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Access to public transportation: An exploration of the National Household Travel Survey appended data

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Access to Public Transportation: An Exploration of the National Household Travel Survey Appended Data

by

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ABSTRACT

Understanding transit usage has become a critical transportation research interest and policy goal. This thesis 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. Statistically significant public transportation distance intervals from households and individuals were chosen for analysis in relation to other key variables in the original dataset. Actual relationships between public transportation and traditional household and person characteristics nationwide are explored, specifically focusing on both rail and bus transit modes for the work commute trip. Geographically, both inclusions and exclusions in analysis are conducted due to the widely accepted ubiquitous transit network present in the NY region.

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 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 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 beyond 0.15 miles from a bus route. These observations imply a high value to services in close proximity to residential areas.

Historical work in this topic area include geographically specific data analysis obtained from surveys which potentially allow a degree of subjectivity in perceived responses whereas accessibility and distance data analyzed in this thesis are actual and spatially measured. Additionally, a regression model exploring the significance of actual access to transit upon mode choice is performed to explore the significance of influence by measured access variables. The analysis suggests that access is even more critical than might have previously been acknowledged by the transit planning profession.

CHAPTER 1

INTRODUCTION

Background

In the Transportation planning profession, including the realm of transportation research, there exists a common desire to understand the influences upon the decision processes involved in mode choice. Particularly, striving for a comprehensive understanding of transit usage has become of key importance especially in a society experiencing continuous growth in travel congestion. Resulting from a wide range of research in the topic area, it has been widely accepted that many factors influence the decision to use the public transportation mode, and, that analyzing only one aspect of the influences upon travel behavior is not alone sufficient. Some of the factors that have been traditionally influential upon an individual's travel choices include those that may be directly controlled by local transit or government agencies such as level-of-service factors including frequency of service and similar traveler convenience factors, route corridors, and fare structure. Other factors beyond the direct control of a responsible agency or government entity include variables such as geographical area population and density, land-use interaction, employment density or even petroleum price or some similar travel cost factor. Perhaps a link between both of these categories of factors is transit access and accessibility. Public transit serves various markets and is utilized by a diverse amount of individuals within various demographics. Transit tends to capture a large portion of work commute trips in part due to location in central business districts (CBD) where concentrations of workplaces have typically been highest. Arguably, however, transit patronage levels are largely subject to the effects of changes in the economy and employment growth or decline, and perhaps foremost, are affected by varying levels of accessibility.

Problem Statement

Understanding transit usage has become a critical transportation research interest and policy goal because of the implications of high degrees of investment and longevity of infrastructure. There is a desire in the transportation industry to more fully understand the distribution of access to public transportation as it relates to both individual segments of the population and the national population as a whole in an effort to most accurately capture the transportation needs of the traveler. Specifically, it is the desire of the Florida Department of Transportation (FDOT), and by the funding of this research effort to explore the relationship between transit access and other geographic, demographic, and socioeconomic factors.

This research effort presents an analysis and result of the 2001 NHTS data specifically focusing a set of newly released, appended variables that spatially measure distances from households and workplaces (where applicable) to public transportation. 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 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 National Household Travel Survey (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 can successfully exhibit that planners would benefit from pursuing collection and analysis of measured data, with the help of advancements in technology, while relying less on personal survey response data.

This analysis will explore the land use variables appended to the National Household Travel Survey data to further explore how land use characteristics influence transit use behavior using both aggregate national data, and New York metropolitan area specific data. While the 1995 Nationwide Personal Transportation Survey (NPTS) and the 2001 National Household Travel Survey utilizes 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.

Methodology

SPSS and Microsoft Excel software are used to carryout the analysis. Each are 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 feasible and 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

LITERATURE REVIEW

Background

As a vital part of the transportation planning process, often surveys or interviews are conducted to ascertain the reasoning processes behind the mode choice decision, especially for the work commuter. Very importantly, data is sought in order to numerically quantify and analyze the many of the input factors potentially influential on the mode choice process. Survey data has become a powerful asset to research professionals and the transit planning profession. In some studies, interviews of transit agency managers have been conducted in order to learn their opinions or perceptions about what general factors affect transit ridership. (Taylor 2002) As a prelude to further analysis of tangible survey data results, these interviews reveal a prevailing assertion among transit agency professionals that "external factors, such as population change, new development, and regional economic conditions" more than likely effect ridership to a greater extent than do agency or service design initiatives. (Taylor 2002)

Public Transportation can be conveniently categorized into two major components: rail and bus. Admittedly, various subcategories of public transportation exist. Alternatively, walk-ability plays a key role in that an individual must walk from either a residence or business to their mode of choice. In a literature study conducted by Robert Cervero, characteristics of rail stations, in particular, those adjacent to residences and commercial projects were examined. After hypothesizing a relationship between proximity and usage, subsequent to review of several survey results and analysis, he concluded that rail transit usage varied significantly with distance to rail lines and stations.

Measurement of Access

In what is considered a highly comprehensive analysis of patronage by a function of distance to key land development in the Washington D.C. area in 1887 and 1989, by JHK & Associates, conclusions indicated that transit trip mode share "declined by approximately 0.65 percent for every one hundred foot increase in distance of a residential site from a Metrorail station." (Cervero 1993) Interestingly, this is somewhat more of a finely scaled documented instance of transit mode share variance by access distance. Additionally, transit work trip mode share for rail ranged from 18 to 63 percent while the ridership experienced the highest percentages for individuals from residences closest to rail stations. Furthermore, through the course of that literature review, Mr. Cervero found that rail transit ridership declined steadily as distance between stations and employment offices increased. Not surprisingly, the result implies that an increase in access causes a decrease in transit use, and conversely, a decrease in distance in transit stops from residences and workplaces displayed increases in ridership. (Taylor 2002)

Another similar study which was related to transit access was actually conducted prior to the Washington D.C. study; it focused on characteristics in the geographic locations of both Toronto and Edmonton, Canada. Notably, this study revealed that individuals were willing to walk approximately 4,000 feet (almost 0.8 miles) to a rail station. (Cervero 1993) However, this study focused on the impacts of variances relevant to the topic of Transit Oriented Development (TOD) whereby more pleasant and desirable urban spaces existed along the walking distances, more than catalogued by other surveys or data. As stated previously, many factors weigh into mode choice as a function of access distance, and walk-ability and related characteristics thereto may play a significant role.

Transit Users

One method in the exploration of the mode choice decision process involves analyzing characteristics of the individual. Arguably, there are many ways to classify a person, household, or trip in a context of transit or even automobile usage, but in a paper by Beimborn et al in 2003**,** travelers are classified into two groups: choice users or captive users. This classification may play an important role in the relationship between mode choice and accessibility. The key difference between these two groups is that option users have more than one choice available to them. As such, accessibility, or at least connectivity, relates to captivity and mode choice.

The data used in this choice and captivity themed paper were obtained from a survey conducted in Portland, Oregon: the 1994 Household Activity and Travel Diary Survey. It simultaneously explored viable individual characteristics from various other sources including but not limited to the Regional Land Information System for the Portland Area, and the U.S. Dept. of Energy. In essence, this paper compared traditional mode choice models with those that included a categorization of users to either captive or choice. The result of this work indicated in part, that transportation models produce more accurate forecasts when captive users are assessed and catalogued based on individual accessibility. Thus, accurate assessment of accessibility has been found to play a vital role in forecasting and transit model development. Not surprisingly, out-of-vehicle travel time (OVTT) was found to be a highly influential factor in this analysis. Considerations for OVTT might prove very useful in the analysis of this research paper; however, data constraints and the lack of temporal variables in the NHTS data set do not easily allow for such analysis. Finally, when compared with other factors, among choice transit users, variances in travel time was found to have little influence upon mode choice, in direct contrast to the highly significant effect of transit access upon mode choice. (Beimborn et al 2003)

Considerations

Two additional terms considered relevant and influential in the context of transit access include mode split and market share. Undeniably, market share is a key aspect involved in transit planning or research since it is necessary to understand the traveler and their needs. According to Beimborn et al, market share and mode split analysis prove difficult and could be captured inappropriately since data limitations exists. A true representative population or even an appropriate sample size for choice individuals or choice trips may be too illusive. When calculating a typical market share or ratio, the numerator may be known, for example trips or boardings; however, the denominator, the user group is somewhat less accurate or even arbitrary. (Beimborn et al 2003) Essentially, the number of individuals or group of individuals for whom transit is a viable option is not exact.

Although in this paper, access considerations are certainly not limited to proximal distribution influences on market share, clearly, properly delineating and understanding user transit accessibility and distances is important to consider in the planning process. Therefore, if market share factors are not properly calculated, the resulting conclusions and forecasts may contain errors that may have serious implications.

Strong consideration of the characteristics of public transit trips augments the understanding of public transit market share as a function of access distance relevant to the planning process. Previous research efforts have produced a focused analysis on several trip characteristics including trip distance, out of vehicle travel time, and travel speed to name a few. While these characteristics are very important factors and deserve adequate consideration, real and obtainable statistics in these categories are mostly limited to personal survey response data. (Polzin and Chu 1995) These data are not actually measured; they are based on the perceptions of the survey respondents involved. (Polzin and Chu 1995) Furthermore, historically, it has been widely accepted that trip makers are typically not accurate at reporting their own trip characteristics and may improperly estimate distances when responding to numerical-answer survey questions. (Polzin and Chu 2001) Perhaps no less important a consideration, transit service supply factors such as frequency, span, geographic connectivity, reliability, and cost, are usually not available nor are they all yet practically measurable for individual trips. Subsequently, statistical data of this nature may not often prove as reliable as might be desired by the transit research community.

An alternative approach to analyzing the effects of accessibility on transit includes examining the land-use interaction for a given geographical area. One paper exploring these characteristics by Ross and Dunning in 1997 utilizes data from the 1995 Nationwide Personal Transportation Survey and examines the relationships between geographical land use variables and demographic characteristics. This prior work mainly focuses on area population densities and area type variables that were available in the 1995 NPTS in the context of access distance intervals. Additionally, demographic variables are examined by correlation of the land-use variables similar to the analysis performed in this research effort. Many of the results presented by Ross and Dunning, which utilize access data derived from user responses, are conveniently and directly compared to the actual measured 2001 NHTS access intervals to explore relationships with other geographic and demographic variables. This comparison is carried out in a later chapter.

CHAPTER 3

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 is not new by several years, it is considered a tool that aids transportation planners and policy makers because of its uniqueness and relevance. The 2001 NHTS updates information gathered in prior Nationwide Personal Transportation Surveys (NPTS) and the American Travel Survey (ATS). (NHTS 2001) These data include variables of 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. 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 inhabitants, prisons, and military base residents. Next, a household member was queried over the phone for household and person characteristics and traits in addition to some 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-on interview was scheduled and conducted for eligible household members about their personal travel behavior.

The NHTS data does 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.

Dataset

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 and 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

At the center and 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. This route data is considered the most comprehensive available although it is expected that transit agencies have modified service routes and corridors since the time the data was assembled. It is believed this data is still an appropriate representation of transit characteristics for 2001, which is conveniently and directly related to the time all other analysis variables were obtained. 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 National Household Travel Survey (NHTS) and similarly formulated regional or local survey data continue to provide a foundation for such analyses.

CHAPTER 4

DISTRIBUTION OF ACCESS TO TRANSIT

Background

Figure 1 graphically illustrates the mechanism of the access measured distances provided by 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, perpendicular to the route. Bus stop information is 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 evidently because of the permanency of a rail stop, they have been provided for in the data and allow for a stop-level analysis for geographical areas with a rail system operating. Quite possibly, a less desired accurate representation of the distance may exist because a perpendicular distance may intersect the bus line halfway in between two stops. As displayed in Figure 1, measured perpendicular distances contained in the NHTS dataset for bus lines may be underestimated due to variances in the network walk path to the actual transit stop or station. As a result, the actual walk path may be significantly longer than actually presented in the data. Nonetheless, the appended access distance dataset provides a unique opportunity to assess the extent of access to transit for the nation.

Minimum Access Concept

Generally, a larger percentage of the analysis content in this research effort considers access to bus route networks. Where appropriate to the analysis, both distances from the household to bus and rail are considered whereby a minimum access distance is generated for each household, person, or trip. Furthermore, 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 would resemble the bus distribution in many cases, as it is determined that access to rail does not significantly affect overall 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

From Figure 1, it can be seen that one may wish to compensate for an additional walking distance in order to capture a more accurate access distance to a bus stop. Generally, planners assume approximately 4 to 8 bus stops per mile for urban bus routes. Therefore, one might arguably and appropriately increase all the stated bus transit access distances by 0.1 miles to capture the variance in walk distance accounting for an additional one half the average bus stop distance per mile. (Polzin 2006)

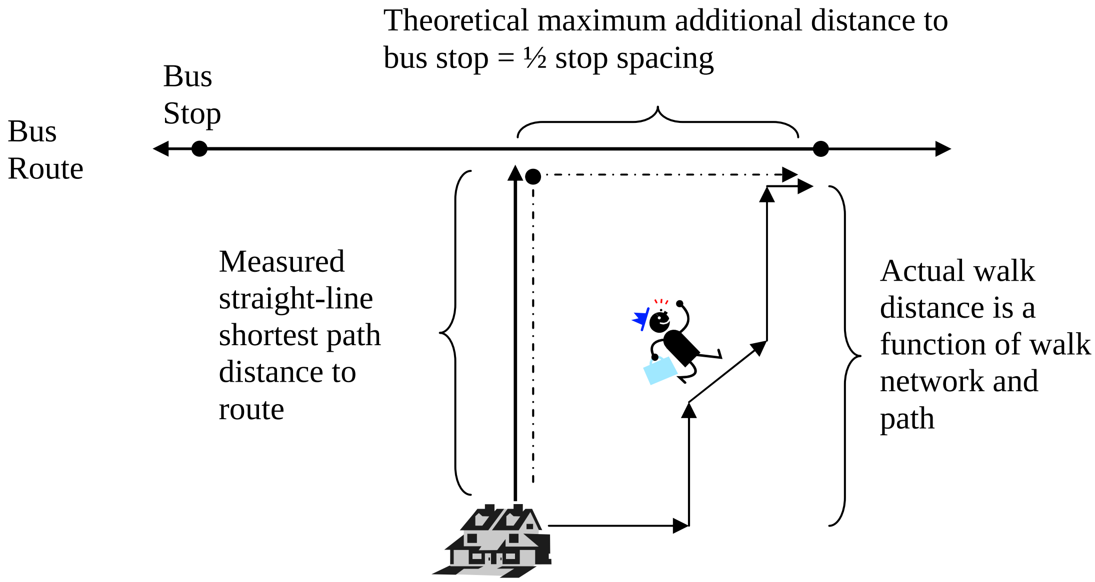

Figure 1 Measured versus Actual Walk Access to Bus

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 half of a mile of a bus route. Additionally, about 65 percent of all households are located within five miles from a bus line. As illustrated, the slope of the line is a maximum at the close in short distances confirming the significance of the closer proximity, excluding the scale break at 5.11 miles. 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.

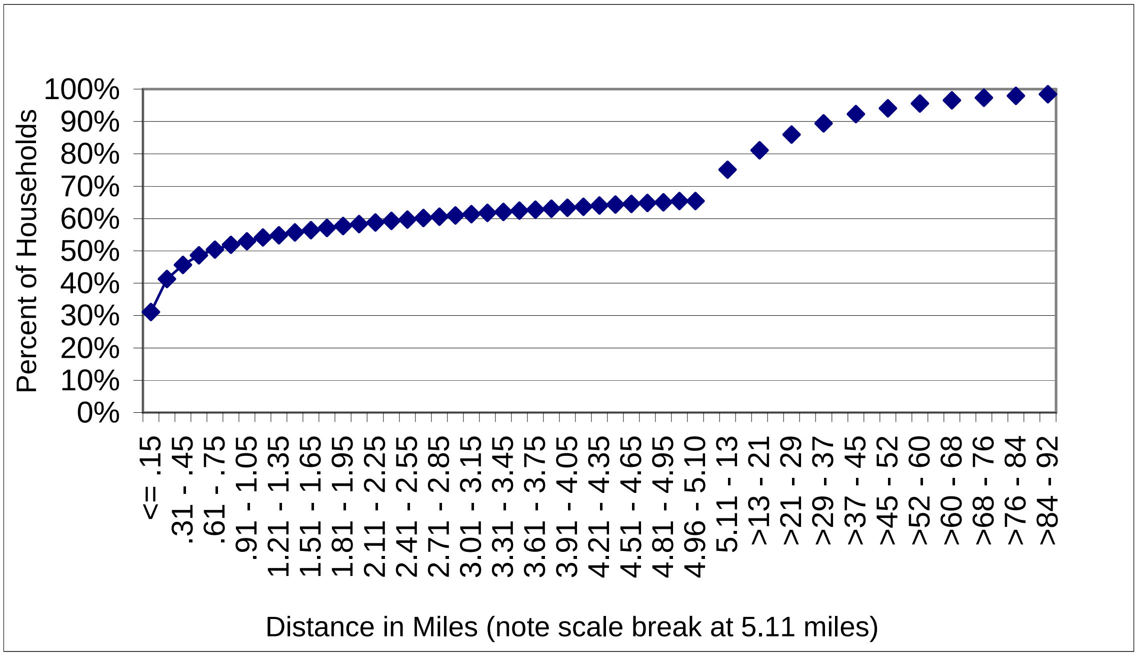

Figure 2 Cumulative Distribution of Household Distance to Bus Line

Figure 3 displays a national cumulative household distribution of distances to a rail stop. In contrast to the cumulative bus graphic in Figure 2, a significantly lower percentage of households are in proximity to a rail stop. A significantly less number of rail systems exist nationally which influences the shape and flatter distribution in this graphic. Figure 3 shows that approximately 10 percent of the national population lives within one mile of a rail station.

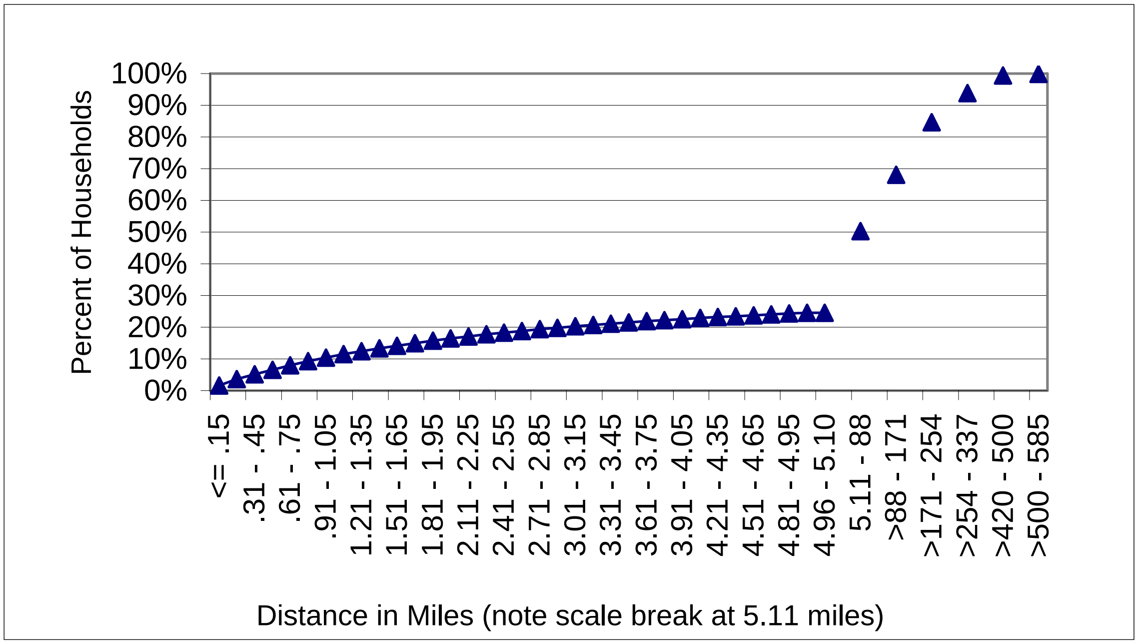

Figure 3 Cumulative Distribution of Household Distance to Rail Stop/Station

In the 1995 Nationwide Personal Transportation, 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 one quarter of a mile from 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 systematic or behavioral changes over time; however, a similar service area can be assumed in which case interesting observations can be made. It appears that over all household distances, the perceived household access distances to bus are consistently closer, which suggests that persons may tend to overstate their access to bus. 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 serious implications to the decision making process going forward.

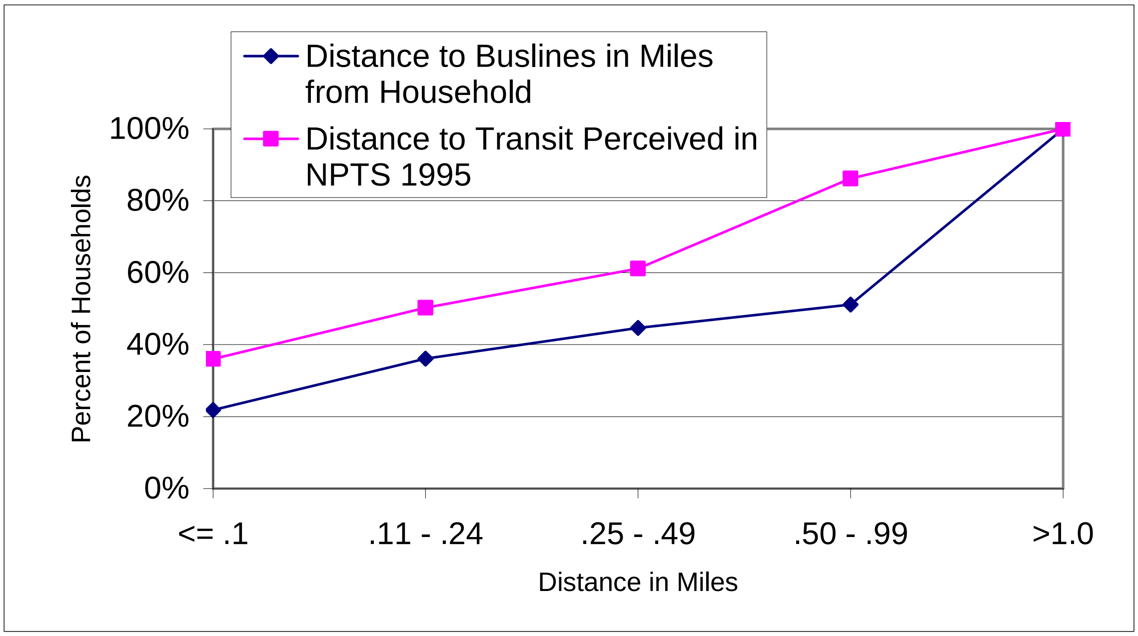

Figure 4 Cumulative Distribution of Person Distance to Bus Route

As shown in Figure 5, a cumulative distribution of distances to the workplace indicates that approximately 60 percent of workplaces are within a half of a mile to 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 three quarters of a 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. (Polzin 2006)

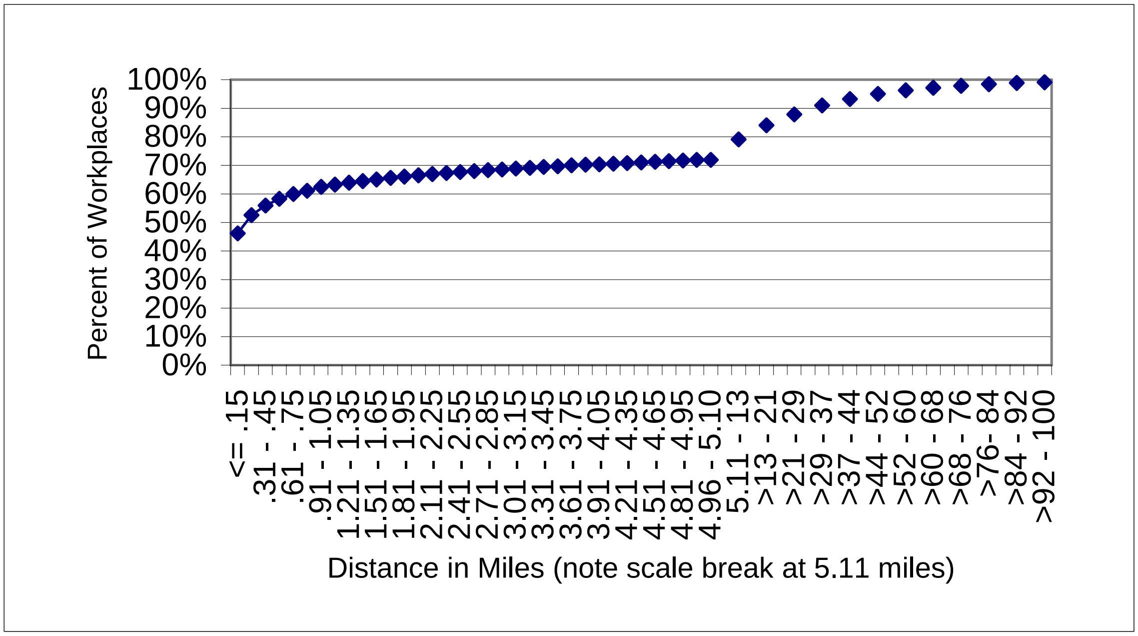

Figure 5 Cumulative Distribution of Distance from Work to Bus Route

Figure 6 illustrates that only about 10 percent of all workplaces are located within one half of a mile from a rail stop or station. The distribution indicates that workplace proximity to rail is bout 20 percent higher within the first five 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.

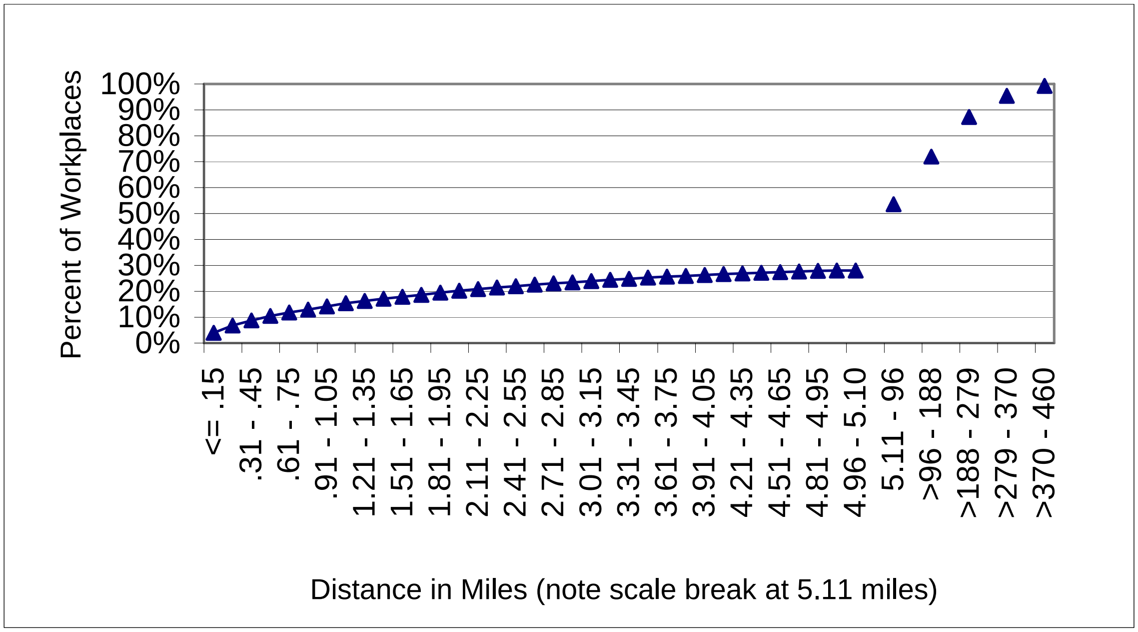

Figure 6 Cumulative Distribution of Distance from Work to Rail Stop

Access and Demographic Distribution

In Figure 7, 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 service areas. (Polzin 2006) This is expected since historically, lower income households have been concentrated in older, central urban areas. (Polzin 2006) Typically, these regions or closer distance intervals allow service to more patrons in general.

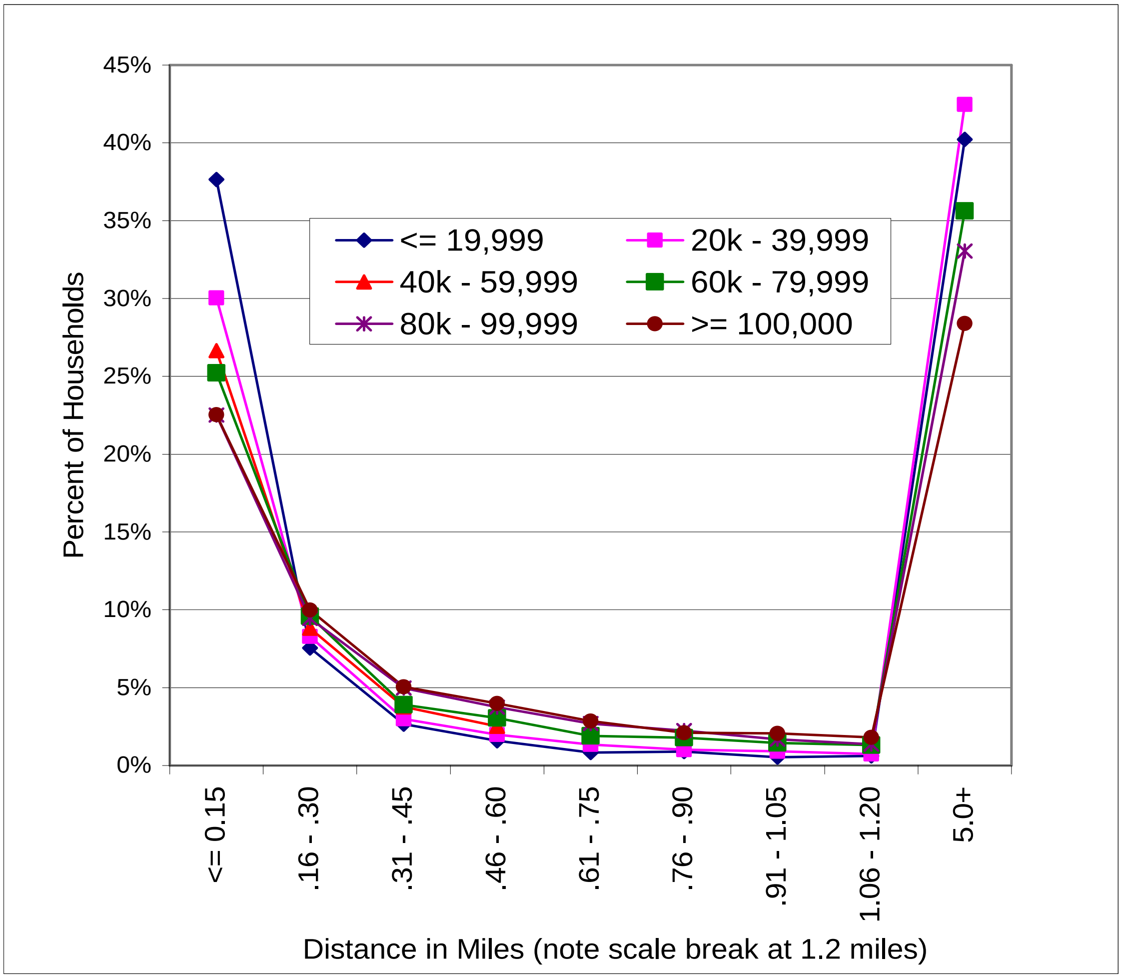

Figure 7 Distribution of Household Access Distance

to a Bus Route by IncomeThe highest income bracket, of 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 8 provides some supplemental data relevant to this observation. Middle income brackets, according to Figure 7, appear to maintain their order of distribution at least up to a 5 mile distance from a bus line.

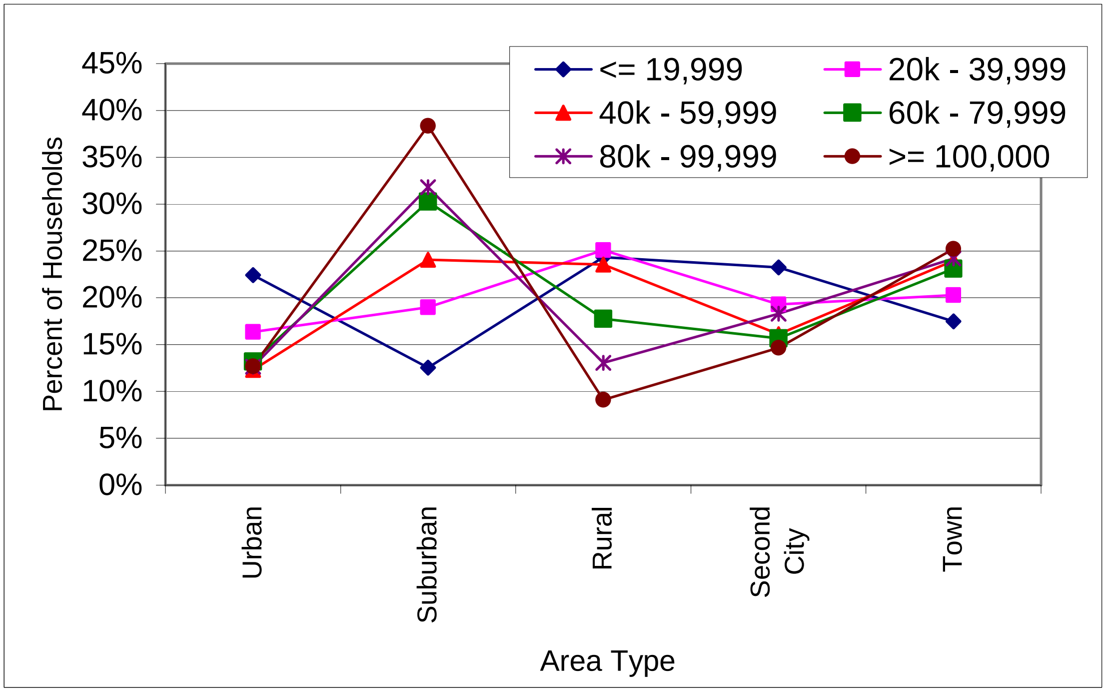

Figure 8 Distribution of Household Access Distance to a Bus Route by Area Type

As a supplement to the information provided by Figure 7, 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 9 displays the distribution by income by rail stop distances from the household. For rail access, income distribution is less obviously related according to the graphic. It can be seen that the effect of changing income is far less pronounced than for bus distances. Primarily, this is most likely the result of a lessened availability to rail in various markets throughout the country although service such as commuter rail may often serve the higher income suburban type markets. (Polzin 2006)

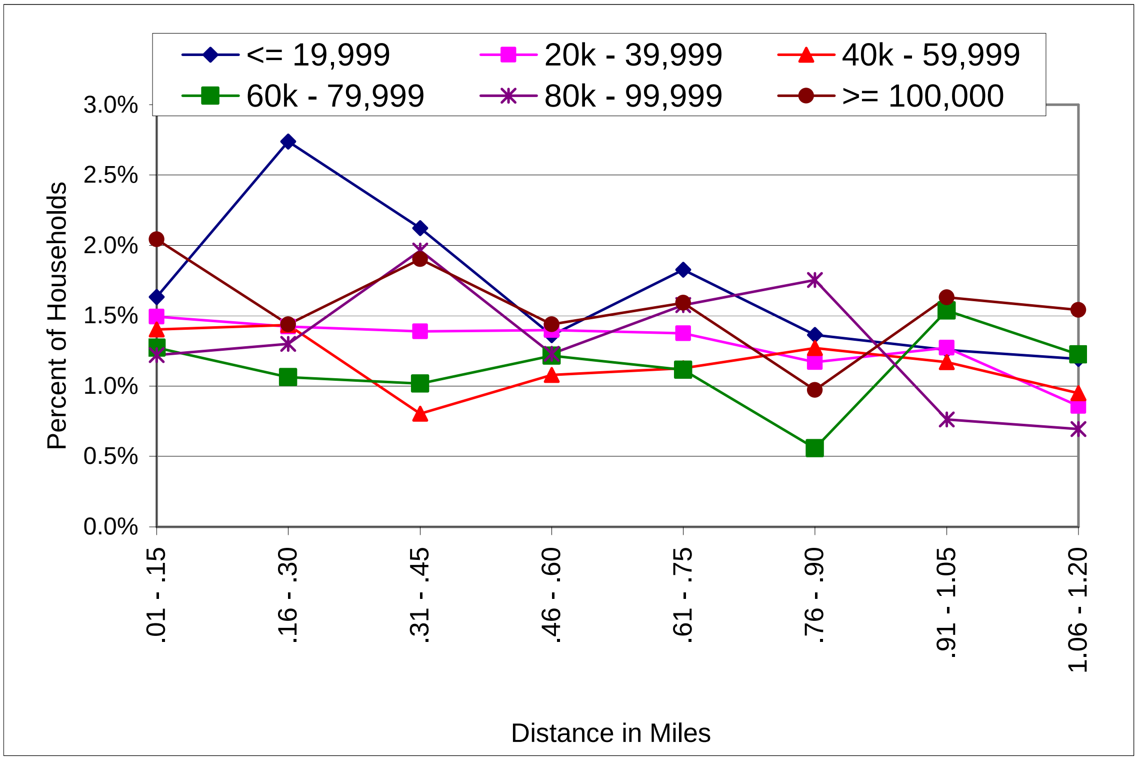

Figure 9 Distribution of Household Access Distance to a Rail Stop by Income

Figure 10 displays household access distance by race (not ethnicity). The concentration for White, within the first interval of 0.15 miles is the lowest for those shown, approximately 24 percent. African American, and Asian only and Hispanic Mexican only display the highest concentrations in the first distance interval to a bus route displaying 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 may have the greatest access to transit by proximity.

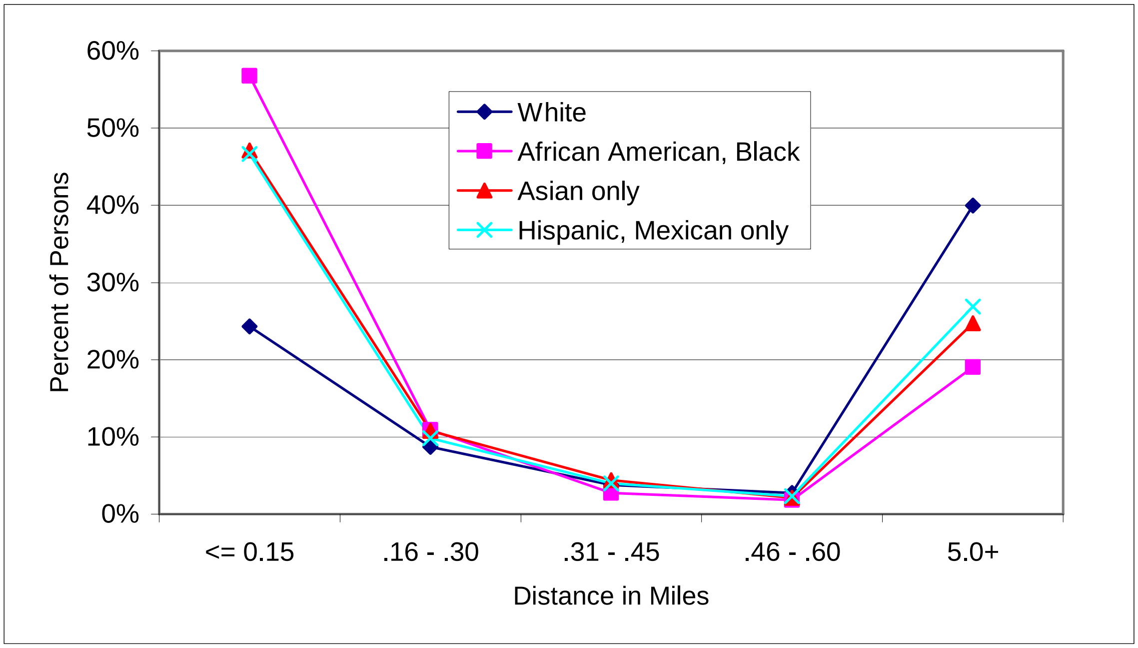

Figure 10 Distribution of Household Access Distance to a Bus Route by Race

Figure 11 illustrates the distribution for car ownership categories by bus route access distance nationally. It is evident from the graph that zero 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 zero and one 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 zero car households exist in the lowest concentration of all categories. Three and four vehicle households are among the highest concentration when compared to other categories greater than 5 miles. Not surprisingly, a lower vehicle availability appears to be exactly inversely proportional to a bus transit access advantage.

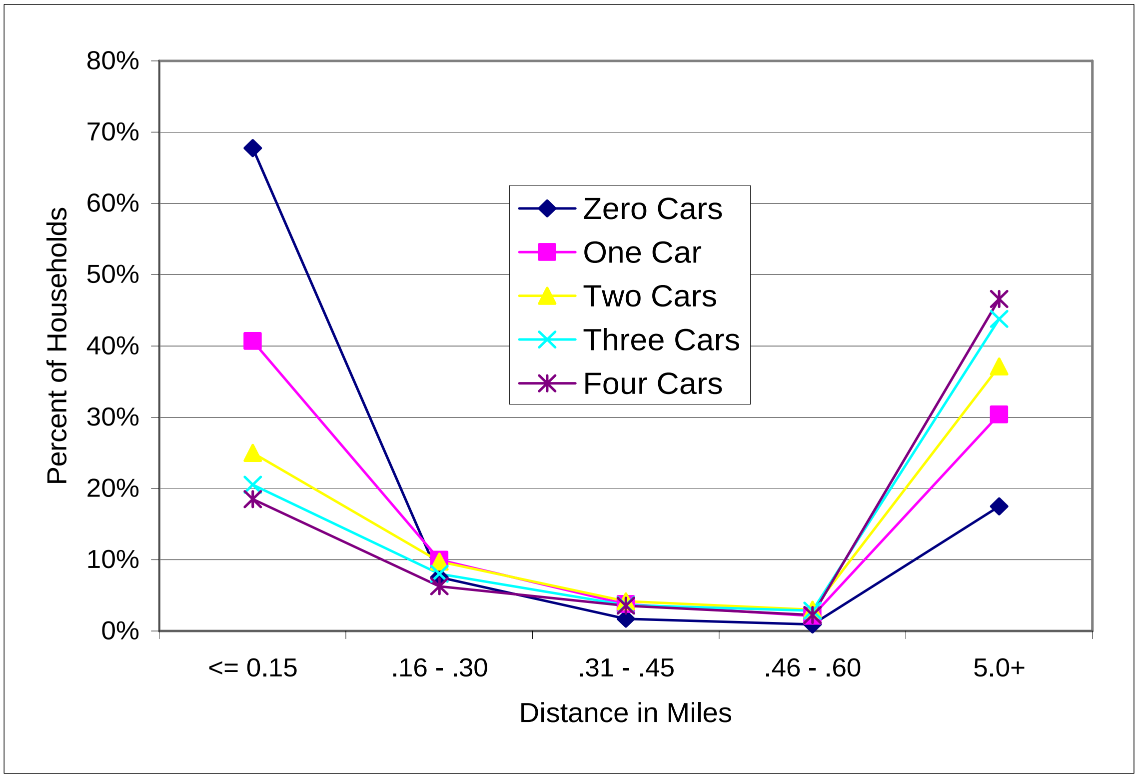

Figure 11 Car Ownership Category, Percent Households by Distance from Bus Route

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, greater than 5 mile interval. This is an expected result from the existence of transit agency bus service that primarily exists 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.

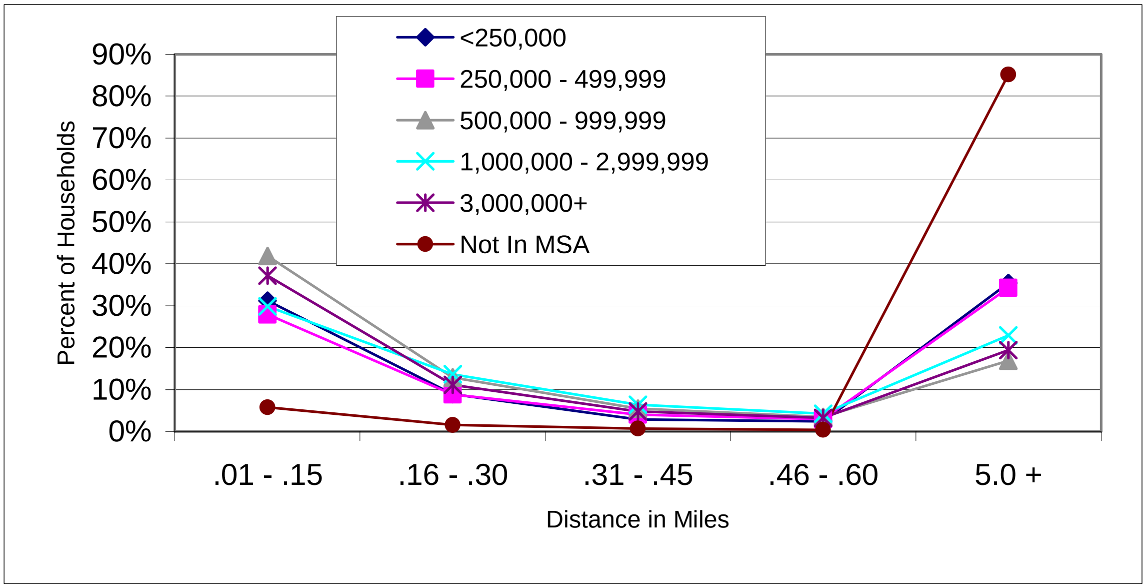

Figure 12 Metropolitan Area Size Category, Percent Households by Distance from Bus Route

Access and Geographic Distribution

Figures 13 through 16 are three dimensional graphics which illustrate the access for workers to and from transit. Since access to transit in the New York Metropolitan area is unique, the graphics with and without the 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.

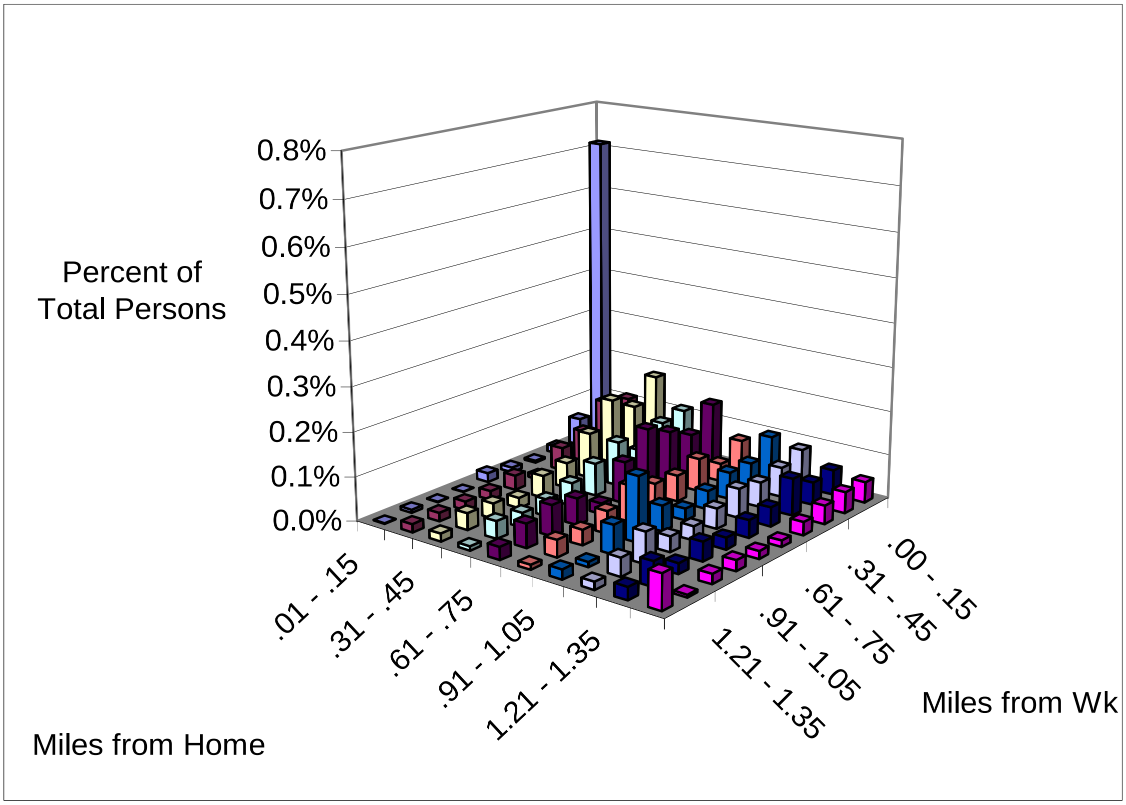

Figure 13 Rail Station Access by Trip End Distance, Nationwide, Excluding NY MSA

From Figure 13, one can infer that for the rest of the nation, rail access for any subset of working individuals within a particular distance interval is marginal. In fact, those workers that reside in places that are within 0.15 miles from a rail station, and where there workplace is located within 0.15 miles from a rail stop make up the highest percentage off workers not inclusive in the New York MSA. It can be seen that for any given category in this graphic, the percentage of the total is modest resulting from a low overall national access to rail as shown in previous graphics. When considering an area where rail access is considered highly prevalent such as the New York Metropolitan area, a very different distribution emerges.

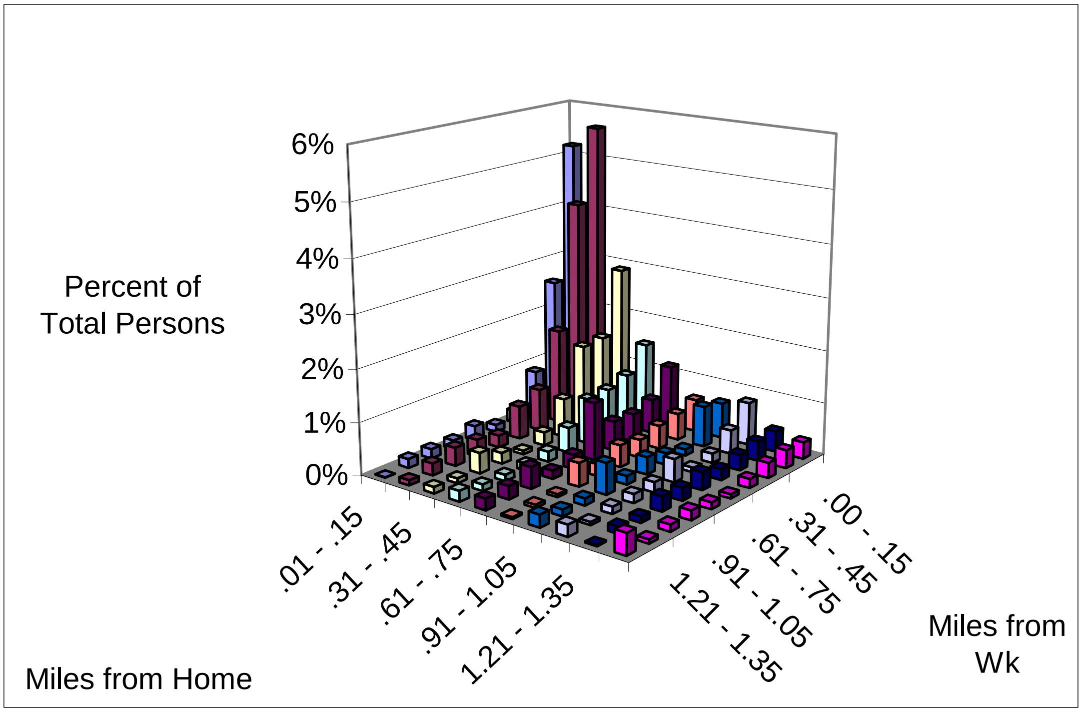

Figure 14 Rail Station Access by Trip End Distance, Only NY MSA

Figure 14 illustrates that within the first few distance intervals, a more gradual decrease in the overall percentage of working persons exists. Also from the figure, it 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 aforementioned fact that workplaces are typically more centrally located than residences and therefore are clustered more frequently around transit, especially in the New York area.

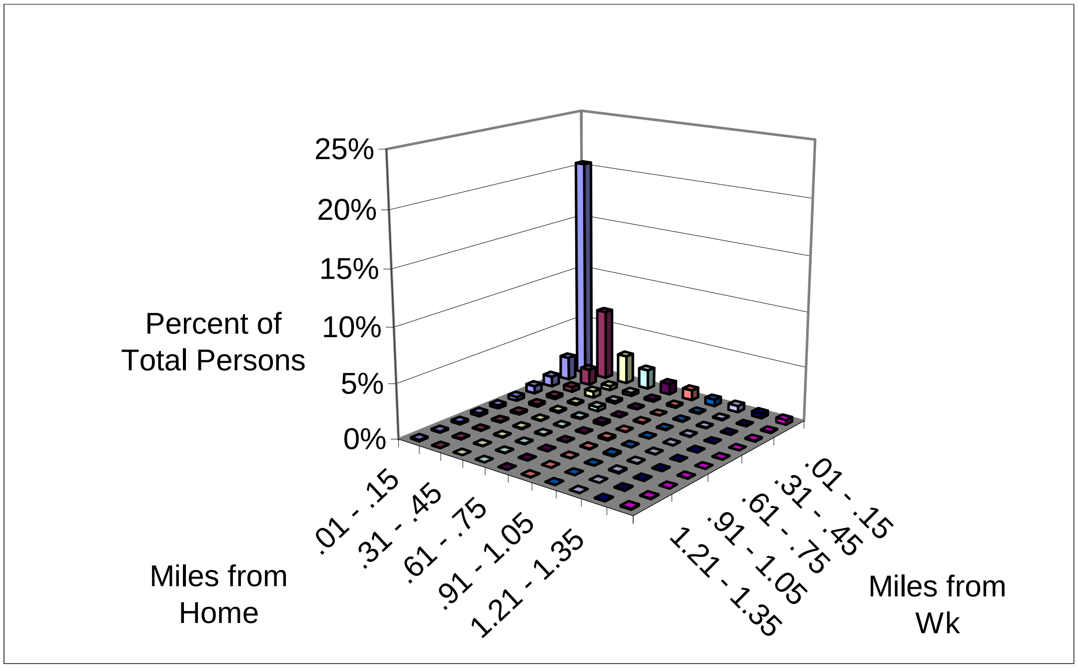

Figure 15 Bus Route Access by Trip End Distance, Nationwide, Excluding NY MSA

Figures 15 and 16 each display a similar three-dimensional analysis for access with the same geographical delineation but for access to a bus route instead of rail. Perhaps a key indication of these two graphics is that when considering all areas in the nation, not including 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 have very near 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 exception.

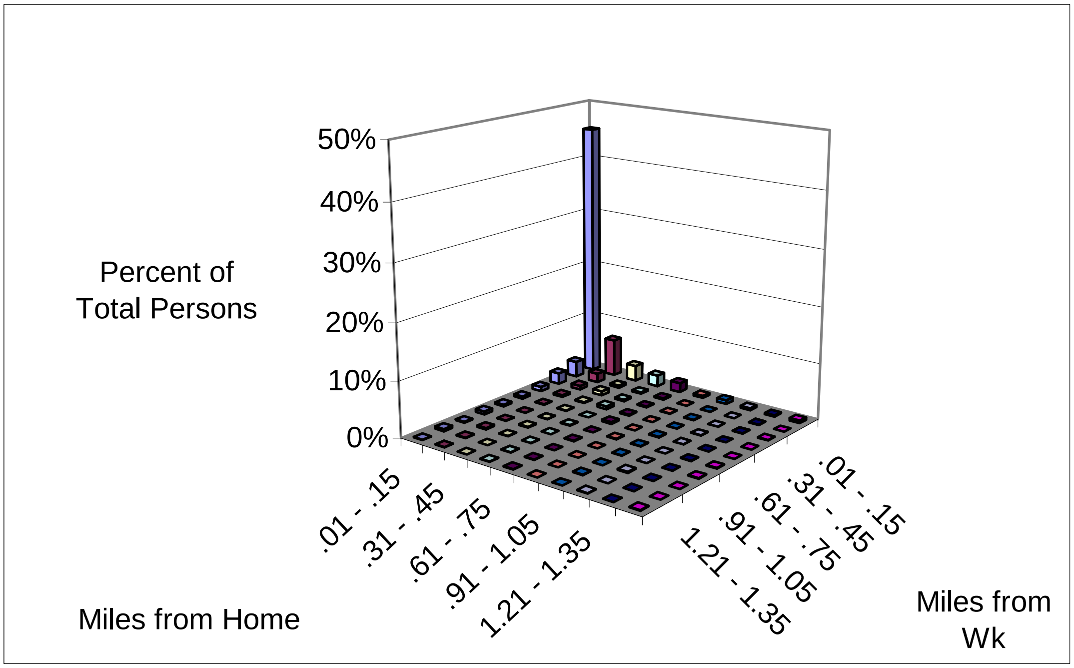

Figure 16 Bus Route Access by Trip End Distance, Only NY MSA

Accessibility, Density, and Area Type

In a report by Ross and Dunning, the same report referenced earlier, the topic of land use interaction was explored by analyzing the 1995 Nationwide Personal Transportation Survey 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. Of interest 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 is very close in that only the very last interval was 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 banded slightly different than in the previous graphics so that they were identical to the intervals depicted in the Ross and Dunning paper for a more appropriate comparison.

Transit access data utilized in the 1995 data table was obtained from variables that were reported by householders 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
< .1 mile	18.5%	20.1%	26.0%	38.4%	57.9%	36.0%
.1 to .24 mile	2.4%	5.6%	13.0%	17.4%	18.3%	14.3%
.25 to .49 mile	3.0%	6.5%	10.4%	13.3%	11.2%	10.8%
.5 to .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						

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 in that the highest percentage of homes is not within close proximity to transit. Thus, in general, as population density increases, transit access distance decreases. (Ross and Manning 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 lists the same categories and 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
< .1 mile	3.9%	14.7%	33.4%	53.4%	22.1%
.1 to .24 mile	2.0%	10.6%	24.0%	28.5%	14.6%
.25 to .49 mile	1.7%	9.2%	13.3%	8.4%	8.2%
.5 to .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; however, they illustrate categories 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 Manning 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. As shown, 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. For a visual comparison of the relative sizes of each category, Figures 23 through 26 are provided in Appendix A.

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

Distance to Transit	Area Type					
	City	Rural	Suburban	Town	Urban	All
< .1 mile	37.9%	21.4%	28.2%	22.1%	52.5%	36.0%
.1 to .24 mile	16.0%	1.6%	13.4%	6.3%	19.6%	14.3%
.25 to .49 mile	12.0%	4.9%	11.6%	5.7%	12.0%	10.8%
.5 to .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						

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

Distance to Transit	Area Type					
	City	Rural	Suburban	Town	Urban	All
< .1 mile	36.4%	1.7%	25.6%	7.2%	59.5%	24.6%
.1 to .24 mile	21.0%	0.8%	21.6%	4.6%	27.8%	14.9%
.25 to .49 mile	9.3%	0.9%	16.3%	4.2%	7.2%	7.9%
.5 to .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 5

TRANSIT USAGE AND ACCESS

Background

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 swiftly beyond 0.15 miles from a household. Beyond about a third of a 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 a third of a mile. For bus transit, the number of trips is comparatively low compared to automobile trips, therefore percentages alone do not capture the phenomenon. Notably, 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. (Polzin 2006) 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 one quarter of a mile are generally undesirable. Some factors influencing the propensity for shorter walk trip distances include but are not limited to weather conditions, physical conditioning, safety, and total allotted travel time.

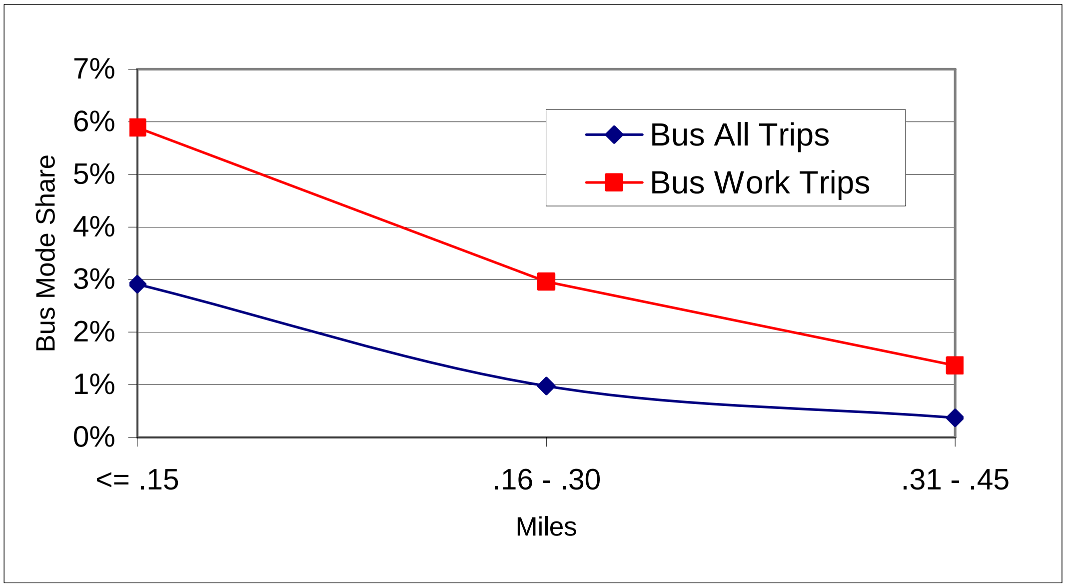

Figure 17 Bus Trip Mode Share by Household Distance

Mode Share

Figure 18 displays a bus work trip share of those persons within their own vehicle ownership category. The vehicle categories include 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 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 these subcategories, this data is presented by share within each own access distance interval. As displayed in the figure, 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. As expected, the figure indicates that a high propensity for bus transit use exists when no vehicle is available, but this propensity diminishes with distance from a bus route in favor of some other mode alternative.

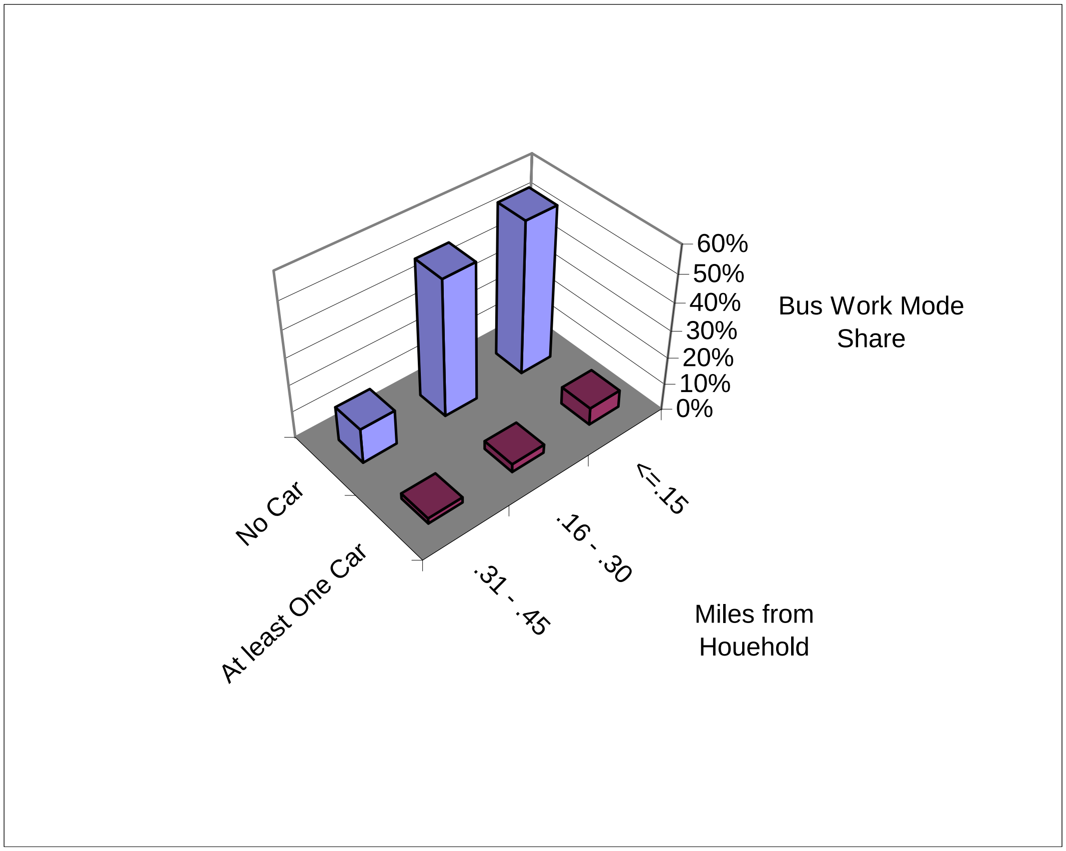

Figure 18 Share of Bus Work Trips within Vehicle Availability Category by Bus Route Access Distance, Nationwide

Matrix Mode Share

For Figures 19 through 28, a three-dimensional analysis of mode share is developed to explore 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 of the data was developed to present the data by a visual method that relates the individual trip choices of workers to accessibility on a finer scale than previously analyzed.

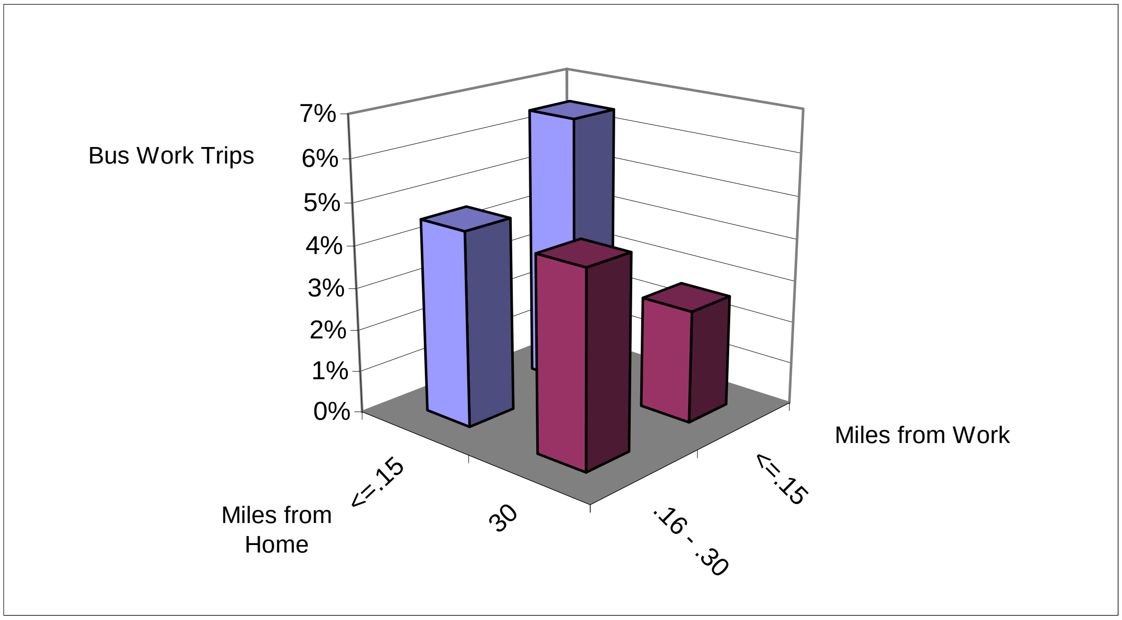

Figure 19 Bus Transit Work Trip Mode Share by Trip End Distance to Bus Route, Nationwide

Figure 19 exhibits a bus transit work trip mode share by trip end distance for a national work trip. Illustrated is the access distance interval to transit from the household and from transit to the workplace for a given work trip. Two intervals are shown due to the lessening of market sample size beyond given distances. The highest mode share exists where the distance categories to and from a bus route are in the minimum categories. Thus, a higher percentage of individual bus transit trips are made where the proximity to transit is the closest on each trip end.

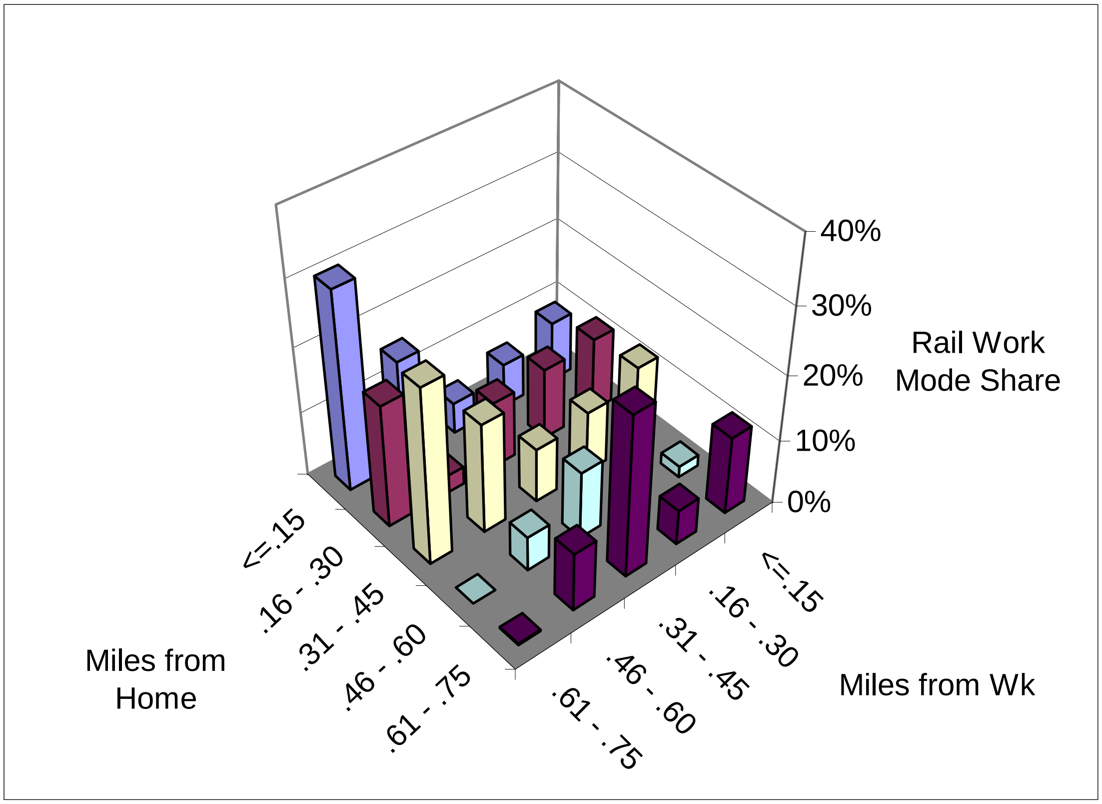

Figure 20 Rail Work Mode Share by Trip End Distance Interval to Rail Station, Nationwide

Similar to the previous graphic, Figure 20 illustrates the work mode percentage for rail person-trips when correlated to rail accessibility for both the household and the workplace. It can be seen from the graph that a higher percentage within distance category 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 proximity users is higher for rail than for bus nationwide, but the percentage of users of transit bus declines with trip end distance. On the contrary, the access category mode share for rail tends to increase slightly with distances up to about three quarters of a mile and then again showing a decline.

In contrast to national trends, 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 half mile access distance intervals. Due to a less robust sample size available in the NHTS data for this market share, many intervals could not be shown for the same analysis for bus in Figure 21. However, from Figure 21, it can be seen 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. (Source) 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 all 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.

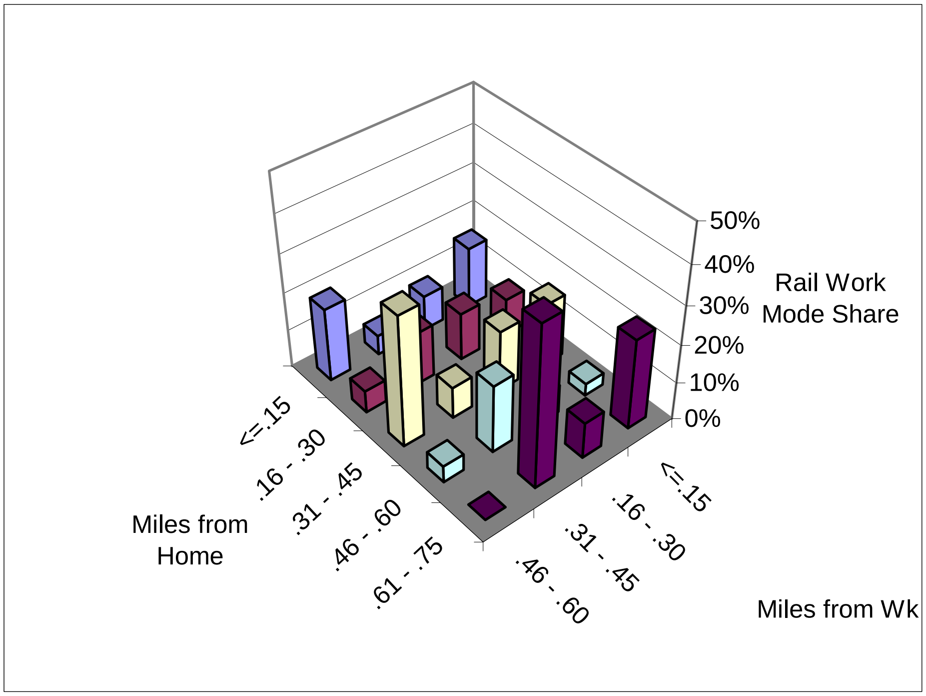

Figure 21 Rail Work Mode Share by Trip End Distance Interval to Rail Station, Only NY MSA

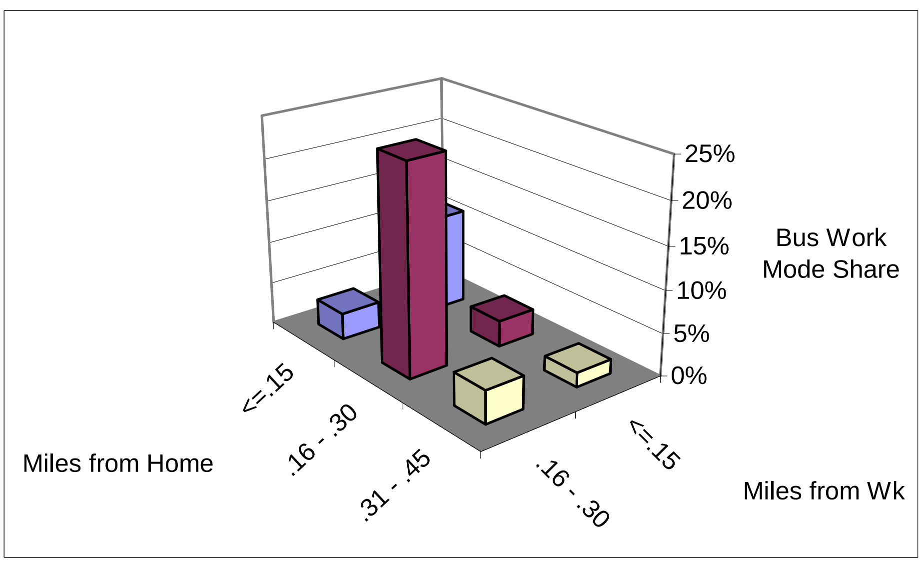

Figure 22 Bus Work Mode Share by Trip End Distance Interval to Bus Route, Only NY MSA

CHAPTER 6

ACCESS LOGISTIC REGRESSION MODEL

Introduction

Transportation forecasting usually begins with utilization of the traditional four step process. The four components of the forecasting model consist of trip generation, trip distribution, mode choice, and route assignment. Notably, transit accessibility can play a large role in mode choice analysis and modeling. After exhaustive usage of cross-tabulation and correlation analysis of various contributing factors, it may be desirable to analyze the effects of many contributing factors at the aggregate or disaggregate level. For instance, linear regression, or more appropriately, logistical regression may be suitable to explore in mathematical models for possible predictability in 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:

$Y=1$ if $Bx + u >= 0$,

$Y=0$ 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.

The field of travel demand modeling includes numerous in depth research work into the exploration and predictability of an individual's travel behavior choices. In this paper, a general logistic regression model is conducted only 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.

From extensive literature in the topic area, studies indicate that many factors play a role in transit usage and mode choice. As previously mentioned, some of the variables that may be considered relevant and subsequently utilized in a predictive regression model include, level of service variables, land use and geographic variables, socioeconomic and demographic variables, and accessibility or distance variables, although these are not exhaustive as arguably an infinite number of characteristics may be considered.

Transit Mode Choice Regression Model

Tables 5 through 8 list the results for a transit model using the national NHTS sample variables. The variables were chosen based on traditional utilization in some classic mode choice models as annotated in the literature. 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 zero, indicate a higher parameter relevance to the model.

Table 5 and 6 list 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. Table 7 and 8 utilize 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 concerning workers.

In a classic travel demand model, variables related to trip characteristics are typically included, but notably, 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 utilizes 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 zero if otherwise. Only workers were considered. Additionally, instances of missing or not available data were filtered from the set of utilized variables. Essentially, 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 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

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 sets of models, both 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 for use has a more limited choice set for their 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 un-weighted model were the age groups. This lower value of significance is not unexpected, since the effects of age over the un-weighted 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 Table 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 un-weighted 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 importantly 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 7

CONCLUSION

Introduction

Understanding transit usage has become a critical transportation research interest and policy goal. As stated, 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. Notably, both inclusions and exclusions in analysis are conducted due to the widely accepted ubiquitous transit network present in the New York region. Additionally the contrasting distributions between New York and the rest of the nation are noteworthy and may be considered a more “finely tuned” analysis of transit access for planners. Overall, the observations imply a very high importance of close proximity transit to for travelers.

Transit Access

Access to transit is well served by an analysis of measured data versus perceived data due to the complexity of issues involved. The analyses reveal strong differences in household and workplace access to transit as a function of race, income, auto ownership, urban area size, and population density. Additionally, a very high sensitivity to access is evident.

Approximately 53 percent of 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. Nearly 60 percent of urban residences are within 0.1 miles from transit, a significant increase from prior survey analysis. Over 50 percent of workplaces are within a quarter mile walk radius of a bus line. Not surprisingly, work is more closely concentrated near transit than are residences.

Transit Choice

Mode choice analysis in relation to transit access distance overall suggests a high preference for users to be very near transit services. Mode share for transit declines approximately two thirds beyond the first interval beyond 0.15 miles from a bus route. The more urban an area, the better transit access is. It has been shown that typically, some transit dependent groups such as zero vehicle householders have an advantage in greater access to transit, as expected. One explanation for the differences in measured versus actual usage may be attributable to non-user segments of transit not being aware of transit proximity or service thus accounting for deviances from prior survey. This may in fact be quite useful to future planning due to the higher degree of accuracy for access data, and the lessening of uncertainties.

Going Forward

This analysis may still be considered the tip of the iceberg in regard to planning tools. Many factors weigh into the planning and ultimate success of transit systems, and this analysis of measured access contributes only a fraction to a comprehensive understanding. Increased ridership is one of the key metrics for success for these systems. It is recognized that this research effort maintains focus on essentially one aspect of transit service supply. 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.

Perhaps future studies will include or append to the dataset a higher number of measured variables that may likely include such variables or information as agency service area size, service frequency. Additionally, comprehensive stop-level and route data, or actual origins and destinations at the trip level could be captured in the dataset and as measured variables for analysis. Going forward, it is expected that there will be an increase in the reliance and usage of Geographic Information Systems (GIS) in constructing future databases, as some of the technology already exists to analyze and manipulate the large geographical databases as those addressed by the appended dataset. Even beyond that technology which is current utilized by the Federal Transit Administration (FTA) and Federal Highway Administration (FHWA), the near future may reveal newer, better techniques.

As an improvement upon this work, the current analysis technique could be enriched by the future addition of more accurate data and information in the dataset. For example, the four newly appended NHTS distance variables may be calculated with an increased accuracy. The actual distance measurement could be calculated as a shortest path distance instead of a Euclidean or straight-line distance. The street and roadway path network is known, and the current technology may allow for such calculation. Thus, the variables could be appended with the improved distance calculation more accurately capturing access distance for a household.

As a first step related to this analysis, it is recommended to construct a bus stop level database to more accurately describe bus transit access. For the bus route access calculation (see Figure 1), a newer bus route dataset could be constructed, improved over the older dataset, if stop-level data was appended to the data. It is conceded that bus stops and service changes more dynamically than rail and are usually shorter-distance spaced, however, the accuracy of the access distance measurement would undoubtedly be significantly improved.

As evidenced from the analysis, there exists a high sensitivity to short access distances for choice transit users. It is understandable that this influences, in part, a traditionally lower mode share for transit. Of key importance is the ability to relate access to mode choice more closely than previously believed. Quite possibly a key contributor to the success of future transit networks may be planning for a higher threshold level of transit access to the population for both rail and bus.

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APPENDICES

Appendix A Geographic Household Access

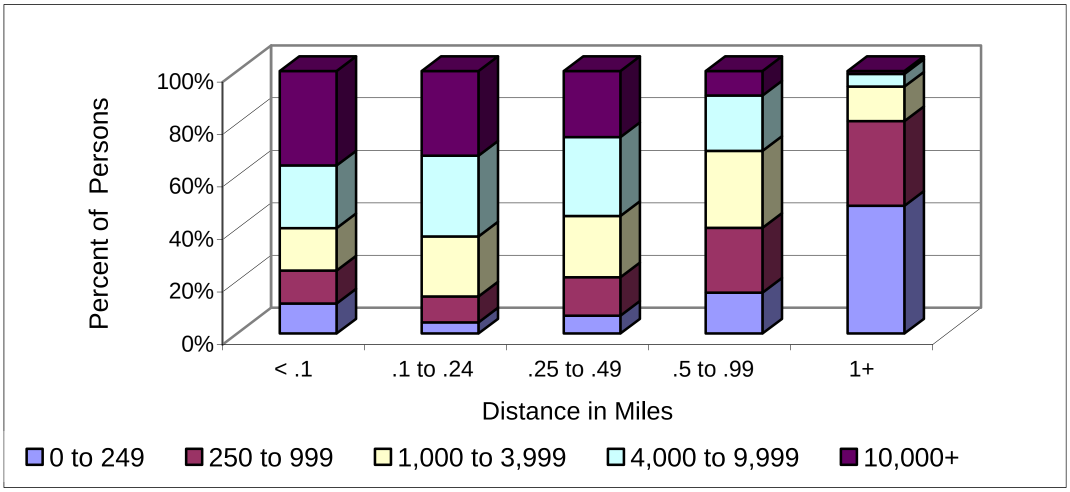

Figure 23 Household Access to Transit by Density 1995 NPTS (Percent Persons per Square Mile)

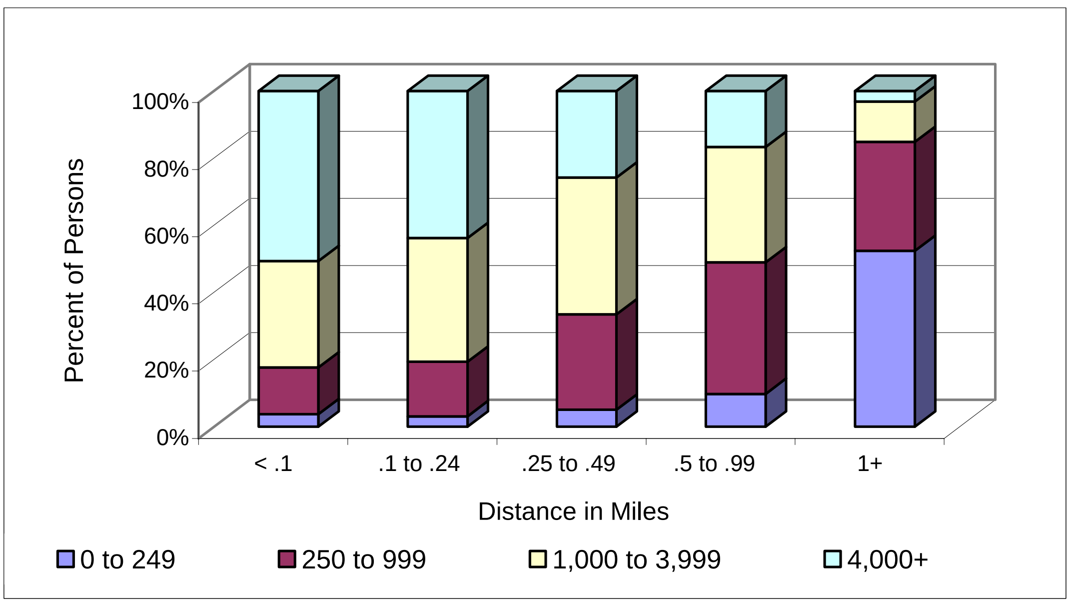

Figure 24 Household Access to Transit by Density 2001 NHTS (Percent Persons per Square Mile)

Appendix A (Continued)

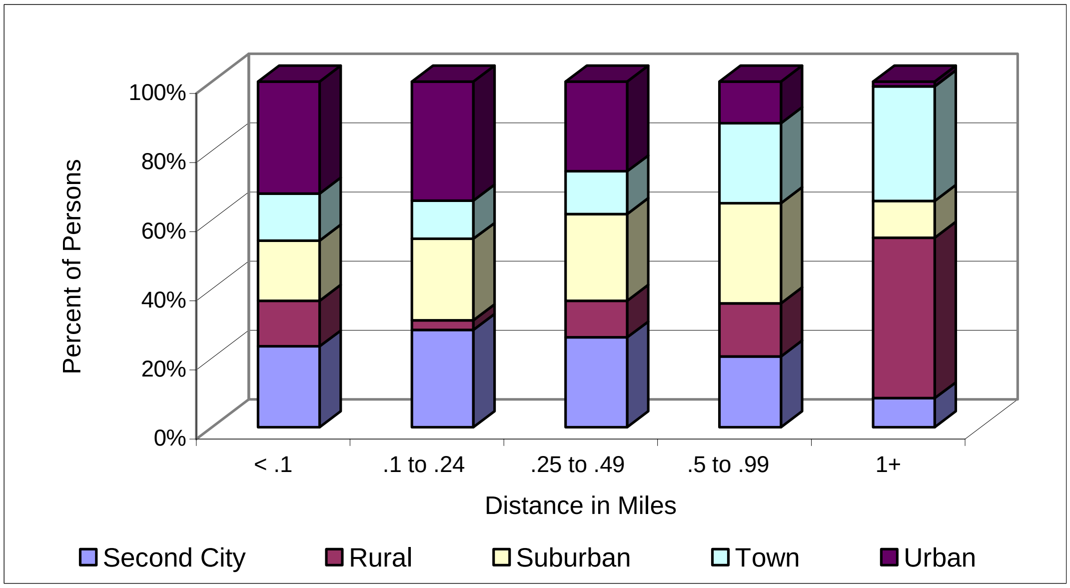

Figure 25 Household Access to Transit by Area Type
1995 NPTS

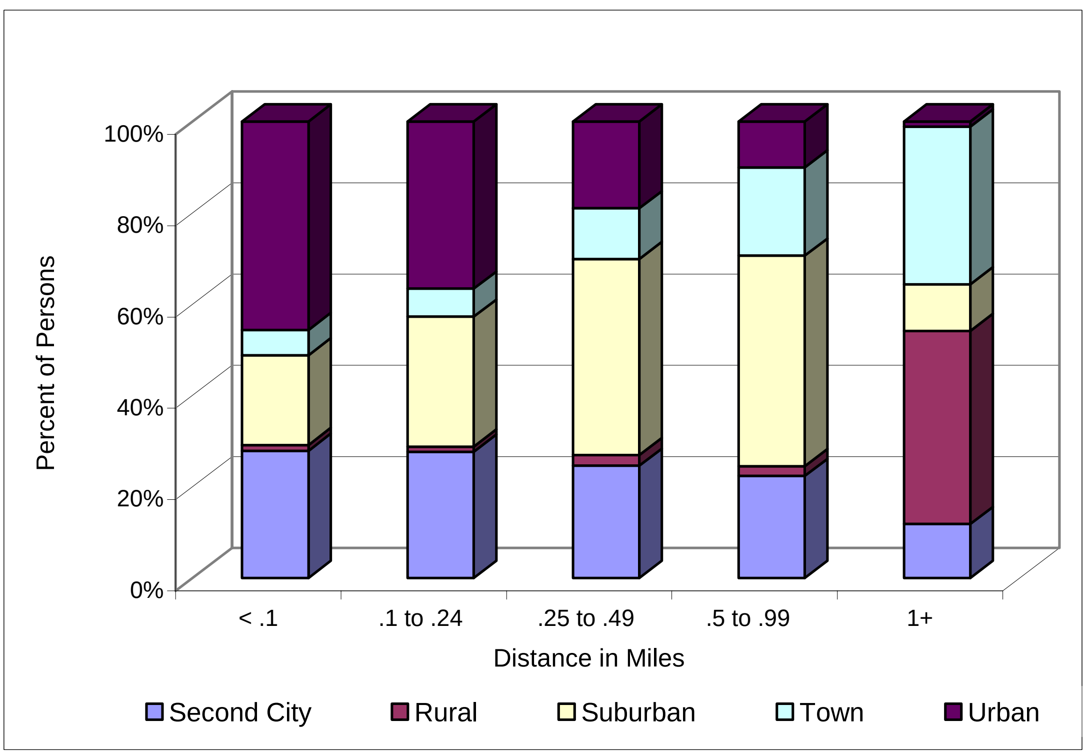

Figure 26 Household Access to Transit by Area Type
2001 NHTS