TRANSPORTATION CENTER

TEMPORAL ANALYSIS OF THE CONSUMER DECISION PROCESS FOR TRANSPORTATION

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Frank S. Koppelman

Associate Professor of Civil Engineering

RESEARCH REPORT

'ESTERN UNIVERSITY EVANSTON • ILLINOIS

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Frank S. Koppelman
Associate Professor of Civil Engineering

and

Patricia K. Lyon
Doctoral Candidate

The Transportation Center
Northwestern University
Evanston, Illinois

Annual Colloquium
European Association of Economic Psychologists
Louvain-Brussels, Belgium
August 27-29, 1980

ABSTRACT

This paper identifies the relationship between consumer attitudes and behavior as being important, theoretically and pragmatically, in the analysis of travel choice behavior. The primary issue of causality between attitude and behavior is formulated in terms of a set of alternative hypotheses. A conceptual model which can be used to test these hypotheses is formulated. This model explicitly represents the dynamic, structural relationship between attitudes and behavior in relation to relevant exogenous variables. The issues involved in operationalization and estimation of the model are described and a specific economic structure is proposed for empirical estimation. Current progress in the research is described to the point of data collection and screening. The results of the proposed empirical analysis will be reported in future papers.

ACKNOWLEDGEMENTS

This research is supported by a research and training grant by the United States Urban Mass Transportation Administration to Monitor the Implementation of Innovative Transportation Services. Supplemental support has been provided by the Transportation Center at Northwestern University. Officials of the Northeastern Illinois Regional Transportation Aurthority and the Village of Schaumburg, Illinois have cooperated in this research. The research is jointly directed by the lead author and Professor John R. Hauser of the Northwestern University Marketing Department. Professor Stephen Cosslett of the Northwestern University Economics Department has provided important technical advice. Ken Wisniewski, Guido Timmermans, and Steven Schorr have provided practical support at every stage of the work to date. We thank each of the above for their support and assistance.

INTRODUCTION

The relationship between attitudes and behavior has been the subject of a great deal of research in the psychological, marketing, and--most recently--transportation disciplines (Ajzen and Fishbein, 1977; Bass, et al., 1972; Golob and Dobson, 1974; Hauser and Koppelman, 1977). The interest in this relationship is both theoretical and practical. The theoretical interest is based on the importance of the interrelation between attitude and behavior to a conceptual understanding of the process by which consumers choose among alternatives. The practical interest is based on the improved diagnosis and prediction of consumer behavior which can be obtained when these relationships are properly identified.

A number of recent studies have examined some aspect of the relationships between attitudes and behavior in the choice of transportation alternatives (Dobson and Tischer, 1976; Golob, et al., 1977; Koppelman and Hauser, 1979; Recker and Golob, 1976; Spear, 1976; COTS, 1977; CRA, 1978).

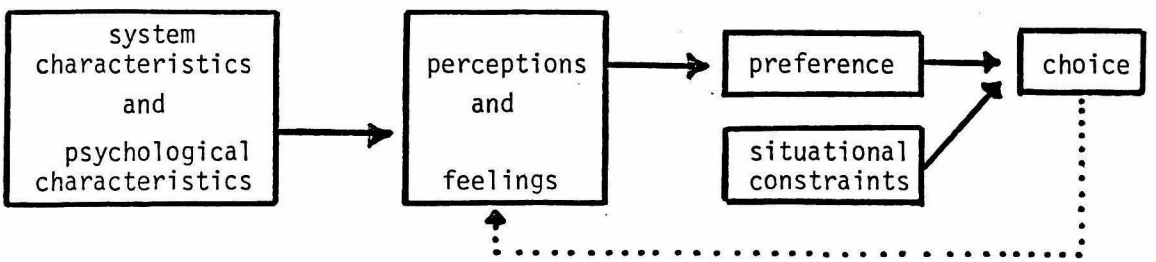

FIGURE 1: A Model of the Consumer Choice Process for Transportation

Researchers at the Northwestern University Transportation Center proposed and developed an integrated consumer behavior, marketing research, and travel demand model structure to describe the consumer

travel choice process (COTS, 1977; Koppelman, 1980). This model structure, depicted in Figure 1, represents the travel choice process as a sequence of steps in which travel choice is ultimately determined by objective service characteristics and individual psychosocial characteristics. In the first step an individual, described by his/her psychosocial characteristics, uses the characteristics of transportation services to form perceptions of and feelings toward these services. In the next step these perceptions and feelings (which are the cognitive and affective components of attitude, respectively) are combined to determine preference. Preference, tempered by situational constraints such as mode availability, determines travel choice. Finally, choice and the experience gained by choice behavior may feed back to mode perceptions and/or feelings.

Modelling each component of the consumer choice process in this way has important practical advantages for the service provider. Marketing managers, or in this application, transportation planners, can use the model to

i) diagnose the success or failure of a particular product (transportation alternative),

ii) influence consumer behavior, and

iii) predict the results of changes in attributes of the system or characteristics of the individual.

Diagnostic capabilities of this model follow from the ability to determine, for example, whether low ridership of a given travel mode is a result of any or all of the following:

a) poor performance on system characteristics,

b) unfavorable perceptions of system performance (even if actual performance is quite good),

c) negative feelings toward the mode (even if perceptions are neutral or favorable), or

d) situational constraints (which may override even positive feelings and perceptions).

Once the problem is correctly diagnosed, the solution can be directed to the point(s) which will have maximal impact on eventual choices. Finally, the impacts of both deliberate and unforeseen changes in the system can be predicted more accurately from a model with a sound conceptual basis.

THE NATURE OF THE ATTITUDE - BEHAVIOR LINK

The generality of the model depicted in Figure 1 has been captured only partially in practice (Koppelman and Pas, 1980; Koppelman and Lyon, 1980). The feed back effect between behavior and attitude (dotted line in Figure 1) is not represented in empirical analysis undertaken to date. Thus, in previous empirical applications of the model it has been assumed that attitudes influence behavior but that behavior does not influence attitudes. This assumption has been commonly made in travel attitude-behavior research (Dobson and Tischer, 1976; Golob, et al., 1977; Koppelman and Hauser, 1979; Recker and Golob, 1976; Spear, 1976; COTS, 1977; CRA, 1978).

However, it has been contested by some critics as an inadequate representation of the consumer response process (Horowitz, 1978; Johnson, 1975). The current research grows out of our own concern for the inadequacy of this representation of the attitude-behavior link.

Initially, we formulate the most general hypothesis which can be made about the relationship between attitudes and behavior. We then examine a variety of alternative hypotheses.

The general hypothesis is that attitudes influence behavior by a process such as that represented by the solid lines in Figure 1 and that behavior influences attitudes by a feedback adjustment process such as that represented by the dotted line in Figure 1.

The first alternative hypothesis is that attitudes influence behavior but that behavior does not influence attitudes or that this influence is comparatively weak. This hypothesis is the one most commonly employed in travel choice studies.

The second alternative hypothesis is that behavior influences attitudes but that attitudes do not influence behavior or that this influence is relatively weak. This hypothesis indicates that the choices an individual makes and the experience incurred influence his/her perceptions and feelings toward the alternatives. This can arise from either or both of two causes. First, the familiarity acquired and the things that are experienced as a result of present or past choices cause the individual to re-evaluate his/her former perceptions and feelings. Second, the choice itself may cause the individual to modify his/her attitudes to be consistent with that choice. This may be due to post-purchase rationalization, or a "self-perception" type inference (Bem, 1972). In addition, this relationship may exist due to an attempt by respondents to appear consistent to the researcher (Horowitz, 1978).

GENERAL HYPOTHESIS: ATTITUDES AND BEHAVIOR ARE MUTUALLY CAUSATIVE

ALTERNATIVE HYPOTHESES

ATTITUDE CAUSES BEHAVIOR

BEHAVIOR CAUSES ATTITUDE

THERE IS NO DIRECT CAUSALITY BETWEEN ATTITUDES AND BEHAVIOR

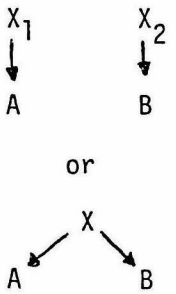

FIGURE 2: Hypotheses About Attitude-Behavior Causality

The third alternative hypothesis is that attitudes do not influence behavior and behavior does not influence attitudes. That is, attitudes and behavior are determined by an external set of variables. If the same or related variables influence both attitude and behavior, we may observe a non-causal correlation between them.

The emphasis of our research is to improve the understanding of the consumer response process represented in Figure 1. It is critical to that understanding to investigate which of the above hypotheses is correct rather than to assume any particular hypothesis, a priori. Adoption of an incorrect assumption about the attitude-behavior relationship is a serious misspecification error which may lead to incorrect interpretations of the behavioral response process.

PREVIOUS EFFORTS TO INVESTIGATE THE ATTITUDE-BEHAVIOR LINK

The investigation of the causal relationships between attitude and behavior must be based on a structural model which allows inclusion and testing of mutual causality as described in the general hypothesis. The alternative hypotheses can then be examined by the imposition of constraints on this general model. There are two ways in which this has been attempted by transportation researchers.

Tischer and Phillips (1978) used data from two points in time to investigate the relationship between attitudes and behavior with respect to transportation alternatives. Given certain assumptions on the nature of the causal process, one can make inferences about causality from the relative strengths of the contemporaneous and cross-lagged correlations. Their results suggest that attitudes and behavior are mutually causative, with attitudes having a slightly stronger influence. The results

obtained are weakened by the exclusion of other explanatory variables which may causally determine the observed correlations.

Tardiff (1977) and Dobson et al (1978) formulate structural equations models on cross-sectional data. Using simultaneous equations estimation techniques, they infer causality from the relative magnitudes and significance of relevant parameters. Dobson et al found mutual causality between attitudes and behavior. Tardiff found that behavior causes attitudes but attitudes do not cause behavior. However, he cautioned that his results might be biased by limitations of his data set. More generally, both sets of results are limited by the logical difficulty of inferring causality from cross-sectional data.

Thus, while both of these approaches are useful first steps, either method taken alone is incomplete. In fact, the two methods are complementarily incomplete in that each lacks a crucial element that the other provides. The first method offers an explicit temporal element but does not embed the attitude and behavior constructs in a larger structure. The second method offers the potential for sound structural modelling, but uses data collected only at a single point of time.

PROPOSED APPROACH TO ATTITUDE-BEHAVIOR HYPOTHESIS TESTING

The ideal approach for testing hypotheses about the attitude-behavior relationship combines the strengths of both of the above methods. This approach employs structural equations modelling on data obtained from more than one point in time. This is the approach we are taking in a study of transportation behavior in response to a change in service in a Chicago suburb.

A new small vehicle demand-responsive service was implemented in September 1979. This service provides local origin-to-destination transit in response to a telephone request. It is the first and only local general public transportation in the community. We, therefore, expect that introduction of the services will have a strong impact on both attitudes and behavior. We formulate the relationships between attitudes and behavior in terms of time dynamic structural equations describing the travel choice response process. Estimation of these relationships will be based on data on attitudes, behavior, and other relevant variables collected several times over seven months including one pre-implementation measure.

In the following sections we discuss the formulation of the time dynamic structural equations model, data collection and measurement issues, and estimation of the system of equations.

The Structural Model

The proposed structural model, depicted in Figure 3, can be visualized as an extension of the model represented in Figure 1. We include some additional variables representing information and explicitly represent the feed back relationships of choice/behavior to perceptions, feelings, and information received. Thus, attitudes are a function of exogenous psychosocial and objective system characteristics as well as a function of the information the individual has. Attitudes, in turn, determine preference, and preference and situational constraints determine choice. Choice then feeds back to attitudes and information in the next time period.

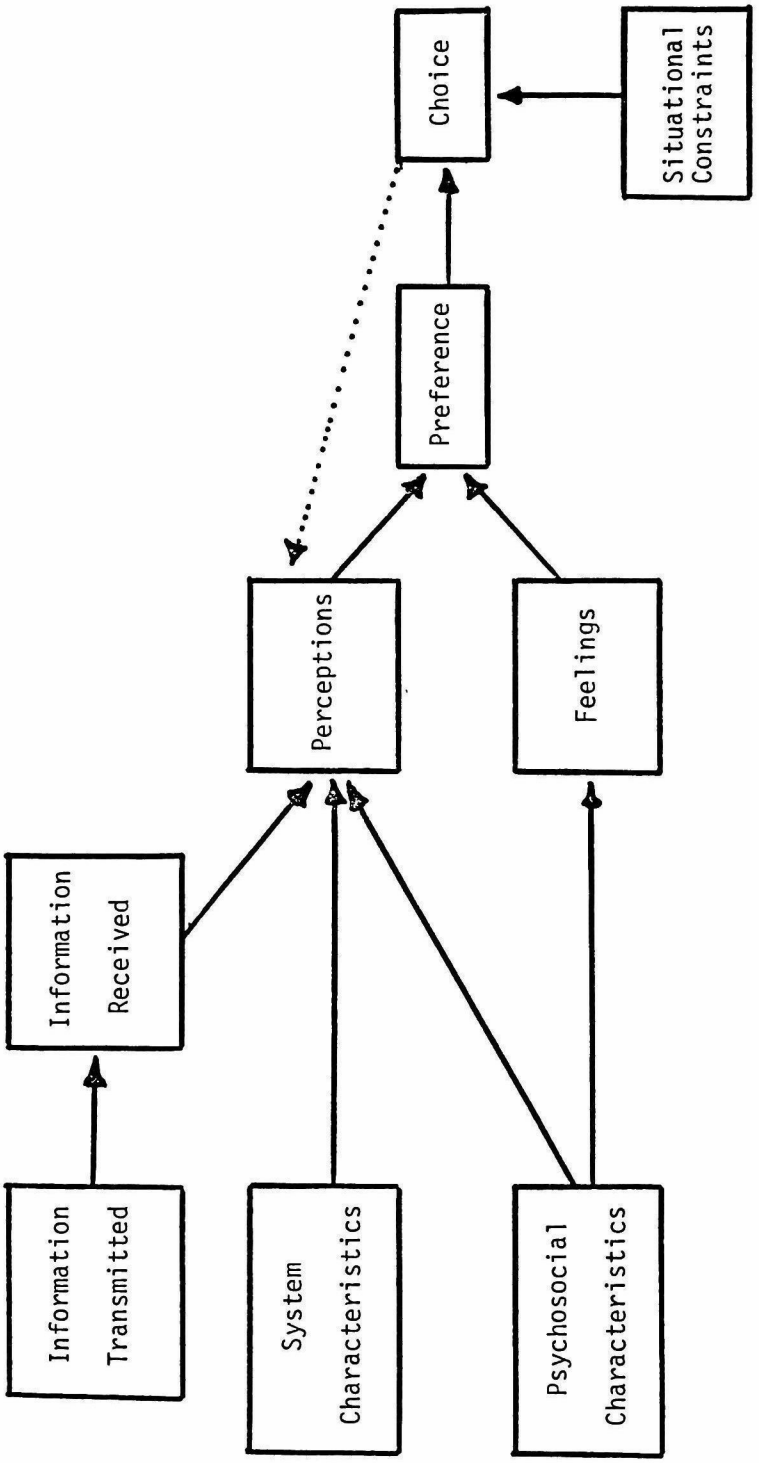

FIGURE 3: Structural Model of the Travel Choice Response Process

At any point in time choice is determined by current preference and situational constraints. Preference is determined by feelings and perceptions formed in the preceding period. Perception, in turn, is determined by objective characteristics of the system, information, and previous choice based on experience. Feelings are treated as exogenous to the relationship in the short term as we identify these to be underlying dispositions toward modal alternatives which are developed based on years of experiences using various types of transportation. Other relationships will be examined in the research but have been excluded here to simplify the presentation. These include feedbacks from preference to perceptions and feelings and interactions between perceptions and feelings.

Objective characteristics are measurable, engineering attributes of an alternative, such as travel time, cost, reliability. These are exogenous, that is, it is assumed that they influence, but are not influenced by, the other variables in the process.

Psychosocial characteristics are exogenous attributes of the consumer's personality, particularly those aspects which impinge directly on travel choice decisions (for example, snobbery/status-seekingness, environmental concern, feelings toward strangers, and tolerance of petty annoyances).

Information is a complex variable consisting of several dimensions. We distinguish between information which is transmitted and that which is actually received or retained by an individual. The information transmitted is exogenous, while the information retained may depend on past behavior (e.g. previous use of an alternative). Other distinctions, such as the source of information (mass media versus interpersonal), the content (factual or persuasive) and whether the information is solicited or unsolicited, may be useful.

Perceptions are the characteristics of a mode (e.g. comfort, convenience, safety, travel time, reliability) as they are perceived by the individual. They are endogenous, that is, functions of other variables in the system. Feelings is a composite term involving normative beliefs and prejudices with respect to transportation alternatives. Feelings are viewed as exogenous in the short term. Perceptions and feelings are conceptually distinct. Perceptions are cognitive, neutral, without any affective component. Feelings are affective; they include liking/disliking. In practice, these measures can be difficult to disentangle; perceptions may include positive or negative connotations and judgements.

Preference represents the overall desirability of each alternative. It is endogenous. Situational constraints are things that intervene to prevent the most preferred alternatives from being chosen; such as auto availability, schedule constraints, and weather. They are exogenous. Finally, the choice variable measures observed choice/travel behavior. Choice is endogenous.

We reformulate the model depicted in Figure 3 in response to the difficulties we identified in measuring psychosocial characteristics and measuring information transmitted. The dynamic structure of the relationships, in this reformulated model, is more clearly illustrated by depicting the model structures as a sequence of relationships over time (Figure 4). This model is not intended to be a definitive behavioral model. Rather, it is a reasonable model which extends state-of-the-art modelling efforts to take explicit account of dynamic relationships between attitude and behavior in a structural environment. The inclusion of additional variables and relationships or the deletion of some of those included

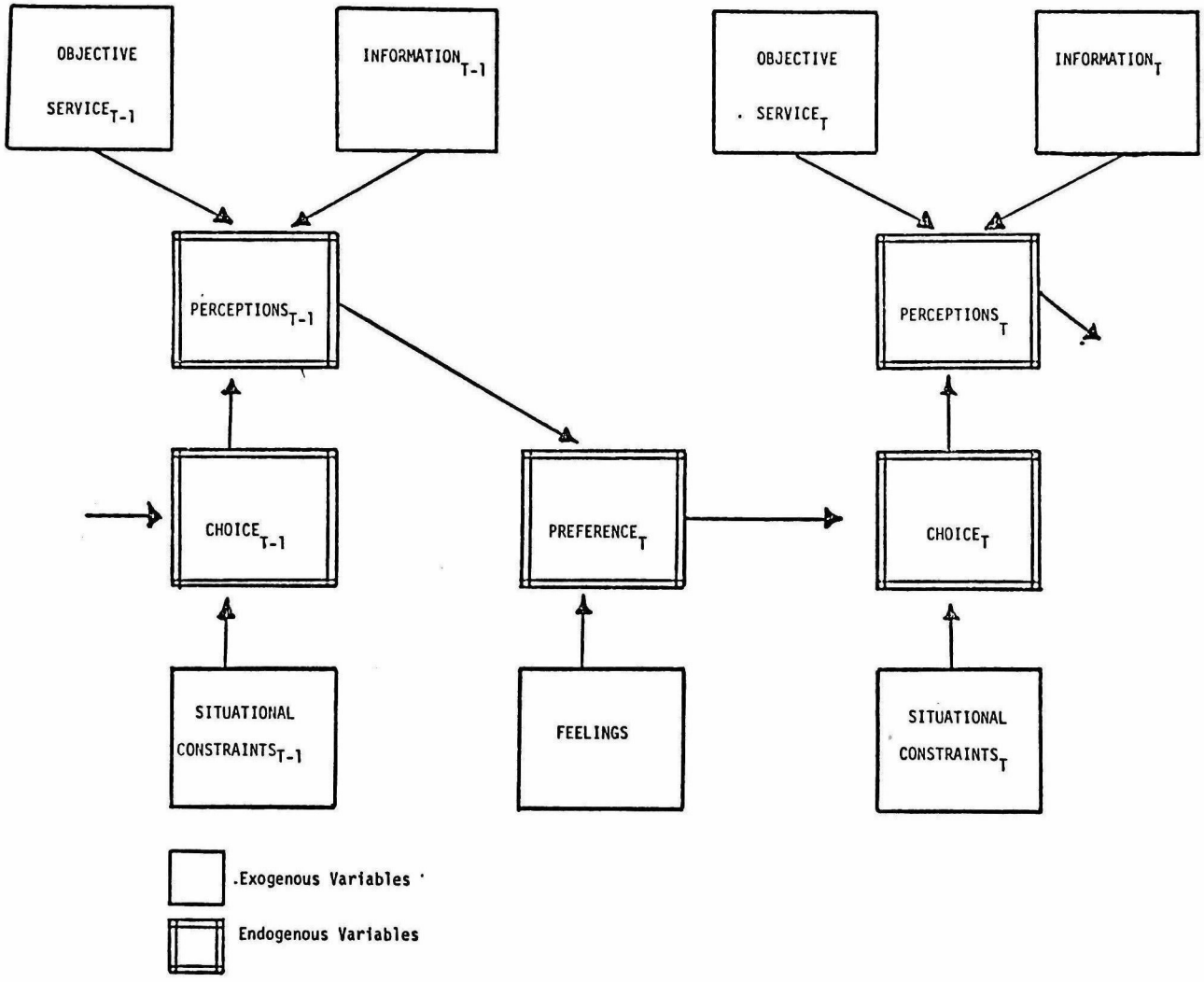

FIGURE 4: Dynamic Structural Model of Consumer Response

are subject to speculation and future hypothesis testing. The model, as described above, provides a useful structure to test a variety of hypotheses about the relationship between attitudes and behavior in a travel choice context. Furthermore, although the model, as presented, is specific to the analysis of travel choice behavior, it may be applicable to other repetitive-choice situations.

Our objective is to empirically operationalize the model depicted in Figure 4 so that the hypotheses of interest can be examined. The succeeding sections describe how this is done.

Data Collection

Since we are studying changes of individual attitudes and behavior over time, it is necessary to obtain measures of attitude and behavior and other relevant variables for the same individual over time. Thus, we established a panel of several hundred residents who volunteered to answer a series of mail-out, mail-back questionnaires. We recognize, and accept, certain disadvantages common to the collection of panel data. These include self-selection bias, selective attrition, and subject sensitization.

Self-selection bias occurs whenever participation in a study is dependent on voluntary cooperation. Self-selection bias will be greatest when the effort requested is large and the inducements offered are small. The present study, which requires considerable effort in the part of the respondent, is particularly subject to self-selection bias. Thus, although we randomly select those people whom we ask to participate,

those who actually participate may differ from the general population in important ways. Most importantly, participants may differ psychologically from refusers in ways that influence the decision process but are not obvious to be observer.

Selective attrition is a variation of self-selection bias. That is, not only do people terminate their participation in the panel, but those who do so may differ from those who choose to continue.

Sensitization results from elevated consciousness of respondents to their own attitudes and behavior and to the transportation services in the community. Thus, these people may change their attitudes and/or behavior partially in response to their experience as participants in the study.

Fortunately, these problems would seem to be less important to the purposes of our study than to a more pragmatic attempt to develop a forecasting model (although that may be a longer-term objective). We argue that the structure of the decision process--the causal linkages among variables--is relatively stable across different population groups in the same community although specific parameter estimates may be unrepresentative of the population as a whole.

The disadvantages of panel data discussed are an unavoidable component of disaggregate analysis of dynamic relationships. We believe the potential benefits justify acceptance of these limitations. Furthermore, we have formulated two external checks to evaluate the extent of biases from these sources. First, we will use census figures to identify demographic biases. Second, we will compare our measures of perceptions and behavior against similar measures collected from non-overlapping

periodic random samples obtained for a related study of the same service change. Inferences on the effect of the bias remain a matter of judgement.

Variable Measurement

We turn now to the issue of variable measurement; that is, how we operationalize such constructs as "perceptions" and information. Measurement is undertaken by a series of mailed questionnaires. The first, or base, questionnaire was distributed prior to implementation of the new service. Periodic questionnaires were mailed at selected intervals during the first seven months of operation.

The base questionnaire collects measures of prior perception of transportation services, feelings about transportation, personal characteristics, and current travel behavior. Periodic questionnaires collect measures of current perceptions, information received, and travel behavior.

We measure choice in terms of "frequency of use in the past week" for both the new service and private automobile. To aid recall (especially necessary for automobile trips), we ask for the number of trips using each mode on a day-by-day basis for the week. Preference for a mode is measured as a desirability rating on a seven-point scale ("highly undesirable" to "highly desirable"). Situational constraints are identified by asking, on a daily basis, if each trip made by auto could have been made with public transportation, and vice versa.

Perceptions are obtained by factor analysis of a set of abstract attributes designed to span the perceptual space. Factor analysis is a technique that, by delineating patterns of common variation, transforms a (relatively) large set of interdependent attributes into a (relatively) small set of independent factors which contain information about the

underlying perceptions. It has been widely employed in the social sciences (see Rummel, 1970 for an extensive list of applications as well as an introduction to the technique), and, more recently, has been successfully applied to transportation choice modelling (Prashker, 1977; Koppelman and Hauser, 1978; COTS, 1977). Feelings are obtained by factor-analyzing a set of statements relating to normative beliefs and prejudices about public and private transportation (Koppelman and Lyon, 1980).

Information is a complex variable describing source and nature of the message, circumstances of its reception, quality or accuracy, source credibility, and relevance. To our knowledge, no studies of travel behavior have explicitly included information variables. We represent information in a less complex form than theory would suggest since this is not the central focus of our research.

We first ascertain whether or not an individual has enough information to be able to use the new service. Secondly, we inquire about what other information he/she has received, including the kind of message (e.g. advertisement, word-of-mouth) and its effect on a five-point scale ("strongly negative" to "strongly positive"). From this data we can construct one or several indices of the quantity and quality of information received.

Psychosocial characteristics present particularly difficult problems. We are not aware of any attempts to directly incorporate psychosocial characteristics (personality traits) into a travel behavior model. This is not surprising in view of the complex theoretical and practical issues. First, there are a large number of psychosocial variables that may affect the behavioral process. Second, considering the undesirability of some

important traits (e.g. snobbery, prejudice) and the desirability of others (environmental concern, tolerance), it is difficult to obtain honest responses from any direct inquiry. Third, it is possible that asking such questions will annoy people to the extent that they refuse to respond at all. On the other hand, in-depth interviews are out of the question.

This is a logical place to compromise conceptual completeness in the face of pragmatic necessity. We do not collect psychological data but we do collect sociodemographic information. We follow past practice and use these as a proxy for some psychological variables.

The relationship between perceptions and objective characteristics is both complex and not well studied at this time. The other variables of the model can be measured by interaction with the individual. But objective characteristics, by definition, cannot be self-reported; they must be measured impartially. Obtaining objective characteristics for each person is infeasible, for it would involve measuring variables for a specific individual and his or her specific trip at a specific time and place.

Thus, we use a proxy measure for objective characteristics. Our approach is to divide the population into geographic segments. For each segment, we compute the average perception for each variable and each mode. This average is assumed to represent the objective value of that variable for that alternative for that segment of the population.

Equation Estimation

We turn now to the estimation of the parameters of the system of structural equations depicted in Figure 4. Econometric theory for the

estimation of simultaneous, structural linear equations is well-developed (Johnston, 1972; Theil, 1971). Wherever possible we formulate relationships as linear. However, the present study is complicated by the fact that one of our endogenous variables, choice, is discrete. That is, the measure of choice is expected to take on a limited number of values (zero, one, two,..., five; in most cases).

Although conventional linear regression techniques are sometimes used to estimate equations with discrete dependent variables (as both Dobson et al. and Tardiff did), it is not desirable to do so. The predicted dependent variables will be continuous and theoretically unrestricted in range, whereas the observed dependent variables take only a finite number of values. Parameter estimates may be biased and, because the error terms are not normally distributed, the usual hypothesis testing procedures (e.g. t-tests for the parameter estimates) are invalid.

Estimation of the parameters of single equation models with a discrete dependent variable can be accomplished by using a probabilistic formulation to obtain a logit, probit or Poisson regression model (Domencich and McFadden, 1975; Daganzo, 1979; Ruygrok and van Essen, 1980). Mode choice, for example, can be analyzed by assuming that the individual chooses the mode alternative with maximum utility. Specification of the distribution of a random utility component (which represents unobserved variables and individual variation in utility formulation) as Gumbel or multivariate normal leads to adoption of either the logit or probit formulation, respectively (Domencich and McFadden, 1975). Choice frequency can be formulated as a sequential comparison of alternative frequency levels to obtain a probit or sequential nested logit

structure (Sheffi, 1979). Alternatively, frequency may be structured as poisson distributed conditional on exogenous variables (Ruygrok and van Essen, 1980). In each of these formulations, the dependent variable is a probabilistically predicted categorical variable.

Heckman (1978) sets forth a procedure for estimating a system of simultaneous equations with both continuous and descrete variables. However, this procedure does not account for dynamic relationships among variables. We incorporate the dynamic relationships, depicted in Figure 4, into this structure to obtain a dynamic set of relationships which include structural state dependence (behavior in period t is structurally influenced by behavior in preceding time periods). However, the single stage dynamic structure which results can not be readily identified as the structural relationship will be confounded by serial correlation of the error terms if it exists (Manski, et al., 1978).

Heckman (1980) formulates a general multi-period choice model which enables identification of structural state dependence and serial correlation of the error terms. However, this formulation does not allow us to account for possible behavior to attitude causality which is a central concern of this research. We formulate our primary research model to include the dynamic, structural relationship between attitudes and behavior in order to address the hypotheses of attitude-behavior causality formulated earlier. In this analysis, we explicitly assume serial independence of the errors in order to identify the structural parameters.

STATE OF THE RESEARCH

The pragmatic problems associated with the empirical analysis of the hypothesis formulated earlier are numerous and complex. They include

coordination with implementation of a service change, recruitment and management of a consumer panel, design and testing of measurement instruments, and finally, data coding and analysis. At the present time, data has been collected for the panel including responses to eleven questionnaires returned by over 250 panel members. We are currently screening the data for completeness. Estimation problems are equally complex. We are in the process of formulating a special purpose maximum likelihood program to estimate the model depicted in Figure 4 with assumed serial independence of error terms. We are also exploring ways to merge the multiple structural equation model with the multi period estimation model structure described by Heckman (1980) in an effort to separately identify structural state dependence and serial dependence of errors. Preliminary estimation of the dynamic structural model is scheduled for early fall. Future papers will report the statistical and substantive results obtained.

SUMMARY

This paper describes a research program undertaken to identify the structural relationship between attitudes and behavior in consumers' response to transportation services.

We emphasize the importance of understanding this relationship to diagnosing, influencing, and predicting consumer behavior. We discuss various hypotheses about the attitude-behavior link, and describe two methods that have been used in the past to test such hypotheses. We point out the weaknesses of these methods and suggest an approach which combines their respective strengths. This approach is structural equations modelling with an explicit temporal element.

We present a candidate structural model of the choice process. We then outline the issues involved in operationalizing this model, and indicate how we are dealing with them in a specific application. Empirical results will be reported upon completion of data collection and analysis.

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