TRANSIT DEPENDENCE AND CHOICE RIDERS IN THE NHTS 2009: ASSOCIATIONS WITH WALK, BICYCLE AND TRANSIT TRIPS

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ABSTRACT

This paper assesses how access to motorized travel options impacts active transportation and transit use. Categories of car availability are used to explore differences between transit dependent and choice riders in active transportation and public transportation trips. Using the National Household Travel Survey (NHTS) of 2009, transit users over 16 (n=25,550) were categorized according to driver status and number of cars and drivers in the household. This typology ranged from choice riders, "fully motorized", to transit dependent "carless unlicensed" transit users. Transit trips and non-motorized trips (walking and bicycling) are estimated in negative binomial models against the car availability typology, and controlling for socio-demographic and spatial characteristics. Overall, 16% of the survey population took transit in the past month; 85% of them lived in car owning households. As income increased, car availability also increased. Groups with lower car availability were generally more likely than fully motorized riders to take more public transit, walking and bicycle trips. Carless but licensed respondents took more transit and walk trips than member of any other group. Transit riders clearly combine the use of multiple modes. Transit users have varying levels of automobile access; their use of alternative modes of transportation fluctuates accordingly. Transit dependent individuals without cars or sharing cars used active transportation more frequently outside of transit trips than car owners. Policies to reduce vehicle ownership in households may enable increases in the use of alternative modes of transportation, even when cars are still owned.

Keywords: Active transportation, Transit dependence, Socioeconomic disparities, Alternative transportation, Population density, Access

INTRODUCTION (PAPER = 4606 WORD)

Promoting the use of public transit is recognised as an important challenge to the development of sustainable cities (Ewing et al., 2007). The development of public transit use has the potential to improve the physical health of the population through additional active transportation, and to reduce greenhouse gas emissions of the transportation sector (Zheng, 2008). Gaining a clearer understanding of the travel patterns of existing markets of transit users can help achieve a modal shift to transit use (Krizek and El-Geneidy, 2007). Transit users are not a homogenous group. People from all income groups, life stages and different levels of mobility use transit (Polzin and Chu, 2005). Understanding how transit users differ in their personal characteristics and in their active transportation patterns can help plan for and provide better public transit service to the nation while improving population health. Such information can also help us understand travel impedances in the lives of those transit users with limited or no car availability, what is referred to in the literature as transit dependence (Bullard et al., 2004). Transit depenent riders are placed in contrast to choice riders, who own a car and have the opportunity to choose to use transit for a specific trip (Sanchez and Brenman, 2007). For these car owning transit users, a higher quality of service will likely be required for public transit to be chosen for a specific trip.

This analysis is focused on the 25,550 respondents of the National Household Travel Survey NHTS 2009 that used transit in the past month. Transit users are categorized based on car ownership and availability. Household socio-demographic characteristics and residential location are compared across categories. Trips by public transit and by non-motorized modes (walking and bicycling) are estimated based on categories of transit use and car availability. Existing analyses using the NHTS has showed differences in active transportation (walking an bicycling) based on socio-economic characteristics (Pucher, et al., 1999; Pucher and Renne, 2003; Pucher et al., 2011) and on built environment (Targa and Clifton, 2005). Car ownership and travel (Coogan et al., 2007), as well as transit use (Polzin and Chu, 2005) have also been explored using the NHTS. At least two studies (Besser and Dannenberg, 2005; Edwards, 2008) have used the NHTS to explore the active transportation patterns of transit users. As in studies using other Metropolitain level surveys on health or transportation (Lachapelle and Frank, 2009; Lachapelle et al., 2011; Brown and Werner, 2009), using public transit was systematically associated with active transportation. The logic is simple: using public transit requires walking walking, at least on one end of a trip, and destinations are likely to be in denser areas with more services nearby. Evidence is lacking on active transportation practice of transit riders across levels of dependence to transit. This analysis focuses on the influence of transit use and car availability on non-motorized and transit trips. By doing so, it provides insights into the travel patterns of choice and dependent transit riders.

A review of the literature on transit dependence and potential links with active transportation provides context to the exploration of transit use and active transportation through the lens of car availability. Variations in socio-demographic characteristics between motorized and carless households are then explored. Active transportation and transit trips are estimated across a typology of car ownership and availability measures and controls for potential confounding factors. The health and mobility implications of these findings on different groups are discussed.

LITERATURE REVIEW

The public transit, active transportation and land use connection

Transit service is typically of higher quality in denser areas (Ewing and Cervero, 2001; 2010). This is because a certain density is required for transit service to be deployed effectively. Furthermore, denser areas have more amenities where a transit user can make purchases and carry out activities along the travel route. These amenities provide opportunities for non-motorized trips to be combined with transit trips. Non-motorized trips, as well a trips combining public transit and non-motorized trip segments have the potential to increase population health through increased participation in physical activity (Zheng, 2009; Lachapelle and Frank, 2009).

Non-motorized travel, also called active transportation, refers to the use of walking and bicycling to access destinations (TRB-IOM, 2005). Public health authorities consider the use of these modes as beneficial to health because they support an active lifestyle (USDHHS, 2008). Transit use requires a person to walk to access transit. Even if a person drove or was driven to a transit station, walking is required on the egress side of the trip to reach the final destination. Furthermore, there is evidence that transit users also take more walking trips to directly access destinations without taking a transit trip (Lachapelle et Noland, 2012). This walking occurs both near the home and workplace for transit commuters (Lachapelle et al. 2011). Higher population densities, and proximity of services found nearby transit stops and stations explain part of this walking. Because of its large sample size, the NHTS enables further exploration of subgroups of transit users.

Dependent and choice riders

In their analysis of the 2001 NHTS, Polzin and Chu (2005) suggest that all socio-economic groups are represented among transit users. The term transit dependence was popularized by Bullard and colleagues (2004) and refers to poorer and carless households, often minorities, with no other means to get around. The Federal Transit Administration (cited in Sanchez and Brenman, 2007) defines transit dependent individuals as those 1) without private transportation, 2) elderly that are no longer able to drive, 3) youths without drivers license, and 4) individuals below poverty or median income levels. Hence transit dependence is defined by the ability to drive (having a license) and the means to drive (having a car), which implicitly suggests having the financial means to own or share a car, being old enough to drive and being physically healthy enough to drive. Transit dependent riders, according to the FTA, represent 30 to 40% of the ridership in urbanized areas (Sanchez and Brenman, 2007).

Sanchez and Brenman (2007, p.148) describe choice riders as transit riders that “either have cars, or that have consciously decided to forgo one and use transit instead”. Other groups may be able to drive but forgo car travel over public transit for convenience, lifestyle, and economic or environmental reasons. Choice riders are typically wealthier car owning suburbanites (Taylor and Breiland, 2011). This group comprises the largest share of the adult population, but a much smaller share of transit users. In this situation, individuals can easily shift their use of public transit to other motorized modes as a result of increases in transit fares or decreases in transit quality. Actual car availability and transit use can be used to define levels of dependency ranging from choice to dependent transit riders. On the other hand, a large share of the American population does not have access to nearby transit service and is therefore considered car dependent (Zhang, 2006).

Increasing the quality of transit service delivery to maintain current markets, and seeking out new markets to increase transit's mode share are two current objectives of public transportation agencies. While the goal of increasing transit ridership is targeted at all level of the socio-economic spectrum (Sanchez and Brenman, 2007), Taylor and Breiland (2011) observe that efforts to generate new ridership have been directed to wealthier riders. The largest share of funding for public transit has gone to rail projects that typically serve wealthier suburban markets (Taylor and Breiland, 2011). Moving people out of their cars and generating new riders to reduce air pollution and greenhouse gas emissions are attractive objectives, but the quality of transit service required to shift habits tends to concentrate large investments in targeted areas. As a result, areas with low-income populations, the largest segment of the existing transit user market, have received a disproportionately low proportion of investments in infrastructure development in past decades.

METHODS

National Households Transportation Survey (NHTS) 2009

The analysis was conducted using the individual level file of the NHTS 2009. The NHTS draws a national representative sample of all civilians, non-institutionalized population of US residents through Random Digit Dialing of a list-assisted sample of telephone numbers. A Computer Assisted Telephone Interview (CATI) process is used to increases the quality of the data by skipping to appropriate question based on acquired knowledge, prompting for illogic sequence of response and checking for acceptable data range discrepancies (USDOT AND FHA, 2011). The survey was fielded between March 17, 2008 and May 7, 2009. Seasonal and weekly variations are represented by assigning travel days to survey respondents across the 14 months period. The response rate was 19.8%, a considerable drop from previous surveys (e.g. 41% in the NHTS 2001). Individuals selected for this analysis were aged between 16 and 92 years old. A first screener interview served to identify valid phone numbers, collect socio-demographic information, assign a travel day and prepare the respondent for the reception of a trip diary package and a retrieval interview. (USDOT and FHA, 2011).

Main outcomes

Four travel and active transportation outcomes were used: whether a person took transit or not in the past month, the number of transit trips in the past month and the number of walk trips and bike trips in the past week. Transit use in the NHTS is defined as the use of any of these modes: mass transit bus, commuter bus, commuter train, subway/elevated rail, and streetcar/trolley (USDOT and FHA, 2011). The question: "In the past month, about how often have you used public transportation such as buses, subways, streetcars, or commuter trains?" was used to identify transit users (at least one trip) and was used as a dependent variable in trip analyses. Active transportation of respondents were assessed using the two following questions: "In the past week, how many times did you take a walk outside including walking the dog and walks for exercise?" and "In the past week, how many times did you ride a bicycle outside including bicycling for exercise?"

Typology of car availability: the transit markets

To capture difference in groups of transit users a typology of car availability is created following the description provided in Table 1. Using the number of vehicles per household, the number of drivers in the household, and whether a person claimed to be a driver, 5 categories are created: 3 for motorized households, and 2 for carless households.

Table 1: Car ownership and availability typology

Fully motorized	= 1 if hhvehcnt >=1 & driver = Yes & hhvehcnt/drvrcnt >=1
Partially motorized	= 2 if hhvehcnt >=1 & driver = Yes & hhvehcnt/drvrcnt < 1
Unlicensed motorized	= 3 if hhvehcnt >=1 & driver = No
Carless licensed	= 4 if hhvehcnt = 0 & driver = Yes
Carless UNlicensed	= 5 if hhvehcnt = 0 & driver = No
Else	= Missing

Where hhvehcnt = number of vehicles in household; driver = is a car driver; drvrcnt = number of licensed drivers in the household

Additional independent variables

Key demographic and land use variables were used to compare members of car availability and transit use categories and to estimate travel behavior. Age (5 categories) gender, being a worker, going to school, job category (4 categories), being a renter and annual household income (6 categories) were selected as independent socio-demographic variables. Land use variables include an indicator for living in one of the eleven Metropolitan Statistical Areas (MSA) that have heavy rail as well as an indicator for living in the New York, New Jersey and Long Island Consolidated Metropolitan Statistical Area (CMSA, population 18,897,109). Eight ranges of residential density per square miles at the census tract level are provided by NIELSEN Claritas as part of the NHTS files. Increments roughly correspond to an effective doubling of residential density.

Statistical approach

The distribution of the typology for the entire sample, for respondents having used transit in the past month and for respondents living in the New York Metropolitan area and having used transit in the past month is first presented. The car availability typology as well as socio-demographic characteristics and land use measures were compared for the entire sample and for the selected sample of respondents having used transit in the past month. The dichotomous variable of transit use is modeled with a binary logistic regression. Three dependent count variables were modeled using negative binomial regressions in STATA 11. The negative binomial model was used because variable distributions were over dispersed, had large clustering of zero values, and were therefore inappropriate for the Poisson regression (Washington et al., 2003). Survey weights provided in the dataset were used to provide reliable estimates at the population level.

RESULTS

Sample

Table 2 presents information on the entire sample and on the sample composed of those having used transit in the past month. The distribution of the car availability typology is compared across the entire sample first (col. 1), and then by the subsample of transit users and of transit users living in the New York, New Jersey and Long Island Census Metropolitan Area (col. 2, 3). Seventy percent of the entire sample drove and had one or more car available. This value reduced considerably in the two public transit user samples. Together, Unlicensed motorized, Carless licensed individuals, and Carless unlicensed respondents represent less than 10% of the entire sample. They however represent about 21% of the sample that used transit during the month preceding the survey, and over 28% of residents of the New York CMSA.

Table 2: Comparing sample and survey population

Car availability	Total NHTS sample	NHTS, Used transit in the past month	New York CMSA, Used transit in past month
	1	2	3
Fully motorized	70.64	63.22	51.92
Partially motorized	9.21	15.26	19.72
Unlicensed motorized	6.05	7.94	5.99
Carless licensed	1.04	6.65	13.22
Carless UNlicensed	1.91	6.93	9.14
Missing data	11.15		
Total percent	100	100	100
Total observations	308,901	27,271	4,605
Pearson Chi Square *p-value*		0.000	0.000

In Figure 1, the percentage of respondents having used transit in the past month is reported within each categories of the car availability typology. Nearly 70% of Carless licensed individuals used transit during the month, the highest rate of transit use within groups. Both Carless unlicensed, and Partially motorized drivers had considerably higher share of transit users than Fully motorized individuals. Because of the size of the group of fully motorized individuals, even if a small proportion of them used transit, they represent a large share of the transit using market (Figure 1, right panel).

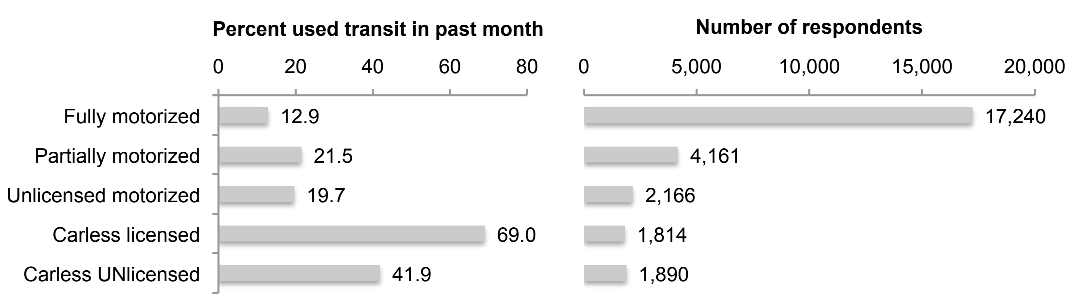

Figure 1: Percent using transit within each car availability groups and actual number of transit users

Socio-demographic and land use analysis

The distribution of binary socio-demographic characteristics on the typology of car availability was explored in Table 3. Many socio-demographic variables present a gradient across the car availability typology, but not as clearly defined as that of income. As car availability decreased, the percent of renters, unemployed and women increased. Figure 2 (top panel) shows a clear income gradient across categories of car availability with Fully motorized individuals being the wealthiest (55% earned over $80,000), and with value decreasing through the car owning households to the Carless unlicensed category (where 60% earned $15,000 or less). As shown in Figure 2 (bottom panel), the distribution of age category does not follow the same pattern. UNlincensed motorized individuals had a higher proportion of younger age groups, and Carless UNlicensed individuals had a higher proportion of people older than the rest of the sample. These two groups also had higher concentration of women. All Chi square comparison test of categorical variables were highly significant (P<0.000).

Table 3: Composition of each car availability typology, transit users sample

	Fully motorized	**Partially motorized**	**Unlicensed motorized**	**Carless licensed**	**Carless UNlicensed**	**Total**
Total	16,213	3,943	2,049	1,698	1,647	25,550
All % of binary variable in category						
Women	49.68	47.88	62.27	58.6	68.55	52.22
Not a worker	31.04	39.36	71.35	56.01	79.72	40.35
Renter	10.55	27.34	31.72	74.56	72.8	23.11
Live in MSA with rail	39.87	50.16	39.14	53.12	39.47	42.25
Live in New York CMSA	13.37	21.99	12.54	33.51	21.55	16.5

Figure 3 shows that each car availability category had group members living within each density ranges. But overall, fully motorized riders lived in lower density environments and the proportion of all other groups increased as density increased. Carless licensed riders were located in denser environments than all other car availability category. They were also more likely to live in the New York CMSA and to live in a MSA with rail transit.

Travel behavior

The mean number of transit trips for individuals using transit is presented in Figure 4. Two groups, the partially motorized individuals and the carless licensed individuals have considerably more frequent use of public transit. Unlicensed motorized and unlicensed carless riders have the lowest frequency of use. Being unlicensed to drive seem to be associated with reduced travelling by all alternative modes. Figure 5 also identifies these two groups as having a lower proportion of individuals that walk and bicycle, and while they may have the lowest average number of walk trips, Carless unlicensed transit riders that use a bicycle have the highest mean number of trips.

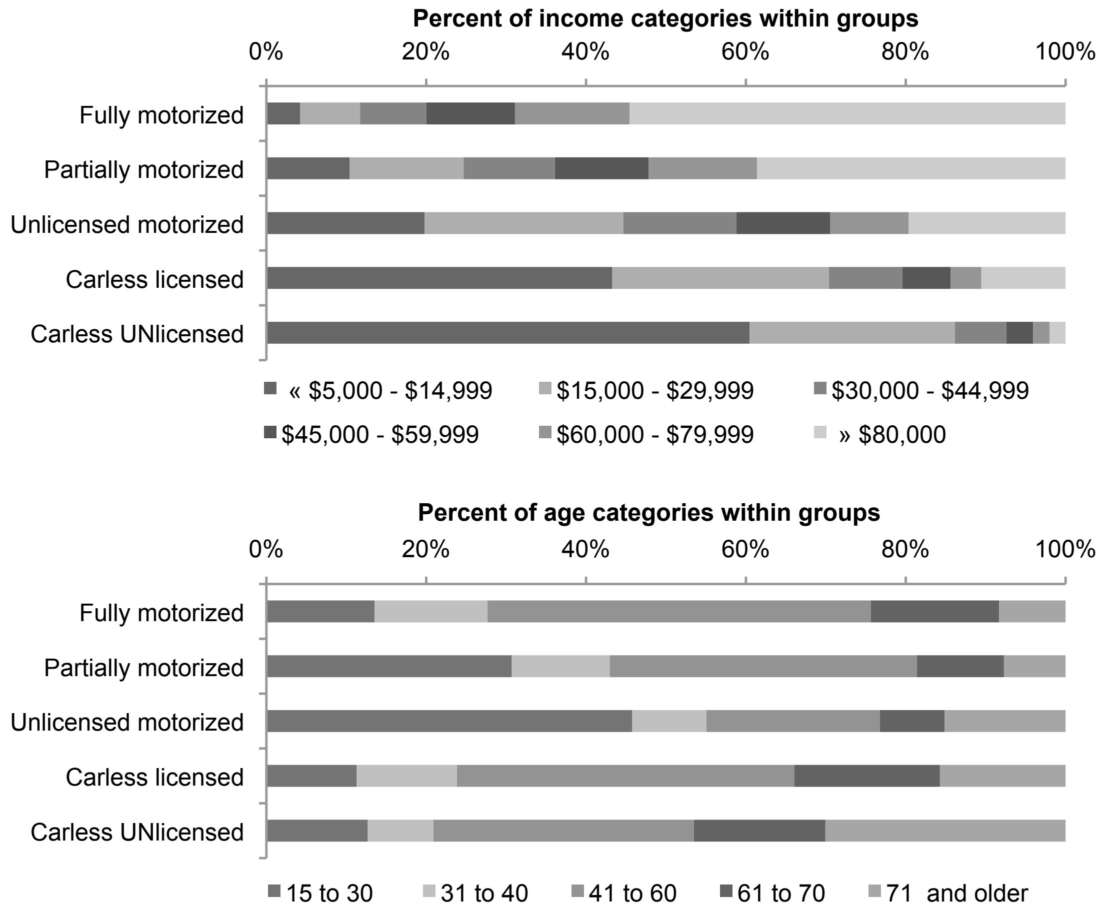

Figure 2: Income and age distribution within car availability categories

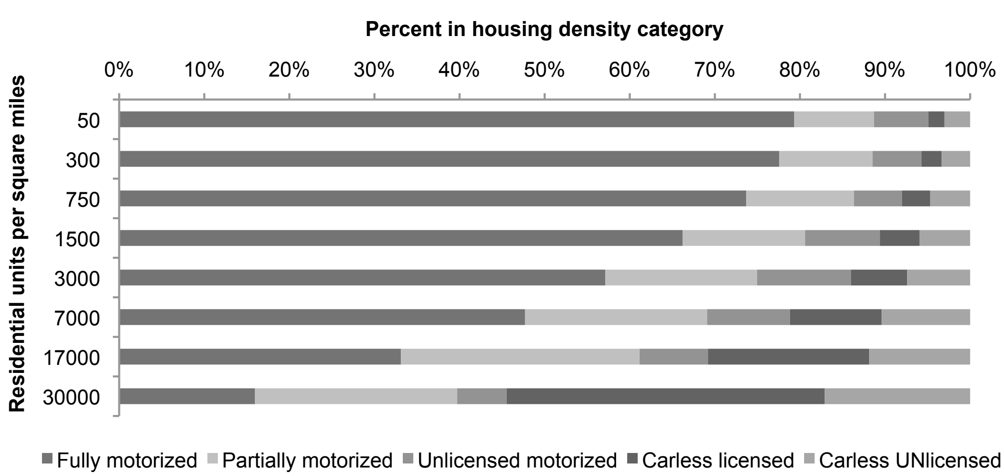

Figure 3: Housing density and car availability categories

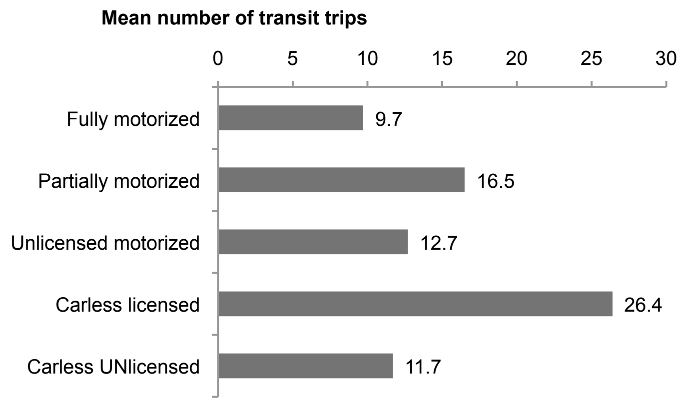

Figure 4: Mean number of transit trips in past month for transit users

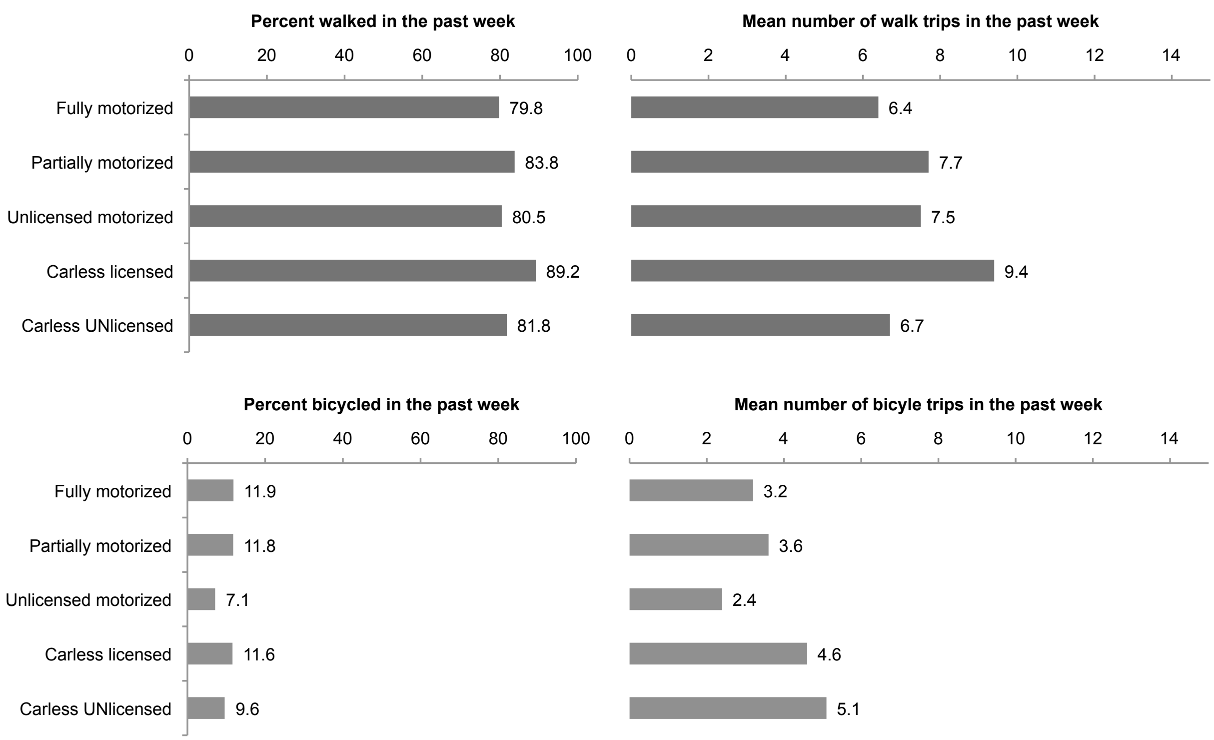

Figure 5: Mean walk and bicycling trips for transit users who walked or bike during the last week

Travel behavior models are presented in Table 4. A logistic regression of transit use over the past month is first estimated (Model 1). Three negative binomial regressions were estimated using the number of transit trips (Model 2), bicycle trips (Model 3), walk trips (Model 4). Each model includes the main variables of interest, car availability and transit use, along with socio-demographic and land use characteristics. The reference case is a Fully motorized male, earning less than 15,000$ a year, that owns a home and lives in an urban area that has rail transit service outside of the New York Metropolitan Statistical area. All results reported below were statistically significant at least at the $p<0.05$ level. Survey weights were used.

In the transit use model (Model 1), all other transit markets were more likely to use transit than Fully motorized individuals. Carless licensed individuals had the highest coefficients associated with transit use. Being older wealthier, a worker, a woman and living in an MSA that does not have rail transit was negatively associated with having used public transit over the month. Living in the New York CMSA was positively associated with having used public transit.

Again in Model 2, all other transit markets were more likely to have taken more transit trips than Fully motorized individuals. Carless licensed individuals took the most trips of all transit markets, followed by Partially motorized individuals. Age, being a woman, a renter and being a worker were all negatively associated with the number of transit trips taken over the month. Individuals earning between $15,000 and $50,0000 were more likely than the poorest to take more transit trip. Individuals earning over $50,000 were even less likely than the poorest group to take transit trips. Living in New York CMSA, in a MSA with rail and employment density were all associated with taking more public transit trips.

The number of walk trips over the last week (Model 3) reveals less variations from the base case. The highest number of trips was taken by Carless licensed individuals, again followed by Partially motorized individuals. Unlicensed motorized riders were not significantly different from Fully motorized respondents. Age and being a woman were negatively associated with walk trips. Only the densest of built environments were positively and significantly associated with taking more walk trips. Being a worker was not associated with walking.

For bicycle trips (Model 4), carless unlicensed individuals were more likely than all other groups to have taken more bicycle trips. Carless licensed individuals followed closely. Unlicensed motorized individuals were less likely to have taken bicycle trips than the Fully motorized. Those living in MSAs without rail, renters and living in the New York CMSA were positively associated with the number of bicycle trips. Using public transit was also positively associated with the number of bicycle trips.

DISCUSSION

An individual level analysis of transit use, transit trips and non-motorized trips was proposed. Results suggest that there is a strong synergy between car availability, transit use and non-motorized modes. Transit users walked more and bicycled more, especially if they didn't have a car or shared cars with other household members. The less access to a car a person had, the more alternative modes of travel were used.

Overall, Carless unlicensed and Unlicensed motorized individuals presented the lowest frequency of transit trips and non-motorized trips. Other household members may more frequently drive Unlicensed motorized individuals to destinations, and Carless unlicensed riders seem to travel the least by all modes. Carless unlicensed individuals were the poorest group, dominated by women and one-person households, and the group was particularly composed of people that were retired and living alone, and young without children and living alone (data not shown). The largest concentration of bicycle riders was found in the Carless unlicensed group which tended to be composed of older people. Perhaps the younger members of this group made important use of bicycling as a mode of transportation.

Table 5: Travel behavior models

Model	**1 (Logistic)**	**2 (Neg. bin.)**	**3 (Neg. bin.)**	**4 (Neg. bin.)**
	Used transit in past month Coef.	Transit trips in past month Coef.	Walk trips in past week Coef.	Bicycle trips in past week Coef.
Car Availability				
Fully motorized [Ref.]				
Partially motorized	0.652***	0.461***	0.164***	0.336*
Unlicensed motorized	0.683***	0.291***	0.127	-0.544**
Carless licensed	2.521***	0.867***	0.309***	0.574**
Carless UNlicensed	1.732***	0.239**	0.033	0.514
Age categories				
15 to 30 [Ref.]				
31 to 40	-0.347***	-0.093	-0.009	0.227
41 to 60	-0.381***	-0.066	-0.002	-0.136
61 to 70	-0.573***	-0.178*	-0.101	-0.773***
71 and older	-1.217***	-0.398***	-0.252***	-2.251***
Women	-0.067	0.028	-0.079*	-0.814***
Household income				
« $5,000 - $14,999 [Ref.]				
$15,000 - $29,999	-0.415***	0.165*	-0.025	-0.188
$30,000 - $44,999	-0.454***	0.275***	0.112	-0.163
$45,000 - $59,999	-0.347***	0.139	0.026	0.23
$60,000 - $79,999	-0.099	0.101	0.006	-0.125
» $80,000	0.221*	0.07	0.036	-0.157
Not a worker	-0.241***	-0.304***	-0.052	-0.045
Renter	0.115*	-0.027	0.039	-0.359**
MSA has rail	0.558***	-0.001	-0.04	-0.139
Lives in New York CMSA	0.414***	0.033	-0.137**	-0.386
Density range of Housing Units (/mile^2)				
50 [Ref.]				
300	0.196*	-0.403***	-0.061	0.12
750	0.083	-0.469***	-0.049	0.326
1500	0.341***	-0.315**	-0.089	0.137
3000	0.501***	-0.338***	-0.008	0.596*
7000	0.991***	-0.203	0.149	0.457
17000	1.944***	0.09	0.345***	-0.113
30000	2.383***	0.219	0.598***	0.338
Constant	-1.470***	2.863***	1.763***	-0.494
lnalpha Constant		0.120***	0.025	2.708***
Observations	159238	25550	25352	25522
ll(base)	-88504673.5	-140456950.4	-110609860.6	-22826860.3
ll(model)	-72748872.1	-137358714.6	-109629667.4	-22319526.7
-2ll Chi2	2316.49	880.02	250.04	344.69
p-value	0.000	0.000	0.000	0.000

Note: Sample sizes are different because of non-response specific to each dependent variable.

Furthermore, based on socio-demographic characteristics, car availability and residential locations, transit users have access to differing quality of transit service and may only decided to use them if the service is competitive with other alternative modes.

Carless licensed driver, on the other hand, traveled the most cumulatively by modes of transit, walking and bicycling. They were in general poorer, but some individuals where relatively wealthy. A high proportion younger people and of renters living in high density suggests young mobile professionals living in central locations with good access to transit that forgo the use of a car because of costs, convenience, lifestyle or beliefs. Some of them may “choose” to be transit dependent and live in places with good transit service. Carless licensed individuals can decide to subscribe to car sharing schemes and use a car parsimoniously. Membership to a car sharing club complements public transit, bicycling and walking, provided the user lives in an environment supportive of these behaviors. Car sharing has had a tremendous growth in recent years (Shaheen et al., 2004; 2006).

If transit trips are lost to walk or bicycle trips, much of the environmental, social and health benefits of mode shift are maintained. But if transit riders decide to switch back to car travel and use their cars more or purchase a new car, transit ridership may suffer. As suggested by Taylor and Breiland (2011) most of recent transit investments have been made to increase the proportion of motorized households travelling by transit. Because this is the largest group of the population, small percentage increases in riders can generate large absolute number of new riders. However, because they have to willingly give up car travel, these riders likely expect higher quality public transit service. Inversely, choice riders can also stop using transit at any time as a result of decrease in service quality.

Individuals living alone with one car (Fully motorized) or sharing a car with a number of household drivers (Partially motorized) may decide to give up their car, thereby becoming Carless licensed individuals, the group for which we expect the most important use of transit, walking and bicycling. Fully motorized individuals in a larger household may also accept to give up one of the house’s car, thereby becoming Partially motorized. This would likely increase their level of transit use and of non-motorized travel. On the other hand, Carless licensed individuals could decide to purchase a car as a result of wage increase, change in lifestyle or life stage (e.g. having a child), or changes in home location. Unlicensed motorized individuals could decide to become drivers and use the household’s car. Because they are typically younger, they may also move out for school, a relationship or a job. Because a decrease in transit service quality may deter choice riders from using transit and a an increase in wages may lead poorly served transit dependent riders to purchase cars and shift travel modes, different strategies must be elaborated to preserve public transit’s markets. By no means are these groups monolithic and rigidly fixed. Changes in service quality, in cost of travel, in life stages and in transport policies may all have influence on car ownership, and consequently on alternative travel.

Study limitations and strengths

This cross-sectional analysis cannot serve to infer causality or to assert the displacement of car trips by transit and non-motorized trips or vice-versa. Unfortunately there was no variable for the number of car trips over the week or month that could complement the analysis. For unlicensed individuals, being driven to a destination is another potential way of completing trips.

Because no information was available for car ownership, being a driver and number of transit trips, teenagers below 16 were excluded from this analysis. They are nonetheless an important potential public transit market that should be further explored given that they will soon reach the age where becoming a driver is possible.

The focus on trip count variables in personal surveys enables the assessment of monthly and weekly travel behavior. Without the use of travel diaries, however, detailed information on specific trips, trips conducted using multiple modes (trip chain) and information on trip destinations. More specific information on quality of transit service, walking and bicycling infrastructure would likely increase the models' predictive capabilities.

No direct information on the motivations for using public transit and especially for being "dependent by choice" were available. Observing this specific categorization shows more clearly the effect of potentially reducing or increasing car availability on transit use active transportation.

CONCLUSION

Observing transit, walk and bicycle trips through the lens of a typology of car availably representing levels of transit dependence reveals the importance of car availability in transit use, walking and bicycling. The more transit dependent a person was, or the less access they had to a car, the more they combined these modes of transportation and likely compensated for the unavailability of a car.

Carless licensed individuals represented 6.7% of transit users and only 1% of the entire sample. This group took the most transit trips, walk trips and bicycle trips of all car availability categories. Group composition provides explanation for some of the results. Both the Unlicensed motorized (highest proportion of young people) and the Carless unlicensed (highest proportion of oldest age group), took the least walk and transit trips of all categories. Carless unlicensed also bicycled the most.

Transit agencies should ensure that provisions are made for the combination of travel modes. This means working in collaboration with urban planners to support Transit Oriented Development and ensuring that housing options nearby transit are available at all price points. Many large rail infrastructure projects and TOD projects cater to wealthier populations. Yet poorer populations have less access to cars, use more public transit and practice more active transportation. Providing transit service that maintains current users while attracting new users is a complex challenge that will require careful consideration.

The differences in active transportation and transit use between groups suggest that giving up an only car will considerably increase the use of alternative modes. Giving up one of the household's vehicle and sharing the remaining vehicle(s) to the rest of the household can also lead to an increase in the use of alternative modes. Working on policies to reduce auto ownership in households with more than one car may be where most new ridership will be developed. Carless households are not the only group using public transit and active transportation. Promoting policies targeted at reducing the number of vehicles in car owning households may also increase active transportation and transit use.

In order to maximize mobility and health benefits, public transit interventions must ensure adequate access to those groups more dependent upon public transit. Foregoing car ownership may be difficult for many households, but working on policies that discourage car use and ownership can increase the use of alternative modes of travel.

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