# Trends and Determinants of Multimodal Travel in the USA

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16. Abstract

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According to our analysis, over 70% of Americans walk, bike, or use public transport during the week. This includes two-thirds of drivers who additionally report walking, cycling, or riding public transportation during the week. The share of travelers who are monomodal drivers decreased between 2001 and 2009, while shares for monomodal and multimodal greens increased. Walking is the dominant green mode for most Americans. In addition, the intensity of multimodality seems to be increasing, as multimodal drivers are making more trips by green modes.

A multivariable regression finds that multimodal drivers, monomodal greens, and multimodal greens are more likely than monomodal drivers to be male and younger, have higher education levels, own fewer cars, and live at higher population densities and in areas with rail access. Additionally, multimodal drivers are more likely white, while multimodal greens are more likely minorities. Individuals in households with children are less likely monomodal or multimodal greens than monomodal drivers. Individuals in the highest income quartile are more likely multimodal—as drivers or users of green modes—while individuals in the lowest income group are less likely multimodal drivers and more likely monomodal greens. Individuals with a driver's license are less likely multimodal or monomodal greens. Increased understanding of multimodality helps identify target groups for policies aimed at increasing walking, cycling and public transport use across the U.S.


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# Trends and Determinants of Multimodal Travel in the USA

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Table of Contents

## Abstract

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According to our analysis, over 70% of Americans walk, bike, or use public transport during the week. This includes two-thirds of drivers who additionally report walking, cycling, or riding public transportation during the week. The share of travelers who are monomodal drivers decreased between 2001 and 2009, while shares for monomodal and multimodal greens increased. Walking is the dominant green mode for most Americans. In addition, the intensity of multimodality seems to be increasing, as multimodal drivers are making more trips by green modes.

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## Executive Summary

This report analyzes trends and determinants of multimodal individual travel, defined as the use of more than one mode of transportation during a tour, day, or week, in the U.S. as well as the South Atlantic Census Division (Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia) and the Commonwealth of Virginia. The report focuses on multimodality during a week, but also highlights multimodal travel behavior during a travel day and a tour. The report primarily utilizes four modality groups to analyze multimodality at the tour, day, and week levels: (1) *monomodal car users* who drive for all trips; (2) *multimodal car users* who drive and also use at least one non-automobile mode; (3) *monomodal green users* who rely exclusively on one non-automobile mode (e.g. walking, cycling, or riding public transport); and (4) *multimodal green users* who combine different non-automobile modes.

The report is divided into four parts. The first part introduces the concept of multimodality and discusses its relevance as an emerging topic for transportation researchers. Next, the report provides an overview of recent multimodality literature, including discussion of key multimodality studies published since 2005. To date, the study of multimodality in the U.S. has been limited, and this is the first research effort to assess multimodality in the U.S. using a nationally representative sample. The next section provides an overview of the data sources for the analysis, which include the household, person, daily trip, and tour files of the 2001 and 2009 National Household Travel Surveys. The final section identifies trends of multimodality in the U.S., and provides bivariate tabulations and multivariable logistic regression analyses to assess determinants of multimodal travel and profiles of multimodal Americans. Increased understanding of multimodality helps identify target groups for policies aimed at increasing walking, cycling and public transport use across the U.S.

**Key Findings:**

- Our analysis reveals that travel by individuals in the USA is more varied than trip-based analysis suggests. Almost two-thirds of Americans drive and take at least one trip by foot, bicycle, or public transportation over the course of a week. Additionally, about 7% of Americans do not use a car at all during a typical week and rely solely on walking, cycling, or public transport. Further the analysis shows that about one in four American drivers make at least seven trips by walking, cycling, or public transportation during a typical week. This finding is important for transportation planners and policy makers, because providing infrastructure for walking, cycling, and public transportation affects a larger share of the population than suggested by the 13% of trips by foot, bicycle, and public transport found in trip-based analysis.
- An analysis of trends between 2001 and 2009 shows that the population share of monomodal weekly drivers declined slightly from 29.4% to 28.0%. The share of those exclusively relying on green modes rose from 4.9% to 7.1%. Multimodal car use, measured as driving and use of at least one other mode of transport during the week, remained stable between the two surveys at about 65% of the population. However, among multimodal car users, those making 4, 5, 6, and 7 trips by other means of transport displayed the strongest increases between the two years (about +2 percentage points for

each group). This suggests that multimodal drivers increased the intensity of their multimodal behavior—using other modes more often.

- In both years walking was the dominant green mode used by multimodal drivers, monomodal greens, and multimodal greens. In 2009, 79.8% of weekly multimodal drivers reported walking as their only other mode of transport (other than driving). Similarly, walking was the only mode used for 90.8% of monomodal greens. Additionally, only 1.1% of multimodal greens reported no walking.
- A series of multivariable binomial logistic regressions estimate the relationship between demographic, socio-economic, and land-use variables and a respondent’s likelihood to fall into the multimodal driver, monomodal green, or multimodal green modality group compared to being a monomodal diver. One of the key findings from the multiple regression analysis is that similar factors distinguish monomodal drivers from multimodal drivers, monomodal green users, and multimodal green users. Compared to monomodal drivers, multimodal drivers, monomodal greens, and multimodal greens are more likely to be male and younger, have higher education levels, own fewer cars, and live at higher population densities and in areas with rail access.
- There are also important differences among those three modality groups when compared to monomodal drivers. Multimodal drivers are more likely white, while multimodal greens are more likely minorities. Individuals in households with children are less likely monomodal or multimodal greens than monomodal drivers. Individuals in the highest income quartile are more likely multimodal—as drivers or users of green modes—while individuals in the lowest income group are less likely multimodal drivers and more likely monomodal greens. Individuals with a driver’s license are less likely multimodal or monomodal greens.
- Our comparison of results for the travel day and week show that longer time periods of observation capture more variability in personal travel. Thus, collection of multiday data is important. The analysis shows that the NHTS can be used for the analysis of multimodality. However, better data about travel behavior during a week are needed. The NHTS data rely on three questions asking about walking, cycling, and public transportation use in the past. Other surveys geared at capturing multimodal travel rely on week-long travel surveys. Similar to the one day travel diaries of the NHTS, these surveys use trip diaries for the entire week. Better data about weekly travel including more information about car use, trip purpose, and motivations for travel could improve information about weekly variability of travel and provide a more accurate picture of multimodality.

## 1. Introduction

In the U.S., over 90% of households own at least one automobile, the vast majority of adults (89%) are licensed drivers, and 86% of trips are made by car (USCB 2009; USDOT 2009). Reliance on the automobile for most trips is associated with traffic congestion, oil dependence, high financial costs for households and the public sector, air and noise pollution, public health problems, decreased quality of life, and lack of accessibility for poor and carless households (Forsyth, Krizek et al. 2009; USDOT 2010; Lucas 2011). To combat these externalities, policymakers at all levels of government seek effective ways to reduce reliance on automobiles and increase use of public transportation, walking, and cycling—the so-called green modes.

Most studies indicate that individuals tend to change their travel behavior slowly. Because car ownership and use is high in the U.S., it is likely that even those Americans who are willing and able to switch to walking, cycling, or public transport for some trips will continue to drive. However, little research has focused on American drivers who use green modes of transport for some trips—the so called 'multimodal car users'.

Multimodality is gaining recognition as a potential strategy for reducing automobile reliance and increasing the efficiency and sustainability of transportation systems (Nobis 2007; Chlond 2012; Kuhnimhof, Wirtz et al. 2012). For example, multimodality has been featured in IBM's Smart Cities Challenge as a key to the creation of a responsive, dynamic, and intelligent mobility system in Nice, France (IBM 2011). TRB (2002) has highlighted multimodality as a central component of "smart growth" initiatives. In addition, multimodality has been discussed in relation to transport system reliability and as a way to make transport systems more resilient (Rietveld 2000; Rietveld, Bruinsma et al. 2001; Brons and Rietveld 2010; IBM 2011). Moreover, support for consideration of multimodality in travel demand forecast models has grown with increasing recognition of the lack of attention historically given to non-motorized modes in these models (Rietveld 2000; Forsyth, Krizek et al. 2009; Clifton and Muhs 2012; Litman 2012).

Based on two National Household Travel Surveys, the NHTS 2001 and 2009, this report analyzes travel behavior of multimodal car users in the U.S, South Atlantic Census Division (comprised of the following states: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia), and the Commonwealth of Virginia. The report focuses on multimodality during a week, but also highlights multimodal travel behavior during a travel day and a tour (or chained trip). For week, day, and tour levels, the study compares socio-economic and demographic profiles of (1) *monomodal car users* who drive for all trips with (2) *multimodal car users* who drive and also use at least one non-automobile mode, (3) *monomodal green users* who rely exclusively on one non-automobile mode (e.g. walking, cycling, or riding public transport), and (4) *multimodal green users* who combine different non-automobile modes.

The goals of this report are to provide an overview of the recent multimodality literature, and to identify trends and determinants of multimodality in the U.S., as well as the South Atlantic and Virginia. The analysis focuses on intrapersonal variability of mode choice over time and thus goes beyond typical analyses of travel behavior that focus on mode choice for only one trip. A better understanding of multimodality will help identify target groups for policies aimed at increasing walking, cycling and public transport use. First, it will help identify drivers who already use other means of transport. This can help shape policies to encourage current monomodal car users to also use other modes for some trips. Second, drivers already using green modes, at least occasionally, could be targeted to increase their walking, cycling, and use of public transport. Policies to support even occasional use of the green modes may have significant impacts on long-term travel behavior, because even infrequent use of a mode may familiarize a traveler enough to enable increased use of that mode of transport over time (Oram and Stark 1996; Kuhnimhof, Chlond et al. 2006; Diana and Mokhtarian 2009; Chlond 2012).

Key goals and research questions are:

(1) What are the levels of multimodality and monomodality in the U.S., South Atlantic, and Virginia? How does multimodality vary across trip-based, travel day, and weekly data?
(2) Who are the multimodal car users and how do they compare to monomodal car users, as well as individuals who solely rely on one or more of the green modes? (This analysis is disaggregated by gender, race/ethnicity, age, education level, employment status, household life cycle, income, car ownership, licensure, population density, and access to rail);
(3) What are trends in multimodality in the U.S., South Atlantic, and Virginia between 2001 and 2009?

## 2. Overview of Multimodality Concept, Data, and Key Findings

### *2.1 Concept and Terminology*

Multimodality is an emerging field of study, but it is an extension of a larger body of research on intrapersonal variability of travel behavior. There are four main dimensions of intrapersonal variability that have been studied: 1) temporal; 2) spatial; 3) purpose; and 4) modal. The 'temporal' dimension refers to variability in timing and frequency of travel. This includes, for example, studies about intrapersonal variability in trip duration, trip start times, or frequency of trip-making during a specific time frame (e.g. a week). The 'spatial' dimension captures variability in geographic location and extent of travel. This includes, for example, studies on variability in route choice for different trips from the same origin to the same destination. The 'purpose' dimension analyzes variability in travel purposes or activities. This includes, for example, variability in trip purposes during a week. Last, the 'modal' dimension focuses on variability in means of transportation over time. This dimension captures the use of different modes of transportation during a week, day, or tour. Studies of intrapersonal variability of travel behavior suggest that travel is more varied – temporally, spatially, modally, and by purpose – than otherwise captured by the more common analyses focusing on individual trips, such as the commute (Schonfelder and Axhausen 2010; USCB 2010).

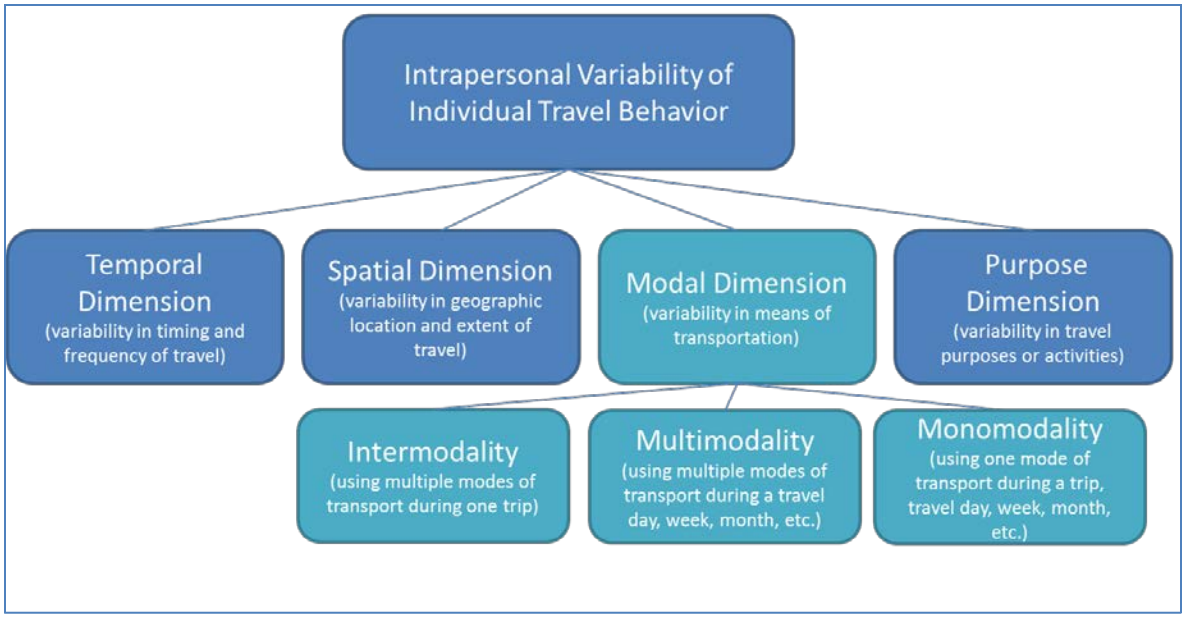


**Figure 1.** Dimensions of Intrapersonal Variability of Individual Travel Behavior and Multimodality. Note: authors' own graphic based on review of literature. (Schlich and Axhausen 2003; Nobis 2007; Block-Schachter 2009; Diana and Mokhtarian 2009; Schonfelder and Axhausen 2010; Vij, Carrel et al. 2011; Chlond 2012; Kuhnimhof, Buehler et al. 2012).

Terminology and definitions of multimodality vary across studies (Block-Schachter 2009). In general, multimodality is defined as the use of at least two modes of transport during a trip, day, week, or longer time period. Monomodality is defined as the use of a single mode during a specified time period. Some studies incorporate intensity measures to further distinguish multi- and monomodality. These studies identify thresholds based on the percentage of trips made by a single mode. For example, one study defined individuals as having a 'monomodal tendency' if they used a single mode for over 70% of all trips (Nobis 2007). Another study identified a 'monomodal car' group based on travelers who made over 90% of tours by car, while a 'multimodal green' group was identified based on those who used a car for fewer than 10% of tours (Vij, Carrel et al. 2011).

Studies further distinguish groups of multi- and monomodal individuals based on the modes of transport used. For example, multimodality is subdivided into groups based on the combination of modes of transport used (e.g. car and bicycle; car and public transport; bicycle and public transport; etc.). Monomodality is based on exclusive travel[1] either by car, foot, bicycle, or public transport. Some studies of multimodality focus on the car, public transport, and bicycling, and exclude 'walking' as a mode of transport (Kuhnimhof, Chlond et al. 2006; Nobis 2007).

The term intermodality is used when referring to the use of multiple modes of transport within one trip. For example, public transport trips are often intermodal trips, because individuals typically access public transport stops or stations by foot, bicycle, automobile, or another public transport service. Intermodality can also be used to describe the use of multiple modes of transport during trip-chaining—defined as stopping between the origin and destination of a trip.

[1] or a heavy tendency toward

This can include access trips to public transport by foot, bicycle, or car (Nobis 2007; Clifton and Muhs 2012).

A body of literature developed by Piet Rietveld and based on data from The Netherlands has focused on intermodality relating to multiple modes in public transport trip chains (Keijer and Rietveld 2000; Rietveld 2000; Rietveld 2000; Rietveld, Bruinsma et al. 2001; Givoni and Rietveld 2007; Brons, Givoni et al. 2009; Debrezion, Pels et al. 2009). These studies have focused on features of access modes relating to trip chain reliability and traveler satisfaction, as well as the role of non-motorized modes in trip chains. They highlight that multimodal trips often entail greater travel time and uncertainty related to potential delays, as well as reduced comfort, and outline strategies to increase multimodal traveler satisfaction, such as improved facilities and physical planning around railway stations. Rietveld's research has contributed to an increased appreciation of the door-to-door experience of a multimodal traveler, and especially the importance of access modes to customer satisfaction with public transport trip chains.

## 2.2 Data Sources

Three main types of data are used in studies of multimodality: (1) multi-week travel surveys; (2) weeklong travel surveys; and (3) one-day travel surveys with questions about travel during longer time periods. As the time period of observation increases, the share of the population exhibiting multimodal behavior increases (Kuhnimhof, Chlond et al. 2006; Nobis 2007). However, most studies suggest that survey periods of one week tend to capture most of the variability in everyday habitual travel behavior (Kuhnimhof, Chlond et al. 2006). In those studies, a week is described as a natural increment for the cyclical recurrence of many day-to-day activities (Nobis 2007; Block-Schachter 2009). Longer multi-week survey periods additionally capture occasional travel behavior (Schlich and Axhausen 2003).

The main drawback of multi-week surveys is that they tend to have comparatively small sample sizes. For example, the six week MobiDrive data set is based on a six-week travel diary of 361 individuals in the German cities of Karlsruhe and Halle/Salle in the fall of 1999 (Axhausen, Zimmermann et al. 2002). Seven-day surveys, such as the German Mobility Panel ("MOP"), more easily generate larger sample sizes (~1,800 individuals). However, compared to single-day travel surveys, multiday data collection typically requires greater resources, faces greater difficulty in recruiting participants, and suffers from a higher rate of participant drop out (fatigue) (Schonfelder and Axhausen 2010). As a result, samples for multiday travel surveys tend to be small (~350 to 1,800 participants) when compared to single-day travel surveys that often include tens of thousands of respondents. One-day travel diaries are more easily administered to large samples, and generate representative cross-sectional data.

Multimodality can also be studied using data derived from single-day surveys that additionally contain questions about habitual or occasional mode use. For example, two key studies of multimodality rely in part on the German National Household Travel Survey, Mobilität in Deutschland ("MiD") (Kuhnimhof, Chlond et al. 2006; Nobis 2007). MiD is based on a single-day travel diary. The survey includes questions about how often different modes of transport are used during a typical week. A limitation of this type of data is that reporting on travel behavior during the prior week is more prone to recall error, particularly for short trips, than data collected from travel diaries for a specific travel day.

### *2.3 Key Findings on Multimodalism*

Empirical study of intrapersonal variability of travel behavior has been limited by the scarcity of information on multiday travel, though increasing recognition of variability of travel over time has led to greater support for multiday data collection (Kuhnimhof 2009; Schonfelder and Axhausen 2010). A systematic overview of the key studies focusing on multimodality published since 2005 is provided in Table 1. Most national level studies focus on Germany or The Netherlands. Other studies only capture a specific urban area or region, such as the San Francisco Bay Area (Diana and Mokhtarian 2009) or the Massachusetts Institute of Technology university community (Block-Schachter 2009). The table provides the author names and year of publication, geographic level and area of analysis, data sources and methods, and a summary of key findings regarding the determinants of multimodality. The following section provides a more detailed description of the individual studies and findings.

| Author(s), Year | Level of Analysis (Study | Main Data Source(s) | Main Method(s) | Factors Significantly Associated with Multimodality (Direction of Impact on Multimodality) |
|---|---|---|---|---|
| Kuhnimhof et al 2012 | National (Germany) | Kontiv 1976; German Mobility Panel (MOP) for 1995-2009; German Income and Expenditure Survey for 1998 and 2008 | Descriptive Quantitative Analysis, Multivariable Regression Analysis | age (young +), auto restraint measures (+), awareness of environmental impacts (+), car availability (-), driver's license (-), educational attainment (+), gender (women +), urban residence (+) |
| Chlond 2012 | Sub-National (Karlsruhe, Germany) | City of Karlsruhe Office of Statistics for 1980-2005; other City of Karlsruhe secondary sources | Case Study Analysis | age (young +), auto restraint measures (+), awareness of environmental impacts (+), car availability (-), urban residence (+) |
| Vij et al 2011 | Sub-National (Karlsruhe and Halle/Salle, Germany) | Survey of Karlsruhe and Halle/Salle residents based on six-week data collection in 1999 (MobiDrive) | Descriptive Quantitative Analysis, Multivariable Regression Analysis | bike (+) and car (-) availability, gender (women +), presence of children (-/+), small household size (+) |
| Brons and Rietveld 2010 | National (The Netherlands) | Rail Use Data from Dutch Railways (NS), Rail Performance Data from ProRail, Car Use Data from CBS-Statline, Additional Station, Postcode Area and Timetable Data From Various Sources, for 2004-2005 | Descriptive Quantitative Analysis, Multivariable Regression Analysis | travel time unreliability (-) |
| Diana/Mokhtarian 2009 | Sub-National (San Francisco Bay Area, CA, and France) | Survey of San Francisco Bay Area residents in 1998; Survey of employees of the French National Institute for Transport and Safety Research in 2004 | Cluster Analysis | car availability (-), educational attainment (+) |
| Block-Schachter 2009 | Sub-National (Massachussetts Institute of Technology university community) | Surveys of MIT students, faculty, and staff based on weeklong data collection in 2004, 2006, and 2008 | Descriptive Quantitative Analysis | car availability (-), gender (~), longer stay in current residence (-), neighbors with multimodal patterns (+), proximity to public transport (+), urban residence (+) |
| Brons and Rietveld 2009 | National (The Netherlands) | Survey by Dutch Railways (NS) on Customer Satisafaction for 2001-2005 | Descriptive Quantitative Analysis, Principal Component Analysis | quality of station access and transfer (+) |
| Brons et al 2009 | National (The Netherlands) | Survey by Dutch Railways (NS) on Customer Satisafaction | Descriptive Quantitative Analysis, Principal Component Analysis, Multivariable Regression Analysis | quality and level of station accessibility (+) |
| Nobis 2007 | National (Germany) | German Mobility Panel (MOP) for 1999-2004; Mobilitat in Deutschland (MiD) for 2002 | Descriptive Quantitative Analysis, Multivariable Regression Analysis | age (young +, old +), car availability (-), driver's license (-), employed (-), small household size (+), urban residence (+) |
| Givoni and Rietveld 2007 | National (The Netherlands) | Survey by Dutch Railways (NS) on Customer Satisfaction in 2005 | Descriptive Quantitative Analysis, Multivariable Regression Analysis | station accessibility improvements (+) |
| Kuhnimhof et al 2006 | National (Germany) | German Mobility Panel (MOP) for 1996-2003; Mobilitat in Deutschland (MiD) for 2002 | Descriptive Quantitative Analysis, Multivariable Regression Analysis | age (young +, old+), car availability (-), commute mode (public transport +), driver's license (-), educational attainment (+), small household size (+), urban residence (+) |

**Table 1.** Selected Multimodality Studies Published Since 2005.

Kuhnimhof et al (2006) evaluate weekly travel in Germany using the German Mobility Panel with weekly travel data. They divide travel into 4 segments based on trip purpose and distance from home: 1) regional and long-distance travel; 2) commuting; 3) walking distance from home; and 4) everyday activity beyond walking distance. Using these categories, they analyze weekly trip frequency for walking, cycling, car use, and public transport ridership for individuals. The analysis finds that multimodal individuals tend to use cars several times per week. Multimodals also use public transport, but less regularly and for a more limited range of trip purposes, such as commuting. Results suggest multimodal individuals tend to live in urban areas, with better access to public transport service, and have less convenient car parking and car availability. In addition, individuals in smaller households without children and with other public transport commuters are more likely multimodal.

Nobis (2007) provides a comprehensive overview of multimodality using the German Mobility Panel and the German National Household Travel Survey. First, multimodals are identified as individuals who use more than one mode of transport used during a week. Resulting mono-and multimodal groups include 1) monomodal car; 2) monomodal bike; 3) monomodal public transport; 4) multimodal car/bike; 5) multimodal car/public transport; 6) multimodal bike/public transport; 7) multimodal car/bike/public transport. A plurality of the sample is in the monomodal car user group, though the majority of respondents belong to one of the multimodal groups.

Next, Nobis generates an intensity measure to more clearly isolate distinct groups. Individuals are considered to have a ‘monomodal tendency’ if they rely on the same mode of transport for more than 70% of trips. Taking this intensity measure into account, only about one-fifth of the population is considered multimodal. A multivariable logistic regression compares individuals in each of the multimodal groups to monomodal car users. Results suggest multimodal individuals tend to live in urban environments, have less car availability, and are members of smaller households without children. Middle age (36-65 years old) is characterized by intensive car use, but younger and older populations tend to be more multimodal.

Vij et al (2011) evaluate multimodality using the 6 week MobiDrive data set. Like Nobis (2007), they incorporate an intensity measure to distinguish mobility groups. Individuals are considered quasi-monomodal car users if 90% or more tours are by car, while individuals are considered quasi-monomodal bike/walk/public transport users if 90% or more tours are exclusively by one of those modes. Likewise, multimodal individuals who make fewer than 10% of all tours by car are considered “multimodal green” while multimodal individuals who make between 10% and 90% of tours by car are considered “multimodal all.” With these thresholds, the authors define five groups: 1) quasi-monomodal auto; 2) quasi-monomodal bike/walk; 3) quasi-monomodal public transport; 4) multimodal green (mainly bike/walk/public transport); 5) multimodal all (bike/walk/public transport/car).

Results of their multivariable estimation suggest women and singles are more likely to be multimodal, while having children reduces the likelihood of being multimodal green but increases the likelihood of being multimodal all. Car availability reduces the likelihood of being multimodal green while bicycle availability increases the likelihood of belonging to that group.

Chlond (2012) provides an overview of the multimodality concept and a case study of multimodality in the City of Karlsruhe, Germany. He highlights ‘push’ and ‘pull’ measures to change mode choice, and argues that urban residence, young age, auto restraint measures, and environmental awareness are positively associated with multimodality.

Kuhnimhof et al (2012) evaluate travel trends for young adults in Germany using the MOP and MiD. Results of their multivariable regression suggest driver's licensure and car availability are negatively associated with multimodality while residence in urban areas, young age, being female, educational attainment, auto restraint measures, and environmental awareness are positively associated with multimodality. A follow-up study (Kuhnimhof, Wirtz et al. 2012) of car use of young Germans highlights the increasing share of young drivers who also use other modes.

### 2.3.1 Studies about Multimodality in the U.S.

Only a few studies have analyzed multimodality in cities or regions of the U.S. For example, Block-Schachter (2009) focuses on multimodality and commuting based on data from the Massachusetts Institute of Technology university community. He finds that car availability and a longer tenure in one's current residence are negatively associated with multimodality. Proximity to public transport, multimodal neighbors, and urban residence are positively associated with multimodality.

Diana and Mokhtarian (2009) compare multimodality in the San Francisco Bay Area and among employees of the French National Institute for Transport and Safety Research (located in Paris, Lyon, Lille, and Marseille). The authors employ a clustering analytical technique to identify levels of satisfaction related to current travel behavior and modal balance. Findings suggest car availability is negatively associated with multimodality while education is positively associated with multimodality.

Clifton and Muhs (2012) provide an overview of data sources and data availability for the analysis of intermodal travel. They focus on access and egress modes for getting to and from public transport stops and stations and not multimodality during a travel day or week.

In summary, studies of multimodality in the U.S. have relied on regional samples that are not representative for the country. No study has utilized a national dataset, such as the 2001 and 2009 National Household Travel Surveys (NHTS). Our analysis contributes to the multimodality literature by utilizing the NHTS data to identify determinants of multimodality in the U.S. We analyze weekly data, but also briefly introduce results from day and tour level data to capture three levels of multimodality. The studies discussed above have informed our definition of multimodality, variable selection, and method of analysis. For example, several studies highlighted car availability, the presence of children in the household, residential location, and age/life stage as important determinants of multimodality. The analysis presented below is most comparable to the previous studies incorporating the MiD, since both the NHTS and MiD surveys are based on one-day travel diaries and include questions about mode use over time. While our formulation of specific demographic, socioeconomic, and land use variables may vary from those used in prior multimodality studies, this study incorporates the key variables highlighted to date, including car availability and licensure, age, household size and life cycle status, gender, and education. In the analysis presented below, many of our results confirm prior findings, while others differ and shed light new light on multimodality in the American context.

## 3. Data Sources and Methods for This Study

### *3.1 NHTS 2001 and 2009 Overview*

Data for this analysis originate from the 2001 and 2009 National Household Travel Surveys (USDOT 2001; USDOT 2009). NHTS 2001 and 2009 have only minor differences and many similarities that render an analysis of trends over time meaningful. Table 2 compares the two travel surveys along several dimensions of potential variability. For both surveys households were contacted via random digit dialing of landline telephone numbers. Both surveys combined telephone interviews with single-day travel diaries to record trips of all household members during a randomly assigned travel day. Once the travel day passed, households were called to report their travel using the diary as a memory jogger. Both surveys also asked respondents about the number of trips by walking and cycling during the previous week, as well as public transport use during the last two months (USDOT 2001) or month (USDOT 2009).

The 2001 survey was conducted between March 2001 and April 2002, whereas the 2009 survey was conducted between March 2008 and April 2009. Responses were collected for all days of the year, including weekdays, weekends, and holidays. The final samples included 160,758 individuals living in 69,817 households making 642,292 daily trips for the 2001 survey, and 324,184 individuals living in 150,147 households making 1,167,321 daily trips for the 2009 survey.

| | NHTS 2001 and 2009 (USA) |
|---|---|
| ***Collection Rhythm*** | Nationwide Personal Transportation Survey (NPTS) '69, '77, '83, '90, '95<br>National Household Travel Survey (NHTS) '01, '09 |
| ***Survey Period*** | 14 months<br>03/2001 - 04/2002 \| 03/2008-04/2009 |
| ***Sample Size*** *Households* | 69,817 (2001) \| 150,147 (2009) |
| *Individuals* | 162,758 (2001) \| 304,184 (2009) |
| ***Survey Method*** | CATI (100% in 2001 and 2009) |
| ***Target Population*** | civilian population |
| ***Eligibility of Household Members*** | adults and all children in 2001<br>adults and children 5 and older in 2009 |
| ***Sampling Technique*** | stratified random sample |
| ***Data Collection Period per Respondent*** | 1 day travel diary |
| ***Response Rates (% of households)*** | 41% (2001) \| 20% (2009) |
| ***Inclusion Criterion for Households*** | at least 50% of household members over 18 years old responding |
| ***Weights*** | selection reciprocal, non-response, household size, weekday, month, regional charactertistics; trimming of large weights |
| ***Data Level*** | household, person, trip, car |
| ***Representative*** | for nation and individual Census regions and add-ons<br>(including state of Virginia for 2009) |
| ***Definition of Trips*** | from one address to another |
| ***Special Treatment of Walk and Bike Trips*** | round trips from and to the same address count as two trips; multiple prompts to report short walk and bike trips |
| ***Definition of Chained-Trip in Tour File*** | trips that are linked together (chained) between two anchored destinations (home, work, other) |
| ***Information About Travel Behavior Over Time*** | number of trips by walking and cycling during the last week; public transport use during the last two months (2001) or last month (2009) |
| *Sources: NHTS surveys.* | |

**Table 2.** Comparability of NHTS Travel Surveys 2001/2002 and 2008/2009. Source: (Buehler, Pucher et al. 2011).

The surveys used stratified sampling of all states, Census regions, and metropolitan areas, such that each survey is representative of the U.S. A complex weighting procedure accounts for non-response as well as the exclusion of households without landline telephone service. Our analysis applies the 2001 and 2009 weights to ensure statistically representative estimates of multimodality for the U.S. as a whole and the South Atlantic Census Division. Nine states and metropolitan planning organizations (MPOs) participated in the Add-On program for the 2001 NHTS to generate representative samples at the state or metropolitan level. For the 2009 NHTS, over 20 states and MPOs participated in the Add-On program, including the Commonwealth of Virginia. Thus, our analysis of multimodality in Virginia is statistically representative for the year 2009 only.

### *3.2 Analyzing Multimodality with the NHTS*

To evaluate multimodality in the U.S., we used data from the tour, daily trip, and person data files of the 2001 and 2009 NHTS surveys. Table 3 presents the definitions of our modality groups at the tour, day, and week[2] levels. At each level we distinguish four groups: (1)

[2] See discussion in 3.2.3 regarding weekly car travel.

monomodal car users who drove for all trips; (2) multimodal car users who drove and used at least one other mode of transport; (3) monomodal green users who only relied on either walking, cycling, or public transport; and (4) multimodal green users who did not drive and used a combination of at least two alternative modes to driving. As for most analyses of multimodality, the main focus of our paper is on the weekly data, but we initially also provide information about multimodality during tours and days.

| **Modality Group** | **Tour** | **Day** | **Week** |
|---|---|---|---|
| Monomodal Car Users | All trips in a tour by car. | All daily trips by car. | All daily trips by car and no weekly trips by walking, biking, or public transport. |
| Multimodal Car Users | At least one trip in a tour by car and at least one trip in the same tour by bicycle, foot, or public. transport. | At least one daily trip by car and at least one trip by walking, biking, or public transport. | At least one daily trip by car and at least one weekly trip by walking, biking, or public. transport. |
| Monomodal Green Users | Exclusive use of either bicycle, foot, or public transport for all trips of a tour. | Exclusive use of either bicycle, foot, or public transport during entire day. | Exclusive use of bicycle, foot, or public transport during entire week. |
| Multimodal Green Users | Trips in a tour by a mix of bicycle, foot, and/or public transport (but not by car). | Daily trips by a mix of bicycle, foot, and/or public transport (but not by car). | Weekly trips by a mix of bicycle, foot, and/or public transport (but not by car). |

**Table 3.** Overview of Definitions of Modality Groups for Tours, Days, and Weeks.

### 3.2.1 Tour Data

For our analysis of intermodality at the tour level we use a special NHTS dataset of tours provided by USDOT. In compiling this dataset USDOT defined a tour as "trips that are linked together (chained) between two anchored destinations (home, work, and other)" (USDOT 2009). A "tour is a series of trips between two anchors" (USDOT 2009) where the stop time (dwell time) at intermediate destinations is 30 minutes or less. In 2001 and 2009 about 18% of all trips were part of a tour. For this analysis, intermodal tours are those that involve different modes of transport for trips within a tour. For example, walking to a neighbor's house and then jointly driving to work would constitute an intermodal tour. Definitions of 'modality' groups at the tour level can be found in Table 3.

### 3.2.2 Data about the Travel Day

Data about variability in mode choice during the day originate from the NHTS trip file based on the single-day travel diary. Individuals recorded all trips made during a randomly assigned travel day. During the data collection interview, NHTS provided multiple prompts reminding respondents to report all walk and bike trips. Trips were defined as travel between two addresses, so walk trips at one address (e.g. to the mailbox or a parked car, within shopping malls) were excluded, but short trips between addresses (e.g. in the local neighborhood) were included. The exceptions to that trip definition were walk and bike trips that originated and ended at home, without any other stop along the way, such as some recreational or exercise trips (e.g., ‘‘going for a walk''). Such trips were split into two trips, one defined as the ''outgoing trip'' to the farthest distance from home, and the other trip defined as the ''in-bound trip'' back home. Definitions of the 'modality' groups at the day level can be found in Table 3.

#### 3.2.3 Weekly Travel Data

In addition to the 24-hour trip data, we analyzed the weekly data available in the NHTS person file with responses to separate questions about the number of trips made by walking and cycling during the previous week. Moreover, we estimated the use of public transport during the last week based on a variable capturing public transport use in the previous two months provided in the 2001 survey and public transport use in the previous month recorded in the 2009 survey[3]. Neither survey included questions about car use in the previous week or month. Our data for car use originate from the single-day travel diary and a question asking about the usual mode of transport for the commute to work last week. Thus, our definition of 'monomodal and multimodal greens' is limited to those who did not commute by car during the last week, did not drive during the travel day, and exclusively walked, cycled, and/or rode public transport during the travel day and the week. This likely overestimates the group of 'greens' because we do not have full information about car travel during the week—other than the usual commute. Definitions of weekly 'modality' groups at the week level can be found in Table 3.

### *3.3 Limitations*

This is the first attempt to utilize the 2001 and 2009 NHTS data sets for an analysis of multimodality. The two surveys limit our analysis of multimodality in several ways. First, the datasets provide detailed information about all modes of transport used during one travel day. Weekly data rely on self-reported trips during the past week for walking and cycling and during the past 1-2 months for public transport; and are likely not as reliable as information from travel diaries for the travel day. Second and as explained above, there was no information about car use during the week (other than the mode for the usual commute and driving during the travel day). Thus, the weekly data likely overestimate the share of those who do not drive. Third, we excluded individuals who did not report any trips for the assigned travel day. Even if they reported walk, bike, or public transport trips during the week, missing information about their car use during the travel day inhibited accurately categorizing them into one of the modality groups. Last, the 2009 survey only asked respondents older than 15 about travel during the last week. Thus, our analysis excludes children 15 years of age and younger. Many analyses of multimodality exclude children who cannot drive, because children legally have to rely on others (often their parents) if they wish to travel by automobile (Kuhnimhof, Chlond et al. 2006; Vij, Carrel et al. 2011). Only including individuals 16 and older (driving age in most U.S. states) focuses our analysis on those who can obtain a driver's license (or provisional driving permit) and legally drive a car.

The modality groups described above are the basis for the following analysis of multimodality. Trends and determinants of multimodality are evaluated using descriptive statistics as well as logistic regression analyses. The next section discusses aggregate trends of multimodality at tour,

[3] If our calculations yielded less than 1 public transport trip per week, individuals were classified as not weekly public transport users.

day, and week levels between 2001 and 2009. Then bivariate and multivariable logistic regression analyses evaluate a variety of demographic, socioeconomic, and land use variables as potential determinants of multimodality at the week level.

## 4. Mode Choice and Multimodality

The following analysis provides a detailed discussion of trends in multimodality across the U.S., the South Atlantic, and Virginia. To briefly summarize the highlights of similarities and differences across the three samples, trip rates as a whole as well as by car in particular fell across all three samples between 2001 and 2009. Nevertheless, while monomodal driving rates fell across the tour, day, and week levels for the U.S. and South Atlantic, they increased in Virginia at the day and week levels. Multimodal driving trends were less clear across the three samples, with some increases and some decreases for each sample and level of analysis. Monomodal greens increased across all three samples at each level of analysis (tour, day, week), while multimodal greens increased at each level only for the U.S. and the South Atlantic. Meanwhile, multimodal green rates actually declined at the day and week levels in Virginia between 2001 and 2009. Walking was the dominant green mode across the three samples for multimodal drivers, monomodal greens, and multimodal greens. In contrast to the U.S. as a whole, where a general trend toward greater intensity of multimodality was found, the South Atlantic and Virginia samples showed no clear trend toward increasing multimodality.

Both the bivariate and multivariable analyses presented below tend to find consistent effects of various demographic, socioeconomic, and land use characteristics across the three samples regarding the determinants of multimodality, at least in terms of the direction of the association, especially when focusing on the 2009 results. The strongest results across samples relate to household vehicles and age, though a number of other characteristics are significant as well.

Of note, as discussed above, the 2001 sample for Virginia is not representative of the state's population, since the Add-On sample was only conducted for Virginia in 2009. Thus, the results presented here for Virginia based on the 2001 sample should not be taken as representative or applied to the state's population. Nevertheless, they are included here for completeness.

### *4.1 Trip Level Analysis: Trends in Mode Choice*

In 2009, Americans of driving age (16+) made 86.0% of their daily trips by automobile. This is a decline of 3.2 percentage points compared to 2001 (see Table 4). The share of trips made by public transport, foot, and bicycle increased during the same time period. Walking witnessed the strongest increase from 7.8% to 10.1% of trips. The public transport and bicycle share of trips rose from 1.7% to 2.1% and from 0.5% to 0.7% respectively.

Overall trip making declined between the two survey periods from 4.81 to 4.52 trips per mobile person per day (Table 4). The car trip rate shrank by 0.40 trips per traveler per day. Public transport (+0.01), walking (+0.09), and cycling (+0.01) trip rates increased between 2001 and 2009. Trip making rates in Table 4 exclude those Americans who stayed at home during their assigned travel day (and reported no trips). Including those who stayed at home during the travel day would show a slightly stronger decline in trip making, because the share of Americans reporting ‘no trips’ during the travel day increased slightly from 11.8% in 2001 to 12.8% in 2009.

| | U.S. | | | |
|---|---|---|---|---|
| | 2001 | | 2009 | |
| | # of Trips | % of Trips | # of Trips | % of Trips |
| **Total** | 4.81 | 100.0% | 4.52 | 100.0% |
| **Car** | 4.29 | 89.2% | 3.89 | 86.0% |
| **Transit** | 0.08 | 1.7% | 0.09 | 2.1% |
| **Walk** | 0.37 | 7.8% | 0.46 | 10.1% |
| **Bike** | 0.02 | 0.5% | 0.03 | 0.7% |
| **Other** | 0.04 | 0.9% | 0.05 | 1.1% |

**Table 4.** Trend in Trip Rates and Shares of Trips by Mode of Transport in the U.S., 2001-2009.

Individuals of driving age in the South Atlantic made 88.0% of their daily trips by automobile in 2009, while in Virginia the percentage was 87.3%. This is a decline of 3.4 percentage points compared to 2001 for the South Atlantic, and a decline of 2.3 percentage points for Virginia. As with the U.S. as a whole, the share of trips made by public transport, walking, and cycling increased during the same time period in both geographic areas. In the South Atlantic, the share of trips by public transport and bike both increased by 0.2 percentage points, and the share of trips by walking increased by 2.5 percentage points. In Virginia, the share of trips made by public transport and by biking actually decreased 0.2 and 0.1 percentage points respectively, while walking increased 1.8 percentage points, resulting in a net increase of the overall share of trips by these modes.

As with the U.S. as a whole, overall trip making declined between the two periods in both the South Atlantic and the Virginia. The car trip rate decreased by 0.50 trips per traveler per day in the South Atlantic and by 0.40 in Virginia. Public transport had no change in the South Atlantic and decreased by 0.02 trips per traveler per day in Virginia, while walking increased by 0.10 trips per traveler per day in the South Atlantic and by 0.05 in Virginia and biking increased by 0.01 trips per traveler per day in the South Atlantic and decreased by 0.01 trips per traveler per day in Virginia.

| | South Atlantic | | | |
|---|---|---|---|---|
| | 2001 | | 2009 | |
| | # of Trips | % of Trips | # of Trips | % of Trips |
| **Total** | 4.80 | 100.0% | 4.43 | 100.0% |
| **Car** | 4.39 | 91.4% | 3.89 | 88.0% |
| **Transit** | 0.06 | 1.2% | 0.06 | 1.4% |
| **Walk** | 0.29 | 6.1% | 0.39 | 8.7% |
| **Bike** | 0.02 | 0.5% | 0.03 | 0.7% |
| **Other** | 0.04 | 0.8% | 0.06 | 1.3% |

**Table 5.** Trend in Trip Rates and Shares of Trips by Mode of Transport in the South Atlantic, 2001-2009.

| | Virginia | | | |
|---|---|---|---|---|
| | 2001 | | 2009 | |
| | # of Trips | % of Trips | # of Trips | % of Trips |
| **Total** | 4.78 | 100.0% | 4.40 | 100.0% |
| **Car** | 4.25 | 89.0% | 3.85 | 87.3% |
| **Transit** | 0.08 | 1.6% | 0.06 | 1.4% |
| **Walk** | 0.38 | 7.9% | 0.43 | 9.7% |
| **Bike** | 0.03 | 0.6% | 0.02 | 0.5% |
| **Other** | 0.04 | 0.9% | 0.05 | 1.1% |

**Table 6.** Trend in Trip Rates and Shares of Trips by Mode of Transport in Virginia, 2001-2009.

### *4.2 Trends in Monomodality and Multimodality at Tour, Day, and Week Levels*

The mode choice data at the trip level presented in Table 4 do not capture intrapersonal variability in mode choice throughout a tour, day, or week. Figure 2 below presents trends in mono- and multimodality at the tour, day, and week levels between 2001 and 2009. As reported by other studies, longer time periods of observation capture more variability in mode choice. In 2009, most tours were made exclusively by automobile (89.8%). Even during a travel day a majority of Americans relied solely on automobiles to get around (77.9%). However, less than a third (28.0%) reported exclusively using the car for all trips during the past week. By contrast, 64.9% of drivers made at least one trip by another mode of transport during the week. The share of multimodal drivers is much lower at the day (14.1%) and tour (4.0%) levels.

In 2009, only 7.1% of Americans did not drive and relied solely on walking, cycling, and/ or public transport during a typical week. The share of multimodal greens is greatest at the week level (4.4%)—a rate roughly 2.5 times greater than at the day level (1.8%), and almost 4 times greater than at the tour level (1.3%). By contrast the share of monomodal greens who either exclusively walked, cycled, or rode public transport was greater during tours (~5.0%) and travel days (6.2%) than during a week (2.7%).

At the tour, day, and week level, the share of monomodal drivers declined between the two surveys (-1.7%; -1.8%; -1.4%). The share of multimodal drivers fell at the tour level (-0.6%), but increased slightly for day (+0.2%) and week levels (+0.2%). The percentage of respondents exclusively relying on one of the green modes increased at the tour (+1.9%), day (+1.2%), and week levels (+0.6%). The share of multimodal greens also increased at all levels—but most strongly at the week level (tour: + 0.4%; day: +0.4%; week: +0.7%).

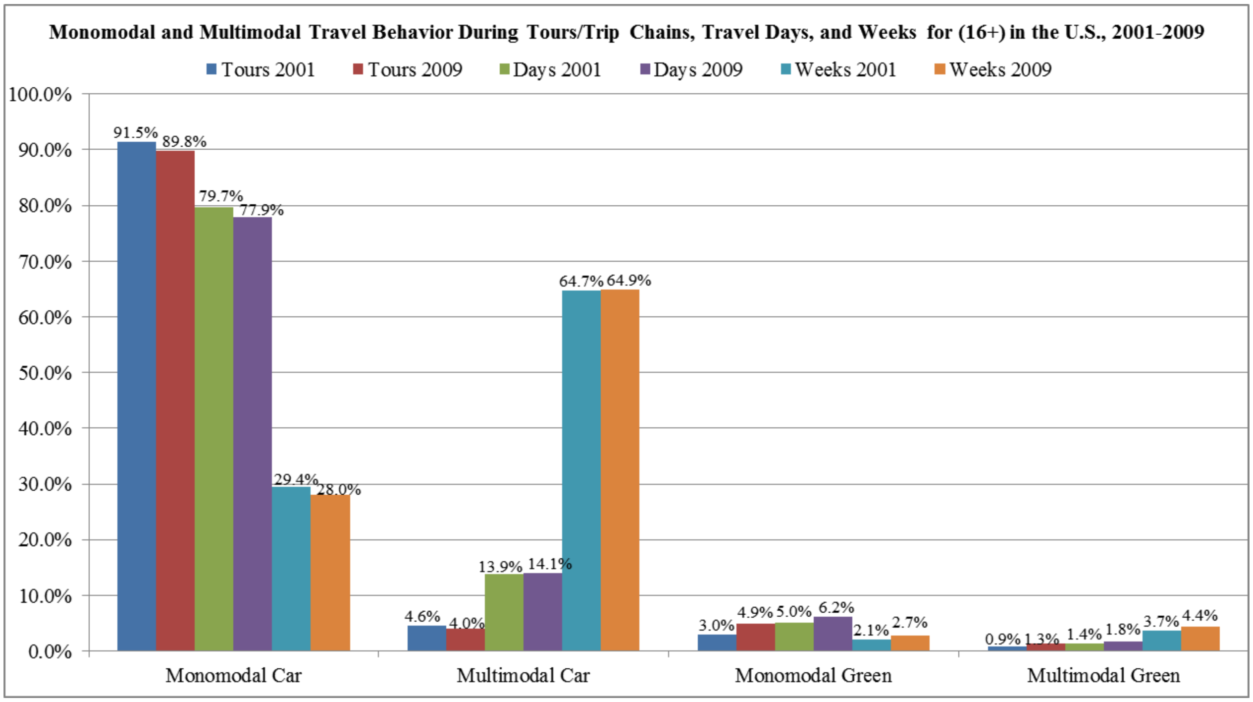


**Figure 2.** Trend in Shares of Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens at Tour, Day, and Week Levels in the U.S., 2001-2009.

A comparison of respondents classified as monomodal during the travel day and multimodal during the week shows that longer time periods of observation capture more variability in personal travel. In 2009, nearly two thirds (64%) of daily monomodal drivers were weekly multimodal drivers. Thus, those individuals drove for all trips during their assigned travel day, but also used other modes of transport during the week. Slightly more than a third (36%) of daily monomodal drivers did not report any trips by foot, bicycle, or public transport during the week. Similarly, 44% of daily monomodal green users were weekly multimodal greens and 11% were weekly multimodal car users. Consistent with the findings for the U.S. as a whole, a significant share of South Atlantic and Virginia daily monomodal drivers and monomodal greens are multimodal during the week. In 2009, about two-thirds of daily monomodal drivers were multimodal drivers during the week (65.4% for SA, 66.2% for VA), about one third of daily monomodal greens were multimodal greens during the week (37.5% for SA, 31.5% for VA), and a significant number of monomodal greens were multimodal drivers during the week (12.4% for SA, 20.5% for VA).

The following figures capture intrapersonal variability in mode choice at the tour, day, and week levels for the South Atlantic and Virginia between 2001 and 2009. As with the U.S. as a whole, most tours (91.4% for SA, 89.7% for VA) and daily trips (80.8% for SA, 79.8% for VA) in 2009 were made exclusively by automobile. However, less than a third (28.0% for SA, 27.0% for VA) of all individuals reported exclusively using the car for all trips during the past week; 66.8% of South Atlantic drivers and 68.3% of Virginia drivers made at least one trip by another mode of transport during the week. The share of multimodal drivers is much lower (13.2% for SA, 14.5% for VA) at the day and tour (3.8% for SA, 5.1% for VA) levels.

A lower share of South Atlantic (5.3%) and Virginia (4.7%) residents did not drive and relied solely on walking, cycling, and/or public transport during a typical week than for the U.S. as a whole (7.1%). As was the case for the U.S. as a whole, in both the South Atlantic and Virginia the share of multimodal greens was greatest at the week level while the share of monomodal greens was greatest at the day level.

The decline in the share of monomodal drivers between 2001 and 2009 at the tour, day, and week levels found for the U.S. as a whole was not fully replicated in the South Atlantic and Virginia. The South Atlantic did have declines at the tour and day level, but a decrease of only 0.1% at the week level. Meanwhile, Virginia had a decline at the tour level of 1.2 percentage points, but an increase of 2.3 percentage points at the day level and an increase of 3.5 percentage points at the week level. The share of multimodal drivers declined at all levels for the South Atlantic, while for Virginia it decreased at the day and week levels but increased at the tour level. The share of both monomodal greens and multimodal greens increased at all levels for the South Atlantic; most notably, the share of monomodal greens at the tour level more than doubled, from 1.7% to 3.9%. However, the trends were less clear for Virginia. The share of monomodal greens increased at the tour and week levels but decreased at the day level, while the share of multimodal greens increased at the tour level but decreased at both the day and week level. This is in contrast to the U.S. as a whole, where the share of both monomodal and multimodal greens increase at all levels.

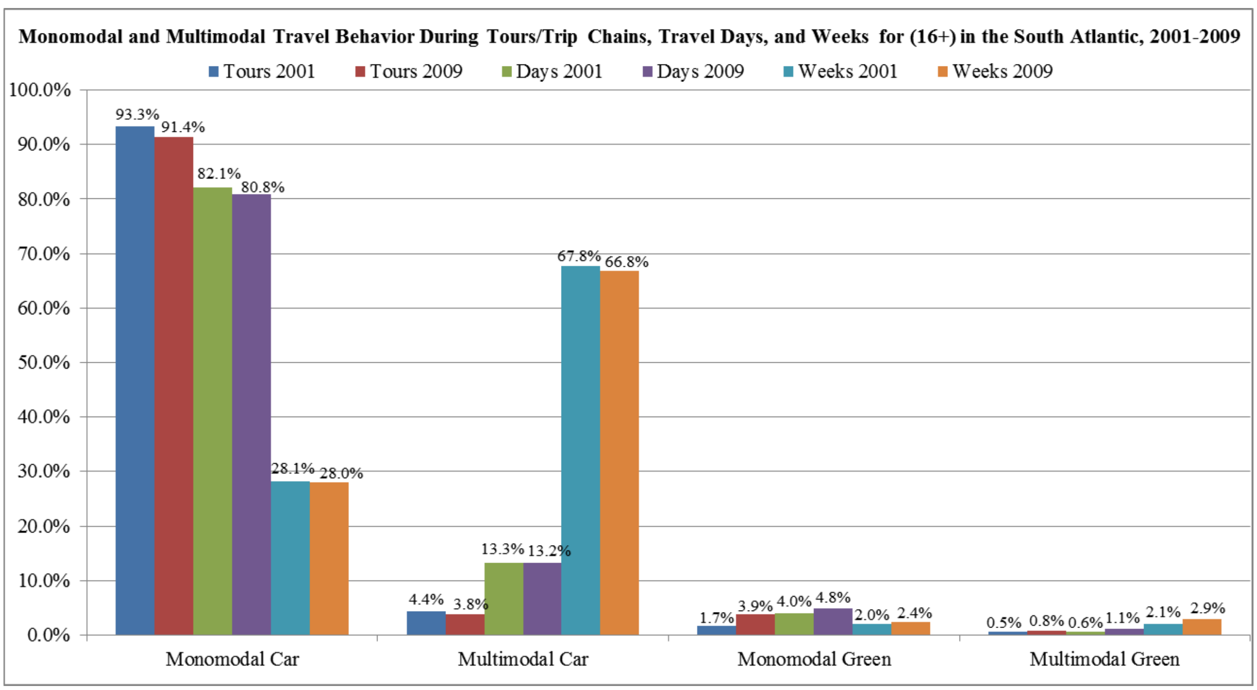


**Figure 3.** Trend in Shares of Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens at Tour, Day, and Week Levels in the South Atlantic, 2001-2009.

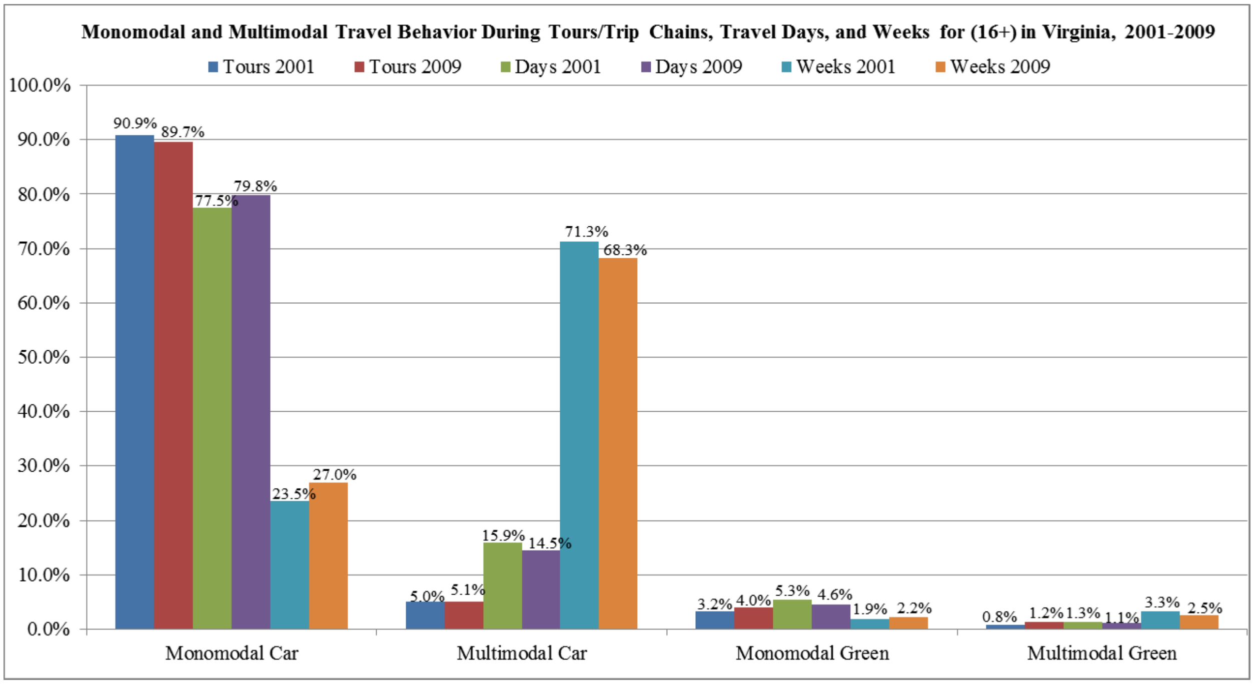


**Figure 4.** Trend in Shares of Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens at Tour, Day, and Week Levels in Virginia, 2001-2009.

In 2009, the vast majority of U.S. multimodal drivers reported walking as their only non-automobile mode of transport at the tour (83.3%), day (84.9%), and week (79.8%) levels (Figure 5). Between 2001 and 2009, the shares of those reporting a combination of driving and walking (86.2% to 83.3%) or driving and bicycling (3.2% to 2.5%) declined at the tour level, while the share of those driving and riding public transport increased by almost three percentage points (8.6% to 11.5%). The share of those combining driving, walking, and public transport for a tour increased from 1.7% to 2.8%.

The use of three different modes of transport is more common during the day and week than at the tour level. In 2009, during the last week 7.9% of respondents drove, walked, and cycled, and 8.0% drove, walked, and rode public transport. In 2009, 1.0% of respondents drove, walked, cycled, and rode public transport during a typical week.

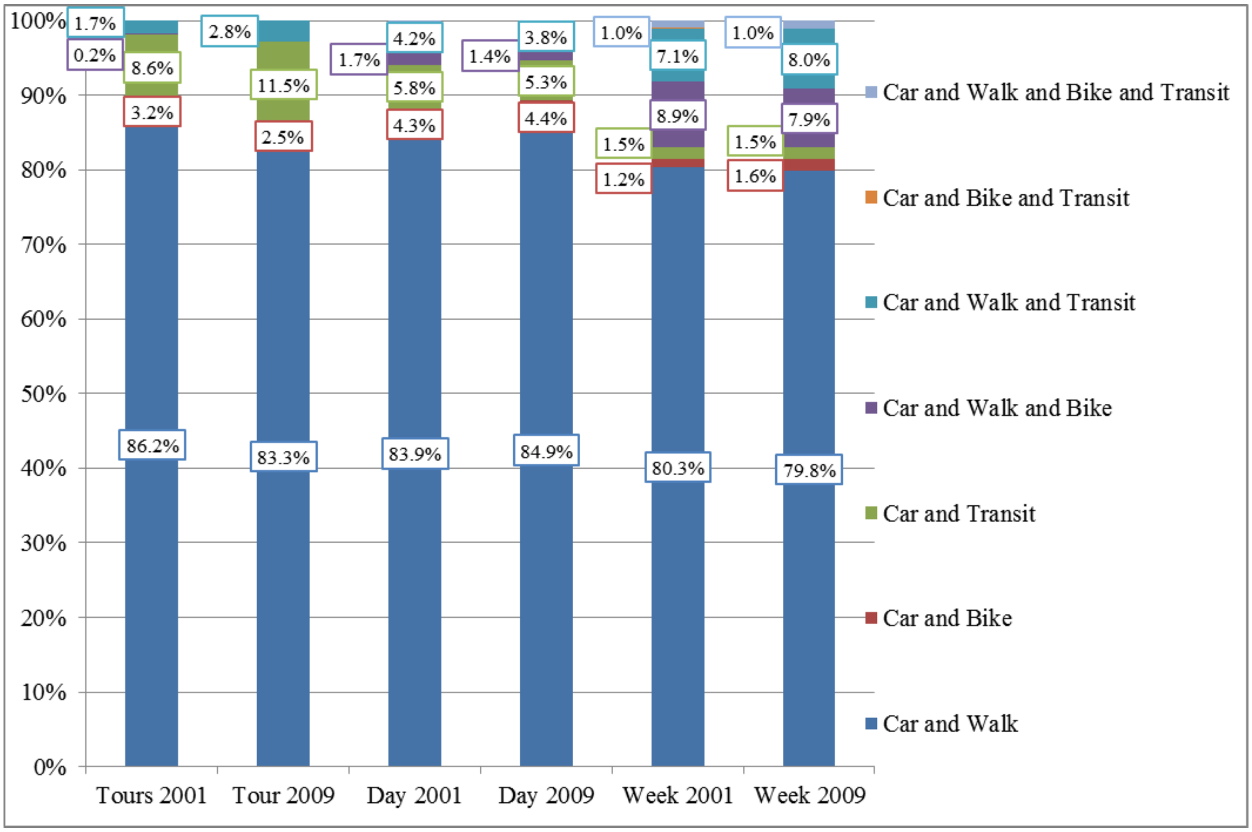


**Figure 5.** Trend in Modal Combinations for Multimodal Drivers at Tour, Day, and Week Levels in the U.S., 2001-2009.

As was the case for the U.S. as a whole, walking is the main green mode at the tour (83.6% for SA, 74.7% for VA), day (85.9% for SA, 87.1% for VA), and week (81.6% for SA, 79.7% for VA) levels in the South Atlantic and Virginia among multimodal drivers. Between 2001 and 2009, the share of multimodal drivers reporting a combination of driving and walking at the tour level (84.7% to 83.6% for SA, 87.7% to 74.7% for VA) decreased. The share of multimodal drivers reporting a combination of driving and biking at the tour level decreased in the South Atlantic (5.0% to 1.3%), but increased in Virginia (~0.0% to 2.5%). In both the South Atlantic and Virginia, the share of multimodal drivers reporting the combination of driving and public transport at the tour level increased (8.0% to 10.4% for SA, 10.9% to 17.2% for VA). Multimodal drivers reporting driving, walking, and transit at the tour level also increased (1.8% to 4.7% for SA, ~0.0% to 5.5%).

Combining three modes is more common at the day and week levels than at the tour level. In the South Atlantic, 8.3% of multimodal drivers used a car, walked, and cycled and 6.6% drove, walked, and rode public transport during the previous week, while in Virginia 6.3% of multimodal drivers used a car, walked, and cycled while 10.3% drove, walked, and rode public transport. Multimodal drivers who combined driving, walking, cycling, and public transport during the previous week were relatively rare, at 0.7% in both the South Atlantic and Virginia (compared to 1.0% for the U.S. as a whole).

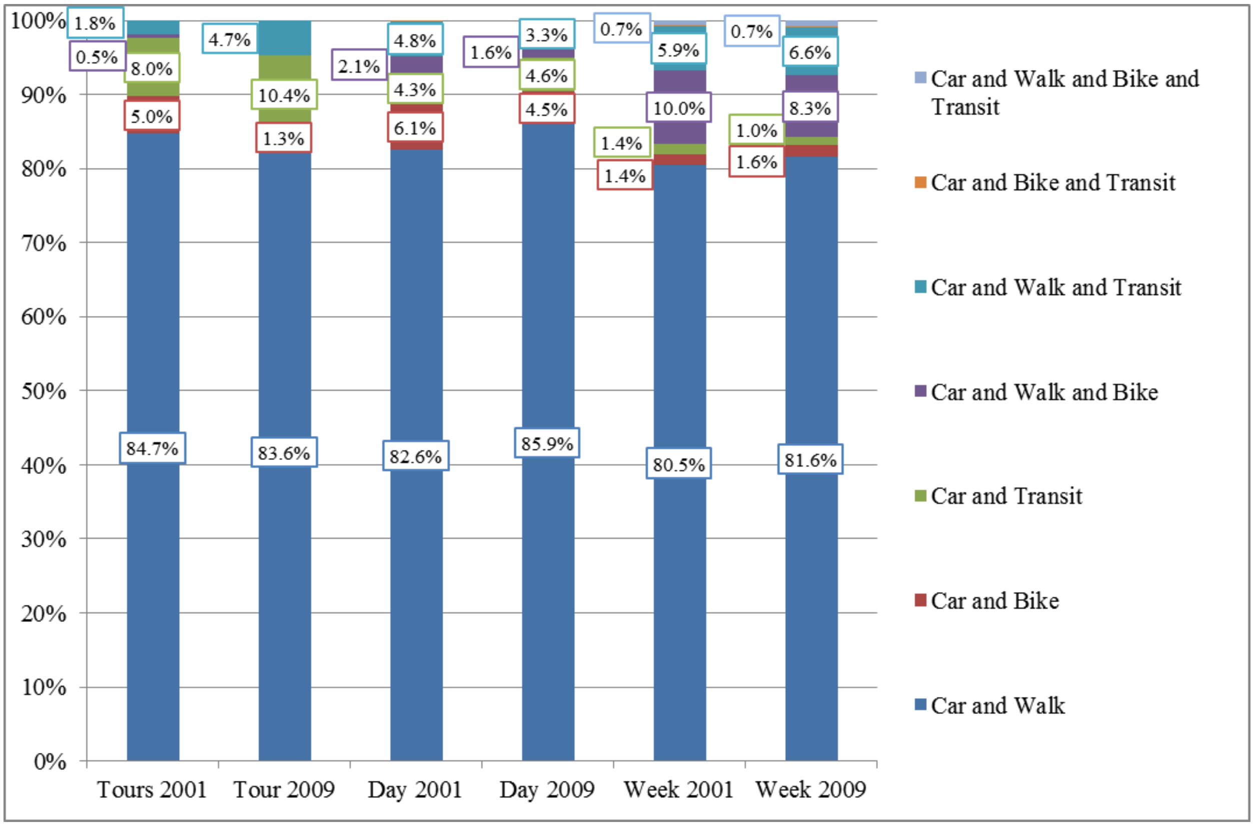


**Figure 6.** Trend in Modal Combinations for Multimodal Drivers at Tour, Day, and Week Levels in the South Atlantic, 2001-2009.

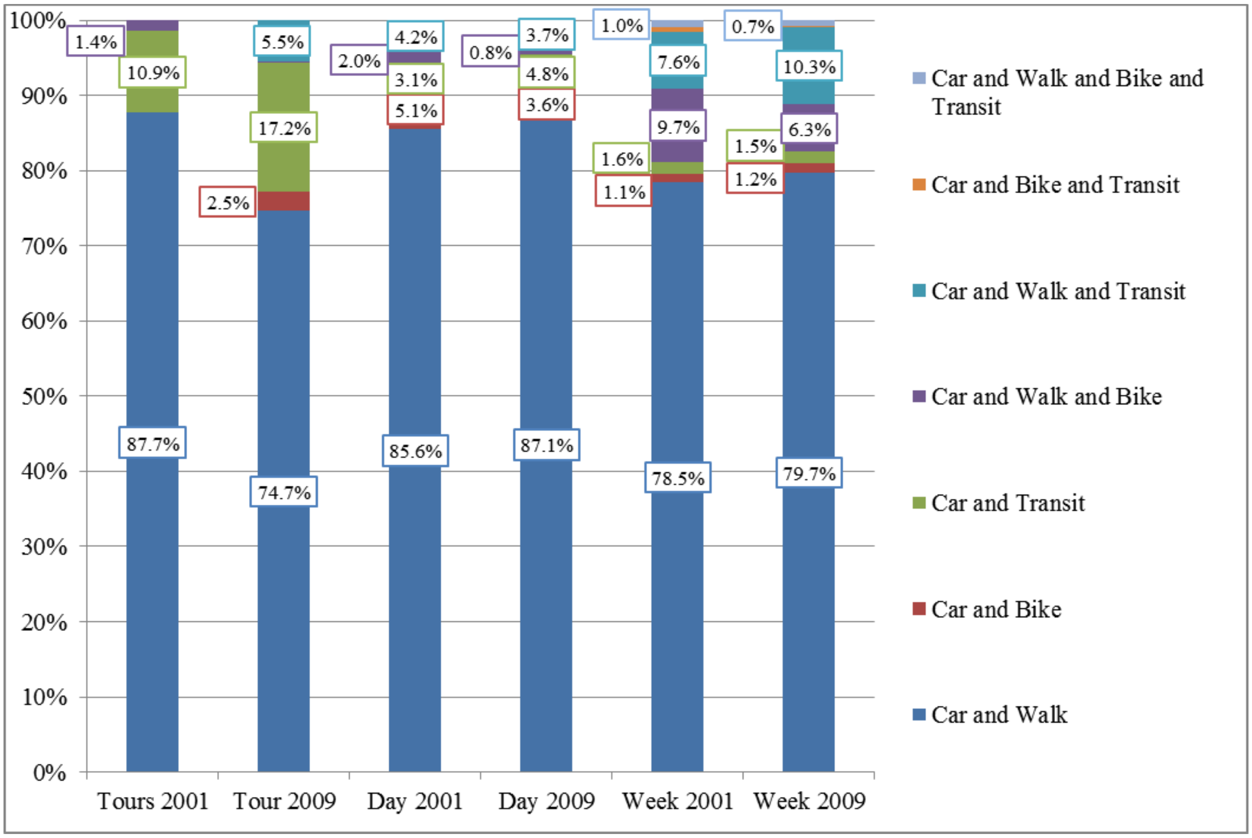


**Figure 7.** Trend in Modal Combinations for Multimodal Drivers at Tour, Day, and Week Levels in Virginia, 2001-2009.

The vast majority of momonodal greens walk for all trips during a tour (83.1%), day (70.4%), and week (90.8%) (see Figure 4). At the tour and day level about 5.5% report exclusively relying on a bicycle—this is almost twice the share reported for the week level (3.7%). Slightly more than 11.0% report making their tours solely by public transport. About one fourth (24.2%) of monomodal greens report riding public transport for all trips during the travel day, but only 5.5% rely exclusively on public transport during a week. Virtually all public transport riders use other modes of transport to get to and from public transport stops or stations and could therefore be defined as multimodal. However, in this study data on access and egress modes to public transport were not available at the week level.

At all levels the share of monomodal public transport riders declined between 2001 and 2009 (tour: -0.9%; day: -5.1%; and week: -2.2%). At the day and week level the share of monomodal cyclists increased by more than 50% between the two surveys, while the share of monomodal cyclists declined at the tour level. The share of monomodal pedestrians increased at the tour, day, and week levels.

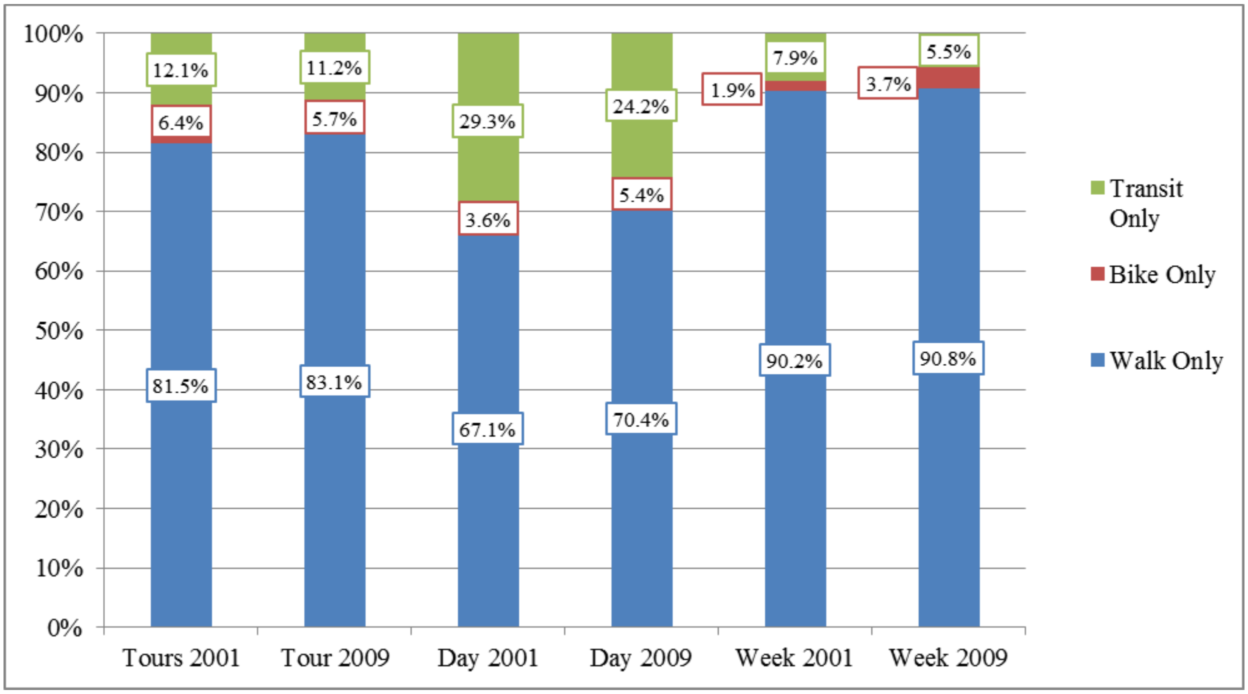

**Figure 8.** Trend in Shares of Pedestrians, Cyclists, and Public Transport user Among Monomodal Greens at Tour, Day, and Week Levels in the U.S., 2001-2009.

Walking was the dominant mode for monomodal greens at the tour (80.0% for SA, 89.6% for VA), day (76.2% for SA, 79.0% for VA), and week (92.8% for SA, 87.6% for VA) levels in 2009. The share of monomodal greens relying exclusively on cycling is highest at the tour level in the South Atlantic (7.4%) but highest at the daily level (7.8%) for Virginia. The share of monomodal greens relying exclusively on public transport is highest at the day level in both the South Atlantic (17.6%) and Virginia (13.2%).

Monomodal greens relying exclusively on walking increased at all levels in the South Atlantic, but only increased at the tour and day level in Virginia while decreasing at the week level. In contrast, monomodal greens relying exclusively on cycling increased at all levels in Virginia, but only increased at the day and week levels in the South Atlantic while decreasing at the tour level. The share of monomodal greens relying exclusively on public transport declined at all levels in the South Atlantic, but increased at the week level in Virginia while decreasing at the tour and day level.

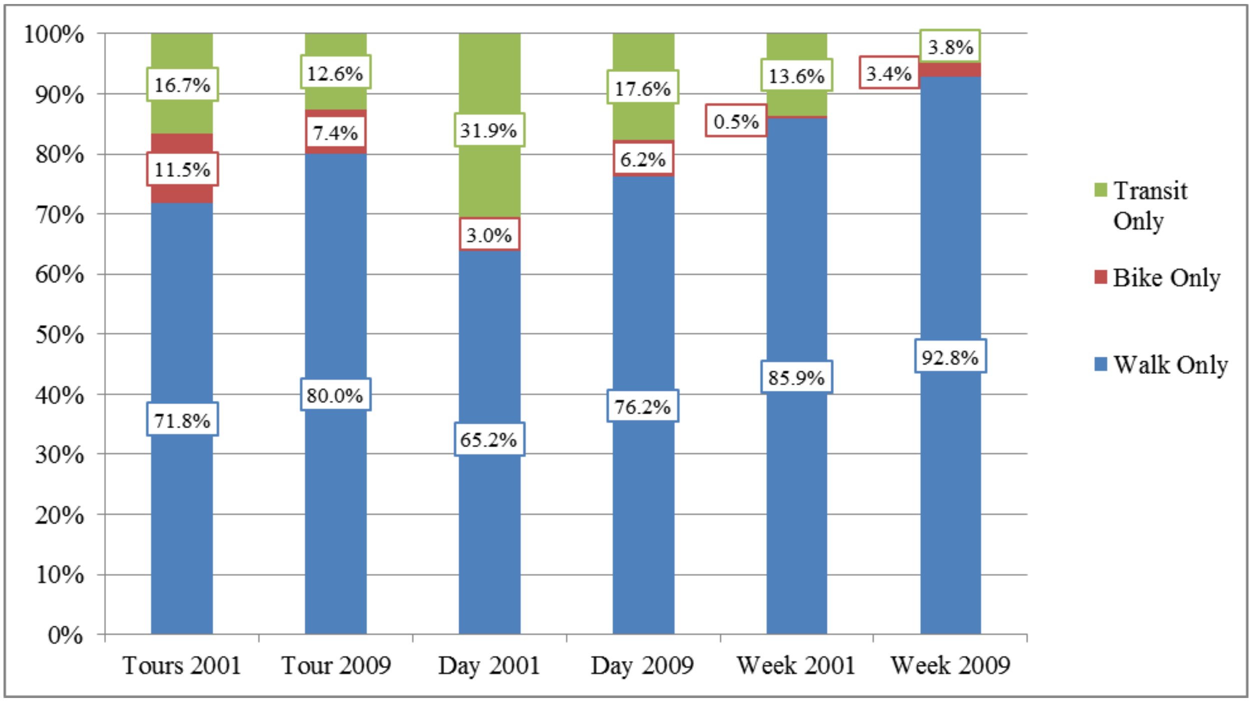


**Figure 9.** Trend in Shares of Pedestrians, Cyclists, and Public Transport user Among Monomodal Greens at Tour, Day, and Week Levels in the South Atlantic, 2001-2009.

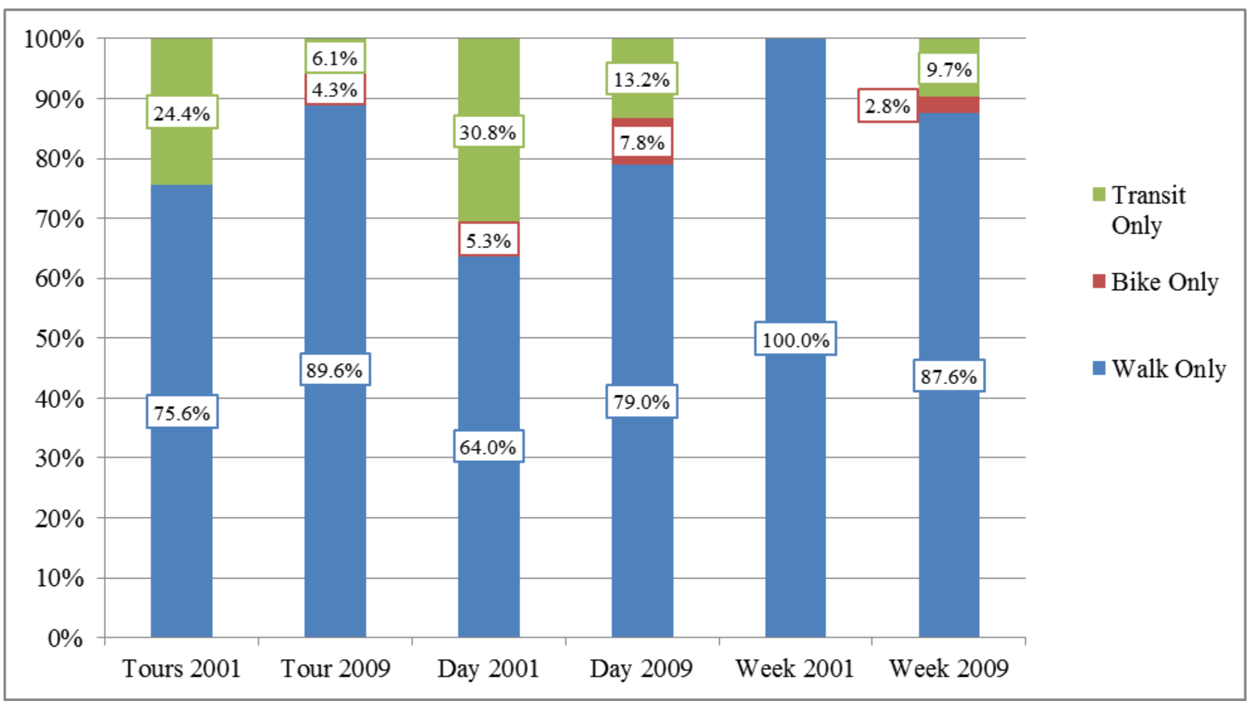


**Figure 10.** Trend in Shares of Pedestrians, Cyclists, and Public Transport user Among Monomodal Greens at Tour, Day, and Week Levels in Virginia, 2001-2009.

In 2009, at all levels most multimodal greens combined walking and public transport (tour: 93.9%; day: 86.7%; and week 77.0%) (see Figure 11). Daily and weekly data show greater variability than the tour data. In 2009, 3.3% of multimodal greens walked, cycled, and rode public transport during the travel day. Slightly more than 11% of multimodal green respondents reported using these three modes during the past week. On the day and week levels the share of multimodal greens walking and biking; biking and riding public transport; or walking, biking, and riding public transport increased between 2001 and 2009.

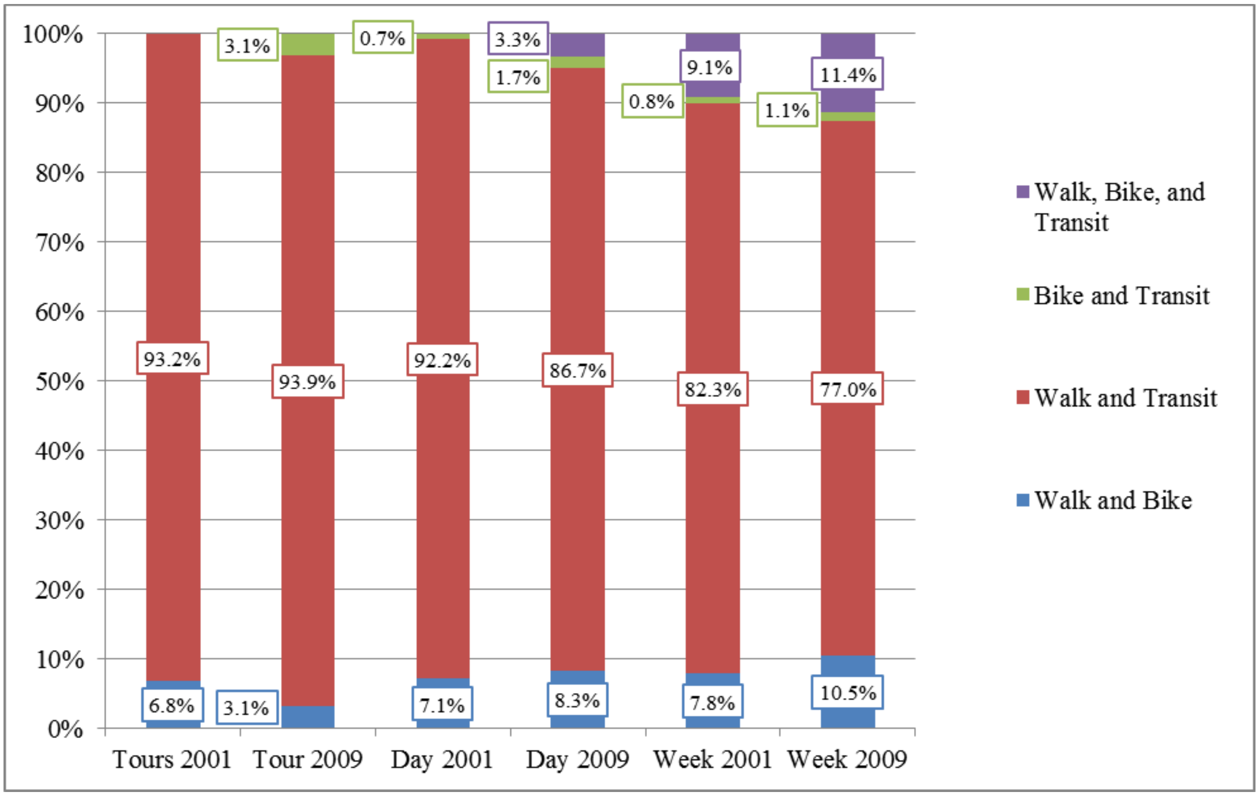


**Figure 11.** Trend in Modal Combinations for Multimodal Greens at Tour, Day, and Week Levels in the U.S., 2001-2009.

As with the U.S., in 2009 most multimodal greens combined walking and public transport (tour: 92.9% for SA, 99.2% for VA; day: 72.6% for SA, 92.8% for VA; week: 68.8% for SA, 80.3% for VA). There is greater variability during the day and week. In the South Atlantic, 19.1% of multimodal greens combined walking and biking and 10.4% combined walking, biking, and transit during the week. In the Virginia, the levels were 12.4% and 5.6% respectively. The share of multimodal greens walking and biking, biking and using public transport, or walking, biking, and using public transport increased at the day and week level between 2001 and 2009 for the South Atlantic. However, in Virginia, the share walking and biking decreased at the day level and the share walking, biking, and using public transport decreased at the week level, while there were no increases in biking and public transport or walking, biking, and public transport at the day level.

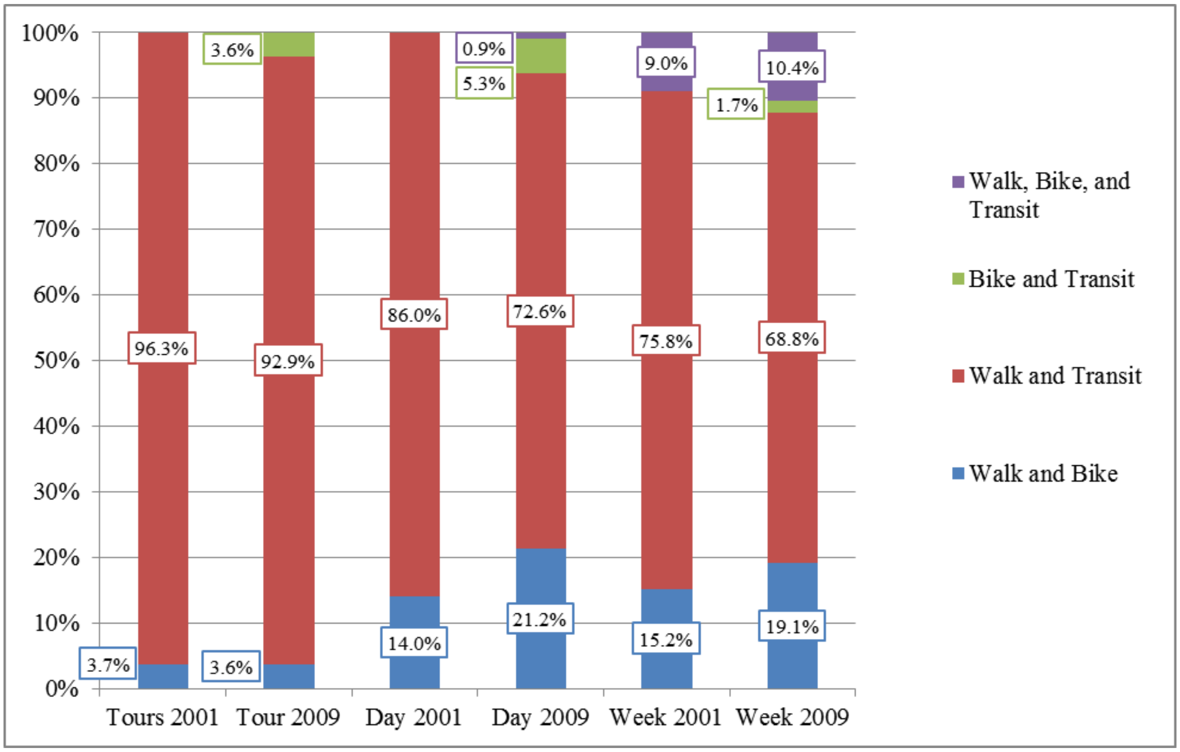


**Figure 12.** Trend in Modal Combinations for Multimodal Greens at Tour, Day, and Week Levels in the South Atlantic, 2001-2009.

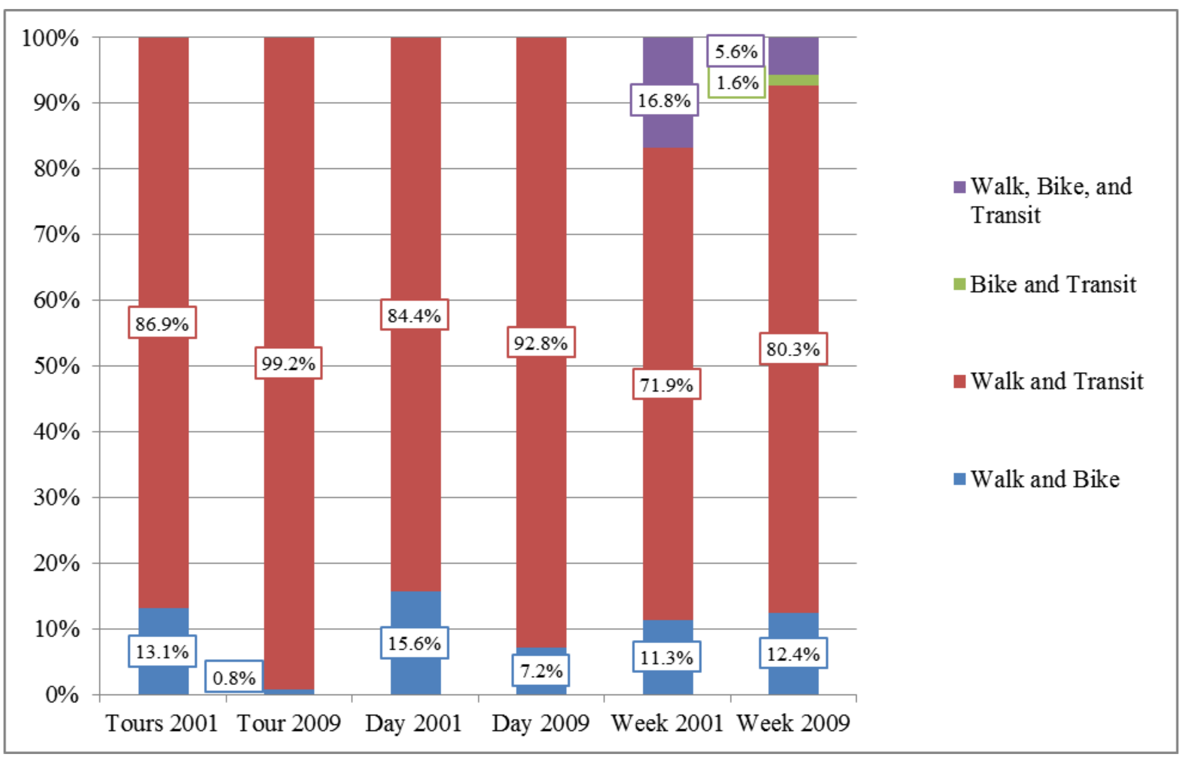


**Figure 13.** Trend in Modal Combinations for Multimodal Greens at Tour, Day, and Week Levels in Virginia, 2001-2009.

### 4.2.1 Intensity of Multimodality

The analysis above defines multimodal drivers as those who make at least one trip by another mode of transport. Some studies consider drivers who only occasionally use other modes as individuals with strong 'monomodal driver tendencies'. Figure 14 shows how the share of those considered multimodal drivers decreases if the definition for multimodal drivers requires at least 2, 3, 4, 5, 6, or 7 trips by non-automobile modes during a week.

For example, in 2009, 1.2% of multimodal drivers reported two or more trips by alternative modes of transport during a tour—compared to 4.0% making at least one trip by walking, cycling, and public transport. During a day 11.5% drove and made two or more trips by alternative means of travel. At the week level 58.1% reported driving in combination with at least two trips without a car—down from 64.9% who drive and make at least one trip by an alternative to the car. Only 23.3% of multimodal drivers report driving in combination with 7 or more trips by another mode of transport during the week. At the week level the groups of multimodal car users who make 4+, 5+, 6+, and 7+ trips without a car showed more significant increases between 2001 and 2009 (~+2%) than groups of lower intensity multimodal car users.

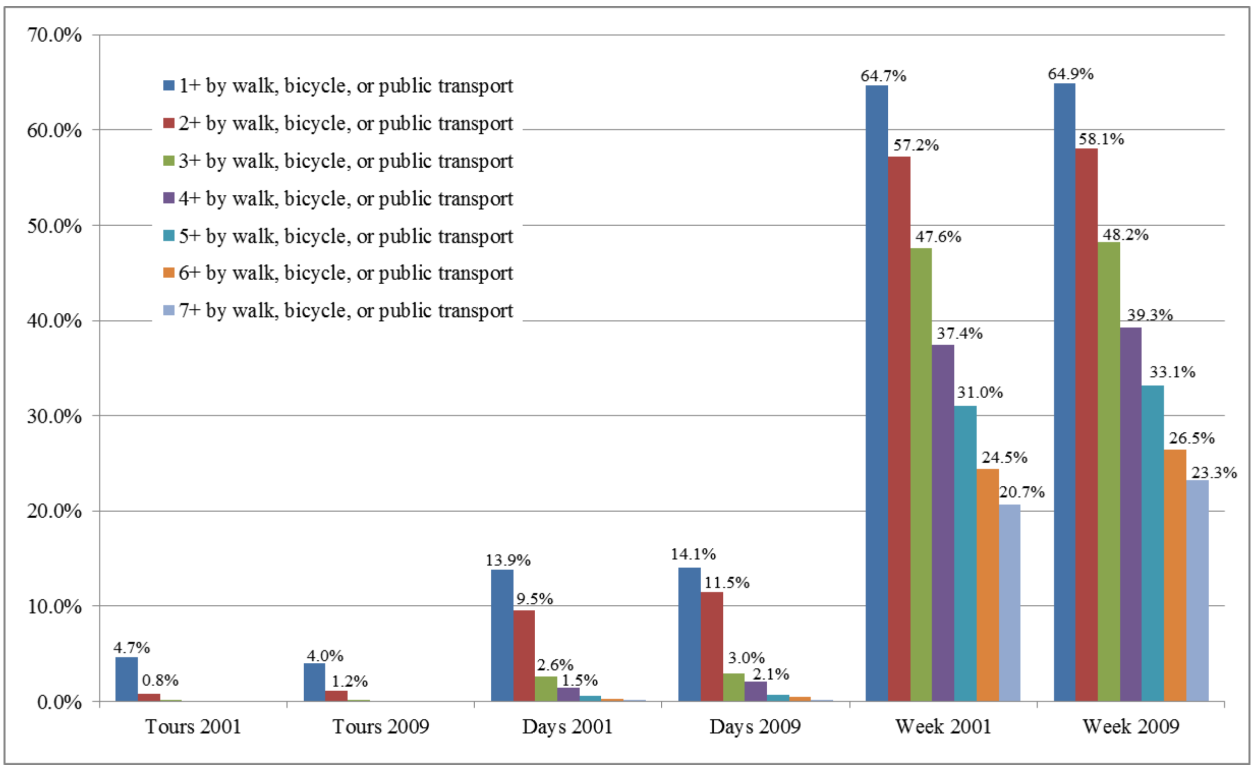


**Figure 14.** Trend in Share of Multimodal Drivers by Different Intensity Cut-Off Values at Tour, Day, and Week Levels in the U.S., 2001-2009.

As with the U.S., the share of individuals who are multimodal decreases with higher intensity thresholds. In 2009, 3.8% of South Atlantic individuals were multimodal drivers using the threshold of at least 1 trip by walking, biking, or public transport during a tour, while only 1.0% made a tour using 2 or more trips by the green modes. In Virginia, the levels were 5.1% and 1.5% respectively. During the day and week, the number of individuals who qualify as multimodal drivers also declines as the intensity threshold increases in both the South Atlantic and Virginia. At the week level, 66.8% of South Atlantic individuals are multimodal drivers using the 1+ definition, but only 25.8% are multimodal drivers using the 7+ definition. In Virginia, the levels are 68.3% and 26.3% respectively. At the week level, in contrast to the U.S. as a whole, where the proportion of the sample who qualifies as multimodal drivers increases between 2001 and 2009 at all intensity thresholds, in the South Atlantic the proportion actually decreases using the 1+ and 2+ definitions, and only increases using the higher 3+, 4+, 5+, 6+, and 7+ definitions. For Virginia, the proportion decreases for all threshold levels except the 5+ and 7+ definitions, where it increases.

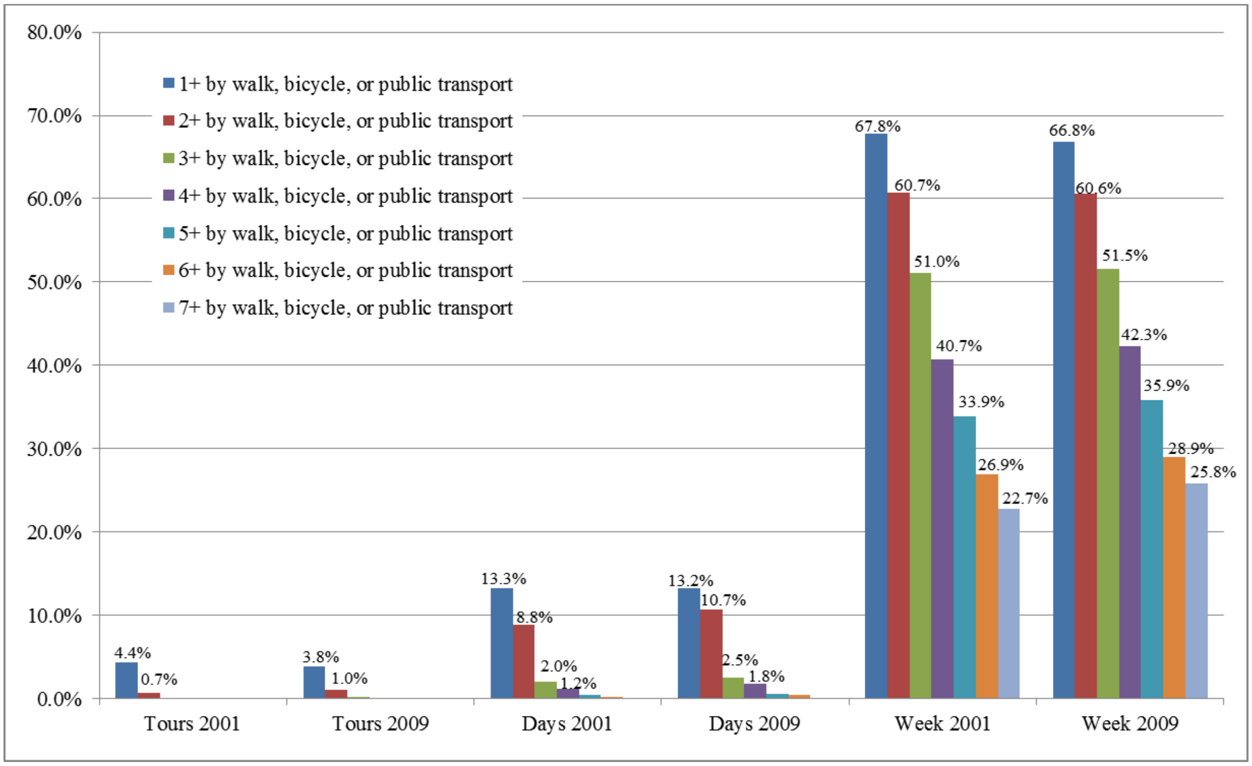


**Figure 15.** Trend in Share of Multimodal Drivers by Different Intensity Cut-Off Values at Tour, Day, and Week Levels in the South Atlantic, 2001-2009.

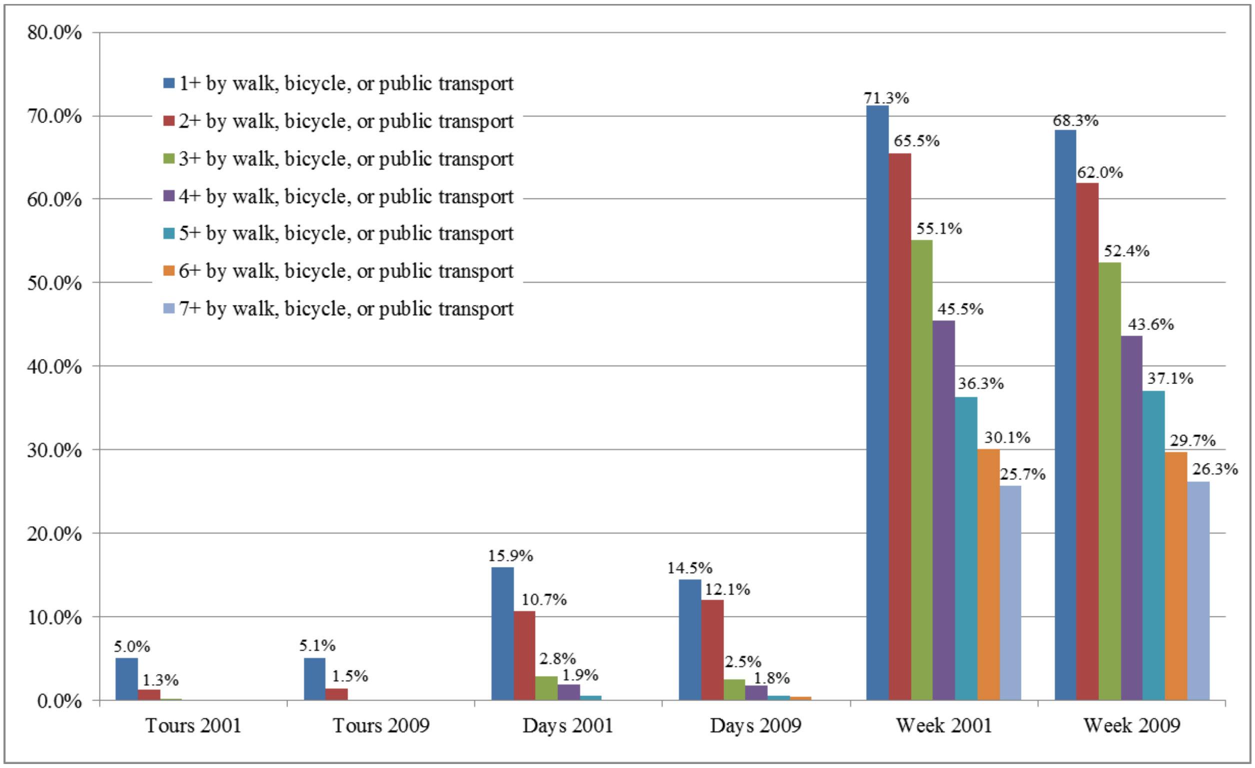


**Figure 16.** Trend in Share of Multimodal Drivers by Different Intensity Cut-Off Values at Tour, Day, and Week Levels in Virginia, 2001-2009.

Similarly to multimodal car users, the group of multimodal greens can be defined based on the relative intensity of use by a single mode. Figure 17 compares the shares of multimodal greens using 4 different definitions. The first definition identifies multimodal greens as those who use at least two green modes. The other definitions additionally restrict one single green mode from accounting for more than 90%, 70%, or 50% of all trips. Figure 17 shows that the share of those considered multimodal greens declines with the more stringent definitions—particularly at the week level.

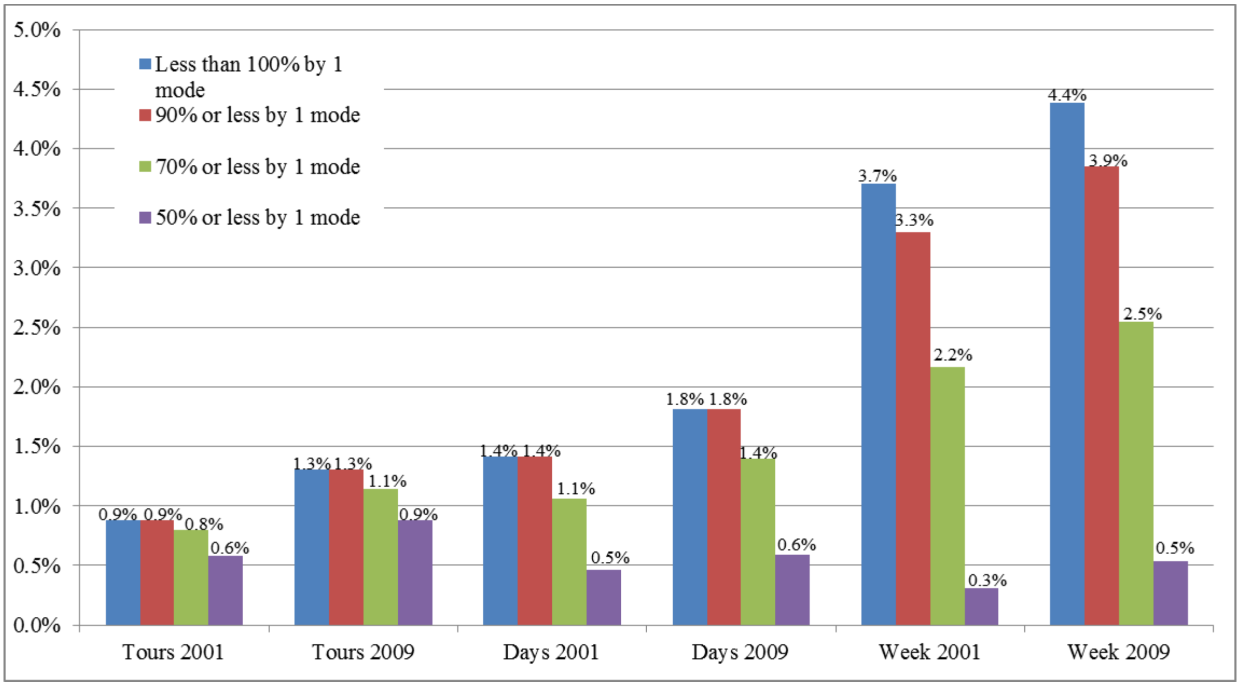


**Figure 17.** Trend in Share of Multimodal Greens by Different Intensity Cut-Off Values at Tour, Day, and Week Levels in the U.S., 2001-2009.

Similar to multimodal drivers, in the South Atlantic and Virginia the proportion qualifying as multimodal greens decreases with higher intensity thresholds. The proportion qualifying as multimodal greens increased or stayed level between 2001 and 2009 at all intensity levels for the tour, day, and week for the South Atlantic. However, in Virginia the trend between 2001 and 2009 across intensity thresholds and tour, day, and week levels was less clear. The proportion increased at the tour level across intensity thresholds except at the highest, where it decreased. At the day level, the proportion decreased at lower thresholds and increased at higher thresholds. At the week level, the proportion decreased at all levels except the <70% level, where it increased.

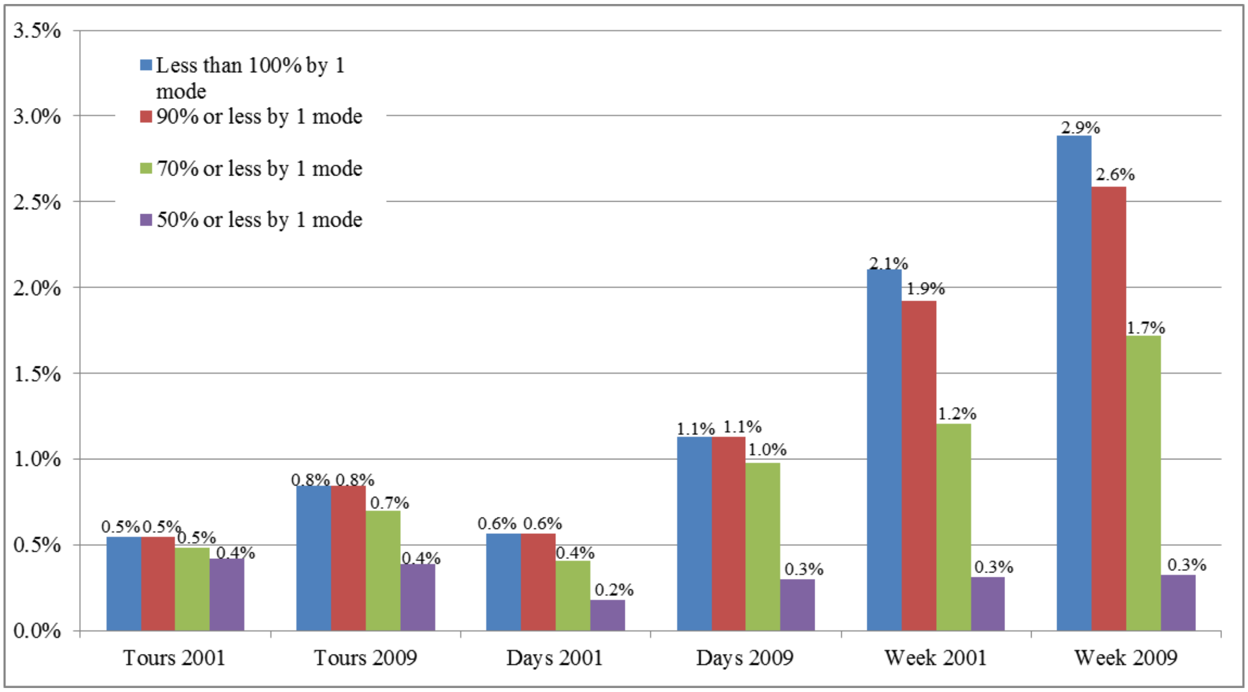


**Figure 18.** Trend in Share of Multimodal Greens by Different Intensity Cut-Off Values at Tour, Day, and Week Levels in the South Atlantic, 2001-2009.

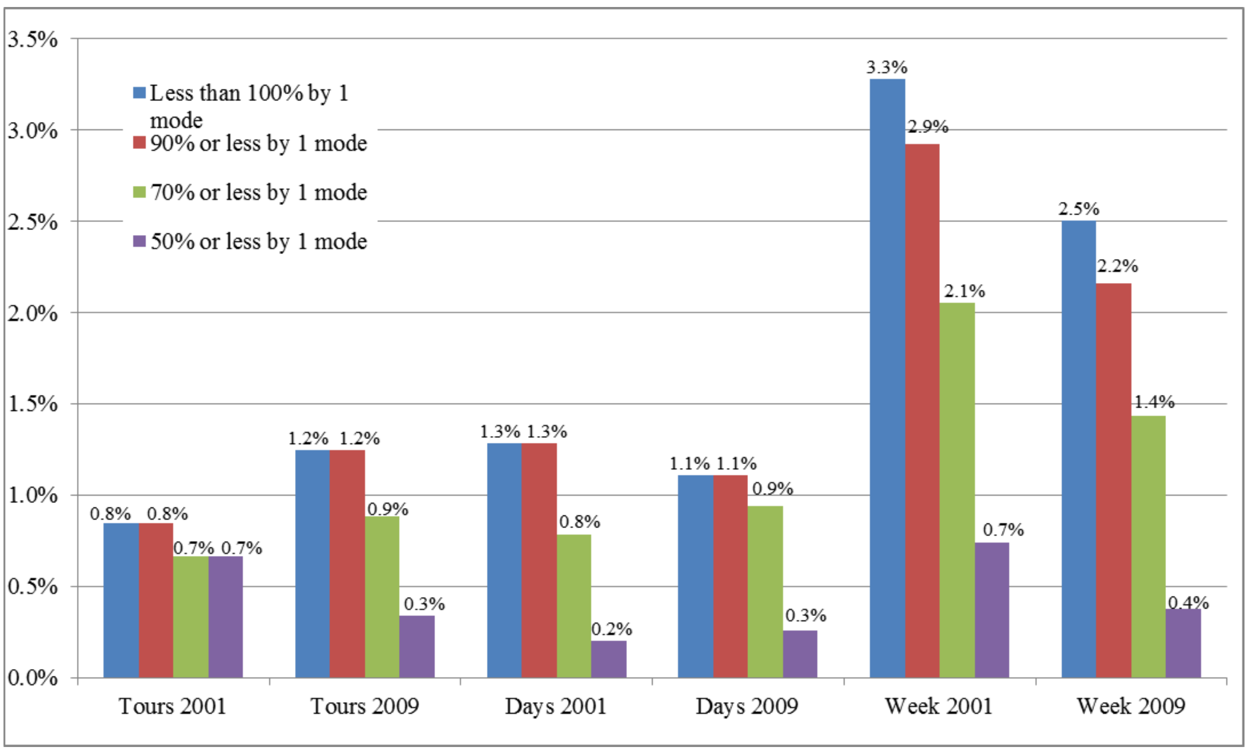


**Figure 19.** Trend in Share of Multimodal Greens by Different Intensity Cut-Off Values at Tour, Day, and Week Levels in Virginia, 2001-2009.

## *4.3 Determinants of Multimodality*

### 4.3.1 Demographic Characteristics: Gender, Race/Ethnicity, Age, and Household Life Cycle

Table 7 displays shares of weekly monomodal and multimodal drivers as well as monomodal and multimodal greens by gender, race/ethnicity, age, and household life cycle stage for the years 2001 and 2009. The shares of monomodal drivers declined for both men (29.6% to 27.7%) and women (29.3% to 28.4%) between the two surveys. In both years men (65.0% and 65.4%) were slightly more likely to be multimodal drivers than women (64.4% for both years) and for both sexes rates of multimodal drivers only changed minimally between 2001 and 2009. By contrast, the share of multimodal greens increased significantly for both men (3.6% to 4.3%) and women (3.8% to 4.4%) between 2001 and 2009.

Shares of monomodal drivers do not differ significantly between whites and other race/ethnicity groups. However, compared to minorities, whites were more likely to be multimodal drivers (67.0% vs. 57.8%). Moreover, whites were less likely to monomodal (2.2% vs. 4.4%) and multimodal (2.8% vs. 8.9%) greens. In 2009, only 5.0% of whites relied solely on green modes for their weekly travel—less than half the rate for minorities (13.3%).

In 2009, the age groups 16 to 24 and 25 to 34 had the highest shares of multimodal greens (5.6% and 5.8%), among the highest shares of monomodal greens (3.1% for each group), and among the lowest shares of monomodal car drivers (26.4% and 24.3%). At the other end of the age spectrum, the age group 65+ was least likely to combine different modes of transport during the week. Those 65 and older have the lowest shares of multimodal drivers (56.8%) and multimodal greens (3.4%). By contrast this age group has the highest shares of monomodal drivers (35.9%) and monomodal greens (4.0%).

In 2009, individuals in households with children were more likely multimodal car users than persons in households without children (67.0% vs. ~62.0%). By contrast, individuals in households without children were more likely monomodal drivers and relied more on green modes only. Between 2001 and 2009, the share of multimodal drivers in households with children increased by over 2 percentage points, while it fell by over 2 percentage points for individuals in households with two adults and no children. Monomodal greens and multimodal greens increased or remained stable for each life cycle group between 2001 and 2009.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 29.4% | 64.7% | 2.1% | 3.7% | 28.0% | 64.9% | 2.7% | 4.4% |
| **Sex** | | | | | | | | |
| *Male* | 29.6% | 65.0% | 1.7% | 3.6% | 27.7% | 65.4% | 2.6% | 4.3% |
| *Female* | 29.3% | 64.4% | 2.6% | 3.8% | 28.4% | 64.4% | 2.8% | 4.4% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 29.3% | 67.0% | 1.7% | 2.0% | 28.4% | 66.7% | 2.2% | 2.8% |
| *Non White* | 29.6% | 58.7% | 3.3% | 8.4% | 27.1% | 59.7% | 4.4% | 8.9% |
| **Age Group** | | | | | | | | |
| *16-24* | 28.8% | 62.8% | 2.7% | 5.7% | 26.4% | 64.9% | 3.1% | 5.6% |
| *25-34* | 29.1% | 64.4% | 1.6% | 4.9% | 24.3% | 66.8% | 3.1% | 5.8% |
| *35-49* | 28.6% | 67.0% | 1.5% | 2.9% | 26.2% | 67.7% | 2.2% | 3.9% |
| *50-64* | 29.4% | 65.8% | 2.0% | 2.9% | 29.1% | 64.8% | 2.2% | 3.9% |
| *65 and older* | 32.6% | 60.6% | 4.1% | 2.7% | 35.9% | 56.8% | 4.0% | 3.4% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 28.8% | 65.5% | 2.2% | 3.5% | 29.7% | 63.3% | 2.7% | 4.3% |
| *Singles* | 29.1% | 60.8% | 3.7% | 6.4% | 28.6% | 60.8% | 3.7% | 6.9% |
| *Households With Children* | 30.0% | 64.9% | 1.8% | 3.3% | 26.7% | 67.0% | 2.5% | 3.8% |

**Table 7.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Demographic Characteristics in the U.S., 2001-2009.

The share of monomodal drivers declined for South Atlantic men between 2001 and 2009, but increased for South Atlantic women, as well as men and women in Virginia. Meanwhile, the share of multimodal drivers decreased for both men and women in the South Atlantic and Virginia, and especially for women in Virginia (71.0% to 66.9%). In both years, men were slightly more likely to be multimodal drivers than women in both geographic areas. The share of both monomodal greens and multimodal greens increased slightly in the South Atlantic for both men and women. However, in Virginia monomodal greens increased for men but decreased for women, and multimodal greens decreased for both men and women.

The share of monomodal drivers was higher among minorities in 2001, but among whites in 2009 for the South Atlantic, while the share was higher among minorities in both years for Virginia. In contrast, whites were more likely to be multimodal drivers – and also less likely to be monomodal and multimodal greens – in both geographic areas and across survey years. The 16 to 24 age group had the highest share of multimodal greens in both survey years and geographic areas, and among the highest shares of monomodal greens as well. Monomodal driving increased slightly for this age group in the South Atlantic, but significantly decreased in Virginia. At the other end of the age spectrum, monomodal driving increased while multimodal driving decreased among those 65 years of age and older in both the South Atlantic and Virginia.

Meanwhile, the proportion of seniors qualifying as monomodal green and multimodal green also increased slightly between survey years across both geographic areas.

Monomodal driving increased and multimodal driving decreased among all household life cycle groups in Virginia. In the South Atlantic, monomodal driving increased and multimodal driving decreased for singles and households without children. For South Atlantic households with children, monomodal driving decreased and multimodal driving increased. Monomodal green travel decreased and multimodal green travel increased among singles in both geographic areas. Singles in Virginia showed a particularly large increase in multimodal green travel (1.7% vs. 5.3%). The total share of individuals traveling only by the green modes increased among individuals in households with children in the South Atlantic, but decreased in Virginia.

| **Bivariate Descriptives, NHTS South Atlantic Sample** | **Week 2001** | | | | | **Week 2009** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | | % | % | % | % |
| **All** | 28.1% | 67.8% | 2.0% | 2.1% | | 28.0% | 66.8% | 2.4% | 2.9% |
| **Sex** | | | | | | | | | |
| *Male* | 28.3% | 68.4% | 1.5% | 1.9% | | 27.7% | 67.3% | 2.1% | 2.8% |
| *Female* | 28.0% | 67.2% | 2.5% | 2.3% | | 28.2% | 66.3% | 2.6% | 2.9% |
| **Race/ethnicity** | | | | | | | | | |
| *White* | 27.0% | 70.5% | 1.4% | 1.1% | | 28.0% | 68.3% | 1.9% | 1.8% |
| *Non White* | 30.6% | 62.0% | 3.1% | 4.2% | | 27.8% | 63.0% | 3.5% | 5.6% |
| **Age Group** | | | | | | | | | |
| *16-24* | 27.8% | 66.4% | 2.8% | 2.9% | | 28.3% | 65.2% | 2.7% | 3.8% |
| *25-34* | 28.3% | 67.8% | 1.4% | 2.5% | | 25.5% | 69.0% | 2.6% | 2.8% |
| *35-49* | 28.1% | 69.0% | 1.1% | 1.8% | | 25.2% | 70.4% | 1.2% | 3.2% |
| *50-64* | 26.3% | 69.6% | 2.0% | 2.2% | | 28.0% | 66.8% | 2.4% | 2.8% |
| *65 and older* | 30.9% | 63.9% | 3.8% | 1.4% | | 35.6% | 58.7% | 4.3% | 1.5% |
| **Household Life Cycle Stage** | | | | | | | | | |
| *Two Adults No Children* | 26.7% | 69.3% | 2.1% | 1.9% | | 29.4% | 65.7% | 2.6% | 2.3% |
| *Singles* | 27.2% | 65.3% | 4.3% | 3.2% | | 29.5% | 61.9% | 3.5% | 5.1% |
| *Households With Children* | 29.6% | 67.0% | 1.4% | 2.0% | | 26.5% | 68.8% | 1.9% | 2.8% |

**Table 8.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Demographic Characteristics in the South Atlantic, 2001-2009.

| Bivariate Descriptives, NHTS Virginia Sample | Week 2001* | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 23.5% | 71.3% | 1.9% | 3.3% | 27.0% | 68.3% | 2.2% | 2.5% |
| **Sex** | | | | | | | | |
| *Male* | 24.6% | 71.5% | 0.9% | 3.0% | 26.1% | 69.8% | 1.7% | 2.5% |
| *Female* | 22.5% | 71.0% | 2.9% | 3.6% | 27.9% | 66.9% | 2.7% | 2.5% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 22.2% | 74.5% | 1.5% | 1.9% | 26.3% | 69.7% | 2.0% | 2.0% |
| *Non White* | 26.9% | 62.3% | 3.3% | 7.4% | 29.0% | 64.4% | 2.7% | 3.9% |
| **Age Group** | | | | | | | | |
| *16-24* | 24.1% | 66.7% | 1.4% | 7.8% | 21.5% | 71.9% | 2.4% | 4.2% |
| *25-34* | 25.8% | 67.5% | 1.3% | 5.3% | 25.5% | 68.9% | 2.4% | 3.2% |
| *35-49* | 19.2% | 77.2% | 1.4% | 2.2% | 25.2% | 70.3% | 1.8% | 2.7% |
| *50-64* | 24.8% | 70.4% | 3.1% | 1.7% | 28.1% | 68.5% | 2.0% | 1.3% |
| *65 and older* | 28.2% | 67.9% | 2.6% | 1.3% | 37.4% | 58.2% | 2.8% | 1.5% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 24.6% | 70.7% | 2.1% | 2.7% | 29.2% | 67.2% | 2.0% | 1.7% |
| *Singles* | 19.5% | 75.9% | 2.9% | 1.7% | 28.9% | 63.0% | 2.7% | 5.3% |
| *Households With Children* | 23.6% | 70.7% | 1.6% | 4.1% | 24.9% | 70.4% | 2.2% | 2.5% |
| ** Virginia 2001 sample not representative; NHTS Virginia Add-On sample was done in 2009 Only* | | | | | | | | |

**Table 9.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Demographic Characteristics in Virginia, 2001-2009.

### 4.3.2 Socioeconomic Characteristics: Education, Employment, Income, Car Ownership, and Driver's License

University or college graduates were more likely to be multimodal car users than those with high school degrees or less. In 2009, 68.7% (vs. 58.2%) of university graduates were multimodal drivers. By contrast those with only high school degrees or less were more likely monomodal drivers (32.3% vs. 25.9%), monomodal greens (4.0% vs. 1.8%), and multimodal greens (5.5% vs. 3.6%).

In 2009, employed individuals were more likely monomodal and multimodal drivers (28.7% and 66.4%) than unemployed individuals or persons not in the workforce (26.6% and 61.6%). However, employed persons were much less likely to exclusively use green modes. Only 1.3% of employed individuals were monomodal greens and 3.6% were multimodal greens compared to 5.7% and 6.1% for individuals who were not employed. For the latter group, the share of monomodal drivers decreased and the shares of monomodal and multimodal greens increased between 2001 and 2009.

Owning a car is closely related to weekly travel behavior. Compared to persons in households with cars, individuals in households without cars are much less likely to be monomodal (6.9% vs. >27.2%) or multimodal car users (31.5% vs. >63.1%). By contrast, 61.6% of persons without a car in the household relied solely on green modes during the entire week compared to less than 10% in households with cars. As the number of cars per household increases, the shares of monomodal and multimodal drivers increases and the shares of monomodal and multimodal greens decreases.

Not having a driver's license has an impact similar to not having a car. Compared to licensed drivers, those without a driver's license are much more likely to be multimodal (14.5% vs. 3.5%) or monomodal (13.8% vs. 1.7%) greens. By contrast, licensed drivers are much more likely multimodal (66.0% vs. 52.0%) or monomodal (28.8% vs. 19.7%) car users.

Finally, the share of multimodal drivers increases with income. Nearly 72.0% of Americans in the wealthiest income quartile are multimodal drivers compared to only 58.8% in the lowest income quartile. By contrast, individuals in the lowest income quartile are more likely multimodal and monomodal greens than other income groups.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 29.4% | 64.7% | 2.1% | 3.7% | 28.0% | 64.9% | 2.7% | 4.4% |
| **Education** | | | | | | | | |
| *High School degree or less* | 33.2% | 59.5% | 3.0% | 4.3% | 32.3% | 58.2% | 4.0% | 5.5% |
| *Education beyond high school* | 27.2% | 68.0% | 1.6% | 3.2% | 25.9% | 68.7% | 1.8% | 3.6% |
| **Employment Status** | | | | | | | | |
| *Employed* | 29.2% | 65.7% | 1.4% | 3.6% | 28.7% | 66.4% | 1.3% | 3.6% |
| *Not in work force or unemployed* | 29.9% | 62.3% | 3.9% | 3.9% | 26.6% | 61.6% | 5.7% | 6.1% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 28.8% | 61.1% | 3.8% | 6.3% | 29.0% | 58.8% | 4.6% | 7.6% |
| *Second and Third* | 30.6% | 65.9% | 1.4% | 2.1% | 28.6% | 67.3% | 1.7% | 2.5% |
| *Highest* | 25.6% | 70.9% | 0.8% | 2.7% | 24.0% | 71.7% | 1.4% | 3.0% |
| **No. of cars** | | | | | | | | |
| *No cars* | 7.7% | 34.1% | 12.7% | 45.6% | 6.9% | 31.5% | 13.3% | 48.3% |
| *1* | 27.4% | 64.1% | 3.4% | 5.1% | 27.2% | 63.1% | 4.2% | 5.5% |
| *2* | 31.3% | 66.3% | 1.3% | 1.0% | 29.0% | 67.5% | 1.8% | 1.6% |
| *3 or more* | 31.3% | 67.0% | 1.0% | 0.7% | 30.4% | 67.6% | 1.3% | 0.7% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 30.5% | 66.3% | 1.3% | 2.0% | 28.8% | 66.0% | 1.7% | 3.5% |
| *Unlicensed* | 17.6% | 46.3% | 12.2% | 24.0% | 19.7% | 52.0% | 13.8% | 14.5% |

**Table 10.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Socioeconomic Characteristics in the U.S., 2001-2009.

Individuals with advanced education are less likely to be monomodal drivers and more likely to be multimodal drivers than individuals with a high school degree or less across both survey years in the South Atlantic as well as in Virginia. However, individuals with advanced education are less likely to be monomodal or multimodal greens, except that they were slightly more likely to be multimodal green in Virginia in 2001. Employed individuals are more likely to be drivers as a whole and less likely to be greens across survey years in both geographic areas, except that employed individuals were less likely to be monomodal drivers in Virginia in 2001.

The share of multimodal drivers increases with income in both geographic areas and survey years, reflecting the trend found for the U.S. as a whole. Meanwhile, low income individuals are most likely to be greens in general across survey years and geographic areas. Individuals in households without a vehicle are least likely to be monomodal and multimodal drivers across survey years and geographic areas, except for Virginia in 2001 where they have the highest rate of monomodal driving[4]. In contrast, individuals in car-free households are most likely to be monomodal greens and multimodal greens in both the South Atlantic and Virginia across survey years. In the South Atlantic, 43% of car-free individuals relied solely on green modes in 2001 and 51.2% did so in 2009. In Virginia, the levels were 33.6% and 51.7% respectively. For both the South Atlantic and Virginia, as the number of household cars increases, the proportion of monomodal greens and multimodal greens decreases across both survey years. Licensure has a similar effect to owning a car, and is associated with greater proportions of monomodal and multimodal driving and lower proportions of monomodal and multimodal greens.

| Bivariate Descriptives, NHTS South Atlantic Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 28.1% | 67.8% | 2.0% | 2.1% | 28.0% | 66.8% | 2.4% | 2.9% |
| **Education** | | | | | | | | |
| *High School degree or less* | 31.1% | 63.2% | 2.9% | 2.8% | 32.2% | 60.6% | 3.6% | 3.7% |
| *Education beyond high school* | 26.5% | 70.4% | 1.4% | 1.7% | 25.7% | 70.4% | 1.5% | 2.4% |
| **Employment Status** | | | | | | | | |
| *Employed* | 28.4% | 68.2% | 1.4% | 2.1% | 28.8% | 68.1% | 0.9% | 2.2% |
| *Not in work force or unemployed* | 27.5% | 67.0% | 3.3% | 2.2% | 26.1% | 64.2% | 5.4% | 4.3% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 28.2% | 64.8% | 3.4% | 3.7% | 30.1% | 61.0% | 3.8% | 5.1% |
| *Second and Third* | 28.0% | 69.3% | 1.4% | 1.3% | 27.8% | 69.2% | 1.5% | 1.5% |
| *Highest* | 26.3% | 71.7% | 0.9% | 1.0% | 23.0% | 73.6% | 1.3% | 2.1% |
| **No. of cars** | | | | | | | | |
| *No cars* | 15.2% | 41.8% | 17.7% | 25.3% | 8.4% | 40.4% | 16.4% | 34.8% |
| *1* | 25.0% | 68.8% | 2.7% | 3.4% | 28.4% | 64.5% | 3.5% | 3.6% |
| *2* | 29.9% | 68.3% | 1.1% | 0.7% | 27.5% | 69.4% | 1.4% | 1.7% |
| *3 or more* | 29.3% | 68.8% | 1.1% | 0.8% | 30.4% | 67.9% | 1.3% | 0.4% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 28.7% | 68.8% | 1.1% | 1.4% | 28.5% | 67.6% | 1.5% | 2.4% |
| *Unlicensed* | 20.4% | 54.7% | 13.3% | 11.6% | 20.0% | 56.0% | 14.2% | 9.8% |

**Table 11.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Socioeconomic Characteristics in the South Atlantic, 2001-2009.

[4] This is likely due to the very small sample size of car-free households in the 2001 Virginia sample and the related lack of representativeness of the 2001 Virginia sample.

| Bivariate Descriptives, NHTS Virginia Sample | Week 2001* | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 23.5% | 71.3% | 1.9% | 3.3% | 27.0% | 68.3% | 2.2% | 2.5% |
| **Education** | | | | | | | | |
| *High School degree or less* | 25.0% | 69.3% | 2.5% | 3.3% | 33.0% | 61.3% | 3.0% | 2.7% |
| *Education beyond high school* | 22.7% | 72.4% | 1.5% | 3.4% | 24.6% | 71.6% | 1.6% | 2.3% |
| **Employment Status** | | | | | | | | |
| *Employed* | 22.2% | 72.5% | 1.1% | 4.2% | 27.5% | 69.8% | 0.9% | 1.8% |
| *Not in work force or unemployed* | 26.3% | 68.7% | 3.8% | 1.2% | 25.9% | 64.6% | 5.2% | 4.3% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 26.3% | 63.9% | 3.3% | 6.4% | 28.8% | 62.7% | 3.6% | 4.9% |
| *Second and Third* | 23.6% | 72.7% | 1.6% | 2.1% | 27.7% | 69.4% | 1.8% | 1.1% |
| *Highest* | 20.3% | 77.2% | 0.9% | 1.6% | 23.0% | 73.4% | 0.9% | 2.6% |
| **No. of cars** | | | | | | | | |
| *No cars* | 33.7% | 32.6% | 11.4% | 22.2% | 6.7% | 41.6% | 16.4% | 35.3% |
| *1* | 17.7% | 70.7% | 4.1% | 7.5% | 25.4% | 66.3% | 3.6% | 4.7% |
| *2* | 28.3% | 68.7% | 1.7% | 1.3% | 25.0% | 71.8% | 1.7% | 1.5% |
| *3 or more* | 21.0% | 76.8% | 0.5% | 1.7% | 30.6% | 67.7% | 1.2% | 0.5% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 23.7% | 72.3% | 1.5% | 2.4% | 27.5% | 69.1% | 1.5% | 1.9% |
| *Unlicensed* | 19.5% | 54.0% | 9.1% | 17.4% | 19.8% | 55.6% | 12.5% | 12.0% |
| ** Virginia 2001 sample not representative; NHTS Virginia Add-On sample was done in 2009* | | | | | | | | |

**Table 12.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Socioeconomic Characteristics in Virginia, 2001-2009.

### 4.3.3 Population Density and Public Transport Access

Individuals who live at higher densities are more likely monomodal (6.3% vs. 2.2%) or multimodal (22.1% vs. 2.0%) greens and individuals at lower density are more likely monomodal (29.2% vs. 19.2%) or multimodal (66.5% vs. 52.4%) car users. Similarly, individuals who live in metropolitan areas with rail are more likely monomodal (3.9% vs. 2.2%) or multimodal (10.2% vs. 1.9%) greens while individuals outside of metropolitan areas with rail more likely to be monomodal (29.5% vs. 24.5%) or multimodal (66.4% vs. 61.3%) car users.

| | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 29.4% | 64.7% | 2.1% | 3.7% | 28.0% | 64.9% | 2.7% | 4.4% |
| **Density** | | | | | | | | |
| *Below 10,000* | 31.0% | 65.9% | 1.8% | 1.4% | 29.2% | 66.5% | 2.2% | 2.0% |
| *10,000 and above* | 18.5% | 56.7% | 4.8% | 20.0% | 19.2% | 52.4% | 6.3% | 22.1% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 22.8% | 64.4% | 3.0% | 9.8% | 24.5% | 61.3% | 3.9% | 10.2% |
| *MSA Does Not Have Rail/HH Not in MSA* | 32.1% | 64.8% | 1.8% | 1.3% | 29.5% | 66.4% | 2.2% | 1.9% |

**Table 13.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Population Density, and Public Transport Access in the U.S., 2001-2009.

These trends for density hold across all three geographic areas, except that in 2001 individuals living in dense areas in Virginia were less likely to be monomodal green and individuals living in dense areas in the South Atlatnic were more likely monomodal drivers. Individuals in MSAs with rail are consistently more likely to be multimodal greens across geographic areas and survey years. MSAs with rail have the same or slightly higher rates of monomodal greens in the South Atlantic, but in Virginia lower rates in 2001 and higher rates in 2009. Multimodal driving rates are lower in MSAs with rail, except for Virginia in 2009 where they are higher. Monomodal driving rates are lower in MSAs with rail across survey years and geographic areas, except for the South Atlantic in 2001 where they are higher.

| **Bivariate Descriptives, NHTS South Atlantic Sample** | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 28.1% | 67.8% | 2.0% | 2.1% | 28.0% | 66.8% | 2.4% | 2.9% |
| **Density** | | | | | | | | |
| *Below 10,000* | 28.1% | 68.5% | 1.9% | 1.5% | 28.1% | 67.4% | 2.3% | 2.2% |
| *10,000 and above* | 29.2% | 53.2% | 4.1% | 13.4% | 24.7% | 52.7% | 4.6% | 18.0% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 31.6% | 62.3% | 2.0% | 4.1% | 26.5% | 65.3% | 2.7% | 5.4% |
| *MSA Does Not Have Rail/HH Not in MSA* | 26.6% | 70.3% | 2.0% | 1.2% | 28.6% | 67.5% | 2.2% | 1.7% |

**Table 14.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Population Density, and Public Transport Access in the South Atlantic, 2001-2009.

| Bivariate Descriptives, NHTS Virginia Sample | Week 2001* | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 23.5% | 71.3% | 1.9% | 3.3% | 27.0% | 68.3% | 2.2% | 2.5% |
| **Density** | | | | | | | | |
| *Below 10,000* | 23.9% | 72.4% | 2.0% | 1.8% | 27.2% | 68.8% | 2.0% | 2.0% |
| *10,000 and above* | 19.8% | 59.5% | 1.2% | 19.5% | 23.0% | 59.0% | 6.0% | 12.0% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 22.9% | 70.4% | 1.1% | 5.6% | 20.6% | 72.4% | 2.3% | 4.8% |
| *MSA Does Not Have Rail/HH Not in MSA* | 23.8% | 71.7% | 2.4% | 2.1% | 30.1% | 66.4% | 2.1% | 1.4% |
| ** Virginia 2001 sample not representative; NHTS Virginia Add-On sample was done in 2009 Only* | | | | | | | | |

**Table 15.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens by Population Density, and Public Transport Access in Virginia, 2001-2009.

### *4.4 Determinants of Multimodality Using Intensity Measures*

As discussed above in section 4.2.1 and presented in Figures 14-19, multimodality may be defined based on different thresholds for the relative intensity of use by a single mode. Tables 16-21 display the bivariate share of weekly multimodal drivers and multimodal greens for demographic, socioeconomic, and land use subgroups across intensity thresholds. The intensity thresholds for multimodal drivers are defined by 1+, 3+, 5+, and 7+ trips per week by non-automobile modes and for multimodal green users are defined by <100%, <90%, <70%, and <50% of trips by a single green mode.

There are three major trends presented in Tables 16-21. First, there is a general trend toward greater intensity of multimodality among multimodal drivers and stable or slightly increased intensity of multimodality among multimodal greens. In almost all cases, the share of multimodal drivers in the 7+ group increased by at least a percentage between 2001 and 2009; exceptions were the 16-24 and 65 and older groups, lowest income, car-free, high density, and MSA with rail groups. Thus, drivers who use other modes seemed to increase use of those other modes between 2001 and 2009; at the sample average level, the 7+ group increased from 20.7% to 23.3%. Likewise, in almost all cases, the share of multimodal greens in the <50% group remained stable or increased slightly, with the exception of the unlicensed group. Second, within the tabulations for 2001 and 2009, the range of subgroup differences tends to decrease with higher intensity thresholds, although exceptions for multimodal drivers include males vs. females, and those inside vs. outside MSAs with rail. Finally, for multimodal greens, the lower intensity threshold tabulations for the subgroups tend to be more significantly different from the sample average than the higher intensity threshold tabulations.

Overall, demographic, socioeconomic, and land use subgroup tabulations based on higher intensity thresholds generally follow the trends presented in section 4.3 above, although in a number of cases the relative positions of subgroups actually change. For example, the relative position for men and women actually reverses at the highest intensity measure for multimodal greens in both 2001 and 2009, and the relative positions among the age, life cycle, income, density, and access to rail groups change for multimodal car use in one or both of the survey years.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 |
| | % | % | % | % | % | % | % | % |
| **All** | 64.7% | 47.6% | 31.0% | 20.7% | 64.9% | 48.2% | 33.1% | 23.3% |
| **Sex** | | | | | | | | |
| *Male* | 65.0% | 48.2% | 32.8% | 22.4% | 65.4% | 49.2% | 35.3% | 25.2% |
| *Female* | 64.4% | 46.9% | 29.3% | 19.1% | 64.4% | 47.3% | 31.0% | 21.4% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 67.0% | 49.4% | 32.0% | 21.3% | 66.7% | 49.6% | 34.0% | 23.9% |
| *Non White* | 58.7% | 42.5% | 28.2% | 19.3% | 59.7% | 44.1% | 30.4% | 21.3% |
| **Age Group** | | | | | | | | |
| *16-24* | 62.8% | 46.5% | 31.8% | 22.2% | 64.9% | 47.4% | 31.4% | 22.8% |
| *25-34* | 64.4% | 45.2% | 28.1% | 18.5% | 66.8% | 47.8% | 32.5% | 21.9% |
| *35-49* | 67.0% | 48.3% | 30.9% | 20.5% | 67.7% | 49.7% | 34.1% | 23.4% |
| *50-64* | 65.8% | 49.8% | 32.5% | 21.4% | 64.8% | 49.2% | 34.4% | 24.9% |
| *65 and older* | 60.6% | 47.4% | 32.7% | 21.9% | 56.8% | 44.6% | 31.4% | 21.8% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 65.5% | 48.7% | 32.3% | 21.7% | 63.3% | 47.8% | 33.7% | 24.4% |
| *Singles* | 60.8% | 47.0% | 31.5% | 21.9% | 60.8% | 46.4% | 32.6% | 23.5% |
| *Households With Children* | 64.9% | 46.8% | 29.9% | 19.7% | 67.0% | 49.0% | 32.9% | 22.4% |

**Table 16.** Variability in Shares of Weekly Multimodal Drivers by Demographic Characteristics and Intensity Thresholds in the U.S., 2001-2009.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% |
| | % | % | % | % | % | % | % | % |
| **All** | 3.7% | 3.3% | 2.2% | 0.3% | 4.4% | 3.9% | 2.5% | 0.5% |
| **Sex** | | | | | | | | |
| *Male* | 3.6% | 3.2% | 2.1% | 0.4% | 4.3% | 3.8% | 2.5% | 0.7% |
| *Female* | 3.8% | 3.4% | 2.2% | 0.3% | 4.4% | 3.9% | 2.6% | 0.4% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 2.0% | 1.8% | 1.1% | 0.1% | 2.8% | 2.4% | 1.5% | 0.4% |
| *Non White* | 8.4% | 7.4% | 5.0% | 0.8% | 8.9% | 7.9% | 5.5% | 1.0% |
| **Age Group** | | | | | | | | |
| *16-24* | 5.7% | 5.2% | 3.4% | 0.6% | 5.6% | 4.8% | 3.4% | 0.6% |
| *25-34* | 4.9% | 4.5% | 2.7% | 0.4% | 5.8% | 5.0% | 3.0% | 0.6% |
| *35-49* | 2.9% | 2.5% | 1.7% | 0.2% | 3.9% | 3.6% | 2.5% | 0.6% |
| *50-64* | 2.9% | 2.5% | 1.9% | 0.2% | 3.9% | 3.5% | 2.4% | 0.4% |
| *65 and older* | 2.7% | 2.2% | 1.4% | 0.2% | 3.4% | 2.8% | 1.6% | 0.4% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 3.5% | 3.2% | 1.9% | 0.3% | 4.3% | 3.8% | 2.5% | 0.5% |
| *Singles* | 6.4% | 5.7% | 3.7% | 0.6% | 6.9% | 6.2% | 4.0% | 1.0% |
| *Households With Children* | 3.3% | 2.9% | 2.0% | 0.3% | 3.8% | 3.3% | 2.2% | 0.5% |

**Table 17.** Variability in Shares of Weekly Multimodal Greens by Demographic Characteristics and Intensity Thresholds in the U.S., 2001-2009.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 |
| | % | % | % | % | % | % | % | % |
| **All** | 64.7% | 47.6% | 31.0% | 20.7% | 64.9% | 48.2% | 33.1% | 23.3% |
| **Education** | | | | | | | | |
| *High School degree or less* | 59.5% | 43.5% | 28.7% | 19.5% | 58.2% | 43.5% | 30.0% | 21.4% |
| *Education beyond high school* | 68.0% | 50.1% | 32.4% | 21.5% | 68.7% | 51.0% | 34.8% | 24.2% |
| **Employment Status** | | | | | | | | |
| *Employed* | 65.7% | 47.7% | 30.7% | 20.4% | 66.4% | 48.7% | 33.1% | 23.0% |
| *Not in work force or unemployed* | 62.3% | 47.2% | 31.7% | 21.5% | 61.6% | 47.2% | 33.2% | 23.8% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 61.1% | 49.9% | 33.2% | 22.9% | 58.8% | 44.2% | 31.4% | 22.8% |
| *Second and Third* | 65.9% | 46.8% | 29.9% | 19.7% | 67.3% | 50.0% | 33.6% | 23.5% |
| *Highest* | 70.9% | 48.1% | 32.0% | 21.6% | 71.7% | 52.7% | 35.6% | 24.3% |
| **No. of cars** | | | | | | | | |
| *No cars* | 34.1% | 28.9% | 23.7% | 19.7% | 31.5% | 25.8% | 20.2% | 16.4% |
| *1* | 64.1% | 48.9% | 33.3% | 23.1% | 63.1% | 48.5% | 34.9% | 25.7% |
| *2* | 66.3% | 47.5% | 30.3% | 19.7% | 67.5% | 49.3% | 33.4% | 22.7% |
| *3 or more* | 67.0% | 49.3% | 31.4% | 20.7% | 67.6% | 50.0% | 33.6% | 23.4% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 66.3% | 48.6% | 31.3% | 20.7% | 66.0% | 49.0% | 33.4% | 23.4% |
| *Unlicensed* | 46.3% | 35.8% | 27.9% | 20.5% | 52.0% | 40.1% | 29.8% | 21.7% |

**Table 18.** Variability in Shares of Weekly Multimodal Car Users by Socioeconomic Characteristics and Intensity Thresholds in the U.S., 2001-2009.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% |
| | % | % | % | % | % | % | % | % |
| **All** | 3.7% | 3.3% | 2.2% | 0.3% | 4.4% | 3.9% | 2.5% | 0.5% |
| **Education** | | | | | | | | |
| *High School degree or less* | 4.3% | 3.7% | 2.6% | 0.4% | 5.5% | 4.8% | 3.0% | 0.6% |
| *Education beyond high school* | 3.2% | 2.9% | 1.8% | 0.2% | 3.6% | 3.2% | 2.2% | 0.5% |
| **Employment Status** | | | | | | | | |
| *Employed* | 3.6% | 3.3% | 2.1% | 0.3% | 3.6% | 3.2% | 2.3% | 0.5% |
| *Not in work force or unemployed* | 3.9% | 3.3% | 2.2% | 0.3% | 6.1% | 5.3% | 3.2% | 0.7% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 6.3% | 5.4% | 3.6% | 0.7% | 7.6% | 6.6% | 4.4% | 1.0% |
| *Second and Third* | 2.1% | 2.0% | 1.2% | 0.1% | 2.5% | 2.3% | 1.6% | 0.3% |
| *Highest* | 2.7% | 2.4% | 1.5% | 0.1% | 3.0% | 2.6% | 1.7% | 0.3% |
| **No. of cars** | | | | | | | | |
| *No cars* | 45.6% | 40.7% | 27.8% | 4.3% | 48.3% | 42.0% | 28.2% | 6.2% |
| *1* | 5.1% | 4.4% | 3.0% | 0.4% | 5.5% | 4.9% | 3.1% | 0.6% |
| *2* | 1.0% | 0.9% | 0.5% | 0.0% | 1.6% | 1.4% | 0.9% | 0.2% |
| *3 or more* | 0.7% | 0.7% | 0.4% | 0.1% | 0.7% | 0.6% | 0.4% | 0.1% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 2.0% | 1.8% | 1.1% | 0.2% | 3.5% | 3.2% | 2.2% | 0.4% |
| *Unlicensed* | 24.0% | 20.7% | 14.2% | 2.0% | 14.5% | 12.0% | 7.0% | 1.7% |

**Table 19.** Variability in Shares of Weekly Multimodal Car Users by Socioeconomic Characteristics and Intensity Thresholds in the U.S., 2001-2009.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 |
| | % | % | % | % | % | % | % | % |
| **All** | 64.7% | 47.6% | 31.0% | 20.7% | 64.9% | 48.2% | 33.1% | 23.3% |
| **Density** | | | | | | | | |
| *Below 10,000* | 65.9% | 48.1% | 30.8% | 20.3% | 66.5% | 49.3% | 33.5% | 23.4% |
| *10,000 and above* | 56.7% | 43.7% | 32.4% | 24.1% | 52.4% | 40.4% | 30.3% | 22.4% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 64.4% | 47.7% | 32.6% | 22.5% | 61.3% | 45.7% | 32.3% | 23.2% |
| *MSA Does Not Have Rail/HH Not in MSA* | 64.8% | 47.5% | 30.4% | 20.0% | 66.4% | 49.3% | 33.5% | 23.3% |

**Table 20.** Variability in Shares of Weekly Multimodal Car Users by Urban Characteristics and Intensity Thresholds in the U.S., 2001-2009.

| Bivariate Descriptives, NHTS U.S. Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% |
| | % | % | % | % | % | % | % | % |
| **All** | 3.7% | 3.3% | 2.2% | 0.3% | 4.4% | 3.9% | 2.5% | 0.5% |
| **Density** | | | | | | | | |
| *Below 10,000* | 1.4% | 1.2% | 0.8% | 0.1% | 2.0% | 1.8% | 1.2% | 0.3% |
| *10,000 and above* | 20.0% | 17.8% | 11.6% | 1.6% | 22.1% | 19.5% | 12.6% | 2.4% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 9.8% | 8.8% | 5.9% | 0.8% | 10.2% | 9.0% | 5.9% | 1.2% |
| *MSA Does Not Have Rail/HH Not in MSA* | 1.3% | 1.1% | 0.7% | 0.1% | 1.9% | 1.7% | 1.1% | 0.3% |

**Table 21.** Variability in Shares of Weekly Multimodal Car Users by Urban Characteristics and Intensity Thresholds in the U.S., 2001-2009.

The three major trends identified for the U.S. as a whole regarding intensity thresholds for both multimodal drivers and multimodal greens generally hold for the South Atlantic and Virginia, though they are more consistent for the South Atlantic while Virginia has more exceptions, likely due to the non-representative nature of the sample for Virginia in 2001. For the South Atlantic and Virginia, the intensity of multimodal drivers tends to increase between 2001 and 2009 and remain stable for multimodal greens, with many exceptions across the demographic, socioeconomic, and land use variables. As is the case for the U.S. as a whole, the range of subgroup differences also tends to decrease with increasing intensity thresholds. Finally, the differences among subgroups for multimodal greens tend to be more significant at the lower intensity thresholds.

Overall trends among demographic, socioeconomic, and land use subgroups based on higher intensity thresholds follow the trends using the lowest intensity threshold, although as with the U.S. as a whole, some of the relative positions for the subgroups shift with the higher intensity thresholds. For example, the relative position for men and women shifts for both the South Atlantic and Virginia for multimodal greens in 2009. A number of shifts for the age and life cycle groups also occur for multimodal drivers in one or both of the years.

| Bivariate Descriptives, NHTS South Atlantic Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 |
| | % | % | % | % | % | % | % | % |
| **All** | 67.8% | 51.0% | 33.9% | 22.7% | 66.8% | 51.5% | 35.9% | 25.8% |
| **Sex** | | | | | | | | |
| *Male* | 68.4% | 52.0% | 36.4% | 25.2% | 67.3% | 53.0% | 38.1% | 28.0% |
| *Female* | 67.2% | 50.1% | 31.7% | 20.4% | 66.3% | 50.1% | 33.8% | 23.7% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 70.5% | 53.9% | 36.3% | 24.5% | 68.3% | 53.1% | 37.2% | 26.6% |
| *Non White* | 62.0% | 45.1% | 29.0% | 19.0% | 63.0% | 47.6% | 32.5% | 23.7% |
| **Age Group** | | | | | | | | |
| *16-24* | 66.4% | 49.8% | 36.5% | 24.9% | 65.2% | 50.3% | 35.0% | 25.3% |
| *25-34* | 67.8% | 49.9% | 31.8% | 20.2% | 69.0% | 50.4% | 34.4% | 25.0% |
| *35-49* | 69.0% | 50.5% | 31.5% | 21.7% | 70.4% | 53.7% | 37.0% | 26.2% |
| *50-64* | 69.6% | 54.5% | 37.0% | 23.5% | 66.8% | 52.6% | 37.1% | 27.4% |
| *65 and older* | 63.9% | 49.9% | 34.8% | 24.9% | 58.7% | 47.5% | 33.8% | 23.4% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 69.3% | 52.6% | 35.5% | 24.3% | 65.7% | 51.7% | 36.7% | 26.9% |
| *Singles* | 65.3% | 48.4% | 32.5% | 23.9% | 61.9% | 48.5% | 34.2% | 24.2% |
| *Households With Children* | 67.0% | 50.3% | 32.9% | 21.1% | 68.8% | 52.1% | 35.6% | 25.4% |
| **Education** | | | | | | | | |
| *High School degree or less* | 63.2% | 53.1% | 34.8% | 23.4% | 60.6% | 47.3% | 33.3% | 24.9% |
| *Education beyond high school* | 70.4% | 47.4% | 32.6% | 21.7% | 70.4% | 53.9% | 37.3% | 26.3% |
| **Employment Status** | | | | | | | | |
| *Employed* | 68.2% | 50.7% | 33.3% | 22.3% | 68.1% | 52.0% | 35.9% | 25.7% |
| *Not in work force or unemployed* | 67.0% | 51.8% | 35.3% | 23.7% | 64.2% | 50.6% | 35.8% | 26.0% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 64.8% | 48.4% | 33.4% | 23.2% | 61.0% | 47.5% | 33.9% | 25.2% |
| *Second and Third* | 69.3% | 51.8% | 33.0% | 22.8% | 69.2% | 52.6% | 35.5% | 24.6% |
| *Highest* | 71.7% | 55.5% | 37.7% | 22.8% | 73.6% | 57.2% | 40.4% | 29.1% |
| **No. of cars** | | | | | | | | |
| *No cars* | 41.8% | 34.0% | 26.5% | 21.5% | 40.4% | 34.7% | 26.7% | 21.2% |
| *1* | 68.8% | 51.2% | 35.3% | 24.6% | 64.5% | 49.7% | 35.2% | 25.9% |
| *2* | 68.3% | 50.2% | 32.9% | 22.1% | 69.4% | 53.0% | 36.5% | 25.6% |
| *3 or more* | 68.8% | 53.5% | 34.9% | 22.2% | 67.9% | 52.7% | 36.6% | 26.5% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 68.8% | 51.8% | 34.3% | 23.0% | 67.6% | 52.0% | 36.2% | 26.0% |
| *Unlicensed* | 54.7% | 40.5% | 29.6% | 18.5% | 56.0% | 44.5% | 31.3% | 23.4% |
| **Density** | | | | | | | | |
| *Below 10,000* | 68.5% | 51.6% | 34.0% | 22.7% | 67.4% | 51.9% | 36.1% | 26.0% |
| *10,000 and above* | 53.2% | 40.3% | 33.8% | 24.4% | 52.7% | 43.2% | 30.5% | 22.6% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 62.3% | 44.3% | 31.1% | 20.5% | 65.3% | 50.4% | 34.8% | 24.8% |
| *MSA Does Not Have Rail/HH Not in MSA* | 70.3% | 54.1% | 35.2% | 23.7% | 67.5% | 52.0% | 36.4% | 26.3% |

**Table 22.** Variability in Shares of Weekly Multimodal Car Users by Demographic, Socioeconomic, and Land Use Characteristics and Intensity Thresholds in the South Atlantic, 2001-2009.

| Bivariate Descriptives, NHTS Virginia Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 |
| | % | % | % | % | % | % | % | % |
| **All** | 71.3% | 55.1% | 36.3% | 25.7% | 68.3% | 52.4% | 37.1% | 26.3% |
| **Sex** | | | | | | | | |
| *Male* | 71.5% | 57.1% | 40.3% | 29.2% | 69.8% | 54.0% | 39.7% | 28.6% |
| *Female* | 71.0% | 53.2% | 32.6% | 22.3% | 66.9% | 50.8% | 34.5% | 23.9% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 74.5% | 57.9% | 38.7% | 27.1% | 69.7% | 54.2% | 38.5% | 27.0% |
| *Non White* | 62.3% | 46.6% | 28.9% | 21.7% | 64.4% | 47.6% | 33.2% | 24.2% |
| **Age Group** | | | | | | | | |
| *16-24* | 66.7% | 52.3% | 40.4% | 29.7% | 71.9% | 55.1% | 39.2% | 25.9% |
| *25-34* | 67.5% | 51.2% | 31.1% | 21.6% | 68.9% | 48.8% | 33.8% | 25.9% |
| *35-49* | 77.2% | 57.5% | 37.1% | 26.9% | 70.3% | 53.7% | 37.4% | 25.8% |
| *50-64* | 70.4% | 56.4% | 35.6% | 21.0% | 68.5% | 53.6% | 38.3% | 28.1% |
| *65 and older* | 67.9% | 55.2% | 39.5% | 33.7% | 58.2% | 47.3% | 34.9% | 24.7% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 70.7% | 56.6% | 36.9% | 24.9% | 67.2% | 51.9% | 38.7% | 28.0% |
| *Singles* | 75.9% | 53.2% | 36.6% | 30.8% | 63.0% | 49.9% | 34.0% | 24.6% |
| *Households With Children* | 70.7% | 54.2% | 35.8% | 25.1% | 70.4% | 53.4% | 36.5% | 25.2% |
| **Education** | | | | | | | | |
| *High School degree or less* | 69.3% | 57.4% | 37.8% | 26.4% | 61.3% | 46.9% | 34.5% | 24.5% |
| *Education beyond high school* | 72.4% | 53.8% | 35.4% | 25.2% | 71.6% | 55.0% | 38.3% | 27.0% |
| **Employment Status** | | | | | | | | |
| *Employed* | 72.5% | 54.6% | 35.7% | 24.5% | 69.8% | 52.7% | 37.4% | 26.5% |
| *Not in work force or unemployed* | 68.7% | 56.2% | 37.8% | 28.2% | 64.6% | 51.7% | 36.4% | 25.7% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 63.9% | 52.6% | 34.9% | 24.5% | 62.7% | 48.7% | 35.9% | 24.9% |
| *Second and Third* | 72.7% | 55.2% | 35.7% | 25.6% | 69.4% | 53.0% | 36.6% | 26.0% |
| *Highest* | 77.2% | 57.3% | 39.1% | 27.0% | 73.4% | 55.9% | 39.7% | 28.1% |
| **No. of cars** | | | | | | | | |
| *No cars* | 32.6% | 26.5% | 19.2% | 15.4% | 41.6% | 35.1% | 22.8% | 13.4% |
| *1* | 70.7% | 53.5% | 40.0% | 29.0% | 66.3% | 51.1% | 37.7% | 28.8% |
| *2* | 68.7% | 53.3% | 34.0% | 24.5% | 71.8% | 54.5% | 38.3% | 26.1% |
| *3 or more* | 76.8% | 59.7% | 38.0% | 25.8% | 67.7% | 52.1% | 36.6% | 26.2% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 72.3% | 55.5% | 36.2% | 25.9% | 69.1% | 53.0% | 37.3% | 26.3% |
| *Unlicensed* | 54.0% | 48.9% | 39.1% | 21.3% | 55.6% | 43.5% | 33.0% | 24.7% |
| **Density** | | | | | | | | |
| *Below 10,000* | 72.4% | 55.4% | 35.5% | 24.7% | 68.8% | 52.6% | 37.0% | 26.1% |
| *10,000 and above* | 59.5% | 52.0% | 45.8% | 35.8% | 59.0% | 48.3% | 38.7% | 28.5% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 70.4% | 52.7% | 39.2% | 26.9% | 72.4% | 55.8% | 39.9% | 28.9% |
| *MSA Does Not Have Rail/HH Not in MSA* | 71.7% | 56.3% | 34.8% | 25.0% | 66.4% | 50.7% | 35.7% | 25.0% |

** Virginia 2001 sample not representative; NHTS Virginia Add-On sample was done in 2009*

**Table 23.** Variability in Shares of Weekly Multimodal Car Users by Demographic, Socioeconomic, and Land Use Characteristics and Intensity Thresholds in Virginia, 2001-2009.

| Bivariate Descriptives, NHTS South Atlantic Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% |
| | % | % | % | % | % | % | % | % |
| **All** | 2.1% | 1.9% | 1.2% | 0.3% | 2.9% | 2.6% | 1.7% | 0.3% |
| **Sex** | | | | | | | | |
| *Male* | 1.9% | 1.6% | 0.8% | 0.1% | 2.8% | 2.5% | 1.8% | 0.3% |
| *Female* | 2.3% | 2.2% | 1.6% | 0.5% | 2.9% | 2.7% | 1.6% | 0.3% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 1.1% | 1.0% | 0.7% | 0.1% | 1.8% | 1.5% | 1.0% | 0.2% |
| *Non White* | 4.2% | 3.8% | 2.3% | 0.8% | 5.6% | 5.2% | 3.4% | 0.6% |
| **Age Group** | | | | | | | | |
| *16-24* | 2.9% | 2.9% | 1.6% | 0.3% | 3.8% | 3.3% | 1.8% | 0.3% |
| *25-34* | 2.5% | 2.2% | 1.2% | 0.1% | 2.8% | 2.5% | 2.0% | 0.3% |
| *35-49* | 1.8% | 1.5% | 1.0% | 0.2% | 3.2% | 3.0% | 2.0% | 0.6% |
| *50-64* | 2.2% | 2.1% | 1.6% | 0.6% | 2.8% | 2.5% | 1.7% | 0.2% |
| *65 and older* | 1.4% | 1.3% | 0.6% | 0.4% | 1.5% | 1.2% | 0.9% | 0.1% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 1.9% | 1.9% | 1.1% | 0.3% | 2.3% | 2.1% | 1.4% | 0.3% |
| *Singles* | 3.2% | 2.9% | 1.2% | 0.4% | 5.1% | 4.8% | 2.8% | 0.5% |
| *Households With Children* | 2.0% | 1.7% | 1.3% | 0.3% | 2.8% | 2.5% | 1.7% | 0.3% |
| **Education** | | | | | | | | |
| *High School degree or less* | 2.8% | 2.5% | 1.9% | 0.5% | 3.7% | 3.3% | 2.1% | 0.5% |
| *Education beyond high school* | 1.7% | 1.6% | 0.8% | 0.2% | 2.4% | 2.1% | 1.5% | 0.2% |
| **Employment Status** | | | | | | | | |
| *Employed* | 2.1% | 1.9% | 1.2% | 0.3% | 2.2% | 2.0% | 1.5% | 0.3% |
| *Not in work force or unemployed* | 2.2% | 2.0% | 1.2% | 0.4% | 4.3% | 3.8% | 2.2% | 0.4% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 3.7% | 3.2% | 1.9% | 0.6% | 5.1% | 4.6% | 3.0% | 0.5% |
| *Second and Third* | 1.3% | 1.3% | 0.8% | 0.2% | 1.5% | 1.4% | 0.9% | 0.2% |
| *Highest* | 1.0% | 0.9% | 0.7% | 0.1% | 2.1% | 1.7% | 1.3% | 0.2% |
| **No. of cars** | | | | | | | | |
| *No cars* | 25.3% | 23.3% | 13.6% | 4.0% | 34.8% | 32.0% | 21.3% | 3.7% |
| *1* | 3.4% | 3.0% | 2.2% | 0.6% | 3.6% | 3.2% | 2.0% | 0.6% |
| *2* | 0.7% | 0.6% | 0.4% | 0.0% | 1.7% | 1.5% | 1.0% | 0.1% |
| *3 or more* | 0.8% | 0.8% | 0.3% | 0.1% | 0.4% | 0.3% | 0.2% | 0.1% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 1.4% | 1.3% | 0.9% | 0.2% | 2.4% | 2.2% | 1.5% | 0.3% |
| *Unlicensed* | 11.6% | 10.3% | 5.4% | 1.8% | 9.8% | 8.4% | 4.4% | 0.8% |
| **Density** | | | | | | | | |
| *Below 10,000* | 1.5% | 1.5% | 0.9% | 0.2% | 2.2% | 1.9% | 1.3% | 0.3% |
| *10,000 and above* | 13.4% | 11.0% | 6.8% | 1.8% | 18.0% | 16.2% | 11.3% | 1.4% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 4.1% | 3.6% | 2.4% | 0.6% | 5.4% | 4.9% | 3.2% | 0.5% |
| *MSA Does Not Have Rail/HH Not in MSA* | 1.2% | 1.1% | 0.6% | 0.2% | 1.7% | 1.5% | 1.0% | 0.2% |

**Table 24.** Variability in Shares of Weekly Multimodal Greens by Demographic, Socioeconomic, and Land Use Characteristics and Intensity Thresholds in the South Atlantic, 2001-2009.

| Bivariate Descriptives, NHTS Virginia Sample | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% |
| | % | % | % | % | % | % | % | % |
| **All** | 3.3% | 2.9% | 2.1% | 0.7% | 2.5% | 2.2% | 1.4% | 0.4% |
| **Sex** | | | | | | | | |
| *Male* | 3.0% | 2.3% | 1.0% | 0.3% | 2.5% | 2.1% | 1.5% | 0.3% |
| *Female* | 3.6% | 3.5% | 3.0% | 1.2% | 2.5% | 2.2% | 1.4% | 0.5% |
| **Race/ethnicity** | | | | | | | | |
| *White* | 1.9% | 1.9% | 1.2% | 0.1% | 2.0% | 1.7% | 1.2% | 0.4% |
| *Non White* | 7.4% | 6.0% | 4.6% | 2.6% | 3.9% | 3.5% | 2.1% | 0.3% |
| **Age Group** | | | | | | | | |
| *16-24* | 7.8% | 7.8% | 6.1% | 1.8% | 4.2% | 3.9% | 2.2% | 0.2% |
| *25-34* | 5.3% | 5.0% | 2.7% | 0.5% | 3.2% | 3.2% | 2.8% | 1.8% |
| *35-49* | 2.2% | 1.2% | 1.0% | 0.0% | 2.7% | 2.5% | 1.8% | 0.1% |
| *50-64* | 1.7% | 1.7% | 1.7% | 1.7% | 1.3% | 0.8% | 0.4% | 0.2% |
| *65 and older* | 1.3% | 1.3% | 0.0% | 0.0% | 1.5% | 0.9% | 0.2% | 0.0% |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | 2.7% | 2.7% | 0.8% | 0.3% | 1.7% | 1.5% | 1.4% | 0.6% |
| *Singles* | 1.7% | 1.7% | 1.7% | 0.0% | 5.3% | 4.6% | 2.5% | 0.2% |
| *Households With Children* | 4.1% | 3.4% | 3.3% | 1.3% | 2.5% | 2.1% | 1.3% | 0.2% |
| **Education** | | | | | | | | |
| *High School degree or less* | 3.3% | 2.4% | 2.4% | 1.1% | 2.7% | 2.2% | 1.7% | 0.2% |
| *Education beyond high school* | 3.4% | 3.3% | 1.9% | 0.6% | 2.3% | 1.9% | 1.3% | 0.5% |
| **Employment Status** | | | | | | | | |
| *Employed* | 4.2% | 3.7% | 2.7% | 0.7% | 1.8% | 1.6% | 1.2% | 0.4% |
| *Not in work force or unemployed* | 1.2% | 1.2% | 0.7% | 0.7% | 4.3% | 3.5% | 1.9% | 0.4% |
| **Income quartiles** | | | | | | | | |
| *Lowest* | 6.4% | 5.4% | 3.2% | 1.7% | 4.9% | 4.0% | 2.4% | 0.1% |
| *Second and Third* | 2.1% | 2.1% | 1.9% | 0.6% | 1.1% | 0.9% | 0.6% | 0.2% |
| *Highest* | 1.6% | 1.4% | 1.0% | 0.0% | 2.6% | 2.4% | 1.8% | 0.9% |
| **No. of cars** | | | | | | | | |
| *No cars* | 22.2% | 22.2% | 10.7% | 3.6% | 35.3% | 29.2% | 22.3% | 1.1% |
| *1* | 7.5% | 6.0% | 5.3% | 2.1% | 4.7% | 4.5% | 2.5% | 1.8% |
| *2* | 1.3% | 1.2% | 0.7% | 0.0% | 1.5% | 1.1% | 0.7% | 0.0% |
| *3 or more* | 1.7% | 1.7% | 1.2% | 0.6% | 0.5% | 0.5% | 0.3% | 0.1% |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | 2.4% | 2.1% | 1.5% | 0.5% | 1.9% | 1.6% | 1.3% | 0.4% |
| *Unlicensed* | 17.4% | 17.4% | 11.7% | 4.3% | 12.0% | 10.7% | 4.0% | 0.2% |
| **Density** | | | | | | | | |
| *Below 10,000* | 1.8% | 1.7% | 1.1% | 0.4% | 2.0% | 1.8% | 1.1% | 0.2% |
| *10,000 and above* | 19.5% | 15.9% | 12.5% | 4.8% | 12.0% | 7.9% | 6.7% | 3.9% |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | 5.6% | 4.5% | 3.9% | 0.8% | 4.8% | 3.9% | 2.6% | 0.9% |
| *MSA Does Not Have Rail/HH Not in MSA* | 2.1% | 2.1% | 1.1% | 0.7% | 1.4% | 1.3% | 0.9% | 0.1% |

** Virginia 2001 sample not representative; NHTS Virginia Add-On sample was done in 2009*

**Table 25.** Variability in Shares of Weekly Multimodal Greens by Demographic, Socioeconomic, and Land Use Characteristics and Intensity Thresholds in Virginia, 2001-2009.

### *4.5 Summary of Changes by Demographic, Socioeconomic, and Urban Characteristics*

For ease of reference, Tables 26-28 summarize the bivariate trends presented above for the U.S. as a whole for monomodal and multimodal drivers, monomodal and multimodal greens, and multimodal drivers and multimodal greens using different intensity thresholds. Each table includes a plus/minus demarcation to indicate whether the subgroup tabulation was at least one percentage point above or below the average of the entire sample.

The bivariate analysis of demographic, socioeconomic, and urban characteristics suggests that monomodal and multimodal car users share some similarities. For example, members of both groups are likely to be part of households with two or more cars, licensed drivers, and residents of low-density areas. There are also some differences between the monomodal and multimodal car user groups. Those 65 years or older, without advanced education, and in the middle-income groups tend to be monomodal car users, while multimodal car users tend to be represented by individuals who are white, 35-49 years old, university educated, and employed. The effect of car ownership is strong for the monomodal and multimodal green groups, with individuals in households without cars being represented in the monomodal green and multimodal green groups in much higher shares. In addition, individuals in one-car households use the green modes at significantly higher rates than individuals in households with at least one car.

Individuals in the monomodal green and multimodal green groups are more likely to be non-white, single, in low income groups, unemployed, without a university degree, in high density areas with rail access, unlicensed, and in households without cars. Women and those 65 and older are more likely to exclusively rely on a single green mode while singles and those between 16 and 34 are more likely to combine multiple green modes during the week. Overall, living at higher densities and close to rail seems to facilitate a car-free lifestyle, while living at lower population densities, or away from rail, is associated with car use – either as a monomodal or multimodal driver.

In addition, with some exceptions, the shares of individuals in the multimodal car and multimodal green groups tend to vary independently of one another, suggesting that determinants of multimodal car and multimodal green use may be distinct. This suggests that a multivariable analysis of multimodality should treat these modality groups as distinct. The next section provides multivariable treatment of the demographic, socioeconomic, and urban characteristics discussed above.

| | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Mono. Car | Multi. Car | Mono. Green | Multi. Green | Mono. Car | Multi. Car | Mono. Green | Multi. Green |
| | % | % | % | % | % | % | % | % |
| **All** | 29.4% | 64.7% | 2.1% | 3.7% | 28.0% | 64.9% | 2.7% | 4.4% |
| **Sex** | | | | | | | | |
| *Male* | | | | | | | | |
| *Female* | | | | | | | | |
| **Race/ethnicity** | | | | | | | | |
| *White* | | + | | - | | + | | - |
| *Non White* | | - | + | + | | - | + | + |
| **Age Group** | | | | | | | | |
| *16-24* | | - | | + | - | | | + |
| *25-34* | | | | + | - | + | | + |
| *35-49* | | + | | | - | + | | |
| *50-64* | | + | | | + | | | |
| *65 and older* | + | - | + | - | + | - | + | - |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | | | | | + | - | | |
| *Singles* | | - | + | + | | - | + | + |
| *Households With Children* | | | | | - | + | | |
| **Education** | | | | | | | | |
| *High School degree or less* | + | - | | | + | - | + | + |
| *Education beyond high school* | - | + | | | - | + | | |
| **Employment Status** | | | | | | | | |
| *Employed* | | + | | | | + | - | |
| *Not in work force or unemployed* | | - | + | | - | - | + | + |
| **Income quartiles** | | | | | | | | |
| *Lowest* | | - | + | + | + | - | + | + |
| *Second and Third* | + | + | | - | | + | - | - |
| *Highest* | - | + | - | | - | + | - | - |
| **No. of cars** | | | | | | | | |
| *No cars* | - | - | + | + | - | - | + | + |
| *1* | - | | + | + | | - | + | + |
| *2* | + | + | | - | + | + | | - |
| *3 or more* | + | + | - | - | + | + | - | - |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | + | + | | - | | + | - | |
| *Unlicensed* | + | - | + | + | - | - | + | + |
| **Density** | | | | | | | | |
| *Below 10,000* | + | + | | - | + | + | | - |
| *10,000 and above* | - | - | + | + | - | - | + | + |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | - | | | + | - | - | + | + |
| *MSA Does Not Have Rail/HH Not in MSA* | + | | | - | + | + | | - |

**Table 26.** Variability in Shares of Weekly Monomodal Drivers, Multimodal Drivers, Monomodal Greens, and Multimodal Greens in the U.S., 2001-2009.

| | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 | Multi. Car 1 | Multi. Car 3 | Multi. Car 5 | Multi. Car 7 |
| | % | % | % | % | % | % | % | % |
| **All** | 64.7% | 47.6% | 31.0% | 20.7% | 64.9% | 48.2% | 33.1% | 23.3% |
| **Sex** | | | | | | | | |
| *Male* | | | + | + | | + | + | + |
| *Female* | | | - | - | | | - | |
| **Race/ethnicity** | | | | | | | | |
| *White* | + | + | + | | + | + | | |
| *Non White* | - | - | - | - | - | - | - | - |
| **Age Group** | | | | | | | | |
| *16-24* | - | - | | + | | | - | |
| *25-34* | | - | - | - | + | | | - |
| *35-49* | + | | | | + | + | + | |
| *50-64* | + | + | + | | | + | + | + |
| *65 and older* | - | | + | + | - | - | - | - |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | | + | + | + | - | | | + |
| *Singles* | - | | | + | - | - | | |
| *Households With Children* | | | - | - | + | | | |
| **Education** | | | | | | | | |
| *High School degree or less* | - | - | - | - | - | - | - | - |
| *Education beyond high school* | + | + | + | | + | + | + | |
| **Employment Status** | | | | | | | | |
| *Employed* | + | | | | + | | | |
| *Not in work force or unemployed* | - | | | | - | - | | |
| **Income quartiles** | | | | | | | | |
| *Lowest* | - | + | + | + | - | - | - | |
| *Second and Third* | + | | - | - | + | + | | |
| *Highest* | + | | + | | + | + | + | + |
| **No. of cars** | | | | | | | | |
| *No cars* | - | - | - | - | - | - | - | - |
| *1* | | + | + | + | - | | + | + |
| *2* | + | | | - | + | + | | |
| *3 or more* | + | + | | | + | + | | |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | + | + | | | + | | | |
| *Unlicensed* | - | - | - | | - | - | - | - |
| **Density** | | | | | | | | |
| *Below 10,000* | + | | | | + | | | |
| *10,000 and above* | - | - | + | + | - | - | - | |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | | | + | + | - | - | | |
| *MSA Does Not Have Rail/HH Not in MSA* | | | | | + | + | | |

**Table 27.** Variability in Shares of Weekly Multimodal Car Drivers by Intensity Thresholds in the U.S., 2001-2009.

| | Week 2001 | | | | Week 2009 | | | |
|---|---|---|---|---|---|---|---|---|
| | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% | Multi. Green <100% | Multi. Green <90% | Multi. Green <70% | Multi. Green <50% |
| | % | % | % | % | % | % | % | % |
| **All** | 3.7% | 3.3% | 2.2% | 0.3% | 4.4% | 3.9% | 2.5% | 0.5% |
| **Sex** | | | | | | | | |
| *Male* | | | | | | | | |
| *Female* | | | | | | | | |
| **Race/ethnicity** | | | | | | | | |
| *White* | - | - | - | | - | - | - | |
| *Non White* | + | + | + | | + | + | + | |
| **Age Group** | | | | | | | | |
| *16-24* | + | + | + | | + | | | |
| *25-34* | + | + | | | + | + | | |
| *35-49* | | | | | | | | |
| *50-64* | | | | | | | | |
| *65 and older* | - | - | | | - | - | | |
| **Household Life Cycle Stage** | | | | | | | | |
| *Two Adults No Children* | | | | | | | | |
| *Singles* | + | + | + | | + | + | + | |
| *Households With Children* | | | | | | | | |
| **Education** | | | | | | | | |
| *High School degree or less* | | | | | + | | | |
| *beyond high school* | | | | | | | | |
| **Employment Status** | | | | | | | | |
| *Employed* | | | | | | | | |
| *Not in work force or* | | | | | + | + | | |
| **Income quartiles** | | | | | | | | |
| *Lowest* | + | + | + | | + | + | + | |
| *Second and* | - | - | - | | - | - | | |
| *Highest* | - | | | | - | - | | |
| **No. of cars** | | | | | | | | |
| *No cars* | + | + | + | + | + | + | + | + |
| *1* | + | + | | | + | + | | |
| *2* | - | - | - | | - | - | - | |
| *3 or more* | - | - | - | | - | - | - | |
| **Driver's Licensure** | | | | | | | | |
| *Licensed* | - | - | - | | | | | |
| *Unlicensed* | + | + | + | + | + | + | + | + |
| **Density** | | | | | | | | |
| *Below 10,000* | - | - | - | | - | - | - | |
| *above* | + | + | + | + | + | + | + | + |
| **Access to Transit** | | | | | | | | |
| *MSA Has Rail* | + | + | + | | + | + | + | |
| *MSA Does Not Have Rail/HH Not in MSA* | - | - | - | | - | - | - | |

**Table 28.** Variability in Shares of Weekly Multimodal Greens by Intensity Thresholds in the U.S., 2001-2009.

### *4.6 Multivariable Analysis of the 4 Modality Groups by Demographic, Socioeconomic, and Urban Characteristics*

The bivariate analysis presented above investigates the relationship between each demographic, socioeconomic, and land-use variable and the four modality groups—monomodal drivers, multimodal drivers, monomodal green users, and multimodal green users—one at a time. The analysis below uses three binomial logistic regression analyses to compare monomodal drivers to multimodal drivers (Model 1); monomodal green users (Model 2); and multimodal green users (Model 3). Monomodal drivers were chosen as the base category for each model, because most government policies have the goal to reduce car use—either by shifting some or all trips to alternative means of transport. Thus, it is relevant to identify how each of the groups differs from monomodal car users who drive for all trips.

The three binomial logistic regression analyses assess the impact of each independent variable on the likelihood to fall into one of the three modality groups compared to the monomodal driver category while controlling for other variables in the analysis. Alternatively, a multinomial logit model MNL could have included all four categories at once. Results of the individual binary regression models and the MNL are comparable. However, statistical tests (Small-Hsiao and Hausman tests) suggest that the MNL model violates the Independence of Irrelevant Alternatives (IIA) assumption.

Tables 29 presents results for the three binary logistic regressions based on data from the 2009 NHTS. The number of cases varies for each regression—each includes the number of individuals in the monomodal driver category plus either multimodal drivers, monomodal greens, or multimodal greens. The three regressions include as explanatory variables all of the demographic, socio-economic, and land-use characteristics introduced above. Results are presented as adjusted odds ratios (AORs) identifying each population sub-group's likelihood of falling into one of the modality groups relative to a specific reference group assigned the base value 1.00. For each AOR the level of statistical significance is indicated at either $p<0.01$, $p<0.05$, or $p<0.10$. Available statistics indicate that all variables have joint significance (Likelihood Ratio Test significant at $p<0.01$ for all models) and that multicollinearity is not a significant concern (VIF <5, Tolerance >0.2, Condition number<30). Model 1 (comparing multimodal and monomodal car users) has a comparatively low Pseudo R-squared (~0.02). Models 2 and 3 have much higher Pseudo R-squared values (~0.16 and ~0.45). However, even Model 1 classifies 69% of all cases correctly (vs. 94% for Model 2 and 97% for Model 3).

| Binomial Logit<br>Monomodal Car as Base<br>U.S. Sample<br>2009 NHTS | Model 1<br>Multimodal<br>Car | Model 2<br>Monomodal<br>Green | Model 3<br>Multimodal<br>Green |
|---|---|---|---|
| | *Odds Ratio* | | |
| Gender | | | |
| Female | 1.000 | 1.000 | 1.000 |
| Male | 1.119*** | 1.302*** | 1.803*** |
| Race/Ethnicity | | | |
| Non-White | 1.000 | 1.000 | 1.000 |
| White | 1.112*** | 0.985 | 0.893* |
| Age Group | | | |
| 16-24 | 1.501*** | 2.135*** | 13.092*** |
| 25-34 | 1.630*** | 2.661*** | 7.480*** |
| 35-49 | 1.588*** | 2.193*** | 4.955*** |
| 50-64 | 1.440*** | 1.803*** | 3.727*** |
| 65 and older | 1.000 | 1.000 | 1.000 |
| Household Life Cycle | | | |
| Two Adults No Children | 1.000 | 1.000 | 1.000 |
| Singles | 1.043** | 0.839*** | 0.565*** |
| Households With Children | 1.022 | 0.794*** | 0.769*** |
| Education | | | |
| High School Degree or Less | 1.000 | 1.000 | 1.000 |
| Education Beyond H.S. | 1.399*** | 1.232*** | 1.406*** |
| Employment | | | |
| Unemployed, Not in Workforce | 1.000 | 1.000 | 1.000 |
| Employed | 0.841*** | 0.233*** | 0.598*** |
| Income | | | |
| Income Quartile 1 | 0.906*** | 1.082* | 1.043 |
| Income Quartiles 2 and 3 | 1.000 | 1.000 | 1.000 |
| Income Quartile 4 | 1.200*** | 1.073 | 1.769*** |
| Household Automobiles | | | |
| 0 Cars | 1.000 | 1.000 | 1.000 |
| 1 Car | 0.496*** | 0.132*** | 0.026*** |
| 2 Cars | 0.483*** | 0.082*** | 0.006*** |
| 3 or more Cars | 0.447*** | 0.067*** | 0.003*** |
| License | | | |
| Unlicensed | 1.000 | 1.000 | 1.000 |
| Licensed | 1.202*** | 0.404*** | 0.717*** |
| Population Density | | | |
| Density < 10,000 | 1.000 | 1.000 | 1.000 |
| Density 10,000 and Above | 1.182*** | 2.189*** | 5.518*** |
| Access to Rail | | | |
| Live Outside MSA With Rail | 1.000 | 1.000 | 1.000 |
| Live Inside MSA With Rail | 1.066*** | 1.358*** | 2.334*** |
| | | | |
| Goodness of Fit Measures | | | |
| McFadden's pseudo-R^2 | 0.016 | 0.149 | 0.436 |
| Nagelkerke pseudo-R^2 | 0.027 | 0.184 | 0.489 |
| LR Test (Pearson's) p-value | 0.000 | 0.000 | 0.000 |
| Correctly Classified | 68.56% | 93.47% | 96.66% |
| Number of Observations | 193,562 | 65,324 | 64,277 |

Source: Calculated by authors based on NHTS 2009 Version 2.0.
Relative likelihoods were calculated using logistic regressions, which control for the influence of other variables.

Excludes persons younger than 16 years.
***: p<0.01; **: p<0.05; *: p<0.10

**Table 29.** Binomial Logistic Analysis of Modality Groups for the U.S., NHTS 2009.

### 4.6.1 Model 1: Comparing Multimodal Drivers to Monomodal Drivers

In 2009 men were 1.119 times as likely as women to be multimodal drivers. Similarly, whites were more likely to be multimodal drivers than other races/ethnicities (AOR 1.112). Compared to other age groups, individuals 65 and older were least likely to be in the multimodal driver category. Singles (AOR 1.043) were more likely multimodal drivers than persons in households with two or more adults and no children. Higher education and higher income levels were associated with a greater likelihood to be a multimodal driver: individuals with education beyond high school were 1.399 times as likely to be multimodal drivers as individuals with a high school degree or less. Similarly, individuals living in households in the highest income quartile (AOR 1.200) were more likely to be multimodal drivers than those in the middle two quartiles. Persons in the lowest income quartile were less likely multimodal drivers (AOR 0.906). Employed individuals were less likely multimodal drivers than unemployed persons and those not in the workforce.

Owning a car was associated with monomodal driving. Individuals in households with one, two, or three or more cars were significantly less likely to be multimodal drivers than individuals in car-free (or carless) households (AORs: 0.496, 0.483, and 0.447). Licensed drivers were more likely multimodal drivers than those without a driver's license (AOR 1.202). Lastly, population density and rail access were also positively associated with multimodal car use (AORs: 1.182 and 1.066).

### 4.6.2 Model 2: Comparing Monomodal Green Users to Monomodal Drivers

The sign and significance of most of the coefficients distinguishing monomodal green users from monomodal drivers in Model 2 are comparable to coefficients in Model 1 identifying multimodal drivers vs. monomodal drivers. Even though the direction of the relationships is similar, the magnitude of most coefficients in Model 2 is stronger than in Model 1—negative relationships are more negative and positive associations are more positive.

Similar to Model 1, in Model 2 men are more likely than women to be monomodal green users. Individuals in the oldest age group are least likely to be monomodal green users. Singles and individuals in households with children are less likely to be monomodal green than individuals in households with two adults and no children. Persons with higher education are more likely monomodal green users than monomodal drivers (AOR 1.232). Employed individuals are less likely to be monomodal green users (AOR 0.233). Low-income individuals are slightly more likely to be monomodal green users (AOR: 1.082). Car ownership is negatively related to being monomodal green, while population density and rail access are positively correlated with falling into the monomodal green category. In contrast to Model 1, race/ethnicity is not significantly related to being a monomodal green user. Moreover, in contrast to the relationship found in Model 1, licensed drivers are only 0.404 times as likely to be a monomodal green user as those without a driver's license.

### 4.6.3 Model 3: Comparing Monomodal Green Users to Monomodal Drivers

The sign and significance of most of the coefficients distinguishing multimodal green users from monomodal drivers in Model 3 are comparable to coefficients in Models 1 and 2. Even though the direction of the relationships is similar, the magnitude of most coefficients in Model 3 is stronger than in Models 1 and 2—negative relationships are more strongly negative and positive associations are more strongly positive.

Similar to Models 1 and 2, men are more likely multimodal green users than women (AOR 1.803). Whites are less likely to be multimodal greens than non-whites (AOR: 0.893). Individuals 65 and older are least likely to fall into the group of multimodal green users. In fact, coefficients for multimodal green users fall with increasing age (AORs 16-24: 13.092; 25-34: 7.480; 35-49: 4.955; and 50-64: 3.727). As found in Model 2, singles (AOR: 0.565) and individuals in households with children (AOR: 0.769) are less likely to be multimodal greens. Those with higher education (AOR 1.406) and in the highest income group (AOR 1.769) are more likely multimodal green users. Like in Model 2, employed individuals are less likely to be multimodal greens. Individuals in households with cars are much less likely to be multimodal green users. Licensed individuals are less likely to be multimodal greens (AOR: 0.717). Density and rail access are positively related to falling into the multimodal green user category. In contrast to the results of the previous two models, whites are less likely than minority groups to be multimodal green users (AOR: 0.893).

### 4.6.4 Changes Over Time: Comparison of Regression Results for 2001 and 2009 NHTS Data

Table 30 shows results of the three binary logistic regression models using data from NHTS 2001. Most coefficients have the same sign and significance level in the 2001 and 2009 analyses. Some relationships were stronger in 2009 than in 2001. For example, coefficients distinguishing between the 65+ age group and other age groups have gotten stronger between the two surveys—especially for Model 3 distinguishing between the multimodal green users and monomodal car users. Other relationships, such as density, were weaker in 2009 than in 2001. Lastly, the sign for some coefficients changed direction—such as the coefficients for the 'employment' and 'driver's license' variables in Model 1. In addition, while singles and individuals in households with children were both significantly less likely to be multimodal drivers in 2001, by 2009 singles were significantly more likely to be multimodal drivers while those with children did not have significantly differing odds from the base group of individuals in households with two adults and no children.

| Binomial Logit<br>Monomodal Car as Base<br>U.S. Sample<br>2001 NHTS | Model 1<br>Multimodal<br>Car | Model 2<br>Monomodal<br>Green | Model 3<br>Multimodal<br>Green |
|---|---|---|---|
| | | *Odds Ratio* | |
| Gender | | | |
| Female | 1.000 | 1.000 | 1.000 |
| Male | 1.007 | 1.114** | 1.586*** |
| Race/Ethnicity | | | |
| Non-White | 1.000 | 1.000 | 1.000 |
| White | 1.672*** | 1.085 | 0.93 |
| Age Group | | | |
| 16-24 | 1.176*** | 1.960*** | 5.595*** |
| 25-34 | 1.160*** | 1.189* | 3.024*** |
| 35-49 | 1.254*** | 1.200* | 3.188*** |
| 50-64 | 1.206*** | 1.326*** | 2.611*** |
| 65 and older | 1.000 | 1.000 | 1.000 |
| Household Life Cycle | | | |
| Two Adults No Children | 1.000 | 1.000 | 1.000 |
| Singles | 0.632*** | 0.632*** | 0.559*** |
| Households With Children | 0.958** | 0.749*** | 0.767*** |
| Education | | | |
| High School Degree or Less | 1.000 | 1.000 | 1.000 |
| Education Beyond H.S. | 1.296*** | 1.377*** | 1.790*** |
| Employment | | | |
| Unemployed, Not in Workforce | 1.000 | 1.000 | 1.000 |
| Employed | 1.053*** | 0.728*** | 1.349*** |
| Income | | | |
| Income Quartile 1 | 1.048*** | 1.332*** | 1.103 |
| Income Quartiles 2 and 3 | 1.000 | 1.000 | 1.000 |
| Income Quartile 4 | 1.094*** | 0.945 | 1.913*** |
| Household Automobiles | | | |
| 0 Cars | 1.000 | 1.000 | 1.000 |
| 1 Car | 0.460*** | 0.154*** | 0.045*** |
| 2 Cars | 0.347*** | 0.083*** | 0.009*** |
| 3 or more Cars | 0.321*** | 0.061*** | 0.006*** |
| License | | | |
| Unlicensed | 1.000 | 1.000 | 1.000 |
| Licensed | 0.908** | 0.186*** | 0.135*** |
| Population Density | | | |
| Density < 10,000 | 1.000 | 1.000 | 1.000 |
| Density 10,000 and Above | 1.327*** | 2.867*** | 6.022*** |
| Access to Rail | | | |
| Live Outside MSA With Rail | 1.000 | 1.000 | 1.000 |
| Live Inside MSA With Rail | 1.050*** | 1.362*** | 2.981*** |
| | | | |
| Goodness of Fit Measures | | | |
| McFadden's pseudo-R^2 | 0.014 | 0.215 | 0.564 |
| Nagelkerke pseudo-R^2 | 0.026 | 0.254 | 0.626 |
| LR Test (Pearson's) p-value | 0.000 | 0.000 | 0.000 |
| Correctly Classified | 62.67% | 95.29% | 96.58% |
| Number of Observations | 93,596 | 37,549 | 38,194 |

Source: Calculated by authors based on NHTS 2001 Version 2.0.
Relative likelihoods were calculated using logistic regressions, which control for the influence of other variables.
Excludes persons younger than 16 years.
***: p<0.01; **: p<0.05; *: p<0.10

**Table 30.** Binomial Logistic Analysis of Modality Groups for the U.S., NHTS 2001.

### 4.6.5 Comparison of Regression Results Using Intensity Thresholds 2009 NHTS Data

Next, Table 31 presents three sets of binomial logistic results for multimodal car users in 2009. The first column replicates the results presented above using the 1+ intensity threshold for multimodal car use. The second column compares drivers making 7 or more trips by green modes in a week with monomodal drivers. The third column incorporates the notion of 'monomodal tendencies' and includes in the monomodal car user base category those drivers who make 6 or fewer trips by green modes each week. Most of the relationships are consistent across the three models. Only the relationships for individuals in households with children and low-income individuals reverse direction. Singles do not have differing odds for being multimodal car users when monomodal car tendencies are incorporated.

Table 32 presents a similar analysis for multimodal greens, with four sets of binomial logistic results. The first column replicates the results for multimodal green users presented above. The second column compares those making less than 50% of trips via a single green mode to monomodal car users. The third column replicates the results presented above for monomodal greens. The fourth column adds to the monomodal green category those individuals who use more than one green mode but for whom a single green mode is used for over 50% of trips. That is, it considers those multimodal greens using a single green mode for over 50% of trips as having monomodal green 'tendencies.' In reviewing the table, pairwise comparisons may focus on columns 1 and 2, and 3 and 4. As found for multimodal car use, the relationships are mostly consistent across intensity thresholds, though levels of significance do shift for a number of subgroups. Unlike for multimodal car use, no relationships reverse direction.

| U.S. Sample 2009 NHTS | Multimodal Car 1+ v Monomodal Car | Multimodal Car 7+ v Monomodal Car | Multimodal Car 7+ v Monomodal Car & Monomodal Tendencies |
|---|---|---|---|
| | *Odds Ratio* | | |
| Gender | | | |
| Female | 1.000 | 1.000 | 1.000 |
| Male | 1.119*** | 1.345*** | 1.341*** |
| Race/Ethnicity | | | |
| Non-White | 1.000 | 1.000 | 1.000 |
| White | 1.112*** | 1.267*** | 1.243*** |
| Age Group | | | |
| 16-24 | 1.501*** | 1.455*** | 1.168*** |
| 25-34 | 1.630*** | 1.553*** | 1.170*** |
| 35-49 | 1.588*** | 1.670*** | 1.312*** |
| 50-64 | 1.440*** | 1.558*** | 1.314*** |
| 65 and older | 1.000 | 1.000 | 1.000 |
| Household Life Cycle | | | |
| Two Adults No Children | 1.000 | 1.000 | 1.000 |
| Singles | 1.043** | 1.029 | 0.989 |
| Households With Children | 1.022 | 0.912*** | 0.862*** |
| Education | | | |
| High School Degree or Less | 1.000 | 1.000 | 1.000 |
| Education Beyond H.S. | 1.399*** | 1.355*** | 1.114*** |
| Employment | | | |
| Unemployed, Not in Workforce | 1.000 | 1.000 | 1.000 |
| Employed | 0.841*** | 0.762*** | 0.812*** |
| Income | | | |
| Income Quartile 1 | 0.906*** | 0.969** | 1.046*** |
| Income Quartiles 2 and 3 | 1.000 | 1.000 | 1.000 |
| Income Quartile 4 | 1.200*** | 1.210*** | 1.081*** |
| Household Automobiles | | | |
| 0 Cars | 1.000 | 1.000 | 1.000 |
| 1 Car | 0.496*** | 0.383*** | 0.508*** |
| 2 Cars | 0.483*** | 0.358*** | 0.468*** |
| 3 or more Cars | 0.447*** | 0.351*** | 0.492*** |
| License | | | |
| Unlicensed | 1.000 | 1.000 | 1.000 |
| Licensed | 1.202*** | 1.257*** | 1.163*** |
| Population Density | | | |
| Density < 10,000 | 1.000 | 1.000 | 1.000 |
| Density 10,000 and Above | 1.182*** | 1.272*** | 1.212*** |
| Access to Rail | | | |
| Live Outside MSA With Rail | 1.000 | 1.000 | 1.000 |
| Live Inside MSA With Rail | 1.066*** | 1.089*** | 1.059*** |
| | | | |
| Goodness of Fit Measures | | | |
| McFadden's pseudo-R^2 | 0.016 | 0.018 | 0.008 |
| Nagelkerke pseudo-R^2 | 0.027 | 0.034 | 0.014 |
| LR Test (Pearson's) p-value | 0.000 | 0.000 | 0.000 |
| Correctly Classified | 68.56% | 57.71% | 74.82% |
| Number of Observations | 193,562 | 109,607 | 193,562 |
| Source: Calculated by authors based on NHTS 2009 Version 2.0. | | | |
| Relative likelihoods were calculated using logistic regressions, which control for the influence of other | | | |
| Excludes persons younger than 16 years. | | | |
| ***: p<0.01; **: p<0.05; *: p<0.10 | | | |

**Table 31.** Binomial Logistic Analysis of Multimodal Car Groups Using 7+ Intensity Threshold for the U.S., NHTS 2009.

| U.S. Sample 2009 NHTS | Multimodal Green <100% v Monomodal Car | Multimodal Green <50% v Monomodal Car | Monomodal Green v Monomodal Car | Monomodal Green Tendencies (>50% by 1 Green Mode) v Monomodal Car |
|---|---|---|---|---|
| | *Odds Ratio* | | | |
| Gender | | | | |
| Female | 1.000 | 1.000 | 1.000 | 1.000 |
| Male | 1.803*** | 2.132*** | 1.302*** | 1.411*** |
| Race/Ethnicity | | | | |
| Non-White | 1.000 | 1.000 | 1.000 | 1.000 |
| White | 0.893* | 0.943 | 0.985 | 0.949 |
| Age Group | | | | |
| 16-24 | 13.092*** | 20.755*** | 2.135*** | 3.605*** |
| 25-34 | 7.480*** | 9.011*** | 2.661*** | 3.336*** |
| 35-49 | 4.955*** | 8.005*** | 2.193*** | 2.551*** |
| 50-64 | 3.727*** | 4.509*** | 1.803*** | 2.078*** |
| 65 and older | 1.000 | 1.000 | 1.000 | 1.000 |
| Household Life Cycle | | | | |
| Two Adults No | 1.000 | 1.000 | 1.000 | 1.000 |
| Singles | 0.565*** | 0.768* | 0.839*** | 0.683*** |
| Households With | 0.769*** | 0.715** | 0.794*** | 0.772*** |
| Education | | | | |
| High School Degree | 1.000 | 1.000 | 1.000 | 1.000 |
| Education Beyond | 1.406*** | 1.525*** | 1.232*** | 1.290*** |
| Employment | | | | |
| Unemployed, Not in | 1.000 | 1.000 | 1.000 | 1.000 |
| Employed | 0.598*** | 0.977 | 0.233*** | 0.316*** |
| Income | | | | |
| Income Quartile 1 | 1.043 | 1.529*** | 1.082* | 1.051 |
| Income Quartiles 2 | 1.000 | 1.000 | 1.000 | 1.000 |
| Income Quartile 4 | 1.769*** | 1.792*** | 1.073 | 1.245*** |
| Household Automobiles | | | | |
| 0 Cars | 1.000 | 1.000 | 1.000 | 1.000 |
| 1 Car | 0.026*** | 0.024*** | 0.132*** | 0.063*** |
| 2 Cars | 0.006*** | 0.005*** | 0.082*** | 0.028*** |
| 3 or more Cars | 0.003*** | 0.002*** | 0.067*** | 0.020*** |
| License | | | | |
| Unlicensed | 1.000 | 1.000 | 1.000 | 1.000 |
| Licensed | 0.717*** | 0.841 | 0.404*** | 0.490*** |
| Population Density | | | | |
| Density < 10,000 | 1.000 | 1.000 | 1.000 | 1.000 |
| Density 10,000 and | 5.518*** | 4.671*** | 2.189*** | 3.489*** |
| Access to Rail | | | | |
| Live Outside MSA | 1.000 | 1.000 | 1.000 | 1.000 |
| Live Inside MSA With | 2.334*** | 2.601*** | 1.358*** | 1.643*** |
| | | | | |
| Goodness of Fit Measures | | | | |
| McFadden's pseudo- | 0.436 | 0.380 | 0.149 | 0.246 |
| Nagelkerke pseudo- | 0.489 | 0.397 | 0.184 | 0.314 |
| LR Test (Pearson's) p- | 0.000 | 0.000 | 0.000 | 0.000 |
| Correctly Classified | 96.66% | 99.42% | 93.47% | 91.44% |
| Number of Observations | 64,277 | 61,264 | 65,324 | 68,337 |

Source: Calculated by authors based on NHTS 2009 Version 2.0.
Relative likelihoods were calculated using logistic regressions, which control for the influence of other variables.
Excludes persons younger than 16 years.
***: p<0.01; **:

**Table 32.** Binomial Logistic Analysis of Multimodal Green Groups Using <50% Intensity Threshold for the U.S., NHTS 2009.

### 4.6.6 Comparison of U.S., South Atlantic, and Virginia Regression Results for 2009 NHTS Data

Tables 33 and 34 present the three binomial logistic analyses for the South Atlantic and Virginia presented above for the U.S. using data from the 2009 NHTS. Models 1-3 again compare multimodal car users, monomodal greens, and multimodal greens to the base group of monomodal drivers, while controlling for relevant demographic, socioeconomic, and land use characteristics. This discussion is based on 2009 sub-samples, because the 2001 Virginia sample is not representative of the sample area population. The following discussion summarizes the 2009 results for the South Atlantic and Virginia, and compares them to the national results.

Men are more likely than women to be multimodal drivers, monomodal greens, and multimodal greens across all three sample areas in 2009, except for monomodal greens in Virginia, where the odds do not differ significantly. Whites are more likely to be multimodal car users across all three samples areas, but only less likely to be multimodal greens in the U.S. and South Atlantic; the odds for Virginia (AOR: 0.712) are not significantly different. The results across samples are generally consistent for the age subgroups. Those in the youngest age group have the highest odds of being multimodal greens (AORs: 13.092 for U.S., 11.946 for South Atlantic, 18.337 for Virginia) and are also more likely to be multimodal car users and monomodal greens than the base group of individuals 65 and older.

The effect of household life cycle is generally less significant in Virginia. While singles are more likely multimodal car users in the U.S. as a whole, the odds do not differ significantly in the South Atlantic or Virginia samples. Singles are less likely to be monomodal or multimodal greens in the U.S. and South Atlantic samples, but odds do not differ in Virginia. Households with children are more likely multimodal car users in the South Atlantic and Virginia samples, but the odds (AOR: 1.022) do not differ significantly in the national sample. The effect of education is generally consistent across the three samples – those with more education are more likely to be multimodal car users, monomodal greens, and multimodal greens (except that the odds do not significantly differ for monomodal greens in the Virginia sample). Employed individuals are less likely to be multimodal car users, monomodal greens, and multimodal greens across all three samples.

Low income individuals are less likely to be multimodal car users and high income individuals are more likely to be multimodal car users and multimodal greens across all three samples. Car ownership is associated with significantly lower odds of being a multimodal car user, monomodal green, or multimodal green across all three samples. Being licensed is associated with higher odds of multimodal car use and lower odds of monomodal green or multimodal green use across all three samples. Density is associated with greater odds of being a multimodal car user, monomodal green, and multimodal green across all three samples except that odds (AOR: 1.116) do not differ significantly for multimodal car use in the South Atlantic. Finally, living in an MSA with rail is associated with greater odds of being multimodal green across all three samples. However, while living in an MSA with rail is associated with a greater likelihood of being a multimodal car user and monomodal green in the U.S. as a whole, the odds of being a multimodal car user in the South Atlantic are slightly lower while the odds do not differ significantly for monomodal green use in the South Atlantic or Virginia.

| Binomial Logit Monomodal Car as Base South Atlantic Sample 2009 NHTS | Model 1 Multimodal Car | Model 2 Monomodal Green | Model 3 Multimodal Green |
|---|---|---|---|
| | | *Odds Ratio* | |
| Gender | | | |
| Female | 1.000 | 1.000 | 1.000 |
| Male | 1.149*** | 1.270*** | 1.964*** |
| Race/Ethnicity | | | |
| Non-White | 1.000 | 1.000 | 1.000 |
| White | 1.097*** | 0.975 | 0.738*** |
| Age Group | | | |
| 16-24 | 1.422*** | 1.393* | 11.946*** |
| 25-34 | 1.607*** | 2.760*** | 7.347*** |
| 35-49 | 1.616*** | 2.074*** | 5.969*** |
| 50-64 | 1.437*** | 1.763*** | 3.914*** |
| 65 and older | 1.000 | 1.000 | 1.000 |
| Household Life Cycle | | | |
| Two Adults No Children | 1.000 | 1.000 | 1.000 |
| Singles | 0.998 | 0.831** | 0.596*** |
| Households With Children | 1.056** | 0.860* | 0.858 |
| Education | | | |
| High School Degree or Less | 1.000 | 1.000 | 1.000 |
| Education Beyond H.S. | 1.379*** | 1.123* | 1.264** |
| Employment | | | |
| Unemployed, Not in Workforce | 1.000 | 1.000 | 1.000 |
| Employed | 0.825*** | 0.193*** | 0.399*** |
| Income | | | |
| Income Quartile 1 | 0.911*** | 0.995 | 1.248* |
| Income Quartiles 2 and 3 | 1.000 | 1.000 | 1.000 |
| Income Quartile 4 | 1.216*** | 1.083 | 2.099*** |
| Household Automobiles | | | |
| 0 Cars | 1.000 | 1.000 | 1.000 |
| 1 Car | 0.482*** | 0.147*** | 0.036*** |
| 2 Cars | 0.478*** | 0.090*** | 0.011*** |
| 3 or more Cars | 0.439*** | 0.077*** | 0.006*** |
| License | | | |
| Unlicensed | 1.000 | 1.000 | 1.000 |
| Licensed | 1.309*** | 0.462*** | 0.666*** |
| Population Density | | | |
| Density < 10,000 | 1.000 | 1.000 | 1.000 |
| Density 10,000 and Above | 1.116 | 2.197*** | 4.343*** |
| Access to Rail | | | |
| Live Outside MSA With Rail | 1.000 | 1.000 | 1.000 |
| Live Inside MSA With Rail | 0.953* | 1.130 | 2.250*** |
| | | | |
| Goodness of Fit Measures | | | |
| McFadden's pseudo-R^2 | 0.016 | 0.133 | 0.329 |
| Nagelkerke pseudo-R^2 | 0.028 | 0.166 | 0.367 |
| LR Test (Pearson's) p-value | 0.001 | 0.000 | 0.000 |
| Correctly Classified | 69.58% | 93.72% | 97.50% |
| Number of Observations | 71,786 | 23,331 | 22,563 |

Source: Calculated by authors based on NHTS 2009 Version 2.0.
Relative likelihoods were calculated using logistic regressions, which control for the influence of other variables.
Excludes persons younger than 16 years.
***: p<0.01; **: p<0.05; *: p<0.10

**Table 33.** Binomial Logistic Analysis of Modality Groups for the South Atlantic, NHTS 2009.

| Binomial Logit<br>Monomodal Car as Base<br>Virginia Sample<br>2009 NHTS | Model 1<br>Multimodal<br>Car | Model 2<br>Monomodal<br>Green | Model 3<br>Multimodal<br>Green |
|---|---|---|---|
| | *Odds Ratio* | | |
| Gender | | | |
| Female | 1.000 | 1.000 | 1.000 |
| Male | 1.164*** | 1.177 | 1.595** |
| Race/Ethnicity | | | |
| Non-White | 1.000 | 1.000 | 1.000 |
| White | 1.169*** | 1.026 | 0.712 |
| Age Group | | | |
| 16-24 | 1.564*** | 1.983** | 18.337*** |
| 25-34 | 1.654*** | 3.560*** | 9.063*** |
| 35-49 | 1.700*** | 2.473*** | 4.989*** |
| 50-64 | 1.591*** | 2.014*** | 4.016*** |
| 65 and older | 1.000 | 1.000 | 1.000 |
| Household Life Cycle | | | |
| Two Adults No Children | 1.000 | 1.000 | 1.000 |
| Singles | 1.046 | 0.881 | 0.718 |
| Households With Children | 1.074* | 1.041 | 0.945 |
| Education | | | |
| High School Degree or Less | 1.000 | 1.000 | 1.000 |
| Education Beyond H.S. | 1.446*** | 1.184 | 1.813** |
| Employment | | | |
| Unemployed, Not in Workforce | 1.000 | 1.000 | 1.000 |
| Employed | 0.830*** | 0.194*** | 0.564** |
| Income | | | |
| Income Quartile 1 | 0.897*** | 0.980 | 1.536 |
| Income Quartiles 2 and 3 | 1.000 | 1.000 | 1.000 |
| Income Quartile 4 | 1.215*** | 1.204 | 3.046*** |
| Household Automobiles | | | |
| 0 Cars | 1.000 | 1.000 | 1.000 |
| 1 Car | 0.432*** | 0.143*** | 0.036*** |
| 2 Cars | 0.436*** | 0.081*** | 0.010*** |
| 3 or more Cars | 0.381*** | 0.063*** | 0.005*** |
| License | | | |
| Unlicensed | 1.000 | 1.000 | 1.000 |
| Licensed | 1.181* | 0.349*** | 0.351*** |
| Population Density | | | |
| Density < 10,000 | 1.000 | 1.000 | 1.000 |
| Density 10,000 and Above | 1.302* | 2.921*** | 5.529*** |
| Access to Rail | | | |
| Live Outside MSA With Rail | 1.000 | 1.000 | 1.000 |
| Live Inside MSA With Rail | 1.019 | 1.160 | 1.846** |
| | | | |
| Goodness of Fit Measures | | | |
| McFadden's pseudo-R^2 | 0.019 | 0.134 | 0.293 |
| Nagelkerke pseudo-R^2 | 0.036 | 0.177 | 0.345 |
| LR Test (Pearson's) p-value | 0.239 | 0.008 | 0.000 |
| Correctly Classified | 69.65% | 94.44% | 97.97% |
| Number of Observations | 20,100 | 6,474 | 6,252 |

Source: Calculated by authors based on NHTS 2009 Version 2.0.
Relative likelihoods were calculated using logistic regressions, which control for
Excludes persons younger than 16 years.
***: p<0.01; **: p<0.05; *: p<0.10

**Table 34.** Binomial Logistic Analysis of Modality Groups for Virginia, NHTS 2009.

## *4.7 Discussion of Multivariable Results of the 4 Modality Groups*

Results of the multivariable regression analysis enhance the findings of the bivariate analysis, which individually assessed the relationship of each demographic, socio-economic, and land-use variable to the modality groups. By contrast, each logistic regression model controls for other variables in the analysis and identifies the relationship of independent variables to a respondent's likelihood to fall into the multimodal driver, monomodal green, or multimodal green modality group compared to being a monomodal diver. Results of the logistic regression analyses draw a first picture of the four modality groups in the U.S. Most prior studies rely on data from Europe or local examples from the U.S. Many of our findings are consistent with previous multimodality research from Europe and the two local level studies from the U.S. However, our national level results also differ from and add to prior findings.

First, five studies on multimodality in Europe and two regional studies in the U.S. have identified car availability as one of the key determinants of individual mode use patterns (Kuhnimhof, Chlond et al. 2006; Nobis 2007; Block-Schachter 2009; Diana and Mokhtarian 2009; Vij, Carrel et al. 2011; Chlond 2012; Kuhnimhof, Buehler et al. 2012). Our multivariable analysis confirms these findings. Additionally, we find a large difference between individuals in households without cars and households with one car. In 2009, individuals in a household with one car were less than half as likely to be multimodal drivers compared to individuals in households without a car. Individuals with car access were also much less likely to solely rely on green modes.

The likelihood to fall in the multimodal driver or one of the green-only categories further decreases with additional cars in the household—but the difference between households without cars and one car appears to be the strongest. Policies that reduce the need to own a car may therefore be the most successful at promoting multimodality. Examples include measures to increase walkability, bikeability, and access to public transport. Car-sharing could play an important role in supporting drivers who also use green modes (TCRP 2005). Car-sharing would offer households the option of occasional vehicle use while mitigating the impact of car ownership on daily modal use patterns. In addition, car-sharing could open access to the marginal benefits of car trips to low-income individuals (Blumenberg and Pierce 2012) without requiring ownership of a vehicle.

Second, four studies from Europe identified young adults as being more multimodal than older individuals (Kuhnimhof, Chlond et al. 2006; Nobis 2007; Chlond 2012; Kuhnimhof, Buehler et al. 2012). One study from Germany found that older individuals are also more multimodal (Nobis 2007). Our results confirm the four European studies and find that in the U.S. individuals in the age group 65+ were more likely monomodal drivers than multimodal drivers, monomodal greens, or multimodal greens. Among adults younger than 65 there were only small differences in the likelihood to be a multimodal driver compared to a monomodal driver. However, the likelihood to be monomodal green or multimodal green declined significantly by age even among adults younger than 65. Multimodal greens displayed the largest differences by age—especially for the 16 to 24 and 25 to 34 age categories.

Results based on the 2009 data are confirmed by our analysis of 2001 data that also found the strongest age-related differences among multimodal greens (and smaller differences for other modality groups). However, the magnitude of the coefficients for multimodal greens more than doubled for the two youngest age groups—indicating diverging travel behavior between the young and old. The finding of more multimodality and less car orientation among younger adults is in line with recent research on the decreasing car-orientation of young adults (Kuhnimhof, Buehler et al. 2012).

Third, consistent with two European studies and one local US study, our analysis finds that those with a college or university degree are more likely multimodal drivers, monomodal greens, and multimodal greens than monomodal drivers (Kuhnimhof, Chlond et al. 2006; Diana and Mokhtarian 2009; Kuhnimhof, Buehler et al. 2012). Higher rates of walking and cycling among individuals with higher education likely help explain this difference (Buehler, Pucher et al. 2011). One reason may be that college students often live on or near campus, do not own a car, have free or reduced transit passes, and get around campus on foot, by bicycle, or public transport (TCRP 2004; Khattak, Wang et al. 2011; Wang, Khattak et al. 2012). This experience may familiarize students with alternatives to the car and make it more likely that they will continue to use green modes after schooling.

Fourth, similar to the findings for education levels, our study suggests that, compared to middle-income persons, individuals with higher household incomes are more likely multimodal car users and multimodal greens. This may be related to the expanded travel options in more expensive urban neighborhoods that offer shorter trip distances, better infrastructure for non-motorized modes, and more frequent public transport service (Knaap 1998; Sohn, Moudon et al. 2012).

Individuals in the lowest income quartile are slightly more likely to be monomodal greens ($p<0.10$). Additionally, individuals in the lowest income quartile are more likely monomodal than multimodal drivers. This may be explained by wealthier individual's ability to own a car and a car to also be able to afford housing in walkable dense mixed use areas or the proximity to higher quality public transport services—thus allowing more multimodal travel. If low income individuals can afford a car, they may not be able to afford housing in dense mixed-use areas with access to high quality public transport (Blumenberg and Waller 2003; McKenzie 2013). Moreover, the car could be a more important status symbol for lower income than higher income individuals. Thus, low income individuals may choose to make all trips by driving—if they can afford a car (Lucas 2011).

Fifth, some European scholars suggest that employed individuals are more likely multimodal, because public transport has a higher mode share for commutes than other trip purposes. However, consistent with empirical findings from one study from Europe, our analysis shows that, compared to the unemployed and those not in the workforce, employed individuals in the U.S. are more likely monomodal drivers and less likely multimodal drivers, monomodal greens or multimodal greens. Even though in the U.S. transit use is higher for the commute (~5%) than for all trips (~2%), the majority of commute trips (~90%) are still by car. Moreover, employed individuals may have less flexibility in travel time throughout the day and may therefore rely on the car more than those not in the workforce or unemployed.

Sixth, European studies suggest that women are less likely to be monomodal drivers than men. However, the present study finds that in the U.S. men have a higher likelihood of being multimodal drivers, multimodal greens, and monomodal greens. This could relate to the greater safety risks associated with the cycling in the U.S., which have contributed to a significant gender gap in cycling rates (Garrard, Handy et al. 2012). Moreover, in households with more traditional gender roles women may be responsible for grocery shopping or chauffeuring children to and from activities—in addition to other trips, such as the commute to work (Turner and Grieco 2000; Goddard, Handy et al. 2006). These additional responsibilities may make scheduling of trips more difficult and most of the destinations inaccessible by foot, bicycle, or public transport (Gossen and Purvis 2005).

Seventh, we find that whites are more likely multimodal than monomodal drivers. However, minorities are more likely multimodal greens who do not drive. There is no difference between whites and non-whites among monomodal greens. These findings are interesting in the context of lower automobile ownership rates as well as greater reliance on public transport of a typically lower level of service (e.g. bus) among minorities in the U.S. (McKenzie 2013). As found for upper income individuals, it may be that whites tend to live in areas with higher quality public transport, such that they drive and use public transport more often than minorities.

Eighth, we find that households with children are less likely monomodal or multimodal greens. This is in line with prior findings from Europe showing that families have more complicated travel schedules that are more difficult to meet by green modes alone. This may be exacerbated in the U.S. For example, lower population densities and longer trip distances in the U.S. (compared to Europe) may make a car more necessary when chauffeuring children from and to different activities.

Ninth, similar to European studies we find that licensed drivers are less likely to rely solely on green modes. It seems that those who do not want to or are unable to drive may not get a driver's license and thus solely rely on walking, cycling, and public transport. However, our finding that licensed drivers are more likely multimodal than monomodal drivers differs from prior studies on multimodality from Europe. The direction of the relationship does not seem to be a statistical quirk of our model, because descriptive statistics for the 2009 NHTS data confirm that there is a slightly higher share of licensed drivers among multimodal than monomodal drivers (96% vs. 95%). However, as shown above, results of our models based on 2001 NHTS data differ from the 2009 results and are in line with findings from Europe that licensed drivers are more likely monomodal drivers than multimodal drivers. More research seems to be needed to identify the role of having a driver's license in determining multimodal car use in the U.S.

Finally, similar to prior studies in Europe and at the regional level in the U.S., we find that access to public transport and higher population density are associated with a greater likelihood to be a multimodal driver, monomodal green user, or multimodal green user. Dense areas typically have higher levels of traffic congestion along with parking that is more expensive and in shorter supply, all of which make car use less attractive (Newman and Kenworthy 1996). Moreover, trip distances in dense areas are shorter and facilitate travel by public transport and especially bicycling and walking. Additionally, dense areas typically have better pedestrian and bicycling infrastructure that encourage the use of non-motorized modes.

Proximity to public transport facilitates its use for some trips and can help increase multimodality or reliance on green modes. In the U.S. public transport service is often geared towards peak hour commuting, while off-peak service is typically marked by longer waits and slower service. Thus even those who commute by transit often use other modes of transport for non-commuting trips, and therefore exhibit a high degree of multimodality. Moreover, our finding that rail access supports both monomodal green and multimodal green travelers is consistent with Rietveld's (Rietveld 2000; Rietveld, Bruinsma et al. 2001) studies of the multimodal nature of public transport chains.

Overall, the effects of the demographic, socioeconomic, and land use characteristics included in our models are generally consistent across the three geographic areas studied. In nearly all cases, the direction of the effect was consistent across the samples, even as statistical significance varied. Two groups of variables – those relating to household vehicles and to age groups – had strong effects on all four modality groups across all three samples. Thus efforts to increase multimodality in Virginia, the South Atlantic, and the U.S. as a whole could focus on these factors.

This is the first multivariable analysis of multimodality using a representative sample of the U.S. population. However, there are several important limitations of our regression analysis—in addition to the data limitations already discussed in section 3.3 above.

First, the limited information available in the surveys regarding weekly car use means that it is possible some individuals categorized as monomodal green or multimodal green did in fact use a car during the previous week. We have no way of knowing the extent to which this occurred in our data set, but to the degree that mis-categorization occurred, it had the potential to influence the estimated relationships between our independent variables and the modal groups. However, the significance and sign of most coefficients were similar across comparisons of multimodal car users, monomodal greens, and multimodal greens to monomodal car users. Thus, we expect that mis-categorization may not be very prevalent.

Second, our study relies on cross-sectional data from two separate time periods and only allows us to report correlation and not causation. Moreover, the two cross-sectional surveys cannot trace changes in travel behavior of the same person over time.

Third, endogeneity and self-selection are problems of most studies on travel behavior—including ours. For example, the direction of causation between our independent and dependent variables may be reversed. Individuals who wish to solely rely on green modes may decide to not own an automobile. Similarly, individuals who wish to be multimodal may move into denser areas with public transport access. Moreover, our analysis did not include variables measuring attitudes or travel preferences. Some European studies on multimodality found that environmental awareness was significantly associated with being multimodal. Not including variables measuring attitudes in our analysis may lead to biased coefficients. However, with our data we were not able to overcome these problems. For example, there were no strong instrumental variables in the dataset for preferences or attitudes.

Fourth, our analysis did not include some key variables that were tested in prior studies in the European context, such as auto restraint policies, quality of transit service, reliability of travel time for different modes, or travel behavior of neighboring households. Including these variables in the future would enhance the analysis and shed more light on policy variables. In addition, attribute-based information, largely absent from our dataset, could allow for more advanced modeling techniques, such as nested logit. Many limitations of our study could be overcome with more and better data on weekly travel behavior and additional variables capturing quality of service and other transport policies.

## 5. Conclusions

Our analysis reveals that travel by individuals in the USA is more varied than trip-based analysis suggests. Roughly 86% of trips are by automobile and almost 90% of regular commuters drive to work, but our analysis shows that only 28% of Americans solely rely on use of a car during a typical week. By contrast, almost two-thirds of Americans drive and make at least one trip by foot, bicycle, or public transportation. Additionally, about 7% of Americans do not use a car at all during a typical week and rely solely on walking, cycling, or public transport. Further the analysis shows that about one in four American drivers make at least seven trips by walking, cycling, or public transportation during a typical week. This finding is important for transportation planners and policy makers, because providing infrastructure for walking, cycling, and public transportation affects a larger share of the population than suggested by the 13% of trips by foot, bicycle, and public transport found in trip-based analysis.

An analysis of trends between 2001 and 2009 shows that the population share of monomodal weekly drivers declined slightly from 29.4% to 28.0%. The share of those exclusively relying on green modes rose from 4.9% to 7.1%. Multimodal car use, measured as driving and use of at least one other mode of transport during the week, remained stable between the two surveys at about 65% of the population. However, among multimodal car users, those making 4, 5, 6, and 7 trips by other means of transport at displayed the strongest increases between the two years (about +2 percentage points for each group). This suggests that multimodal drivers increased the intensity of their multimodal behavior—using other modes more often.

Further analysis of multimodality during a travel day and tour (trip chain) shows that shorter time periods capture less variability in mode choice. During a typical day 78% of Americans are monomodal drivers, 14% are multimodal drivers, and 8% do not drive. The vast majority of tours (trip chains) are solely made by car (90%). Only 4% of tours combine driving with other modes and 6% of tours are made without a car.

In both years walking was the dominant green mode used by multimodal drivers, monomodal greens, and multimodal greens. In 2009, 79.8% of weekly multimodal drivers reported walking as their only other mode of transport (other than driving). Similarly, walking was the only mode used for 90.8% of monomodal greens. Additionally, only 1.1% of multimodal greens reported no walking. Bicycling and public transportation were used as well, but at a much lower rate than walking.

The bivariate analysis reveals that compared to green-only users, monomodal and multimodal drivers are more likely to own two or more cars per household, are licensed drivers, and live in lower density areas. Compared to multimodal drivers, monomodal car users are more likely to be at least 65 years old, have a lower education level, live in households with children, and are in the mid-income groups. Multimodal car users, by contrast, are more likely white, 35-49 years old, university educated, and employed. Drivers in one-car households use the green modes at significantly higher rates than drivers in households with two or more cars. In addition, the bivariate analysis shows that, in contrast to car users, individuals who solely rely on green modes are more likely non-whites, in low income groups, unemployed, without a university degree, without a driver's license, in households without cars, in dense areas, and in areas with rail access. Overall, living at higher densities and close to rail seems to facilitate a car-free lifestyle, while living at lower population densities, or away from rail, is associated with car use.

The multivariable regression analysis enhances the findings of the bivariate analysis by investigating the relationship between individual variables and the modality groups while controlling for other explanatory factors. Our binomial logistic regressions estimate the relationship between each demographic, socio-economic, and land use variable and a respondent's likelihood to fall into the multimodal driver, monomodal green, or multimodal green modality group compared to being a monomodal diver. One of the key findings from the multiple regression analysis is that similar factors distinguish monomodal drivers from multimodal drivers, monomodal green users, and multimodal green users. Compared to monomodal drivers, multimodal drivers, monomodal greens, and multimodal greens are more likely to be male and younger, have higher education levels, own fewer cars, and live at higher population densities and in areas with rail access. There are also important differences among those three modality groups when compared to monomodal drivers. Multimodal drivers are more likely white, while multimodal greens are more likely minorities. Individuals in households with children are less likely monomodal or multimodal greens than monomodal drivers. Individuals in the highest income quartile are more likely multimodal—as drivers or users of green modes—while individuals in the lowest income group are less likely multimodal drivers and more likely monomodal greens. Individuals with a driver's license are less likely multimodal or monomodal greens.

Understanding the demographic, socio-economic, and land use factors relating to weekly modality patterns may enable state and regional policymakers to more effectively encourage multimodality. For policymakers in the South Atlantic and Virginia in particular, this study offers an opportunity to place travel trends in these geographic areas in the context of national trends for multimodality. Although Virginia experienced an increase in weekly monomodal driving between 2001 and 2009 from 23.5% to 27.0%, the 2009 rate was still lower than for the U.S. and South Atlantic (both 28.0%). Similarly, although multimodal driving fell in Virginia to 68.3%, this rate was still higher than for the U.S. as a whole (64.9%) and the South Atlantic (66.8%). Meanwhile, the South Atlantic and Virginia had lower rates of monomodal and multimodal greens in both 2001 and 2009 than the U.S. as a whole. Together these trends suggest that it is more difficult to live without a car in the South Atlantic or Virginia than in the U.S. as a whole. South Atlantic and Virginia policymakers could look to national policies and other geographic regions of the country to understand more ways to effectively encourage travel by the green modes and support individuals who do not own a private automobile.

Our comparison of results for the travel day and week show that longer time periods of observation capture more variability in personal travel. Thus, collection of multiday data is important. The analysis shows that the NHTS can be used for the analysis of multimodality. However, better data about travel behavior during a week are needed. The NHTS data rely on three questions asking about walking, cycling, and public transportation use in the past. Other surveys geared at capturing multimodal travel rely on week-long travel surveys. Similar to the one day travel diaries of the NHTS, these surveys use trip diaries for the entire week. Better data about weekly travel including more information about car use, trip purpose, and motivations for travel could improve information about weekly variability of travel and provide a more accurate picture of multimodality.

This study provides the first comprehensive assessment of the composition of modality groups in the USA. Identifying the population subgroups most likely to be multimodal car users in particular may enable policymakers to target groups who already have experience using alternatives to the car. These groups may be more likely to increase their use of alternatives to driving. For example, the shift from being a two-vehicle household to a one-vehicle household may be more feasible for many American households than shifting to no automobiles. Policies to support car-sharing, ride-sharing, cycling-transit integration, bike sharing, and teleworking may all enable multimodal drivers to increase their use of the green modes. This study advances the understanding of multimodality in the American context, and contributes to an increased ability to plan for and encourage multimodal travel.

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