Factors Determining Transit Access by Car-Owners: Implications for Intermodal Passenger Transportation Planning

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Abstract

Although walking is the dominant mode of transportation to transit facilities, there are variations by socio-demographics, geography, mode of public transit used and other factors. There is particularly a need to understand ways in which car owners who choose to use public transportation can be encouraged to carpool, walk or bicycle in the "first mile" and "last mile" of the transit trip, instead of driving. These considerations have implications for addressing cold start trips resulting from short drives to transit facilities, active transportation strategies that may benefit transit users who currently drive, and in deriving solutions for shared transportation such as bicycle-sharing and car-sharing programs. Using data collected in the Chicago Metropolitan Area, we investigate how the mode choice for the access trip to bus and rail transit stops is related to costs, personal and household variables, trip characteristics, and neighborhood factors including crash frequencies, crime prevalence, neighborhood racial characteristics, population density, roadway density etc. for persons in car owning households. The results suggest that while much of the choice depends on personal and trip related variables, some neighborhood level factors as well as the provision of parking at transit stations have important relationships to mode choice that can influence built environment factors such as density and policy areas such as the provision and operation of transit parking facilities.

Introduction

Access to transit facilities can be an important factor in the choice to use public transportation and in the overall quality of public transportation trip experience (*1*, *2*). Yet research has focused to a far greater extent on the availability of transit itself and on the quality of the transit trip. However, in order to improve transit service from the perspective of users, there is a need to consider the entire transit trip – the quality of the transit facility access trip, the waiting conditions in the facility, the transit trip itself and the trip from the facility to the final destination.

Although walking is the dominant mode of transportation to transit facilities, there may exist variations by socio-demographics, geography, mode of public transit used and other factors. There is particularly a need to understand ways in which car owners who choose to use public transportation can be encouraged to carpool, walk or bicycle in the "first mile" and "last mile" of the transit trip, instead of driving. These considerations have implications for addressing cold start trips resulting from short drives to transit facilities, active transportation strategies that may benefit transit users who currently drive and in deriving solutions for shared transportation such as bicycle-sharing and car-sharing programs. The goal of developing innovative public transportation-centered intermodal passenger transportation systems may be further assisted by green neighborhood vehicles and innovative ICT-based strategies such as real-time walking buddy-finder to and from transit stations and stops.

In this paper, we explore the transit facility access mode behavior of car owners. We have primarily used the Chicago Metropolitan Agency for Planning's Household Travel Tracker Survey (2007-2008) (*4*) for a case study of the Chicago metropolitan area. Our goal is to understand factors that contribute to the propensity of auto-owning transit riders to choose specific transit access modes. We use a mixed multinomial logit model for this purpose and draw implications regarding strategies that may needed to increase active transportation and shared transportation access modes. We also estimate a binary logit model of the propensity to drive very short distances to transit facilities with the goal of understanding factors that may help reduce cold start emissions from these trips.

The paper is organized as follows: in the next section, we briefly describe main findings from the literature on the topic of access trips to transit facilities and factors that determine such behavior. We then present a conceptual model of the traveler's decision-making process that pertains to the context here. We describe the data used and then present the model results. In the closing section, we draw policy implications and future research recommendations.

Background

The "first mile" and the "last mile" problems, whereby travelers experience difficulties in accessing transit facilities and in going from transit stops to their destinations, is a major deterrent to using public transportation. Most strategies to improve public transit ridership focuses on the actual transit service levels and use conditions. However, while the ability of transit systems to allow access to jobs, shopping, social or health-related destinations have an effect on transit use, lack of convenient and safe access to and from transit facilities itself has major detrimental effects on transit ridership and the overall efficiency of the transportation system. Brons et al (*1*) supported this statement by highlighting that rail stations accessibility is an important aspect of whether rail is chosen as travel mode. They demonstrated that facilitating access to rail is more important than providing parking lots at the stations or improving rail travel itself. Improved strategies are needed to allow wider geographical coverage of access by various sustainable modes, lower access time and cost, improved information about travel options, and safe and quality travel to and from transit facilities.

Several authors have commented on various aspects of the transit facility access problem. We consider three different aspects of the research: the role of the built environment, role of social factors such as crime and road safety, and finally, some opportunities provided by transit access and strategies to address the problem.

The first line of research considered focuses on factors in the built environment which support transit access. For instance, Cervero et al (*5*) utilized ANOVA and regression analysis to show that people in denser places (downtowns) usually walk to transit stations in contrast to individuals in suburban settings who frequently drive. The author further notes that transit catchment areas are larger for lower density suburban places than higher density downtowns. Other authors (*9*) have also noted that the assumption of transit station walking catchment areas being 400 meters or 800 meters may lead to an underestimation of actual transit facility catchment size. Their research highlighted that people are willing to walk longer distances to reach transit stations especially rail stations. Daniels and Mulleys (*10*) emphasized that walking distance to transit stops is mostly related to the mode of transit being accessed and that people are more likely to walk longer distance to train stations than to bus stops.

The availability of park-and-ride lots at stations also influences transit access mode, as noted by Cervero et al (*5*). People with cars were likely to drive to stations if parking was available. More significantly, he emphasized that the absence of pedestrian–friendly environment (connected crosswalks, narrower streets, fewer lanes, and so on) and the land use mix around stations influence people’s decision to drive instead of walking to transit stations. The same study found that the built environment had limited effect on whether or not people ride buses to and from rail stations (*5*).

Cervero (*6*) also emphasized that in order to overcome built environment barriers encountered by pedestrians while accessing transit stations, park-and-ride lots should be converted to transit oriented developments. These findings are generally supported by Park (*7*) who noted that street design, the quality of path walkability, and the walking distance itself significantly affect people’s mode choice to transit stations.

A second line of research has focused on safety, and personal well-being while accessing transit facilities. The results are mixed. Using logistic regression models along with state crash location data and information on the existence of bus stops near those crash locations, Hess et al (*8*) showed that roads with bus stops have a higher number of pedestrian crashes. Other authors have considered social factors, particularly crime. Kim et al (*11*) considered Light Rail Transit (LRT) access in the St Louis metropolitan region and showed that in addition to built environment, individual characteristics, socio-economic and socio-demographic status of household members, the level of crime around stations also impact transit ridership as well as the mode choice to transit stations. They noted that female riders are unlikely to walk at night from or to stations especially when the stations are reputed to have high levels of crime. Their results showed that women are usually picked-up or dropped-off at high crime stations at night. Walton et al (*12*), on the other hand, found that fear of crime, distance to transit stops, carriage of goods, or concern for time are of lesser importance compared to the convenience of the car and bad weather in explaining why people drive instead of walk to transit.

A third line of work has focused on the opportunities presented by the transit access trips for health and well-being outcomes as well as on developing innovative "last-mile" transportation. In particular, Consolvo et al (*13*) noted that opportunistic physical activities, where a person incorporates activities into their normal, everyday life is a sustainable approach to a healthy lifestyle in contrast to structured physical activity, where people elevate their heart rate for the purpose of exercising. Recent evidence from the health disciplines clearly shows that moderate levels of exercise on a daily basis have positive health outcomes. Besser et al (*15*) evaluated if walking to transit stations helps a person meet the US Surgeon General's recommendation of 30 minutes or more of daily physical activity. They found that transit users in the U.S. spend a median of 19 minutes walking from and to transit stations. They also found that 29% of transit users get their full 30 minutes or more of their recommended daily physical activity just by walking from and to transit stations. Based to their results, improved non-motorized access to transit stations can contribute to an active lifestyle especially for minority and low-income people and for people living in high density areas.

Several recent papers and reports have focused on innovative sustainable means of public transportation facility access. Shaheen and Finson (*16*) investigated the feasibility of the Segway Human Transporter (Segway HT). They determined that this electric mobility device will be successful only with the cooperation among public and private companies. Other sustainable first or last mile connectors, as previously mentioned, are bicycles, station electric cars and electric bicycles, folding bicycles and others (*17*).

Research Approach

As mentioned previously, we seek to understand transit access mode choice behavior of car-owners. While most studies focus on access to rail stations, this study will look at both rail and bus boarding location especially focusing on persons with at least one personal vehicle in their household. The trips considered in this study are all home based access trips when people most likely have all the potential mode alternatives at their disposal. Figure 1 depicts the conceptual decision-making process. In the top half of the figure, we show the overall process, and in the bottom half, we show an expanded process that provides more details on the decision process that ranges from the long-term to the short-term (18, *19*). The medium to long term decision of auto-ownership affects the alternatives available for day-to-day decisions on what mode to use (though different modes may be taken on different days). A household's residential location decision – the residence with its built environment and access characteristics - may partly determine the decision to own automobiles. It is also possible that residential location choice and automobile ownership choices are jointly determined. The choice of mode for a particular trip may be affected by automobile availability as well as residential location characteristics and decisions may be altered on different days.

The choice of mode to access a transit station is likely quite different for car owners and non-car owners. Those without a personal vehicle have made a decision (or are driven by economic circumstance) to very likely use non-motorized options. Because these decisions occur over different time scales, we focus on car-owning transit users in this paper. This also makes it possible to examine the extent to which their mode choices are affected by neighborhood factors, location-related factors, socio-demographics and trip-related factors.

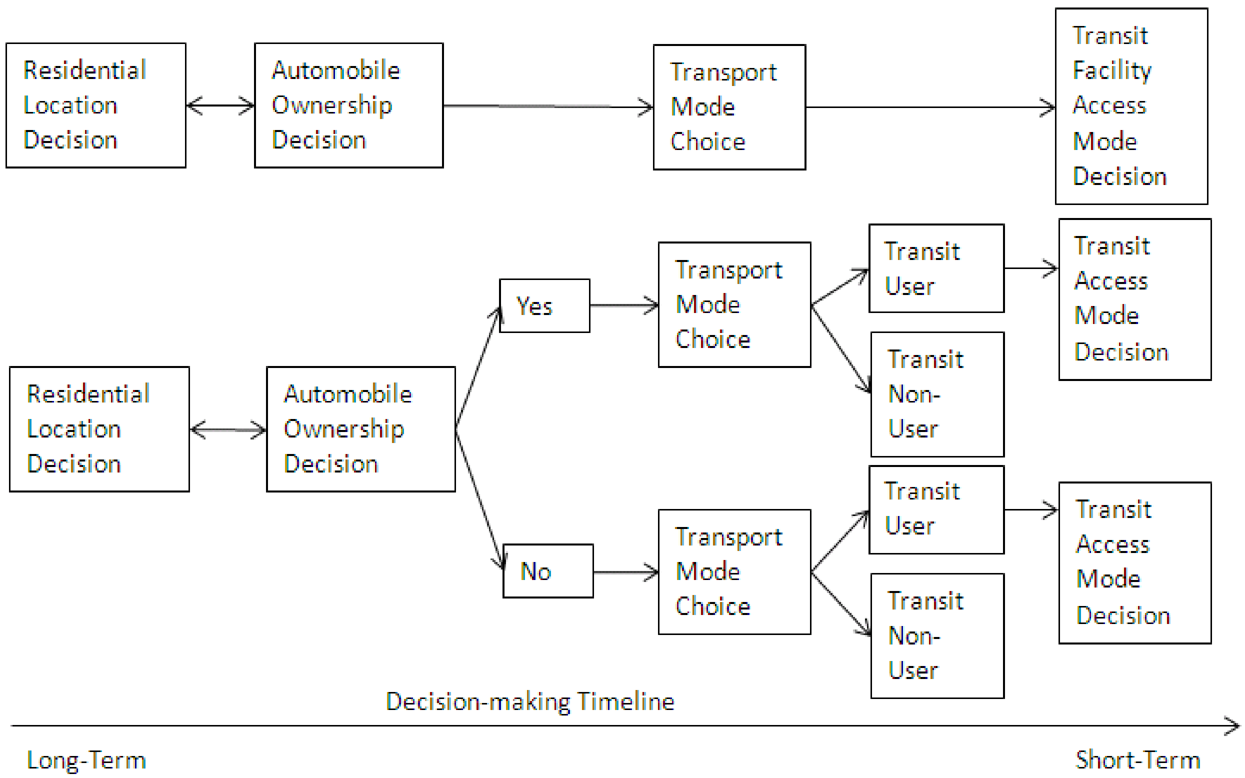

Figure 1. Conceptual framework for long, medium and short term decisions affecting mode choice

Data

Part of the data for this paper is from the Chicago Metropolitan Agency for Planning (CMAP) Travel Tracker Survey, which was conducted between January 2007 and February 2008 for use in the agency's regional travel demand modeling. Telephone, mail, internet, GPS, and in-person interviewing techniques were employed. The sample is composed of 10,552 households out of a total of 2,940,016 households in the Northeastern Illinois area, based on the 2000 U.S. Census. All household members provided detailed information about their travel for the assigned travel day (s), 1 or 2 day(s). Survey completion rates by county were as follow: 6,986 households (66.2%) in Cook, 994 households (9.4%) in Du Page, 67 households (0.6%) in Grundy, 463 households (4.4%) in Kane, 73 households (0.7%) in Kendall, 988 households (9.4%) in Lake, 369 households (3.5%) in McHenry, and 612 households (5.8%) in Will. The full details of the data are provided in (*4*).

From the survey data, we only used the subset of respondents who are in vehicle-owning households. In addition, only those trips where the respondent originated from home and took transit to their ensuing activity is considered. This is done because in many cases, if an individual walked, drove and parked, or bicycled to a transit station when they left home, their vehicle would not be available to them for accessing transit during later parts of the day.

Three models describing mode choice are estimated and discussed. Figure 2 shows two 2-dimensional tables for Model I (all home-based transit trips) and Model II (home-based work trips by transit for transit users from car-owning households. In Model III, a subset of the individuals in Model I, specifically those for whom a transit station is within 15 minutes of walking time from home, is also used to explore the decision to drive for very short distance travel.

Model I

		Auto ownership	
		Owner	**Non-owner**
Trip Origin for all Transit trips	**Home-based**	**Yes**	**No**
	Non-home based	**No**	**No**

Model II

		Auto ownership	
		Owner	**Non-owner**
Trip Origin for Work trips only	**Home-based**	**Yes**	**No**
	Non-home based	**No**	**No**

Figure 2: Samples for Models I (all home-based transit trips) and II (home-based transit trips to work)

For each respondent who used transit, the transit file in the survey includes the mode they used for accessing transit, the location, and in cases when the person walked or biked, the travel time or distance to the station. When a person used a vehicle to access the transit station and the trip was the first of the day, travel times had to computed based on home and boarding location coordinates using Google maps. In each case travel times for the modes that were not used had to computed by making assumptions about walking, bicycling, and driving speed and using the known modes' travel time to compute the travel time for others. For these conversions, we assume an average speeds of 3.1mi/hr for walking and 15.5mi/hr for bicycling. To calculate the travel times for driving when the mode used by the respondent was bicycling or walking, instead of relying a constant average driving speed for all observations, a two-step process was used. This process first calculates what the average travel time by auto is to travel from the tract centroid for respondent's residence to the boarding location using Google maps. Tract centroids are used since for privacy reasons the actual home coordinates are masked in the public data. The estimated travel time and network distances from Google maps is then used to compute an average travel speed that is specific for the tract. Since the type of network and facilities available are likely to differ by the part of the metropolitan area that respondents live in, this allows us to account for that heterogeneity which may influence the driving time. This average speed is then used to convert to driving travel times what has been provided for the walking or biking modes.

Finally, when a respondent drove or was dropped off at the transit station, travel times are first calculated by using Google maps. In these cases, the centroid based travel times are "corrected" by using average ratios between actual to centroid based travel time calculations based on cases where persons reported their actual travel times. Once these mode specific travel times are calculated, we focus our analysis only on those individuals who are 18 and over.

This data is then linked to tract level demographic data from the ACS 2005-2009 5-year data as well as parking availability and capacity data was taken from the Regional Transportation Authority Mapping and Statistics (RTAMS) (*21*). Another portion of the data were obtained from a Spatial Decision Support System (SDSS) developed by the authors as a repository of geographical attributes within the Chicago metro area (*22*). The Chicago area SDSS integrates a Multi-Criteria Decision Making (MCDM) environment with small-area spatial data to integrate transportation decision-making with housing, community development, economic development and physical planning. Using a number of raw data sources and modeling outputs, it consists of a number of indicators on traffic and transportation, accessibility measures, regional employment opportunities, small-area employment estimates based on forecasted job openings and actual jobs, affordable housing, school quality, crime, health, land-use and the built environment.

The factors within the SDSS used in this paper can be categorized into two groups: The first group of factors relate to the physical environment of the area that may be conducive to biking or walking including the availability of transit; population density; quality, complexity and connectivity of the walking environment; distance from the city center; extent of violent and non-violent crime in the region; extent of roads in the area and level of vehicular traffic flow (called Built Environment factors). The second group of factors relate to social behaviors, cognitive and demographics (called Behavioral factors) including percent of school-going children and percent of carless households.

A summary of the variables from the SDSS and summary statistics for the variables used in the models below are given in Table 1.

Model

This study looks at only transit trips that that originate from home. Respondents could have walked, bicycled, driven and parked, or be dropped off at the transit boarding location. We frame the mode choice problem in this context as an outcome that is explained by four groups of factors (i) the cost of travel from home to the boarding location (ii) the characteristics of the person and their household (iii) the characteristic of the trip and (iv) the characteristics of the urban environment in which the decision is made.

Household and demographic variables are mainly included to control for the constraints imposed by within-household tradeoffs and preferences that change with age, gender and life-stage. The characteristics of the trip including the duration of the transit leg of the trip, and the purpose at the end activity, can also limit which mode is used to access the transit station. For example, the attire and appearance required at work may deter the likelihood of using more physically intensive modes. Finally, the characteristics of the urban environment are included to control for built environment as well as perceptions of the environment related to the access trip. These include variables such as roadway density, block density within the tract, racial composition as well as crime and roadway crash statistics for the tracts in question.

Models I and II are mixed multinomial logit models, where, in addition to the attributes of the person, location and trip, also includes attributes of the transit access mode alternatives, namely, the travel time of each access mode from home to the work place. This model is used to draw associations among the four sets of factors discussed above and the choice of the access mode.

Model III, a binary logit model, is estimated for the decision to drive on very short trips to a transit station. We identify these as trips that would have taken 15 minutes or less to walk from home to the boarding location. Model III estimates the propensity to drive very short trips as a function of the same set of individual/household, trip, and neighborhood level variables. These trips are particularly important as they can presumably be replaced by non-motorized modes and yet remain a source of cold start emissions which are substantially greater than emission levels under normal engine operating temperatures.

Models I and II have four outcome variables – walk, bike, drive and park, dropoff. Three models are estimated. The choice is considered to be a multinomial choice problem where the systematic part of the utility for individual *i* taking mode *j* is as follows:

$$U_{ij} = a_j + b_i t_{ij} + g' z_j + e_{ij}$$

where:

a_j : is an alternative specific constant for mode j

b_i : are unobserved parameters for person i with density $f(b_i / q)$ in the population, where q reprents the parameter of the density distribution. In this case we assume a normal distribution for b.

e_{ij} : is an unobserved random term distributed iid extreme value

t_{ij} : is a the alternative specific trave time for mode j for individual i

z_j : demographic and neighborhood-specific variables

g_j : vector of alternative-specific coefficients related to choice j

.

These models are estimated for all trips as well as only for trips that are destined to work. A third binomial logit model is also estimated where the independent variables are the individual and neighborhood related variables and the dependent choice is the choice to travel by auto to the transit station. This analysis is limited to individuals where the transit station chosen is within 15 minutes walking time of the respondent's home.

Results

The estimated results for Models I and II are given in Table 2. Table 3 presents the results of Model III.

Model I: Mode Choice for All trips

We will first discuss the results from model I where mode choice is predicted using travel time, personal variables, household characteristics, and the characteristics of the area in which the respondent lives. The base mode is auto.

Travel time: The estimates of β for travel time in all models are as expected negative. We estimate taste heterogeneity under assumptions of normality which suggests that the estimate is negative in over 99.9% of cases suggesting the assumption of normality is a reasonable one. The model says that as the difference in travel time between any two modes increases, it becomes more and more likely that the person would choose the faster mode. In part, this means less-direct pedestrian routes, for example, would make it less likely that a person would opt for the walking mode, if travel times on alternative modes are not as affected by the complexity of the network or if they provide speed advantages to these alternatives.

Demographic variables: Several demographic variables are important in describing the odds of being dropped-off or choosing to walk to a station. Each additional worker in a household increases the odds that a person would be dropped off. Increases in household vehicles reduce the odds of carpooling. For the walking mode, increased household vehicle reduces its odds while age of the person also has the effect or reducing the odds of choosing to walk as opposed to driving.

Few demographic and household level variables explain the choice to bicycle. The decision appears to be independent of age, household factors such as number of workers, gender (not reported in model) at least in this sample. Households with larger number of vehicles are less likely to bicycle than drive. Every additional vehicle lowers the odds of using bicycle to a greater degree than of walking or being dropped off. In total though, the decision to bicycle is not explained by the person, trip, or location factors descriptors considered.

Trip related variables: Trip related variables including purpose of trip, departure time, the duration of the length of the transit trip, as well as the duration of the activity at the end of the transit trip were included in the initial models. Of these trips duration and work trip purpose significantly explained choice. Longer duration trips favor the base auto mode against both walking and being dropped off. The reason for these may be that for longer duration transit trips decisions to walk may significantly increase total travel time. In addition, those with longer duration trips may be less likely to be dropped off because of potential substantial delays that may ensue when the coordination with other household members fails. The results also show that in general, the auto mode share is significantly favored for work trips compared to walking or bicycling and shows some evidence, although less significant, against being dropped off.

Neighborhood/Environment variables: These variables include those that physically influence the modal choice such as roadway density, block density, population density, transit availability in the area, transit operator-provided parking availability at chosen bus or rail station as well as those factors which may influence people's perceptions of the walking environment. Additionally, we include social/behavioral factors such as the maximum number of bicycle and pedestrian crashes either at the home tract or the boarding tract, the number of crimes in the census tract per thousand population, the median tract income, as well as the racial composition of the tract.

Population density and block density increase the odds of walking even after controlling for the amount of time that it takes to walk to the transit station. While roadway density had some positive effect on getting dropped off, it does not influence the walking preference. Provision of parking at the boarding location by the transit station significantly lowers the odds of walking. The relationship is not necessarily one-directional, meaning that in some cases it may be that those who prefer driving seek out the transit facilities with parking and in other cases, the availability of parking makes it attractive to drive, park and then take transit. The availability of parking also lowers the odds that a person would be dropped off.

Surprisingly both crashes as well as crimes per thousand populations were not related to the choice of the access mode in the all-trips mixed model. Rather racial composition and median income seem to influence the choice to walk as opposed to drive. In a way, these may reflect personal perceptions of respondents about the areas in which they are making the mode choice. Places with higher incomes may be deemed safer and hence increases the odds of walking in such areas. However, there may be some reluctance to walk in areas where the percentage of minority populations may be very large for fear of crime. For example, Quillian and Pager (*23*) report that "the percentage of a neighborhood's black population, particularly the percentage young black men, is significantly associated with perceptions of the severity of the neighborhood's crime problem." It is possible that the percent minority variable is serving as a proxy for perceived fear of crime, rather than actual crime statistics.

While the factors explaining the work-only model (Model II) are for the most part similar to the model for all trips in the sign and significance of the estimates, a few exceptions are present. In particular, the racial composition of a neighborhood and population density are not important in the mode choice decision. Both variables however appear potentially important for the access mode choice to transit stations when the trip purpose is non-work trips (based on a model that is not presented here for sake of brevity). Time of day when these trips are taken may also have an influence on the differences in significance.

Short trips

We have defined very short trips as those for which walking travel times to the transit station are 15 minutes or less. The choice being modeled is the decision to drive as a function of personal, trip, and neighborhood characteristics. The results are given in Table 3. Overall, the likelihood to drive such short distances is small as evidenced by the intercept term. However, some covariates increase its likelihood. The results for this smaller subset of access trips are not very different from the variables that encourage driving for the larger subset. Age as before plays an important role favoring driving as one gets older. Higher number of household vehicles and work trips also favor the decision to drive. The availability of larger parking capacity at transit stations contributes positively to a decision to park and ride even amongst those with very short trips. Neighborhood and built environment factors do not affect the choice in a systematic way. Finally, increasing median income lowers the probability to drive to transit facilities a short distance away.

Conclusion

The analysis in this paper has the overarching goal of informing policy areas that may favor switching from automobile use to non-motorized modes or car-sharing for trips to access a transit station. Such a modal switch has implications for addressing issues related to cold start trips resulting from short drives to transit stations, active transportation strategies that may benefit transit users who currently drive, and in deriving solutions for shared transportation. We employ three mode choice models to access transit from home. Our findings by and large show that transit access mode choice is heavily influenced by the cost of getting to a station, individual/household conditions that induce different constraints or enable flexibility on the travel choice of the individual, and the trip characteristics themselves. Primarily, travel time explains much of the mode choice. Factors that increase the travel time by non-motorized modes relative to driving such as circuitous pedestrian routes and unavailability of pedestrian facilities would significantly skew the odds of against non-motorized travel.

Our analysis also finds that other than the travel time variable, the use of bicycling is not explained very well by household, trip-related, or neighborhood variables. It appears that demographic and built environment variables are not well suited to capture the motivation to bicycle.

Higher number of within-household workers correlates positively with the choice to being dropped off. The policy challenge in this respect is whether the same coordination can be enabled at neighborhood level scales for community-wide shared transportation. Here different innovative strategies may be desired to match people and create opportunities for ride sharing to a transit station. The key is likely not only to generate the necessary matches, which may not be technologically challenging, but to enable building trust and confidence among coordinating individuals so that users can reliably and safely reach the transit station. When coordination occurs within the household, this type of trust is implicit in the arrangement.

While parking availability enables transit use, the increased number of spaces available to park tends to correlate with park and ride arrangements and less so with walking or drop-off arrangements. Here opportunities may exist to encourage sharing rides either among household members or with other neighborhood transit users with the goal of creating higher-occupancy parking spots with differential pricing. The behavioral response to a reduction in parking or solo parking or introduction of differential parking pricing may result in inducing coordination for ride-sharing to transit or for some persons to altogether abandon transit as a mode. If transit users, especially for work trips, travel to high density, high parking cost locations, the possibility for coordination may be attractive. These issues need further research.

Of the neighborhood-level variables in the model for all home-based transit trips, those that tend to favor walking are population density and median income while racial composition lowers the odds. When work trips are modeled separately, only the effect of median income remains significant in increasing the odds of walking. This may be due to both the physical appearance and perception of the neighborhood safety that are associated with higher income locations. When non-work trips are modeled separately (not reported in the paper), the influence of population density is found to positively contribute (p-val=0.070) to the odds of walking. In addition, the proportion of minorities, while not statistically significant (p-value=0.15) still shows the negative association with the probability of walking to a transit station in largely minority areas when the trip purpose is non-work related. In the similarly specified non-work model, the only other variable that significantly predicts access mode choice is the travel time (p-val=0.001). From a policy perspective, the contrasting results from the work and non-work models suggest, albeit weakly, that population density still matters in encouraging walking to transit. Perceptions that likely are associated with higher concentration of minority populations also likely have some impact on the travel decision.

Finally, for very short trips that could be walked, the choice to drive appears mainly related to individual’s age, and their trips characteristics particularly to work. Here again, however, parking capacity increases the possibility of driving very short distances with potentially substantial consequences for cold start emissions.

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Table 1 Model Variables

Variables		Mean	Units/description
Transit station access mode shares	Auto	28%	
	Bike	2%	
	Carpool	7%	
	Walk	64%	
Age		44	
Number of household workers		2	
Number of household vehicles		2	
Transit trip duration		59 minutes	
Work destined trips		71%	
Number of parking at boarding location		281	
The higher of number of bike/ped crashes (killed/injured) at either home tract or boarding tract		12	
Number of crimes per 1000 population in tract		42	Total violent and non-violent crimes in census tracts per thousand population for 2006
Transit Availability Index (TAI)		0.657	Composite index with range (0-1) which gives the extent to which residents have access to transit (bus and rail); based on three input measures – frequency (person-minutes served), hours of service (number of hours) and service coverage (percentage of census tract area covered)
Pedestrian Environmental Factor (PEF)		20.040	Composite index with range (0-100) which ranks tract suitability for pedestrian travel; based on input values of population, income, number of households, amount of commercial and residential land uses as a percentage of census tracts, weighted trip origins and destinations, and Pedestrian Environment Factor (PEF) values, where PEF's are the average number of blocks for the quarter section within each census tract and the eight adjacent quarter sections
Density		14520	2010 Population /square mile in census tract
Road density		0.031	Total Linear Miles of Roads (in all functional classes) within Census Tract
Percent population not white 2010 (by tract)		36%	
Household income 2010 for tract		$69,950	
Observations		1388	

Table 2 Mixed Model for Access to transit station

		All trips Estimate (t-stat)	Work trips Estimate (t-stat)
β	travel time to station (β)	-0.264 (-8.722)***	-.238 (-7.286)***
σ(β)	Heterogeneity in β	0.099 (4.411)***	0.080 (3.817)***
Bicycle	(intercept)	3.330(0.690)	2.702 (0.500)
	Age	-0.040 (-0.987)	-0.041 (-0.786)
	Household workers	0.403 (0.675)	0.595 (0.600)
	Household vehicles	-1.363 (-1.896).	-1.345 (-1.555)
	Trip duration	-0.017 (-1.367)	-0.017 (-0.847)
	Work trip?	-1.629 (-2.132)*	-
	Parking (100s)	-0.012 (-0.371)	-0.135 (-0.648)
	Crime per 1000 pop	-0.001 (-0.069)	0.006 (0.209)
	Maximum bik/ped crashes	-0.043 (-0.700)	-0.018 (-0.247)
	Transit availability index	-0.237 (-0.049)	-2.365 (-0.442)
	Block density	0.027 (0.729)	0.028 (0.865)
	Population density	0 (0.167)	0.000 (0.048)
	Roadway density	5.614 (0.490)	4.733 (0.339)
	Non-white percentage	-1.922 (-0.616)	-1.697 (-0.366)
	Median tract income	0.006 (0.444)	0.010 (0.868)
Dropped off	(intercept)	-0.108 (-0.076)	-0.641 (-0.429)
	Age	-0.008 (-0.660)	-0.009 (-0.694)
	Household workers	0.668 (2.674)**	0.656 (2.439)*
	Household vehicles	-0.646 (-3.375)***	-0.579 (-2.804)**
	Trip duration	-0.016 (-2.864)**	-0.010 (-1.691).
	Work trip?	-0.614 (-1.872).	-
	Parking (100s)	-0.074 (-1.957).	-0.088 (-2.144)*
	Crime per 1000 pop	0.003 (0.467)	0.001 (0.074)
	Maximum bik/ped crashes	0.015 (0.755)	0.011 (0.508)
	Transit availability index	0.888 (0.650)	-0.119 (-0.086)
	Block density	-0.018 (-1.393)	-0.018 (-1.291)
	Population density	0.000 (-0.488)	0.000 (0.020)
	Roadway density	4.208 (1.716).	3.133 (1.268)
	Non-white percentage	-0.980 (-1.563)	-0.178 (-0.262)
	Median tract income	0.010 (2.227)*	0.013 (2.666)**
Walk	(intercept)	7.034 (4.470)***	6.595 (3.954)***
	Age	-0.039 (-3.334)***	-0.040 (-3.207)**
	Household workers	0.022 (0.092)	0.183 (0.663)
	Household vehicles	-0.840 (-4.172)***	-0.805 (-3.402)***
	Trip duration	-0.020 (-3.309)***	-0.021 (-2.871)**
	Work trip?	-0.772 (-2.397)*	-
	Parking (100s)	-0.088 (-2.390)*	-0.101 (-2.534)*
	Crime per 1000 pop	0.012 (1.450)	0.012 (1.256)
	Maximum bik/ped crashes	0.015 (0.655)	0.028 (1.107)
	Transit availability index	0.170 (0.117)	-0.583 (-0.381)
	Block density	0.027 (1.881).	0.020 (1.327)
	Population density	0.00005 (2.723)**	0.000 (1.636)
	Roadway density	1.426 (0.263)	-2.910 (-0.484)
	Non-white percentage	-1.291 (-2.132)*	-1.002 (-1.508)
	Median tract income	0.010 (1.930).	0.010 (1.625)
Goodness of fit	Log-Likelihood	635.600	485.810
	McFadden R^2:	0.465	0.447
	Likelihood ratio test : chisq =	1104.200	785.820
	Likelihood ratio test : p-value =	0.000	0.000

Significance: *** < 0.001, ** < 0.01, * <0.05, . < 0.10

Table 3: Driving Choice on transit access trips that are shorter than 15 minutes by walk mode

	Estimate	Standard Error	z value	Pr(>|z|)
Intercept	-4.040	1.634	-2.472	0.013*
Age	0.026	0.011	2.252	0.024*
Household Size	-0.207	0.139	-1.488	0.137
Household workers	0.066	0.234	0.281	0.779
Household vehicles	0.903	0.212	4.267	0.000***
Trip duration	0.023	0.005	4.386	0.000***
Work trip	0.728	0.351	2.072	0.038*
Parking (100s)	0.080	0.039	2.078	0.038*
Crime per 1000 pop	-0.007	0.008	-0.870	0.384
Maximum bik/ped crashes	-0.013	0.019	-0.690	0.490
Transit availability index	-1.097	1.468	-0.747	0.455
Pedestrian Environmental Factor	-0.003	0.014	-0.196	0.845
Population density	0.000	0.000	-1.288	0.198
Roadway density	-1.002	5.632	-0.178	0.859
Non-white percentage	-0.129	0.662	-0.195	0.846
Median tract income	-0.012	0.006	-2.150	0.032*
Null deviance	505.110	on 837 degrees of freedom		
Residual deviance	399.750	on 822 degrees of freedom		
AIC:	431.750			
psuedo r2:	0.209			

Significance: *** < 0.001, ** < 0.01, * <0.05, . < 0.10