Abstract

Development and Application of Individual Choice Models for Holiday Travel

Moshe Ben-Akiva (1)
Ilan Salomon (2)
and
Lionel Silman (3)

This paper develops a choice hierarchy for holiday decision processes and presents some preliminary estimation results and prototypical applications of individual choice models for holiday trips. The choice that was modelled is the combined choice of mode and destination, which are the lowest level decisions in the choice hierarchy. At the intermediate level are the decisions concerning the annual holiday program, that is, the number of holiday trips, the duration and season. The upper level in the hierarchy consists of the longer term decisions on the type of holiday one aspires to engage in. A joint choice model for the lower level decisions was estimated using survey data from the Federal Republic of Germany. A household survey of holiday trips was complimented by other auxiliary data sources for attributes of holiday destinations and transport level of service.

Individual choice models can be aggregated in several ways to provide forecasts of domestic and international holiday trips. These forecasts are sensitive to economic variables such as disposable income, fuel prices and exchange rates; to socio-demographic variables such as level of education and family size; and to attributes of alternative holiday trips, including travel times and costs and cost and availability of accomodations and other holiday services. The presentation of the model is followed by prototypical applications to analyze changes in travel times and costs. These results indicate that policies designed to reduce travel times produce significant changes in in patterns of holiday trips. On the other hand, changes in travel costs produce a highly inelastic response. Holiday frequency or the choice of an annual holiday program is potentially more elastic and should be studied in further research.

Acknowledgement

Partial funding was provided by the Ministry of Transport of the Federal Republic of Germany through a subcontract from Socialdata, Munich to Cambridge Systematics Europe B.V., The Hague. The authors acknowledge the support of Dr. H.P. Weber of the Ministry and Mr. W. Brog and Dr. H. Collin of Socialdata who provided most of the data used in this study. Also, discussions with Dr. R. BarOn on tourism models are greatly acknowleged.

1) Dept. of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Ma. 02139, USA.
2) Dept. of Geography, The Hebrew University, Jerusalem, Israel.
3) Cambridge Systematics Europe B.V., 32 Laan Van Meerdervoort, 2517 AL, The Hague, The Netherlands.

DEVELOPMENT AND APPLICATION OF INDIVIDUAL CHOICE MODELS FOR HOLIDAY TRAVEL

1. Introduction

The tourism sector has grown dramatically over the last two decades and in many countries it has become an important element in the national economy. Its role in maintaining the balance of payments and as a basis of employment is such that for many countries changes in tourism levels can create accute crises.(Gray, 1982). Forecasts of holiday travel are needed by national and local governmental agencies and by tourism and transport operators. Holiday travel poses a wide-range of problems to the transport systems. (See for example, the review in ECMT, 1979). The continuing growth of holiday traffic has been accompanied by dramatic shifts in the patterns of these trips such as the significant increase in shorter duration holidays and the increasing proportion of domestic holidays (See for example, ECMT, 1979 and CSE, 1980). Thus, there is a clear need for models of holiday travel that are capable of predicting changes in the number of holiday trips by type, destination, travel mode and duration resulting from exogenous factors or policy decisions. Thses models should be sensitive to transport and accomodation prices, to investments in transport and tourism infrastructure and to a variety of institutional, socio-economic and demographic variables that directly affect holiday patterns.

Reviews of existing models of the demand for recreational travel and tourism are given, for example by Dwyer (1980), Vickerman (1978), Gearing et.al. (1976) and O'Rourke (1974). The litrature includes a wide spectrum of modelling techniques including elaborate aggregate sequential models (e.g., MRI, 1976), aggregate models with limited spatial detail using cross-sectional regressions or time-series analyses (e.g., Archer, 1976; BarOn, 1975; Wadner and Van Erden, 1980; and Kliman, 1981), and prototypical applications of disaggregate models of recreational trips (e.g., Harvey, 1975; Kocur et.al., 1979; and Gottardi, 1981).

As a generalization, it can be argued that tourism research has developed in at least two parallel routes and little effort has been made to bridge them. Research on the social psychology, motivation, and tourist behavior have been performed, as phenomenological studies, by sociologists and anthropologists (See Cohen, 1979, and Pearce, 1982). Across the disciplinary lines, economists have dealt primarily with macro level analyses of demand and supply and have been accused of conceiving the tourist as a "money-dispencing machine" (Pearce, 1982, p.7). There is an obvious lack of micro economic studies, not only in the sense of project level analysis as suggested by Gray (1982), but of policy sensitive behavioral models capable of incorporating theories of consumer or tourist behavior in a quantitative framework.

With that objective, this paper employs the individual choice modelling approach. First, developing an overall structure of choice models for holiday travel, and, based on the choice hierarchy concept (Ben-Akiva, 1973; Salomon, 1980), a model which is capable of forecasting tourists' choice of destination and mode is estimated. The choice hierarchy concept for holiday travel behavior is described in the following section of this paper.

An initial demonstration of the proposed approach is reported in section 3. The principal data source for this demonstration is a household survey of holiday trips by residents of the Federal Republic of Germany. The paper presents estimation results of a policy sensitive choice model of holiday destination and travel mode and the results of implementing these models to give prototypical predictions of the impacts of various policy changes such as travel times and travel costs. The final section of the paper discusses the conclusions from this study. It is concluded that the empirical study has demonstrated methodological contributions and provided a useful model for policy analyses of holiday travel employing this approach. While the viability of this approach has been demonstrated, directions for further work to extend and refine the holiday travel model are then identified.

2. A CHOICE HIERARCHY FOR A HOLIDAY TRAVEL DEMAND MODEL

In order to analyze the complex interaction between policy actions and the demand for holiday travel, a holiday demand model is required which predicts the demand for holiday trips,

- by holiday type
- by season
- by trip duration
- by destination
- by travel mode

as a function of

- motive for travel
- socio-economic characteristics of potential holiday makers including disposable income and constraints on length and timing of holidays associated with work and educational activities of household members.
- cost, travel time and travel comfort to alternative destinations by available modes
- quality, cost and attractiveness of holiday facilities by destination

It would seem that the most feasible way to develop such a comprehensive model system is to relate to the decision processes of the decision making unit which is the household. Typically several household members travel together on a holiday trip and the type and timing of the holdiday reflects a compromise between the desires and possibilities of the participants.

While the possibilities can, to a great extent, be identified through socio-economic and demographic variables such as income, age, available vacation time etc., desires are by far more complex and less easily identifiable. It can be assumed, following Cullen (1978), that, in contrast to urban travel patterns, the less routinised an activity is, the more it is deliberated and planned. This assumption implies that, first, given the time frame, an individual does process information about the alternatives and chooses the one that provides the greatest utility. Second, that in that process, so as to maximize the utility, an individual must cognize the motives or objectives of his or her desire to travel.

Tourists are travellers who make trips for a variety of purposes: resort in a different climate, pilgrimage, visiting family, attending conferences, participating in adventures and more. For each type there is an array of characteristics and constraints which define the choice situation of the individual.

It is natural to model this decision-making on an annual basis since most holiday decisions are taken within this time-frame. This does not mean that all tourist activities are in fact decided upon within an annual cycle. Pearce, (1982), suggests that tourist behavior is under long-term rather than short-term motivational control (p.50). The decision making time frame may in fact be multi-year, as much as shorter than a year, and that again will depend on the type of holiday in question. For pragmatic as well as substantive purposes it is convenient to use the annual cycle, being that time frame in which workplaces and educational institutes allocate vacation time.

The aim of this behavioral analysis is to predict the annual holiday program of the household including number of holidays by type, duration, seasonality and participation of household members. For each holiday, one also wants to predict the holiday destination and mode of travel.

In order to operationalize a model system with such a large number of dimensions of choice, it is valuable to use the choice hierarchy concept. The household is conceived of as making its decisions in stages. Firstly, more general longer-term decisions are taken based on an overall evaluation of the utility of the shorter-term more detailed choices. Then detailed decisions are taken regarding these shorter-term possibilities within the framework of the higher-level decision.

We propose analyzing holiday travel demand using a three-level choice hierarchy (see Figure 1). The upper level is the long-term decision on the type of holiday an individual or household is aspiring to engage in. At the second level the household decides on an annual holiday program in which decisions on the number of holidays by type, duration and season are taken. At a lower level, detailed decisions are taken for each holiday trip including destination and mode of travel.

The Choice of Holiday Type

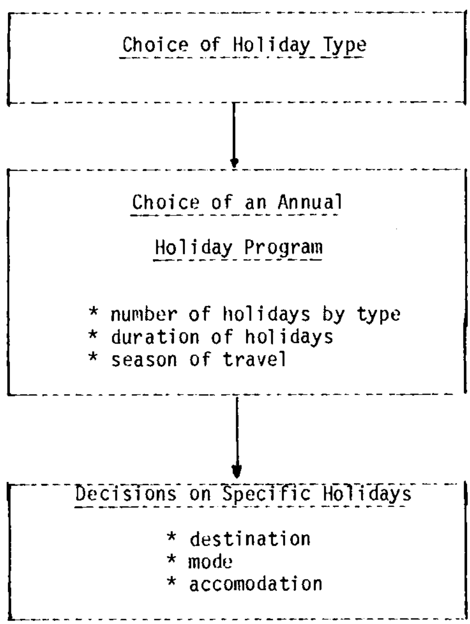
A household is assumed to make a long term choice of holiday type (e.g., resort, sightseeing, family visit, pilgrimage etc. or combinations of these). The decision is made in a time frame of a year or longer. The type of of holiday chosen is dependent on two factors: motivation for travel and available resources.

Research on tourist motivation is very diversified (see Pearce, 1982) and one should not expect to find a coherent body of research on this subject in the future (Dunn, 1981). Among the major issues which complicate our ability to explain motivation are, according to Pearce, (1982), the need to consider long-term goals, the multi-motive causes of behavior, measurement problems and the identification of intrin-sically motivated behavior.

Presently it seems to be too early to attempt the development of a model for the choice of holiday type. Further understanding of the relationship between motives and available resources and the substitution between holiday types, vis-a-vis the underlying motivation, is necessary. With that in mind, we can at this point attempt to identify the groups or market segments likely to choose each holiday type and then, continue the model development at the lower level decisions. In other words, it is presently sufficient to identify groups of tourists who are homogeneous in their long-term choice of holiday type.

Figure 1:

A Choice Hierarchy for Holiday Travel



In dealing with the relationship between long-term objectives and observed behavior, it is instrumental to draw upon the life style concept as conceived by Salomon, (1980). The longest term decisions, termed "life decisions" a person makes are jointly serving as "policy goals" which he or she aspires to fulfill in the day-to-day behavior. It can be viewed as a fourth level, above the holiday type decision in Figure 1. In the present context, aspirations determine the choice for certain types of holidays: some people will only wish to participate in an adventurous holiday, others will only consider sunny beaches and still others will consider only environments of historical interest.

Identification of a person's life-style will enable us to assume what are his or her preferences for leisure activities and holiday type. This approach is widely used by market researchers (see for example, Schewe and Calantone, 1978, and Solomon and George, 1977 , and also initial attempts to use this concept in leisure planning contexts, e.g., Glyptis, 1981). There still remains a major question as to the methodology of identifying life-styles. Psychographic analysis is commonly used by market researchers (see Wind and Green, 1974) while mulivariate techniques are proposed by others (Salomon, 1980).

The Holiday Program:

The decision on how to spend its holidays is an important part of the households' overall decision on the allocation of its resources between current consumption (e.g. purchase of a home or a second home, car, caravan, boat, etc.) and other non-current items (e.g., children, education). The decision on the allocation of money and time to holidaymaking in a particular year is made against the background of longer term (multi-year) decisions on the allocation of household resources (see Becker, 1965; Ghez and Becker, 1975; Nerlove, 1974 for a discussion of these decision processes).

Most households in developed countries allocate some resources to recreation and holidays spent away from home, and their number is important and growing in most countries (see WTO, 1981). Given the household budget, holiday time avaiability and timing constraints, individual preferences for leisure activities as represented by life styles, educational background etc., and general expectations of "price" and "quality" of different holiday trips, the household develops an annual program of holiday trips. In this decision the household can trade-off, for example, a long and expensive summer holiday abroad against two or more short and less expensive domestic holidays.

To explain the choice of a holiday program, such variables as disposable income, available holiday time from work, time constraints with regard to school holidays (when the children are of school age), with regard to the workplace (annual closure, slack or peak seasons) and specific attractions (fairs, Olympics), economical and political events and natural catastrophies seem to be relevant. Also, educational background, the stage of the household in its life cycle, ownership of appropriate durables (car, second home, caravan), previous holiday experience and the desire to holiday with (or at) friends and relatives will also affect the decisions. We should also take into account cultural, ethnic and language affinity which probably affect the annual program in a given cultural setting.

The fact that many households can now afford to take two or more weeks of annual holiday away from home, which they may take as a single holiday (perhaps abroad) or two shorter holidays, perhaps in both the summer and winter has important implications for planning purposes. Taking two holidays rather than one doubles the number of holiday trips, which has major consequences for travel operators (airlines, bus companies, etc.) and affects their seasonality and that of the destinations. If the second holiday involves winter sports or winter sunshine it may be more distant than the summer holiday. Modelling the choice of holiday program was not included in the present effort and should be addressed in future research.

Decisions on Specific Holidays

The decision on specific holidays are highly interdependent. For example, distant holidays involve relatively high travel costs and time, and will therefore usually be for a duration of at least a week. Most households will try to optimise their decisions with regards to the destination, the mode of travel, and the package or accomodation. To that end, individuals will collect infomation on alternatives, from sources such as travel advertisement, brouchures on specific operators or specific destinations, friends and travel agents.

Given that the household is planning to take a holiday trip of specific type, duration etc., it can now choose the destination and mode of travel. The travelling party is envisioned to make a joint choice of destination and mode from a set of available alternatives, i.e., the set of feasible combinations of destinations and modes for the specific holiday type chosen at the upper level.

It is realistic and statistically efficient to have a single joint choice model for the destination and mode choice, at the lower level of the hierarchy. The family car may be practical for most domestic trips in Europe or between The US and Canada and Mexico. Rail will be available for most intra-European trips, but for a few domestic trips in the US. Air may not be available or economic for nearby destinations or for those travelling with children or intending considerable tours on route.

For choice of mode and destination, it is appropriate to use a single multinomial logit (MNL) joint choice model, where each possible mode and destination combination constitutes an alternative. The MNL model allows us to evaluate the probability that an individual will choose a particular alternative out of a set of available alternatives. This MNL model has an overall "utility function" associated with it, based on the overall utility of each trip type considered for every household. The number and type of holidays taken in each year will then be a function of the travel and holiday costs and the other parameters, including the attractiveness of the destination.

Since choice of destination, mode and season are influenced by type of holiday, e.g.,
- Leisure and the three S's (sun, sea and sand);
- Engage in winter sports;
- Visit art treasures abroad;
- Enjoy a city holiday- theatre, restaurants, shopping;
- Have a quiet country holiday;
- Go on a safari;
- Visit ancestral homeland, etc.,

it may be advantageous to have different mode and destination models for these different types of holidays.

Interaction Between Stages in Hierarchy:

A key technical question is the way in which the interaction between the stages is represented. For example, holiday costs refer to individual destination, and thus appear in the lower detailed holiday choice model but changes in holiday costs may influence not only the choice of holiday and destination but also the number and duration of holidays taken by households. This is handled by using a maximum utility measure derived from a lower trip choice model in a higher level model. (See Ben-Akiva and Lerman, 1977.)

Aggregate Prediction:

There are several methods available to derive aggregate predictions of holiday travel from the individual choice models and the method to be used should depend on the context of the particular study. A very simple and powerful method is called Sample Enumeration (Ben-Akiva and Atherton, 1977). A sample of households is taken, together with their expansion factors which enable the calculation of aggregates by segment from sample results. Using past values of the explanatory variables, the model is applied to each household in the sample to reproduce the past demand for holiday travel. Policies are analyzed by representing them as changes in the explanatory variables (for example policy actions may be changes in some air fares, an increase in the quantity of accommodation in some region). Also, changes in exchange rates between currencies could be represented and analyzed. For each policy to be analyzed, the model is applied again to each household in the sample, using the changed values of the explanatory variables. The predicted demand for each household is then used to forecast the demand for holiday travel by destination, by mode, etc. This technique is very flexible, economical and enables the analysis of a wide range of policies and provides forecasts by all market segments represented in the household sample.

Greater accuracy can be achieved through the use of refined market segmentations, as separate models can be estimated for each segment. A number of alternative schemes are available to construct homogeneous and relevant market segments. Mitchell and Marchant (1977) reviewed a series of segmentation schemes and suggest that psychographic analysis has the potential to predict the possible impacts of social trends. This conforms with our contention that lifestyle is the most relevant basis for segmenting the tourism market.

3. THE EMPIRICAL STUDY

This empirical study considers the two dimensions of holiday choice in the lower level of the choice hierarchy:

- -- choice of travel mode (the most important modes are car, rail and air); and
- -- choice of holiday destination (different regions in Germany and abroad).

This choice was modelled by a multinoimial logit (MNL) model of choice where each relevant destination and mode pair constitutes an alternative.

The other dimensions of holiday behavior, including frequency (i.e. how many holidays are taken per year), seasonality (when is the holiday taken) and duration (how long is the holiday) belong to the upper level of the choice hierarchy and should, however, be modelled in a follow-up study.

After estimation of the joint holiday destination and mode choice model, it was applied to predict the consequences of prototypical policies influencing travel time and cost. These predictions reflect short-term shifts in holiday travel patterns constrained by the observed holiday programs.

3.1 ESTIMATION DATA

Three sources of data were used for model estimation:

(1) A household survey containing socio-economic data and details on all holiday trips
(2) Level-of-service data from all origins to all destiantions by the three modelled modes (car, rail and air).
(3) Destination attributes.

For each holiday trip taken in the survey, level-of-service data and destination attributes were taken from the two other sources and added to the household survey record describing the trip. This required the use of a common set of origin and destination zones for all three data sources. In all 314 zones were used, consisting of 295 domestic regions and 19 foreign destinations. (These were foreign countries coded both in the survey and for which level-of-service variables are available. It would certainly have been better to use a more detailed zoning system outside Germany, but neither the survey or the level of service data would support a finer system.)

It is easy to appreciate that explicit consideration of all mode/destination alternatives from a given origin will engender a huge computational load. There are three mode x 314 destinations which could give 942 alternatives. In order to reduce the computational load, the sampling of alternatives approach was used (McFadden, 1978). A sample of six alternative destinations was taken for every trip in the sample -- three in Germany and three abroad; this sample consisted of the chosen destination and five randomly chosen destinations. In model estimation it is sufficient to explain choice of the chosen alternative from the sample of available alternatives; estimated model parameters are afterwards corrected, where necessary, to reflect this sampling.

The Household Survey Data

The household data was drawn from a mail survey undertakn by Socialdata for the Federal Ministry of Transport. It includes socio-economic chracteristics of all household members, and origins, destinations, durations and modes of all holiday trips (defined as trips away from home for four or more nights, for non-business purposes) during the year preceding the data on which the questionnaire was completed.

The household trip file contained records for approximately 50,000 person holiday trips. This was more than required for estimation. Moreover, it was preferable to estimate models of the party's choice of mode and estination for which the personal characteristicss of all party members is available. So, the first step was to select a sub-sample of distinct party trips and to add the characteristics of all household members to these records (so that the characteristics of all household party members would certainly be available). Because of the prototypical nature of this study and in order to reduce the computational costs the estimation runs were performed with small sub-samples of some 400 party trips or less.

Level of Service Attributes:

The prime source of level of service data was a set of six matrices of travel attributes between the 314 origin/destination zones. The six attributes are:

1. Car Travel Time
2. Car Travel Distance
3. Rail Travel Time
4. Rail Travel Distance
5. Air Travel Time
6. Air Travel Distance

Destination Attributes:
Destination attributes available for zones in Germany included:

Area
Population
Employment
Students
Holiday Traffic Potential (being accommodation in terms of beds)
Weekend Traffic Potential (which measures the attractivenss of various recreational facilities)

A comparable set of attributes for foreign destinations was assembled, consisting of:

Area
Population
Employment
Accomodation

Some additional attributes were also assembled for these foreign destinations:

Tourism Cost Index (published annually for some major tourism destinations and giving tourism costs at foreign destinations relative to the base of 100 for the Federal Republic of Germany).
Cost of Living Index for foreign countries (relative to 100 in Germany).
German-speaking country dummy variable (having a value of one for destinations in German-speaking countries and zero otherwise).

Three weather variables:

Average daily hours of sunshine in July
Average maximum daily temperature in July
Average number of days with rain in July

3.2. ESTIMATION RESULTS

In this section we first describe in detail the most satisfying model specification obtained to date and then present some of the other model specifications estimated in the process of developing this model.

Model Specification:
The joint mode and destination choice model is a multinomial logit model giving the probability of a party of household members travelling together choosing a particular mode/destination combination for their holiday. These probabilities are a function of level-of-service variables for travel from the household residence zone (origin) to the alternative destinations by the alternative modes, of household socio-economic variables and of destination attributes. The model relates to three modes of travèl (car, rail, and air) and to 314 destinations.

Alternative Availability -- Not all of the 942 mode/destination combinations (3 X 314) are feasible alternatives for all holiday trips. In particular:

Air is regarded as not available for trips in Germany (since it is a rare mode for holiday trips to destinations in Germany).

Car is only available for car-owning households. (the possibility of renting a car was ignored in the present work).

For some foreign destinations rail and/or air are not available.

Mode/destination combinations for which the return travel time by the given mode exceeds the holiday duration are not feasible (e.g. a four day car trip to Spain from Hamburg).

The model contains the following variables: (see Table 1).

Travel Time: Travel time in minutes is measured from the origin centroid to the centroid of the final destination. The coefficient of this variable is negative, so that increasing travel time by any one mode to a single destination will descrease the probability of choice of that mode/destination pair.

Travel Cost: Travel cost in DM is distance based using rather out-dated cost/distance coefficients, provided with the network level-of-service data. The variable in the model is party travel costs. For car, this does not depend on the travel party size, but for rail and air the person travel cost is multiplied by Adult Equivalents where persons over 12 years old count as adults, and those under 12 as 0.5 adults. Another problem is that most holidays by air are Inclusive Tours, but cost information on Inclusive Tours was not available in the data used for model estimation. The coefficient of this variable is negative as expected (but its standard deviation is relatively large; it is not precisely estimated).

Net Holiday Duration Divided by Holiday Duration: Holiday duration (in days) was calculated from the reported starting and finishing days of the holiday. Net holiday duration was calculated by subtracting the days used for travelling (outward and return trips) from the overall duration. The travel time for air was taken to be one day. It was assumed that a day's travel by car was up to 600 km and by train up to 900 km. A mode/destination alternative for which a high proportion of the total holiday time is spent in travel will be regarded as undesirable; accordingly one expects the coefficeint of this variable to be positive, which it is.

Party Size: Travel party size appeared as two distinct variables, once for the car mode and once for the rail mode (such a variable which does not vary among alternatives cannot be specified for all alternatives; assigning it to the car and rail mode and not the air mode is arbitrary and has no substantial significance). The fact that larger parties tend to travel by car is reflected in the significant positive sign of the car-specific party-size variable.

Accomodation Costs: A variable measuring accomodation cost at the destination was calculated by multiplying holiday duration in days by number of Adult Equivalents in the party and this by the cost index (see note in Table 1) at the destination. Such a cost variable is expected to have a negative sign. Moreover, the influence of destination cost was found to be more marked for lower income households (see note 3 in Table 1). Accordingly, this variable was applied to such households only. The coefficient of this variable has the expected negative sign.

Table 1: Model Variables and Estimated Coefficients

Variable No.	Applies to Alternative	Variable Definition	Estimated Coefficient	Coeff. Std. Err.
1	All	One way travel time (min.) as given in LOS matrices	-.00097	.00041
2	All	One way travel cost (1) in DM for the party	-.00024	.00074
3	All	Net duration/duration (2)	2.06	.97
4	Car	Party size	.68	.43
5	Rail	Party size	-.17	.40
6	All	Accomodation cost measure(3)	-.00032	.00014
7	All	=1 for higher educ. (4) households travelling to non-German speaking countries =0 otherwise	.34	.26
8	Germany	=1 for non-car owning households =0 otherwise	1.80	.41
9	Air	=1 for households taking more than one trip annually =0 otherwise	.23	.41
10	All	Ln accomodation	.81	.07
11	Car+Germany	Constant	.23	.48
12	Car+abroad	Constant	-2.46 (5)	.58
13	Rail+abroad	Constant	-2.75 (5)	.50
14	Air+abroad	Constant	-5.39 (5)	.90
15	NW Europe	Constant	-1.15	.26
16	Alpine Des.	Constant	.88	.27
17	Balkan Des.	Constant	-1.07	.41
18	Air+Spain	Constant	4.06	.70
19	Air+Italy	Constant	1.20	.68
20	Air+Balkans	Constant	3.84	.84

See notes on following page.

High Education/Non-German Speaking Destination Dummy: this is a 0/1 variable taking the value 1 for high-education households in the utility of non-German speaking destinations. The positive sign of the coefficient reflects the fact that high education people are more likely to travel to non-German speaking destinations.

Non-Car Owning/Germany Dummy: This 0/1 variable reflects the lack of knowledge of households with no cars about foreign destinations.

Multiple Holidays and Air Dummy: This variable takes the value 1 for trips made by air by households with more than one annual holiday. It has a positive sign since such multiple holiday households, travelling more frequently than others, are likely to place a higher premium on the comfort and convenience provided by the air mode.

Accomodation: Accomodation in terms of number of beds is a measure of destination size. Clearly larger destinations are, other things being equal, more likely to be chosen than smaller ones. Unlike the definition of modes, the definition of zonal alternatives is arbitrary but it is to be hoped that the model form and coefficients are to a great extent independent of the way in which the study region is divided into zones. It can be shown that this occurs when the destination choice model has a variable which is the natural logarithm of such a size variable and the coefficient of the ln (size) variable is unity. If the division of the region into zones has some substantial content, the coefficient of this variable may be between 0 and 1. The estimated value of 0.81 for this ln (accomodation) variables is in accordance with this expectation.

Notes to Table 1.:

1) Travel costs apply to the party and is distance based. The cost coefficients used are as follows: Car: .32DM/Km, Rail: .18DM/Km, and Air: .35Dm/Km. Rail and air fares were multiplied by party size (see text).
2) Net holiday duration is calculated as holiday duration (in days), less twice holiday travel days (which is a function of travel mode and distance). For air, the number of travel days was assumed to equal 1, independent of distance. For car and rail, 600Km and 900Km were assumed to be daily travel distances, respectively.
3) A household is defined as "high-income" if it contains a full-time employed person classifying himself as either "Beamter"; "Selbstandiger" or "Freiberufler". The variable is defined as: (Cost index at destination) X (Vacation duration) X (Party size).
4) A household is defined as "high-education" if it contains a person whose educational status is: "Abitur"; "Fachhochschule" or "Hochschule".
5) The coefficients given in the table are the raw coefficients obtained from the estimation. As explained in the text, different sampling rates were used for sampling in Germany than those abroad. This should be corrected for by subtracting a constant from the utilities of all alternatives with travel abroad. Adjusting coefficients 12, 13 and 4 by subtracting -3.19 of each of them will correct this.
6) For those destinations for which the Tourist Cost Index was available, it was used. Otherwise, the Cost-of-Living Index was used. For East-European countries, neither index was available and the value 100 was imputed.

In addition to these explanatory variables, the model contains a number of mode and destination constants which do not have a behavioral interpretation. These constants reflect aspects of the attractiveness of the modes and the destinations, which are not explained by the variables which have been included in the model, and may also reflect the way in which the alternatives were defined. There are three groups of alternative specific constants (See Table 1):

1. Mode and Germany/Abroad Constants
   One can divide all the alternatives into five groups:
   Car and Germany
   Rail and Germany
   Car and Abroad
   Rail and Abroad
   Air and Abroad

   Zero/One dummy variables can be assigned to any four of these alternative groups. The rail and Germany alternative grouping was arbitrarily chosen as the base which does not explicitly have such a dummy variable.

2. Destination Costs
   Three such constants were used for:

   High Education/Non-German Speaking Destination Dummy: this is a 0/1 variable taking the value 1 for high-education households in the utility of non-German speaking destinations. The positive sign of the coefficient reflects the fact that high education people are more likely to travel to non-German speaking destinations.

   Non-Car Owning/Germany Dummy: This 0/1 variable reflects the lack of knowledge of households with no cars about foreign destinations.

   Multiple Holidays and Air Dummy: This variable takes the value 1 for trips made by air by households with more than one annual holiday. It has a positive sign since such multiple holiday households, travelling more frequently than others, are likely to place a higher premium on the comfort and convenience provided by the air mode.

   Accomodation: Accomodation in terms of number of beds is a measure of destination size. Clearly larger destinations are, other things being equal, more likely to be chosen than smaller ones. Unlike the definition of modes, the definition of zonal alternatives is arbitrary but it is to be hoped that the model form and coefficients are to a great extent independent of the way in which the study region is divided into zones. It can be shown that this occurs when the destination choice model has a variable which is the natural logarithm of such a size variable and the coefficient of the ln (size) variable is unity. If the division of the region into zones has some substantial content, the coefficient of this variable may be between 0 and 1. The estimated value of 0.81 for this ln (accomodation) variables is in accordance with this expectation.

In addition to these explanatory variables, the model contains a number of mode and destination constants which do not have a behavioral interpretation. These constants reflect aspects of the attractiveness of the modes and the destina-'

tions, which are not explained by the variables which have been included in the model, and may also reflect the way in which the alternatives were defined. There are three groups of alternative specific constants (See Table 1):

1. Mode and Germany/Abroad Constants
   One can divide all the alternatives into five groups:
   - Car and Germany
   - Rail and Germany
   - Car and Abroad
   - Rail and Abroad
   - Air and Abroad

   Zero/One dummy variables can be assigned to any four of these alternative groups. The rail and Germany alternative grouping was arbitrarily chosen as the base which does not explicitly have such a dummy variable.

2. Destination Costs
   Three such constants were used for:
   N.W. Europe destinations (Scandinavia, G.B., Benelux and France)
   Alpine countries (Switzerland and Austria)
   Balkans Destinations (Greece and Yugoslavia)

3. Mode and Destination Constants
   Three constants apply to travel to specific destinations by air:
   Spain and air
   Italy and air
   Balkans and air

   It is conjected that these constants reflect the wide availability of cheap Inclusive Tours by air to these destinations. Note that the characteristic of air level-of-service are taken for scheduled air services.

Further Model Estimation Results:

Table 2 presents the estimation results of some further specifications, including that presented above (which is repeated as specification D in Table 2). This table shows some of the variables which were used in preliminary tests but not in the final specification. It is important to see which model coefficients are stable over the series of runs, for such stability increases confidence that the coefficient has been correctly estimated.

Specification A was one of the earlier ones tested and uses the first 200 observations in the estimation file. It contains few alternative specific constants. Travel time and cost were inserted in a mode-specific manner, as were "Higher Education and Abroad" dummy variables. Two interesting variables which were tried were the "Accompanying Children" dummy (taking value 1 when the party includes a child) and the "High Season" dummy (taking value 1) for trips departing in July and August. It was conjectured that parties of a given size would be more likely to use a car if they included children, but this specification did not support that conjecture.

Specification B uses a much larger number of alternative specific constants. It was estimated on every second observation in the estimation file. In order to see what influence income has on the air travel cost variable, two coeffients of

TABLE 2: TESTS OF MODEL SPECIFICATION--COEFFICIENT ESTIMATES AND THEIR t-STATS (IN BRACKETS)

VARIABLE NAME	APPLIES TO ALTERNATIVES	SPECIFICATION A		SPECIFICATION B		SPECIFICATION C		SPECIFICATION D*	
Travel time	Car	-0.0029	(3.1)	-0.0020	(1.9)				
Travel time	Rail	-0.0018	(2.2)	-0.0002	(1.4)				
Travel time	Air	-0.0037	(1.2)	-0.0010	(0.4)				
Travel time	All					-0.0012	(2.4)	-0.00097	(2.3)
Travel cost	Car	+0.0097	(3.5)	+0.0007	(0.3)	-0.000036	(0.1)		
Travel cost	Rail	+0.0112	(2.8)	-0.0022	(0.6)	+0.0035	(0.4)		
Travel cost	Air	+0.0035	(3.1)			-0.00028	(0.4)		
Travel cost	All							-0.00024	(0.3)
Travel cost (LOWORK)	Air			+0.0030	(1.7)	0.69	(1.5)		
Travel cost (HIWORK)	Air			+0.0035	(2.6)	-0.42	(0.9)		
Net duration/duration	All	3.6	(2.2)	-0.27	(0.2)	+2.04	(1.8)	2.06	(2.1)
Party size	Car	2.66	(3.4)	2.8	(3.1)			0.68	(1.6)
Party size	Rail	0.85	(0.9)	1.3	(1.5)			-0.17	(0.4)
Accom. cost index (LOWORK)	All			-0.00026	(1.3)	-0.00031	(2.1)	-0.00032	(2.2)
High Educ. dummy	Abroad+C	-0.0019	(0.1)						
High Educ. dummy	Abroad+R	-1.32	(1.2)						
High Educ. dummy	Abroad+A	0.45	(0.7)						
High Educ. dummy	Abroad			0.18	(0.5)	0.34	(1.3)	0.35	(1.3)
Non car-owning HH	Germany					1.81	(4.4)	1.80	(4.3)
Multiple Ann. Hol.	Air			0.8	(0.1)	0.22	(0.5)	0.23	(0.6)
Accomp. children	Car	-1.38	(1.6)						
Accomp. children	Rail	-1.12	(1.2)						
High season trip	Car	-0.55	(0.9)						
High season trip	Rail	-0.57	(0.9)						
Index·Duration	All	0.0009	(2.1)						
Ln (accommodation	All	0.62	(7.5)	0.86	(8.9)	0.81	(11.9)	0.81	(12.1)
Constant	C+Germany	-1.36	(1.7)	-0.7	(0.9)	0.99	(1.9)	0.23	(0.5)
Constant	C+abroad	-3.60	(4.1)	-3.5	(3.4)	-2.46	(4.2)	-2.46	(4.2)
Constant	R+abroad	-2.72	(5.3)	-3.0	(5.8)	-2.8	(5.4)	-2.75	(5.5)
Constant	A+abroad	-3.06	(2.6)	-5.3	(3.6)	-5.4	(6.0)	-5.39	(6.0)
Constant	NW Europe			-1.24	(3.2)	-1.20	(4.5)	-1.15	(4.4)
Constant	Alps			0.92	(2.2)	0.83	(2.9)	0.88	(3.2)
Constant	Balkans			-0.88	(1.6)	-1.09	(2.6)	-1.07	(2.6)
Constant	B.c/Alps	0.33	(0.9)						
Constant	Spain+A			2.1	(3.1)	4.04	(5.6)	4.06	(5.8)
Constant	Italy+A			0.05	(0.1)	1.20	(1.8)	2.28	(1.8)
Constant	Balkans+A					3.90	(4.5)	3.84	(4.6)
NUMBER OF OBSERVATIONS		200		202		403		403	
INITIAL LN (LIKELIHOOD)		-521		-532		-1055		-1055	
FINAL LN (LIKELIHOOD)		-399		-343		-706		-707	

* This is the specification described in Table 1.

travel cost by air were estimated, one for lower income groups and the other for higher income groups. (see the definition of these income groups in Note 3 of Table 1).

Specification C was estimated on the same sample as D. It had a single travel time variable applying to all modes and destinations. The final specification differs from it only in that in D a single cost variable is used for all alternatives.

3.3. PROTOTYPICAL POLICY ANALYSIS

In order to demonstrate the implications of the estimated model, it is useful to apply it to evaluate the effect of changes in some explanatory variables which might be produced by transportation policy measures. At this stage, the changes which have been analyzed are somewhat diagrmatic or prototypical and should be regarded as part of the model evaluation process rather than as substantive policy analyses.

Prediction Methods:

The model was aplied to the estimation sample using the Sample Enumeration Technique presented earlier using the same sampling of destinations as in the estimation. The predicated number of observations in a sample of trips taking some alternative is obtained by summing the probability of that alternative over all observations in the sample. When explanatory variables are changed, the model gives new probabilities to the alternatives and so new sample predictions are obtained which can be compared to the base case.

Prediction Results:

In Table 3, holidays are divided into six types by destination (Germany or Abroad) and by travel mode:

Germany and Car
Germany and Rail
Abroad and Car
Abroad and Rail
Abroad and Air
Other (trips by unmodelled modes).

This breakdown is given for the base case (this is the percentage of observations in the estimation sample) and predicted for application of policies described by the following changes in the level of service variables:

Time A -- Decrease of 20% in rail time
Time B -- Decrease of 20% in rail time and increase of 20% in car time
Time C -- Increase of 40% in car time

Cost A -- Increase of 50% in car cost
Cost B -- Increase of 100% in car cost
Cost C -- Increase of 200% in car cost

Time A: In this case, the number of trips by rail is predicated to increase by 5%. Car and Air are predicted to decrase by 1% and 2% respectively. Note also that a small increase of trips abroad is predicted, arising from an 11% increase in the number of rail trips abroad. This indicates a higher sensitivity of longer distance trips to travel time policies.

Table 3: Policy Test Results

(Percentage of person-trip by holiday type in estimation sample and change in base in brackets)

Holiday Type	Base Case	Time Scenarios			Cost Scenarios		
		Time A Decrease 25% in Rail time	Time B As Time A and 20% increase in car time	Time C Increase 40% in Car time	Cost A Increase 50% in Car cost	Cost B Increase 100% in Car cost	Cost C Increase 200% in car cost
By Mode and Destination	%	%	%	%	%	%	%
Germany and Car	26.8	26.6	27.8	28.3	26.9	26.9	27.0
Germany and Rail	9.4	9.5	9.8	9.5	9.5	9.6	
Abroad and Car	42.8	42.4	40.5	39.2	42.5	42.3	41.7
Abroad and Rail	6.5	7.2	7.6	7.3	6.6	6.7	6.8
Abroad and Air	8.2	8.0	8.5	9.1	8.2	8.3	8.5
Other	6.3	6.3	6.3	6.3	6.3	6.3	6.3
	100.0	100.0	100.0	100.0	100.0	100.0	100.0
By Destination							
Germany	36.2	36.1	37.1	38.1	36.4	36.4	36.6
Abroad	57.5	57.6	56.6	55.6	57.3	57.3	57.1
By Mode							
Car	69.6	69.0(-.9%)	67.B(-2.6%)	67.5(-3.0%)	69.4(-.03%)	69.2(-.6%)	68.7(-1.3%)
Rail	15.9	16.7(5.0%)	17.4(9.4%)	17.1(7.5%)	16.1(1.3%)	17.8(11.9%)	18.2(14.5%)
Air	B.2	8.0(-2.4%)	8.5(3.7%)	9.1(11.0%)	8.2 (-)	8.3(1.2%)	8.6(4.9%)

Time B: The model predicts a 9% increase in rail trips, a 4% increase in air trips and a 3% fall in car trips. The choice model implies a 2% increase in the number of trips to destinations inside Germany in this case. This is primarily a result of a shift towards shorter car trips with a predicted 1% increase of domestic car trips. Thus, an overall increase of car travel time leads to an increase in the fraction of holiday car trips within Germany.
Time C: The model predicts an 11% increase in air trips, a 7% increase in rail trips and a 3% decrease in car trips. It also predicts a 4% increase in trips to Germany, that is primarily a shift towards shorter holiday trips by car.
Cost A: The model predicts a 1% increase in rail trips, a 0.3% fall in car trips and no change in air trips. It could well be that the effect of increase in car costs is more a reduction in trip making by car rather than mode switching. In this case, a model system with no generation sub-model will predict only small changes in modal-split.
Cost B and Cost C: The model predicts small decreases of 0.6% and 1.3% in car use for Cost B and Cost C respectively. As suggested above, this may be because the main effect of increase in car cost is a decrease in holidaymaking rather than mode or destination switching.

It should be appreciated that it is easy to use the model to predict the consequences of a wide range of policies (in addition to those already described) on holiday travel behavior. Examples of such policies are:

Increase of accomodation cost (in Germany or abroad)
Change in the exchange rate of currencies relative to the DM.
Changes in air fare and/or inclusive tour prices
Changes in Holiday duration

4. CONCLUSIONS

4.1 EVALUATION OF THE EMPIRICAL STUDY

Scope of the model -- the model deals with mode and destination choice for holiday travel. It is important to add a generation component to the model, so that the reduction (or increase) in the number of trips made when costs, income or travel time change can be reflected.
Alternatives Considered -- for reasons of data availability, only three modes were modelled, the foreign destinations were a limited number of entire countries. It would be better to use more modes (for example, scheduled air services and charters should be separated) and more foreign destinations. The increased set of alternatives could easily be handled by the powerful "Sampling of Alternatives" approach used in this study.
Decision Unit -- the modelling of the travel party decision appears to add behavioral validity without complicating the estimation or application procedures.
Accuracy of Coefficient Estimates -- most of the coefficients are estimated with acceptable accuracy. The standard deviation of the travel cost coefficient is somewhat high; better data on travel costs would contribute to its more accurate estimation. Estimating the model on a larger sample of trips would enable more accurate estimates of all coefficient estimates.
Variables in Model -- the model contains ten variables and ten mode/destination constants. These variables make the model sensitive to a wide variety of important policies. The use of additional destination attractiveness and travel

level of service variables (if they were available for all destinations), would add behavioral realism.

Model Application Technique -- The Sample Enumeration technique applied in the study is a rapid, flexible and sensitive technique for policy analysis. However, this model can be applied with other prediction techniques for other types of analyses such as longer-term forecasts.

Prototypical Policy Analysis -- the policy analyses involving changes in travel time are intuitively very acceptable. In particular, the effect of increased travel time by a single major mode resulting in holiday-making being done nearer home certainly exists and the current model structure represents it fully. The change in modal-split due to icreased car costs appears low. It can be conjectured that the cost coefficient (being imprecisely estimated) has a value rather too low.

In conclusion, given the restricted resources and the limitations of the available data, the study has made a methodological contribution and provided a potentially valuable tool for policy analysis.

4.2 DIRECTIONS FOR FURTHER WORK

This study has demonstrated the feasibility of the individual choice model approach for Holiday Travel Forecasting, using readily available data. However, this study only provides a starting point and further work will enable the development of a more complete holiday travel model. Three important extensions of the current study have been identified:

1. Development of Holiday Frequency Model -- For forecasting holiday travel, it is important to model holiday frequency choice or what was termed above as the choice of the holiday program. Policies and economic trends may bring about changes in the level of trip-making, rather than changes in mode or destination choice. Frequency choice models should reflect the complex household process in which the number and duration of holidays is dependent on income, holiday entitlement and other socio-economic variables. The joint choice model of destination and mode can be used to develop composite measures of holiday opportunities. These variables will be introduced in the frequency choice models and provide the linkage between the policy variables and holiday participation rates.

2. Refinement of Model Estimation Data -- data availability always places constraints on model development. For developing holiday models the primary data constraint was the coarseness of the destination zones. This was a consequenc of both survey data and level-of-service data considerations. The foreign destinations in the survey were coded only to the country level; the level of service variables were also generally coded to the country level, but are available for relatively few destinations. Clearly, providing a level of service for travel to France without distinguishing between Paris, the Loire valley or the Riviera is unsatisfactory. Model estimates would be more precise is one could use a zoning scheme, including many more foreign countries, and for which large nearby countries are divided into regions.

In order to use such a scheme, improvements are required in both the survey, level of service data and the destination attributes data. At the same time, more detailed level of service data would be useful for trips outside Germany. In particular, the data for air travel should refer more specifically to

Inclusive Tour travel, as well as Scheduled Flights (since some 70% of holiday air travel is by Inclusive Tour).

It would also be advantageous to have available a wider range of socio-economic variables than is included in the household survey. Even if it is not possible to have an income variable, more detailed information on car-ownership, education level and work status could possibly be obtained.

3. Breakdown of Holidays by Purpose -- It is probably better not to model holidays as single travel purpose, but to develop models for several distinct holiday purposes (e.g. "Sun and Sea", "Winter Sports", "City", "Countryside Camping"). Most certainly different attraction variables are relevant for the different purposes. To do this, the household survey would have to include further questions on holiday activity, to facilitate proper segmentation.

References

Archer B. (1976), Demand Forecasting in Tourism, University of Wales Press, Wales.

BarOn R.R.V., (1975), Seasonality in Tourism - A Guide to the Analysis of Seasonality and Trends for Policy Making, Technical Series No. 2, The Economist Intelligence Unit, London

Ben-Akiva M., (1973), Structure of Passenger Travel Demand Models, Ph.D. Thesis, Dept. of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Ma.

Ben-Akiva M. and Atherton T., (1977), "Methodology for Short-Range Travel Demand Predictions", Journal of Transport Economics and Policy, Vol. XI, No. 3

Ben-Akiva M. and Lerman S., (1977), "Disaggregate Travel and Mobility Choice Models and Measures of Accessibility", in Hensher D. and Stopher P. (eds.), Behavioral Travel Modelling, Croom Helms, London.

CSE-- Cambridge Systematics Europe B.V. (1980), Forecasting Holiday Travel by Air: Analysis of Holiday Patterns, 1969-1978 and Collection of Data on Holiday Characteristics, Prepared for the Rijksluchtvaartdienst, Ministrie var Verkeer en Waterstaat and N.V. luchthaven Schiphol, The Netherlands.

Cohen E. (1979), "Rethinking the Sociology of Tourism" in Annals of Tourism Research Vol. 6, pp. 18-35.

Cullen I. (1978), "The Treatment of Time in the Explanation of Spatial Behavior", in Carlstein T., Parkes D. and Thrift N. (eds.), Human Activities and Time Geography, John Wiley, NY.

Dunn G. (1981), "Tourist Motivation - An Appraisal" in Annals of Tourism Research, Vol. 8, pp. 187-219.

Dwyer J., (1980), "Estimating Consumer Satisfaction Associated with an Increase in Public Tourism Supply; An Economic Approach", in Hawkins D. et.al., Tourism Planning and Development Issues, George Washington Univ., Washington, DC.

ECMT- European Conference of Ministers of Transport, (1979), Holiday Traffic, Round Table No. 44, Paris.

Gearing C.E., Swart W. and Turgut V., (1976), Planning for Tourism Development: Quantitative Approaches, Praeger Publishers, New York, NY.

Ghez G. and Becker G.S., (1975), The Allocation of Time and Goods over the Life Cycle, NBER, NY.

Glyptis S. (1981), "Leisure Life-Styles", in Regional Studies, Vol. 15, No. 5.

Gottardi G. (1981), "Estimation of the Determinants of weekend Travel with Disaggregate Behavioral Demand Models", paper prepared for presentation at the PTRC Annual Meeting, University of Warwick, England.

Gray P.H., (1982), "The Contribution of Economics to Tourism Research and Efficiency", in Annals of Tourism research, Vol. 9, pp. 105-125.

Harvey G.W., (1975), Demand Models for Weekend outdoor Recreational Travel, MS Thesis, Dept. of Civil Engineering, Massachusetts Institute of Technology, Cambridge, Ma.

Kliman M.L., (1981), "A Quantitative Analysis of Canadian Overseas Tourism", Transportation Research, Vol. 15a, No. 6, pp. 487-498.

Kocur G.A., MacMann J.F., Brown H.P. and Daly A.J., (1979), "A Model of Weekend Recreational Travel Demand", Paper presented at the annual PTRC meeting, Univ, of Warwick, England.

McFadden D., (1978), "Modelling the Choice of Residential Location", in Karlquist A. (ed.), Spatial Interaction Theory and Planning Models, North Holland, Amsterdam.

Mitchell D. and Marchant L. (1977), "Is Attitude Segmentation in the Holiday Market a Reliable Predictor of Future Behavior?", in Travel and Tourism, Seminar of the European Society for Opinion and Marketing Research, (ESOMAR), Amsterdam.

MRI- Midwest research institute, (1976), Development of Models for Predicting Weekend Recreation Travel, prepared for the National Cooperative Highway Research Program, Washington DC.

Nerlove M., (1974), "Household and Economy: Toward a New Theory of Population and Economic Growth", in Journal of Political Economics, pp 5200-5218.

O'Rourke B., (1974), "Travel in the Recreational Experience -- A Literature Review", in Journal of Leisure research, Vol. 6.

Pearce P.L., (1982), The Social Psychology of Tourist Behaviour, Pergamon Press, Oxford.

Salomon I. (1980), Life Style as a factor in travel Demand Models, Ph.D. Thesis, Transportation Systems division, Massachusetts Institute of Technology, Cambridge Ma.

Schewe C.D., and Calantone R.J. (1978), "Psychographic Segmentation of Tourists", in Journal of Travel Research, Vol.16, (3), pp. 14-20.

Solomon P.J. and George W.V. (1977), " The Bicentennial Traveller: A Life-Style Analysis of the Historian Segment", in Journal of Travel Research, Vol. 15,(3) pp. 14-17.

Vickerman R.W., (1978), "Travel Choices for Recreatinal Journeys", in Hensher D. and Dalvi (eds.), Determinants of Travel Choice, Saxon house, Farnsborogh, England.

Wander S. and Van Erden J., (1980), "Estimating the Demand for International tourism Using Time series Analysis", in Hawkins D. et.al., Tourism Planning and Development Issues, George Washington Univ., Washington DC.

Wind Y. and Green P. (1974), "Some Conceptual, Measurement and Analytical Problems in Life-Style Research", in Wells W. (ed.) Life Style and Psychographics, American Marketing Association, Chicago.

WTO- World Tourism Organization, (1981), Domestic Travel statistics (including travel Abroad), Madrid.