Public Transit in America: Analysis of Access Using the 2001 National Household Travel Survey

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Public Transit in America: Analysis of Access Using the 2001 National Household Travel Survey

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16. Abstract

Understanding transit ridership has become a critical research interest and policy goal. This paper presents the results of an analysis of the NHTS data specifically focusing on the appended variables that measure access or distances to public transportation. Statistically significant distance intervals were chosen for analysis respective of a chosen variable. This document augments the report titled "Public Transit in America: Results from the 2001 National Household Travel Survey."

The analysis reveals strong differences in household and workplace access to transit as a function of race, income, auto ownership, and urban area size. Additionally, a very high sensitivity to access exists suggesting that the share of transit accessible trips is smaller than previously acknowledged. Approximately 53 percent of national households are within a mile of bus service and 40 percent within a quarter-mile. Approximately 10 percent of the population lives within one mile of rail. Over 50 percent of nationwide workplaces are within a quarter mile walk radius of a bus line. Not surprisingly, work is more closely concentrated near transit than are residences. Furthermore, mode share for transit declines approximately two thirds beyond the first interval (up to 0.15 miles) from a bus route. These observations imply a high value to services in close proximity to residential areas. The analysis suggests that access is even more critical than might have previously been acknowledged by the transit planning profession.

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CHAPTER 1 INTRODUCTION

Background

Transportation planners and researchers have long sought to develop a comprehensive understanding of the importance of access to public transportation in the mode choice decision. Fully appreciating the importance of access is important in the design of services and accordingly in being able to predict how service might perform. Historically, there's been a wealth of information regarding how various social demographic factors influence transit use. Numerous research initiatives have explored transit use as a function of such characteristics as age, race and ethnicity, income, auto availability, and gender. The National Household Travel Survey (NHTS), Census data, and local survey data have provided strong knowledge bases for these analyses. It has been far more difficult to establish relationships between characteristics of service supply and transit use. National survey data such as the NHTS/NPTS series has not included service supply data nor does census long form Journey-to-Work data and the successor American Community Survey. Local travel modeling initiatives have typically incorporated some service traits such as speed, cost, and frequency but have been less sophisticated in capturing access data, most often relying on zonal centroid mean access measures.

This paper presents the results of an analysis of the NHTS data specifically focusing on the appended variables that measure access distance to public transportation. The appended NHTS data set now offers an opportunity to introduce a measure of service supply to the analysts' attempts to better understand transit use, specifically access to bus and rail from a residential and work location of a traveler.

The importance of access to transit is increasingly recognized and improving data sets and analytical capabilities such as GIS are enabling researchers to better understand this critical aspect of mode choice. The heightened interest in access considerations complements the growing interest in leveraging the transportation land-use relationship of public transportation. Greater knowledge of the importance of access has implications in development location decisions and in establishing relationships such as tax assessment districts, between land-use and transit service. Understanding the relationship between access and transit use can influence how development impact assessments are carried out and can influence emerging policy issues such as the willingness of aging baby boomers to use transit as an alternative to driving.

Urban design issues, pedestrian access, user amenities, personal safety, and accessibility for mobility-limited persons are all considerations influenced by access to transit. A growing number of data sources are beginning to incorporate information on access. For example, the National Transit Database (NTD) provides a measure of the population living within a half-mile buffer of public transportation fixed routes. The 1995 Nationwide Personal Travel

Survey (NPTS) asked respondents whether transit was available (63% self-reported that transit was available in proximity to their home). Other surveys are similarly paying growing attention to access to public transportation.

Unlike the other sources, the NHTS data is a measured indicator (regardless of whether or not the users are aware of the presence of transit service) of available transit for a nationwide sample. Using this database enables a variety of descriptive analyses of the quality of access to transit available to various market segments of the traveling public. This report, supported by resources from the Florida Department of Transportation through their support of the National Center for Transit Research at the University of South Florida, builds on comprehensive analyses of the transit market previously published in various venues, most recently documented in a comprehensive report, "Public Transit in America: Results from the 2001 National Household Travel Survey." http://www.nctr.usf.edu/html/527-09.htm

This report intends to provide the reader with a rich understanding of differential access to transit for various submarkets as well as providing insight into mode use as a function of access. Statistically significant public transportation access distance intervals that group residences and workplaces were chosen for analysis and correlated to other key demographic and geographic variables present in the complete (all add-on samples) NHTS dataset. Actual relationships between household distances from public transit locations and geographical and demographical characteristics nationwide are explored; the analysis specifically focuses on both rail and bus transit modes for both the home and work end of the work commute trip.

Objectives

The objective of this research effort is to obtain an improved understanding of the relationship between transit access distances and population characteristics. This is accomplished by conducting analysis of the 2001 NHTS database, including the appended variable data sets which will be described in further detail. The resulting graphical relationships and conclusions can help professionals and policy makers make more informed decisions regarding the design and provision of transit services. Additionally, this research provides insights regarding how additional data collection or research might, with the help of advancements in technology, enable a still richer understanding of transit access while relying less on personal survey response data.

This analysis will explore the land use variables appended to the NHTS data to further explore how land use characteristics influence transit use behavior using both aggregate national data, Florida only data, and New York metropolitan area specific data. While the 1995 NPTS and the 2001 NHTS utilize mostly subjective or perceived measures of transportation characteristics, spatially measured proximity to transit for the household location is new for the 2001 survey. Also new for 2001 is spatially measured proximity to transit for the employment location for workers.

It is important to note that the appended measure of access to service is the only service supply measure that is available in the NHTS database. Data on service cost, speed, connectivity to destinations, reliability, frequency, and span of service are not available. Thus, while understanding access is important, there are several other aspects of service quality that impact the attractiveness of transit to potential travelers.

Methodology

SPSS and Microsoft Excel software are used to carry out the analysis. Each is well suited to the task of organizing and graphically representing characteristics for a database of this size. The relationships between household access distances and the person-traveler characteristics are developed in tabular and subsequently in graphical format in order to clearly visualize possible correlations in attributes. The NHTS data set for the Household file, Person file, and Day Trip file all contain appended instances of the access distance variables; that is, each instance of a household, person, and trip is allotted an attribute for distance between the household and an attribute specifying the distance to the workplace where applicable. These comprehensive variable additions enable subsequent cross-tabulations while providing a means for descriptive analysis and finally, conclusions. Due to the volume of data and enormous number of possible tabulations, the relationships deemed most relevant are analyzed. Additionally, access distances are categorized to the smallest or finest scale practicable, to the extent that adequate sample sizes allow. Specifically, access distances are explored for possible existing relationships to key demographic variables such as age, race, income, and vehicle ownership while evaluating in the desired geographical characteristics. To achieve a more appropriate representation of characteristics, both inclusions and exclusions in analysis are conducted because of the generally ubiquitous transit network present in the NY metropolitan region.

CHAPTER 2 NHTS DATA REVIEW

Background

The 2001 NHTS is a sample survey of the nation's daily personal travel and is generally considered the primary source for national personal travel behavior and related information. Although the data are not new by several years, they are considered a resource that aids transportation planners and policy makers because of their uniqueness, prior surveys providing comparability, breadth of coverage, and relevance. The 2001 NHTS updates information gathered in prior Nationwide Personal Transportation Surveys and the American Travel Survey (ATS). These data include information for all trips, modes, purposes, trip lengths, trip times, and geographical areas of the country.

Methodology

The 2001 NHTS was conducted from March 2001 through May 2002 with a three month break following September 11, 2001. Similar to prior surveys in the series, the procedure began with first obtaining a random sample of telephone numbers, then selecting only residential numbers from the sample. Exclusions from the pool of numbers included college dormitory residents, nursing homes residents, prison population, and military base residents. Next, a household member was queried over the phone for household and person characteristics and traits as well as vehicle information and other administrative data. Perhaps of key importance to the survey, the household was assigned a travel-day for recording trip information. The respective respondent was asked to mail back a 'travel diary" containing all pertinent travel information regarding the day, and a subsequent follow-up interview was scheduled and conducted for eligible household members about their personal travel behavior.

The NHTS data do not contain all of the information that the transportation planning profession might deem beneficial to transit planning and mode choice analysis. Some other possibly desirable information might include travel cost(s), travel routes, infrastructure type, and long-term temporal variance in household activities. Additionally, actual household and workplace locations are not available to the public; however, a recent variable data set addition was derived containing measured distances from the household and employment location for workers to bus and rail transit.

2001 NHTS Dataset

The 2001 NHTS is a sample survey of the nation's daily personal travel. It is the only authoritative source of national data on daily trips including, but not limited to:

- purpose of the trip (e.g., work, shopping),
- means of transportation used (e.g., car, bus),
- how long the trip took (i.e., travel time),
- time of day the trip took place; and,
- day of week the trip took place.

The 2001 NHTS involved several stages of data collection. First, a stratified random sample of telephone numbers was obtained. Second, the sample of telephone numbers was screened to identify residential households. People living in college dormitories, nursing homes, other medical institutions, prisons, and on military bases were excluded from the sample. Third, a member of the household was asked a series of questions by phone about the persons and vehicles of the household. Following this household interview, the household was assigned a travel day for trip reporting. Then, travel diaries were prepared and mailed to the household. Following the household's travel day, interviewers called to conduct person interviews for each eligible household member. A six-day window was established to obtain the travel day data. During the person interviews, travel diary information was recorded on a computer, along with responses to a number of additional questions. The 2001 NHTS survey represented a survey designed to replace the NPTS and the ATS. The ATS, conducted in 1995 by the Bureau of Transportation Statistics (BTS), was a survey of trips of 100 miles or more taken over the course of a calendar year. There were problems in trying to use 1995 NPTS and the 1995 ATS together to form a picture of total household travel by the American public. The combined survey approach for the 2001 NHTS was designed to give one data source for the full continuum of person travel.

For the first time in the NPTS/NHTS series, travel data were collected for household members including persons less than four years old not surveyed in prior surveys. All previous surveys had collected travel data only from household members ages five and older, on the dated assumption that younger children made trips only with other household members. However, this ignored the trips of this young group that were made with a day care provider, as part of a preschool activity, or with non-household members and thus altered the overall statistics when presented in per capita terms.

For the 2001 NHTS, more than 152,000 telephone numbers were sampled initially for household screening. Of these numbers, 90.6 percent were from residential households. Of these, 57,506 were contacted and confirmed as eligible households. Household interviews were completed for 64 percent of the residential households. Of these, 70.7 percent were classified as useable for the 2001 NHTS. Within the usable households, person interviews were completed with 90.6 percent of the eligible persons. The overall response rates were 58 percent for household interviews and 37.1 percent for person interviews.

The data files utilized in the analysis in this study include the nominal release of the 2001 NHTS dataset, including all subsequent geographical area add-on samples to date. These files include Household File, Person File, and Travel Day File. The Household File contains data on household demographic, socio-economic, and residence location characteristics for 69,817 households. The Person File contains data about personal and household characteristics, attitudes about transportation, and general travel behavior characteristics such as usual modes of transportation to travel to work for 160,758 persons. The Travel Day File contains trip-based data on trip purposes, modes, trip lengths in terms of time, distance, and trip start times for 642,292 trips. Each comprehensive file has its own weighting variable that approximates as accurately as practicable the national estimates for the Household and Person Files, and annualized national estimates in the case of the Day Trip File (NHTS 2001).

New Data

The focus of analysis of this paper are four newly appended variables that were developed and released to the Center for Urban Transportation Research (CUTR) in 2006. These access variables augment the survey data file, for each of the data files, and accurately denote scalar distances from the household to transit and from the workplace (if applicable) to transit without revealing any privacy sensitive information or addresses. These new variables include:

- PTDISTHH - distance (in miles) from the household location to the nearest bus line
- PTDISTWK - distance (in miles) from the workplace location to the nearest bus line
- RRDISTHH - distance (in miles) from the household to the nearest rail stop (including light rail, commuter rail, and subway)
- RRDISTWK - distance (in miles) from the workplace location to the nearest rail stop (including light rail, commuter rail, and subway)

Bus route geographical location information calculated for the new access variables was obtained from the 1995 Federal Transit Administration (FTA) database of transit routes for all reporting properties in the United States. These route data are considered the most comprehensive available although it is expected that transit agencies have modified service routes and corridors since the time the data were assembled. It is believed these data are still an appropriate representation of transit geographic availability for 2001, which is the reference time of the other analysis variables. A review of National Transit Database information indicated that bus route mileage increased approximately 10 percent between 1995 and 2001. This does not necessarily mean that a 10 percentage increase in coverage occurred as some share of service expansion is additional route mileage in corridors with existing service. Most probably some share of the population (remembering that service expansion is typically into more recently developed less dense areas) does have more accessible service than is represented by the 1995 bus route networks. Thus, the reader should recognize that actual bus accessibility is slightly better than portrayed by this analysis. The location of the rail stops is known and current as of 2001.

As stated, a realization and complete understanding of the dynamic relationship between transit accessibility and service planning and design would greatly benefit the transit profession. Numerous research initiatives have previously examined transit usage in relation to demographic variables such as age, race and ethnicity, income, auto availability, and gender. The NHTS and similarly-formulated regional or local survey data continue to provide a foundation for such analyses.

CHAPTER 3 DISTRIBUTION OF ACCESS TO TRANSIT

Background

Figures 1.1-1.4 graphically illustrate how access distances are measured for the new NHTS data variables. Utilizing Geographical Information Systems (GIS) and related software, a straight-line distance is calculated between each residential address and the nearest bus route, measured perpendicular to the route. Bus stop information is not present in the data set since a comprehensive and accurate database for nationwide bus stops is not available. Due to the availability of rail station information and because of the permanency of rail stops, they have been provided in the data and allow for a stop-level analysis for geographical areas with a rail system operating.

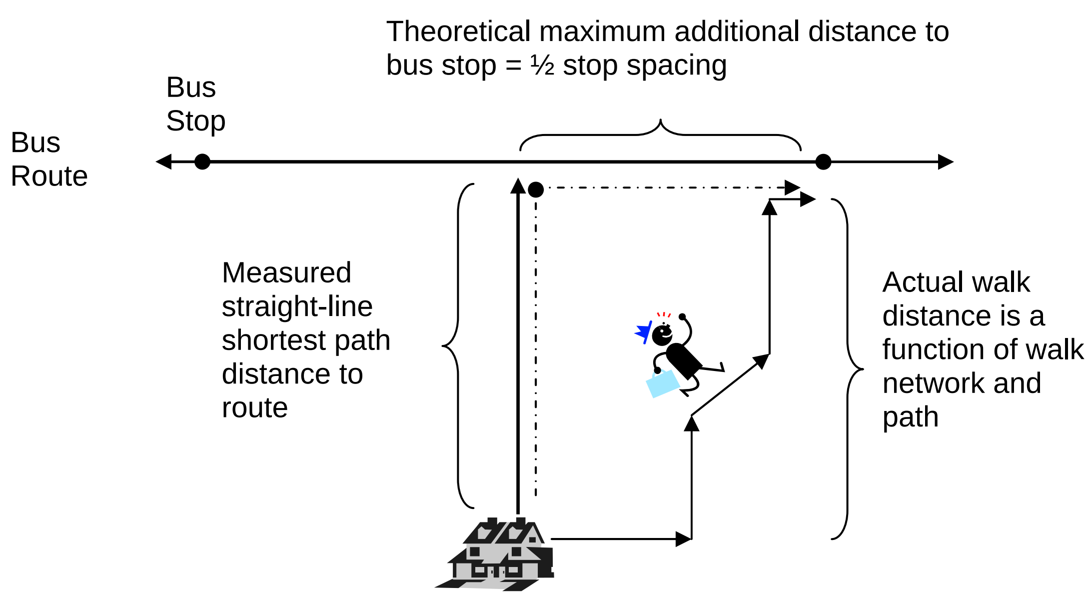

Figure 1.1 Measured versus Actual Walk Access to Bus

Definition of Public Transit

Public transit in this report includes four categories of transit mode: bus, commuter train, streetcar/trolley, and subway/elevated rail.

Bus: The bus category includes local buses and commuter buses that are available to the general public. However, shuttle buses operated by a government agency or private industry for the convenience of employees; contracted or chartered buses (for example tourist charter or sightseeing buses), city-to-city buses, and school buses are excluded. Data on these modes are available, but analysis of public transit use in this report does not include them.

Commuter Train: The commuter train category includes commuter trains and passenger trains other than elevated rail transit and subways. Amtrak intercity service is excluded.

Streetcar/Trolley: The streetcar/trolley category includes trolleys, streetcars, and cable cars.

Subway/Elevated: The subway/elevated rail category includes elevated railways and subway trains in a city.

Experience with the data suggests that questionnaire respondents do not necessarily have an understanding of these terms and may use them in ways different than a transit professional would. The changes in survey methodology require caution in comparing the 2001 NHTS to earlier surveys.

Minimum Access Concept

Generally, most of this analysis considers access to bus route networks. Where appropriate to the analysis, distances from the household to bus and rail are considered whereby a minimum access distance is generated for each household, person, or trip. In many cases, a new variable was constructed to denote minimum access to transit, where transit included either bus or rail. Resulting from the generally higher availability and larger number of bus transit systems present nationally, the distributions for minimum access resemble the bus distribution in many cases. Even in locations with rail, there are often dense feeder bus networks and the minimum distance to transit is to bus transit. It was determined that including access to rail does not significantly affect overall measure of transit access nationally. Minimum access is utilized in the density and access analysis described later in this chapter for ease of comparison to preexisting analyses.

Access Measurement

In Figure 1.1, it can be seen that one may wish to supplement the walking distance measure in order to capture a more accurate reflection of actual access distance to a bus stop because a perpendicular distance may intersect the bus line halfway in between two stops and the network walk path to the actual transit stop may not be a straight line. Generally, planners assume approximately 4 to 8 bus stops per mile for urban bus routes. Therefore, one might arguably increase all the stated bus transit access distances by approximately 0.1 miles to capture the variance in walk distance accounting for an additional one-half the average bus stop distance per mile. In spite of this lack of precision, the appended access distance dataset provides a unique opportunity to evaluate the extent of access to transit for the nation.

Hypothetical Access Distribution

Before presenting results for measured access distance, a hypothetical urban route structure is presented to give the reader a perspective on how the distribution of access distance is impacted by route network density. This hypothetical example is based on the access distribution of the population to bus service, given a homogenous urban land use pattern with a hypothetical uniform grid bus route network. Figure 1.2 shows the example of a household in the center of a block surrounded by a grid bus network. The household in the center is most distant from bus service of all households in the block. This worse case situation had the farthest household with an access distance of one-half the bus network grid spacing. Figure 1.3 shows how the mean access distribution can be calculated for the block with a given route spacing. As can be seen by the triangular shape of area whose base is on the grid bus route, the mean distance to the route is one third the triangle's height or one-sixth the route spacing. Figure 1.4 shows the calculated perpendicular distance to bus service for the hypothetical grid network with uniform population distribution. The distribution distance is expressed in terms of the share of the grid route spacing. For example, with one mile grid route spacing, 100 percent of the households would be within one-half mile of service and 50 percent of the households would be within approximately 0.17 miles of the nearest bus route. This distribution can be contrasted with actual distributions based on the NHTS data in subsequent sections of this research.

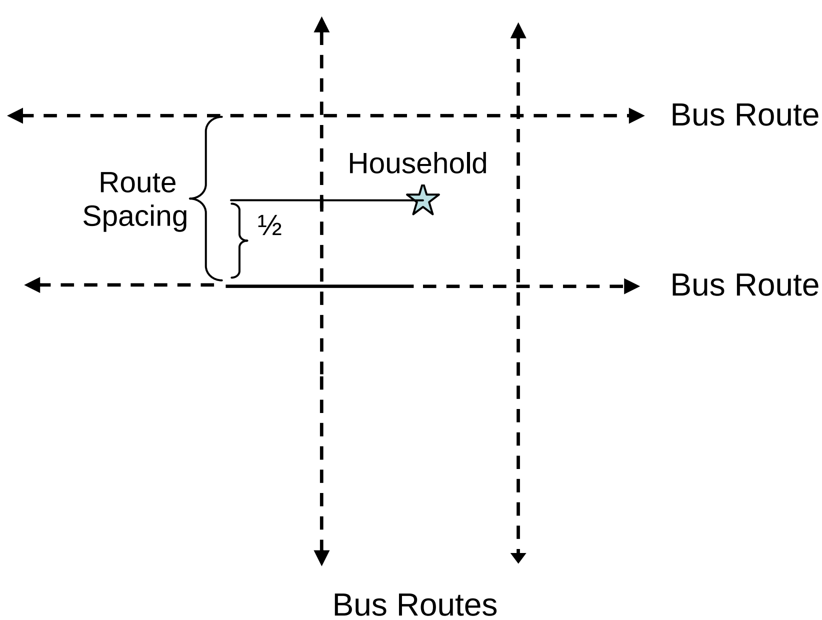

Figure 1.2 Ideal Bus Route Grid

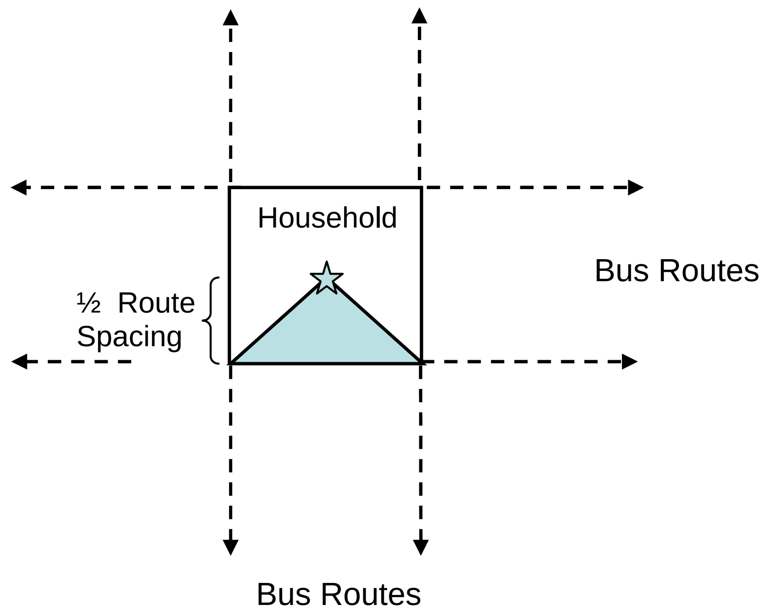

Figure 1.3 Distribution of Access

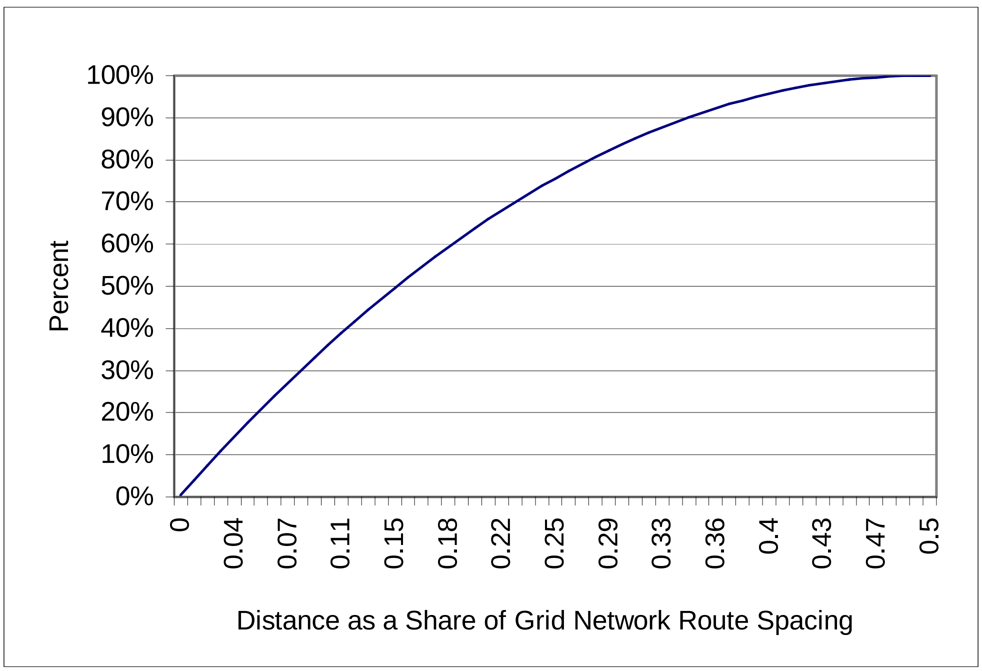

Figure 1.4 Ideal Cumulative Distribution of Access Distance to a Bus Route in Hypothetical Grid Network

Measured Access Distribution

Figure 2 and subsequent graphics display the national cumulative distributions for access to transit. Interval distances of one fifteenth of a mile were chosen to maximize the fineness of scale where statistical sample sizes mathematically allowed. Figure 2 illustrates that almost 50 percent of all individuals nationally live within ½ mile of a bus route. Additionally, about 65 percent of all households are located within 5 miles from a bus line. As illustrated, the slope of the line is a maximum at the close in short distances. This of course supports the fact that bus lines are located in populated market areas where a higher population and household density is likely. The slope of the curve remains relatively flat beyond about the 1 mile distance interval. There is a scale break at 5.11 miles to enable the graphic to cover the full population.

With this cursory review, it is apparent that less than half of the U.S. population lives within what could reasonably be called walk access of bus service.

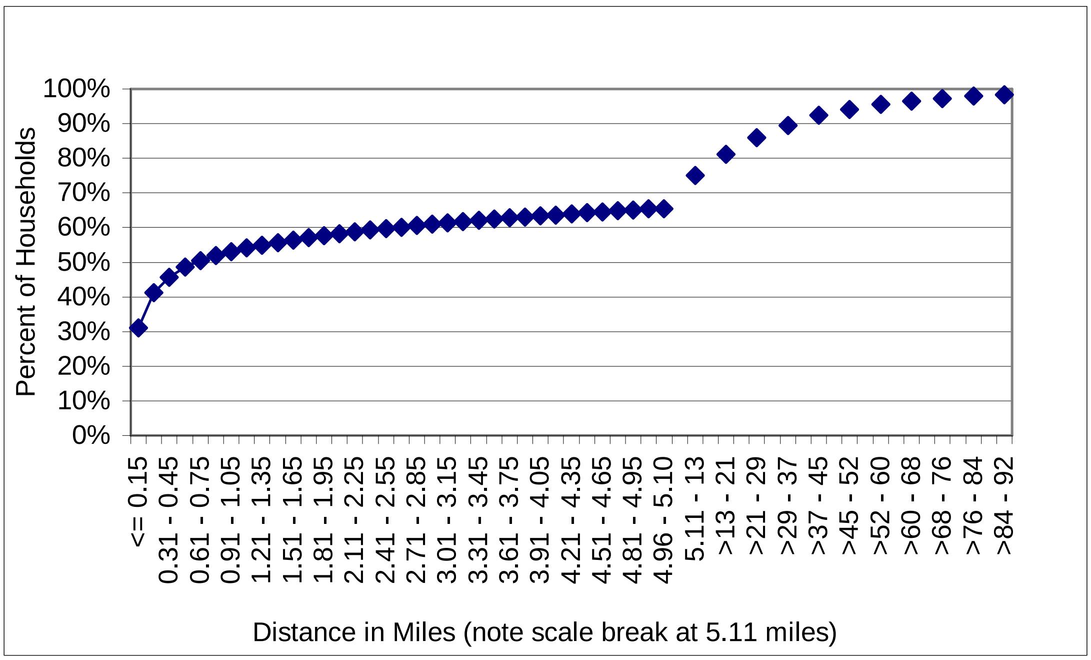

Figure 2 Cumulative Distribution of Household Distance to Bus Line

Figure 3 displays a national cumulative household distribution of distances to a rail stop. In contrast to the cumulative bus data in Figure 2, a significantly lower percentage of households are in proximity to a rail stop. The limited number of rail systems nationally influences the shape and flatter distribution in Figure 3. Figure 3 shows that approximately 10 percent of the national population lives within one mile of a rail station. Approximately 25 percent live within 5 miles, a distance that could be considered a reasonable park and ride access distance.

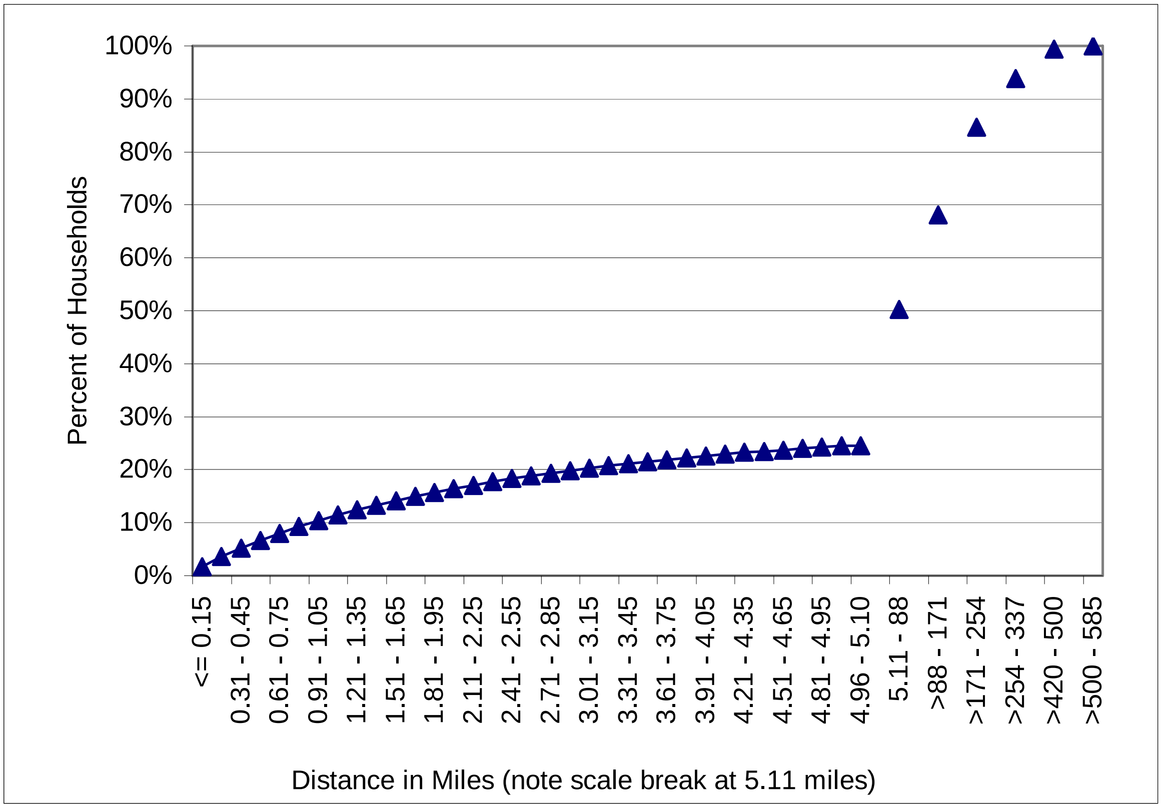

Figure 3 Cumulative Distribution of Household Distance to Rail Stop/Station

In the 1995 NPTS, respondents were asked about their perceived access to transit. As illustrated in Figure 4, about 50 percent of households interviewed in the 1995 NPTS believed that they lived within ¼ mile of a public bus route. The figure compares the perceived access distance by household respondents in the 1995 NPTS, to the measured sample in the 2001 NHTS. The comparison is not ideal due to the effects of service changes over time; however, actual service access is probably similar. The graphic suggests a meaningful difference between actual and perceived access to service. It appears that over all household distances, the perceived household access distances to bus are consistently shorter, which suggests somewhat counter intuitively that persons perceive transit as closer than it actually is. This phenomenon is compounded by the effects of an already assumed greater access distance resulting from the probable walk access increase described in Figure 1. The relationship or differences between actual and perceived access to transit, as described by this graphic may be of key importance to industry. As stated, transit access data is typically obtained by survey. Consequently, transit planners have based decisions and planning principles on such research. The implication of a higher degree of accuracy of measurement may have implications to the decision making regarding service access process going forward.

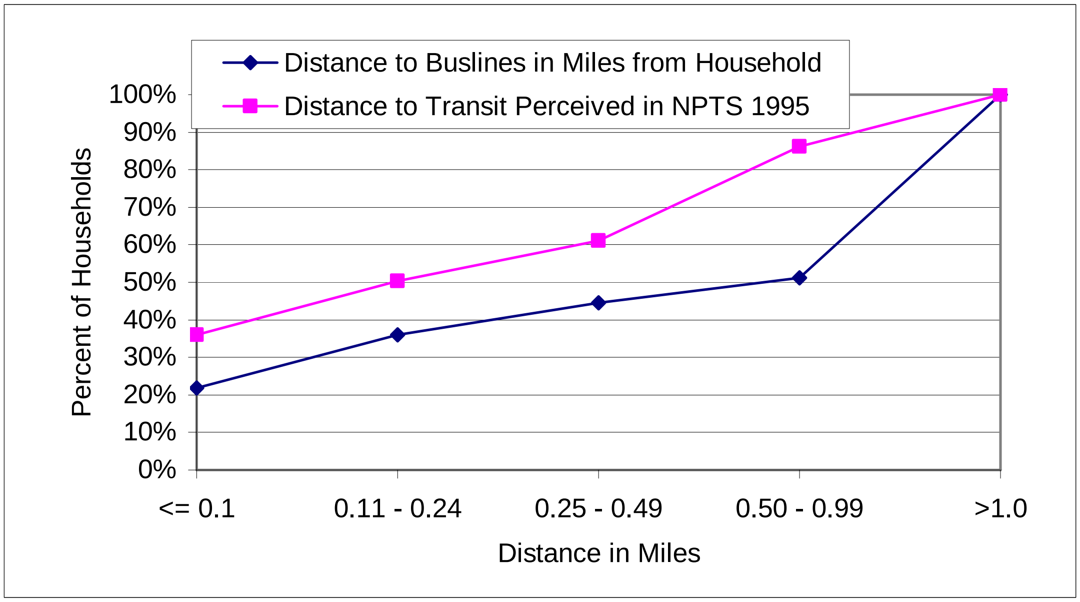

Figure 4 Cumulative Distribution of Person Distance to Bus Route

As shown in Figure 5, a cumulative distribution of distances to the workplace indicates that approximately 60 percent of workplaces are within ½ mile of a bus line. The distribution is very similar in shape to the household distribution; however for workplaces, about 15 to 20 percent more workplaces are within the first ¾ mile than for households. This shows that a higher percentage of workplaces are, in fact, in close proximity to transit, which is expected as workplaces tend to be more densely and centrally located.

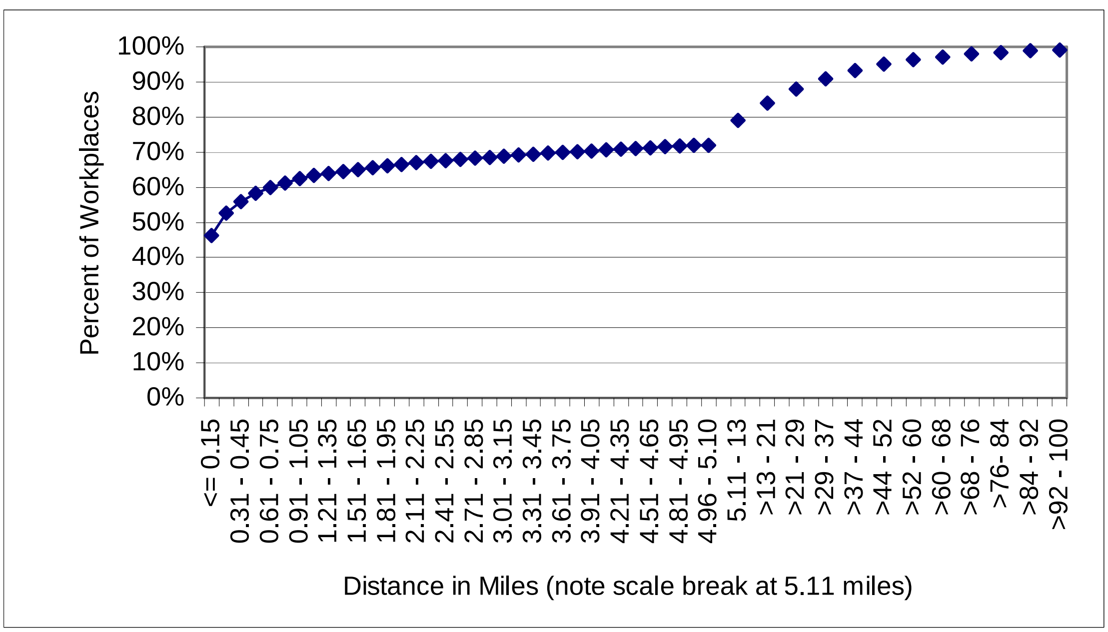

Figure 5 Cumulative Distribution of Distance from Work to Bus Route

Figure 6 illustrates that only about 10 percent of all workplaces are located within ½ mile from a rail stop or station. The distribution indicates that workplace proximity to rail is bout 20 percent higher within the first 5 miles than is the case for residences. The relative differences in geographic availability between rail and bus in general play a large role in the distributions of these cumulative graphics. Nationwide, 2004 National Transit Data indicated that there were nearly 90,000 miles of fixed route directional bus service reported and nearly 11,000 miles of directional rail service, the majority of which was commuter rail. The bus mileage advantage is further leveraged in terms of accessibility due to the much greater frequency of stops per mile of bus route compared to rail stops.

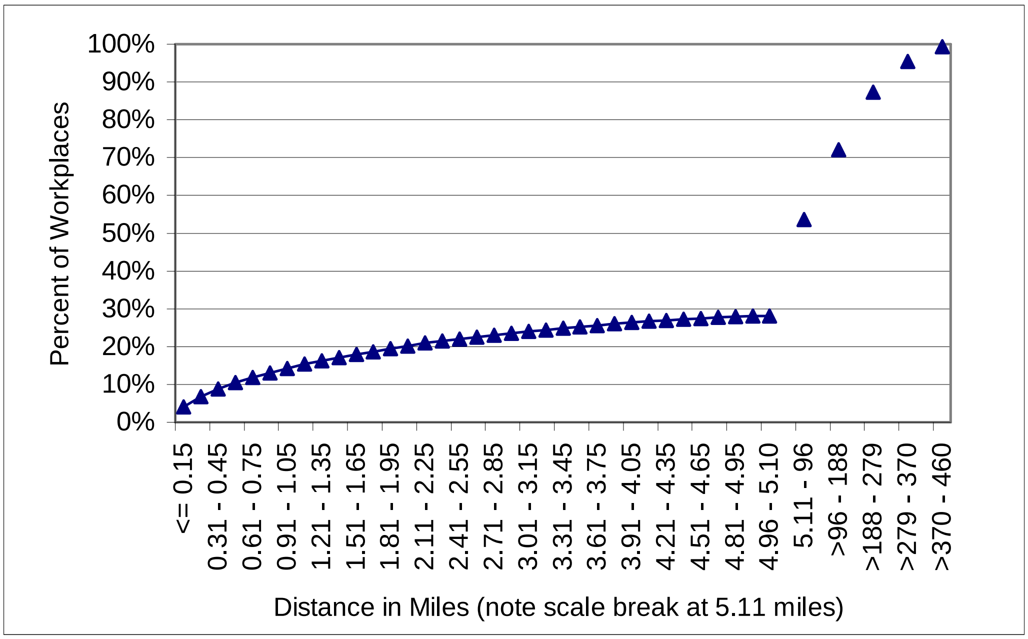

Figure 6 Cumulative Distribution of Distance from Work to Rail Stop

Access and Demographic Distributions

Having reviewed basic household access distributions, the research now shifts to focusing on how access to transit varies as a function of various demographic characteristics.

In Figure 7.1, a household income bracket distribution is plotted against access distance intervals to a bus route. Income brackets were derived from the NHTS variable data; however, every two brackets in that dataset were combined to give $20,000 interval sizes for convenience and improved graphical representation. Several phenomena can be observed. Initially, the highest concentration of households for each income group occurs within the first access distance bracket of 0.15 miles. Approximately 37 percent of the under $20,000 income bracket resides within the closest distance interval. These areas are likely more centralized and in higher density urban areas with more dense transit service networks. This is expected since, historically, lower income households have been concentrated in older, central urban areas. The highest income bracket, greater than $100,000, displays the lowest concentration of households within this first interval, about 22 percent. It is also evident from the graph that the highest income bracket has the lowest concentration compared to other brackets beyond 5 miles from bus transit. Interestingly, the highest income group has the highest concentration percentage consistently between distances of 0.15 and 5 miles. This observation could arguably indicate that a greater percentage of higher income persons choose to reside in areas likely considered suburban. These areas typically exhibit expanding access distances.

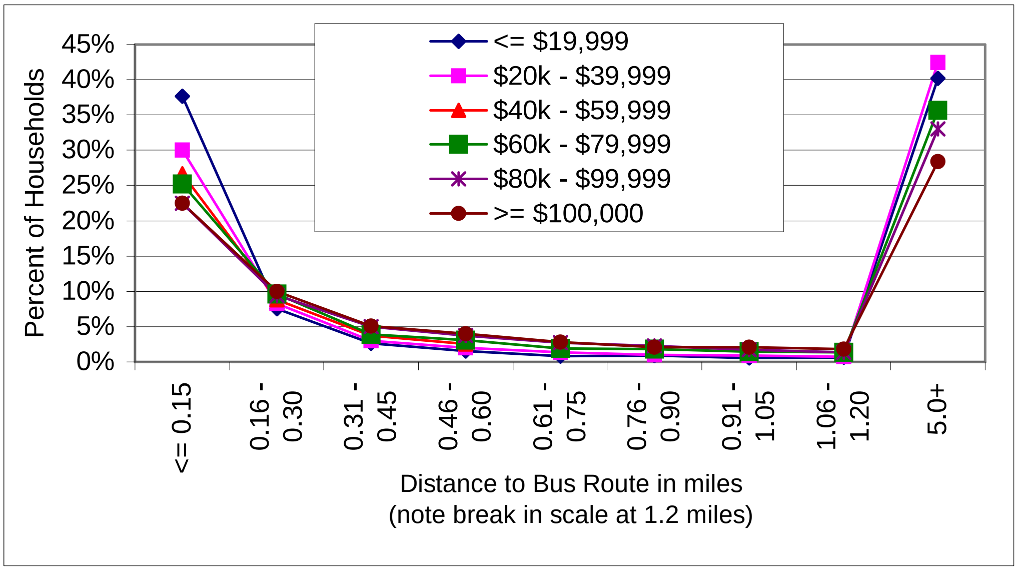

Figure 7.1 Household Access Distance to a Bus Route by Income

While there is evidence of better transit access for lower income households, the graphic also indicates that the largest share of households, including low income households, live beyond walk access to fixed route transit. These are suburban and rural households that are in small communities, suburbs, exurbs or rural areas where no regular transit service exists.

Similarly, in Figure 7.2, household distance to a bus route by income is displayed; however, only Florida households are utilized in the income bracket distributions. Initially, similar to the U.S., the highest concentration of households for each income group occurs within the first access distance bracket. Interestingly, the middle income bracket ($40,000 to $60,000) displays the second-highest contribution of households in the interval. For the longer distance interval of greater than 5 miles, the lowest income bracket displays the highest percentage, (nearly 34 percent) of low income households. In contrast to the national data, Floridians in the first few interval brackets experience slightly higher concentrations than those in the extreme intervals. In other words, the income distribution by access distance appears to be more evenly distributed and spread out over distance than for the U.S. This result is not unexpected due to the land use and development in those areas served by bus transit agencies in Florida.

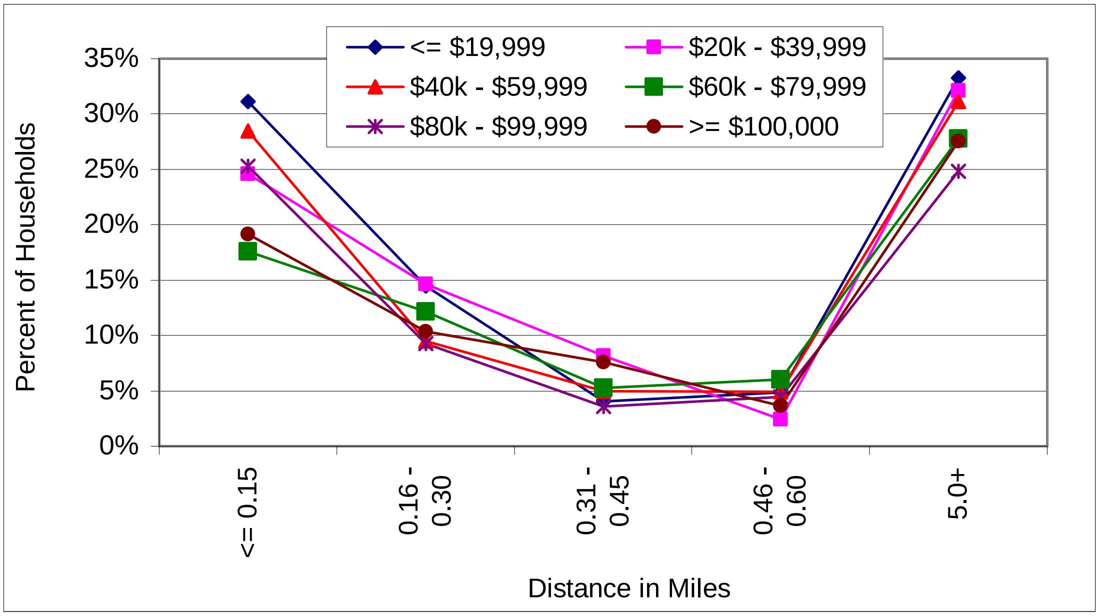

Figure 7.2 Florida Household Access Distance to a Bus Route by Income

Figure 8 displays residential household area location by the same income bracket using 2001 NHTS data. It can be seen from the figure that the lowest income bracket displays its highest concentration in urban regions in contrast to the highest bracket which experiences its highest concentration in suburban regions.

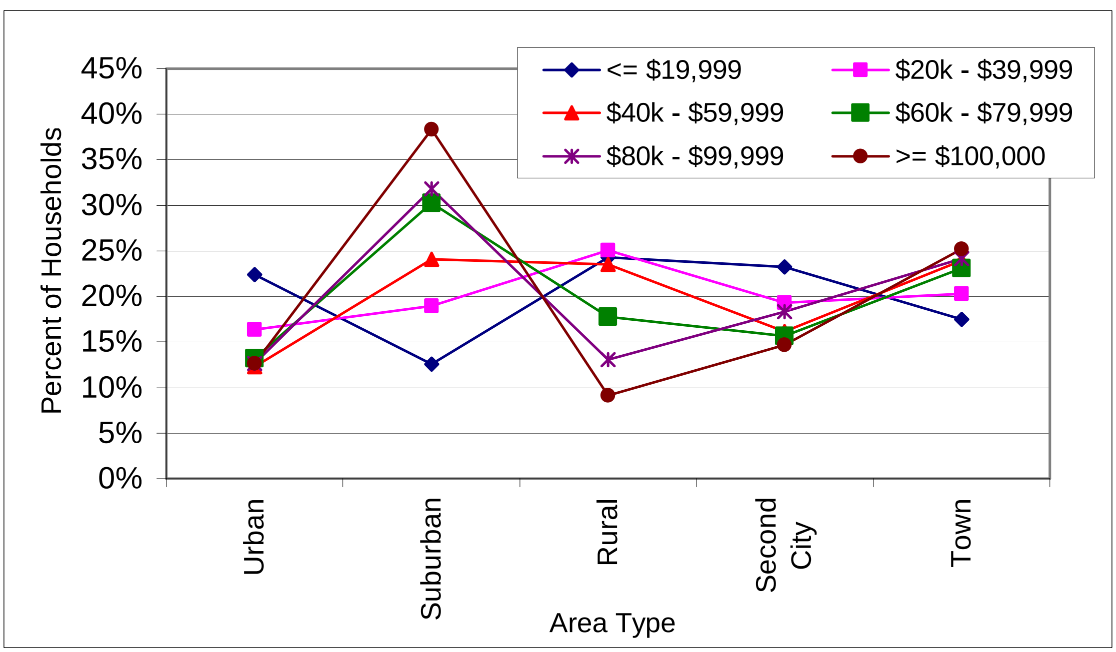

Figure 8 Distribution of Household Income by Area Type

Figure 9 displays the distribution by income by rail stop distances from the household. For rail access, income distribution is less obviously related to access distance, according to the graphic. It can be seen that the effect of changing income is far less pronounced than for bus distances and that the vast majority of all income level households are beyond walk access distances of rail. This is most likely the result of a lessened availability of rail in various markets throughout the country, although service such as commuter rail may often serve the higher income suburban type markets.

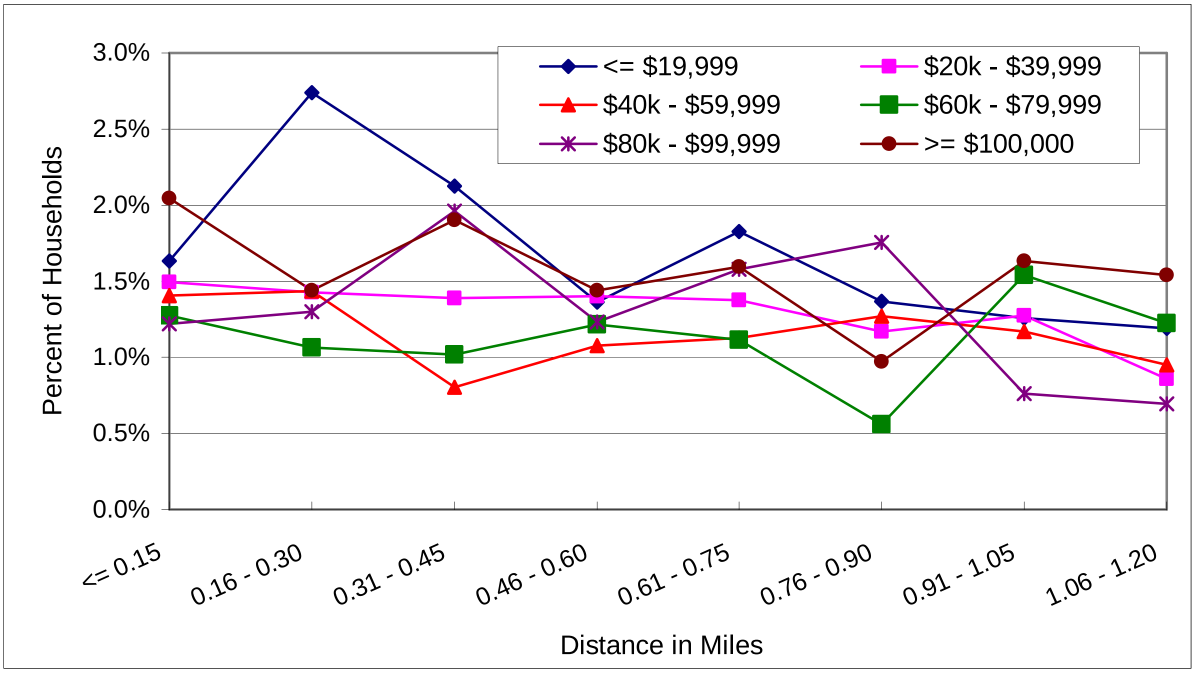

Figure 9 Distribution of Household Access Distance to a Rail Stop by Income

Figures 10.1 and 10.2 display household access distance by race (not ethnicity) nationally and for Florida. The top four largest groups in the sample were utilized for each graphic respectively. The concentration for White, within the first interval of 0.15 miles, is the lowest of those shown, approximately 24 percent. African American, Asian Only, and Hispanic Mexican Only display the highest concentrations in the first distance interval to a bus route at 56 percent and 47 percent, respectively. The subsequent distance categories show a similar order of access concentration, where an inverse relationship occurs beyond 5 miles. The findings indicate that the minority populations have the greatest access to transit by proximity.

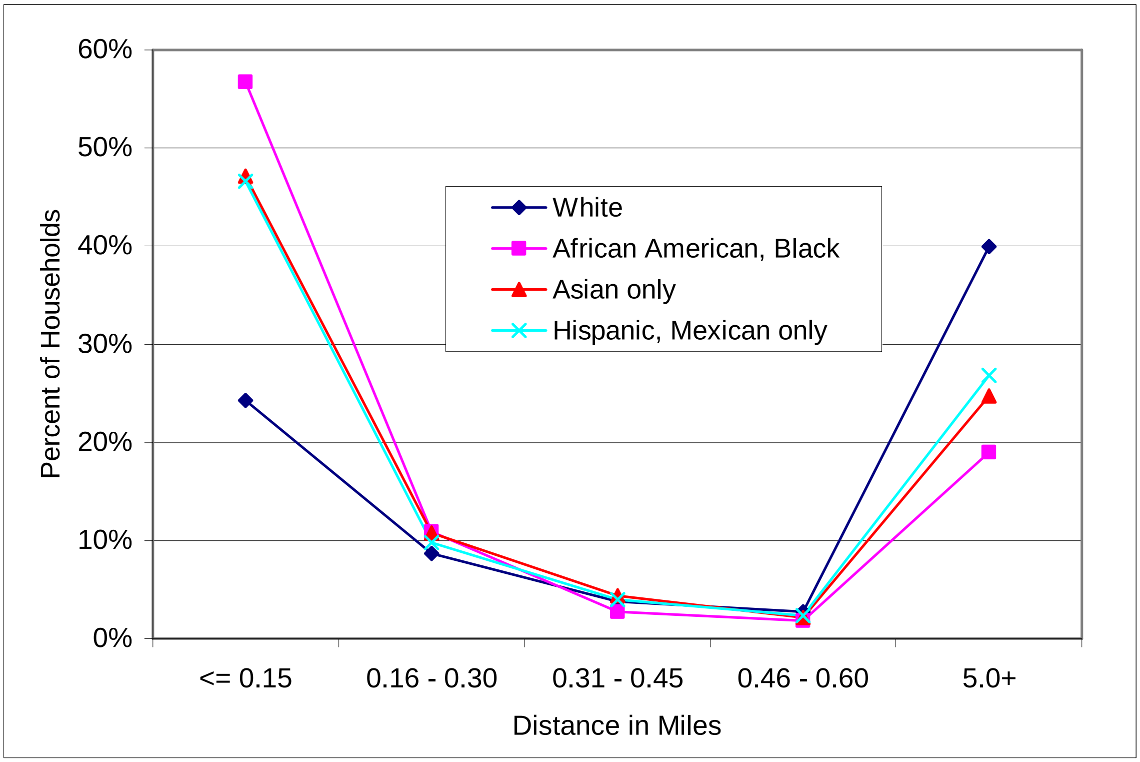

Figure 10.1 Household Access Distance to a Bus Route by Race

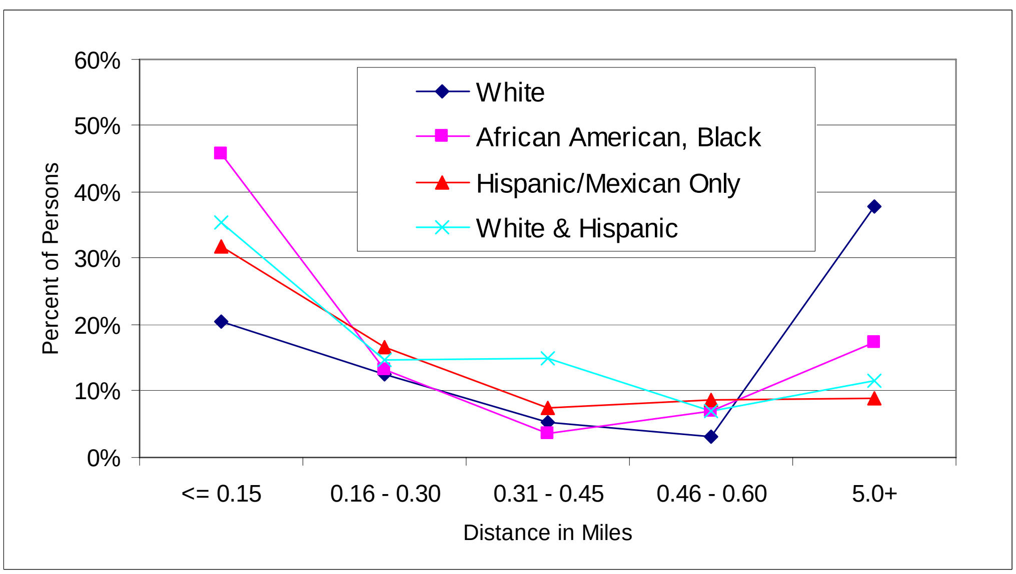

Figure 10.2 Florida Household Access Distance to a Bus Route by Race

Figure 10.2 displays Florida household access distance by race. The concentration for White, within the first interval of 0.15 miles, is again the lowest for those shown, approximately 20 percent. African American, Hispanic/Mexican Only, and Hispanic & White display the highest concentrations in the last distance interval. Interestingly, Hispanic/Mexican Only and White & Hispanic displayed the lowest of their respective concentrations in the greater-than-5-mile distance category. The findings indicate that the minority populations in Florida may have the greatest walk access to transit; however, the overall distribution is somewhat flatter for Florida than for the U.S. This may also indicate a higher dispersion of bus transit access in Florida or a more integrated distribution of population.

Figure 11.1 illustrates the distribution for car ownership categories by bus route access distance nationally. It is evident from the graph that 0-car households display their highest concentrations within the first measured access distance category of 0.15 miles. Interestingly, the order of concentration mimics the number of cars owned per household as indicated by the NHTS data. However, only the 0- and 1-car categories achieve their maximum within this first interval category. A very close concentration for all categories occurs through the next few distance categories, with a slightly decreasing percentage for each with rising distance. Notably, beyond a distance of 5 miles from a bus route, nationally, the 0-car households exist in the lowest concentration of all categories. The 3- and 4-vehicle households are among the highest concentration when compared to other categories greater than 5 miles. Not surprisingly, lower vehicle availability appears to be inversely proportional to a bus transit access advantage.

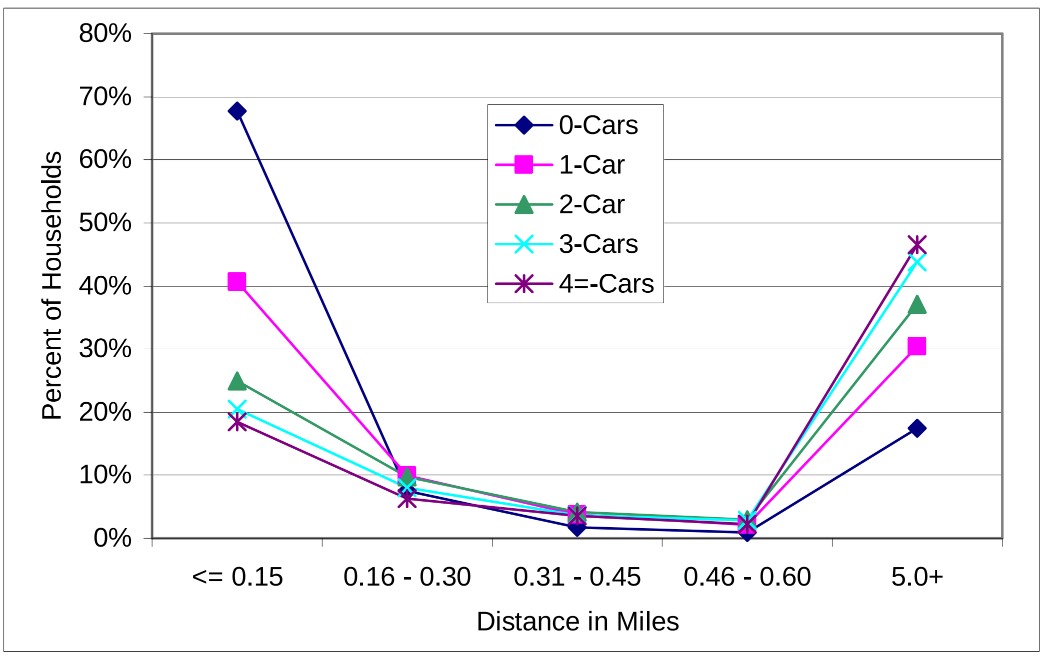

Figure 11.1 Car Ownership Category, Percent Households by Distance from a Bus Route

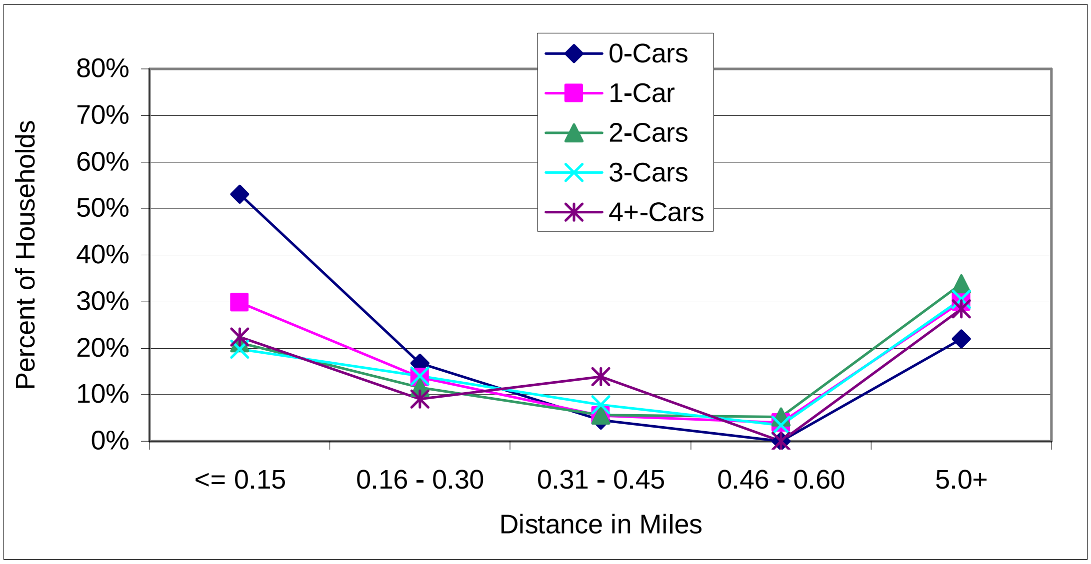

Figure 11.2 Florida Car Ownership Category, Percent Households by Distance from a Bus Route

Figure 11.2 illustrates the Florida distribution for car ownership categories. As illustrated, approximately 53 percent of 0-car households are within the closest access interval to a bus route. This is notably lower than the national percentage of nearly 70 percent within 0.15 miles. In this case, the order of concentration does not follow the number of cars owned per household as indicated by the NHTS data. However, only the 0- and 1-car categories achieve their maximum within this first interval category. Like the national data, a very close concentration for all categories occurs through the next few distance categories. Notably, beyond a distance of 5 miles from a bus route nationally, the 0-car households exist in the lowest concentration of all categories. In Florida, the 2-vehicle category exhibits its highest concentration among other categories in the greater than 5 mile distance range. Overall, the lower vehicle availability follows an inversely relationship with increasing bus transit access.

In Figure 12, the Metropolitan Area Size (MSA) categories are displayed by bus line access intervals from national households. It can be seen from the graph that the concentration of households not within any MSA category show the lowest percentages in the first distance interval and the highest percentage in the longer distance interval. This is an expected result from the existence of transit agency bus service that exists primarily in more populated areas consequently considered an MSA of a notable size. Also as expected, the more largely populated MSA categories generally exhibit higher concentrations at the closer proximity distance intervals.

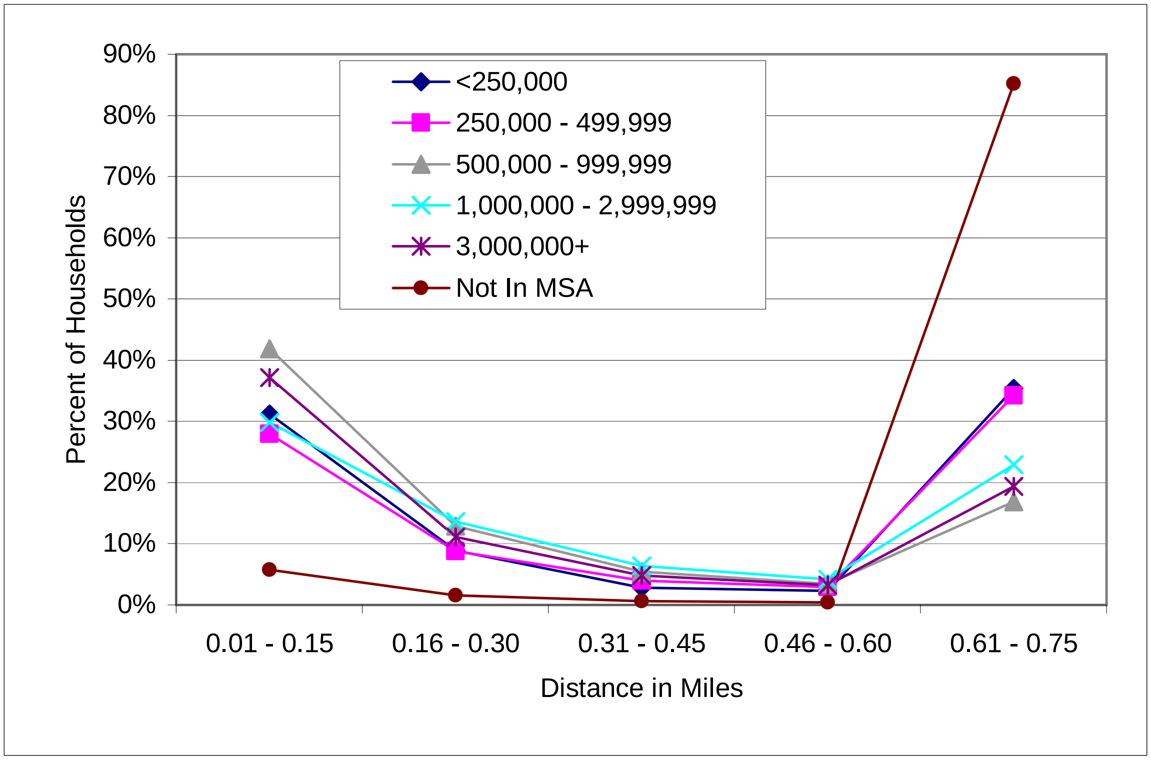

Figure 12 Metropolitan Area Size Category, Percent Households by Distance from Bus Route

Access and Geographic Distribution

Figures 13 through 16 illustrate the access for workers to and from transit. Since access to transit in the New York Metropolitan area is unique, graphics with and without NY MSA data have been calculated. Access for both rail and bus transit has been delineated utilizing the aforementioned methodology with the stipulation that the sample size for the nation excluding the NY MSA is much larger, and that geographical areas around the nation are inclusive, particularly all areas that are rural or where transit systems are generally not present. These figures assume connectivity among individual transit modes.

It can be inferred from Figure 13, for the rest of the nation, rail access for any subset of working individuals within a particular distance interval is small. In fact, those workers who reside in places that are within 0.15 miles from a rail station and whose workplace is located within 0.15 miles from a rail stop make up the highest percentage of workers when excluding the New York MSA. It can be seen that, for any given category, the percentage of the total is modest resulting from a low overall national access to rail, as shown in previous graphics. In an area where rail access is considered highly prevalent, such as the New York Metropolitan area, a very different distribution emerges.

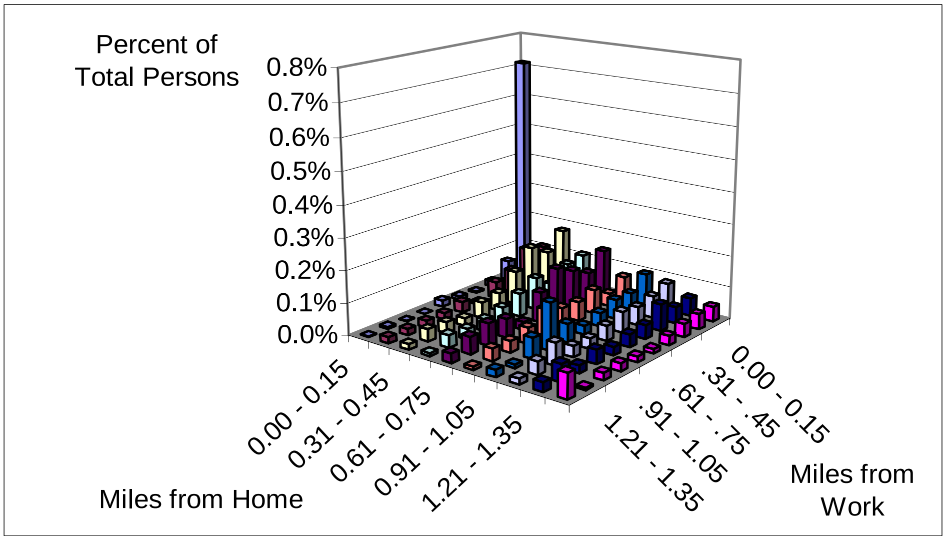

Figure 13 Rail Station Access by Trip End Distance, U.S., Excluding NY MSA

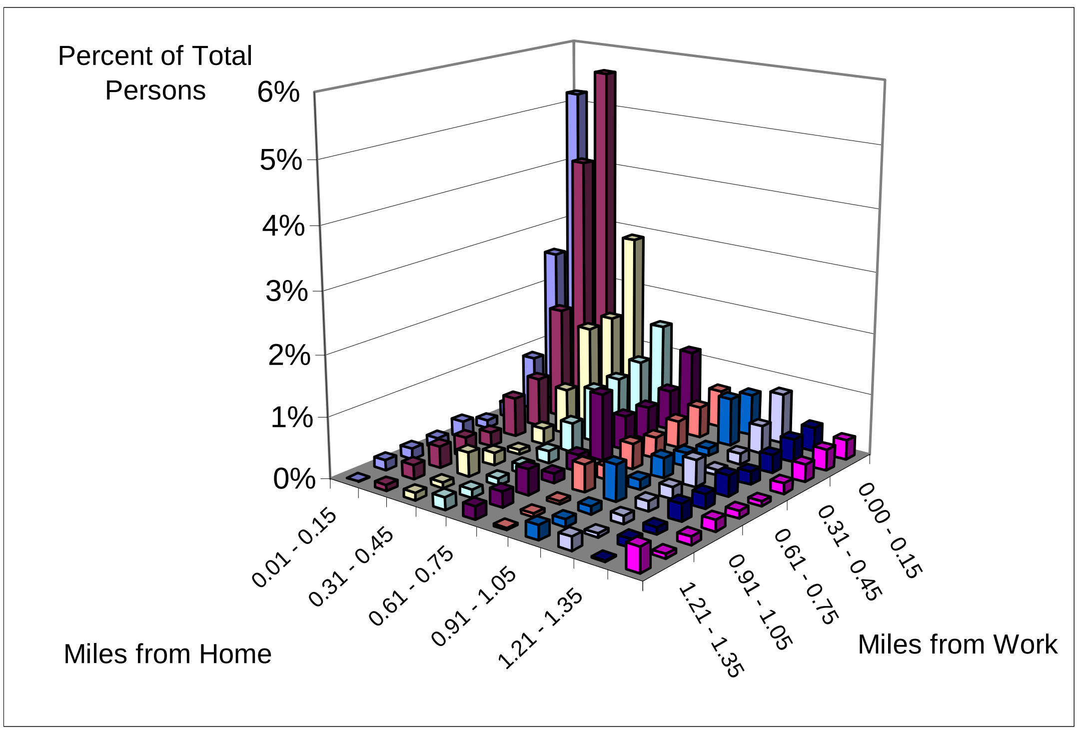

Figure 14 Rail Station Access by Trip End Distance, Only NY MSA

Figure 14 illustrates that, within the first few distance intervals, a more gradual decrease in the overall percentage of working persons exists. It also can be seen that, for those intervals where proximity to the workplace is closer than to the household, the percentages are generally higher. Notably, the closest access interval for workplaces, not the closest interval for households, exhibits the highest concentration of workers in the region.

Generally, this agrees with the fact that workplaces are typically more centrally located than residences and therefore are clustered more frequently around transit, especially in the New York area.

Figures 15 and 16 display a similar three-dimensional analysis for access to a bus route instead of rail. When considering all areas in the nation, excluding the New York MSA, approximately 20 percent of working travelers are within 0.15 miles from bus transportation for both their residence and workplace. In the New York area, more than double that percentage (nearly 45 percent) of workers in the region has close access to bus transit. The result is somewhat expected since the bus transit network in New York is considered complex and uniquely dense in comparison to the rest of the nation with few exceptions.

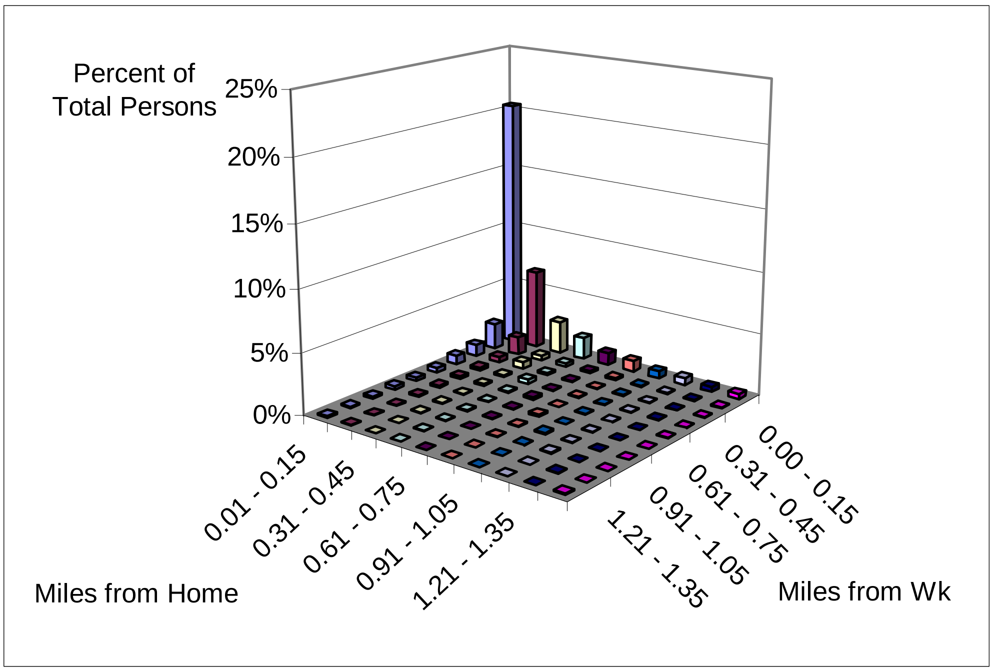

Figure 15 Bus Route Access by Trip End Distance, U.S., Excluding NY MSA

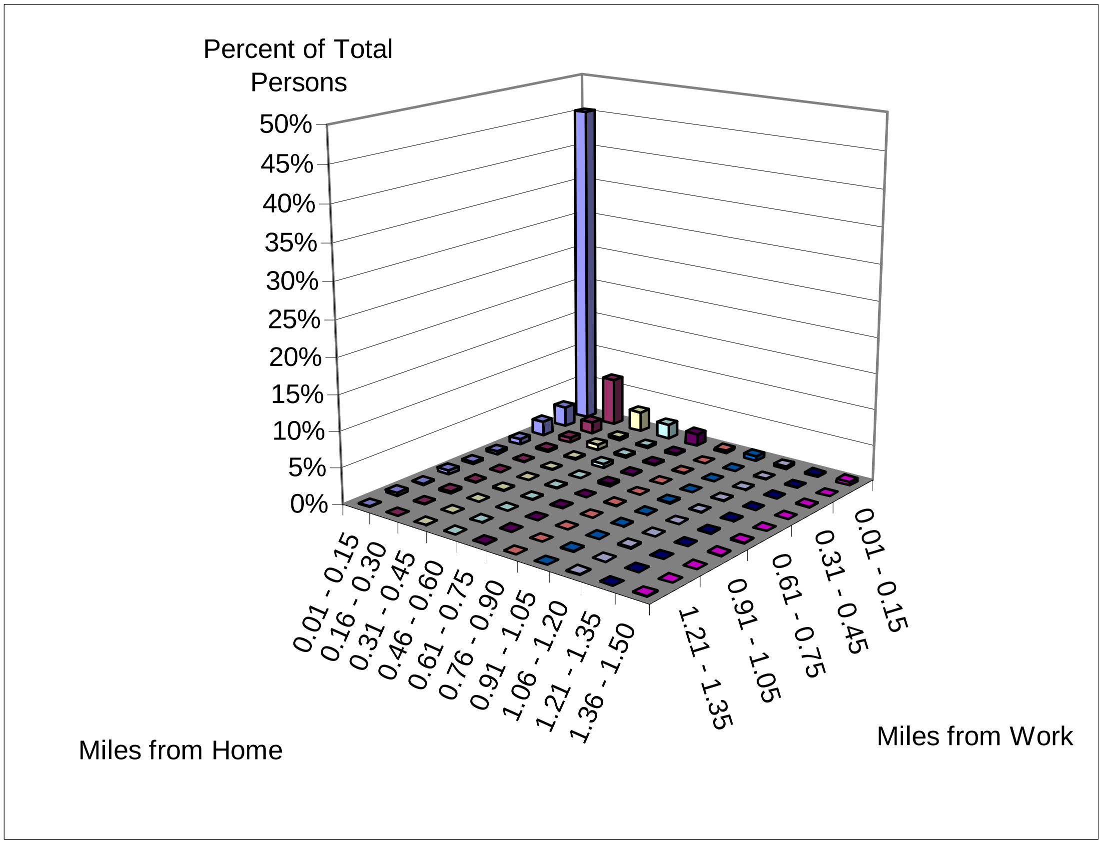

Figure 16 Bus Route Access by Trip End Distance, NY MSA Only

Accessibility, Density, and Area Type

In a report by Ross and Dunning (1997), the same report referenced earlier, the topic of land use interaction was explored by analyzing the 1995 NPTS dataset. The geographic layout of various areas available in the NPTS and NHTS surveys may provide a further insight into the nature of transit access. In this analysis, aspects of the relationships between household distances to transit are correlated to variables for geographical area type and population density. The variable for area type present in both surveys is well-suited for comparison since it utilizes the exact same categories for each. Similarly, the population density data are very close, with only the very last interval slightly modified in the latest survey. Thus, a unique opportunity exists to explore the data across both surveys. Notably, the directly measured new appended household access variables for transit were grouped slightly differently than in the previous graphics to match the intervals depicted in the Ross and Dunning paper.

Transit access data utilized in the 1995 data table were obtained from variables that were reported by households in contrast to the 2001 dataset appended access dataset containing measured data. This comparison offers a unique insight to the differences between perception and measured data despite the fact that both surveys were taken some years apart. Access to “transit” considers the minimum distance to either bus (commuter, transit) or rail (subway, light rail, commuter rail).

Table 1 Household Distance to Transit by Population Density, 1995 NPTS

Distance to Transit	People per Square Mile					
	0 to 249	**250 to 999**	**1,000 to 3,999**	**4,000 to 9,999**	**10,000+**	**All**
< 0.1 mile	18.5%	20.1%	26.0%	38.4%	57.9%	36.0%
0.1 to 0.24 mile	2.4%	5.6%	13.0%	17.4%	18.3%	14.3%
0.25 to 0.49 mile	3.0%	6.5%	10.4%	13.3%	11.2%	10.8%
0.5 to 0.99 mile	18.7%	29.6%	35.1%	25.2%	11.3%	25.1%
1 mile+	57.4%	38.2%	15.5%	5.7%	1.3%	13.8%

Source: Ross and Dunning (1997)

From Table 1, it can be observed that, for higher density areas, households within closer proximity intervals are more prevalent. Conversely, for lower density areas, access to transit is much less prevalent. Thus, in general, as population density increases, transit access distance decreases (Ross and Dunning 1997). Interestingly, in the 1995 analysis, the closest distance interval of less than 0.1 miles did not follow the trend exactly, in that a significant concentration of households was present in all density access categories. In the 2001 dataset, this phenomenon did not occur, and the trend was consistent ascending across all categories.

Table 2 displays the relationship utilizing the measured transit access data for the 2001 NHTS households. The percentages of lower density areas with longer access distances and higher density areas with shorter transit distances were much higher in the later dataset.

Table 2 Household Distance to Transit by Population Density, 2001 NHTS

Distance to Transit	People per Square Mile				
	0 to 249	**250 to 999**	**1,000 to 3,999**	**4,000+**	**All**
< 0.1 mile	3.9%	14.7%	33.4%	53.4%	22.1%
0.1 to 0.24 mile	2.0%	10.6%	24.0%	28.5%	14.6%
0.25 to 0.49 mile	1.7%	9.2%	13.3%	8.4%	8.2%
0.5 to 0.99 mile	2.5%	9.9%	8.7%	4.2%	6.5%
1 mile+	89.9%	55.7%	20.6%	5.4%	48.6%

Table 3 and 4 compare both survey data sets in a similar manner as population density but for geographical area type. For the 1995 data analysis, 52.5 percent of persons residing in an urban area are within 0.1 miles from transit. (Ross and Dunning 1997) Notably, the 2001 data analysis, illustrated in Table 4, shows a much lower percentage of households with access to transit within 0.1 mile than did the 1995 dataset listed in Table 3. Nearly 60 percent of urban residences are within 0.1 miles from transit, an increase in percentage over the prior older survey result. This phenomenon agrees with analysis that suggests that respondents may tend to overstate their proximity to transit when asked for their perception. Additionally, it may be inferred that a shift of the share of total households has occurred. Several additional factors may contribute to this effect such as area development or redevelopment, service area sizes may have shifted or changed in size, and or geographical land use reclassification may have occurred. The measured, 2001 data in Table 4 also illustrates the same circumstances for the Town category, and even the Urban category.

Table 3 Household Distance to Transit by Area Type, 1995 NPTS

Distance to Transit	Area Type					
	City	Rural	Suburban	Town	Urban	All
< 0.1 mile	37.9%	21.4%	28.2%	22.1%	52.5%	36.0%
0.1 to 0.24 mile	16.0%	1.6%	13.4%	6.3%	19.6%	14.3%
0.25 to 0.49 mile	12.0%	4.9%	11.6%	5.7%	12.0%	10.8%
0.5 to 0.99 mile	24.3%	18.3%	34.4%	27.5%	14.3%	25.1%
1 mile+	9.7%	53.8%	12.3%	38.4%	1.6%	13.8%

Source: Ross and Dunning 1997

Table 4 Household Distance to Transit by Area Type, 2001 NHTS

Distance to Transit	Area Type					
	City	Rural	Suburban	Town	Urban	All
< 0.1 mile	36.4%	1.7%	25.6%	7.2%	59.5%	24.6%
0.1 to 0.24 mile	21.0%	0.8%	21.6%	4.6%	27.8%	14.9%
0.25 to 0.49 mile	9.3%	0.9%	16.3%	4.2%	7.2%	7.9%
0.5 to 0.99 mile	6.5%	0.6%	13.4%	5.6%	2.9%	6.2%
1 mile+	26.8%	96.0%	23.1%	78.3%	2.6%	46.3%

CHAPTER 4 TRANSIT USAGE AND ACCESS

Mode Share

This section looks at transit use as a function of access distance. Figure 17 illustrates a comparison between bus work trips and the entire set of bus trips as a function of household access distance for the closest three intervals. A sharp decreasing slope is evident beyond the first interval, which indicates that the work mode share for bus transit trips declines rapidly beyond 0.15 miles from a household. Beyond approximately 1/3 mile distance from transit, the all-trip mode share drops below 1 percent. For work trips, a 50 percent decrease in mode share occurs beyond 1/3 mile. For bus transit, the number of trips is comparatively low compared to automobile trips; therefore, percentages alone do not capture the phenomenon. From Figure 17, it can be seen that the overall share of work trips using bus transit is higher for each category, thus illustrating the importance of the work trip. The decreases in share beyond 0.15 miles indicate that there is a distinct walk distance limit that travelers are willing to undertake. Historically, it has been accepted that individuals undoubtedly greatly value their time, and that walk trip distances beyond ¼ mile are generally undesirable. Some factors influencing the propensity for shorter walk trip distances include weather conditions, physical conditioning, safety, and total allotted travel time.

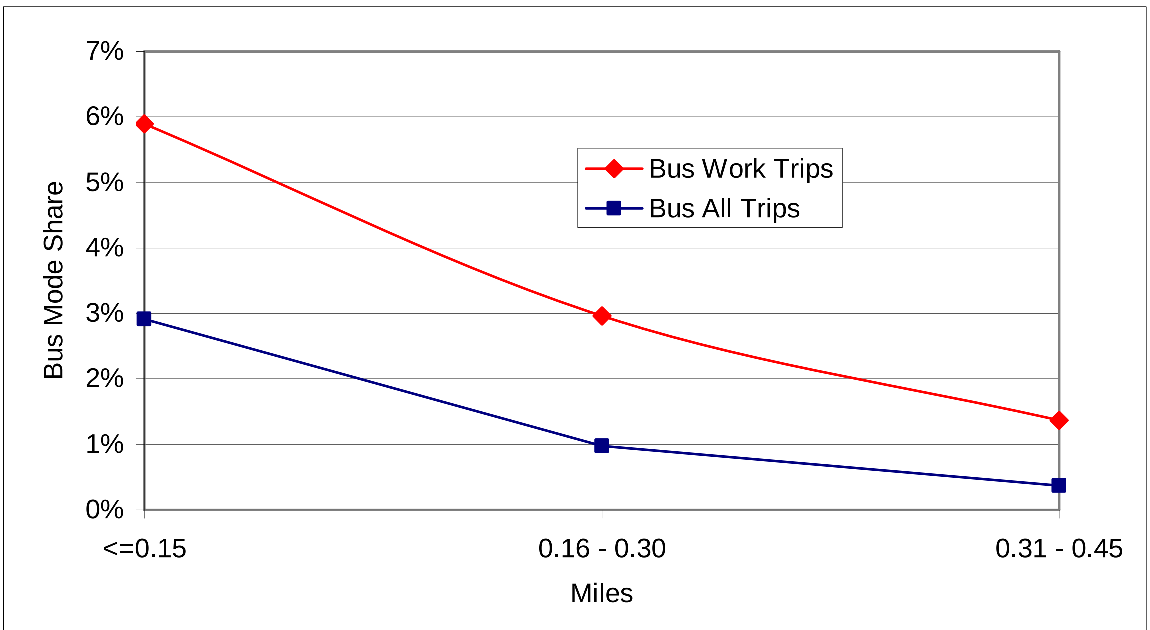

Figure 17 Bus Trip Mode Share by Household Distance

Figure 18.1 and Figure 18.2 display the bus work trip share of those persons by vehicle ownership category for both the U.S. and Florida. The categories are those trips taken by persons who do not have access to a vehicle and all other persons taking trips who have access to at least one vehicle. The mode share in these graphics is not typical in the sense that a disproportionate share of total work trips are taken by those with vehicle access. Additionally, due to a diminished sample size and low percentage of trips within some subcategories, these data are presented by share within each access distance interval. Nationally, over 55 percent of trips taken by those who live within 0.15 miles from a bus route and have no vehicle available make a bus transit trip. Conversely, for those person-trips made by individuals who live within 0.15 miles from a bus route and have indicated that they have access to a car, only about 6 percent choose the bus transit mode.

In Florida, the percentage of those 0-car households who lived within the closest distance interval and made bus transit trips was slightly higher than for the U.S. Beyond the first distance interval, trip rates were extremely small compared to the first interval. A plausible reason for the higher first interval larger percentage may be a lower number of available or plausible modes of travel for Floridians. Many additional factors such as age, warm climate exposure, or lack of rail as an alternative may explain this result. As expected, however, the figures indicate that a high propensity for bus transit use exists when no vehicle is available, which diminishes with distance from a bus route.

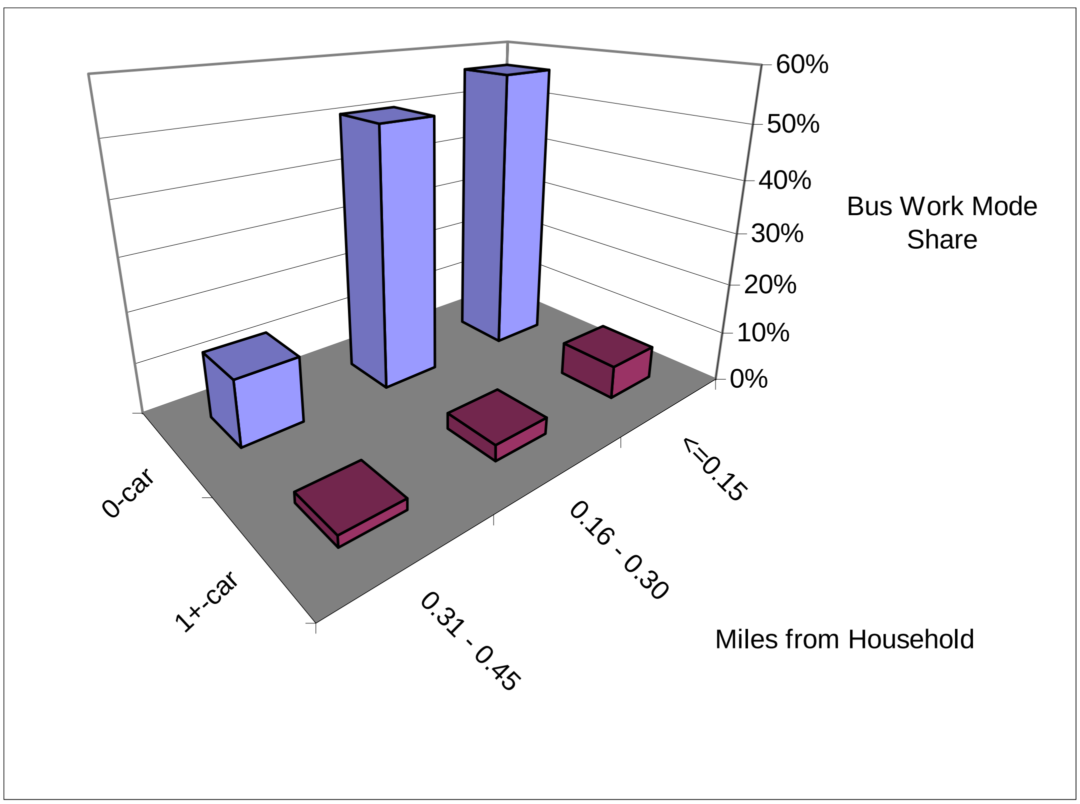

Figure 18.1 Share of Bus Work Trips within Vehicle Availability Category by Bus Route Access Distance, U.S.

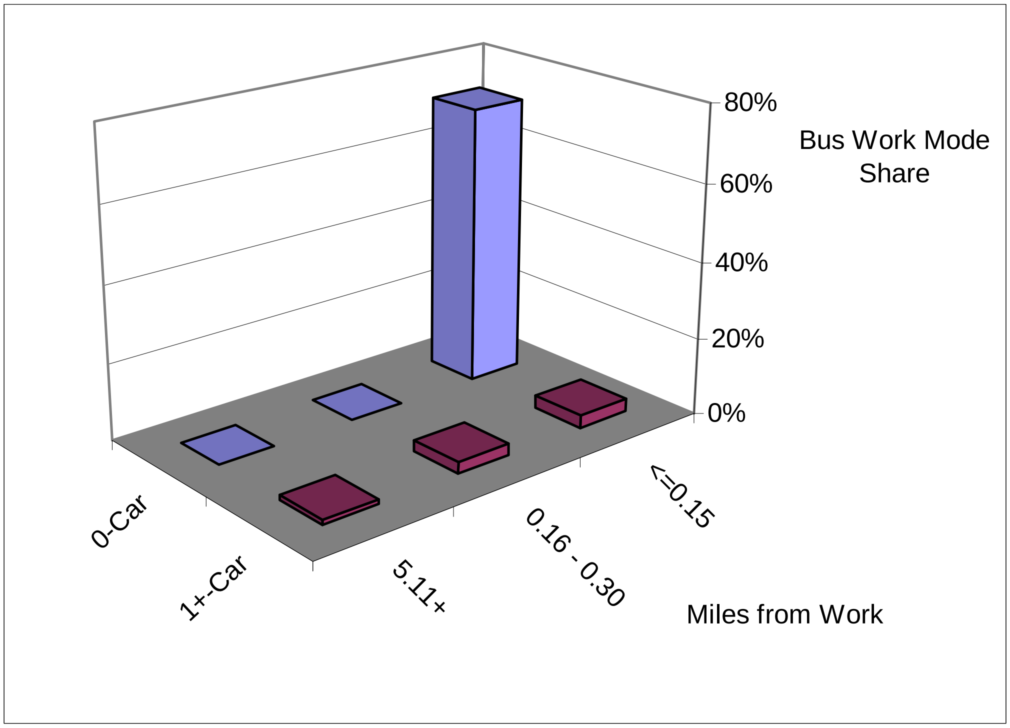

Figure 18.2 Florida Share of Bus Work Trips within Vehicle Availability Category by Bus Route Access Distance, U.S.

Matrix Mode Share

For Figures 19 through 28, graphically depict the percentage of transit trips (both bus and rail) that were chosen within each particular access interval. The intervals resemble a matrix of cells of individual work trips that fall into the specific access distance categories for both residences and workplaces. The percentages displayed represent mode share within each cell. This analysis was developed to present the data visually on a finer scale than previously analyzed.

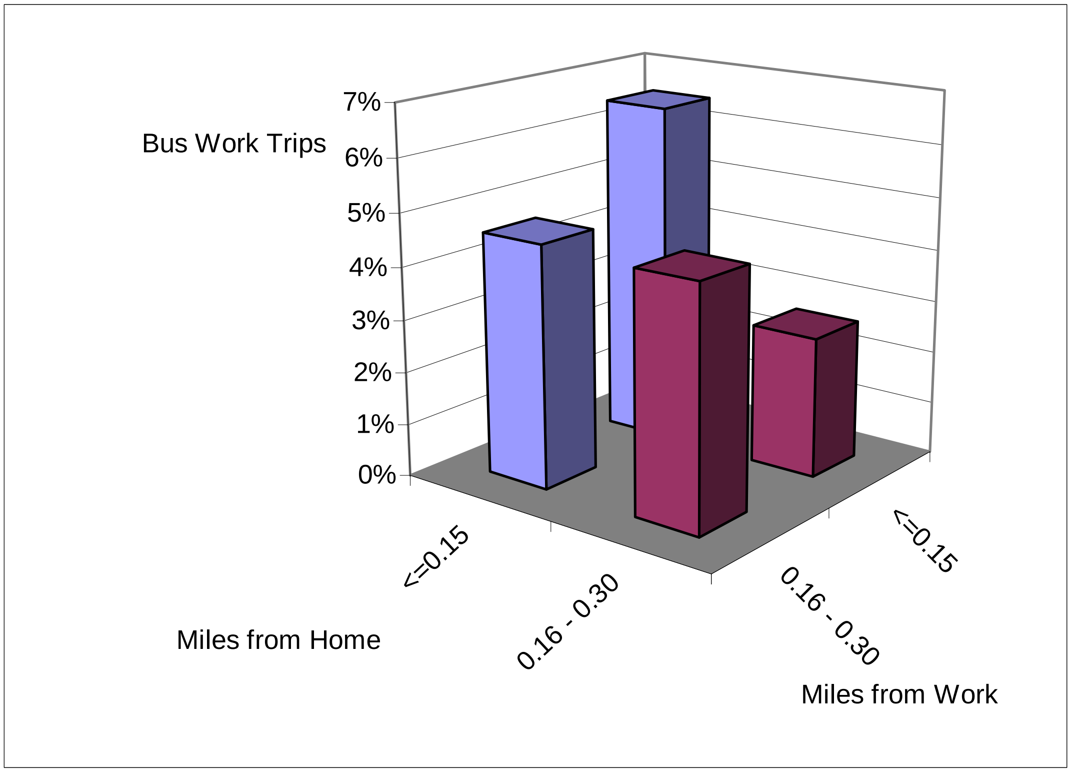

Figure 19 Bus Transit Work Trip Mode Share by Trip End Distance to Bus Route, U.S.

Figure 19 shows bus transit work trip mode share by trip access distance. Only two access distance interval intervals are shown due to the lessening of sample size beyond the given distances. As expected, the highest mode share exists for the shortest access distance category.

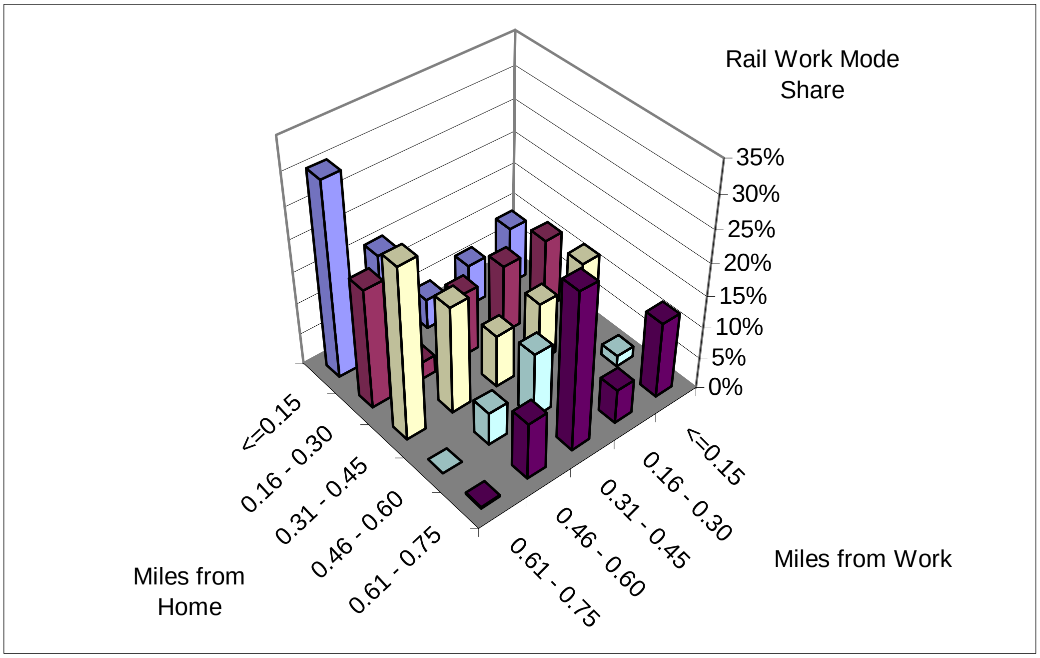

Figure 20 Rail Work Mode Share by Trip End Distance Interval to Rail Station, U.S.

Figure 20 illustrates the work mode percentage for rail person-trips when correlated to rail accessibility for both the household and the workplace. A higher rail mode share occurs where the household distance is shortest, less than 0.15 miles and where the distance from the rail station to individual's workplace is just under three quarters of a mile. Interestingly, the rail mode choice percentage for these workplace access distance groupings is higher for rail than for bus nationwide, but the percentage of users of transit bus declines with trip home end distance. On the contrary, the access category mode share for rail tends to increase slightly with distances up to about ¾ of a mile and then shows a decline. Access mode options (drop-off, park and ride, feeder bus), land use around rail stations, and the trip length of rail trips are factors that may affect the mode use distribution as a function of distance to and from a station. Historically, there is an acknowledged willingness of travelers to walk farther to access premium modes and for longer trips.

In contrast to national trends, in Figure 21, New York area rail trip percentages by access category far surpass that of bus transit. Many of the proximity distance categories from a rail stop to residences and workplaces for workers in the New York MSA exhibit approximately a 20 percent share for rail within each category, up to the ½ mile access distance intervals. Due to a less robust sample size available in the NHTS data for this market segment, many intervals could not be shown for the same analysis for bus in Figure 22. However, Figure 22 shows that the local mode choice percentage for bus is less than that of rail for the New York MSA. Historically in this region, ridership on rail has surpassed that of bus transit, especially for the work commute. This is as expected, due to the usually higher overall speed of travel of the heavy rail system in New York City. Vehicle speed of travel, stop intervals, and surface traffic play a role in the mode choice decision in New York City, in addition to the obvious choice constraints resulting from available of desired origin-destination pairs and transfers.

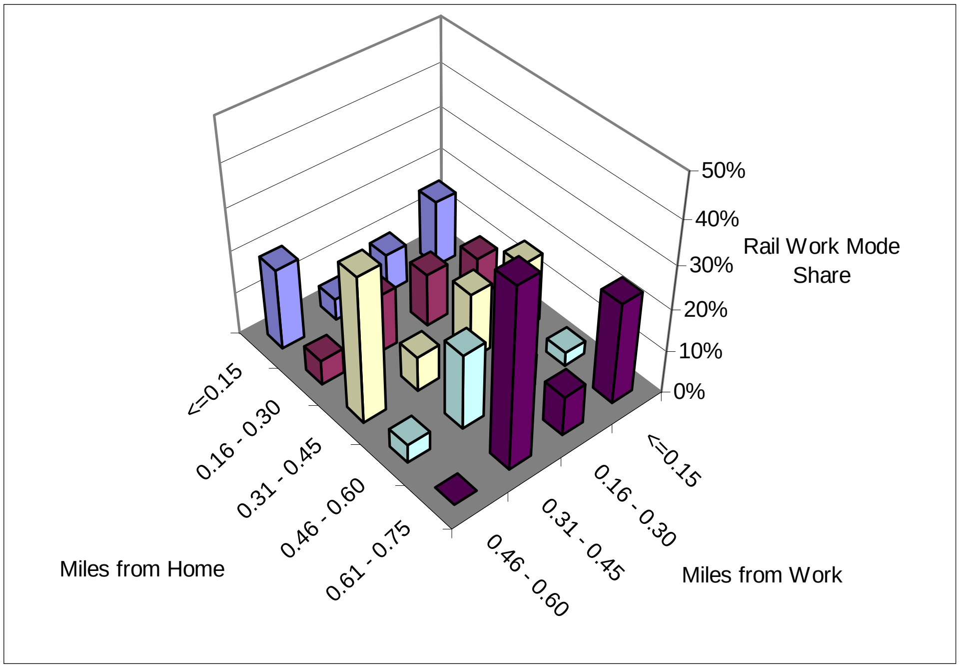

Figure 21 Rail Work Mode Share by Trip End Distance Interval to Rail Station, Only NY MSA

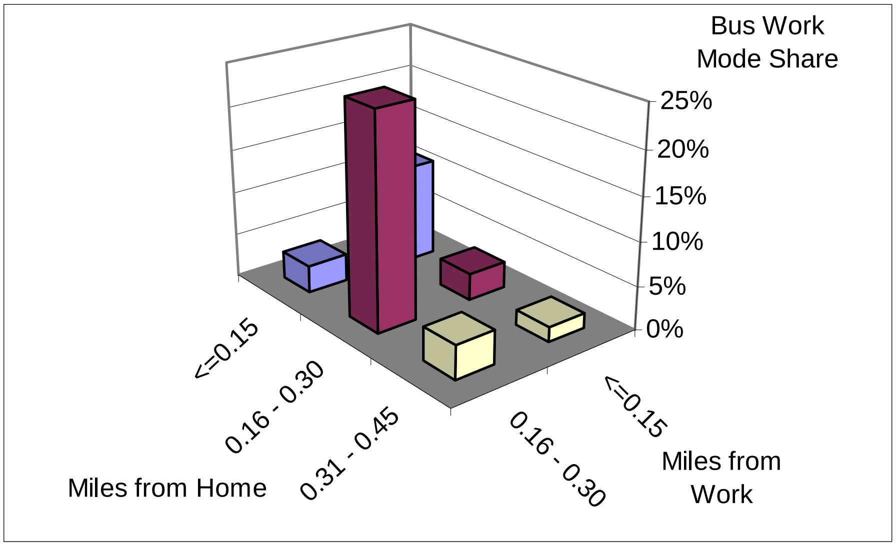

Figure 22 Bus Work Mode Share by Trip End Distance Interval to Bus Route, Only NY MSA

CHAPTER 5 ACCESS LOGISTIC REGRESSION MODEL

Introduction

Transportation forecasting usually begins with the traditional four-step forecasting model consist of trip generation, trip distribution, mode choice, and route assignment. Transit accessibility can play a large role in mode choice analysis and modeling. After cross-tabulation and correlation analysis of various contributing factors, it may be desirable to analyze the effects of contributing factors at the aggregate or disaggregate level. For instance, logistical regression may be suitable to explore mathematical models for predicting mode choice. Binary choice logistic regression has been widely utilized in econometric analysis to investigate travel behavior (Racca and Ratledge 2004). The binary model is based on the following mathematical convention:

$$Y=1 \text{ if } Bx + u >=0,$$
$$Y=0 \text{ otherwise}$$

where Y is a choice outcome for behavioral response such as mode choice, x is a vector of attribute variables, and B is a vector of parameters.

Travel demand modeling explores and predicts an individual's travel behavior choices. In this chapter, a general logistic regression model is tested to explore the possibility that the inclusion of a measured accessibility variable will improve a given model. It is hypothesized that the significance of such a model will improve more than if the variable were a perceived access response variable.

Studies indicate that many factors play a role in transit use and mode choice. Some of the variables that may be considered relevant and subsequently used in a predictive regression model include, level of service variables, land use and geographic variables, socioeconomic and demographic variables, and accessibility or distance variables.

Transit Mode Choice Regression Model

Tables 5 through 8 show the results of a transit model using the national NHTS sample variables. The variables were chosen based on traditional utilization in classic mode choice models. The Beta coefficients for each categorical variable are listed in the second column of the table. In the third column, the standard error for each variable is listed. Significance of a given variable in the model is determined by a ratio between the coefficient and its standard error term, which is labeled the Z-Statistic in column 4 of both tables. SPSS provides the resulting Wald statistic when calculating the model, which is the square of the aforementioned Z-ratio. Finally, the overall significance of each variable is listed in the last column and provides an indication of how relevant the variable is when included in the equation and subsequent model. It should be noted that even though a variable may be very significant, it is not guaranteed to play a vital role in the overall equation. Higher Wald statistics indicate stronger influences. Lower significance values, or those close to 0, indicate a higher parameter relevance to the model.

Tables 5 and 6 show the coefficients and results for the models with and without the access distance variables for the un-weighted sample of workers present in the NHTS dataset. Tables 7 and 8 use exactly the same variables but display the results of the model when the NHTS national person weighting factor is applied to the variables. That is, the total number of working persons in the models annotated by Tables 7 and 8 is expanded to include the entire population of workers.

Table 5 Model Results, Un-weighted Variables Not Including Measured Access

	B	S.E.	Z-stat	Wald	Sig.
R_AGE_17 (Cat)				5.432	0.246
R_AGE_18 TO 29 (Cat)	0.353	0.354	0.997	0.994	0.319
R_AGE_30 TO 49 (Cat)	0.072	0.213	0.338	0.114	0.735
R_AGE_50 TO 64 (Cat)	-0.055	0.203	-0.271	0.073	0.787
R_AGE_65 (Cat)	0.131	0.21	0.624	0.390	0.532
HHFAMINC_LOW (Cat)				51.487	0.000
HHFAMINC_MID (Cat)	0.906	0.135	6.711	45.047	0.000
HHFAMINC_HIGH (Cat)	0.439	0.087	5.046	25.712	0.000
HHVEHCNT_AVAIL (Cat)	-2.244	0.095	-23.621	556.578	0.000
HBHUR_URBAN (Cat)				172.923	0.000
HBHUR_SUBURBAN (Cat)	1.067	0.09	11.856	139.584	0.000
HBHUR_RURAL (Cat)	-1.612	0.385	-4.187	17.492	0.000
Constant	-2.008	0.231	-8.693	75.834	0.000
Hosmer and Lemeshow					0.111

In a classic travel demand model, variables related to trip characteristics are typically included but are not utilized in this model. As mentioned, the NHTS dataset does not provide for service characteristics or measured temporal characteristics; therefore, the model is performed using demographic and geographic variable information only while the objective of the varying models is to indicate the effects of the inclusion of the measured access variables on the predictability of transit mode choice.

Importantly, this model uses variables from the person file and relates them to the variable for an individuals' usual mode choice for the prior week. Variables for household family income, respondent age, geographic area type, vehicle availability, and access distance to a bus route were utilized. Arguably, geographic area type may be considered an exception to traditional usage in this type of model, but was included because of the inclusion in the cross-tabulation analysis earlier in this report. The variables were reclassified from the numerous categories provided in the NHTS variable data set and grouped into less categories of a more general nature before analyzing with SPSS. The mode choice variable, or usual-mode variable was recoded to indicate a one if bus transit was chosen as the primary mode, or 0 if otherwise. Only workers were considered. Additionally, instances of missing or not available data were filtered from the set of utilized variables. The equation was modeled around a propensity to choose bus transit based on demographics while analyzing for both the inclusion and exclusion of the access distance component.

Table 6 Model Results, Un-weighted Variables Including Measured Access

	B	S.E.	Z-stat	Wald	Sig.
R_AGE_17 (Cat)				5.118	0.275
R_AGE_18 TO 29 (Cat)	0.371	0.367	1.011	1.022	0.312
R_AGE_30 TO 49 (Cat)	0.149	0.218	0.683	0.465	0.495
R_AGE_50 TO 64 (Cat)	0.029	0.209	0.139	0.019	0.891
R_AGE_65 (Cat)	0.216	0.215	1.005	1.005	0.316
HHFAMINC_LOW (Cat)				48.320	0.000
HHFAMINC_MID (Cat)	0.9	0.137	6.569	43.348	0.000
HHFAMINC_HIGH (Cat)	0.414	0.088	4.705	22.305	0.000
HHVEH_AVAIL (Cat)	-2.214	0.096	-23.063	530.607	0.000
HBHUR_URBAN (Cat)				118.304	0.000
HBHUR_SUBURBAN (Cat)	0.977	0.095	10.284	106.016	0.000
HBHUR_RURAL (Cat)	-1.15	0.399	-2.882	8.325	0.004
PTDISTHH (Continuous)	-0.266	0.082	-3.244	10.539	0.001
PTDISTWK (Continuous)	-0.035	0.024	-1.458	2.153	0.142
Constant	-1.954	0.238	-8.210	67.423	0.000
Hosmer and Lemeshow					0.305

Table 7 – Model Results, Weighted Variables Not Including Measured Access

	B	S.E.	Z-stat	Wald	Sig.
R_AGE_17				0.000	0.000
R_AGE_18 TO 29	0.827	0.007	118.514	0.000	0.000
R_AGE_30 TO 49	0.245	0.005	48.628	0.000	0.000
R_AGE_50 TO 64	0.054	0.005	10.775	0.000	0.000
R_AGE_65	0.092	0.005	17.664	0.000	0.000
HHFAMINC_LOW				0.000	0.000
HHFAMINC_MID	1.016	0.003	391.707	0.000	0.000
HHFAMINC_HIGH	0.795	0.002	444.226	0.000	0.000
HHVEHCNT_AVAIL	-2.302	0.002	-1190.550	0.000	0.000
HBHUR_URBAN				0.000	0.000
HBHUR_SUBURBAN	0.601	0.002	341.853	0.000	0.000
HBHUR_RURAL	-4.463	0.038	-116.924	0.000	0.000
Constant	-1.931	0.005	-355.259	0.000	0.000
Hosmer and Lemeshow					0.000

Table 8 – Model Results, Weighted Variables Including Measured Access

	B	S.E.	Z-stat	Wald	Sig.
R_AGE_17				15908.32	0.000
R_AGE_18 TO 29	0.467	0.008	57.411	3295.966	0.000
R_AGE_30 TO 49	0.358	0.005	68.485	4690.229	0.000
R_AGE_50 TO 64	0.147	0.005	28.491	811.7415	0.000
R_AGE_65	0.217	0.005	40.211	1616.922	0.000
HHFAMINC_LOW				249911.5	0.000
HHFAMINC_MID	1.127	0.003	426.065	181531.7	0.000
HHFAMINC_HIGH	0.794	0.002	430.211	185081.3	0.000
HHVEHCNT_AVAIL	-2.217	0.002	-1110.73	1233726	0.000
HBHUR_URBAN				88189.29	0.000
HBHUR_SUBURBAN	0.533	0.002	273.791	74961.49	0.000
HBHUR_RURAL	-4.279	0.038	-111.988	12541.42	0.000
PTDISTHH	-0.024	0.001	-18.443	340.1576	0.000
PTDISTWK	-0.002	0.000	-180.480	32573.03	0.000
Constant	-1.979	0.006	-347.186	120538.2	0.000
Hosmer and Lemeshow					0.000

Model Results

In both models, with and without the access variable, it is evident that the vehicle availability variable, with its relatively high negative Beta value, indicates a strong propensity not to use transit when a vehicle is available to the individual. This result is expected since a person with no vehicle available has more limited choices for his/her work trip. In fact, the vehicle variable dominates the equation in each case. The income variable was categorized by low income being less than $20,000, medium income between $20,000 and $50,000, and high income above $50,000. The medium and high income group shows a positive relationship for bus transit mode when compared to the low income group. This is an expected result, as alternatives to transit tend to increase with income level.

The variables with the lowest significance in the unweighted model were the age groups. This lower value of significance is not unexpected, since the effects of age over the unweighted sample may be dynamically biased. Thus, this variable becomes a less appropriate predictor unless the sample size is expanded significantly. Subsequently, when expanding the sample using the NHTS weighting variable factor in the second set of models, namely Tables 7 and 8, the categorical age variables increased in significance. The variables included in the analysis were measured relative to the lowest age category, less than 17 years. All but one of the category coefficients was positive against the lowest in the un-weighted model, notably, the 50 to 64 year old age group, indicating a negative propensity for transit. Among the other three models, the age variables were all positive; however, the higher age groups do exhibit the lowest positive coefficient which may indicate a higher likelihood for transit than in the other age groups.

The addition of the access distance variables from household to transit and from transit to the workplace for workers slightly increased the overall significance of the nationally unweighted model, as indicated by the Hosmer and Lemeshow goodness-of-fit test. In the weighted model, the Hosmer and Lemeshow test did not exhibit significance which may be a direct indication that the model is improved by the addition of other variables and warrants even further analysis. Perhaps most important in this analysis, the addition of the continuous distance variables for the household and the workplace for individuals, resulted in the application of slight negative Beta coefficients, thus indicating an overall negative propensity for transit use with distance as expected.

CHAPTER 6 SUMMARY

Observations and Implications

Understanding transit use has become a critical transportation research interest and policy goal. This research effort presents results of an analysis of the 2001 NHTS data specifically focusing on the newly-released appended variables that measure access or distance to public transportation. Actual relationships between public transportation and traditional household and person characteristics nationwide are explored by analyzing correlations between demographic and geographic variables. The data is explored both with and without New York. Additionally, the contrasting distributions between New York and the rest of the U.S. are noteworthy. Overall, the observations imply a very high importance of close proximity to transit for travelers. For some variables, Florida-specific analyses were conducted.

The NHTS is perhaps the single best data source to use in developing a rich understanding of the nature of the public transit market and a profile of public transit users at the national scale. While the survey has shortcomings and is slightly dated, it is professionally designed, administered, and documented so that readers are able to understand any potential for biases from sample size, non-response, or question structure features. Using these data in the context of both the historical series of national home travel surveys and also in the context of other data sources, both national and local, can enable a user to develop a useful knowledge base. With regard to public transportation, the survey results as analyzed in this project reveal a number of key findings.

This analysis of the NHTS data reaffirms the significance of access to the mode choice decision. Approximately 53 percent of households are within 1 mile of bus service and 40 percent within ¼ mile. Approximately 10 percent of the population lives within 1 mile of rail. Over ½ of workplaces are within ¼ mile walk radius of a bus line. Not surprisingly, work is more closely concentrated near transit than are residences. Furthermore, mode share for transit declines approximately two thirds beyond the first interval beyond 0.15 miles from a bus route. These observations imply a high value to services in close proximity to residential areas. The analysis suggests that access is even more critical than might have previously been acknowledged by the transit planning profession. While the sensitivity to access distance may well be dynamic over time and context, these data suggest a very strong preference for very short transit access distances. Numerous factors may contribute to this, including concerns about personal safety, the quality of the walk environment, the high premium persons place on travel speed, the high availability of auto travel options, and a reluctance to tolerate the exertion associated with walking – perhaps because general physical stamina is lower than was historically the case. Over time, this may change due to concerns about health and the healthful benefits of walking, concern about petroleum product use and cost, and a lessening sensitivity to travel time as roads become more congested and baby boomers move beyond the most time demanding peak parenting years. However, speculation of a greater willingness to accept greater walk access to transit is only conjecture.

The results also suggest that forecasting transit use will benefit from a far more disaggregate data set or methodology. Smaller zones for zone based models, parcel-level data and dense route or roadway networks would seem to offer a greater chance for both accuracy and precision. Historic assumptions regarding the aggregation of walk distances or the design of route buffers might need to be reviewed. Similarly, when these findings are applied in the context of the rapidly-evolving interest in transit-oriented development, it may suggest that full benefits from the presence of transit service will require that the combination of land-use patterns and transit route network be such that walk distances are very modest. Bicycle or scooter access may be more important than previously recognized for persons beyond a very short walking distance. While planners may be tempted to argue that walking longer distances is beneficial and easily tolerable, unless travelers' values change or the choice conditions change (dramatically higher fuel costs for example), good intentions may not result in good transit use whereas good access may.

This analysis also reveals strong differences of access to transit as a function of race, income, vehicle ownership, and urban area size. In general, groups living in urban core areas have better geographic access to transit. To the extent that the historical pattern of concentration of low income and minority populations in core urban areas continues, these populations will have superior walk access to transit. However, rural poor continue to suffer from a lack of convenient access to fixed route transit.

The high sensitivity to short access distances suggests that the share of transit accessible trips is smaller than previously acknowledged. While this may help explain modest transit mode share, it also may suggest transit service initiatives will benefit from a move toward transit service and technology options that optimize accessibility versus other service improvements. For example, a denser route network may offer value to travelers. Unfortunately, the absence of data on service frequency in the data set precludes the opportunity to compare the relative importance of walk access versus service frequency. As this is a classic tradeoff decision with which service planners are regularly faced, more definitive analysis will be of benefit to service planners. Based on this research, one can conclude that close access appears to be more important than might have previously been believed.

Mode choice analysis in relation to transit access distance overall suggests a high preference for users to be very near transit services. It has been shown that, typically, some transit dependent groups such as 0-vehicle households have an advantage in greater access to transit, as expected.

Many factors weigh into the planning and ultimate success of transit systems, and this analysis of measured access contributes to a comprehensive understanding of this increasingly important factor. Importantly, some of the analysis of this research effort can be continued in the future as advances in technology and data collection techniques allow for a more accurate and measured database in aspects such as accessibility and other service supply variables related to frequency or span of service.

Acknowledging the messages revealed by the empirical data presented in this paper reiterates the importance of having very convenient access to transit services. This implies that the route network should be relatively dense and that premium access will pay dividends in terms of higher transit use. Land use design to complement transit should concentrate residents very near transit as mode share falls off steeply with walk distance particularly for choice transit users.

A key contributor to the success of future transit networks may be planning for a higher level of transit access for both rail and bus.

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