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An annual time use model for domestic vacation travel

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Abstract

Vacation travel in the USA, which constitutes about 25% of all long-distance travel, has been increasing consistently over the past two decades and warrants careful attention in the context of regional and statewide transportation air quality planning and policy analysis, as well as tourism marketing and service provision strategies. This paper contributes to the vacation travel literature by examining how households decide what vacation travel activities to participate in on an annual basis, and to what extent, given the total annual vacation travel time that is available at their disposal. To our knowledge, this is the first comprehensive modeling exercise in the literature to undertake such a vacation travel time-use analysis to examine purpose-specific time investments. A mixed multiple discrete-continuous extreme value (MDCEV) model structure that is consistent with the notion of "optimal arousal" in vacation type time-use decisions is used in the analysis. The data for the empirical analysis is drawn from the 1995 American Travel Survey (ATS). The results show that most households participate in different types of domestic vacation travel over the course of a year, and spend significantly different amounts of time on each type of vacation travel, based on household demographics, economic characteristics, and residence characteristics.

Keywords: vacation, long distance, leisure activities, time use, choice modelling

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1 Introduction

1.1 Background and Motivation for Study

It has long been recognized in the transportation and tourism literature that long distance leisure travel is an important aspect of American households' lifestyle.[1] For instance, recent research studies reveal that US households, on average, spend nearly one-half of their total leisure expenditures on vacation travel (Gladwell, 1990) and that nearly one-third of US households' long-distance trips by private vehicles are for leisure (see Mallett and McGuckin, 2000); In the rest of this paper, we will use the terms "long distance leisure travel" and "vacation travel" interchangeably, preferring the latter term for conciseness). Further, recent changes in the economy and fuel prices do not seem to have had a substantial impact on household time and money expenditures on vacation travel. (Hotel News Resources, 2007; Holecek and White, 2007) For instance, according to an AARP study, baby boomers, aged 35 to 53, continue to spend approximately $157 billion dollars per year on leisure vacation travel (Davies, 2005). Besides, it has been well established for some time now that individuals over the age of 50 spend substantially more time and money on vacation travel than their younger peers, because of fewer family obligations, comparable incomes as their younger peers, and fewer required expenditures (Walter and Tong, 1977, Anderson and Langmeyer, 1982, and Newman, 2001). By this token, the baby boomers are just about "moving into their big traveling years" (Mallett and McGuckin, 2000), which is likely to imply higher demands for vacation travel over the next several years. This is particularly because the cohort of baby boomers is relatively healthy and active, and continues to consider vacation travel as a necessity rather than a luxury (Ross, 1999). Of course, in addition to age-related factors, other factors that have been identified as potential contributors to the growth of vacation travel in recent years (and that may continue to contribute to future growth) in the US and other western industrialized countries include a reduction of work hours (Garhammer, 1999), an increase in paid leave time (Alegre and Pou, 2006), increasing average household incomes (Schlich *et al.*, 2004), enhanced participation and control of the vacation experience by researching and planning on the internet (American Automobile Association, 2006), and focused efforts to preserve and showcase cultural and natural heritage sites (such as the National Scenic Byways program administered by the Federal Highway Administration and other groups in the US; see Eby and Molnar, 2002).

Within the context of overall vacation travel, the private automobile is the mode of transportation for about 80-85% of such travel in the US and elsewhere (see Newman, 2001, American Automobile Association, 2005, and Schlich *et al.*,

[1] Long-distance travel is usually defined to include trips whose (home-to-home) lengths exceed 100 miles. Leisure travel may be defined as "all journeys that do not fall clearly into the other well-established categories of commuting, business, education, escort, and sometimes other personal business and shopping (Anable, 2002).

2004). The high use of the automobile as the mode of transportation for domestic vacation travel may be attributed to several factors. First, an increasing percentage of households own private automobiles today than in the past. For instance, the 2001 NHTS data shows that about 92% of US households owned at least one motor vehicle in 2001 (compared to about 80% in the early 1970s; see Pucher and Renne, 2003). This makes it possible to use the car for vacation travel. Second, the destination footprint of vacation trips has been shrinking to a relatively compact geographic area around the household's residence. In fact, 80% of the vacation travel of US households is within 250 miles of the home, according to the American Automobile Association. The compact geographic footprint entails less expenditure per trip, less pre-planning, and less time investment per trip. The latter issue is of particular relevance because long vacation time investments are possible only during a few full weeks during the year (and these weeks are determined, among other things, by work schedule considerations in multiple worker households, and additional children's school schedule and activity considerations in households with children). Thus, households plan several short vacation trips over the weekends, which contribute to the compact geographic footprint. In turn, the compactness of travel destinations encourages the use of the car mode of travel. Third, the National Scenic Byways program created by the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) and other Scenic Byway programs offer a set of destinations in every state of the US that collectively provide rich and diverse opportunities for leisure, and are also easily accessed by the automobile.

The substantial and increasing amount of auto-based vacation travel over shorter distances has important implications for transportation air quality planning and tourism (see Beecroft *et al.*, 2003). From a transportation planning standpoint, auto-based vacation travel adds to intra-city traffic in urban areas, and can lead to traffic congestion at certain points of the transportation network on holidays and weekends (see Lockwood *et al.*, 2005). In addition to traffic delays, such congestion contributes to mobile-source emissions and air quality degradation (Roddis *et al.*, 1998). Besides, vacation travel inevitably involves side-stops for leisure activities and/or biological needs, and the vehicle engine stop-start activity also contributes to mobile source emissions. Understanding the vacation travel flow patterns, therefore, can help in building appropriate roadway capacity, designing adequate parking facilities and park-and-ride facilities, and implementing transportation control policies. From a tourism standpoint, a good understanding of auto-based vacation travel patterns can aid in enhancing the vacation experience of travelers by, for example, providing adequate service facilities on heavily traveled corridors and at scenic byway locations (Eby and Molnar, 2002). Doing so is in the interests of regional and state economies, which depend quite considerably on vacation travel expenditures (Horowitz and Farmer, 1999). Specifically, regions and states that accommodate the needs of vacation travelers can tap into the billions of dollars tourism generates each year. Further, understanding the preferences for leisure travel of different population sub-groups

facilitates the targeting and positioning of leisure activity opportunities.

1.2 Previous Research vis-à-vis The Current Study

The importance of studying vacation travel should be clear from the discussion above. Unfortunately, vacation travel has received little attention in the transportation planning literature, being relegated to the aggregate class of "through" trips or "internal-external" trips or "visitor" trips in regional travel demand models and being considered in relatively statistical (rather than behavioral) ways in statewide travel modeling (see van Middlekoop *et al.*, 2004 and Horowitz and Farmer, 1999).[2] While vacation travel has received much more focus in leisure travel research, the studies in this area have been mainly confined to either (1) theoretical models, or (2) overall roles and impacts of household members on vacation decisions in general, or (3) univariate descriptive models of the effect of social-psychological and individual factors on vacation decision-making for a single vacation trip (typically the "most recent vacation trip"), or (4) specific travel dimensions for a certain kind of vacation trip. As examples of the first category of theoretical models, Woodside and Lysonski (1989) develop a theoretical model of traveler destination awareness and choice for a vacation trip, while Iso-Ahola (1983) proposes a dialectically optimizing theory of vacation participation in which the individual/family balances needs for familiarity and novelty to provide themselves an "optimally arousing experience". The early studies of Hawes (1977), Jenkins (1978) and Cosenza and Davis (1981) belong to the second category of studies, and examine vacation-related perceptions and decision-making influence of different household members. On the other hand, several other studies including Walter and Tong (1977), Anderson and Langmeyer (1982), Etzel and Woodside (1982), Gladwell (1990), Nickerson and Jurowski (2001), and Davies (2005) focus on a single vacation trip (pursued at a certain pre-determined location or pursued as the most recent vacation trip), and undertake a univariate descriptive analysis of vacation patterns/experiences (mode, duration, destination, purpose, *etc.*) based on such individual/family attributes as age, presence and number of children, education, income, occupation, job requirements, and family life cycle. These are examples of the third category of studies. Finally, as examples of the fourth category, a few studies have focused on vacation site choice for specific types of vacation trips such as fishing (see, for example, Train, 1998, Herriges and Phaneuf, 2002; see Phaneuf and Smith, 2005 for a comprehensive review of such studies).

The research works in the leisure travel field discussed above have provided valuable insights into the process of vacation travel decision-making. However,

[2] It should be mentioned here, however, that there has been more focus recently in the transportation research field on leisure travel and time-use within urban areas, corresponding to local metropolitan area travel (for example, see Bhat and Misra, 1999, Lanzendorf, 2002, Bhat and Gossen, 2004, Schlich *et al.*, 2004, and Srinivasan and Bhat, 2006). But these are not directly relevant to the current paper on long distance leisure travel.

they are limited in two important and inter-related ways. First, these studies do not consider the several vacation travel activity purposes that households participate in during a certain time period (say in a year). Instead, these studies either do not consider different leisure purposes separately, or focus on one particular type of vacation purpose, while focusing on a single vacation episode as the unit of analysis. As indicated earlier, households are pursuing vacation travel more frequently and for a variety of activities. The diversification of activities across multiple vacation trips is a natural consequence of a social-psychological need for optimal arousal based on stability (psychological security) as well as change (novelty), as discussed by Iso-Ahola (1983). Earlier studies ignore this diversity of vacation activity participations of the same household. Second, the use of a vacation trip as the unit of analysis in earlier studies does not allow the study of how individual vacation trip purpose choices link to total vacation demand preferences by purpose over longer periods of time.

This paper addresses the two limitations identified earlier by developing a model of total vacation travel demand by purpose over a period of time. It is based on the optimal arousal theory of vacation travel, which states that individuals and households "suffer psychologically and physiologically from understimulating and overstimulating environments" (see Iso-Ahola, 1983). That is, individual and households choose to participate in multiple kinds of vacation activities over multiple vacation trips to balance familiarity and novelty. For instance, individuals and households may choose certain familiar types of vacation trips over a given period, but then will start seeking variety at some point when the environmental stimulus becomes very similar to the coded information and experience from the past (which leads to boredom and a lack of novelty and adventure). In the parlance of the model proposed here, individuals have a certain baseline marginal utility for pursuing each kind of vacation activity (with a higher baseline marginal utility for the most familiar activity type than for other activity types). They first participate in this most familiar activity type, but as they participate more and more, the marginal utility of an additional unit of participation in the activity type decreases (we will refer to this as satiation behavior). At some point, the novelty signal (or the marginal utility of participation in the next most familiar activity at the point of no consumption of this next most familiar activity) becomes stronger than the familiarity signal (or the marginal utility of participation in one additional unit of the most familiar activity), which causes the household to participate in the next most familiar activity. This process continues in an optimization process until the household runs out of overall available leisure time. Overall, a higher (lower) level of satiation for a particular type of vacation activity implies a shorter (higher) participation duration in that type of vacation activity

The specific model structure employed in the current paper is Bhat's (2008) multiple discrete-continuous extreme value (MDCEV) model. This model is used to obtain an understanding of how households spend their available vacation leisure time among several types (or purposes) of vacation activity. The frame-

work adopted here enhances that of van Middlekoop *et al.* (2004), Hellstrom (2006), and Cambridge Systematics, Inc. (2006) by modeling demand by vacation activity purpose and using a vacation time-use structure that is firmly grounded in the social-psychological optimal arousal theory of vacation travel. The paper also introduces the MDCEV model to the vacation research field as a valuable structure to examine time use in vacation travel demand modeling.

The rest of this paper is structured as follows. Section 2 describes the data source and sample characteristics. Section 3 presents the MDCEV model structure and estimation technique. Section 4 discusses the empirical results. Finally, Section 5 concludes the paper by summarizing the major findings and discussing applications of the model.

2 The Data

2.1 Data Source

The data for the empirical analysis in the current paper is drawn from the 1995 American Travel Survey (ATS). Even though the 1995 American Travel Survey is the predecessor to the more recent 2001 National Household Travel Survey (NHTS), it includes valuable information on long distance trips not captured in the 2001 NHTS. In particular, while the 2001 NHTS collected information on all trips (long distance and local), it only elicited information about long distance trips undertaken over a four-week period prior to the assigned survey day for the household. The 1995 ATS, on the other hand, collected information on long distance trips over the course of a complete year. Specifically, several sampled households were contacted on a periodic basis over the course of the year to obtain the complete list of vacation trips and trip durations by purpose. This yearly period of data collection is a more appropriate unit of analysis for vacation travel time-use decisions rather than a single month.

The ATS survey collected information from 80,000 American households on all long-distance trips of 100 miles or more over the course of the year. The trips for which data were sought from each household only included complete trips, or travel that eventually returns to its origin (*i.e.*, home-to-home trips or tours)[3]. For each trip, households were asked to identify the main purpose of the trip in one (and only one) of 12 purposes, of which 5 were leisure-oriented.

2.2 Sample Formation

The process of generating the sample for analysis from the 1995 ATS data involved several steps. First, we selected only those trips from the ATS data that

[3] In the usual urban area travel demand terminology, such home-to-home journeys are referred to as tours. Thus, the ATS collects information on all tours whose lengths are 100 miles or more. In this paper, we will refer to these home-to-home journeys in the more common terminology of leisure travel research as trips.

corresponded to a vacation trip and had the primary purpose as one of the following five leisure types: (1) Visit relatives or friends (or visiting for short), (2) Rest or relaxation (relaxing), (3) Sightseeing or visit a historic or scenic attraction (sightseeing), (4) outdoor recreation, including sports, hunting, fishing, boating, and camping (recreation), and (5) Entertainment, such as attending a sports event, an opera performance, or a theatre performance (entertainment). Second, we selected only those trips that were undertaken using an automobile (car, truck, van, rental vehicle, recreational vehicle, motor home, or motorcycle). Third, we aggregated all the vacation trips from the second step for each household, and selected out only those vacation trips that correspond to the 99% of households who had no more than 15 trips during the year. Fourth, the total duration of time (in number of days) invested in each of the five vacation activity purpose categories was computed based on appropriate time aggregation across individual vacation trips within each category to obtain the following five yearly time-use values for each household: (1) time spent in visiting, (2) time spent in relaxing, (3) time spent in sightseeing, (4) time spent in recreation, and (5) time spent in entertainment. If a certain household did not participate in any vacation trip of a specific purpose, this corresponds to non-participation in that vacation activity purpose with an associated time-use value of 0. Fifth, we obtained the total yearly vacation travel budget as the sum of the individual time-uses in the five leisure categories identified above, and restricted the analysis to the more than 99% of households who had a total annual vacation travel budget of 10 weeks (*i.e.*, 70 days) or less. Finally, data on individual, household, and residence characteristics were appropriately added.

The final sample for analysis includes the annual domestic vacation travel time-use information of 30,880 households. The variables that describe a household's vacation travel time-use correspond to participation in the five travel purposes (of which households can choose any combination) and the total duration of time spent pursuing each of these travel purposes (in number of days).

2.3 Sample Description

Table 1 presents the descriptive statistics of households' annual vacation purpose participations and durations. The second and third columns indicate the number (percentage) of households participating in each vacation type and information on the total duration of time investment among those who participate, respectively (we will use the terms "vacation purpose" and "vacation type" interchangeably in this paper). It is clear from the table that there is a relatively high participation level (58.3%) in visiting vacation travel compared to other kinds of vacation travel. Relaxing and recreation-oriented vacation travel are also quite popular, while sightseeing and entertainment travel have the lowest participation levels. Also, when participated in, the mean times (in number of days) invested in visiting vacation travel is highest, while that in entertainment vacation travel is lowest. These results are rather intuitive. Entertainment trips will be shorter because

they are centered on a set activity with a predefined (and usually short) duration. Visiting trips, on the other hand, require more time to allow people to reconnect and pursue activities together. Overall, these results suggest a relatively high intrinsic preference for visiting and relaxing-oriented vacation travel relative to other types of vacation travel. In addition, there is a low level of satiation for visiting-related vacation travel and a high level of satiation for entertainment-related vacations. The satiation levels for relaxing, sightseeing, and recreation are between those of visiting and entertainment.

The last major column in Table 1 presents the split between solo participation (*i.e.*, participation in only one type of vacation travel) and multiple vacation type participation (*i.e.*, participation in multiple types of vacation travel) for each vacation travel type. Thus, the numbers in the first row indicate that, of the 18,216 households participating in a visiting type of vacation travel, 9,528 (52.3%) households participate only in visiting type of vacation travel during the year, while 8,688 (47.7%) households participate in visiting vacation travel as well as other types of vacation travel. The results clearly indicate that households participate in visiting vacation travel more often in isolation during the year than in other vacation travel types. This may be an indication of the low satiation associated with visiting vacation travel (as discussed earlier) or a strong preference for visiting vacation travel by some households. Further, the results show that households participate in sightseeing, recreation, and entertainment types of vacation travel very often in conjunction with other types of vacation travel during the year. Again, this may be reinforcing the notion of high satiation associated with these three kinds of vacation travel, or may be because household factors that increase participation in these kinds of vacation travel also increase participation in other types of vacation travel. The model in the paper accommodates both possibilities and can disentangle the two alternative effects. In any case, a general observation from Table 1 is that there is a high prevalence of participation in multiple kinds of vacation travel over the year, highlighting the need for, and appropriateness of, the MDCEV model.

Another time-use statistic of interest is the total vacation travel time (or "budget") of households over the year (this is the sum of the durations invested in each of the five vacation type categories). The distribution of this total vacation travel budget is as follows: 3 or fewer days (19.7%), 4-7 days (26.9%), 8-14 days (26.5%), 15-21 days (12.6%), 22-28 days (6.1%), 29-35 days (3.7%), 36-42 days (1.9%), 43-49 days (1.1%), 50-56 days (0.8%) and more than 56 days or 8 weeks (0.7%).

3 Methodology

In this section, we present an overview of the MDCEV model structure, which is used to examine households' annual participation, and time investment, in each vacation type.

Table 1: Vacation Type Participation and Durations

Vacation Type	**Total Number (%) of Households Participating**		**Participation Duration (Days)**				**Number of Households (% of Total Number Participating) Who Participate**			
			Mean	**St. Dev.**	**Min.**	**Max.**	**Only In This Vacation Type**		**In This and Other Vacation Types**	
Visiting	18,216	(58.30%)	9.71	9.32	1	70	9,528	(52.30%)	8,688	(47.70%)
Relaxing	10,416	(33.30%)	7.70	7.84	1	70	4,053	(38.90%)	6,363	(61.10%)
Sightseeing	5,648	(18.10%)	4.80	4.89	1	62	1,862	(33.00%)	3,786	(67.00%)
Recreation	7,198	(23.00%)	7.23	6.87	1	67	2,210	(30.70%)	4,988	(69.30%)
Entertainment	5,155	(16.50%)	4.37	4.08	1	50	1,470	(28.50%)	3,685	(71.50%)

3.1 Basic Structure

Let k be an index for the vacation type travel alternatives, and let K be the total number of vacation type alternatives (in the current empirical context, $k = 1, 2, \ldots, 5$ and K=5, corresponding to the vacation type alternatives of visiting, relaxing, sightseeing, recreation, and entertainment). Consider the following additive utility function form[4]:

$$U(\mathbf{t}) = \sum_{k=1}^{K} \gamma_k \exp(\beta' z_k + \varepsilon_k) \ln\left(\frac{t_k}{\gamma_k} + 1\right), \tag{1}$$

where $U(\mathbf{t})$ is a quasi-concave, increasing, and continuously differentiable function with respect to the consumption quantity ($K \times 1$)-vector t ($t_k \geq 0$ for all k), and γ_k is a parameter associated with good k. In the current empirical context, the consumption quantity t corresponds to the vector of time investments (t_1, t_2, ..., t_K) in number of days spent on the various vacation types over the course of a year. Whether or not a specific t_k value ($k = 1, 2, 3, \ldots, K$) is zero constitutes the discrete choice (or extensive margin of choice) component, while the magnitude of each non-zero t_k value constitutes the continuous choice component (or intensive margin of choice). In this context, the treatment of time investments in the form of number of days as a continuous variable deserves some mention. Specifically, one may argue that number of days should be treated as a count variable, rather than a non-negative continuous variable. However, there is substantial variation in duration from 1 to almost 70 days for each vacation type over the course of the year in our empirical application, lending itself to consideration as a continuous variable. Further, our conceptual framework that uses a continuous form for number of days has the advantage of being (a) explicitly derived from a random utility maximization framework, and (b) consistent with the social-psychological theory of "optimal arousal" as espoused in the theoretical vacation literature. Also, von Haefen and Phaneuf (2003) find little difference between the use of a continuous and count data system approach in a study that has even lesser variation in the intensive margin of choice than the variation from 1 to 70 days in the current study. In fact, von Haefen and Phaneuf (2003) indicate that "....the choice of continuous or count data frameworks is an issue of secondary importance".

z_k in Equation 1 is a vector of exogenous determinants (including a constant) specific to alternative k. The term $\exp(\beta' z_k + \varepsilon_k)$ is the marginal random utility of one unit of time investment in alternative k at the point of zero time investment for the alternative (as can be observed by computing $\partial U(\mathbf{t})/\partial t_k|_{t_k=0}$). Thus $\exp(\beta' z_k + \varepsilon_k)$ controls the discrete choice participation decision in alternative k. We will refer to this term as the baseline preference for utility k. The

[4] Some other utility function forms were also considered, but the one below provided the best data fit. For conciseness, we do not discuss these alternative forms. The reader is referred to Bhat (2008) for a detailed discussion of alternative utility forms.

term γ_k is a translation parameter that serves to allow corner solutions (zero consumption) for any of the vacation type alternatives $k = 1, 2, \ldots, K$ (γ_k>0). However, it also serves as a satiation parameter for these alternatives - values of γ_k closer to zero imply higher satiation (or lower time investment) for a given level of baseline preference (see Bhat, 2008). The constraint that $\gamma_k > 0$ for $k = 1, 2, \ldots, K$ is maintained by reparameterizing γ_k as $\exp(\mu_k' \omega_k)$, where ω_k is a vector of household-related characteristics and μ_k is a vector to be estimated. This form also allows us to specify the satiation parameters as functions of household-related attributes.

From the analyst's perspective, households are maximizing random utility $U(\mathbf{t})$ subject to the vacation time budget constraint that$\sum_k t_k = T$, where T is the total vacation travel time (in number of days) available for households to participate in. The reader will note that we assume the total annual household vacation travel time, T, as being known *a priori.* We also focus only on households who undertake some amount of vacation travel each year (*i.e.*, we only consider households for whom $T > 0$). This is because we do not have information from the survey to construct a value for overall leisure time, some of which may be spent on non-vacation activities in the immediate neighborhood of one's residence (such going to a mall in the neighborhood, reading a novel at home, jogging and running around the neighborhood, *etc.*). If this information were available, we can add another alternative corresponding to non-vacation activity pursuits. This category can be considered as an "outside good" which is always "consumed", since households will pursue some amount of leisure over the course of a year. In this modified framework, T would correspond to the total annual leisure time, and whether an individual participates in any vacation travel at all or not as well as the total vacation travel time would be endogenously determined in the model. The methodology used here is readily applicable to such an extended empirical setting (see Bhat, 2008), if the data were available.

The optimal time investments t_k^* (k = 1, 2, ..., K) can be determined by forming the Lagrangian function (corresponding to the problem of maximizing utility $U(\mathbf{t})$ under the time budget constraint T) and applying the Kuhn-Tucker (K-T) conditions. The Lagrangian function for the problem is:

$$\mathcal{L} = \sum_k \gamma_k \left[\exp(\beta' z_k + \varepsilon_k)\right] \ln\left(\frac{t_k}{\gamma_k} + 1\right) - \lambda \left[\sum_{k=1}^{K} t_k - T\right], \tag{2}$$

where λ is the Lagrangian multiplier associated with the time constraint. The K-T first-order conditions for the optimal vacation time allocations (the t_k^* values) are given by:

$$\begin{aligned} &\left[\exp(\beta' z_k + \varepsilon_k)\right] \left(\frac{t_k^*}{\gamma_k} + 1\right)^{-1} - \lambda = 0, \; if \; t_k^* > 0, k = 1, 2, \ldots, K \\ &\left[\exp(\beta' z_k + \varepsilon_k)\right] \left(\frac{t_k^*}{\gamma_k} + 1\right)^{-1} - \lambda < 0, \; if \; t_k^* = 0, k = 1, 2, \ldots, K \end{aligned} \tag{3}$$

The above conditions have an intuitive interpretation. For all vacation travel purposes to which time is allocated during the year (*i.e.*, $t_k^* > 0$), the time investment is such that the marginal utilities are the same across purposes (and equal to λ) at the optimal time allocations (this is the first set of K-T conditions; note that the first term on the left side of the K-T conditions corresponds to marginal utility). Also, for a vacation travel purpose k in which no time is invested, the marginal utility for that purpose at zero time investment is less than the marginal utility at the consumed times of other purposes (this is the second set of K-T conditions in Equation 3). These conditions capture the concept of "optimal arousal" in vacation travel decision-making.

The optimal vacation travel demand by purpose satisfies the conditions in Equation 3 plus the vacation time budget constraint $\sum_{k=1}^{K} t_k^* = T$. The time budget constraint implies that only $K-1$ of the t_k^* values need to be estimated, since the time invested in any one vacation purpose is automatically determined from the time invested in all the other vacation purposes. To accommodate this constraint, designate activity purpose 1 as a vacation purpose to which the household allocates some non-zero amount of time (note that each household will participate in at least one of the K purposes, given that $T > 0$ and vacation travel is a good that provides utility).

For the first activity purpose, the K-T condition may then be written as:

$$\lambda = \left[exp\left(\beta' z_k + \varepsilon_k\right)\right]\left(\frac{t_k^*}{\gamma_k} + 1\right)^{-1}. \tag{4}$$

Substituting for λ from above into Equation 3 for the other vacation travel purposes ($k = 2, \ldots, K$), and taking logarithms, we can rewrite the K-T conditions as:

$$\begin{aligned} &V_k + \varepsilon_k = V_1 + \varepsilon_1,\ if\ t_k^* > 0\,(k = 1, 2, \ldots, K) \\ &V_k + \varepsilon_k < V_1 + \varepsilon_1,\ if\ t_k^* = 0\,(k = 1, 2, \ldots, K) \end{aligned} \tag{5}$$

where $V_k = \beta' z_k - \ln\left(\frac{t_k^*}{\gamma_k} + 1\right)$ $(k = 1, 2, \ldots, K)$.

Assuming that the error terms ε_k $(k = 1, 2, \ldots, K)$ are independent and identically distributed across alternatives with a type 1 extreme value distribution, the probability that the household allocates vacation time to the first M of the K alternatives (for duration t_1^* in the first alternative, t_2^* in the second, $\ldots t_M^*$ in the Mth alternative) is (see Bhat, 2008):

$$P(t_1^*, t_2^*, \ldots, t_M^*, 0, 0, \ldots, 0) = \left[\prod_{i=1}^{M} c_i\right]\left[\sum_{i=1}^{M} \frac{1}{c_i}\right]\left[\frac{\prod_{i=1}^{M} e^{V_i}}{\sum_{k=1}^{K} e^{V_k}}\right](M-1)!, \tag{6}$$

where $c_i = \left(\frac{1}{t_i^* + \gamma_i}\right)$ for $i = 1, 2, \ldots, M$.

3.2 Mixed MDCEV Structure and Estimation

The structure discussed thus far does not consider correlation among the error terms of the vacation type alternatives. On the other hand, it is possible that households who like to participate in a certain kind of vacation type due to unobserved household characteristics will participate more than their observationally-equivalent peers in other specific vacation types. For instance, households that intrinsically prefer an element of adventure or something "new" may have a high common generic preference for sightseeing, recreation, and entertainment (relative to visiting and relaxing). Such unobserved correlations can be accommodated by defining appropriate dummy variables in the z_k vector to capture the desired error correlations, and considering the corresponding β coefficients in the baseline preference of the MDCEV component as draws from a multivariate normal distribution. In general notation, let the vector β be drawn from $\phi(\beta)$. Then the probability of the observed vacation time investment $(t_1^*, t_2^*, \ldots, t_M^*, 0, 0, \ldots, 0)$ for the household can be written as:

$$P(t_1^*, t_2^*, \ldots, t_M^*, 0, 0, \ldots, 0) = \int_{\beta} P(t_1^*, t_2^*, \ldots, t_M^*, 0, 0, \ldots, 0 \mid \beta)\phi(\beta)d\beta, \quad (7)$$

where $P(t_1^*, t_2^*, \ldots, t_M^*, 0, 0, \ldots, 0 \mid \beta)$ has the same form as in Equation 6.

The parameters to be estimated in Equation 7 include the β vector, the μ_k vector embedded in the γ_k scalar $(k = 1, 2, \ldots, K)$, and the σ vector characterizing the covariance matrix of the error components embedded in the β vector.

The likelihood function (7) includes a multivariate integral whose dimensionality is based on the number of error components in β. The parameters can be estimated using a maximum simulated likelihood approach. We used Halton draws in the current research for estimation (see Bhat, 2003). We tested the sensitivity of parameter estimates with different numbers of Halton draws per observation, and found the results to be very stable with as few as 75 draws. In this analysis we used 100 draws per household in the estimation.

4 Empirical Analysis

4.1 Variable Specification

The variables selected for consideration in the vacation travel time use model characterize households in a number of ways. They capture information regarding household demographics, household economic characteristics, and household residence characteristics. The household demographic variables include age of the head of the household, number of children in the household, family structure, and ethnicity.[5] The household economic variables include employment of

[5] The head of the household is identified in the 1995 ATS as the person who owns or rents the house or apartment. If the mortgage or rent is under multiple names, one of these adults is

the head of the household, annual household income, and number of household vehicles. The household residence variables include housing tenure, housing type, and residence region. All of these variables are readily available to metropolitan and state planning organizations through census, national household surveys, or local household surveys. Several of these variables have been used in earlier leisure travel research. While these earlier research studies have not modeled vacation travel time-use by purpose, they do provide important input for variable specification. For instance, in a simple cross-tabulation analysis, Anderson and Langmeyer (1982) found that households with individuals under 50 years are more likely to participate in recreation vacations than those older than 50 years. This, and other studies examining the role of age on vacation travel, strongly suggest a need to consider non-linear effects of age rather than use a simple linear relationship between age and vacation travel (see Nicolau and Mas, 2004). Another documented area of study is the influence children have on a household's vacation travel. Several studies report that parents agree vacations either are or should be planned around the needs and desires of children (Hawes, 1977, Nickerson and Jurowksi, 2001, Newman, 2001). Some studies have identified how the family vacation travel decision-making process changes as families go through various stages (Rosenblatt and Russell, 1975, Jenkins, 1978, Cosenza and Davis, 1981, Fodness, 1992). Ethnicity, employment, and income have also been found to impact vacation decisions (Hawes, 1977, Mallett and McGuckin, 2000), though their impact on time-use in different vacation activity purposes has not been studied. However, there has been little to no examination of the impact of household residence characteristics on vacation patterns in the earlier literature.

Several different variable specifications (such as head of household's occupation, household size and composition, and home type), and functional forms for variables (such as linear and non-linear age/income effects), were attempted in our empirical analysis. Different error components specifications were also considered to generate covariance patterns in the baseline preference of the MDCEV alternatives. The final specification in the vacation time-use model was based on intuitive considerations, parsimony in specification, statistical fit/significance considerations, and insights from previous literature.

4.2 Estimation Results

The final specification results of the mixed MDCEV model are presented in Tables 2 and 3. Table 2 presents the results of the parameters in the baseline preference (the β parameter vector in Equation 1), while Table 3 presents the results of the coefficients in the satiation parameters (*i.e.*, the $\mu_k$vector for each k, where the satiation parameter $\gamma_k$for vacation type k is written as $\exp(\mu_k'\omega_k)$).

arbitrarily designated as the head of household. Also, the ethnicity of the household corresponds to the ethnicity of the head.

Table 2: Baseline Preference Parameter Estimates

	Vacation Type (visiting vacation used as base)							
	Relaxing		**Sightseeing**		**Recreation**		**Entertainment**	
	Coeff.	*t-stat*	*Coeff.*	*t-stat*	*Coeff.*	*t-stat*	*Coeff.*	*t-stat*
Baseline Preference Constants	-1.72	-11.11	-1.703	-16.46	-2.134	-18.60	-2.137	-32.70
Household Demographics								
Age of Head of Household[1]								
35-49 years	0.076	2.33	0.242	6.17	-	-	-	-
50-69 years	-0.158	-3.92	0.120	2.72	-0.493	-12.41	-0.221	-5.62
$\geq$ 70 years	-0.523	-10.92	-	-	-0.925	-13.26	-0.523	-10.92
Children in the Household								
Presence of Children	-	-	-	-	0.189	5.54	-	-
Number of Children under 6 Years	-0.105	-4.08	-0.086	-2.69	-0.218	-7.10	-0.190	-5.64
Ethnicity[2]								
Caucasian	0.213	2.88	-0.255	-3.23	0.332	3.94	-	-
African American	-0.214	-2.29	-0.933	-8.15	-1.048	-7.62	-0.308	-3.81
Household Economic Characteristics								
Head of Household Full Time Employed	0.172	5.62	-	-	0.186	6.77	0.186	6.77
Annual Household Income[3]								
Between \$15,000 and \$29,999	0.127	2.16	0.096	1.73	0.255	3.48	0.096	1.73
Between \$30,000 and \$49,999	0.206	3.68	0.132	2.52	0.417	5.96	0.132	2.52
Between \$50,000 and \$99,999	0.377	6.56	0.191	3.56	0.522	7.33	0.191	3.56
\$100,000 or Greater	0.432	5.56	0.171	2.27	0.646	7.12	0.171	2.27
Number of Household Vehicles	0.015	1.77	0.029	2.84	0.085	9.60	0.067	6.65
Household Residence Characteristics								
Home Ownership[4]								
Own	-	-	0.234	4.63	0.102	2.04	0.283	6.52
Rent	-0.227	-5.60	-	-	-0.227	-5.60	-	-
Housing Type[5]								
House	0.195	3.45	0.195	3.45	0.110	2.61	-	-
Apartment	0.145	2.07	0.175	2.48	-	-	-	-
Household Residence Location[6]								
Middle Atlantic	0.298	6.56	0.298	6.56	-	-	0.139	1.82
East North Central	-	-	-	-	0.190	4.01	0.318	5.84
West North Central	-0.625	-14.96	-0.215	-4.72	-	-	0.348	7.75
South Atlantic	0.197	5.84	-	-	-0.174	-4.06	-	-
East South Central	0.162	3.46	0.314	5.75	-0.131	-2.19	0.432	7.24
West South Central	-0.346	-6.40	-0.120	-2.42	-0.120	-2.42	0.208	3.16
Mountain	-0.458	-12.39	-	-	0.269	8.41	0.269	8.41
Pacific	-	-	0.328	5.72	0.777	15.56	0.423	6.55

[1] < 35 used as base

[2] non-Caucasian and non-African American households form the base category

[3] $< \$15,000$ used as base

[4] free housing used as base

[5] non-house and non-apartment type is base

[6] Northeast location is base category

Table 3: Satiation Parameter Estimates

	Vacation Type									
	Visiting		**Restful**		**Sightseeing**		**Outdoor Recr.**		**Entertainment**	
	Coeff.	*t-stat*	*Coeff.*	*t-stat*	*Coeff.*	*t-stat*	*Coeff.*	*t-stat*	*Coeff.*	*t-stat*
Satiation Parameter Constants	4.027	23.58	2.314	74.97	1.992	36.13	2.415	62.15	1.673	60.38
Household Demographics										
Age of Head of Household[1]										
35-49 years	-0.13	-2.08	-	-	-0.199	-2.82	-	-	-	-
50-69 years	-0.194	-2.87	0.168	2.99	-0.228	-3.11	-	-	-	-
$\geq$70 years	-	-	0.742	6.28	-	-	-	-	-	-
Presence of Children in the Household	-	-	-	-	-	-	-0.326	-6.01	-	-
Household Economic Characteristics										
Annual Household Income[2]										
Between \$15,000 and \$29,999	-0.765	-4.19	-	-	-	-	-	-	-	-
Between \$30,000 and \$49,999	-1.214	-6.97	-	-	-	-	-	-	-	-
Between \$50,000 and \$99,999	-1.387	-7.97	-	-	-	-	-	-	-	-
\$100,000 or Greater	-1.678	-8.82	-	-	-	-	-	-	-	-

[1] < 35 used as base

[2] $< \$15,000$ used as base

The next section (Section 4.2.1) discusses the baseline preference parameter results. Section 4.2.2 presents the results associated with the satiation coefficients. Section 4.2.3 discusses the error-components specification that allows us to accommodate correlations in the baseline preferences across vacation types. All of these parameters are estimated jointly, as discussed in Section 3. However, they are being presented separately for presentation ease. Section 4.2.4 provides the likelihood-based measures of fit.

4.2.1 Baseline Preference Parameters

The visiting vacation travel purpose serves as the base category for all the baseline preference parameters. In addition, a '–' for a variable for a vacation travel purpose in Table 2 indicates that the purpose also represents the base category along with the visiting category.

Baseline Preference Constants
The baseline preference constants indicate the overall inherent preference for visiting-oriented vacation travel relative to all other vacation purposes, as reflected in the significantly negative preference constants in Table 2.[6]

Effects of Household Demographics
Among the household demographic variables, the effect of the age of the head of the household (a proxy variable for the ages of all adult household decision-makers) is introduced in a non-linear form as age-bracket specific dummy variables (alternative forms, including a continuous linear form as well as a piece-wise linear spline form were also considered, but the dummy variable form provided the best results). The age dummy variables are introduced with the youngest category (less than 35 years) serving as the base. The results indicate that households with young and middle-aged adults (with the age of the head below 50 years) have a higher inclination to participate in relaxing vacation than households with older adults (age of the head being 50 years or more). This can be observed from the negative signs on the "50-69 years" and "$\geq$ 70 years" variables in the relaxing vacation type column of Table 2). Young and middle-aged individuals are likely to be building up or stabilizing their careers, resulting in more work-related stress caused by hectic schedules and long work durations (Akerstedt *et al.*, 2002). Thus, it is reasonable that, when they are able to get away, they prefer relaxing vacations than the more fast-paced nature of other vacation types. This preference for relaxing vacations is particularly the case

[6] Strictly speaking, the constants reflect the preference for visiting in the "base segment" that is formed from the combination of the base categories for the dummy variables and zero car ownership. However, the magnitude of the constants are quite high relative to the parameters on the dummy independent variables, the number of children under 6 years old, and the car ownership ordered variable. Thus, the negative constant signs are retained for almost all other segments too, indicating the generic preference for visiting in the overall population.

for middle-aged individuals (35-49 years), as can be observed from the positive coefficient on this variable in the relaxing vacation type column. The results also reveal that (1) households with heads who are between 35-69 years have a higher preference for sightseeing than households with young individuals (age of head $<$ 35 years) or old individuals (age of head $\geq$ 70 years), and (2) households with older adults (age of head over 50 years) have a lower preference for recreation and entertainment, and a higher preference for visiting, compared to households with younger adults (age of head no more than 50 years). Earlier descriptive research by Anderson and Langmeyer (1982) support these results. Older individuals, in general, may not be as physically active as their younger peers, and so are less likely to participate in physically strenuous recreation-oriented vacations. At the same time, their network of family and old friends may be away from their immediate neighborhood, because of which they are likely to undertake more visiting-oriented vacations.

The effect of children was considered in our empirical analysis both as a dummy variable (representing whether or not a child was present in the household) as well as the number of children. Further, to accommodate possible differences in vacation preferences based on the age of children, we considered the presence and number of children by age group. The results in Table 2 show that households with children all of whom are 6 years or older have a higher preference to participate in recreational vacations relative to other types of vacations (compared to households with no children at all or households with children all of whom are younger than 6 years of age). This finding is quite consistent with two related findings from earlier studies. The first is that "the activities most enjoyed by children were those activities where participation interaction occurred" (Nickerson and Jurowski, 2001), and that children most prefer something new and adventurous (Edwards, 1994). In our classification, the activity type that best characterizes "interactive", "something new", and "fun" is clearly recreation in the form of such activities as fishing, boating, and sports (rather than visiting, relaxing, sightseeing, or entertainment). The second finding in earlier studies, as indicated earlier, is that a large fraction of adults with children believe that vacations should be planned for children (see Hawes, 1977; Newman, 2001). These two findings, when put together, support our result regarding the effect of the presence of children. Indeed, it is interesting to note that, though not directly focused on children's vacation travel preferences, our results suggest that the preference toward recreational vacation is uniform across different children age groups beyond the age of 6 years. The results change, however, when there are children in the household younger than 6 years of age. Specifically, such households are uniformly less likely to participate in non-visiting vacations and more likely to participate in visiting vacations compared to households with no children or all children 6 years or older. This result may be because visiting vacation travel makes it easier to accommodate the biological needs of a young child than other types of vacation travel (since the visiting family may provide some assistance in caring for the child in a "home away from home" setting.

The empirical results also reveal significant race variations in vacation travel preferences (the race dummy variables are introduced with the non-Caucasian American and non-African American household as the base category). Caucasian-American households have the highest baseline preference for pursuing relaxing and recreation vacations, while African-American households have the lowest preference for pursuing these two types of vacations. Both Caucasian- and African-American households have a lower preference for sightseeing than other households, with African-American households having an even lower preference for sightseeing than Caucasian-American households. African-American households also have a lower preference for entertainment vacations than other households. Overall, the results indicate that Caucasian-American households are most likely to pursue relaxing and recreation vacation trips, while African-American households are the most likely to pursue visiting vacation trips (notice the negative sign on the African-American household dummy variables for all the vacation type categories relative to the base category of visiting). These findings mirror similar results on race variations in the context of urban area leisure activity time-use (see Philipp, 1998, Wilcoxa *et al.,* 2000, Mallett and McGuckin, 2000, Berrigan and Troiano, 2002, Bhat, 2005, Sener and Bhat, 2007, and Copperman and Bhat, 2008). Additional research to study these variations in vacation travel time use is an important area for future research.

Effect of Household Economic Characteristics

The second set of household characteristics assesses the economic vitality of a household. Overall, the results of the household economic variables indicate the higher preference for non-visiting vacation travel relative to visiting vacation travel among households whose heads are employed full-time (relative to households whose heads work part-time, or are retired, or unemployed), whose relative incomes are high, and who have a high car ownership. This is to be expected since the economic vitality of a household is a direct indicator of expenditure potential on vacations, and visiting vacations, which are generally spent with relatives and friends, constitute the most inexpensive type of vacation (see also Hawes, 1977 and Mallett and McGuckin, 2000).[7]

Effect of Household Residence Characteristics

The third set of household characteristics describes housing tenure, housing type, and household residential location in the US. Housing tenure is available in three categories in the 1995 ATS: (1) Owned or being bought by one or more householders, including those who have finished paying their mortgages or are in the mortgage payment period (own house), (2) Rented for cash (rent house), and (3) Occupied without any kind of payment of rent (*i.e.*, staying in a house owned or

[7] We also introduced education level variables in the model, but they turned out to be statistically insignificant when the annual income dummy variables were introduced. This is interesting, since it suggests that education does not have a direct bearing on vacation travel type. Rather, its effect on vacation travel type is indirect and mediated through income earnings.

rented by someone else or "free" house). The effect of tenure is considered in our specification by including dummy variables for "own house" and "rent house", with "free house" being the base category. Housing type is available in several categories in the ATS, which were regrouped for the purpose of our estimation into three categories: (1) House (independent house, townhouse, duplex, and modular home), (2) Apartment (multi-dwelling apartment units and flats), and (3) Other (mobile home, hotel and/or motel, rooming house, and other housing types). Our estimation includes dummy variables for house and apartment, with other housing types being the base. The household residential location in the US is introduced in the specification by using eight dummy variables, one each for Middle Atlantic (New York, New Jersey, Pennsylvania), East North Central (Ohio, Indiana, Illinois, Michigan, Wisconsin), West North Central (Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas), South Atlantic (Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida), East South Central (Kentucky, Tennessee, Alabama, Mississippi), West South Central (Arkansas, Louisiana, Oklahoma, Texas), Mountain (Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada), and Pacific (Washington, Oregon, California, Alaska, Hawaii). The Northeast part of the US (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut) constitutes the base category.

The results in Table 2 reveal that households who own their house have a higher baseline preference for sightseeing, recreation, and entertainment vacations relative to households who rent or live free. This finding may be a reflection of the fact that households who own their home are generally more settled in an area, and in their career and finances. Consequently, they may psychologically feel more prepared to partake in the generally more expensive vacations associated with sightseeing, recreation, and entertainment (even after controlling for income earnings). The results also show that households who rent have the lowest baseline preference for relaxing and recreation, and are more likely to participate in visiting vacations, relative to other households (the higher likelihood for visiting vacations may be imputed from the signs and magnitudes of the coefficients on the "own house" and "rent house" variables). The higher likelihood for visiting among renters is quite intuitive, since their decision to rent is likely to be influenced by the presence of significant others who live elsewhere and whom they visit on a regular basis. Also, households that rent apartments may not be able to host many visitors in their home, which may lead to more visiting trips to meet with friends and family.

The housing type variables, in general, show that households who live in a house or apartment have a higher preference for relaxing, sightseeing, and recreation, and are less likely to undertake visiting and entertainment vacations, relative to households who live in relatively more unconventional types of housing. Those who live in relatively unconventional housing are the ones who are likely to be less well-settled in a given location or their career or in a family, possibly explaining their higher participation in visiting vacations. Also, because they have

fewer family obligations, these individuals may be the ones who are likely to be able to pursue vacations based on their individual entertainment-related interests and hobbies, leading to the higher participation in entertainment vacations.

The location of households in the US is included in our specification to control for inherent travel differences in different regions of the country (due to such factors as weather conditions, locational norms, and diversity of vacation opportunities; see Schlich *et al.*, 2004 for a similar control approach). It is difficult to make much of these results, but they are useful in the model specification to capture the variation in vacation travel behavior preferences across the country. In general, households in the pacific division have the highest preference for sightseeing, recreation, and entertainment vacations, while households in the Northeast and in the South Atlantic regions have the lowest preference for entertainment vacations.

4.2.2 Satiation Coefficients

The satiation coefficients in Table 3 refer to the elements of the μ_k vector for each vacation type alternative k, where the actual satiation parameter γ_k for vacation type k is written as $\exp(\mu_k'\omega_k))$. A positive coefficient on a variable for vacation alternative k in Table 3 increases the satiation parameter for alternative k, and therefore implies lesser satiation (or higher duration of participation) in alternative k. On the other hand, a negative coefficient on a variable for vacation alternative k in Table 3 decreases the satiation parameter for alternative k, and therefore implies higher satiation (or lower duration of participation) in alternative k. The inclusion of independent variables in both the baseline preference and satiation parameters allows variables to impact only the participation decision (this is the case if a variable appears only in the z_k vector), only the duration of participation given the baseline preference (this is the case if a variable appears only in the ω_k vector), or both (this is the case if a variable appears in both the z_k and ω_k vectors). The net result is that the participation decision and the amount of participation decision are not tied tightly together.

The constants in Table 3 reflect the satiation coefficients for the base population segment corresponding to households with young adults (head's age < 35 years), with no children, and with an annual income of \$15,000 or less. For this population segment, the satiation level for visiting vacations is highest (reflecting long durations of visiting vacations) and the satiation level for entertainment vacations is lowest (reflecting short durations of entertainment vacations). The satiation levels for the relaxing, sightseeing, and recreation fall in between.

The results corresponding to age in Table 3 show that young and middle-aged households (with a head whose age is less than 70 years) get satiated more easily with visiting and sightseeing vacations (*i.e.*, spend lesser time on these vacations when they participate in such vacations) than older households (with a head whose age is 70 years or more). Also, the middle-aged and older households participate longer in relaxing vacations than the younger households. These results

are consistent with lower time expenditures among older households in physically intensive recreation vacations and high "visibility" entertainment vacation pursuits (Anderson and Langmeyer, 1982).

The effect of children on the satiation parameter for outdoor recreation in Table 3 is interesting, and points to the different roles played by children in the participation and duration decisions related to recreation vacations. Specifically, while children 6 years of age and older increase the participation propensity in recreational vacations, they also decrease the participation duration in recreational pursuits. This perhaps is a reflection of the limited attention span of children in recreational pursuits. Households with children must also fit vacation travel within a tight school schedule when planning vacation travel. The overall implication here is that vacation travel-related marketing campaigns targeted at families with children would do well to emphasize recreation vacations with a short duration "burst".

Finally, the income effects in Table 3 reflect the higher satiation (lower duration of participation) in visiting vacations as household income increases. This may be attributed to the higher expenditure potential of high-income households, which allows them to spend longer durations of time in the relatively more expensive non-visiting types of vacation travel.

4.2.3 Error Components

The final specification included a single error component specific to the sightseeing, recreation, and entertainment vacation types. This error component has a standard deviation of 0.234 (with a t-statistic of 3.73), and indicates that there are common unobserved factors that predispose families to participate in sightseeing, recreation, and entertainment vacations. This may be due to a general inclination to pursue something different and/or adventurous, an element common to sightseeing, recreation, and entertainment activities.

4.2.4 Likelihood-Based Measures of Fit

The log-likelihood of the final mixed multiple discrete-continuous extreme value (MDCEV) model is -111,441.6. The corresponding value for the multiple discrete-continuous extreme value (MDCEV) model with only the constants in the baseline preference terms, the constants in the satiation parameters, and no error components is -113,522.6. The likelihood ratio test for testing the presence of exogenous variable effects on baseline preference and satiation effects, and the presence of error components, is 4,162.0, which is substantially larger than the critical chi-square value with 78 degrees of freedom at any reasonable level of significance (the 78 degrees of freedom in the test represents the 77 distinct parameters on exogenous variables estimated in the final specification plus the one error component). Also, the log-likelihood of a non-mixed MDCEV model (with the same specification as the final mixed MDCEV, except without any error component)

is -111,478.3. The corresponding likelihood ratio test for testing the significance of the single error component in the mixed MDCEV model is 73.4, which is substantially higher than the critical chi-squared value with one degree of freedom at any reasonable significance level. This clearly indicates the value of the model estimated in this paper to predict family vacation type participation and time use based on household demographics, household economic characteristics, and household residential location attributes.

5 Conclusions

Vacation travel constitutes about 25% of all long-distance travel, and about 80% of this vacation travel is undertaken using the automobile. Another way to characterize the substantial amount of vacation travel by the private automobile is that such travel constitutes nearly one-third of all long-distance trips undertaken by the automobile. Further, vacation travel by the automobile has been increasing consistently over the past two decades (Eby and Molnar, 2002), and it is likely that this trend will pick up even more in the next decade or two as the baby boomers "move into their big traveling years" (Mallett and McGuckin, 2000). At the same time that the overall amount of vacation travel by the private automobile has been increasing, the geographic footprint of vacation travel around households' residences is getting more and more compact due to increasing schedule constraints (and the resulting winnowing of vacation time window opportunities) imposed by, among other things, the presence of multiple-workers in the household. The net result of all these trends is that vacation travel warrants careful attention in the context of regional and statewide transportation air quality planning and policy analysis. Further, understanding vacation travel patterns also aids in boosting tourism by developing appropriate marketing strategies and service provision strategies. Of course, understanding the aggregate vacation travel patterns has to start from understanding how individual households make vacation travel decisions and choices.

This paper contributes to the vacation travel literature by examining how households decide what vacation travel activities to participate in, and to what extent, given the total vacation travel time that is available at their disposal. To our knowledge, this is the first comprehensive modeling exercise in the literature to undertake such a time-use analysis to examine purpose-specific time investments. The consideration of different purposes of vacation travel is particularly important today because of the increasing variety of vacation travel activities households participate in (Mallett and McGuckin, 2000, Newman, 2001). The variety in vacation travel is not surprising, as households plan their vacation travel over a period of time so that they are "optimally aroused" (Iso-Ahola, 1983) under the harried schedules and vacation time budget constraints they face. We use a mixed MDCEV model structure in this paper that is consistent with this notion of optimal arousal in vacation type time-use decisions. The data used in

the analysis is drawn from the 1995 American Travel Survey.

There are several interesting findings from the study. In general, the results show that households participate in multiple kinds of vacation travel during the course of the year (rather than participating in the same kind of vacation activity over and over again). Households are most likely to participate and spend time in visiting vacation travel, and least likely to participate and spend time in entertainment vacation travel. Of course, our model also indicates significant variation in participation and time investment tendencies across households based on demographics, economic characteristics, and residential characteristics. For instance, in the category of household demographics, older households have a higher participation propensity and duration of participation in visiting and sightseeing vacation trips. Households with children 6 years or older are more likely than other households to participate in interactive recreation vacation travel rather than the relatively more passive visiting, relaxing, sightseeing, and entertainment vacation travel. However, these same households participate for shorter durations of time in recreational vacations. Race also has an influence on the preferences for the type of vacation travel. The effect of household economic factors shows that households with an employed head are more likely to focus their vacation travel on a combination of relaxation and recreation activities, and higher income households are more likely than lower income households to participate and invest time in non-visiting vacation travel (and particularly in recreational pursuits that are likely to be more expensive to participate in). Finally, household residence characteristics also play a role in household vacation time-use choices. The model developed in this paper can be used to predict the changes in vacation travel time-use patterns due to the changes in all these demographic, economic, and residence characteristics over time. Such predictions can be used to examine the changing vacation travel needs of households, so that appropriate service and transportation facilities may be planned.

The model developed in this paper can also be integrated within a larger microsimulation-based system for predicting complete vacation activity-travel patterns for transportation air quality analysis. To be sure, there are several dimensions that characterize vacation travel choices. The suite of leisure travel choices may be viewed as originating from three inter-related decision stages (see Bhat and Koppelman, 1993; van Middlekoop *et al.*, 2004). In the first step, households determine their employment choices (whether household adults will be employed, employment type, work duration, and work schedule) along with their desired long-term (say, annual) time/money investments in physiological and biological maintenance needs and leisure needs. In the second step, households determine how to use their available annual leisure time and money resources among in-home activities, out-of-home non-vacation activities by purpose (going shopping in the neighborhood, going to the local movie theatre, jogging around the neighborhood, *etc.*), and vacation travel activities by purpose (this determination is based on, among other things, coupling constraints that limit vacation travel window opportunities among individuals in a household and

lifestyle/lifecycle preferences as determined by the composition of members of the household). In the third step, households decide on the activity scheduling characteristics of vacation travel within the overall vacation travel time-use plan by purpose from the second decision stage (including whether to make day-trips or overnight vacation trips, number of day-trips and overnight trips by purpose, and the characteristics of each vacation trip, including the duration, amount to spend, where to go, how to travel, with whom to go, time of year, and type of accommodations). The current research contributes to the second stage of the three-stage decision process just identified. While the methodology proposed here can be used to model the entire second stage, the empirical analysis in the paper is focused on vacation travel time-use by purpose given a total annual vacation travel budget. This empirical focus is necessitated by the lack of data on all the different kinds of leisure time-use (in-home, out-of-home non-vacation, and vacation). We suggest that future travel data collection efforts consider all the different types of travel, rather than confining themselves to only local urban travel or only long-distance travel.

An important issue that needs attention in the future is to study the process by which households make vacation travel decisions and schedule them. The framework proposed above is a plausible one, but makes several assumptions about vacation scheduling behavior. For example, it may be that households do not consider vacation decisions on an annual basis, but rather use a dynamic updating process after each vacation trip and before the next. In addition, the precise time frames used and the interactions of the many dimensions of vacation travel decisions are not yet well understood. Further, it is important to consider the impact of accessibility to recreational opportunities, cost considerations, and individual preferences within a family in vacation time-use decisions. Clearly, the field offers several challenging directions for further scientific enquiry and data collection.

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