on a much larger sample and uses an overlapping rotation sequence which retains a large fraction of the sample in the interview group during successive quarters. The rotation sequence is designed to minimize sampling errors while maintaining the representative nature of the panel and automatically producing reinterview data.

come change, the index of industrial production, lagged durable goods purchases, the consumer attitude index, and index of consumer buying intentions, Eva Mueller [11, pp. 915–916] concluded that: "In summary, the analysis indicates that discretionary spending by consumers is determined to a large extent by income *level* and the state of consumer optimism and confidence [as measured by the attitude index]. The index of consumer attitudes does consistently well in the time-series test. Consistency of performance was observed over the entire 10-year time span and regardless of how the forecast equations were formulated . . ." (italics supplied by the author).

Mueller's findings with respect to buying intentions were that: "The predictive performance of buying intentions is much less satisfactory in these time-series regressions [i.e., less satisfactory than attitudes]. . . . When income, attitudes and buying intentions are used jointly to predict durable goods spending . . . the buying intentions term adds virtually nothing to the reliability of the forecast." [11, p. 905.] And, "throughout, the contribution of car buying intentions [to predicting automobile purchases] is negligible when attitude also appear in the equation." [11, p. 913.]

In a study published a short time later, covering the period 1952–62, Friend and Adams came to similar but less clear-cut conclusions about the importance of consumer attitudes, primarily because they found that the influence of attitudes on purchases could, to some degree, be represented by lagged purchases plus deviations from trend in an index of stock prices. "Joint use of lagged purchases and stock price deviations predicts automobile purchases nearly as well as the attitudinal data. The combination of the attitudes data and the stock prices show an improvement in predictive power over the case where either of these variables is used separately." [3, p. 993.]

And "the exclusion from the analysis of the earlier years [1952–56], particularly 1955, greatly reduces the role of attitudinal factors . . . The stock price variable is comparable in its effect to the attitudes, a little better in predicting number of vehicles delivered and a little worse in predicting expenditures." [3, p. 993.]

Friend and Adams come to the same conclusion as Mueller about intentions: "In the prediction of numbers of cars delivered as well as dollar amount of expenditures, . . . buying plans . . . add little or nothing." And again, "buying plans are not useful, and are not shown, although the attitudes continue to make a significant net contribution." [3, p. 993.]

Finally, in a study by Suits and Sparks [13] for the Brookings-SSRC econometric model, the index of consumer attitudes proved to be the most important variable in the automobile-demand equation. An income variable and the stock of automobiles also appear in the model, but buying intentions do not.

THE TIME-SERIES, CROSS-SECTION PARADOX

These time-series results stand in marked contrast to the findings of studies that rely on cross-section evidence to evaluate the role of consumer anticipations. The findings reported in [4, 8, 10, and 14] are representative. All showed buying intention to be strongly related to purchases of durables net of a large number of financial, demographic, and attitude variables, while all experienced great difficulty in detecting significant relationships between attitudes and subsequent purchases. Hence the paradox originally noted by Adams [1]: Attitudes are generally not related to purchases in cross sections, other things being equal, while intentions always are; but attitudes show a stronger relation to purchases in time series than intentions do, and, in fact, the latter seem to have no relation at all when other variables (including attitudes) are held constant.[3]

[3] Of the twin facets of the paradox, one is a firmly established empirical generalization (the superior cross-section performance of buying intentions) while the other stands on shakier ground (the superior time-series performance of attitudes). In fact, the opposite conclusion—that intentions have predictive value in time series but attitudes do not—was reached after an examination of a limited amount of data covering an earlier period [12, 15]. These early time-series results, buttressed by cross-section evidence that intentions and purchases were highly correlated, formed the basis for the recommendations made in 1955 by the Consultant Committee on Consumer Survey Statistics [15]. The committee essentially recommended that federal government resources be reallocated in the direction of more emphasis on intentions data and less on attitudes, although they recognized that this judgment was neither universally accepted nor as firmly grounded empirically as would be desirable.

The Consultant Committee recommendations were, in turn, one of the important considerations underlying the subsequent decision of the Federal Reserve Board to reduce its financial support for the SRC attitude studies and extend support to a new consumer survey that concentrated on buying intentions questions, large sample size to reduce sampling error, and regular quarterly interviewing to obtain more frequent measures of consumer anticipations. If the results reported by Mueller and Friend and Jones [3, 11] are correct, and if the cross-section, time-series paradox noted by Adams [1] is real, both the Consultant Committee and the Federal Reserve Board were in error.

The several attempts to resolve the paradox have essentially taken the view that the time-series results are correct and that the problem lies either with misspecification or measurement error in the cross-section analysis. Katona [6, Appendix, pp. 254–256] discusses a number of potential difficulties in the use of cross-section data to test the influence of consumer attitudes on purchases. Adams [1] suggests that differences among households in the interpretation of attitudinal questions are likely to provide enough noise to blur any cross-sectional influence of attitudes. Eliminating this source of noise, by taking differences in the responses of identical households in consecutive surveys as the "true" measure of attitude change, Adams finds some evidence that attitudes are in fact related to purchases in cross sections. The relationship is relatively weak (as measured by, say, explained variance), but there is no a priori reason for it to be strong. Maynes [9], who examines the problem at considerable length, points out several sources of systematic error in measuring the influence of attitudes in cross sections. He argues that the systematic errors could, in conjunction with the purely random sampling errors, easily account for an observed attitudes-purchases correlation of zero in cross sections even though the true correlation were significantly positive.

This line of argument may well be correct, although it should be kept in mind that the supporting evidence consists for the most part of a priori speculation rather than empirical observation. Systematic measurement errors and other sources of statistical noise evidently have only a random influence on time-series observations of mean values, but they might exert a strong influence on cross-sectional relationships. The lack of an observed relation between attitudes and purchases in cross sections, and the highly significant relationship observed in time series, are therefore consistent with this explanation.

THE PARADOX REEXAMINED

Whatever the merits of the Katona, Adams, and Maynes argument that systematic measurement errors explain the failure of attitudes to show up in cross sections, there remains the paradox that buying plans or intentions typically exert a dominant statistical influence on purchases in cross-section analysis but appear to have a weak or nil influence in time series.[4]

[4] In most of the cross-section studies cited earlier, intentions to buy are the most im-

Some possible explanations are that: (1) Intentions are a stable series (like age, for example), and thus have little or no time-series variance. (2) Intentions are highly correlated with purchases in cross sections mainly because they reflect the influence of idiosyncratic circumstances for particular households, and the distribution of such circumstances is, except for random variations, constant over time. Thus intentions may have an important element which behaves randomly over time but is highly correlated with behavior in cross sections, and the other elements may add little or no information to that provided by variables like income and attitudes. (3) Sampling or other measurement errors may be a relatively more serious problem for intentions data in time series than in cross sections, and thus the time-series relation may be obscured by error while the cross-section relation is not. (4) Time-series demand models that use an intentions variable may be improperly specified, and proper specifications might alter the conclusion that no time-series relationship exists.

The first possibility can be dismissed immediately. Intentions have more time-series variance than attitudes or, indeed, than most economic series. The second cannot be tested empirically in any direct way, although there is obviously an important element of truth in the proposition that some part of the cross-section correlation between intentions and purchases is a reflection of idiosyncratic and largely uninteresting differences in household circumstances. The third possibility (time-series measurement errors) is clearly of some relevance. The time-series variable produced by an intentions survey is the proportion of intenders in a sample. This proportion is typically rather small (about 10 per cent), depending on the particular survey question from which the variable is formed. As a consequence, the sampling errors of differences between successive surveys in the proportion of intenders is large relative to the proportion itself, and the sampling error of the difference often exceeds the observed difference. Partly because of its approximately rectangular distribution and partly because it is constructed as an average of several independently measured variables, sampling errors of successive time-series differences

portant single variable in the analysis. In this sense they can be said to "dominate," although the proportion of cross-section variance explained by intentions is quite small (from 5 to 20 per cent, usually).

are much smaller, relative to observed differences, for the attitude variable. Kish [7] has compared the sampling errors of time-series differences with the mean observed difference for both attitudes and intentions. His results indicate that relative sampling errors for the two types of surveys (sampling error of the difference divided by mean observed difference) would be equalized only if the sample size were about ten times as large for intentions as for attitudes. Since all the anticipations data analyzed above were drawn from the same sample (SRC), the noise generated by sampling error is much more serious for the intentions data than for attitudes.

It is worth noting that the measurement errors relevant to a cross-section analysis of these two kinds of anticipations data may well contain the opposite bias. The major source of error in measuring cross-sectional influence may not be sampling variability but, in Maynes' terminology, scale compression, anchor point variability among respondents, and interval nonlinearity.[5] It seems likely to me that these types of errors are much more serious for attitudes than for intentions.

The last possibility, specification error, is perhaps the most interesting one. It is argued below that a time-series demand equation which contains the usual intentions variable (the proportion of intenders) in a linear and additive model is likely to be improperly specified. The

[5] "Scale compression" refers to the fact that attitude questions are apt to have upper and lower limits which are described qualitatively, e.g., increase or decrease. Thus a respondent who reports that an income increase is expected may not be able to report on subsequent occasions that an even larger increase is expected, or that a given increase is expected with greater certainty. Once a respondent gets to the upper or lower limit of the scale used for a particular question, it is generally not possible for his responses to show further change even though there may in fact be a further change.

"Anchor point variability among respondents" refers to the fact that two respondents may mean quite different things by the statement "I expect to be worse off next year." One may really mean that he expects to be considerably worse off because income will be reduced drastically, while another with the identical response may simply mean that he does not expect any income increase and thinks it likely the prices will rise somewhat. In part, anchor point variability is a scale compression problem in disguise.

The last factor discussed by Maynes, "interval nonlinearity," refers to the possibility that there may be larger real differences between one pair of consecutive points on an attitude scale than between another pair; the customary linear scaling implies equal distance. For example, there may be a bigger difference between those who expect to be worse off and those who expect things to remain the same than between the latter and those who expect to be better off, or vice versa. Interval nonlinearity is more apt to be a problem where the scales are more refined and include varying degrees of being better or worse off.

basic reason is that such an equation implicitly assumes that the purchase rates of intenders and nonintenders (those reporting and not reporting intentions to buy) can be explained by a common set of parameters and independent variables. There is by now a considerable body of evidence which indicates that such an assumption is invalid. The evidence suggests that intenders are simply households whose ex ante purchase probabilities are higher than some undetermined level, while nonintenders are simply those whose ex ante probabilities are lower than the same undetermined level.

Further, the evidence suggests that mean purchase probability in the various intender classes (definite, probable, etc.) is approximately random over time, but that mean probability for nonintenders varies systematically with factors such as income, expectations, and so on. Thus the proportion of intenders can be viewed as a mediocre proxy variable for what an intention survey is really designed to measure—the mean ex ante purchase probability in the population. In the absence of a direct measure of probability, the problem can be managed by a model which specifies that the intender purchase rate is a constant while the nonintender purchase rate has a functional relationship to some specified set of variables.[6]

[6] A direct measure of mean purchase probability is currently being obtained in a new Census Bureau survey which began in July 1966. It is interesting to note that one of the principal conclusions of this paper—that intender and nonintender purchase rates must be treated separately—has a direct carry-over to analysis of the new probability data. Although evidence is inconclusive because so few observations are available (five quarterly measurements) at current writing, it appears that purchase rates in the various probability classes are essentially random provided that the respondent indicated a nonzero probability. For those indicating a purchase probability of zero, the limited evidence we have suggests that purchase rates behave in roughly the same way as did nonintender purchase rates in surveys of buying intentions. That is, the purchase rates of zero probability households appear to vary with factors like income, income change, and consumer attitudes, and hence can be explained with the aid of these or other variables.

Thus the appropriate model for purchase probability data may well be precisely the same as the one that seems optimum for buying intention data: Nonzero probability classes (intenders) should be viewed as having fixed purchase rates, while zero probability households (nonintenders) should be viewed as having purchase rates that need to be explained. A major difference, of course, is that most observed purchases were located in the nonintender class for buying intentions surveys, while just the reverse is true in the probability data. Thus it is much less important to be able to predict the purchase rates of zero probability households than to predict the purchase rate of nonintenders, simply because the first group contributes relatively little to the time-series variance in total purchases while the second contributes relatively much.

PLAN OF THE PAPER

Section II of this paper examines the influence on time-series models of sampling errors in the measurement of buying intentions; several related problems are also discussed. Section III examines the specification problem as it relates to time-series demand models with an intentions variable. Section IV presents updated empirical estimates of the role of both types of consumer anticipations variables in simple time-series models.

SUMMARY AND CONCLUSIONS

Reducing sampling errors by increasing sample size results in a significantly higher time-series correlation between buying intentions and purchases. An empirical measure of the improvement can be obtained by comparing actual purchases with both the Census Bureau's Quarterly Survey of Intentions (QSI, 16,000 households) and the essentially identical survey conducted by the Survey Research Center (1,500 to 3,500 households). Over and above reduction of sampling error, the evidence indicates that adjustment for seasonal variation and the use of weights representing ex ante mean purchase probabilities for various intender categories also improves the time-series correlation between intentions and purchases. The improvement in correlation resulting from the combination of all three factors (reduced sampling error, seasonal adjustment, and weights) is substantial: in round numbers, from 30 to 70 per cent of explained variance in one of the periods tested, and from 10 to 90 per cent during another.

Demand equations involving an intentions variable should specify different purchase rate functions for intenders and nonintenders, since the factors determining purchase rates for these two classes of households appear to differ considerably. In fact, the purchase rate of intenders can be described with reasonable accuracy as a random variable with a fixed mean value. Preliminary empirical tests indicate that best results are obtained from a two-stage estimation procedure: First, the nonintender purchase rate is predicted by regression methods; then the population purchase rate is predicted as a weighted average (the weights themselves being obtained directly from the survey) of nonintender and intender purchase rates.

At the present writing it is not possible to produce a firm generalization about either the relative or joint usefulness of different types of consumer anticipations surveys in time-series prediction models. The most accurate generalization appears to be that surveys of consumer attitudes and of consumer buying intentions both play distinctive and important roles in prediction models. Consumer attitudes appear to be a major determinant of the purchase rates of households classified as nonintenders; intentions data are needed to estimate the relative proportions of various classes of intenders and of nonintenders. These conclusions are based on analysis of Census Bureau Intentions data and Survey Research Center Attitudes data that cover a relatively short time span (1959–66) characterized mainly by a strong upward trend. Examination of similar data for different time periods will not necessarily yield the same conclusions, although the presence of very large sampling errors for intentions data other than the Census QSI series makes it difficult to evaluate periods prior to 1959.

The forecasting record of simple demand models that use consumer anticipations survey variables indicates three things: (1) When used in conjunction with variables like income or income change, the anticipations variables typically exert the dominant influence in the model. (2) Anticipations models generate much more accurate forecasts than autoregressive models. (3) The anticipations models examined in this paper are seriously deficient in a number of important respects.

Models that use consumer attitudes do especially well at predicting major turning points in expenditures on automobiles and other consumer durables. However, most such models seriously underestimated the strength of automobile and durable goods purchases during the 1961–66 expansion.

Models containing both consumer attitudes and consumer buying intentions seem to perform quite well provided a reliable estimate of intentions is available. However, these models cover a relatively short time period mainly characterized by economic expansion, and predictive performance is based largely on evaluation of ex post rather than ex ante forecasts.

II. SAMPLING ERRORS, MEASUREMENT ERRORS, AND THE TIME-SERIES CORRELATION BETWEEN PURCHASES AND INTENTIONS

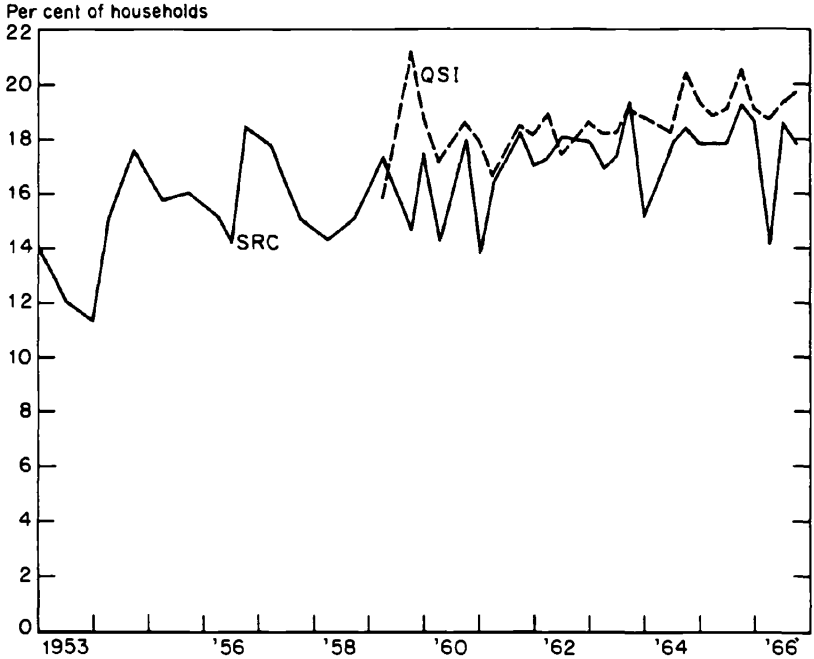
As noted in Section I, buying intentions surveys have been conducted since 1946 by the Survey Research Center (SRC) and since 1959 by the Bureau of the Census (QSI). QSI has been conducted quarterly since its inception, while SRC is available for almost every quarter since 1959. The only substantive difference between the two is their respective sample sizes: roughly 16,000 households for QSI and from about 1,500 to about 3,500 for SRC.[7]

Although the two surveys are essentially identical in design (QSI was originally based on SRC methodology), there appear to be differences in either the coding or interpretation of responses. For example, about 10 per cent of QSI respondents are reported as indicating that they "don't know" about car buying intentions, and an additional 2 per cent or so report that they "don't know" whether they will purchase a new or used car if they do buy. SRC does not publish a response category comparable to the first of these two classes; "don't know" responses in SRC data reflect only indecision about new versus used car intentions. The average percentage of SRC and QSI intenders (those who report they definitely, probably, or might buy) is quite similar for comparable time periods, hence the straightforward intender categories apparently mean roughly the same thing in both series. Thus the interpretative or coding differences come down to the fact that QSI reports a large fraction of households as being uncertain about their buying plans, while SRC apparently classifies similar respondents as nonintenders.

Although QSI and SRC show comparable results on average, there are large differences between the results of single surveys taken at identical time periods; these differences presumably reflect sampling variability. For example, the 1959-II and 1959-IV percentages for twelve-month car-buying intentions are 17.3 and 14.6, respectively, from SRC. But from QSI, comparable percentages are, respectively,

[7] The January-February SRC survey has the 3,500 sample size because the intentions data are obtained in conjunction with the Annual Survey of Consumer Finances. All other SRC surveys use the 1,500 sample size.

FIGURE 5-1. Intentions to Buy Automobiles as Reported in Survey Research Center (SRC) and U.S. Census Bureau (QSI) Surveys, 1953–1966



Source: Appendix Table 5-A-1.

15.8 and 21.2—a reversal of the direction and almost of the extent of change! In 1963-IV the two show virtually identical results (19.3 for SRC and 19.1 for QSI); but for the next quarter, 1964-I, SRC shows a sharp drop to 15.1 while QSI is practically unchanged at 18.8. As can be seen from Figure 5-1, SRC tends to be the more erratic series, although both have a good deal of apparently random variation.

The larger QSI sample not only generates smaller over-all sampling errors, but also facilitates more effective use of the considerable detail which both surveys contain relating to subcategories of intenders.[8] In principal, each intentions subcategory should be weighted by

[8] SRC publishes very little detail in its intentions series, especially for surveys where the sample size is about 1,500 cases. In a typical SRC survey there might be from 100 to 150 respondents with some kind of intention to buy a new car within twelve months. Based on Census Bureau data, from fifteen to thirty of these households might report "definite" intentions to buy a new car within six months. The latter figure obviously has a very large relative sampling error.

the mean ex ante purchase probability of respondents in that category. The resulting series would be a more analytically appropriate measure of aggregate buying intentions than the simple sum of all intenders. The purchase rates of various classes of intenders, which can be obtained from reinterview studies, are approximations to the desired probability weight [4].

Finally, the intentions series is clearly in need of adjustment for seasonal variation. Intentions to buy cars—either the sole or the major component of the intentions variable generally used in demand studies—have a marked seasonal high around October when new automobile models are introduced, and this seasonal movement has no counterpart in actual purchases. There appear to be other seasonal variations as well.

From Census Bureau intentions data it is thus possible to construct alternative series which can be viewed as potentially superior to SRC intentions data. Three types of conceptual differences are investigated. First, the influence of pure sampling error can be examined by comparing series which differ only in sample size. Such series are designated QSI-NS (quarterly survey of intentions, not seasonally adjusted), and SRC-NS. Second, the effect of seasonal adjustment can be measured. Here the best comparison presumably involves two Census Bureau series because sampling errors are smaller than in SRC data. Hence the next series is designated QSI-S (quarterly survey of intentions, seasonally adjusted). The third difference involves construction of a weighted series designed to measure the number or proportion of "expected" purchases.[9] This statistic can be represented by the probability of purchase in each category multiplied by the number or proportion of households in the category. If mean purchase probability in any class is independent of the proportion of households in that class, the probability weights should be constant over time. If mean probability is not independent of class size, the weights ought not to be constant, and must be predicted either as a function of class size or of other variables.

[9] In the studies analyzed to date (all of which use SRC data), the intentions series consists of all households "definitely" or "probably" intending to buy new or used cars within twelve months plus one-half of those who report that they "might" buy within twelve months. The series therefore involves implicit weights, but these weights lack empirical foundation.

Census Bureau reinterview data (largely unpublished) suggest that the mean probabilities in intender categories, as measured by observed purchase rates, are in fact largely independent of the proportion of intenders. It is clear, however, that nonintender purchase rates are not independent of the proportion of nonintenders. Thus we have constructed an expected purchase series which applies fixed weights to the proportions of various kinds of intenders but eliminates the nonintender group entirely.[10] The weights (which are designed to correspond to the mean ex ante probabilities implied by the new-car purchase rates observed in reinterview studies) are 0.7 for those reporting definite plans to buy new cars within six months, 0.5 for those reporting probable or possible plans to buy new cars within six months, 0.3 for those reporting definite, probable, or possible plans to buy new cars within twelve months but no plans to buy within six months, and 0.2 for those reporting plans to buy used cars within either six or twelve months. These weights are somewhat higher than observed purchase rates due to the presence of regression bias in the observed purchase data [4]. The series is designated QSI-SW_0 (seasonally adjusted and weighted buying intentions). An alternative weighted series contains all these components but also includes the class of households reporting that they "don't know" about their car buying intentions. These households are assigned a weight of 0.3, and the series is designated QSI-SW_3.

Thus we have five buying-intentions series to be compared: (1) SRC-NS; (2) QSI-NS; (3) QSI-S; (4) QSI-SW_0; and (5) QSI-SW_3. Differences between the first and second are due entirely to the differential importance of sampling errors. Differences between the second and third are due entirely to the effect of seasonal adjustment. Differences between the third, fourth, and fifth are due to differences in the weights attached to various classes of intenders or to differences in the coverage of intenders.

Comparisons among the series are hampered by the fact that Census Bureau intentions data are not available until 1959. Unfortunately,

[10] Other procedures could be used. One could treat all intender categories as separate variables and allow the data to provide the weights. I do not think that this procedure is desirable, given the amount of multicollinearity in the data. Another alternative is to estimate intender and nonintender purchase rates separately and then combine them into an estimate of the over-all purchase rate. This procedure is examined in the next section.

the 1959–66 period cannot be regarded as typical of the economic environment in which survey data are used to predict purchases; since 1959 the U.S. economy has in general been in a period of sustained economic expansion (the 1960–61 recession was very mild, and brief as well). Thus comparisons can be drawn either between QSI and SRC series starting in 1959, or between the SRC series and a QSI series consisting mainly or partly of Census Bureau data, but with a link to SRC data for periods prior to 1959. Although for some purposes the period since 1959 is clearly preferable, for others (the measurement of seasonal adjustment and the separation of trend from cyclical influences) it is not so evident, which is better.

Thus for the present we are left with a choice of evils: We can compare a series which consists entirely of SRC observations with one that consists mainly but not entirely of QSI observations, and these comparisons will cover a period characterized both by large cyclical swings and a long-term upward trend. Alternatively, we can compare a series drawn entirely from QSI with one drawn entirely from SRC but only for a period mainly characterized by an upward trend.

Both types of comparisons are shown in Table 5-1. The series labelled QSI consists of whatever Census data are available plus whatever SRC data are needed because the period includes quarters prior to 1959. Three time periods are examined: 1953 through 1961, the period examined in other recent studies; 1953 through most of 1965, the period available when this analysis was written; and 1959 through most of 1965, the period for which the QSI series consists entirely of Census Bureau data.[11]

[11] Only quarters for which SRC data are available have been included in the analysis summarized in Table 5-1. As noted in the text, SRC surveys of either attitudes or intentions were not conducted quarterly until 1962. Hence we have thirty-seven surveys available for analysis between 1953-I and 1965-III (the latest survey for which relevant purchase data were available at writing). One of these (1964-II) has been excluded from all regressions because the comparison between anticipation and action is strongly affected by the automobile strike in the third and fourth quarters of 1964. Although other quarters were also affected by the strike, either anticipation and action were both affected (e.g., 1964-IV and 1965-I) or else actions were only slightly affected on balance (e.g., 1964-III).

Most of the empirical analysis relates anticipations during a particular quarter to purchases in the two *subsequent* quarters; thus 1964-III anticipations are related to purchases during 1964-IV and 1965-I, and for that period the effect of the strike probably balanced out. The quarters used in the analysis are shown below.

Table 5-1 summarizes correlations between automobile purchases (deflated, per household) and the alternative buying intentions series. The variable to be predicted is either deflated per household purchases of automobiles or the ratio of deflated per household automobile purchases to past income.[12] The table shows simple correlations, where the only explanatory variable is buying intentions, and partial correlations, where an income or income change variable is held constant. The basic hypothesis is simply that reduced sampling variability, seasonal adjustment, and appropriate weighting will all tend to increase the correlation between purchases and intentions.

The results are striking. During the 1953–61 period, when the QSI series consists largely of linked SRC data, the differences are quite small and erratic; some of the differences in partial correlation go in the opposite direction from the differences in simple correlations. For the 1953–65 period, where the majority of the observations are drawn from Census Bureau data, sampling error, seasonal adjustment,

1953-I	1956-IV	1960-IV	1963-II
1953-III	1957-II	1961-I	1963-III
1954-I	1957-IV	1961-II	1963-IV
1954-II	1958-II	1961-IV	1964-I
1954-IV	1958-IV	1962-I	1964-III
1955-II	1959-II	1962-II	1964-IV
1955-IV	1959-IV	1962-III	1965-I
1956-II	1960-I	1962-IV	1965-II
1956-III	1960-II	1963-I	1965-III

The following quarters were not used because SRC intentions data were not available:

1953-II	1955-III	1958-I	1960-III
1953-IV	1956-I	1958-III	1961-III
1954-III	1957-I	1959-I	
1955-I	1957-III	1959-III	

In addition, 1964-II was eliminated because of an auto strike in the associated purchase period of 1964-IV.

For some of the quarters labelled "no SRC data," an SRC survey was taken, but it was either a telephone follow-up involving part of the previous quarter's sample or else no intentions data have been published. Only quarters in which the full SRC sample was personally interviewed, and for which both attitudes and intentions data have been published, are used in the analysis.

[12] The dependent variable in equations with buying intentions as the independent variable ought, in principle, to be number of automobile purchases rather than deflated value of purchases, since the intentions survey asks whether a car will or will not be purchased. Deflated purchases will differ from the number of purchases if aver-

and weighting all make a significant difference, although weighting seems to be the most important of the three.[13] For the 1959–65 period—where the comparison is most clear-cut between alternative data sources but where the nature of the period is troublesome—all of the differences are important although the relative amounts of improvement are different for simple and for partial correlations and for equations predicting purchase levels as distinct from the ratio of purchases to income.

The combined effects of all the above differences results in a dramatic improvement, especially for the second and third time periods. The simple r^2 is more than doubled for the second period and the partial r^2 is increased by a factor of at least five. For the third period, the improvement is by a factor of ten or more. In effect, SRC-NS explains almost no variance in the 1959–65 period but QSI-SW_3 explains close to 90 per cent of the variance (for simple regressions), and close to 90 per cent of the residual variance when the ratio of purchases to income is dependent. We conclude that the powerful cross-section relationship repeatedly observed between intentions and purchases does in fact show up in time series, and that the paradox noted by Adams [1] is an illusion. Given reasonably small sampling errors, adequate adjustment for seasonal variation, and proper aggregation, intentions

age real price per car changes over time, that is, if people upgrade or downgrade their car purchases. In most of the empirical analysis in this paper deflated purchases are used, since there is no reliable series on number of car purchases by households. The available car registrations series includes purchases by business and nonprofit organizations, and registrations lag behind purchases by several weeks on average. The Census Survey of buying intentions contains a series on actual purchases by households. This series is the conceptually appropriate one for the analysis, but there is a great deal of sampling variability in the data even though the sample size is quite large. Therefore, I have preferred for the most part to use the deflated expenditure data. The alternative series are of course highly correlated, and the analysis in this part of the paper is not likely to be very sensitive to the choice of dependent variable. Other investigators have reported that it seems to make little difference, e.g., Mueller [11].

In Section III of the paper, results are presented using an estimate of number of cars purchased by households. The form of the equation for these results requires that number of purchases be used, hence no alternative was possible.

[13] The most important respect in which weighting improves the correlation is in the distinction between new and used car buying intentions. Intentions to buy used cars are erratic in the QSI data. They show little systematic change over the entire period, and car purchases (both new and used) rose strongly. The other elements in the weighting scheme also make a positive contribution.

TABLE 5-1. Correlations Between Automobile Purchases and Alternative Indexes of Intentions

Intentions Variable	Adjusted Simple Correlation Squared, Time Periods			Partial Correlation Squared, Time Periods			Percentage Distribution of Total Improvement in Simple $\bar{r}^2$, Time Periods			
	I (1953–61)	II (1953–65)	III (1959–65)	I (1953–61)	II (1953–65)	III (1959–65)	I (1953–61)	II (1953–65)	III (1959–65)	Average
				A: Purchase Levels Dependent [a]						
SRC-NS	.16	.30	.09	.28	.06	(−).00				
QSI-NS	.21	.35	.16	.40	.07	.04	46.3	10.3	8.9	21.8
QSI-S	.23	.46	.44	.42	.11	.07	17.1	25.9	33.9	25.6
QSI-SW_0	.25	.66	.77	.37	.32	.12	18.3	49.0	39.9	35.7
QSI-SW_3	.27	.72	.91	.41	.40	.23	18.3	14.7	17.3	16.8
				B: Ratio of Purchases to Income Dependent [b]						
SRC-NS	.02	.15	.07	.00	.05	.07				
QSI-NS	.02	.18	.17	.06	.15	.45	7.5	12.3	12.1	10.6
QSI-S	.03	.23	.45	.06	.17	.66	13.1	21.2	35.2	23.2
QSI-SW_0	.08	.37	.75	.12	.29	.84	73.5	56.6	38.2	56.1
QSI-SW_3	.08	.39	.86	.07	.27	.87	5.9	9.8	14.6	10.1

[a] Equations are:

$$M_6 = b_0 + b_1 BI, \text{ and}$$

$$M_6 = b_0 + b_1 Y_{-6} + b_2 BI,$$

where BI is one of the intentions variables, M_6 is deflated per family expenditures on automobiles during the six-month period following the quarter in which the survey was taken, and Y_{-6} is deflated per family income during the six-month period preceding the survey quarter. See Appendix Table 1 for detailed description.

[b] Equations are:

$$M_6/Y_{-6} = b_0 + b_1 BI,$$

$$M_6/Y_{-6} = b_0 + b_1 \Delta Y + b_2 BI,$$

where BI is one of the intentions variables, ΔY is the difference between income in the survey quarter and Y_{-6}, and the other variables are as defined above in note a. See Appendix Table 1 for detailed description.

show a strong association with purchases in time series as well as in cross sections.

The cross-section, time-series paradox referred in principle to the fact that buying intentions showed a significant relationship to purchases in cross sections, holding constant other relevant variables including attitudes, but did not show a significant relation in time series holding these variables constant. The results above show only that the performance of an intentions variable can be greatly improved by reducing sampling errors and adjusting for seasonal variation and weighting, but they do not demonstrate that the improved intentions variable is significantly related to purchases when attitudes are held constant. This question is taken up below. To anticipate the results, the improved intentions variable does, in fact, show a highly significant relation to purchases, holding constant other variables including attitudes.

III. EQUATION SPECIFICATION AND INTENTIONS DATA

A possible inference from the results in Section II is that reduction of sampling errors and measurement errors so improves the time-series relation between intentions and purchases that the problem of forecasting the demand for consumer durables has been largely solved. This conclusion is not warranted, if for no other reason than the trend-dominated character of the period over which intentions and purchases appear to be so closely associated. Hence we turn to the examination of the equation specification problem.

Time-series tests of buying intentions surveys seek to determine whether one or more intentions variables contribute significantly to the explanation or prediction of purchases. Empirical tests have asked whether the proportion of intenders, the usual variable obtained from an intentions survey, has a net association with purchases in a linear and additive model which includes a number of other variables like income, attitudes, the unemployment rate, and so forth. It can be shown that this test gives valid results if, and only if, highly restrictive and empirically unrealistic behavioral assumptions are made.

Less restrictive and empirically justifiable assumptions require equations with somewhat greater flexibility. The argument is developed and preliminary empirical results are presented.

The key to the proper specification of demand equations that use an intentions variable is the recognition that an intentions survey really divides the population of both households and purchases into two compartments—intenders and nonintenders. The fact that the survey further divides intenders into subcompartments is useful but irrelevant to the analysis. Given the basic dichotomy of intender versus nonintender, the variable to be predicted (future purchase rates) can be divided into two components: future purchase rates for intenders and future purchase rates for nonintenders. Defining: p as the proportion of intenders (weighted or unweighted); $1 - p = q$ as the proportion of nonintenders; r as the future purchase rate of intenders; s as the future purchase rate of nonintenders; and x as the future purchase rate in the population as a whole, we have the identity,

$$x \equiv pr + (1 - p)s \equiv pr + qs.$$

The future purchase rate in the population is thus a weighted average of the future purchase rates for households in each of the two compartments, the weights being the proportions of each kind of household. The problem is then to substitute functional relationships for r and s in the above identity; the sizes of p and q are determined by the intentions survey.

A priori it seems that little can be said about the probable determinants of the r and s functions. The basic causes of short-term variations in aggregate purchases of consumer durables are not only complex but are likely to involve factors that are difficult to measure with precision. Purchases of durables may be viewed as an attempt to adjust actual to desired stock. Desired stock is presumably determined by forward looking variables like expected income (including both mean and variance) as well as by other variables such as relative prices, credit terms, asset and debt holdings, family composition, and so forth. Moreover, the speed with which actual stock is adjusted to desired stock may itself be a function rather than a constant; for example, the speed of adjustment may depend on the variance of expected income. It is precisely because of the difficulty of providing an adequate structural explanation of durable goods purchases that surveys of consumer anticipations have come to be widely used in models designed to predict durable goods demand.

The appropriate relationships are even less apparent when we consider variations in intender and nonintender, rather than aggregate, purchase rates. Intenders are, after all, simply households that classify themselves as having some kind of positive buying expectation, while nonintenders are those who fail to provide any positive expectation. Thus one would expect intenders, relative to nonintenders, to have higher average values of any variable that tends to be positively associated with purchases, and lower average values of variables that are negatively associated with purchases. But it does not necessarily follow that even powerful behavioral variables like income or expected income will be determinants of either intender or nonintender purchase rates. A large increase in income may simply shift households from the nonintender to the intender category. As a consequence, average income in *both* categories may remain the same or even decline, and purchase rates in *both* categories could rise, remain the same, or even fall; for the population as a whole, both average income and the purchase rate would evidently rise.

One a priori consideration that is likely to be of some relevance has to do with the question of homogeneity: Is there apt to be a smaller or a larger variance in the distribution of purchase probabilities among intenders than among nonintenders? Since there are several different categories of intenders, and since classification as an intender requires a positive reaction from the respondent rather than the absence of a positive reaction, it is plausible to suppose that the various intender classifications are relatively homogeneous, the nonintender classification, relatively heterogeneous.

With these considerations in mind, let us examine the empirical implications of alternative hypotheses about functional relationships for intender and nonintender purchase rates.

HYPOTHESIS A

A simple but extreme assumption is that the purchase rates of intenders r and nonintenders s are both random variables with means $\bar{R}$, $\bar{S}$ and disturbances d_r, d_s; that is,

$$r = \bar{R} + d_r$$

$$s = \bar{S} + d_s.$$

In such a case we need only the intentions survey to give us optimum predictions; the addition of other data will not improve matters.

(1.0) $$x \equiv pr + qs$$

(2.0) $$x \equiv p(\bar{R} + d_r) + q(\bar{S} + d_s)$$

$$\equiv p\bar{R} + q\bar{S} + p(d_r) + q(d_s);$$

since $q \equiv 1 - p$,

(2.1) $$x \equiv p(\bar{R} - \bar{S}) + \bar{S} + p(d_r - d_s) + d_s$$

$$\hat{x} \equiv p(\bar{R} - \bar{S}) + \bar{S}.$$

If equation (2.1) is fitted to data on x and p, we should find that:

(2.2) $$x = a + bp + u,$$

where, $a = \bar{S}$, $b = \bar{R} - \bar{S}$, and $u = p(d_r - d_s) + d_s$.

The variance of the error term depends on the respective variances of d_r and d_s, the size of p, and the correlation between p and both r and s. Since p is a relatively small fraction (.1 to .3), the error variance is likely to be dominated by the variance of d_s.

HYPOTHESIS B-1

A comparable and equally extreme assumption is that the purchase rates of intenders and nonintenders are systematically related to other variables and the relationship is precisely the same for both. For example, where $\bar{Y}_r$, $\bar{Y}_s$ are intender and nonintender mean income, respectively, $\bar{E}_r$, $\bar{E}_s$ are the respective mean expectations, and u_{rs}, u_{sr} are the respective error terms when both purchase rate functions are fitted with identical parameters, we have:

$$r = f(\bar{Y}_r, \bar{E}_r) = a + b\bar{Y}_r + c\bar{E}_r + u_{rs}$$

$$s = f(\bar{Y}_s, \bar{E}_s) = a + b\bar{Y}_s + c\bar{E}_s + u_{sr}.$$

If the mean values of income and expectations for intenders and nonintenders were equal, the survey would be of no value; the purchase rates of intenders and nonintenders would be equal. When the above expressions for r and s are substituted into the definitional equation, the survey variable drops out entirely.

(1.0) $$x \equiv pr + qs \equiv pr + (1 - p)s$$

(3.0) $$x = p(a + b\bar{Y}_r + c\bar{E}_r + u_{rs}) + (1 - p)(a + b\bar{Y}_s + c\bar{E}_s + u_{sr}).$$

If $\bar{Y}_r = \bar{Y}_s$ and $\bar{E}_r = \bar{E}_s$,

(3.1) $$x = a + b\bar{Y} + c\bar{E} + p(u_{rs} - u_{sr}) + u_{sr},$$

and the error term, u_x, is:

$$u_x = p(u_{rs} - u_{sr}) + u_{sr}.$$

Because of the nature of the intender-nonintender classification, it is quite probable that the mean values of independent variables, such as income and expectations, will in fact be different for intenders and nonintenders. In this case equation (3.1) has two additional terms:

$$bp(\bar{Y}_r - \bar{Y}_s) + cp(\bar{E}_r - \bar{E}_s).$$

These terms obviously vanish if $\bar{Y}_r = \bar{Y}_s$ and $\bar{E}_r = \bar{E}_s$; if, as seems likely, this is not the case, both terms could still be ignored without serious error unless mean income and expectations behaved differently over time for intenders and nonintenders and these differences contribute to the explanation of variance in population purchase rates. Although one cannot demonstrate empirically that either condition holds, it seems reasonable to suppose that omission of the terms in question will not seriously bias the results.

HYPOTHESIS B-2

A more plausible form of the B-1 assumption is to suppose that the regression coefficients in the two functions are the same but that the constant terms differ—an assumption consistent with the empirically observable differences in reinterview purchase rates. If this is so, and if, in addition, a is greater than a' and $u_{rs'}$, $u_{sr'}$ designate the respective error terms where the constant is permitted to vary but the other coefficients are not, we have:

$$r = a + b\bar{Y}_r + c\bar{E}_r + u_{rs'}$$

$$s = a' + b\bar{Y}_s + c\bar{E}_s + u_{sr'}$$

$$(4.0) \quad x = p(a + b\bar{Y}_r + c\bar{E}_r + u_{rs'}) + (1 - p)(a' + b\bar{Y}_s + c\bar{E}_s + u_{sr'})$$

$$(4.1) \quad x = a' + (a - a')p + bY_s + cE_s + p(u_{rs'} - u_{sr'}) + u_{sr'} + [\quad],$$

$$u_x = p(u_{rs'} - u_{sr'}) + u_{sr'}.$$

The expression omitted in brackets in equation (4.1) consists of $bp(\bar{Y}_r - \bar{Y}_s) + cp(\bar{E}_r - \bar{E}_s)$. On the same argument as outlined above, this term probably has no appreciable variance and hence can be ignored.

If B-2 holds, the proper specification for equation (4.1) simply involves adding the survey variable p to the other explanatory variables. This is, in fact, what all existing studies have done. The specification is correct if, and only if, all regression coefficients are the same in both the intender and nonintender purchase-rate functions, the constant terms differ, and the mean income and expectations of the population approximate those of nonintenders.[14]

HYPOTHESIS C-1

A somewhat different approach to the problem is to specify contrasting assumptions for the r and s functions. Both cross-section and time-series evidence suggests that it is not wholly unreasonable to think of r as an approximately random variable, but that s cannot be so viewed. Thus we can usefully examine the implications of assuming that the purchase rate of intenders, r, is a random variable whose value depends on the particular question asked in the survey, while the nonintender purchase rate, s, varies systematically with other known variables.

Let us suppose that s is related to p, $\bar{Y}$, and $\bar{E}$; that is, to the proportion of intenders, income, and expectations, while r is a random variable with mean $\bar{R}$ and disturbance d_r. Then we have, assuming $\bar{Y} = \bar{Y}_s$,

[14] Still a third version of this general assumption is to suppose that the functional relationships for intender and nonintender purchase rates are different; perhaps the relevant variables are different, or perhaps the regression coefficients of common variables are different. The equation gets very involved in this case, particularly if the assumption of equality in mean values between intender and nonintender income, expectations, etc., does not hold, as is likely to be the case. Correct specification then involves a series of terms involving the interaction of the p variable with intender and nonintender income, expectations, etc., in addition to terms involving nonintenders' income, expectations, etc., by themselves. Empirically simpler ways to handle this case are discussed under hypotheses C-1 and C-2.

and $\bar{E} = \bar{E}_s$,

$$r = \bar{R} + d_r$$

$$s = a + bp + c\bar{Y} + d\bar{E} + u_s.$$

Substituting into equation 1.0, we get

$$x = p\bar{R} + q(a + bp + c\bar{Y} + d\bar{E} + u_s) + pd_r \tag{5.0}$$

$$x = p\bar{R} + aq + bqp + cq\bar{Y} + dq\bar{E} + qu_s + pd_r. \tag{5.1}$$

Equation (5.1) cannot be fitted without serious bias because the error term $(qu_s + pd_r)$ is correlated with most of the other independent variables $(qp,\ q\bar{Y},\ q\bar{E})$. Most of the bias can be eliminated by dividing through by q.[15]

$$\frac{x}{q} = \frac{p\bar{R}}{q} + a + bp + c\bar{Y} + d\bar{E} + u_s + \frac{p}{q}\,d_r. \tag{5.2}$$

Equation (5.2) can be put into a more revealing form by shifting the first term on the right-hand side over to the left.

$$\frac{x - p\bar{R}}{q} = a + bp + c\bar{Y} + d\bar{E} + \left(u_s + \frac{p}{q}\,d_r\right). \tag{5.3}$$

Equation (5.3) is of course nothing more than the original nonintender purchase-rate equation with the error term specified to include any additional error arising from the assumption that d_r is zero. Given the basic definitional relationship, $x \equiv pr + qs$, and substituting $(\bar{R} + d_r)$ for r, we get:

$$s \equiv \frac{x - pr}{q} \equiv \frac{x}{q} - \frac{p}{q}(\bar{R} + d_r) \equiv \frac{x - p\bar{R}}{q} - \frac{p}{q}\,d_r. \tag{5.31}$$

We can think of s as having two components, a predicted value designated $\hat{s}$, and a deviation designated $d_{s'}$. From equation (5.31) we can define $\hat{s} \equiv \dfrac{x - p\bar{R}}{q}$, and $d_{s'} \equiv \dfrac{p}{q}\,d_r$. The predicted and actual values of s will be the same only if r and $\bar{R}$ are always equal; otherwise they will differ by $\dfrac{p}{q}\,d_r$.

The implicit model for hypothesis C-1 uses a two-step prediction

[15] Even then, however, the new error term $(u_s + \frac{p}{q}\,d_r)$ is still positively correlated with at least one of the independent variables. Since p/q is small (much less than 0.5), the remaining bias is less serious.

method. First we regress predicted values of s on the relevant independent variables:

$$(5.4) \qquad \hat{s} \equiv \frac{x - p\bar{R}}{q} = a + b\bar{Y} + c\bar{E} + u_{\hat{s}}.$$

From this equation we obtain regression estimates of $\hat{s}$, designated s°:

$$(5.41) \qquad s^\circ = a + b\bar{Y} + c\bar{E}.$$

The latter are then used to obtain estimated values of x from the equation

$$(5.42) \qquad \hat{x} = p\bar{R} + qs^\circ.$$

The error variance in predictions of x derived from this procedure is somewhat smaller than the error variance in equation (5.4) provided that q is less than unity, since the error term in predictions of x based on equation (5.42) works out to be equal to $u_{\hat{s}}$ (from equation 5.4) multiplied by q.

HYPOTHESIS C-2

Extending this approach one further step yields an equation much like (5.42), with at least as small an error variance. Following the procedure outlined for hypothesis C-1, we have:

$$(1.0) \qquad x \equiv pr + qs.$$

Combining (5.31), (5.4), and (5.41), we can write

(5.5) $s \equiv s^\circ + u_{\hat{s}} - \frac{p}{q} d_r$; rewriting (1.0) and substituting (5.5),

$$(5.6) \qquad r \equiv \frac{x - q(s^\circ + u_{\hat{s}} - pd_r/q)}{p}.$$

Let us now relax the assumption that the intender purchase rate r, is a random variable with mean $\bar{R}$ and disturbance d_r, and think of r as having an estimated component $\hat{r}$ and an error component $d_{r'}$. The estimated component is the first part of equation (5.6);

$$(5.71) \qquad \hat{r} \equiv \frac{x - qs^\circ}{p},$$

while the error component is the rest.

(5.72) $$d_{r'} = -\frac{q}{p} u_{\hat{s}} + d_r.$$

The estimated value ($\hat{r}$) in (5.71) may be further divided into a systematic component r° and error component $u_{\hat{r}}$, provided $\hat{r}$ varies systematically with other factors, e.g., $\bar{Y}$ and $\bar{E}$.

(5.73) $$\hat{r} = d + e\bar{Y} + f\bar{E} + u_{\hat{r}}$$

(5.74) $$r^\circ = d + e\bar{Y} + f\bar{E}.$$

Finally, putting all the parts together, we can express the intender purchase rate as

(5.8) $$r = r^\circ + u_{\hat{r}} - \frac{q}{p} u_{\hat{s}} + d_r,$$

and substituting both (5.5) and (5.8) in the definitional equation $x \equiv pr + qs$ gives us:

(5.9) $$x = p\left(r^\circ + u_{\hat{r}} - \frac{q}{p} u_{\hat{s}} + d_r\right) + q\left(s^\circ + u_{\hat{s}} - \frac{p}{q} d_r\right).$$

Using predicted values of both r and s to obtain predicted values for x, we have

(5.91) $$\hat{x} = pr^\circ + qs^\circ,$$

with an error term consisting of

$$u_{\hat{x}} = pr^\circ + pu_{\hat{r}} - qu_{\hat{s}} + pd_r + q_{s^\circ} + qu_{\hat{s}} - pd_r - pr^\circ - qs^\circ;$$

cancelling terms,

$$u_{\hat{x}} = pu_{\hat{r}}.$$

HYPOTHESIS C-3

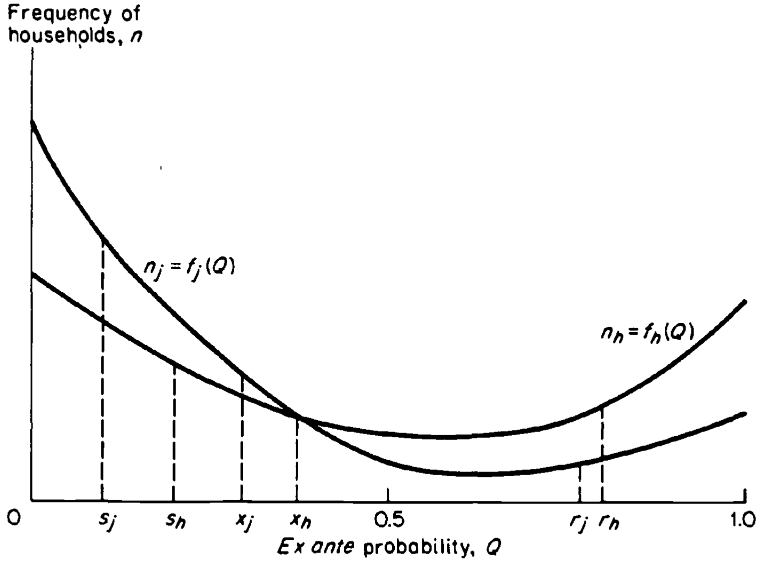
A symmetrical hypothesis to C-2 uses the same structure but proceeds initially on the assumption that s is a random variable with mean $\bar{s}$ and disturbance d_s. Estimated values ($\hat{r}$) are then regressed on selected independent variables, and the resulting regression estimates (r°) are used to obtain a series of predicted values ($\hat{s}$). The latter is in turn regressed on selected independent variables to obtain s°, and both predicted variables (r° and s°) are used to obtain another estimate of $\hat{x}$. The procedure is completely symmetrical to C-2, and the formulation of the error term is predictably symmetrical as $u_{\hat{x}} = qu_{\hat{s}}$.

There is a good deal of cross-section evidence, both theoretical and empirical, that bears on the question of which set of assumptions is likely to hold. Elsewhere [4] I developed the notion that responses to intentions surveys reflect an underlying continuous distribution of purchase probabilities. Thus intenders (nonintenders) are simply households with relatively high (low) mean ex ante purchase probabilities. The extensive empirical evidence examined in [4] suggests that the probability density functions for groups of households classified by an attribute like income level are apt to be roughly symmetrical in the high-probability part of the function where relatively few households are located. The functions cannot be symmetrical throughout if the mean values differ, as would be true for a classification based on income, but the lack of symmetry appears to show up primarily in the low-probability part of the distribution where the bulk of households are located. Thus intenders with high incomes do not necessarily have higher mean probabilities and purchase rates than intenders with low incomes, although mean probabilities and purchase rates among *nonintenders* clearly differ with income class. Similar results are obtained for other classifications associated with purchase rate differences. Intenders reporting that their automobiles "need to be replaced" do not always have higher mean probabilities and purchase rates than other intenders; but among nonintenders, reported replacement need is a powerful discriminator of purchase rates.

Moreover, empirical tests of the probability hypothesis [5] not only indicate that this hypothesis is a useful way to interpret intentions data, but are consistent with the assumption that shifts over time in the probability-density functions are likely to be roughly parallel at the high end of the scale but not at the low end. In general the distributions are shaped like an inverse J; the type of distributions that seem to be typical are shown in Figure 5-2. These portray cross-section differences, where the j subscripts refer to low-income and the h subscripts to high-income families.

Taking a probability of 0.5 as the dividing line between intenders and nonintenders, and denoting x_h and x_j as the mean probability for high- and low-income families, it is often true that the mean probabilities for intenders (r_h, r_j) are independent of income, but it is never true that mean probabilities for nonintenders (s_h, s_j) are independent of income. Although the empirical results bearing on this question all relate to cross sections, the potential application of the analysis to time series is clear: high and low income could readily be income at

FIGURE 5-2. Illustrative Distributions of Purchase Probabilities for High- and Low-Income Respondents



time t and $t + n$. These considerations all suggest that hypotheses C-1 and C-2 are likely to be the equation forms with minimum errors.

EMPIRICAL RESULTS

Preliminary regression estimates showed pronounced serial correlation in the residuals for practically all equations tested, indicating either incomplete or improper specification of the model. Since the main focus of this paper is on the forecasting role of expectational variables in the context of relatively simple standard models, we decided to improve the fit by incorporating the autoregressive structure of the disturbances into the model. Hence lagged dependent variables were introduced into all equations. In a number of equations both one- and two-period lag terms proved to be useful.[16]

[16] There is no simple interpretation of what lagged dependent variables represent in a regression model. One possibility is that they stand for the influence of variables that should be included in the model but have been omitted. Another is that they stand for the influence of lagged values of the independent variables. If the true lag structure happens to take the form of geometrically declining weights for successive past values of all the independent variables, the appropriate specification is to add the lagged dependent variable to the right-hand side of the equation. If the lag structure is more complicated—say, the weights rise to a peak and then decline—the addition of one- and two-period lagged dependent variables may be the appropriate form.

An additional reason for the introduction of lagged values of the dependent variable is that a purely autoregressive model provides a benchmark against which to measure the explanatory power of the substantive part of the model. It was noted earlier that the period covered by the Census intentions survey is largely dominated by a strong cyclical upswing, and that such a period cannot constitute a very satisfactory test for alternative demand models involving different anticipatory variables. One characteristic of such a period is that it can be rather fully explained by an autoregressive model. Asking whether alternative anticipations variables add significantly to the explanation provided by an autoregressive model is thus a much more satisfactory test than asking whether anticipatory variables explain significant amounts of the total variance.

To the several hypotheses outlined above we therefore add one more: A naive or autoregressive model does as well as any of the substantive ones. Designating this hypotheses as N, putting the appropriate lag structure into the equations corresponding to the alternative A . . . C_2 hypotheses, and representing expectations by the SRC index of consumer attitudes (A) and unspecified variables by Z, Z_1, Z_2 . . . , we have:

Hypothesis

N: $x_t = b_0 + b_1 x_{t-1} + b_2 x_{t-2} + u_{x_t}$

A: (2.2) $x_t = b_0 + b_1 p + b_2 x_{t-1} + b_3 x_{t-2} + u_{x_t}$

B-1: (3.1) $x_t = b_0 + b_1 Y + b_2 A + b_3 x_{t-1} + b_4 x_{t-2} + u_{x_t}$

B-2: (4.1) $x_t = b_0 + b_1 Y + b_2 A + b_3 p + b_4 x_{t-1} + b_5 x_{t-2} + u_{x_t}$

C-1: $\hat{r}_t = \bar{R}$

(5.4) $\hat{s}_t \equiv \dfrac{x_t - p_t \bar{R}}{q_t} = b_0 + b_1 Y + b_2 A + b_3 Z + b_4 \hat{s}_{t-1} + b_5 \hat{s}_{t-2} + u_{\hat{s}_t}$

(5.42) $\hat{x}_t = p_t \bar{R} + q_t s_t^\circ$.

For our purposes, it is not necessary to choose between these alternative interpretations. Putting the autoregressive structure of the disturbances to use by adding one or more lagged dependent variable to the equation will optimize the forecasting accuracy of the model whether or not these terms stand for omitted variables or for a distributed lag structure. If one were interested in the size of the parameters, however, it would be necessary to specify an interpretation.

C-2: (5.4) $\hat{s}_t = \dfrac{x_t - p_t\bar{R}}{q_t} = b_0 + b_1Y + b_2A + b_3Z + b_4\hat{s}_{t-1} + b_5\hat{s}_{t-2} + u_{\hat{s}_t}$

(5.73) $\hat{r}_t \equiv \dfrac{x_t - q_t s_t^\circ}{p_t} = b_4 + b_5Z_1 + b_6Z_2 + u_{\hat{r}_t}$

(5.91) $\hat{x}_t = p_t r_t^\circ + q_t s_t^\circ$

The above equations are fitted to estimates of new automobile purchase rates obtained by dividing personal consumption expenditures on automobiles by the average retail price of new automobiles. Both survey variables are measured during the first quarter of the purchase period, while income is measured as the average for the survey quarter and the two prior quarters. The dependent variables—the population purchase rate for new automobiles (x) and the purchase rate for nonintenders (s)—are measured for alternative time spans involving six, nine, or twelve months.

After some experimentation with the earliest available Census intentions data (1959-I), it was decided to fit regressions over the period 1960-I through 1967-III. The first two Census surveys appear to be markedly out of line with the others, which can plausibly be attributed to the fact that both interviewers and respondents must be "broken-in" to any new survey vehicle. The 1959-III and 1959-IV surveys cannot be used because one of the lagged dependent variables for these quarters must be estimated from 1959-II data. The most recent survey variables included in the regressions are for 1966-IV; one of the dependent variables for that quarter covers the latest period for which purchase data are available (1967-III) at current writing.

The results are summarized in panels 1 through 5 of Table 5-2. The autoregressive equation in panel 1 indicates that the test period is relatively easy to explain statistically: Most of the variance in purchase rates is due to the prolonged upward movement from 1961 through the first part of 1966. Panels 2, 3, and 4 clearly contradict all of the extreme hypothesis outlined above. The naive hypothesis (panel 1) is contradicted by the fact that both survey variables contribute significantly to explained variance (panels 2, 3, or 4). Hypothesis A, that both intender (r) and nonintender (s) purchase rates are random and hence that other variables are of no value, is contradicted by the finding that the index of consumer attitudes has a significant partial correlation with purchases, holding constant the proportion of in-

TABLE 5-2. Tests of Alternative Hypotheses About Equation Specification for Demand Models With a Buying Intentions Variable

Dependent Variable	Independent Variables (t ratios)	Regression Statistics [a] R^2	SE	DW
	Panel 1. Naive Model: Autoregressive Equation			
$x_6 =$	$1.35 + 1.144x_{-1} - 0.252x_{-2}$ (5.8) (1.3)	.890	0.46	1.45
$x_9 =$	$0.96 + 1.350x_{-1} - 0.426x_{-2}$ (7.7) (2.5)	.937	0.34	1.77
$x_{12} =$	$0.80 + 1.477x_{-1} - 0.542x_{-2}$ (8.7) (3.2)	.955	0.28	1.91
	Panel 2. Hypothesis A: r, s Random Variables			
$x_6 =$	$-1.72 + 0.820x_{-1} - 0.405x_{-2} + 0.320p^*$ (5.4) (2.9) (5.1)	.946	0.32	1.75
$x_9 =$	$-0.95 + 1.024x_{-1} - 0.470x_{-2} + 0.232p^*$ (5.9) (3.3) (3.5)	.957	0.28	2.22
$x_{12} =$	$-0.68 + 1.262x_{-1} - 0.663x_{-2} + 0.202p^*$ (7.7) (4.4) (3.0)	.966	0.24	2.01
	Panel 3. Hypothesis B-1: r, s Functions Have Identical Parameters			
$x_6 =$	$-9.34 + 0.726x_{-1} - 0.187x_{-2} + 0.100A + 0.076Y_e$ (3.9) (1.1) (4.1) (2.0)	.932	0.36	1.48
$x_9 =$	$-6.96 + 0.982x_{-1} - 0.352x_{-2} + 0.077A + 0.058Y_e$ (5.2) (1.9) (3.2) (1.8)	.954	0.29	1.46
$x_{12} =$	$-3.04 + 1.254x_{-1} - 0.447x_{-2} + 0.042A + 0.019Y_e$ (5.9) (2.1) (1.6) (0.6)	.957	0.27	1.73
	Panel 4. Hypothesis B-2: r, s Functions Differ Only in Their Respective Constant Terms			
$x_6 =$	$-5.91 + 0.668x_{-1} - 0.240x_{-2} + 0.057A + 0.267p^*$ (4.8) (1.8) (3.0) (4.7)	.960	0.28	1.79
$x_9 =$	$-5.58 + 0.722x_{-1} - 0.252x_{-2} + 0.058A + 0.233p^*$ (4.3) (1.9) (3.4) (4.2)	.971	0.23	1.93
$x_{12} =$	$-4.57 + 0.945x_{-1} - 0.480x_{-2} + 0.047A + 0.235p^*$ (5.2) (3.3) (2.8) (3.9)	.974	0.21	1.92
	Panel 5. Hypothesis C-1: r Function Random, s Function Systematic			
$\hat{s}_6 =$	$-10.96 + 0.332s_{-1} + 0.095A + 0.176p^*_{-1}$ (2.8) (4.0) (3.3)	.864	0.28 [b]	1.15
$\hat{s}_9 =$	$-12.28 + 0.249s_{-1} + 0.112A + 0.180p^*_{-1}$ (2.0) (4.8) (3.8)	.895	0.24 [b]	1.08
$\hat{s}_{12} =$	$-10.12 + 0.376s_{-1} + 0.103A + 0.112p^*_{-1}$ (2.2) (3.4) (2.1)	.872	0.25 [b]	1.09

[a] The DW statistic is biased towards a value of 2.0 because lagged dependent variables have been included in the model. The presence of serially correlated residuals cannot therefore be gauged by the usual tests. R^2 and SE values are adjusted for degrees of freedom. All equations are fitted with a dummy (1,0) variable to represent the influence of the automobile strike in 1964-IV. The dummy usually has a significant t ratio.

Variables are as follows (more complete definitions and basic data are in Appendix Table 2): x_6, x_9, x_{12} = six-month, nine-month, and twelve-month purchase rate for new automobiles, based on estimates of consumer expenditures for new cars and the estimated average retail price. A = SRC index of consumer attitudes, 1956 = 100. p^* = weighted Census Bureau intentions to buy cars, the weights being rough *a priori* approximations to mean ex ante purchase probability for different classes of intenders. Y_e = per family real disposable income, averaged for the survey quarter and the preceding six months. $\hat{s}_6, \hat{s}_9, \hat{s}_{12}$ = the estimated purchase rate of nonintenders. Estimates are based on the assumption that intender purchase rates are constant at the levels implied by the weights used in construction of the p series.

[b] Estimated from x equation: $\hat{x} = p\bar{r} + qs^\circ$, where $\hat{x}$ is the predicted values of x, p and q are the proportions of intenders and nonintenders in the survey, $\bar{r}$ is the fixed purchase rate of intenders, and s° is the predicted value of s from the equations in panel 5.

tenders (panel 4). Hypothesis B-1, that both *r* and *s* functions have identical parameters and hence that the intentions variable is of no value, is also contradicted by the results in panel 4; intentions clearly have a significant partial correlation with purchases.[17]

The next hypothesis, B-2, which states that the *r* and *s* functions are identical except for a difference in the value of the constant term, is not clearly contradicted by any of the evidence. The p^* coefficient (which should be roughly equal to the difference between intender and nonintender purchase rates) has about the right order of magnitude, and the fits are quite good for all purchase periods.

These equations essentially say that automobile purchase rates can be explained by the autoregressive structure of the data and by the two survey variables *A* and p^*. Income does not appear in the equation, apparently because the lagged dependent variables swallow up its trend effect while the survey variables pick off its cyclical movements.

Tests of hypothesis C-1, given in the last panel, show results that are about on a par with tests of B-2. For the nonintender purchase rate function, the dependent variable is estimated from the observed population purchase rate on the assumption that intender purchase rates are constant. This estimated variable is best explained by the index of consumer attitudes (*A*) and lagged buying intentions (p^*_{-1}). It should be noted that lagged rather than current buying intentions play a role in the *s* equation: Current intentions add nothing to the explanation of variance. A possible explanation is that changes in the desired level of automobile stocks constitute a kind of "social disease" which infects intenders first and nonintenders subsequently. Intenders are, after all, simply those who have reported an awareness that they are likely to purchase a car. Thus they may differ from nonintenders, among other reasons, partly because they react more quickly to the same economic stimuli which eventually will cause reactions throughout the population.

Although the proportion of explained variance in the nonintender purchase rate equations is markedly lower than in panels where popula-

[17] Although income is not included as one of the independent variables in the panel 4 regressions, it would make no difference to the results; income has a *t* ratio of less than unity in the panel 4 equation, apparently being redundant to a combination of the lagged dependent variable and buying intentions.

tion purchase rates are the dependent variable, the standard error of population purchase rate prediction based on these nonintender equations is just about the same as in the best of the direct estimates. The standard error calculations in panel 5 are not the standard errors applicable to the equations shown in that panel. Rather, they are the standard errors applicable to the x equations, which correspond to, and are estimated from, the s equations.

On the whole, however, the purchase rate functions in panel 5 are not very satisfactory. They provide no evidence to support the a priori argument that hypothesis C-1 is a better description of reality than, say, hypothesis B-2. I have not found any sensible way to rectify the shortcoming of these nonintender equations, although it is easy to add variables which provide much better fits in the s equation as well as substantially smaller standard errors in the x equations derived from them. For example, the inclusion of income in the panel 5 equations produces a marked increase in explained variance and reduction in standard error. However, income enters with a negative sign whether it is measured with a lag (expected income) or contemporaneously (actual income). I can think of no reasonable explanation for the empirical finding that income exerts a negative effect on nonintender purchase rates. Expected income might well have this effect, since it could easily be standing for unexpected income change. However, not only expected but also actual income have strongly significant and negative regression coefficients in these equations, and the inclusion of both, which provides a measure of unexpected income change, yields a negative coefficient for expected income and either an additional negative coefficient for actual income or a coefficient of approximately zero.

Tests of hypothesis C-2 (the assumption that a random r variable is an oversimplification and that r is functionally related to other variables), were inconclusive. If variations in intender purchase rates are not in fact random but can be explained, C-2 should yield better estimates of the population purchase rate than C-1. But neither income, the index of consumer attitudes, the weighted proportion of intenders, nor the lagged dependent variable prove to have any association at all with "predicted" intender purchase rates. For the limited number of independent variables against which predicted values of r were regressed, the adjusted R^2 was always 0: the series of predicted r values appears to be wholly random.[18] This result is consistent either with hypothesis C-1 (that the r and s functions are quite different, r being random and s systematically related to other variables) or with hypothesis B-2 (that the r and s functions are identical except for the constant). If the latter happens to be the case, the s function specified by hypothesis C-1 will pick up all of the systematic variation in r as well as in s, leaving no systematic variation in r to be explained.

Although the evidence does not give any clear advantage to either the B-2 or C-1 hypotheses, the structure of the underlying model seems to me more satisfactory for the latter. Both provide very close fits to the observed purchase rate. In fact, the fit of B-2 is so good that I do not view the inability of C-1 to improve the fit as constituting strong evidence against it. Hence, I conclude that, although improper specification arising out of differences in intender and nonintender purchase rate functions has not (during the 1959–67 period) adversely affected the fit of equations that include an intentions variable and has not, therefore, been a source of error in measuring the time-series contribution of intentions surveys, nonetheless, this type of specification error is probably characteristic of demand models incorporating an intentions variable. It is more accurate, in my judgment, to treat intender purchase rates as a random variable with a fixed mean value than as being determined by the parameters and variables in the nonintender purchase rate function. And nonintender purchase rates, in turn, appear to be most accurately described as a function of the consumer attitude index and lagged buying intentions. Thus, both types of anticipatory surveys are essential ingredients in demand models. Intentions surveys provide data on the proportions of various classes of intenders (to whom fixed purchase rates can be applied) and the proportion of nonintenders. Attitude surveys provide the data needed to estimate the purchase rate of nonintenders.

It should be noted that the above analysis can readily be applied

[18] If the predicted r variable from equation (5.73) is a random variable, then the variance of predicted r is equal to the variance of the error term in that equation, u_r, the constant is equal to the mean value of predicted r, and the regression coefficients of all independent variables are zero. If this is the case, it can easily be shown that the error term for equation (5.91) pu_r is precisely the same as the error term for equation (5.42) qu_s.

to a new body of survey data which measures subjective purchase probabilities directly rather than intentions or plans to purchase. The basic structure of the C-1 equation specifies a distinction in the time-series variability of purchase rates in two subgroups of households—those who have so classified themselves that their purchase rates can be presumed largely or wholly independent of other factors, and those who have not. The first group is taken to comprise intenders in the above analysis, but could equally well be viewed as comprising households reporting purchase probabilities in excess of some specified level. The second group is taken to comprise nonintenders in the above analysis but could evidently be viewed as comprising those with purchase probabilities at or below some specified level. In short, high-probability households may have stable purchase rates that do not need to (and cannot be) explained, while low- or zero-probability households may have purchase rates that vary systematically with other factors and hence do need to be explained. There would of course be differences between the proportions of the population in the two groups depending on whether intentions or probabilities were the basis for the classification, but the general principle seems applicable to either basis of classification.

DEFLATION BIAS

A second type of specification error arises from the use of deflated per capita (or per household) expenditures as the variable to be explained in a model of durable goods demand. In most such models [e.g., those in 3, 10, 13] the influence of both price and population movements are ordinarily removed from both dependent and independent variables, since otherwise common trends are likely to be imposed on both. But the resulting model seems clearly misspecified.

For simplicity of both analysis and empirical testing, we deal only with demand for a single product—automobiles. We can define: M_t as the rate of consumer expenditures on new automobiles, V_t as the average unit price of new automobiles, S as unit sales to consumers of new automobiles, P_a as the price index of new automobiles, and H as the number of households in the population. Dropping the time subscripts for convenience, M can be expressed as SV. Deflated per household expenditure, M^*, can be expressed as $\frac{M}{HP_a}$. Thus,

$$M^* = \frac{M}{HP_a} = \frac{SV}{HP_a} = \frac{S}{H}\left(\frac{V}{P_a}\right).$$

The first of the two terms on the right hand side is the purchase rate, denoted as x, while the second is the real price per unit, denoted as V^*.

$$x = \frac{S}{H}$$

$$V^* = \frac{V}{P_a};$$

hence,

$$M^* = xV^*.$$

Demand models seeking to explain M^* evidently should be structured in terms of a multiplicative relation involving the two component variables, x and V^*. The only exception arises when either x or V^* are best described as random variables with constant mean values. In that case, the appropriate M^* equation is simply a linear transformation of the function for the component which contains systematic variation. That is, if

$$x = f(Z) \quad \text{and} \quad V^* = \bar{V}^* + u,$$

$$M^* = \bar{V}^* f(Z) = f'(Z),$$

where the x and M^* functions differ only by a multiplicative constant.

Thus we have alternative demand models for M^*: we can write either

(1) $M^* = f(Z_1)$, where
$M^* = xV^*$, or

(2) $M^* = f(Z_2) \cdot f(Z_3)$,

where

(2.1) $x = f(Z_2)$,

(2.2) $V^* = f(Z_3)$.

Let us look first at empirical estimates of equations 2.1 and 2.2, the two components of real expenditures per family. Regressing both x and V^* on a common set of parameters indicates that the relevant independent variables are entirely different. The numbers below the regression coefficients are t ratios; the independent variables are weighted buying intentions (p^*), the index of consumer attitudes (A), real per family disposal income in the recent past (Y_e), and a dummy variable (D) reflecting the shift of purchases (between the last quarter of 1964 and the first half of 1965) induced by the automobile strike in late 1964. The R^2 and standard error (SE) values are both adjusted for degrees of freedom.

$$(2.10) \quad \underset{}{x} = \underset{(5.0)}{4.15p^*} + \underset{(4.4)}{1.03A} + \underset{(0.6)}{0.23Y_e} + \underset{(1.5)}{3.50D} - 108, \qquad R^2 = 0.942,\ SE = 3.27,\ DW = 1.27$$

$$(2.20) \quad V^* = \underset{(0.2)}{0.17p^*} - \underset{(-0.9)}{0.18A} + \underset{(9.7)}{3.07Y_e} + 100, \qquad R^2 = 0.964,\ SE = 2.94,\ DW = 0.87$$

The survey variables p^* and A dominate the purchase rate equation, while income dominates the real price per unit equation. A look at the x and V^* series indicates that changes in unit purchase rates are the dominant cyclical component in the expenditure series, while changes in real price per car (= increased quality per unit) are dominantly a secular influence. The cyclical movements in purchase rates are captured by the survey variables p^* and A, while the secular movements in real price per unit are captured by income. It will come as no surprise that regressing real expenditures on the same variables shows all three to be highly significant.

$$(1.0) \quad M^* = \underset{(4.4)}{11.7p^*} + \underset{(4.0)}{2.97A} + \underset{(4.3)}{4.81Y_e} + \underset{(2.1)}{15.5D} - 576, \qquad R^2 = 0.966,\ SE = 10.5,\ DW = 1.10$$

The "best" x, V^* and M^* functions are slightly different from the ones just summarized. Introduction of a distributed lag structure considerably improves the fit and seems plausible on a priori grounds; all independent variables continue to be highly significant with the exception of Y_e in the M^* equation. The best fitting lag structure usually but not always involves geometrically declining weights.

$$(2.11) \quad x = \underset{(4.3)}{2.32p^*} + \underset{(3.6)}{0.59A} + \underset{(2.2)}{3.41D} + \underset{(4.4)}{0.72x_{-1}} \underset{(1.9)}{-0.25x_{-2}} - 56. \qquad R^2 = 0.972,\ SE = 2.27,\ DW = 2.01$$

Alternatively,

$$(2.12)\quad x = \underset{(4.4)}{2.18p^*} + \underset{(4.5)}{0.80A} - \underset{(2.2)}{0.58A_{-1}} + \underset{(2.0)}{2.90D} + \underset{(5.2)}{0.87x_{-1}} - \underset{(2.4)}{0.30x_{-2}} - 30. \qquad R^2 = 0.976 \quad SE = 2.10 \quad DW = 2.26$$

$$(2.21)\quad V^* = \underset{(4.8)}{1.61Y_e} + \underset{(4.6)}{0.52V^*_{-1}} + 34. \qquad R^2 = 0.980 \quad SE = 2.19 \quad DW = 1.86$$

$$(1.1)\quad M^* = \underset{(3.7)}{7.8p^*} + \underset{(3.6)}{2.08A} + \underset{(1.2)}{1.33Y_e} + \underset{(3.0)}{16.1D} + \underset{(4.7)}{0.48M^*_{-1}} - 319. \qquad R^2 = 0.982 \quad SE = 7.7 \quad DW = 1.73$$

As before, the "best" x and V^* equations indicate quite different roles for the two survey variables and for income. The survey variables dominate the purchase rate equation, and income does not even appear; income would have a small negative coefficient in equation (2.11) and a t ratio of less than unity. For the real price equation, in contrast, neither survey variable appears and income is the only significant variable other than the lag term.

The analysis suggests that equation $2[M^* = f(Z_2) \cdot f(Z_3)]$ should give a better empirical fit than equation $1[M^* = f(Z_1)]$. The "best" estimate of the latter (equation 1.1) has a very close relationship to actual expenditures and there is limited room for possible improvement in fit. Equation (2) says that the appropriate form of the M^* equation is a multiplicative version of the underlying x and V^* equations. If both equations have constant terms, as they do, proper specification would involve all of the independent variables that appear in either the x or V^* equations plus all the possible cross-product terms involving variables that appear in either. Selecting equation (2.10) for x and (2.20) for V^*, for example, implies fitting an M^* equation with sixteen terms and comparing its characteristics to those of equation (1.0). If the x and V^* equations are more complicated, as in equations (2.11) and (2.21), there are even more terms in the multiplicative equation. Given the limited number of truly independent observations available in a time series with autoregressive characteristics, it was judged inadvisable to estimate an equation with that many variables.

The tabulation below compares adjusted R^2 values and incremental F ratios for two additive M^* equations and several versions of the associated multiplicative equation. I did not conduct systematic tests to determine the maximum obtainable adjusted R^2 for the multiplicative equations, but simply experimented with a limited number of equations involving different terms of the sort that should appear in the latter equation. Since all the multiplicative equations actually estimated are missing most of the relevant cross-product terms, the regression coefficients are highly unstable and are often implausible. What matters, however is whether any of the independent variables implied by the multiplicative equation contribute significantly to the explanation of variance in M^*, and the F ratio is a measure of this contribution. The results suggest that the multiplicative relation is in fact superior; some of the F ratios shown in the tabulation below are highly significant.

Equation Type and Independent Variables	R^2	*SE*	*DW*	*F Ratio* [a]
Additive (1.0)				
$M^* = f(p^*, A, Y_e, D)$	.966	10.5	1.10	–
Multiplicative (2.10 × 2.20)				
$M^* = f(p^*, A, Y_e, D, p^*Y_e)$	.973	9.4	1.00	6.4 [b]
$M^* = f(p^*, A, Y_e, D, p^*Y_e, AY_e)$	.972	9.5	1.03	3.5
Additive (1.1)				
$M^* = g(p^*, A, Y_e, D, M^*_{-1})$	.982	7.7	1.73	–
Multiplicative (2.11 × 2.21)				
$M^* = g(p^*, A, Y_e, D, x_{-1}, x_{-2}, V^*_{-1})$	.983	7.4	2.17	1.9
$M^* = g(p^*, A, Y_e, D, x_{-1}, x_{-2}, V^*_{-1}, p^*Y_e)$	.989	6.0	2.38	5.9 [c]
$M^* = g(p^*, A, Y_e, D, x_{-1}, V^*_{-1}, p^*Y_e)$	.990	5.8	2.37	9.2 [c]

[a] F ratio for incremental explained variance. multiplicative equation relative to associated additive equation.
[b] F ratio significantly different from unity at 5 per cent level.
[c] F ratio significantly different from unity at 1 per cent level.

Hence I conclude, tentatively, that a multiplicative relation

$$M^* = f(Z_2) \cdot f(Z_3), \quad \text{where}$$

$$x = f(Z_2) \quad \text{and} \quad V^* = f(Z_3),$$

is the appropriate specification for a deflated expenditure equation.

IV. AN APPRAISAL OF SOME EXISTING TIME-SERIES MODELS

This section examines a number of relatively simple demand models that make use of consumer anticipations data, focusing mainly on an examination of forecasting accuracy. Models similar to some of the ones examined here were originally fitted to data covering the 1950's and the early 1960's. For these, an ex ante measure of forecast accuracy can be generated by extrapolating the model beyond the original period of fit. Next, the stability of the parameters in the various models can be examined by comparing parameter estimates for different periods of fit. Finally, the forecasts generated by the substantive (anticipations) models can be compared with a realistic benchmark—forecasts from autoregressive models which use only lagged values of the dependent variable.

The purpose of this excursion into forecast models is not to bestow praise on "winners" or cast blame at "losers," although one objective is certainly to find out if being a "winner" is a serially correlated property of forecast models. More important aims are to examine the stability of the parameters of alternative models, to find out if the models contain any information about the future other than some extrapolative element of the variable to be forecast, and to measure the consistency and importance of the apparent contribution of consumer survey data.

All the models examined below have a relatively simple structure. The dependent variables all measure expenditures during the six months after the survey quarter, that is, the quarter in which the survey data are obtained. Independent variables are per household deflated disposable income during the six months prior to a survey quarter (Y_{-6}), the difference between income of the survey quarter and past income (ΔY), the SRC index of consumer attitudes (A) and a buying intentions variable (p^*) that is a spliced series consisting of weighted Census Bureau QSI data from 1959 to date and essentially unweighted SRC intentions data before 1959. A lagged dependent variable is included in some models. Alternative dependent variables are deflated per household expenditures on automobiles and parts during the six months after the survey quarter (M_6), deflated per household expenditures on total durables during the six months after the survey quarter (D_6), and the two ratios M_6/Y_{-6} and D_6/Y_{-6}. The denominators of the last two variables use past rather than contemporaneous income, both because it was desirable to have all variables predetermined except for expenditures and because it also seemed desirable to eliminate the possible causal association running from expenditures in a given period to disposable income of the same period.

The models are fitted to a number of different time spans. One of the most extensive recent investigations of the role of consumer anticipations in durable goods demand models is Eva Mueller's 1963 study, which estimated relationships from surveys covering the 1953–61 period; since the dependent variable (purchases) extends two quarters beyond the last survey quarter, Mueller's data actually go through the second quarter of 1962. Other recent studies (Friend and Adams and the Suits chapter in the Brookings-SSRC model) use the 1953–62 period. Hence, we start with the fit period 1953–61 and generate forecasts for the period 1962–67. Other fit periods are obtained by adding additional quarters to the original 1953–61 span. Parameters are also estimated for periods constructed by removing observations from the beginning of the fit period and simultaneously adding an equal number of observations to the end; the extrapolation periods are the same as for spans in which all observations are retained. This second set of parameters is designed to get a better measure of the influence of the buying intentions variable, which, as indicated above, is a spliced series.[19]

Table 5-3 summarizes the parameter estimates for alternative forms of two simple demand models. Equation (1) is the model found to be optimum by Mueller [11] after investigation of a large number of po-

[19] From Section II we know that the part of the p^* series based on SRC data is subject to much larger sampling and other measurement errors than the part based on Census QSI data. Hence, we have a more accurate measure of intentions for the period from 1959 to date than for 1953–58, and dropping observations in the latter period should tend to improve the usefulness of the intentions variable.

It should be noted that the procedure of dropping pre-1959 observations does not provide a really satisfactory test of the role of buying intention in time-series models. The 1960's, the period for which Census intentions data are available, has been trend-dominated until quite recently, while the 1950's showed virtually no trend in durables purchases from 1953 onward but contained large cyclical fluctuations.

TABLE 5-3. Regression Statistics for Alternative Prediction Models and Fit Periods, 1953–67

Fit Periods	Regression coefficients (t ratios): Equation 1		Equation 2			DW		$\bar{R}^2$		$\overline{SE}$ (billions of dollars)		Forecast Error (billions of dollars)	
	Y_{-6} [a]	A	Y_{-6} [a]	A	p^*	Eq. 1	Eq. 2	Eq. 1	Eq. 2	Eq. 1	Eq. 2	Eq. 1	Eq. 2
				A: M_6 Dependent									
	(2.8)	(4.7)	(1.3)	(3.5)	(2.2)								
1953-II–1962-II	.061	.323	.032	.250	.101	1.47	1.72	.505	.588	1.38	1.26	2.90	3.18
	(5.3)	(5.8)	(2.8)	(4.5)	(2.3)								
1953-II–1962-III	.076	.341	.049	.275	.098	1.44	1.62	.671	.720	1.29	1.19	2.27	2.37
	(7.9)	(6.2)	(3.6)	(4.7)	(2.7)								
1953-II–1964-III	.092	.358	.059	.280	.110	1.30	1.51	.759	.802	1.29	1.17	1.26	1.66
	(12.2)	(7.3)	(5.3)	(5.8)	(2.7)								
1953-II–1966-I	.101	.378	.071	.312	.105	1.35	1.46	.890	.907	1.24	1.14	1.05	1.19
	(18.6)	(8.0)	(7.5)	(6.0)	(2.7)								
1953-II–1967-II	.103	.346	.078	.280	.099	1.29	1.38	.918	.930	1.19	1.10	–	–
				B: M_6/Y_{-6} Dependent									
	(2.5)	(3.1)	(2.5)	(3.0)	(2.0)								
1953-II–1962-II	.078	.071	.075	.064	.023	1.46	1.51	.622	.676	1.24	1.16	2.57	1.49
	(2.4)	(3.6)	(2.6)	(3.3)	(2.8)								
1953-II–1963-III	.072	.077	.070	.064	.025	1.32	1.47	.609	.694	1.24	1.09	2.82	1.55
	(3.2)	(3.4)	(3.0)	(3.4)	(3.8)								
1953-II–1964-III	.089	.072	.071	.062	.028	1.16	1.46	.616	.741	1.27	1.04	3.01	1.69
	(3.0)	(4.2)	(2.5)	(4.0)	(5.1)								
1953-II–1966-I	.081	.093	.054	.069	.032	1.16	1.55	.674	.813	1.40	1.06	3.77	1.90
	(3.0)	(3.0)	(2.2)	(3.6)	(7.0)								
1953-II–1967-II	.086	.069	.045	.056	.038	0.77	1.44	.550	.802	1.66	1.11	–	–

C: M_6 Dependent, Earliest Data Dropped as Fit Period Is Extended													
1953-II–1962-II	.061 (2.8)	.323 (4.7)	.032 (1.3)	.250 (3.5)	.101 (2.2)	1.47	1.72	.505	.588	1.38	1.26	2.90	3.18
1955-III–1963-III	.076 (3.8)	.326 (5.6)	.055 (2.4)	.280 (4.5)	.088 (1.6)	1.61	1.53	.651	.677	1.20	1.15	2.29	2.18
1957-I–1964-III	.117 (6.1)	.286 (4.0)	.097 (4.5)	.221 (2.9)	.083 (1.7)	1.34	1.42	.840	.855	1.01	0.96	0.85	0.71
1959-III–1966-I	.156 (8.0)	.152 (1.3)	.052 (1.7)	.202 (2.3)	.258 (3.9)	1.29	1.32	.942	.967	0.86	0.65	3.18	0.90
1961-II–1967-II	.116 (17.9)	.328 (7.2)	.066 (6.1)	.186 (4.5)	.230 (5.1)	1.08	2.45	.949	.978	0.78	0.52	—	—
D: M_6/Y_{-6} Dependent, Earliest Data Dropped as Fit Period Is Extended													
1953-II–1962-II	.078 (2.5)	.071 (3.1)	.075 (2.5)	.064 (3.0)	.023 (2.0)	1.46	1.51	.622	.676	1.24	1.16	2.57	1.49
1955-III–1963-III	.054 (1.7)	.082 (4.0)	.065 (2.2)	.066 (3.3)	.029 (2.2)	1.63	1.65	.633	.697	1.16	1.06	2.81	1.46
1957-I–1964-III	.051 (1.7)	.096 (3.9)	.070 (3.1)	.032 (1.3)	.043 (4.0)	1.24	1.48	.650	.804	1.11	0.83	2.77	1.28
1959-III–1966-I	.011 (0.3)	.168 (4.9)	.018 (1.1)	.035 (1.4)	.068 (7.4)	1.72	1.14	.704	.922	1.27	0.65	4.34	1.01
1961-II–1967-II	.016 (0.4)	.086 (2.4)	−.009 (0.7)	.054 (4.4)	.066 (12.5)	0.28	2.16	.349	.929	1.67	0.56	—	—

(continued)

TABLE 5-3 (concluded)

Fit Periods	Regression coefficients (t ratios) Equation 1 Y_{-6} [a]	Equation 1 A	Equation 2 Y_{-6} [a]	Equation 2 A	Equation 2 p^*	DW Eq. 1	DW Eq. 2	$\bar{R}^2$ Eq. 1	$\bar{R}^2$ Eq. 2	$\overline{SE}$ (billions of dollars) Eq. 1	$\overline{SE}$ Eq. 2	Forecast Error (billions of dollars) Eq. 1	Forecast Error Eq. 2
E: D_6 Dependent Variable													
	(5.3)	(5.0)	(3.7)	(3.9)	(1.4)								
1953-II–1962-II	.138	.415	.114	.354	.084	1.32	1.36	.644	.662	1.65	1.61	6.93	7.17
	(9.2)	(6.1)	(6.1)	(4.8)	(1.4)								
1953-II–1963-III	.164	.448	.142	.394	.080	1.27	1.27	.806	.814	1.61	1.58	6.04	6.13
	(11.6)	(5.6)	(6.4)	(4.3)	(1.7)								
1953-II–1964-III	.207	.498	.172	.417	.115	0.86	0.92	.841	.852	1.97	1.91	3.09	3.61
	(17.7)	(6.9)	(8.9)	(5.5)	(1.5)								
1953-II–1966-I	.228	.556	.200	.494	.098	0.92	0.89	.932	.934	1.94	1.90	2.12	2.39
	(27.4)	(7.2)	(12.4)	(5.5)	(1.4)								
1953-II–1967-II	.239	.492	.218	.437	.084	0.86	0.81	.956	.957	1.88	1.86	–	–
F: D_6/Y_{-6} Dependent Variable													
	(2.9)	(3.4)	(2.9)	(3.2)	(1.5)								
1953-II–1962-II	.105	.089	.102	.082	.019	1.40	1.36	.679	.698	1.43	1.39	6.25	5.14
	(2.5)	(3.7)	(2.7)	(3.4)	(2.4)								
1953-II–1963-III	.096	.100	.093	.085	.029	1.10	1.20	.627	.690	1.55	1.41	7.01	5.25
	(3.4)	(2.5)	(3.4)	(2.4)	(4.1)								
1953-II–1964-III	.154	.085	.124	.067	.047	0.75	1.01	.571	.728	2.01	1.60	6.96	4.27
	(3.6)	(3.3)	(3.4)	(3.0)	(6.0)								
1953-II–1966-I	.166	.126	.114	.081	.061	0.82	1.16	.650	.830	2.41	1.68	8.61	4.71
	(3.3)	(1.6)	(2.9)	(1.7)	(8.4)								
1953-II–1967-I	.186	.074	.100	.047	.081	0.43	0.99	.458	.809	3.27	1.94	–	–

G: D_6 Dependent, Earliest Data Dropped as Fit Period Is Extended

1953-II–1962-II	.138 (5.3)	.415 (5.0)	.114 (3.7)	.354 (3.9)	.084 (1.4)	1.32	1.36	.644	.662	1.65	1.61	6.93	7.17
1955-III–1963-III	.181 (7.6)	.438 (6.4)	.172 (5.9)	.418 (5.3)	.039 (0.6)	1.45	1.37	.802	.794	1.42	1.45	5.18	5.13
1957-I–1964-III	.288 (9.6)	.322 (2.9)	.267 (7.6)	.254 (2.0)	.087 (1.1)	0.84	0.87	.897	.899	1.56	1.55	1.73	1.58
1959-III–1966-I	.335 (11.2)	.154 (0.9)	.220 (4.0)	.209 (1.3)	.286 (2.4)	0.94	1.00	.965	.972	1.32	1.18	5.11	1.38
1961-II–1967-II	.270 (24.4)	.458 (5.9)	.188 (9.6)	.224 (3.0)	.376 (4.6)	0.97	1.81	.969	.985	1.34	0.94	—	—

H: D_6/Y_{-6} Dependent, Earliest Data Dropped as Fit Period Is Extended

1953-II–1962-II	.105 (2.9)	.089 (3.4)	.102 (2.9)	.082 (3.2)	.019 (1.5)	1.40	1.36	.679	.698	1.43	1.39	6.25	5.14
1955-II–1963-II	.076 (2.0)	.106 (4.2)	.089 (2.4)	.087 (3.5)	.032 (2.0)	1.29	1.35	.668	.711	1.43	1.33	6.08	4.48
1957-I–1964-III	.116 (2.1)	.129 (2.8)	.154 (3.7)	.005 (0.1)	.083 (4.3)	.72	1.05	.576	.776	2.08	1.51	6.48	3.02
1959-III–1966-I	.064 (1.1)	.272 (4.5)	.076 (3.0)	.027 (0.7)	.125 (9.0)	1.46	1.43	.721	.946	2.23	.98	9.58	1.83
1961-II–1967-II	.100 (1.1)	.085 (1.1)	.042 (1.8)	.014 (0.7)	.145 (15.9)	.17	2.59	.211	.945	3.58	.94	—	—

(Table notes are on following page)

tential explanatory variables. Equation (2) is the same model with the spliced buying intentions variable included. A slightly different version of both models is also estimated. The dependent variable (either automobile or total durable expenditure) is put in the form of a ratio to past income, and an additional independent variable (past change in income) is used. Separate regressions are estimated for automobiles and for total durable goods expenditures, and data are shown for alternative sets of five sequential fit periods. Reading vertically, the columns indicate the change in regression coefficients, standard errors, etc., as the fit period is altered either by adding observation or by both adding and dropping observations simultaneously.

One of the first things to note is that the parameter estimates of equation (1) in the 1953–61 period are by no means the same as originally estimated in [11] simply because the basic income and expenditure data have been revised. For example, the Y_{-6} variable had a *t* ratio of less than unity in the Mueller study, but shows a *t* ratio of almost three in Table 5-3. Mueller also found that buying intentions (SRC series) did not add significantly to the explanation of variance in

Notes to Table 5-3

Variables are defined as follows:

M_6 deflated per household expenditures on automobiles and parts (*Survey of Current Business* definitions) during the six months following the survey quarter.

D_6 deflated per household expenditures on durable goods (*Survey of Current Business* definitions) during the six months following the survey quarter.

Y_{-6} deflated per household disposable income during the six months prior to the survey quarter.

A index of consumer attitudes as prepared by the Survey Research Center, University of Michigan: The measure of A used above does not include the two buying intentions components.

p^* weighted seasonally adjusted intentions to buy automobiles, based on Census Bureau data for the period 1959–67 and on SRC (largely unweighted) data for periods prior to 1959.

A more complete description of the basic data is contained in the Data Appendix.

General Note: Period shown covers the *purchase* period included in the equation. The survey data cover a slightly earlier period since the equations are designed to be forecasting equations. For the first fit period 1953-II–1962-II, for example, the surveys cover the period 1953-I–1961-IV; the 1953-I survey is used to predict purchases during 1953-II and -III while the 1961-IV survey is used to predict purchases during 1962-I and -II. Not all quarters are used in the regressions because the survey variables are not always available.

All estimates of $\overline{SE}$ and *RMS* are in billions of 1958 dollars. Where the dependent variable has the form of a ratio to past income (M_6/Y_{-6}), the $\overline{SE}$ and *RMS* are converted to billions by multiplying the computed values by the average value of Y_{-6} during the fit period (for $\overline{SE}$) and forecast period (for *RMS*), respectively. This is not precisely the same as converting each residual to billions and then reestimating the $\overline{SE}$ and *RMS*, but the resulting error is small.

The root-mean-square error is for the period covering the end of the fit period up to 1967-II. For the first fit period there are nineteen forecast or extrapolation periods: for the second, fifteen extrapolations; for the third, ten; and for the fourth, five extrapolations.

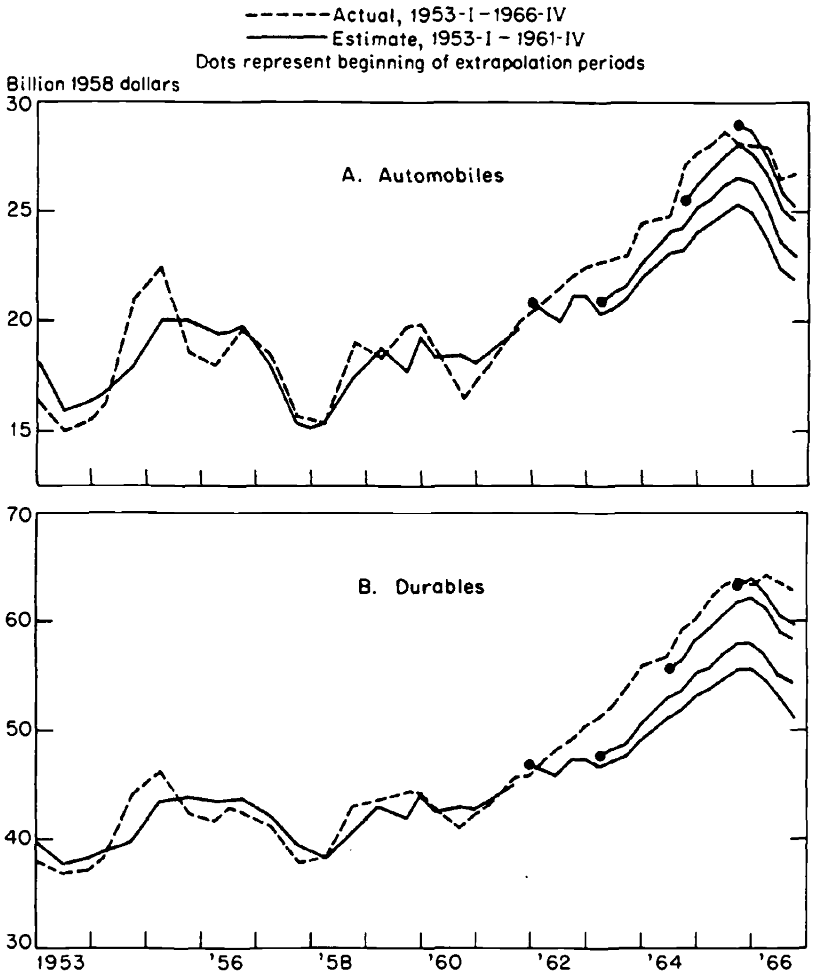
[a] In equations where the ratio of expenditures to income is the dependent variable, ΔY rather than Y_{-6} is used. ΔY is the difference between Y (deflated per household disposable income during the survey quarter) and Y_{-6}.

either automobile or durable goods purchases. Using the spliced p^* series to measure intentions, Table 5-3 shows a significant partial correlation between intentions and purchases of automobiles, holding income level and attitudes constant, although the association between intentions and durable goods purchases is not significant at conventional levels.

Three general points stand out clearly from the data. First, the regression coefficient of all variables in both equations is a function of the time span included in the fit period. Simply extending the fit period beyond 1961-IV by adding additional quarters ordinarily results in higher regression coefficients for all three independent variables when purchase levels are dependent, and in higher coefficients for both survey variables when the ratio of purchases to past income is dependent. Second, both attitudes and buying intentions generally make a significant contribution to the explanation of variance in either automobile or durable goods purchases during all of the fit periods examined, although the relative importance of the two survey variables depends both on the time span and on the form of the dependent variable. Third, the partial correlation between buying intentions and purchases increases strongly as the fit period is extended, especially when pre-1959 observations are dropped as additional quarters are added and when the dependent variable is in ratio form. In fact, when both these conditions are met (panels D and H), the buying intentions variable tends to dominate both the automobile and durable goods purchase equation.

The instability of the regression coefficients when alternative fit periods are used suggests that these models are apt to provide unreliable forecasts. That this is indeed the case is demonstrated by Figure 5-3, which shows the successive forecasts made by the simplest of the above models fitted to alternative periods. The top panel has forecasts of expenditures for automobiles, the lower panel forecasts of total durable goods expenditures. The dashed line shows actual purchases. The solid line for 1953-I–1961-IV shows regression estimates of purchases for the original period of fit. Starting with the solid black dots, both panels show extrapolations beyond alternative fit periods. Thus we have an extrapolation period running from 1962-I through 1966-IV (which covers purchases through 1967-II), a somewhat shorter extrapolation period beginning with 1963-I and also going to

FIGURE 5-3. Predicted and Actual Expenditures for Automobiles (Panel A) and Total Durable Goods (Panel B), Alternative Fit Periods and Forecast Periods



Equations are: Panel A: $M_8 = b_0 + b_1Y_{-8} + b_2A$
Panel B: $D_8 = b_0 + b_1Y_{-8} + b_2A$
Source: Appendix Table 5-A-3.

1966-IV, and two additional and shorter extrapolation periods. Each set of extrapolations is based on a regression fitted to all data up to the point where the extrapolation begins.

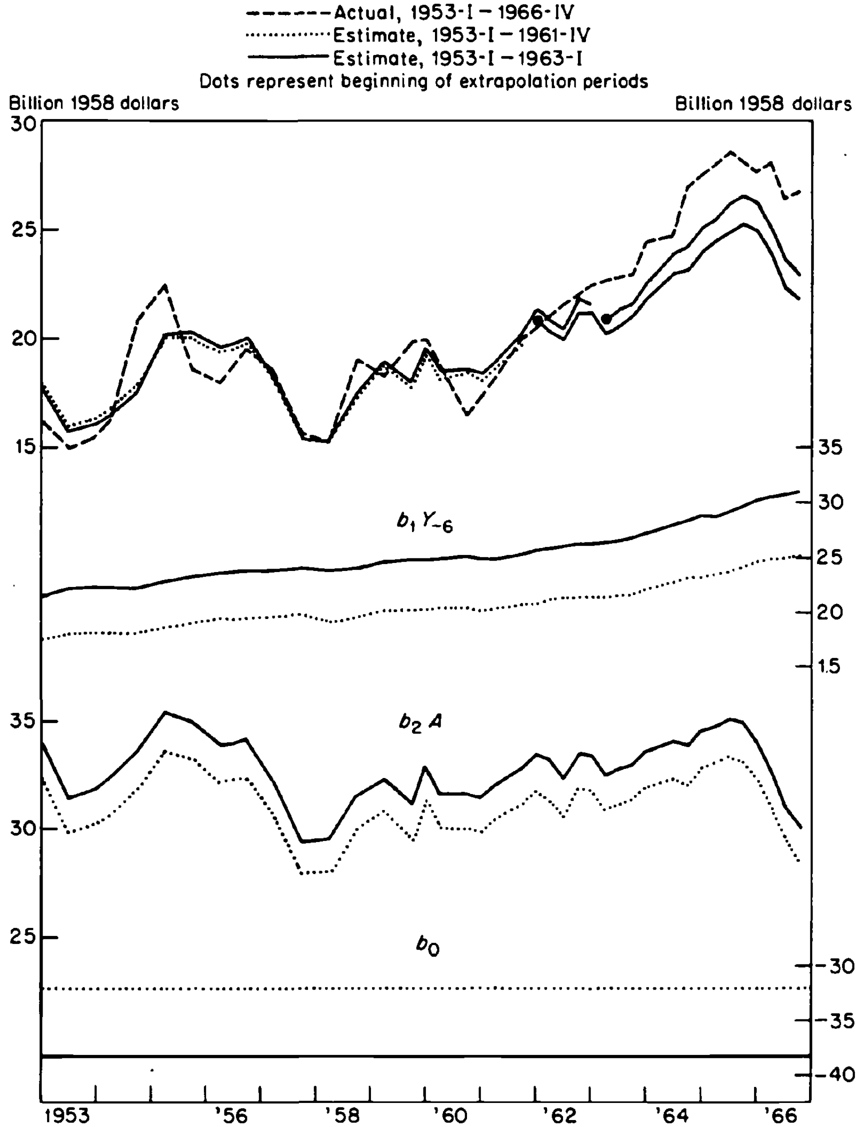
The extrapolations have two characteristics: (1) all, with the possible exception of the last extrapolation in the top panel, consistently underpredict purchase levels; (2) for any given extrapolation period, the forecast value is less far below the actual value when the forecast is based on a more up-to-date fit period. That is, reestimating the parameters of the regression will reduce, but will not eliminate, a persistent tendency towards underprediction.

The reason for the systematic underprediction in Figure 5-3 is apparent from examination of Figure 5-4, which shows the contribution of each independent variable to the predicted value of the dependent variable for two of the time spans shown in Table 5-3. The extrapolation period runs from the beginning of 1962 through 1966. In general, the dependent variable (expenditures six months ahead) rises consistently from the beginning of 1962 up through about the third quarter of 1965, and then declines. Of the two independent variables, the first (income) rises steadily and fairly rapidly during the period when expenditures are rising, but the income coefficient in the regression does not have sufficient weight to pull predicted expenditures up unless the second (attitudes) also shows a consistent and rapid improvement. However, during the first two years of the extrapolation period, 1962-I–1964-I, the attitude index essentially moves sideways with some gentle upward tilt. Thus, by 1964, a substantial gap had developed between actual and predicted expenditures and the gap is never fully overcome by reestimating parameters.[20]

Virtually all the equations which use expenditure level as the dependent variable and any combination of the three independent varia-

[20] It is, incidentally, quite clear from Figure 5-4 that cyclical turning points in automobile purchases are, on the whole, well reproduced by the equation, due almost entirely to the contribution of the consumer attitudes variable. However, the relative strengths of cyclical upturns or downturns is not well foreshadowed. The equation yields serious underpredictions of the strength of the expansion from 1962 on, and one can see evidence that the attitude index is an erratic predictor of the strength of contractions. For example, the brief decline from 1960 to 1961 is barely reflected in attitudes, but the fairly modest rate of decline from 1966 on appears to be seriously overstated by the decline in attitudes. For identification of turning points in the automobile expenditure series, however, the attitude variable has quite a good record.

FIGURE 5-4. Components of Predicted Value for Automobile Expenditures, Alternative Fit Periods and Forecast Periods



Equation is: $M_6 = b_0 + b_1 Y_{-6} + b_2$

Source: Appendix Table 5-A-3.

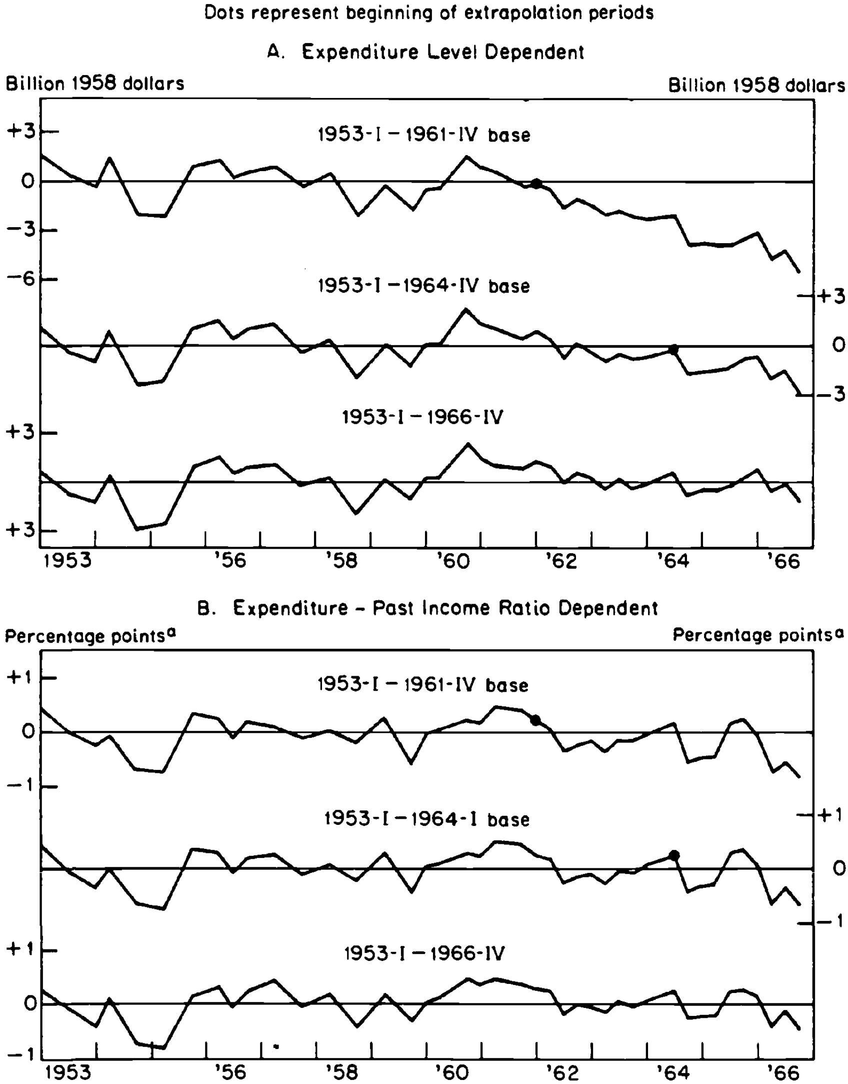
bles shown in Table 5-3 show this same pattern. That is, they all consistently underpredict the strength of the 1962–66 expansion. The tendency towards underprediction is somewhat less pronounced for models that drop off pre-1959 observations as additional post-1962 ones are added, largely because those models give relatively more weight to the intentions variable (which rose more or less consistently from 1961-I to 1965-III) and relatively less to attitudes (which rose during 1961 and after 1964).

It is interesting to note that the equation form which uses ratio of expenditures to past income appears to give systematically better predictions during most of the extrapolation period. Figure 5-5 shows two sets of extrapolation-period and fit-period residuals. The top panel has residuals from equation (2) with the level of automobile purchases dependent; the lower panel has residuals from a comparable equation with the ratio of automobile purchases to income dependent. The last line in each panel shows residuals using the entire 1953–67 span as the fit period, while the first two lines show residuals for shorter fit periods and their associated extrapolation periods.

Extrapolations based on the level equations systematically underpredict purchases, and the underpredictions are consistently worse the further the base period from the extrapolation period. Although the residuals from equations that use the ratio of expenditure to past income as the dependent variable are not small, they do not systematically deteriorate to the same extent as the others do. Yet, if one were to look at the fit-period statistics for both equations, it would be difficult to see any reasons why predictions should be based on the equation in the lower panel rather than on the one in the upper panel. The standard errors are quite comparable if put into the same units, the extent of serial correlation is about the same, and the coefficients are just as plausible.

One possible explanation for the finding that durable goods demand models with the ratio of expenditures to income as the dependent variable give better predictions than comparable models with expenditure level dependent is that the first equation is more accurately specified. In Section III it was found that the correct specification for a demand model with deflated per household expenditures as the dependent variable was a multiplicative relation involving purchase rate and real price per unit. If income is a determinant of real price and the

FIGURE 5-5. Residuals from Automobile Expenditure Regressions, Alternative Equation Forms and Time Spans



[a] One percentage point in the M_6/Y_{-6} ratio is roughly equal to 3.5 billion 1958 dollars.

Equations are: Panel A: $M_6 = b_0 + b_1 Y_{-6} + b_2 A + b_3 p^*$

Panel B: $M_6/Y_{-6} = b_0 + b_1 \Delta Y + b_2 A + b_3 p^*$

Source: Appendix Table 5-A-3.

anticipatory variables are determinants of purchase rate, a properly specified real expenditure equation should have p^*Y and AY as independent variables. But regressing the expenditure–income ratio on the survey variables is equivalent to the introduction of the cross-product terms p^*Y and AY into a real expenditure equation, as can be seen below.

$$M_6/Y_{-6} = b_0 + b_1\Delta Y + b_2p^* + b_3A + u;$$

therefore,

$$M_6 = b_0Y_{-6} + b_1\Delta YY_{-6} + b_2p^*Y_{-6} + b_3AY_{-6} + uY_{-6}$$

DISTRIBUTED LAG EQUATIONS

Evidence presented above in Section III indicated that introduction of a lagged dependent variable resulted in considerable improvement in the fit for most of the equations tested. Let us interpret this result as suggesting the presence of a distributed lag structure in the relation between independent and dependent variables. This interpretation seems reasonable, since the demand for durable goods basically constitutes an attempt to equate actual with desired stocks, and desired stocks are quite likely to be a function of past as well as current values of the explanatory factors.

Table 5-4 summarizes the results of putting the model in distributed lag form. It is assumed that the weights for lagged values of the independent variables decline geometrically, hence that a simple Koyck transformation provides the appropriate lag structure. Regression statistics covering two fit periods, presence and absence of a lag structure, and all four of the dependent variables used above are summarized.

Introduction of a lag structure considerably improves the results. All independent variables continue to show a significant association with automobile or durable goods expenditures, and the standard errors are substantially reduced. The estimated mean lag generally runs between one and two quarters, suggesting that past values of the independent variables have appreciable effects for three or four quarters, which seems reasonable a priori.

The distributed lag equations fit the data somewhat better for automobiles than for total durables. As can be seen from Figures 5-6 and 5-7, the over-all fit is quite good for both, but almost all the turning

TABLE 5-4. Comparison of Anticipations Models With and Without Distributed Lag Adjustment Process

Dependent Variable and Fit Period	Regression Coefficients and *t* Ratios							
	Y_{-6}	ΔY	A	p^*	Lagged Dep. Var.	$\bar{R}^2$	SE	DW
M_6								
1953-II–1962-II	.032(1.3)		.250(3.5)	.101(2.2)	–	.588	1.26	1.72
1953-II–1962-II	.008(0.4)		.109(1.4)	.063(1.5)	.532(2.8)	.700	1.08	2.10
1953-II–1967-II	.078(7.5)		.280(6.0)	.099(2.7)	–	.930	1.10	1.38
1953-II–1967-II	.026(2.0)		.121(2.5)	.062(2.1)	.590(4.9)	.957	.87	2.01
D_6								
1953-II–1962-II	.114(3.7)		.354(3.9)	.084(1.4)	–	.662	1.61	1.36
1953-II–1962-II	.037(0.9)		.114(0.9)	.068(1.3)	.546(2.5)	.738	1.42	1.60
1953-II–1967-II	.218(12.4)		.437(5.5)	.084(1.4)	–	.957	1.86	.81
1953-II–1967-II	.041(1.5)		.100(1.4)	.074(1.8)	.765(6.9)	.981	1.23	1.88
M_6/Y_{-6}								
1953-II–1962-II		.075(2.5)	.064(3.0)	.023(2.0)	–	.676	1.16	1.51
1953-II–1962-II		.053(1.9)	.032(1.3)	.016(1.5)	.417(2.3)	.738	1.04	1.91
1953-II–1967-II		.045(2.2)	.056(3.6)	.038(7.0)	–	.802	1.11	1.44
1953-II–1967-II		.026(1.5)	.027(1.9)	.019(3.0)	.511(4.4)	.869	.90	1.94
D_6/Y_{-6}								
1953-II–1962-II		.102(2.9)	.082(3.2)	.019(1.5)	–	.698	1.39	1.36
1953-II–1962-II		.080(2.0)	.052(1.5)	.017(1.3)	.265(1.3)	.707	1.37	1.51
1953-II–1967-II		.100(2.9)	.047(1.7)	.081(8.4)	–	.809	1.94	.99
1953-II–1967-II		.039(1.6)	.011(0.6)	.032(3.3)	.644(6:8)	.914	1.30	1.55

Note: *t* ratios are in parentheses.

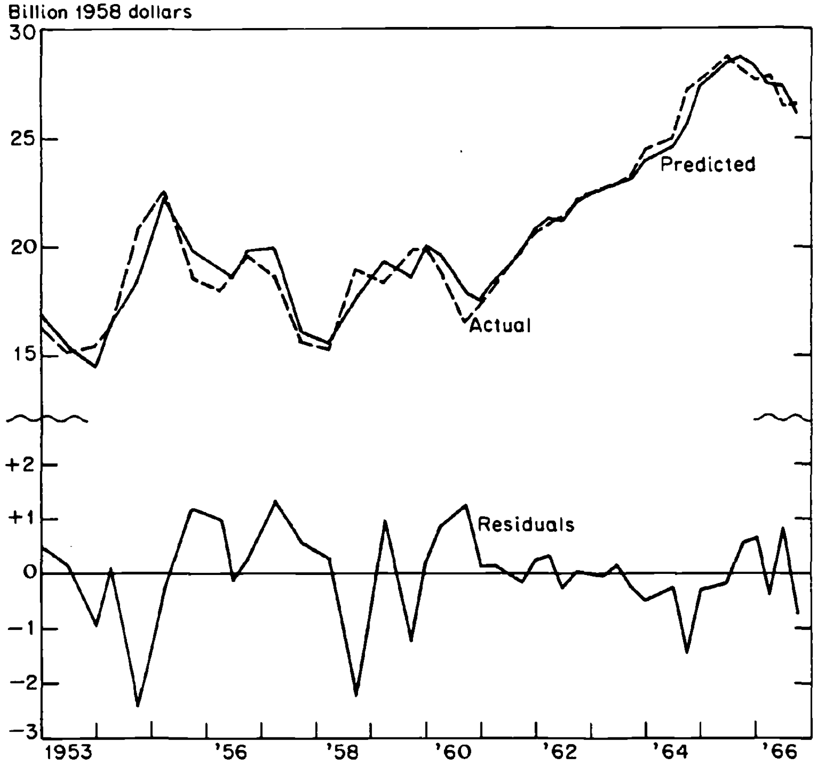
Variables are as described earlier in the notes to Table 5-1. The lagged dependent variable used above overlaps the dependent variable by one quarter; if the dependent variable covers the period 1961-III and -IV, for example, the lagged dependent variables would cover the period 1961-II and -III.

The period shown covers the *purchase* period included in the equation. The survey data cover a slightly earlier period since the equations are designed to be forecasting equations. For the first fit period, 1953-II–1962-II, for example, the surveys cover the period 1953-I–1961-IV; the 1953-I survey is used to predict purchases during 1953-II and -III while the 1961-IV survey is used to predict purchases during 1962-I and -II. Not all quarters are used in the regressions because the survey variables are not always obtainable.

Estimates of SE are in billions of 1958 dollars. Where the dependent variable has the form of a ratio to past income (M_6/Y_{-6}), the SE are converted to billions by multiplying the computed values by the average value of Y_{-6}. This is not precisely the same as converting each residual to billions and then reestimating the SE, but the resulting error is small.

The Durban and Watson statistic is biased towards 2.0 in equations with a lagged dependent variable, hence does not constitute an adequate test for the presence of serial correlation in the residuals.

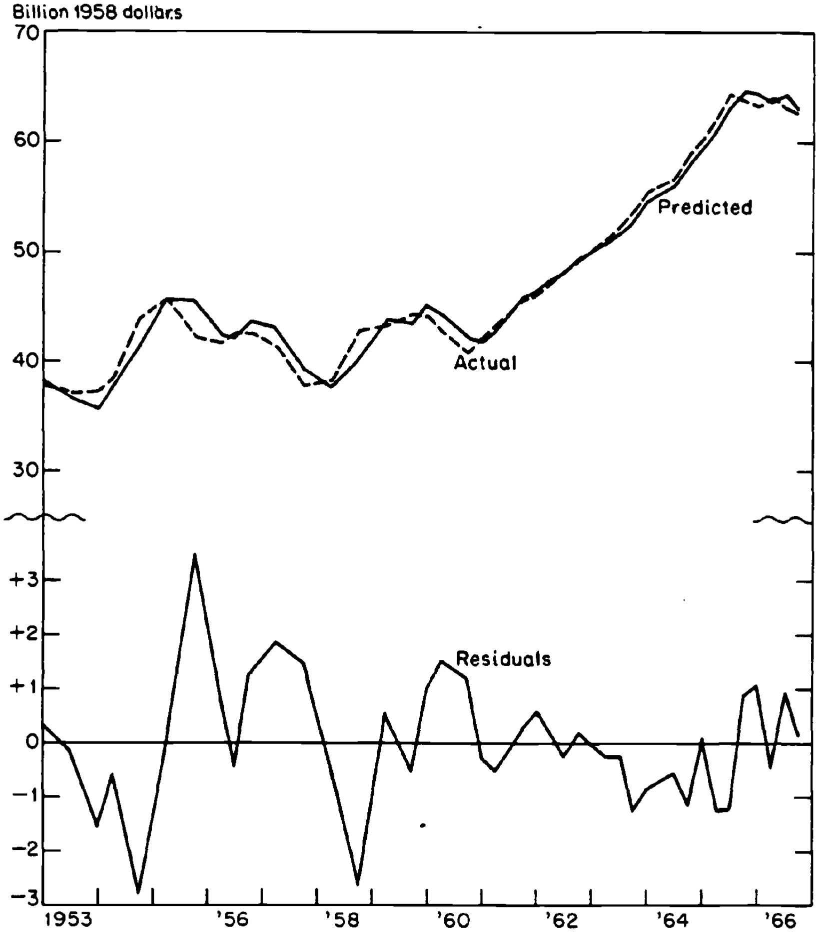
FIGURE 5-6. Predicted and Actual Expenditures on Automobiles, Distributed Lag Equation



Equation is: $M_6 = b_0 + b_1 Y_{-6} + b_2 A + b_3 p^* + b_4 (M_6)_{-1}$
Source: Appendix Table 5-A-3.

points in the durable goods series are missed by the fitted regression line. Moreover, the adjustment coefficient for total durables in the distributed lag equation may be on the high side. According to Table 5-4, the adjustment process implied by the coefficient of the lag term is considerably more gradual and extends further back in time for total durables than for automobiles. Since the most important independent variables (p^* and A) reflect consumer *decisions* about expenditures rather than the factors that influence decisions, one would have thought that the total durables equation should show shorter average lags than the automobile equation. But the data indicate just the reverse, possibly because the coefficient of the lagged dependent variable reflects habit

FIGURE 5-7. Predicted and Actual Expenditures on Durables, Distributed Lag Equation



Equation is: $D_6 = b_0 + b_1 Y_{-6} + b_2 A + b_3 p^* + b_4 (D_6)_{-1}$
Source: Appendix Table 5-A-3.

persistence and the highly autoregressive nature of total durables expenditures rather than incomplete adjustment to change.

COMPARISON WITH AUTOREGRESSION MODELS

Although the regression estimates considered above indicate that one can get quite good fits with anticipations variables in quarterly time series, the relevant question is whether these models are markedly superior in forecasting performance to naive models. For this comparison, we use an autoregressive naive model consisting of up to eight lagged values of the dependent variable. The autoregressive model is constrained in the same way as the anticipations models, in that we use only those lagged dependent variables that would have been available at the forecast date (the survey quarter). Each of the expenditure variables is regressed against successive lagged dependent variables in the respective base periods; the process is stopped arbitrarily when additional lagged values fail to improve the adjusted R^2. Thus, each of the autoregressive models could contain different numbers of lagged dependent variables, although in general the optimum number of lags was about the same in all periods. Autoregressive models of automobile expenditures generally showed a maximum adjusted R^2 after three lagged values had been used, while for total durables expenditures, adjusted R^2 was maximized after seven or eight lags.

The anticipations models used for this test are the ones analyzed above in Table 5-3. In equations where the level of durable goods expenditures is the dependent variable, explanatory factors include income level and either one or both of the survey variables A and p^*. Where the ratio of durable goods expenditures to income is the dependent variable, explanatory variables are income change and one or both of the survey variables. Lagged values of the dependent variable do not appear as explanatory factors in any of the anticipations models. With rare exceptions, the lagged dependent variable failed to improve the statistical fit in any of the anticipations equations during any of the base periods tested. The apparent inconsistency between the results here and in the preceding section of the paper is due to the fact that the models under discussion here are pure forecast models; the values of all independent variables must be known prior to the start of the time period covered by the dependent variable. The distributed lag equations discussed earlier did not impose this constraint. As a consequence, the first lag term available for the pure forecast model is actually the third lag term in the series.[21]

Both autoregressive and anticipations models are estimated for the same set of base periods as are shown in Table 5-3, and for the same set of dependent variables. Table 5-5 summarizes the root mean square forecast errors for the three anticipations models and the autoregressive model, using alternative extrapolation periods and dependent variables. The first set of four extrapolation periods is constructed by simply adding quarters to the 1953–61 fit period, while the second set is constructed by simultaneously adding and dropping quarters at the end and the beginning, respectively, of the 1953–61 period. As noted above, the anticipations models include, besides the survey variable shown in Table 5-5, either income level (when expenditure level is dependent) or income change (when the expenditure–income ratio is dependent).

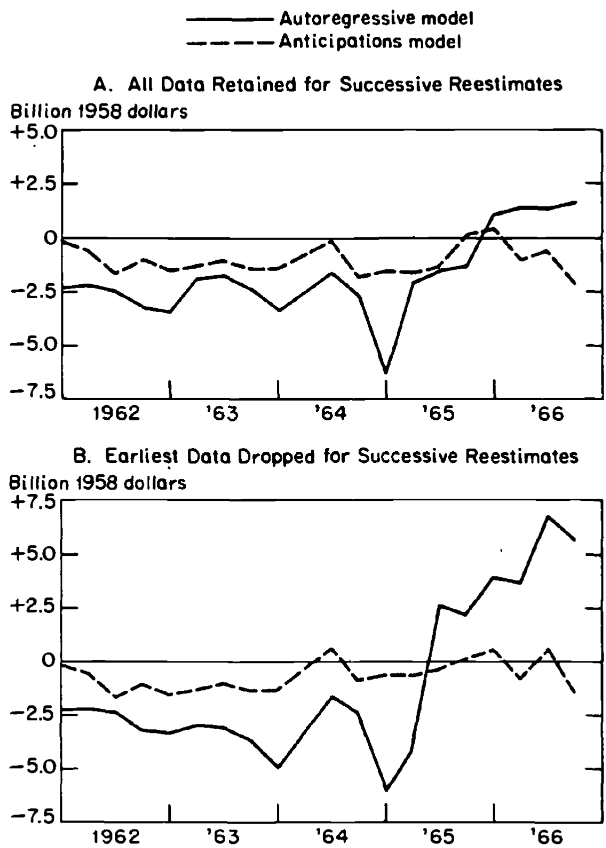
There are only a few cases in which any of the anticipations models is outperformed by the autoregressive model, although the margin of superiority varies considerably. In general, the comparative advantage of the anticipations model is somewhat stronger for automobile than for total durable regressions. The anticipations model is also generally superior for extrapolation shown in the right-hand side of Table 5-5 where beginning period observations are dropped as additional quarters are added. Relatively speaking, the worst performance of the anticipations models is in prediction of total durables purchases with the ratio of purchases to income dependent and with all data retained for successive extrapolation. Here, the prediction errors in the autoregressive equation average about the same size as in each of the three anticipations models, and none of the latter is consistently superior to the autoregressive model. The best performance of the anticipations model, again relatively speaking, is for automobile regressions with the ratio of expenditures to income dependent

[21] The forecast model predicts durable goods expenditures during the two quarters subsequent to the quarter in which the anticipations survey or surveys are taken. Thus, a survey taken in 1967-I would be used to forecast expenditures during 1967-II and 1967-III. A dependent variable lagged one quarter would thus consist of expenditure during 1967-I and 1967-II, one lagged two quarters would include expenditures during 1966-IV and 1967-I, and so forth. At the survey date of 1967-I, the latest known expenditure data would be expenditures during 1966-III and 1966-IV, that is, the third in the above series of dependent variable lags.

and with observations in the early part of the fit period dropped as additional quarters are added. Here, autoregressive model errors are at least twice as high, and in the last few extrapolation periods four to five times as high, as in the best anticipations model.

The contrast between automobile and total durables expenditures models can be clearly seen in Figures 5-8 and 5-9. The top panel of each figure plots extrapolation errors from models in which parameters are reestimated every four or five quarters; all data are re-

FIGURE 5-8. Residuals From Anticipations and Autoregressive Models of Automobile Expenditures



Equations are: Panel A: $M_6 = b_0 + b_1 Y_{-6} + b_2 A + b_3 p^*$
Panel B: $M_6 = b_0 + b_1(M_6)_{-3} + b_2(M_6)_{-4} + \cdots$
Source: Appendix Table 5-A-3.

TABLE 5-5. Comparison of Extrapolation Errors for Autoregressive and Anticipations Models, Alternative Prediction Periods, Fit Periods, and Forms of Dependent Variable, 1953-II–1967-II

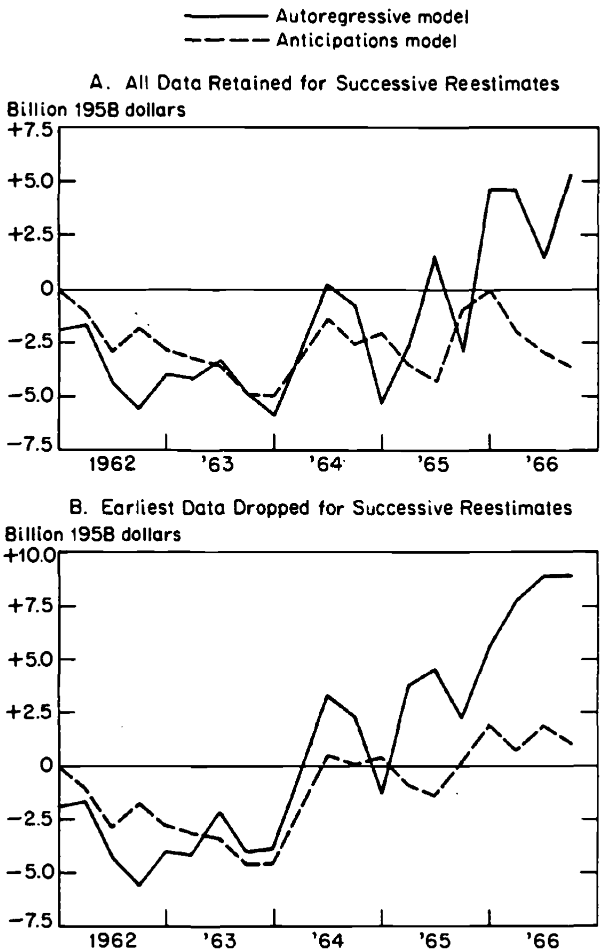
Equation Form	Beginning Quarters for Fit Period (F) and Extrapolation Period (E)							
	1 F 1953-II E 1962-III	2 F 1953-II E 1963-IV	3 F 1953-II E 1964-IV	4 F 1953-II E 1966-II	1 F 1953-II E 1962-III	2a F 1955-III E 1963-IV	3a F 1957-I E 1964-IV	4a F 1959-III E 1966-II
A: Prediction Errors [a] for Expenditures on Automobiles, Billions of 1958 Dollars								
M_6 dependent								
Autoregressive	5.16	3.94	2.76	1.51	5.16	6.58	3.52	4.78
Anticipations, using								
A	2.90	2.27	1.26	1.05	2.90	2.29	0.85	3.18
p^*	5.13	3.35	2.70	1.02	5.13	3.16	1.74	2.27
A, p^*	3.18	2.37	1.66	1.19	3.18	2.18	0.71	0.90
M_6/Y_{-6} dependent								
Autoregressive	3.01	3.09	2.76	1.22	3.01	3.84	3.02	4.19
Anticipations, using								
A	2.57	2.82	3.01	3.77	2.57	2.81	2.77	4.34
p^*	1.42	1.43	1.68	1.37	1.42	1.40	1.29	1.50
A, p^*	1.49	1.55	1.69	1.90	1.49	1.46	1.28	1.01

B: Prediction Errors[a] *for Expenditures on Total Durables, Billions of 1958 Dollars*

D_6 dependent								
Autoregressive	9.12	5.82	3.31	4.31	9.12	3.58	7.12	7.22
Anticipations, using								
A	6.93	6.04	3.09	2.12	6.93	5.18	1.73	5.11
p^*	9.92	7.54	5.17	1.70	9.92	6.59	2.98	3.88
A, p^*	7.17	6.13	3.61	2.39	7.17	5.13	1.58	1.38
D_6/Y_{-6} dependent								
Autoregressive	5.59	5.99	3.72	4.34	5.59	3.73	6.24	6.65
Anticipations, using								
A	6.25	7.01	6.96	8.61	6.25	6.08	6.48	9.58
p^*	4.77	4.59	4.06	3.60	4.77	3.39	2.98	1.57
A, p^*	5.14	5.27	4.27	4.71	5.14	4.48	3.02	1.83

[a] Prediction errors are defined as the root mean square error of the extrapolation. Errors for equations where the dependent variable is the ratio of expenditures to past income (M_6/Y_{-6}, D_6/Y_{-6}) are converted to billions of 1958 dollars by multiplying the computed *RMS* error by the average level of Y_{-6} during the prediction period. As indicated above in the notes to Table 5-4, the resulting inaccuracy (the correct procedure is to convert each error first and then average) is quite small.

FIGURE 5-9. Residuals From Anticipations and Autoregressive Models of Durables Expenditures



Equations are: Panel A: $D_6 = b_0 + b_1 Y_{-6} + b_2 A + b_3 p^*$
Panel B: $D_6 = b_0 + b_1 (D_6)_{-3} + b_2 (D_6)_{-4} + \cdots$

Source: Appendix Table 5-A-3.

tained with each reestimation. The bottom panel follows the same procedure except that beginning period observations are dropped with successive reestimation, so that the fit period continually moves forward in time. Figure 5-8 has prediction errors for automobile expenditures, Figure 5-9 prediction errors for total durables expenditures. The anticipations model in both these figures uses all three independent variables, that is, Y_{-6}, A, and p^*.

For automobiles, both upper and lower panels clearly show that the anticipations model out-performs the autoregressive model in virtually every quarter of the extrapolation period. Both the margin of superiority of the anticipations model as well as the absolute size of its forecast errors are improved in the lower panel where older data are dropped. In Figure 5-9, in contrast, the upper panel shows no clear advantage to either anticipations or autoregressive models, although the former actually has a somewhat lower mean error. The anticipations model shows a small but marked advantage in the lower panel during virtually the entire period, especially toward the latter part where the autoregressive model goes completely off the track.

On the whole, this examination of anticipatory demand models brings out two clear-cut conclusions. First, the anticipations series themselves are strong cyclical indicators; both consumer attitudes and consumer buying intentions have cyclical turning points which precede those in durable goods and automobile expenditures by about six months. The attitude index appears to be a bit better at reflecting turning points than buying intentions, partly because the series itself is considerably smoother; however, the random component of the buying intentions series appears to be considerably reduced since the initiation of the large sample Census Bureau survey in 1959.

Although both anticipations series contain pronounced cyclical movements, only buying intentions appear to have a distinct trend component. This factor works to the comparative disadvantage of the attitude variable in regression models, since all of the trend influences on durable goods expenditures must be picked up by other variables. This difference in ability to measure trends is very probably the explanation for the results obtained in Section III, where it was found that the attitude index was comparatively more useful in predicting changes in the purchase rate of nonintenders than in predicting changes in the population purchase rate. The first variable (nonintender purchase rates) appears to be trendless; the secular movement in the proportion of total purchasers in the population apparently shows up as a secular increase in the proportion of intenders rather than as an increase in purchase rates for either intenders or nonintenders.

Whether the anticipations variables are more accurate predictors of cyclical movements in durables expenditures than variables like unemployment rate, average weekly hours, and so forth, is a purely empirical question. We have not examined this question here, although other studies which have done so, e.g. [11], found that attitudes were a more useful variable than other candidates for the cyclical role. However, the question has not been answered in a definitive way and clearly warrants further investigation.

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V. DATA APPENDIX

TABLE 5-A-1

Survey Quarter	Y_{-6} ($ bills.) (1)	M_6 ($ bills.) (2)	ΔY ($ bills.) (3)	1956 = 100 A (4)
1953-I	251.9	14.5	5.3	100.0
III	258.4	12.5	0.1	92.3
1954-I	258.3	13.5	−2.4	93.6
II	257.0	14.2	−1.7	95.1
IV	255.9	18.3	3.4	98.7
1955-II	259.9	19.7	7.3	104.2
IV	268.9	15.8	5.1	102.6
1956-II	273.7	15.1	2.6	99.3
III	274.8	15.3	1.8	99.8
IV	276.5	15.9	2.2	100.3
1957-II	278.4	15.5	2.4	94.4
IV	281.3	12.1	−2.7	86.0
1958-II	277.4	12.3	−0.8	86.5
IV	279.8	15.4	4.4	92.7
1959-II	285.4	14.9	6.0	95.1
IV	290.4	16.2	−0.8	91.1
1960-I	289.5	16.0	0.4	96.7
II	289.8	15.2	2.8	92.9
IV	292.9	13.3	−0.9	92.8
1961-I	292.6	14.2	−0.5	92.4
II	292.1	14.8	3.6	94.4
IV	297.3	16.3	5.6	96.4
1962-I	300.9	16.7	3.3	98.7
II	303.6	16.8	2.8	96.8
III	305.3	17.5	1.0	95.0
IV	306.4	18.2	1.3	
1963-I	307.0	18.4	2.1	98.3
II	308.4	18.5	2.3	95.4
III	309.9	18.9	3.2	96.2
IV	311.9	19.4	4.2	96.9
1964-I	314.6	20.1	6.6	99.0
III	324.5	20.4	5.5	100.2
IV	328.9	22.1	3.9	99.4
1965-I	331.4	22.4	4.7	101.5
II	334.5	23.2	2.8	102.2
III	336.7	23.5	7.7	103.2

Per Cent of Households Reporting Intentions to Buy Automobiles					Weighted Per Cent of Households Reporting Intentions to Buy Automobiles	
Basic SRC (5)	Unweighted QSI (6)	SRC-NS (7)	QSI-NS (8)	QSI-S (9)	QSI-SW$_0$ (10)	QSI-SW$_3$ (11)
14.1	n.a.	15.2	15.2	15.1	4.29	7.00
12.0	n.a.	12.9	12.9	13.5	3.79	6.16
11.3	n.a.	12.2	12.2	12.2	3.44	5.62
15.0	n.a.	16.2	16.2	16.6	4.70	7.69
17.6	n.a.	19.0	19.0	17.9	4.90	7.99
15.7	n.a.	16.9	16.9	17.3	4.93	8.04
16.0	n.a.	17.2	17.2	16.2	4.46	7.25
15.1	n.a.	16.3	16.3	16.7	4.74	7.74
14.2	n.a.	15.3	15.3	16.0	4.48	7.30
18.5	n.a.	19.9	19.9	18.7	5.08	8.38
17.7	n.a.	19.1	19.1	19.6	5.56	9.07
15.1	n.a.	16.3	16.3	15.3	4.20	6.86
14.3	n.a.	15.4	15.4	15.8	4.49	7.30
15.1	n.a.	16.3	16.3	15.3	4.20	6.86
17.3	15.8	18.6	15.8	16.2	4.30	7.08
14.6	21.2	15.7	21.2	20.0	5.57	8.17
17.5	18.7	18.8	18.7	18.6	4.95	8.25
14.2	17.1	15.3	17.1	17.5	4.67	7.78
17.9	18.6	19.3	18.6	17.5	4.61	7.61
13.8	17.9	14.9	17.9	17.8	4.89	7.80
16.4	16.6	17.7	16.6	17.0	4.59	7.70
18.3	18.5	19.7	18.5	17.4	4.73	8.07
17.1	18.1	18.4	18.1	18.0	5.05	8.14
17.4	18.9	18.7	18.9	19.4	5.33	8.64
18.1	17.4	19.5	17.4	18.1	5.01	8.30
17.9	18.6	19.3	18.6	18.5	5.19	8.46
16.9	18.2	18.2	18.2	18.7	5.41	9.00
17.4	18.2	18.7	18.2	19.0	5.43	9.12
19.3	19.1	20.8	19.1	18.0	5.15	8.85
15.1	18.8	16.3	18.8	18.7	5.40	9.08
17.8	18.3	19.2	18.3	19.1	5.64	9.14
18.3	20.4	19.7	20.4	19.2	5.73	9.74
17.8	19.4	19.2	19.4	19.3	5.79	9.57
n.a.	18.8	18.6	18.8	19.3	5.89	9.77
17.8	19.1	19.2	19.1	19.9	5.97	9.89

(Table notes are on following pages)

NOTES TO TABLE 5-A-1

GENERAL NOTE: The income and expenditure data used in Table 5-A-1 are formed from series in the *Survey of Current Business* (*SCB*). All variables are in constant (1954) dollars and are deflated by an index of the number of families. After 1964, data for disposable income and durables purchases are available only in 1958 constant dollars; these series were converted to a base 1954 = 100. The deflation for the number of families is based on an index (1954 = 100) constructed from a series interpolated from the *Statistical Abstract of the U.S.* The index is as follows:

1953-I	98.5	1958-II	105.8	1963-I	113.2
1953-III	99.0	1958-IV	106.3	1963-II	113.5
1954-I	99.4	1959-II	107.1	1963-III	113.8
1954-II	99.8	1959-IV	108.1	1963-IV	114.1
1954-IV	100.6	1960-I	108.4	1964-I	114.4
1955-II	101.6	1960-II	108.8	1964-III	114.9
1955-IV	102.7	1960-IV	109.4	1964-IV	115.1
1956-II	103.6	1961-I	109.8	1965-I	115.4
1956-III	104.0	1961-II	110.2	1965-II	115.7
1956-IV	104.4	1961-IV	111.0	1965-III	116.7
1957-II	104.9	1962-I	111.5		
1957-IV	105.3	1962-II	111.9		
		1962-III	112.4		
		1962-IV	112.8		

Column 1: Y_{-6} is average disposable income in 1954 dollars for the six months preceding the survey quarter, deflated by the index of families.

Column 2: M_6 is the average expenditure on automobiles and parts in 1954 dollars for the six months after the survey quarter, deflated by the index of families. The *Survey of Current Business* quarterly series for automobile expenditure in current prices was deflated by the Consumer Price Index for new automobiles, 1954 = 100, as reported in the quarterly releases of the Bureau of Labor Statistics.

Substantive revisions of the series in the August 1965 *SCB* are taken into account: data are made comparable with the original series by using the average ratio of an overlap period.

Column 3: ΔY is the difference between disposable income in the survey quarter and disposable income in the six months preceding the survey. Data are in 1954 prices deflated by an index of families.

Column 4: A is the SRC Index of Consumer Attitudes, based on responses to a battery of questions about the household's financial condition and prospects and about general business and product market conditions; the fall of 1956 is taken as 100. See [11] for a complete description. In the 1966 *Survey of Consumer Finances*, the 1959-IV index is shown as 91.4. This revised figure was unavailable at the time the regressions were run.

Prior to August 1963 the published index averaged the responses to six questions. One question, on attitudes towards expected price changes, was deleted from the index in August 1963 and in all subsequent quarters. Thus the A series used here is a composite based on six questions during the 1953-I 1963-II period and on five questions thereafter. The 1966 *Survey of Consumer Finances* describes the modification introduced in August of 1963, and gives data for the five question index back to 1953.

Column 5: SRC automobile buying intentions. The series measures the proportion of families intending to buy automobiles in the next twelve months, and includes those who reported that they would or probably would buy, plus one-half of those who said they might buy. Prior to 1961 the published series counts all "might buy" responses. The early data were made comparable by adjustment factors which were available for the period 1956–60; prior to 1956 an average adjustment factor was used. The data for 1964-III and -IV are not quite comparable to the others because of differences in sample composition. Basic data for these quarters are linked on the assumptions that families with income under $5,000 would behave in the same way as others, and also increased by 1 per cent to compensate for the bias arising from the fact that the entire sample had been interviewed in previous surveys. These data and the estimated factors were obtained directly from the Survey Research Center. In Figure 5-1, this series is plotted through 1966-IV. The data are as follows:

	Basic SRC
1965-IV	19.3
1966-I	18.6
1966-II	14.1
1966-III	18.6
1966-IV	17.9

Column 6: Census Bureau series, unweighted percentage of all families reporting an intention to buy new or used automobiles in the next twelve months; basic data from *Consumer Buying Indicators*, U.S. Census Bureau Series P-65, various issues. In Figure 5-1, this series is plotted through 1966-IV. The data are as follows:

	Unweighted QSI
1965-IV	20.5
1966-I	19.1
1966-II	18.7
1966-III	19.3
1966-IV	19.7

Column 7: SRC-NS is col. 5 ratioed to the level of col. 6 by the average ratio during an overlap period. The figure for 1965-II, for which no reliable survey data are available, is interpolated; it is assumed that the seasonally adjusted series is unchanged from 1965-I to 1965-II. Regressions that include data through 1964-IV only were run before these SRC data were available. For the 1964-III-IV quarters, QSI-NS was used.

Column 8: QSI-NS is col. 6 with a link to col. 7 to provide data for the period before 1959.

Column 9: QSI-S is col. 8 seasonally adjusted by the following seasonal factors calculated from col. 6: $Q_1 = 100.4$, $Q_2 = 97.5$, $Q_3 = 95.9$, $Q_4 = 106.2$.

Column 10: QSI-SW_0 is a weighted series based on Census Bureau data with a link to col. 5 to provide data for the period before 1959. The following weights are assigned to the various intended categories: definitely planning to buy a new automobile within the next 6 months = .7; probably or may buy a new automobile within the next 6 months = .5; intending to buy a new automobile within 12 months but not within 6 months = .3; intending to buy a used automobile within 12 months = .2; does not know about 12 month intention or does not know about 6 months intention = 0. The weighted series is seasonally adjusted by factors estimated from the Census Bureau part of the series. The seasonal factors are as follows: $Q_1 = 99.4$, $Q_2 = 96.3$, $Q_3 = 95.8$, $Q_4 = 108.5$.

Column 11: QSI-SW_{3C} is an alternative weighted Census Bureau series; the weights and construction are the same as in col. 10 except that the "don't know" categories are given a weight of .3. As before, the series is linked back to col. 5 to provide data for the period before 1959. The pre-1959 part of the series is seasonally adjusted as in col. 10. The 1959–65 part is seasonally adjusted by slightly different factors, estimated from the 1959–65 part of the series. The latter seasonal factors are: $Q_1 = 101.1$, $Q_2 = 98.3$, $Q_3 = 95.8$, $Q_4 = 104.8$.

TABLE 5-A-2

Survey Quarter	Y_e (1958 dollars) (1)	M (1958 dollars) (2)	Percentage of Households			
			x (3)	x_6 (4)	x_9 (5)	x_{12} (6)
1959-I	6,368	304	10.41	10.68	10.80	10.41
II	6,422	321	10.95	11.00	10.41	10.63
III	6,430	325	11.04	10.14	10.53	10.74
IV	6,429	279	9.24	10.28	10.64	10.78
1960-I	6,411	326	11.31	11.34	11.29	11.10
II	6,429	325	11.36	11.28	11.03	10.63
III	6,440	324	11.20	10.87	10.39	10.21
IV	6,422	299	10.53	9.99	9.88	9.93
1961-I	6,405	268	9.45	9.56	9.72	9.90
II	6,419	272	9.66	9.86	10.04	10.36
III	6,472	285	10.06	10.24	10.59	10.79
IV	6,549	299	10.41	10.86	11.03	11.20
1962-I	6,604	324	11.30	11.35	11.46	11.60
II	6,658	331	11.39	11.55	11.69	11.85
III	6,687	339	11.70	11.85	12.01	12.10
IV	6,721	351	11.99	12.16	12.23	12.26
1963-I	6,758	363	12.33	12.35	12.35	12.37
II	6,797	363	12.37	12.36	12.38	12.47
III	6,848	369	12.35	12.39	12.51	12.61
IV	6,899	370	12.42	12.59	12.69	12.81
1964-I	6,985	381	12.76	12.83	12.94	12.69
II	7,094	384	12.90	13.04	12.67	13.16
III	7,206	398	13.17	12.56	13.24	13.43
IV	7,288	354	11.94	13.28	13.52	13.70
1965-I	7,342	451	14.62	14.31	14.28	14.27
II	7,390	430	14.00	14.12	14.15	14.28
III	7,491	443	14.23	14.23	14.00	14.00
IV	7,613	446	14.23	14.45	13.93	13.76
1966-I	7,727	469	14.67	13.78	13.60	13.48
II	7,771	416	12.89	13.06	13.08	12.76
III	7,803	433	13.24	13.18	12.71	12.69
IV	7,843	422	13.12	12.45	12.51	12.32

V (current dollars) (7)	V* (1958 dollars) (8)	P_a (9)	Households (millions) (10)	A (1956 = 100) (11)	Percentage of Households p (12)	Percentage of Households q (13)
3,012	2,919	103.2	51.36	93.9*	23.2	76.4
3,041	2,935	103.6	51.66	95.1	22.8	77.1
3,049	2,943	103.6	52.00	93.1	24.3	75.6
3,082	3,019	102.1	52.35	91.1	25.6	74.4
2,953	2,887	102.3	52.69	96.7	25.4	74.8
2,928	2,862	102.3	52.91	92.9	24.9	74.8
2,909	2,892	100.6	53.08	92.8*	24.1	75.3
2,854	2,837	100.6	53.24	92.8	24.0	75.4
2,852	2,832	100.7	53.41	92.4	24.3	74.9
2,873	2,814	102.1	53.66	94.4	24.3	75.3
2,892	2,838	101.9	53.96	95.4*	25.7	74.5
2,939	2,867	102.5	54.26	96.4	25.5	74.6
2,921	2,872	101.7	54.55	98.7	25.7	74.4
2,951	2,905	101.6	54.74	96.8	26.9	72.8
2,959	2,895	102.2	54.88	95.0	26.1	74.2
2,987	2,926	102.1	55.01	98.6	26.8	73.5
2,985	2,941	101.5	55.14	98.3	26.9	73.4
2,995	2,936	102.0	55.32	95.4	27.9	72.9
3,019	2,989	101.0	55.53	96.2	28.7	72.5
3,034	2,977	101.9	55.73	96.9	27.9	73.2
3,040	2,983	101.9	55.93	99.0	28.9	72.3
3,035	2,981	101.8	56.21	98.1	29.3	71.9
3,064	3,025	101.3	56.52	100.2	28.8	72.3
2,991	2,961	101.0	56.83	99.4	30.5	71.1
3,123	3,086	101.2	57.15	101.5	30.5	71.3
3,087	3,075	100.4	57.39	102.2	30.3	71.5
3,075	3,112	98.8	57.60	103.2	31.1	71.2
3,111	3,136	99.2	57.81	102.6	30.2	71.6
3,126	3,196	97.8	58.02	99.8	30.3	71.7
3,157	3,225	97.9	58.22	95.8	29.7	71.8
3,195	3,274	97.6	58.41	91.1	30.7	71.4
3,187	3,213	99.2	58.59	88.3	29.0	72.5

(Table notes are on following page)

NOTES TO TABLE 5-A-2

Source, by column

Column 1: Y_e is disposable income per family in constant (1958) dollars, averaged for the survey quarter and the two preceding quarters. Data for the period up to 1963-IV are obtained from *The National Income and Product Accounts of the U.S., 1929–1965*, a supplement to the *Survey of Current Business*. Later periods are obtained from various issues of the *Survey of Current Business*.

Column 2: M is personal consumption expenditures for automobiles per household in constant (1958) dollars. Data are obtained from Table 1.16 in the *Survey of Current Business*.

Column 3: x is the portion of households purchasing new automobiles during the survey quarter, expressed as an annual rate of purchase. Since it is obtained from seasonally adjusted data on expenditures for automobiles and average retail prices paid for automobiles, x is also a seasonally adjusted series.

Column 4: x_6 is the new automobile purchase rate averaged for the survey quarter and the following quarter, expressed as an annual rate.

Column 5: x_9 is the new automobile purchase rate averaged for the survey quarter and the two following quarters, expressed as an annual rate.

Column 6: x_{12} is the new automobile purchase rate for the survey quarter and the three quarters following, expressed as an annual rate.

The three variables above (x_6, x_9, x_{12}) are simply moving averages of the x series in column 3.

Column 7: V is the average retail price of new automobiles in current dollars. The data were obtained directly from the Office of Business Economics, U.S. Department of Commerce. The prices reflect not only pure price changes but also changes in the mix of models, differences in optional equipment from one year to the next, and so forth. The series is adjusted for seasonal variation in trade-in margins.

Column 8: V^* is column 7 deflated by an index of new automobile prices.

Column 9: P_a is a new automobile price deflator derived from Tables 1.15 and 1.16 of the *Survey of Current Business*.

Column 10: The number of families in the U.S. population is derived from annual series given in *Current Population Reports*, Series P-20; quarterly figures are estimated by straight-line interpolation of the annual figures.

Column 11: A is the SRC Attitude Index, 1956 = 100. This index is identical to the one in Table 5-A-1, except that values have been interpolated (indicated by asterisk) for quarters in which no SRC survey was taken and for which the index is therefore not obtainable.

Column 12: p is an estimate of the average probability of purchase by those reporting some kind of intention to buy a new or used car in the Census Bureau's Quarterly Survey of Intentions. Probability weights are assigned to the various classes of intenders reported in the QSI, the weights being estimated from the purchase rates observed in reinterview studies. The derivation of the p series is such that it can be expressed as a weighted proportion of intenders divided by the average weight in a base period; hence p and the series labeled QSI-SW_{3V} are identical except for a multiplicative constant. The latter series is shown in Table 5-A-3.

Column 13: q is 1 minus the proportion of intenders in the Census Bureau's Quarterly Survey of Intentions. It is obtained by subtracting from unity the proportion of the population reporting any kind of six-month intention to buy, any kind of twelve-month intention to buy, and "don't know" about twelve-month buying intentions.

TABLE 5-A-3

	Y_{-6} (1)	M_6 (2)	D_6 (3)	ΔY (4)	A (5)	QSI-SW_{3V} (6)
1953-I	288.8	16.4	37.8	4.7	100.0	7.00
III	295.3	15.1	36.9	0.1	92.3	6.16
1954-I	294.9	15.5	37.2	−1.0	93.6	5.62
II	294.2	16.2	38.3	−2.2	95.1	7.69
IV	293.1	20.8	44.0	6.5	98.7	7.99
1955-II	300.6	22.6	45.8	6.7	104.2	8.04
IV	309.4	18.6	42.2	4.8	102.6	7.25
1956-II	314.2	18.0	41.6	1.0	99.3	7.74
III	314.7	18.8	42.6	0.5	99.8	7.30
IV	315.2	19.6	42.5	3.6	100.3	8.38
1957-II	318.4	18.6	41.2	0.7	94.4	9.07
IV	319.7	15.6	37.7	−1.3	86.0	6.86
1958-II	316.6	15.3	38.1	−1.8	86.5	7.30
IV	317.9	19.0	42.9	6.5	92.7	6.86
1959-II	325.7	18.4	43.4	5.6	95.1	7.27
IV	329.5	19.8	44.4	−.4	91.1	8.16
1960-I	328.4	19.9	44.1	2.8	96.7	8.10
II	330.2	18.8	42.9	2.4	92.9	7.92
IV	332.4	16.5	40.9	−3.7	92.8	7.63
1961-I	330.3	17.4	42.1	−.4	92.4	7.75
II	329.3	18.1	43.4	5.0	94.4	7.74
IV	336.3	20.0	45.6	7.1	96.4	8.11
1962-I	340.8	20.6	46.2	3.9	98.7	8.18
IV	344.1	21.0	47.3	3.2	96.8	8.56
III	346.0	21.5	48.3	1.6	95.0	8.30
IV	347.5	22.1	49.2	1.3	98.6	8.55
1963-I	348.2	22.5	50.1	3.6	98.3	8.56
II	350.3	22.7	51.1	2.6	95.4	8.87
III	352.4	22.9	52.2	4.3	96.2	9.13
IV	354.8	23.4	54.0	5.9	96.9	8.87
1964-I	358.7	24.5	55.6	8.0	99.0	9.20
III	370.8	24.9	56.8	8.2	100.2	9.18
IV	376.9	27.2	59.2	3.9	99.4	9.71
1965-I	379.9	27.7	60.1	4.7	101.5	9.70
II	382.7	28.1	62.3	5.3	102.2	9.66
III	386.3	28.6	64.4	12.6	103.2	9.91
IV	393.5	28.1	63.9	11.1	102.6	9.63
1966-I	401.8	27.6	63.4	5.8	99.8	9.64
II	406.1	27.9	64.2	0	95.8	9.46
III	406.9	26.5	63.2	2.0	91.1	9.79
IV	411.0	26.7	62.7	2.0	88.3	9.25

(Table notes are on following page)

NOTES TO TABLE 5-A-3

Column 1: The Y_{-6} series is conceptually identical to that in column 1 of Table 5-A-1; its differences are that it (a) covers a slightly longer time period, (b) is in 1958 rather than in 1954 dollars, and (c) uses the revised data that began to appear with the August 1965 revision of the NIP Accounts.

Column 2: M_6 is average expenditure on automobiles and parts in 1958 dollars for the six months after the survey quarter, deflated by an index of families. The same procedures followed in derivation of the M_6 series in Table 5-A-1 were followed in this series except that revised income and product data (August 1965 issue of the *SCB*) were used.

Column 3: D_6 is average expenditures for total durable goods in 1958 prices for the six months after the survey quarter, deflated by an index of families.

Column 4: ΔY is the difference between disposable income in the survey quarter and average disposable income in the six months preceding the survey. Data are in 1958 prices deflated by an index of families.

Column 5: A is identical to the series in column 4, Table 5-A-1, extended forward to 1966-IV.

Column 6: QSI-SW_{3V} is the same weighted series as in column 11 of Table 5-A-1 except for the seasonal adjustment. Data in this column have seasonal adjustment factors which vary through time. The difference between the contant seasonal adjustment in Table 5-A-1 and the variable seasonal in this table shows up mainly over the period 1959 through 1963 in quarters I and II. The estimated seasonal adjustment factor for the first quarter declines from 103.7 in the first quarter of 1959 to 99.9 in the first quarter of 1963, while for the second quarter the estimated seasonal rises from 95.7 in the second quarter of 1959 to 99.7 in the second quarter of 1963. Since 1963, the estimated seasonal adjustment factors show only small and apparently random variation. The seasonal factors estimated for 1966 are as follows: first quarter, 100.0; second quarter, 99.2; third quarter, 95.6; fourth quarter, 105.4.