

Analysis of Long-Distance Travel Behavior of the Elderly and Low Income

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ABSTRACT

This paper provides a detailed analysis of long-distance travel behavior for two key socioeconomic groups of the population—the elderly and the low income. The analysis utilizes data from the 1995 American Travel Survey that provides a rich source of information on long-distance travel (i.e., trips greater than 100 mi) undertaken over a period of 12 months. The analysis focuses on comparing the elderly and the low-income groups of the population against other groups with respect to various demographic and trips characteristics. The travel behavior comparison includes an analysis by trip purpose, travel mode, distance, trip duration, and trip frequency. In addition, regression models of long-distance trip generation are estimated separately for different groups to examine differences in trip generation propensity across the groups. The results show that both the elderly and the low income undertake significantly fewer long-distance trips than other socioeconomic groups. It was found that nearly half of the low income and elderly made no long-distance trips in the 1-year survey period. In addition, it was found that long-distance trips made by these groups were more likely to be undertaken by bus and geared towards social and personal business activities. The paper discusses the implications of these findings in the context of transportation service provision and policy formulation.

INTRODUCTION

The American Travel Survey (ATS) provides an extensive database on the long-distance travel patterns of a sample of individuals in the United States. Long-distance travel constitutes a sizeable portion of total travel in the nation. However, primarily due to a lack of disaggregate behavioral data, research in travel behavior and travel demand analysis has focused on trip-making patterns within urban areas. The availability of data from the recent 1995 ATS provides a key opportunity for examining various facets of long-distance travel behavior.

Long-distance travel has important social and economic consequences. Long-distance travel tends to be dominated by two primary trip purposes: business and leisure. These trip purposes constitute economic and recreational opportunities that provide value both to the individual as well as to the geographic areas where the trips are made. In

Florida, for example, the tourism industry relies heavily on the ability of individuals to undertake long-distance trips for recreational purposes. In turn, the state depends on the vitality of the tourism industry for its revenues.

Two special market segments merit consideration in the context of long-distance travel behavior. They are the elderly and the low-income households. The elderly include individuals who are 65 years or more, while low-income households may be those whose income is below \$25,000 annually. These market segments tend to be of interest to researchers, planners, and policy makers because of their potential lack of access to opportunities. For example, quite often, long-distance travel entails the use of the automobile. However, individuals within these market segments may have disproportionately less access to an automobile when compared with the rest of the population. The elderly may not be able to drive long distances because of physical limitations, while low-income individuals may not have access to an automobile even if they are able to drive. Similarly, long-distance travel by air may not be comfortable for the elderly and may not be affordable for the low income.

This paper is aimed at performing a detailed analysis of long-distance travel behavior for these two key market segments. Trip-making patterns of these two market segments are compared with those of the rest of the population with respect to standard travel demand indicators such as overall trip rates, trip rates by purpose, mode choice, destination choice, trip length distribution, and travel time. Long-distance trip-generation models are estimated for these two market segments to determine the factors that affect their long-distance travel. Coefficients in the models of these two market segments are compared against coefficients obtained for the rest of the population to identify differences in trip-making elasticities for these market segments. The analysis in this paper provides key insights into the long-distance travel needs, preferences, sensitivities, and opportunities (or lack thereof) for these market segments.

Mobility issues associated with these market segments have been of interest to researchers and transportation planners in the recent past. ITE (1994), Rosenbloom (1995), and Benekohal et al. (1994) describe travel behavior characteristics of the elderly age groups in comparison to other age groups. They find that average vehicle trip length declines steadily with age. The average daily vehicle miles of travel (VMT) declines significantly after the age of 64. In addition, it was found that transit usage declines with age. Other studies have looked at travel characteristics of the elderly from a safety and technology standpoint. For example, Chu (1994) and Abdel-Aty and Jovanis (1999) assess the transportation infrastructure needs of the elderly. They report that the elderly tend to avoid traveling at night, during rush-hour conditions, and when icy snow conditions prevail. Interestingly, Chu (1994) notes that the elderly make as many trips as other age groups, but the total VMT declines as they make trips of shorter length.

There has also been considerable research in the area of travel behavior by income group. Recently, the focus has been on travel behavior characteristics of zero-vehicle households. For example, Crepeau and Lave (1994) find that zero-vehicle households make significantly fewer trips than the general population. Their analysis was based on the 1990 Nationwide Personal Transportation Survey (NPTS). If one considers car ownership as a surrogate of income, then these findings have important implications for transportation policy formulation.

By no means does the above constitute a comprehensive literature review pertaining to the travel behavior characteristics of the elderly and low income. It merely points to

the widespread attention that these socioeconomic segments have been receiving in the literature within the past decade. However, it should be noted that the literature has thus far focused on intra-urban trip-making characteristics. This paper attempts to build on the knowledge accumulated in the literature by focusing on the long-distance travel behavior of these socioeconomic groups using the recent 1995 ATS database.

The remainder of this paper is organized as follows. Following this introductory section, the paper provides an overview of the ATS. This is followed by a description of the survey sample used in this study. The fourth section of the paper provides a detailed analysis of long-distance travel behavior of the elderly while the fifth section focuses on the low-income households. Within these sections, statistical analyses of the ATS sample are conducted to compare long-distance travel patterns of the elderly, and the low income with those of the rest of the population. Regression models of long-distance trip generation models are estimated and comparisons of coefficients across population groups are performed. Finally, the paper ends with concluding remarks.

DESCRIPTION OF THE ATS

The 1995 ATS collected detailed information about long-distance travel behavior in the United States. The survey was conducted for the Bureau of Transportation Statistics (BTS) of the U.S. Department of Transportation (USDOT) by the Bureau of the Census as a component of the Census of Transportation (BTS, 1998). The previous survey that focused on long-distance travel was the National Transportation Survey (NTS) and was conducted nearly 20 years earlier in 1977. As such, the 1995 ATS served as a timely resource for obtaining a clearer picture of long-distance travel in the contemporary context.

Approximately 80,000 households nationwide were randomly selected to participate in the survey. The survey consisted of four detailed interviews conducted approximately every 3 months between April 1995 and March 1996. The interviews were conducted primarily by telephone, with in-person interviews for some respondents who could not be reached by telephone. The survey yielded a very respectable response rate of 85 percent for those households that were eligible for interview.

The survey gathered detailed demographic characteristics of all household members regardless of age. Detailed travel information was collected for all one-way trips over 100 miles long that were undertaken between April 1995 and March 1996. Data collected in the surveys were compiled into numerous databases containing demographic and travel characteristics. The household and person demographic files contained information on household size, household and family income, household type, number of vehicles, employment status, age, type of residence, place of residence, race, marital status, and education level. The information that is available in the trip databases includes origin and destination of the trip, mode used, distance traveled, number of nights away from home, the trip purpose, number of side trips, access and egress modes, number of members in the traveling party, type of lodging, and number of stops along the way to the main destination.

Several reports published by the BTS provide interesting facts and figures arising from the 1995 ATS (BTS, 1997 and 1998). The following points highlight some of the key facts and figures related to long-distance travel in the nation:

- The survey showed that the nearly 100 million households in the United States took 685 million long-distance trips—an average of 7 trips per household during the year. This amounted to over 1 billion person trips—an average of 4 long-distance trips per person.

- More than half of all person trips were to destinations outside the traveler's home state. However, 58 percent of all trips were less than 500 mi round-trip suggesting that even though people leave their home state frequently, they tend to travel to neighboring states. The median trip length for all person trips was 425 mi and that for car trips was 368 mi—roughly a 6- or 7-hour drive away from home.

- Eighty percent of long-distance trips within the United States were taken in a personal vehicle. The average air trip was nearly five times longer than the average car trip—1,732 mi compared with 368 mi.

- Thirty-three percent of all trips were undertaken to visit friends or relatives, another 33 percent were undertaken for leisure, relaxation, and vacation purposes, and about 23 percent were undertaken for business purposes. The remaining trips were undertaken for purposes of a personal nature such as school-related activities, weddings, funerals, or medical reasons.

- Forty-three percent of all air travel was undertaken for business purposes, compared with just 19 percent for personal vehicle trips. Nearly 80 percent of all vehicle trips were either for pleasure or personal business.

- Nearly one-fourth of all long-distance trips were day trips, i.e., trips to a destination at least 100 mi away from home and completed in a single day. Excluding all single day trips, travelers spend an average of 4.3 nights away from home on each trip. Considering the average person undertook four trips throughout the year, this amounted to an average of 3 weeks away from home each year while on long-distance travel.

- About 33 percent of all vacation trips were undertaken during the summer months of July, August, and September. Business travel declined considerably during the fall months of October, November, and December when visits to friends and relatives appeared more likely. Nearly 33 percent of all trips to visit friends and relatives occurred during this period.

As the ATS focused on long-distance trips more than 100 mi long, it did not capture long-distance trips between 50 and 100 mi in length. Despite this limitation, the ATS is a rich disaggregate source of behavioral data that permits the analysis and modeling of long-distance travel in the United States. This paper utilizes the first release of the 1995 ATS databases to explore long-distance travel characteristics of selected socioeconomic segments of the population. A more detailed description of the overall survey sample used for analysis is furnished in the next section.

ATS SAMPLE CHARACTERISTICS

This section provides a brief overview of the 1995 ATS sample used in the analysis for this paper. As this paper is intended to analyze long-distance travel behavior of two specific market segments—namely, the elderly and the low income—this overview section provides descriptive statistics only for key sociodemographic and travel indicators.

All of the statistics presented in the paper correspond to those obtained for the weighted sample. The weights used were those provided by the BTS within the ATS databases. These weights make the sample representative of the general population of the United States. Even though analysis was also performed on the unweighted sample, those results are not presented in the paper in the interest of brevity.

The ATS household demographic database contained information on 54,120 households that had responded to the survey. The ATS household trip file included only those households that made at least one long-distance trip during the 12-month period covered by the survey. The total number of households in this database was 48,527 and the corresponding number of household trips included in the database was 337,520. It should be noted that there are several households in the trip file that do not appear in the household demographic file. On the person side, the person demographic file included information on 136,193 persons that resided in the households that responded to the survey. The corresponding person trip file contained information on 556,026 records or person trips of 116,176 persons. All of the sample sizes noted in this paragraph reflect unweighted samples.

Various reports and publications of the BTS (1997) provide further details on the survey methodology, sample composition, and terminology. One aspect that merits note here is that of the distinction between household and person trips. If a household of three persons undertook a vacation trip together, then that trip is counted as one household trip and three person trips.

Sociodemographic Characteristics

This section provides a brief overview of the socioeconomic and demographic characteristics of the weighted sample of households and persons in the demographic files. Table 1 provides key descriptive statistics pertaining to household characteristics. The average household size of the weighted sample was found to be about 2.5 persons per household. About one-fourth of the households constituted families with children under 18 years, while about 8 percent of the households were single-parent households. Average vehicle ownership was about 1.7 vehicles per household with 18 percent of the households indicating a zero-car ownership status. About one-fourth of the sample had household incomes less than \$15,000, while just about one-tenth of the sample had incomes over \$60,000. Several characteristics of the household are depicted with reference to the householder. An examination of the householder revealed that half of them had not had any college education experience. With respect to race, about 20 percent of the households are either African American or Hispanic. Nearly two-thirds of the sample reside in single-family dwelling units. About 60 percent of the householders are employed full-time, while nearly 35 percent are not employed. The average age of the householder was found to be 48 years with about three-fourths falling in the age range of 25 to 64 years. All of these descriptive statistics are reasonable, thus indicating that the household data sets are suitable for travel behavior analysis.

Table 2 provides a similar description of personal characteristics for the weighted sample of persons in the 1995 ATS database. The average age of the weighted sample was found to be 35 years with about 60 percent in the middle-age group of 25 years to 64 years. Currently a little more than half are married and another 30 percent reported as having never been married. The remainder have been divorced, separated, or widowed. A

little more than half of the sample reported being employed full-time, while about 40 percent indicated that they were not employed at all. The sample was nearly equally distributed with respect to gender. Also, more than 50 percent of the sample did not have any college-level educational experience. Once again, it is noted that these descriptive statistics appear to be reasonable and plausible, thus indicating that the ATS databases are suitable for travel behavior analysis.

TABLE 1 Key Household Characteristics (Weighted Sample; N = 98,299,154)

Characteristic	Value
<i>Average Household Size</i>	<i>2.5 persons</i>
Single person	27%
<i>Household Type Distribution</i>	
Married with children under 18 years old	24%
Married with no children under 18 years old	29%
Single with children under 18 years old	8%
<i>Average Vehicle Ownership</i>	<i>1.7 vehicles</i>
Zero car households	18%
One car households	32%
<i>Average Household Income</i>	<i>\$38,788</i>
Less than \$15,000	23%
\$15,000–\$24,999	14%
Greater than \$60,000	9%
<i>Education Level of Householder</i>	
High school or less	50%
4-year college degree or more	25%
<i>Race and Ethnicity</i>	
White	83%
African-American	12%
Hispanic	8%
<i>Type of Residence</i>	
Single-family dwelling unit	65%
Multi-family dwelling unit	34%
<i>Employment Status of Householder</i>	
Full-time employed	59%
Part-time employed	7%
Unemployed	35%
<i>Average Age of Householder</i>	<i>48 years</i>
15–24 years	5%
25–44 years	43%
45–64 years	31%
65 years and over	22%

TABLE 2 Key Person Characteristics (Weighted Sample; N = 264,207,543)

Characteristic	Value
<i>Average Age</i>	<i>35 years</i>
15–24 years	12%
25–44 years	30%
45–64 years	18%
65 years and over	11%
<i>Marital Status</i>	
Married	54%
Divorced	8%
Widowed	6%
<i>Employment Status</i>	
Full-time employed	51%
Part-time employed	10%
Unemployed	40%
<i>Gender</i>	
Male	49%
<i>Education Level</i>	
High school or less	53%
4-year college degree or more	28%

Travel Characteristics

This subsection focuses on the overall travel characteristics of the ATS sample that are included in the household demographic and trip files. As such, the statistics reported within this section pertain only to household trips and their associated characteristics. Detailed information on travel characteristics can be found in various publications of the BTS. Therefore, only major trip characteristics are highlighted in this section.

Table 3 provides an overview of major travel indicators associated with household trips. On average, the survey indicated that the long-distance trip frequency is equal to seven trips per household per year. Nearly one-third of the households reported no long-distance trips of length 100 miles or more. In future studies of long-distance trip making, it would be interesting to further examine the characteristics of households that report zero long-distance trips. The analysis conducted in this paper sheds some light on this topic. About 20 percent of the households made between 5 and 10 long-distance trips in the survey year. These trip frequency figures are derived from the household demographic file that includes the households that made zero trips. The remaining trip characteristics are derived from the household trip file.

With respect to trip purpose, it was found that about 30 percent of the trips are made for business, nearly 60 percent of trips are made for social visits and vacations, and about 15 percent of the trips are made for personal business. More than three-fourths of all long-distance trips are made by personal automobile and about 1 in 5 trips are made by air. Conceivably, the trip-mode choice distribution varies considerably by trip purpose and trip length. Cross-tabulating these trip characteristics would provide a mechanism for capturing these variations. Interestingly, 60 percent of long-distance trips reported were undertaken by single adults with no children. About one-fourth of the trips were day trips

involving no overnight stay, while another half of the trips involved overnight stays of just 1 to 3 nights.

In order to shed additional light on the relationships between mode, purpose, and distance, an additional table has been included in this subsection. Table 4 shows how the modal distribution, trip length distribution, travel duration, and travel party size changes across trip purpose. The table reveals some interesting differences across various trip purposes. For example, with respect to the mode choice distribution, it is found that the percent of business trips that are undertaken by air is nearly twice that for other trip purposes. Similarly, the percent of trips that are undertaken by personal vehicle is found to consistently increase as the type of trip purpose becomes increasingly personal or social in nature. On the other

**TABLE 3 Key Household Travel Characteristics
(Weighted Sample; N = 656,462,000 trips)**

Characteristic	Value
<i>Average Trip Frequency</i>	<i>7 trips</i>
Zero trips	32%
1–4 trips	29%
5–10 trips	20%
<i>Trip Purpose Distribution</i>	
Business	29%
Recreation and Vacation	27%
Social Visits	30%
Personal Business	14%
<i>Trip Mode Distribution</i>	
Personal Vehicle	77%
Bus	3%
Train	1%
Air	20%
<i>Average Round Trip Length Distribution</i>	<i>872 miles</i>
100–299 mi	30%
300–499 mi	27%
500–999 mi	21%
2000 mi or more	11%
<i>Average Size of Travel Party</i>	<i>1.6 persons</i>
One adult, no children under 18 years	59%
2 or more adults, no children under 18 years	24%
One adult, one or more children under 18 years	5%
2 or more adults with children under 18 years	10%
<i>Average Travel Duration Distribution</i>	<i>4.5 nights</i>
0 nights (day trip only)	25%
1–3 nights	49%
4–7 nights	19%

hand, the differences in trip length distributions are not as marked. In general, it is found that a smaller proportion of business trips are within a 300-mi range. But, across all trip purposes, about 30 percent are over 300 mi.

With respect to travel party size, the difference between business trips and other trip purposes is marked. While more than 80 percent of business trips are undertaken by one adult with no children, the corresponding percentage for other trip purposes is only about 45 to 50 percent. An examination of travel duration shows that recreation and social visit trips tend to be longer in duration than business or personal business trips. While only 15 to 20 percent of recreational and social trips involved no overnight stay, the corresponding percentage range for business and personal business trips was found to be 30 to 35 percent.

In all of the cross-tabulations examined in Table 4, the χ^2 statistic that tests the null hypothesis of independence was found to be greater than the critical χ^2 value at the appropriate degrees of freedom. This indicates that, in all cases, the null hypothesis of independence between trip purpose and the dimension examined may be rejected at the 95 percent confidence level. It is clear from this analysis that business trips differ significantly from other trip purposes. However, the differences among the non-business

**TABLE 4 Mode, Length, Party Size, and Duration Variation by Purpose
(Weighted Sample; N = 656,462,000 trips)**

Characteristic	Trip Purpose				Total
	Business	Recreation and Vacation	Social Visit	Personal Business	
<i>Travel Mode</i>					
Personal Vehicle	63%	77%	80%	83%	77%
Bus and Train	3%	5%	2%	1%	4%
Air	33%	16%	17%	15%	20%
<i>One-Way Trip Distance</i>					
100–299 mi	64%	71%	68%	71%	68%
300–499 mi	11%	9%	11%	11%	10%
500–999 mi	12%	8%	10%	9%	10%
1000 mi or more	13%	12%	11%	11%	12%
<i>Travel Party Size</i>					
1 adult, no child	83%	45%	49%	49%	59%
≥ 2 adults, no child	11%	32%	27%	34%	24%
1 adult with child	2%	5%	6%	6%	5%
≥ 2 adults with child	3%	14%	14%	10%	10%
<i>Travel Duration</i>					
0 nights	32%	22%	14%	35%	25%
1–3 nights	44%	49%	54%	41%	49%
4–7 nights	17%	21%	21%	16%	19%
8 nights or more	7%	8%	11%	8%	8%

trip purposes (social visit, recreation and vacation, and personal business) are less marked.

This section has provided an overall description of the ATS sample and their travel characteristics. The remainder of this paper is dedicated to analyzing long-distance travel behavior for the two socioeconomic market segments that constitute the focus of this paper, namely, the elderly and the low-income groups.

LONG-DISTANCE TRAVEL BY THE ELDERLY

In the context of this paper, the elderly age group corresponds to those individuals whose age is 65 or over. As the analysis in this section is intended to be detailed in nature, the elderly age group is further subdivided into those between 65 and 74 years and those 75 or older. The analysis concentrates on the travel characteristics of these groups as compared to the other age groups in the sample. However, it was felt appropriate to also compare sociodemographic characteristics, as such a comparison may shed light on the reasons behind the differences in travel characteristics.

Socioeconomic Characteristics of the Elderly

Table 5 provides a summary comparison of key socioeconomic and demographic characteristics across the various age groups. The comparison reveals several noticeable and statistically significant differences across the various age groups. More interestingly, it was found that there are statistically significant differences even among the elderly with those between 65 and 74 years of age being quite different from those aged 75 years or over.

Average household sizes are found to diminish with age of householder and correspondingly the percent of single person households increases dramatically from about 20 percent in the lower age groups to about 55 percent in the highest age group. With respect to car ownership, it is found that car ownership also diminishes with increasing age and the percent of households not owning a car in the age group of 75 years or more is nearly at one-third. While only about one-third of those in the age group of 65 to 74 years may be considered low income (i.e., income less than \$15,000 per year), the corresponding percentage for those in the age group of 75 years or more is more than 50 percent. Similar significant differences are also seen when examining such characteristics as gender, employment status, and marital status.

Once again, it must be emphasized that the most important finding here is that even within the group that is traditionally categorized as “elderly,” there are significant differences with respect to various demographic characteristics. It is to be noted that all of the comparisons shown in Table 5 are statistically significant at the 95 percent confidence level. These differences are likely to play an important role in shaping the travel characteristics of people in different age groups. The travel characteristics comparisons furnished in the subsequent sections should be interpreted in light of the socio-economic comparisons reported in this subsection.

TABLE 5 Comparison of Demographic Characteristics Across Age Groups (Weighted Sample)

Characteristic	Age Group				Total
	25 years or less	26–64 years	65–74 years	75 years or more	
<i>Average Household Characteristics</i>					
Household size	2.4	2.8	1.9	1.5	2.5
Car ownership	1.5	1.8	1.5	1.0	1.7
Zero Cars	22%	15%	19%	30%	18%
Household income < \$15,000	\$26,600 33%	\$43,450 16%	\$30,400 36%	\$23,200 57%	\$38,800 23%
<i>Gender</i>					
Female	49%	51%	55%	62%	51%
<i>Employment Status</i>					
Full-time employed	32%	67%	12%	4%	51%
Part-time employed	16%	9%	7%	3%	10%
School	42%	2%	0%	0%	9%
Not Working	11%	21%	80%	91%	31%
<i>Household Type</i>					
Married with child under 18 years	15%	34%	1%	0%	25%
Married with no child under 18 years	14%	32%	54%	36%	35%
Single person	24%	18%	36%	55%	25%
<i>Marital Status</i>					
Married	12%	66%	65%	45%	54%
Widowed	0%	2%	20%	45%	6%
Divorced or Separated	2%	13%	9%	4%	10%
Never Married	85%	18%	6%	6%	30%

Trip Characteristics of the Elderly

The discussion in this section parallels the discussion furnished in the section entitled Travel Characteristics where overall travel characteristics for the entire ATS weighted sample were tabulated. In this subsection, travel characteristics are tabulated by age group for the same trip attributes that were considered in the previous section on characteristics. Table 6 provides a comparison of travel characteristics across various age groups considered in this paper.

In general, it can be seen that the older age groups participate in fewer long-distance travel activities and even within the older age groups, there are substantial differences between the age group of 65 to 74 years and the age group of 75 years or more. A χ^2 test conducted on each of the cross-classification tables shows that all of the differences across age groups are statistically significant at the 95 percent confidence level given the appropriate number of degrees of freedom. The following points are especially noteworthy:

**TABLE 6 Comparison of Trip Characteristics Across Age Groups
(Weighted Sample)**

Characteristic	Age Group				Total
	25 years or less	26–64 years	65–74 years	75 years or more	
<i>Person Trip Frequency</i>					
Average trips per year	2.9	5.0	3.9	2.0	4.0
Zero trips	41%	33%	40%	58%	38%
1–4 trips	38%	35%	33%	27%	36%
5–9 trips	14%	17%	15%	10%	15%
10 or more trips	7%	15%	12%	4%	11%
<i>Trip Purpose</i>					
Business	15%	31%	15%	9%	25%
Social Visits	41%	28%	36%	43%	33%
Recreation/Vacation	34%	29%	32%	30%	31%
Personal Business	11%	12%	17%	18%	12%
<i>Trip Mode Choice</i>					
Personal Vehicle	85%	76%	77%	70%	78%
Airplane	11%	21%	15%	19%	18%
Bus	3%	1%	5%	9%	2%
Train	1%	0%	1%	1%	0%
<i>One-Way Trip Distance</i>					
Average Trip Length	370 mi	475 mi	480 mi	510 mi	450 mi
100–299 mi	74%	68%	67%	66%	70%
300–499 mi	10%	10%	10%	10%	10%
500–999 mi	8%	10%	9%	9%	9%
2000 mi or more	3%	5%	5%	6%	4%
<i>Travel Duration</i>					
Average No. of Nights	4 nights	3 nights	3 nights	5 nights	3.5 nights
Zero nights	20%	24%	27%	27%	23%
1–3 nights	52%	50%	40%	36%	49%
4–7 nights	20%	19%	19%	20%	19%
8 or more nights	9%	7%	13%	17%	8%

- On average, the 65 to 74 age group makes about four trips per year, nearly twice as many as those in the 75 years or more group. The trip frequency distributions reveal that more than 10 percent of those in the 65 to 74 age group make 10 or more trips per year. The corresponding percentage for the age group of 75 years or more is only 4 percent.

- As expected, the proportion of trips undertaken for business diminishes drastically after the onset of 65 years. On the other hand, increasing proportions of personal business and social visit trips occur with increasing age. A significant decrease in recreational trip generation occurs at age 75. While the recreational trip generation rate for the other three age groups is greater than one trip per year, the corresponding average rate for those 75 years and above is only 0.6 trips per year.

- The use of airplane and bus increases significantly as age increases, while the share of trips undertaken by the personal automobile significantly decreases. Whereas the age group of 65 to 74 does not seem substantially different from the 26 to 64 age group, those 75 years or older are found to significantly differ from both of these age groups with respect to mode choice. For example, the mode share of bus doubles when transitioning from the 65 to 74 age group to the 75 years or more group.

- It is interesting to note that average trip length increases with age. However, it is found that the trip length distributions only marginally differ across the age groups. For example, it is noted that about 15 percent of the trips are 500 mi or more for the 3 age groups of 25 to 64 years, 65 to 74 years, and 75 or more years.

- With respect to travel duration, the average number of nights away from home increases significantly for the age group of 75 years or more. Interestingly, it is also found that the percentage of zero night trips is the highest for this particular age group. The increase in average duration away from home is caused by the significant increase in trips that involve long stays of eight nights or more away from home. This may be because people in this age group are undertaking larger percentages of social visit and personal business trips, which may typically be of longer duration than business trips.

The analysis in this table reveals older age groups, particularly those over the age of 74, are less mobile with respect to long-distance travel. This is a result that one would expect. However, the dramatic drop of 50 percent in long-distance trip making (from four trips per year to two trips per year) seen between the age groups of 65 to 74 and those 75 years or more raises important questions regarding the potential loss in mobility that occurs among the “older elderly.”

As seen above, Table 6 is quite informative regarding the travel characteristics of the elderly. However, it would be of interest to see how the travel characteristics differ for different trip types. For example, are the older elderly (i.e., those 75 years or more) more prone to undertake vacation trips of shorter length than the younger age groups that are potentially more mobile? Answers to these types of questions may shed light on the types of transportation opportunities that the older elderly may benefit from.

Table 7 shows how the travel characteristics compare across various age groups for different trip purposes. As the elderly do not undertake significant levels of business trips, only the three other trip purposes of social visits, recreation/vacation, and personal business are analyzed.

The analysis in Table 7 reveals some interesting differences and trends by trip purpose. Once again, it is noteworthy that all of the χ^2 statistics associated with the cross-tabulations and the F-statistics associated with the multigroup comparison of means were statistically significant at the 95 percent confidence level.

For the social visit trips that involve visiting friends and relatives, it is found that the proportion of trips undertaken by personal vehicle decreases and the proportion by air increases as age increases. There is virtually no difference in the proportions of trips undertaken by bus, train, and other modes across the age groups. This drop in personal vehicle share is expected considering the driving impairments suffered by those in older age groups and the higher proportion of carless households. It is interesting to note that

TABLE 7 Comparison of Characteristics of Different Trip Types Across Age Groups (Weighted Sample)

Trip Purpose	Characteristic	Age Group				Total
		25 years or less	26–64 years	65–74 years	75 years or more	
<i>Social Visits</i>	Mode Choice Distribution					
	Personal Vehicle	87%	84%	83%	78%	84%
	Airplane	11%	15%	15%	19%	14%
	Bus	1%	1%	1%	1%	1%
	Train	1%	1%	1%	1%	1%
	Other	1%	1%	1%	2%	1%
	Average Trip Length (miles)	368	407	430	495	409
Average Trip Duration (nights)	4.0	3.3	3.4	5.2	3.8	
<i>Recreation/Vacation</i>	Mode Choice Distribution					
	Personal Vehicle	86%	81%	77%	65%	80%
	Airplane	10%	15%	16%	15%	14%
	Bus	3%	2%	3%	15%	4%
	Train	0%	0%	0%	0%	0%
	Other	1%	2%	3%	5%	2%
	Average Trip Length (miles)	377	447	505	654	463
Average Trip Duration (nights)	3.3	3.0	3.6	6.4	3.6	
<i>Personal Business</i>	Mode Choice Distribution					
	Personal Vehicle	91%	83%	86%	86%	86%
	Airplane	8%	16%	13%	12%	13%
	Bus	1%	1%	1%	1%	1%
	Train	0%	0%	0%	1%	0%
	Other	0%	0%	1%	1%	0%
	Average Trip Length (miles)	335	437	382	354	384
Average Trip Duration (nights)	3.0	2.4	3.0	4.6	3.0	

the average one-way trip length increases steadily across the age groups and a similar trend is found to exist for average trip duration as well (measured in terms of number of nights away from home). While the longer trip duration may be explained by the fact that those in the older age groups are not time constrained by work commitments, the longer trip length is not as easily explained. Here too, one could conjecture that the increased

time availability allows those in the older age groups to undertake longer trips both in length as well as in duration.

A similar trend is seen for recreation and vacation trips. However, the most noticeable difference is that the drop in personal vehicle share is significantly larger than that found for social visit trips and the share of trips undertaken by air is virtually similar across the age groups (unlike the social visit trips). On the other hand, the percentage of recreational trips undertaken by bus is found to dramatically increase for the older elderly group of persons. Whereas the percentage of recreational trips undertaken by bus is between 2 and 3 percent for those 74 years or younger, the corresponding percentage for those over 74 years is found to be 15 percent. This is potentially explained by the increased usage of special charter and tour buses by those in the older elderly age groups. Again, the lack of binding time constraints imposed by rigid employment schedules appears to allow those in the older age groups to undertake longer trips both in length and duration.

The personal business trips include those undertaken for such purposes as family functions (weddings, funerals, and graduations), medical treatment, and other personal matters. These trips are found to follow the same trends as the social visit trips. However, the decrease in personal vehicle share is not as large as that found for social visit trips. In fact, the shares associated with personal vehicle and airplane are virtually similar across the different age groups. Even though the travel duration of personal business trips is found to increase with age just as in the case of the other trip purposes examined, the trip length is not found to follow that trend. The average trip length of personal business trips appears to be highest for those in the 25 to 64 age group.

The analysis in this section shows that the elderly are less mobile than other age groups with respect to long-distance travel. However, the drop in mobility appears to occur on a larger scale among the older elderly groups. The trip generation rates of those 75 years and over for all trip purposes are found to be significantly lower than those for all other age groups including those in the 65 to 74 year group. Similarly, the dramatic increase in bus usage, or conversely the dramatic decrease in personal vehicle usage, especially in the context of recreational trips, occurs again at the 75-year-old mark as seen in Table 7. The decreased mobility experienced by the older elderly may be explained by lower income levels, lower car ownership levels, and perhaps some physical limitations that make it difficult for them to engage in long-distance travel. This finding is worthy of further investigation considering that those in this age group are the most vulnerable members of our society.

Long-Distance Trip Generation Models by Age Group

The previous two subsections provided valuable insights into the differences in long-distance trip-making behavior across various age groups. However, the analysis presented in those sections does not shed light on the potential sensitivity of different groups to various independent variables such as income and car ownership. It is possible that there are differences among the age groups with respect to the change in trip generation that would be brought about by a change in one of these independent variables.

In order to examine these differences, linear regression models of trip generation were estimated for each age group and comparisons of selected trip generation elasticities

were done. In Table 8, estimation results from the linear regression models are presented for total trip generation and for recreation/vacation trip generation. As recreation/vacation trips tend to be the most discretionary in nature, it was felt that a comparison of elasticities for this trip purpose would be insightful. Moreover, in several states (particularly the authors' home state of Florida), recreation/vacation trips are vitally important to the region's economy. A note is due here regarding the t -statistics that are presented in the regression results. In order to obtain meaningful t -statistics that are not inflated (due to the huge size of the weighted sample), a simple scale factor was applied to the sample for regression estimation. The scale factor does not change the values of the model coefficients or descriptive statistics in any way. It only changes the values of the test statistics such as F-statistic and t -statistics so that they are not artificially inflated by the mere presence of a huge sample.

TABLE 8 Linear Regression Model Estimation Results (Weighted Sample)

Variable	Age Group								Total	
	25 years or less		26–64		65–74		75 or more			
	□	t -stat	□	t -stat	□	t -stat	□	t -stat	□	t -stat
Total Trip Generation Model										
Intercept	3.41	10.78	2.46	6.49	2.26	3.37	1.16	2.60	2.41	11.30
Vehicle ownership	0.17	3.28	0.27	3.32	0.52	2.59	0.25	1.68	0.26	5.34
Hhld size	-0.39	-6.28	-0.47	-5.21	-0.82	-2.91	-0.19	-0.79	-0.40	-7.91
Income (x10,000)	0.24	7.90	0.58	12.64	0.39	3.26	0.20	2.08	0.44	16.01
Single, w/child <18 years (dummy)	-0.92	-4.23	-0.84	-1.66	—	—	—	—	-0.64	-2.65
African-American (dummy)	-0.63	-2.12	-1.17	-2.37	—	—	—	—	-0.91	-3.15
Hispanic (dummy)	-0.57	-2.89	-0.73	-1.62	—	—	—	—	-0.60	-2.35
Post grad education (dummy)	2.95	1.75	3.53	7.74	2.63	2.22	0.64	0.65	3.65	10.64
Employed full time (dummy)	0.38	1.47	0.86	3.22	—	—	—	—	1.26	8.16
Married person (dummy)	—	—	—	—	1.52	2.43	0.63	1.40	—	—
Goodness-of-fit stats	$R^2 = 0.053$ F = 26.54		$R^2 = 0.075$ F = 52.00		$R^2 = 0.06$ F = 8.75		$R^2 = 0.026$ F = 2.67		$R^2 = 0.08$ F = 109.00	

continued on next page

**TABLE 8 (continued) Linear Regression Model Estimation Results
(Weighted Sample)**

<i>Recreation/Vacation Trip Generation</i>								
Variable	25 years or less		26–64 years		65 or more		Total	
	□	<i>t</i> -stat	□	<i>t</i> -stat	□	<i>t</i> -stat	□	<i>t</i> -stat
Intercept	1.17	4.54	1.44	7.82	1.28	3.75	1.35	10.04
Vehicle Ownership	0.09	2.19	0.17	2.83	0.09	0.89	0.10	3.67
Hhld Size	-0.10	-1.77	-0.19	-4.04	-0.20	-1.29	-0.17	-5.33
Hhld Income (x10,000)	0.15	6.31	0.20	9.09	0.13	2.37	0.18	11.82
Single, w/child <18 years (dummy)	-2.80	-1.41	-0.39	-1.38	—	—	-0.35	-2.14
African- American (dummy)	-0.09	-0.37	-0.21	-0.82	—	—	-0.15	-0.86
Hispanic (dummy)	-0.28	-1.22	-0.20	-0.79	—	—	-0.22	-1.31
Post grad education (dummy)	—	—	0.31	1.52	0.23	0.45	—	—
Employed full time (dummy)	0.31	1.47	—	—	—	—	0.18	2.04
Married person (dummy)	—	—	—	—	0.43	1.44	—	—
Goodness- of-fit stats	$R^2 = 0.031$ F = 10.02		$R^2 = 0.037$ F = 19.46		$R^2 = 0.019$ F = 2.35		$R^2 = 0.036$ F = 33.60	

The regression models presented in Table 8 offer reasonable indications that are consistent with expectations. All of the model coefficients have the expected values and signs and the goodness-of-fit statistics are as one would expect from a person-based trip generation model. It is to be noted that the selection of explanatory variables to be included in the model was not purely driven by *t*-statistic values. If the model coefficient offered plausible indications and the authors considered the variable to be of value to the model (from an interpretive standpoint), then even a variable that offered a statistically insignificant *t*-statistic was retained in the model. It should also be noted that all of the F-statistic values presented at the bottom of each model were statistically significant at the 95 percent confidence level and appropriate degrees of freedom.

The top half of the table shows the results of estimating models for total trip generation. In general, it is found that car ownership and household income positively and significantly influence long-distance trip generation. Within each group, it is found

that household size negatively impacts long-distance trip generation. This may be attributable to the fact that larger households may have more constraints with respect to disposable income and time. Among household types, a single person with a child is likely to make fewer trips than other household types as evidenced by the negative coefficient. This variable was not at all significant in the older age group models, possibly because those age groups do not have a sizeable number of households that fall within this household type. Both the African-American and Hispanic dummy variables exhibited negative coefficients. Higher education, full-time employment, and being married were other factors that positively impacted long-distance trip generation for various age groups.

With respect to recreation/vacation trip generation, the models provided similar indications as in the case of total trip generation. Again, car ownership and income positively influenced recreation/vacation trip generation. Variables representing the household size, a single-parent household, and African-American and Hispanic groups were all associated with negative coefficients. These findings were consistent with expectations as these households consistently exhibited lower trip generation rates in the descriptive analysis. It should be noted that the last two elderly age groups had to be combined into one age group because of sample size considerations (recreation/vacation trip frequency variable among the 75 years and over group had a very high proportion of zeros).

An informal comparison of the coefficients across age groups indicates that the age groups differ substantially with respect to their trip generation propensity as a function of different explanatory variables. In order to further examine this difference, trip generation elasticities are computed for two explanatory variables, namely, vehicle ownership and income. These two variables were chosen because they clearly represent factors that could potentially increase opportunities for long-distance trip making.

The elasticities were computed by considering the “average” person, i.e., the sample means were used to calculate the multiplier for the β -coefficient. In other words, the elasticity of trip making (Y) with respect to variable X as, $E = \beta \times (\text{sample mean of X}) \div (\text{sample mean of Y})$. This was done for each age group separately to facilitate a comparison of elasticities across age groups.

The elasticities of total trip generation with respect to car ownership were found to be

- 25 years or less: 0.087
- 26–64 years: 0.098
- 65–74 years: 0.199
- 75 years or more: 0.127
- Total Sample: 0.108

In general, elasticity of trip making with respect to car ownership is found to increase dramatically when transitioning from the 26- to 64-year age group to the 65- to 74-year age group. This is quite plausible as those in the older age groups have fewer cars and may be able to undertake increased trip making if additional cars were made available to their households. On the other hand, the younger age groups may be constrained by household and employer obligations that prevent them from increasing their total trip generation as much as the elderly. However, it is noteworthy that the elasticity for the

older elderly in the age group of 75 years or more is quite lower than that for those in the 65 to 74 age group. This is probably because those in the older elderly age group have physical and other limitations that prevent them from driving long distances even if additional cars were made available to them.

The income elasticities of total trip generation by age group are

- 25 years or less: 0.219
- 26–64 years: 0.508
- 65–74 years: 0.307
- 75 years or more: 0.230
- Total Sample: 0.425

The lowest age group shows the lowest income elasticity of trip generation, probably because they are still in school and do not have the time and inclination to undertake long-distance trips that are typically associated with business and household social and recreational activities. This also explains why the age group of 26 to 64 has the highest average elasticity among all age groups. As mentioned earlier, the older age groups show diminishing elasticities possibly because of the onset of physical and other limitations that inhibit their potential trip generation increase that might be associated with an increase in income.

The elasticities of recreation/vacation trip generation with respect to car ownership were

- 25 years or less: 0.138
- 26-64 years: 0.140
- 65 years or more: 0.099
- Total Sample: 0.148

As in the case of total trip generation, it is once again found that the elasticity is lower for the elderly, possibly because of physical and other limitations that make long-distance travel difficult to perform even if car ownership levels were raised. The same trend is seen again when elasticities of recreation/vacation trip generation with respect to household income are examined.

The elasticities of recreation/vacation trip generation with respect to household income were

- 25 years or less: 0.135
- 26-64 years: 0.176
- 65 years or more: 0.135
- Total Sample: 0.176

In summary, the analysis in this section has shown that trip generation increases with income, car ownership, education level, employment, and married status. On the other hand, it decreases in association with household size, single-parent household types, and African-American or Hispanic racial groups. All of these trends were found to be consistent with one's expectations. More noteworthy are the differences found among age groups when examining elasticities in trip generation with respect to car ownership and

income. While both car ownership and income positively influenced trip generation for all age groups, it was found that the elasticities diminished for the older age groups. This finding appears to imply that there are age-related limitations besides automobile availability and disposable income that inhibit the potential long-distance travel of the elderly. Once again, these findings point to the need to specially consider the physical and other capabilities/needs of the elderly in the provision of transportation services.

LONG-DISTANCE TRAVEL BY INCOME GROUP

Another market segment that has been the focus of much research attention over the past decade is that of the low income. The analysis in this section of the paper focuses on this group of households and parallels the analysis presented in the section entitled Long-Distance Travel by the Elderly. A note is due here regarding the method by which the “low-income” group is defined in this paper.

For the analysis, the “household income” variable in the household demographic and trip files was used to categorize households by income level. However, it was considered desirable to control for household size effects in the definition of various income levels. For example, a household income of \$30,000 may be considered low for a family of four persons, but not so for a single-person household. Therefore, a new variable was constructed for analyzing long-distance travel by income group. The new variable is defined as “income per household member” and is calculated by dividing the household income variable by the household size. In order to do this, the household income categorical variable has to be converted into a variable with units of dollars. For this, the midpoint of each income range was used to represent the dollar value corresponding to each household income category. This mid-value was then divided by household size to derive the household income on a per person basis. Considering the newly created variable, income groups were defined as

- Household income per person less than or equal to \$7,499.
- Household income per person between \$7,500 and \$12,499.
- Household income per person between \$12,500 and \$22,499.
- Household income per person greater than or equal to \$22,500.

Comparisons across these income groups are furnished in the next few subsections.

Socioeconomic Characteristics of the Low Income

Table 9 shows a comparison of demographic and socioeconomic characteristics across various income groups. As expected the household size decreases as the income level increases. This is expected because of the way in which the income grouping was done. As the income grouping was done by dividing household income by household size, it is more likely that higher household sizes would fall into the lower income groups. However, it is interesting to note that an examination of the average household income shows that higher household sizes are associated with lower household income levels. The reasons behind this merit further investigation.

Also, as expected, car ownership levels are slightly higher for those in the higher income groups. While only 10 percent of the households in the highest income group are carless, nearly one-fourth are carless in the lower income groups. The second income group shows a larger proportion of elderly, nearly twice that in other income groups. An examination of employment status indicates that there are substantial differences between the two lower income groups and the two higher income groups. Whereas less than half of the householders in the lower income households are employed full-time, more than two-thirds are employed in the two higher income groups. This appears to correlate very well with education level of the householder. In the lower income groups, householders are predominantly high-school educated only. On the other hand, the higher income groups have higher percentages of householders who have had at least some college experience.

With respect to household type, the trends observed are quite revealing. In general, the lower income groups have relatively higher proportions of households that are married with children, single parent, and single person when compared with households in the higher income group. The highest income group has a relatively high percentage of households that are married with no children. Perhaps the absence of children under the age of 18 allows both married partners to participate in the labor force; the higher income level resulting from dual-labor participation coupled with a small household size places this group in the highest income level.

Finally, another revealing trend is seen in the aspect of race and ethnicity. The percentage of minorities is highest in the lower income groups and diminishes as income levels rise. This is quite important as there appears to be a strong correlation between income and race and ethnicity. If mobility is related to income, then it follows that mobility is also related to race and ethnicity. An analysis of the causal relationships underlying the dynamics of race, income, and mobility is beyond the scope of this study.

Trip Characteristics of the Low Income

The previous section highlighted the important demographic trends that may affect the mobility patterns of individuals in different income groups. The analysis presented in this subsection will focus on trip characteristics of long-distance travel, but should be interpreted in the context of the demographic trends presented in the last subsection.

Table 10 presents a comparison of trip characteristics across income groups. It is to be noted that this table compares household level travel characteristics. First and foremost, the table shows that mobility differs very significantly across the various income groups. Whereas the highest income group makes 11 long-distance household trips per year, the lower income groups make only about 4 to 5 trips. Nearly half of the lower income groups make zero long-distance trips in a 1-year time frame.

**TABLE 9 Comparison of Demographic Characteristics Across Income Groups
(Weighted Sample)**

Characteristic	Income Group (Household Income per Person)				Total
	Less than \$7,500	\$7,500– \$12,499	\$12,500– \$22,499	\$22,500 or more	
<i>Average Household Characteristics</i>					
Household size	3.7	2.3	2.5	1.9	2.5
Car ownership	1.6	1.4	1.9	1.9	1.7
Zero Cars	19%	25%	15%	10%	18%
Average Age of Householder	43 years	53 years	47 years	49 years	49 years
65 years or over	15%	34%	17%	17%	22%
Average Household Income	\$16,480	\$22,800	\$45,350	\$68,400	\$38,800
<i>Employment Status</i>					
Full-time employed	47%	45%	67%	73%	58%
Part-time employed	9%	7%	6%	4%	6.5%
School	3%	3%	2%	1%	2%
Not Working	35%	33%	23%	20%	30%
<i>Household Type</i>					
Married with child under 18 years	39%	25%	25%	9%	24%
Married with no child under 18 years	21%	14%	37%	44%	29%
Single person with child under 18 years	25%	6%	5%	2%	8%
Single person with no child under 18 years	13%	5%	7%	6%	7%
<i>Education Level of Householder</i>					
High School or Less	70%	60%	43%	26%	50%
College Degree or More	13%	20%	36%	53%	31%
<i>Race and Ethnicity</i>					
African American	22%	14%	8%	5%	11%
Hispanic	20%	8%	6%	3%	8%

As expected, the higher income groups show a higher percentage of business trips, probably due to their higher employment and education levels. Even though the percentage of recreation and vacation trips is relatively similar across the income groups, it should be noted that the highest income group makes about three times as many recreational trips as does the lowest income group. Lower income groups show higher percentages of social visit and personal business trips, possibly because these trips are low cost (e.g., do not involve lodging expenses) and relatively more obligatory.

**TABLE 10 Comparison of Trip Characteristics Across Income Groups
(Weighted Sample)**

Characteristic	Income Group (Household Income per Person)				Total
	Less than \$7,500	\$7,500–\$12,499	\$12,500–\$22,499	\$22,500 or more	
<i>Person Trip Frequency</i>					
Average trips per year	3.9	4.7	8.0	11.0	7.0
Zero trips	46%	42%	24%	17%	31%
1–4 trips	30%	30%	30%	26%	29%
5–9 trips	13%	15%	20%	21%	18%
10 or more trips	11%	14%	27%	36%	22%
<i>Trip Purpose</i>					
Business	24%	27%	31%	38%	32%
Social Visits	36%	34%	29%	25%	29%
Recreation/Vacation	24%	26%	29%	27%	28%
Personal Business	16%	13%	10%	9%	11%
<i>Trip Mode Choice</i>					
Personal Vehicle	84%	79%	77%	65%	74%
Airplane	10%	15%	20%	32%	22%
Bus	5%	4%	2%	1%	3%
Train	1%	1%	0%	1%	1%
<i>One-Way Trip Distance</i>					
Average Trip Length	354 mi	405 mi	450 mi	600 mi	482 mi
100–299 mi	74%	72%	69%	61%	68%
300–499 mi	10%	10%	10%	11%	10%
500–999 mi	8%	9%	10%	12%	10%
2000 mi or more	2%	3%	4%	7%	5%
<i>Travel Duration</i>					
Average No. of Nights	3.8 nights	3.7 nights	3.7 nights	3.5 nights	3.6 nights
Zero nights	30%	28%	24%	21%	24%
1–3 nights	45%	44%	49%	50%	48%
4–7 nights	16%	18%	19%	21%	19%
8 or more nights	9%	9%	9%	8%	9%

An examination of trip mode choice reveals that higher income levels are associated with increased usage of air transportation. Nearly one-third of household trips are made by air in the highest income group compared with just one-tenth in the lowest income group. Bus usage is also higher among the lower income groups. The differences in mode usage should also be interpreted in conjunction with the differences in trip lengths. The trips of higher income groups are, on average, 80 percent longer than the lowest income group. In general, the mode and trip length distributions show that higher income groups have greater spatial access because of their ability to afford air transportation to a greater extent than the lower income groups.

While significant differences were noted in mode and distance distributions, the differences in travel duration (in terms of nights per trip) were not found to be significant

across the income groups. However, one should note that the total time spent away from home on long-distance travel is much higher for high-income households. Whereas the highest income group spent nearly 40 nights away from home in 1 year, the corresponding duration for the lowest income group was only 14 nights.

The analysis in Table 10 reveals that lower income groups have significantly lower mobility levels when compared with higher income groups. While this was an expected result, the amount of difference, especially between the lowest and highest income groups, is striking. The highest income group makes about 300 percent more trips than the lowest income group and is about three times more likely to utilize air transportation for their long-distance trips. Clearly, the low-income groups are significantly less mobile than other income groups, depend heavily on the automobile for their means of transportation, and have a substantially smaller action space within which they undertake their long-distance travel activities. Once again, these findings are consistent with one's expectations, but merit further consideration in the context of transportation equity.

Long-Distance Trip Generation Models by Income Group

As in the section Long-Distance Trip Generation Models by Age Group, this section focuses on the sensitivity of long-distance trip generation with respect to various independent variables for different income groups. Table 11 shows the results of linear regression estimation of long-distance trip generation models for different income groups.

As expected, vehicle ownership, household size, and household income positively influence household long-distance trip generation. On the other hand, being a single parent, African American, or Hispanic negatively impacts household long-distance trip generation. Once again, these trends are as expected and indicate that certain minority segments and household types are less prone to undertake long-distance travel. Higher education levels and full-time employment are found to positively influence long-distance trip generation, possibly because households within these groups tend to have higher incomes.

The trends seen in the total trip generation model are virtually repeated in the recreation/vacation trip generation model. A couple of differences are noteworthy, even though they are not fully explicable within the analysis presented here. For example, household size is found to be statistically insignificant in all of the models presented. Similarly, the dummy variable representing single-parent households is also insignificant in all of the models; however, it has been retained in several models because of the plausible negative coefficient. Another interesting difference is the finding that the dummy variable representing Hispanic households has a statistically significant positive coefficient for the highest income group. The reasons for this are not readily apparent.

In general, the results seem to indicate that at the very high-income levels (i.e., the group with household income per person = \$22,500 or more), the influence of such variables as race and household type becomes quite marginal in nature. In both models, with the exception of the Hispanic dummy variable in the recreation/vacation model, the coefficients associated with race and household type were statistically insignificant. However, they offered plausible signs and were retained for that reason. It is quite reasonable to expect that these variables will play diminishing roles in influencing long-distance travel when income levels reach very high categories.

TABLE 11 Linear Regression Model Estimation Results (Weighted Sample)

Variable	Income Group (Household Income per Person)								Total	
	Less than \$7,500		\$7,500–\$12,499		\$12,500–\$22,499		\$22,500 or more			
	□	t-stat	□	t-stat	□	t-stat	□	t-stat	□	t-stat
Total Trip Generation Model										
Intercept	1.27	2.07	0.67	1.95	1.24	1.83	-1.37	-1.44	0.81	2.75
Vehicle ownership	0.53	4.08	0.54	3.86	0.65	3.90	0.61	3.06	0.60	7.30
Hhld size	0.28	1.60	—	—	0.44	0.94	1.44	2.68	0.27	2.83
Hhld Income (x10,000)	0.91	3.12	1.32	9.31	0.86	3.14	0.76	5.50	0.97	19.59
Single, w/child <18 yrs (dummy)	-0.55	-1.14	-0.83	-1.10	-2.32	-2.15	-3.58	-1.75	-1.26	-2.79
African American (dummy)	-1.69	-.326	-1.16	-2.19	-2.74	-3.08	-1.42	-1.00	-1.72	-4.41
Hispanic (dummy)	-1.91	-3.67	-1.60	-2.39	-3.67	-3.70	—	—	-2.23	-5.00
Post grad education (dummy)	4.42	2.98	5.14	6.03	4.42	5.23	3.50	4.19	4.16	9.29
Employed full time (dummy)	0.15	0.36	0.80	1.92	1.37	2.62	3.53	5.03	1.44	5.59
Goodness-of-fit stats	$R^2 = 0.062$ F = 14.05		$R^2 = 0.088$ F = 39.80		$R^2 = 0.061$ F = 26.85		$R^2 = 0.097$ F = 28.19		$R^2 = 0.111$ F = 155.88	
Recreation/Vacation Trip Generation										
Intercept	0.58	2.45	0.61	3.98	1.26	3.80	0.69	2.34	0.75	5.52
Vehicle Ownership	0.16	2.88	0.13	2.59	0.11	1.41	0.24	3.49	0.17	4.56
Hhld Size	—	—	—	—	—	—	0.19	1.05	—	—
Hhld Income (x10,000)	0.22	2.18	0.27	5.05	0.25	3.95	0.19	4.10	0.24	11.09
Single, w/child <18 years (dummy)	0.27	1.18	-0.32	-1.16	-0.92	-1.63	-0.72	-0.98	-0.39	-1.73
African American (dummy)	-0.67	-2.63	-0.56	-2.41	—	—	-0.48	-0.95	-0.38	-1.82

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**TABLE 11 (continued) Linear Regression Model Estimation Results
(Weighted Sample)**

Hispanic (dummy)	-0.39	-1.71	-0.49	-1.91	-0.98	-1.79	2.34	3.29	-0.36	-1.60
Post grad education (dummy)	1.36	2.52	0.50	1.70	—	—	—	—	0.37	1.94
Employed full time (dummy)	0.13	0.71	0.29	1.81	—	—	—	—	0.24	1.95
Goodness-of-fit stats	$R^2 = 0.04$ F = 5.40		$R^2 = 0.049$ F = 12.48		$R^2 = 0.011$ F = 6.87		$R^2 = 0.047$ F = 14.52		$R^2 = 0.036$ F = 37.06	

As done previously in the section on Long-Distance Trip Generation Models by Age Group, elasticities of household long-distance trip generation were computed with respect to car ownership and total household income. The car ownership elasticities of total trip generation by income group are

- Less than \$7,500: 0.218
- \$7,500–\$12,499: 0.160
- \$12,500–\$22,499: 0.153
- \$22,500 or more: 0.105
- Total Sample: 0.147

The decreasing trend in the magnitude of car ownership elasticities is quite plausible and explicable. As income levels rise, car ownership is probably not a limiting factor in long-distance trip generation. Most high-income households have high levels of car availability and already have a high level of long-distance mobility. Therefore, it may be expected that, as income rises, the increase in trip generation brought about by an increase in car ownership will diminish.

The income elasticities of total trip generation by income group are

- Less than \$7,500: 0.382
- \$7,500–\$12,499: 0.643
- \$12,500–\$22,499: 0.485
- \$22,500 or more: 0.473
- Total Sample: 0.538

In this case, it is noted that there is a decreasing trend in elasticities, except for the very first category of low-income households. The decreasing trend seen for the latter three groups may be explained in exactly the same way as was done in the case of car ownership. The low elasticity seen for the first category is also explicable. In the lowest income group, it is conceivable that households have not yet reached a state where increases in income would yield disposable income sufficient to permit long-distance travel. Instead, it is likely that households in this category would utilize extra income to

first pay for other necessities and comforts of life and indulge in long-distance travel only if and when they enter the second or higher income groups.

The car ownership elasticities of recreation/vacation trip generation by income group are

- Less than \$7,500: 0.268
- \$7,500–\$12,499: 0.153
- \$12,500–\$22,499: 0.094
- \$22,500 or more: 0.154
- Total Sample: 0.148

As in the case of total trip generation, a decreasing trend is seen for the first three income groups. However, in this case an increase in elasticity is seen for the highest income group. While the decrease in elasticity for the first three groups may be explained in the same way as was done for total trip generation, the increase seen in the last group is not immediately explicable.

The income elasticities of recreation/vacation trip generation by income group are

- Less than \$7,500: 0.387
- \$7,500–\$12,499: 0.496
- \$12,500–\$22,499: 0.490
- \$22,500 or more: 0.447
- Total Sample: 0.475

The trend seen here is similar to that seen in the case of total trip generation, except that the trend is more gradual. The lowest income group shows the lowest elasticity, whereas the other three groups exhibit a decreasing trend.

In summary, it may be concluded that substantial differences in trip generation behavior exist between the different income groups. It appears that the higher income groups already indulge in significant levels of long-distance trip generation and are possibly more limited by time and other constraints than by car ownership and income. That is why the trip generation elasticities decrease with rising income. The lowest income group shows the highest car ownership elasticity, indicating that the increased availability of an automobile would enhance their long-distance trip generation. On the other hand, a nominal increase in income would not be able to make a sufficient impact on their ability to undertake long-distance travel; hence they show the lowest income elasticity when compared with other income groups.

CONCLUSIONS

This paper analyzed long-distance travel behavior in considerable detail for two key market segments that have been receiving considerable attention in the recent past, namely, the elderly and the low income. Using the 1995 ATS that collected detailed information about long-distance trips undertaken in a 12-month period, various aspects of long-distance travel behavior were analyzed for these market segments and compared with the general population. The trip characteristics analyzed included trip frequency, trip purpose, trip mode, trip distance, trip duration, and travel party size. The analysis

included the estimation of long-distance trip generation models using linear regression methods for different market segments. This facilitated a comparison of car ownership and income elasticities of long-distance trip generation. Some of the main findings and unanswered questions are highlighted here:

Age-Based Analysis

- There is a decline in trip generation with age, with the greatest decrease occurring in the 75 or over age group; this group is also associated with the lowest household income and car ownership levels.
 - The elderly are significantly more dependent on the bus mode than the rest of the population. Also, the auto mode share is found to diminish significantly at the 75 or over age group.
 - Recreation/vacation trip generation decreases dramatically with the onset of the age of 75 or over. Whereas the other age groups made more than one recreational trip per year, this older elderly age group made just a little more than one-half of a trip per year (on average).
 - Interestingly, both the average one-way trip distance and overall trip duration were found to increase with age; the older elderly 75 years or over depicted the highest average values for these variables.
 - In general, both income and car ownership elasticities of long-distance trip generation are found to increase with age, but only until the onset of old age. Elasticities drop especially the age group of 75 or over indicating that physical and other limitations may be playing a role in inhibiting long-distance travel even if car ownership and income were to increase.

Income-Based Analysis

- There is an increase in long-distance trip generation with income; the trip generation rate almost triples when one transitions from the very low-income group to a very high-income group. Whereas 46 percent of the lowest income group households made zero long-distance trips, just 17 percent of the highest income group did so.
 - The lower income groups were much more likely to travel by road (either auto or bus) when compared to other income groups; the share of air travel steadily increased with rising income levels.
 - As expected, higher income levels were associated with higher percentages of business trip engagement possibly due to the employment status of the household members. The share of recreation/vacation trips was rather similar across the groups; however, the absolute number of recreation/vacation trips increased with income. Interestingly, the shares of personal business and social visit trips decrease with increasing income level. More than 50 percent of all trips for the lowest income group were either personal business or social visits; the corresponding percent for the highest income group was only 33 percent.
 - Coupled with the increased usage of air transportation as income rises, the average one-way trip length was also found to increase significantly with income. On the

other hand, no substantial differences were noticeable with respect to overall trip duration.

- In general, car ownership elasticities of long-distance trip generation decreased with increasing income, indicating that car availability had the greatest impact for the lower income groups that traditionally have lower car ownership levels. For the higher income groups, car ownership plays a diminishing role.
- Similarly, income elasticities of long-distance trip generation were also found to decrease with increasing income; however, the lowest income group depicted the lowest income elasticity of trip generation. This is possibly because a nominal increase in income is not sufficient for households in the lowest income group to undertake long-distance travel that tends to be resource-consuming.

Overall, then, it can be seen that both the elderly and the low income have significantly lower long-distance mobility when compared to other segments of the population. The findings related to the elderly are very significant and important in the context of the aging of the U.S. population over the next several decades. Similarly, the findings related to the lower income groups are significant in the context of providing access to opportunities outside their immediate vicinity.

The 1995 ATS is a very rich database that provides detailed personal and household demographic and long-distance travel information. There are many aspects of the database that have not been analyzed within the scope of this paper. Future analyses utilizing this data set will undoubtedly reveal long-distance travel trends valuable in a policy-making context.

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