What factors influence trip duration of work trips and shopping trips in Boston?

Background

Various approaches have been used to understand travel behavior -trip based approach, trip chaining based approach, and activity based approach. It is not only determined by the activities in which someone participates, but also the characteristics of the location of these activities.

Multiplicity of factors that influence travel behavior have been constantly highlighted. It has been argued that changing the three dimensions or 3D's of the built environment - density, diversity and design can help achieve the objectives of trip generation. Destination Accessibility and Distance to Transit have also been added as significant. This research is an attempt to analyze trip duration for work trips and shopping trips in the Boston Metropolitan Area. The focus is on below median income households and the analysis takes into consideration both the elements of the built environment and socio-economic characteristics of households that can impact travel behavior.

Research Questions:

What are the patterns observed for trip duration of work and shopping trips for below median households in Boston?

What are the variables of the built environment and socio economic characteristics of households, that are significant to the duration of work trips and shopping trips?

Results

Smart Location Database Variables	*Work Trips*		*Shopping Trips*	
	t-statistic	*p-value*	*t-statistic*	*p-value*
Density				
Gross residential density (HU/acre) on unprotected land	-0.90	0.37	-0.33	0.74
Gross population density (people/acre) on unprotected land	0.57	0.57	-1.01	0.31
Gross employment density (jobs/acre) on unprotected land	1.12	0.26	-0.67	0.50
Diversity				
Jobs per household	**3.48**	**0.00**	0.22	0.83
Employment and Household Entropy	1.35	0.18	**-2.27**	**0.02**
Trip productions and trip attractions equilibrium index; the closer the one, the more balanced the trip making	-0.35	0.72	1.19	0.23
Regional Diversity. Standard calculation based on population and total employment: Deviation of CBG ratio of jobs/pop from regional average ratio of jobs/pop	**-4.28**	**0.00**	0.63	0.53
Household workers per job, by CBG	-0.53	0.60	0.21	0.83
Household workers per Job Equilibrium Index; the closer to one the more balanced the resident workers and jobs in the CBG	0.63	0.53	-1.49	0.14
Design				
Total Road Network Density	0.66	0.51	**1.96**	**0.05**
Network Density in terms of facility miles of auto-oriented links per square mile	0.40	0.69	-1.00	0.32
Street intersection density (weighted, auto-oriented intersections eliminated)	-0.25	0.80	-1.04	0.30
Transit				
Distance from population weighted centroid	-1.50	0.13	0.64	0.52
Aggregate frequency of transit service per square mile	-0.40	0.69	-0.29	0.77
Destination Accessibility				
Jobs within 45 minutes auto travel time, time-decay (network time travel) weighted	0.35	0.73	1.21	0.23
Working age population within 45 minutes of auto time travel, time decay (network time travel) weighted	-0.09	0.93	1.24	0.21
Jobs within 45 minute transit commute, distance decay weighted	-0.50	0.62	0.99	0.32
Working age population within 45 minutes transit commute, time decay weighted	-0.44	0.66	0.06	0.95
Proportional Accessibility to regional destinations - Auto: Employment Accessibility expressed as a ratio of total MSA accessibility	0.22	0.83	1.45	0.15
Regional Centrality Index - Auto: CBG score relative to max CBSA score	-0.35	0.73	-1.49	0.14

Socio-economic Variables	*Work Trips*		*Shopping Trips*	
	t-statistic	*p-value*	*t-statistic*	*p-value*
Age	-0.12	0.90	-0.46	0.65
Education	0.10	0.92	**-2.65**	**0.01**
Household Size	**5.44**	**0.00**	**5.78**	**0.00**
Income	1.55	0.12	-0.50	0.62
Household Trips	**-6.79**	**0.00**	**-7.73**	**0.00**
Sex	**2.18**	**0.03**	-0.35	0.72
Demographics				
Households (occupied housing units), 2010	1.02	0.31	-0.13	0.89
Population, 2010	-0.84	0.40	0.22	0.82

Work Trips

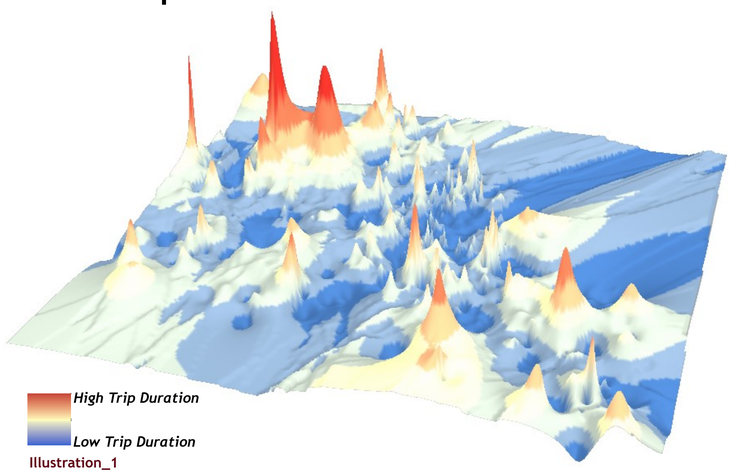


Illustration_1

Shopping Trips

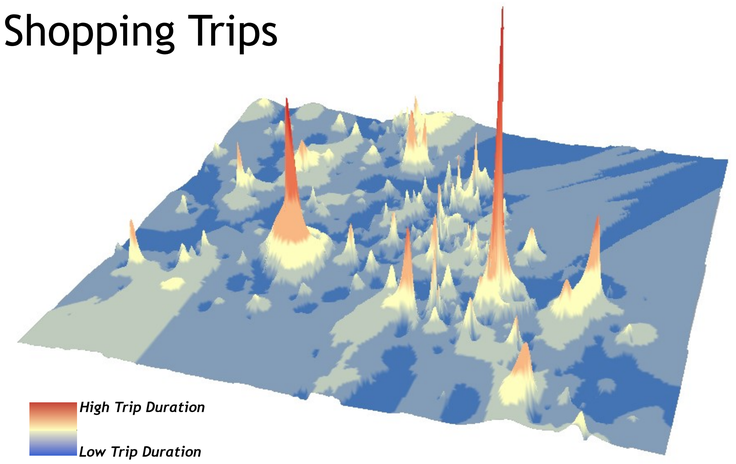


Illustration_2

Conclusions

Interpolating work trip durations for the Boston Metropolitan region show that below median income households from the suburban areas in the north west spend the highest time on their work trips. For shopping trips for the same subset of people, it is seen that the households that are located south of Boston, around Ashmont, Dorchester, Milton, spend the highest on shopping trip times, as compared to households from other regions in the area. (Illustration_1&2)

Regression Analysis was conducted in GeoDa, for all variables considered, the results show that out of the socio economic variables, for work trips, household size and the number of household trips are observed to be significant. Similarly, for shopping trips, the socio-economic variables that are seen to be significant are Education, Household Size and Household Trips.

From the smart location database variables which measure the characteristics of the built environment, for work trips, jobs per household and the variable of regional diversity based on population and total employment were seen as significant. Areas where high regional diversity is observed in terms of jobs and total employment (Map_2),are areas where people spend less time in getting to work. Map_2 illustrates the regional diversity, and trip duration illustrates households which spend more time/less time on work trips (Illustration_1). Another significant variable of measure, is the number of jobs per household, being the ones with high trip duration(Map_1).

For shopping trips, it can be seen that employment and household entropy, and total road network density are the variables that are significant(Map_3 & Map_4).

Discussion

Total Population and Total Employment by CBG being a variable that is a proxy of regional diversity, which means higher densities in mixed used setting, with good regional accessibility, is associated with less time spent on work trips. This holds true for the way below median households travel.

For this subset of below median income population, relatively weak relationships are seen for the many variables of the density and design metrics, like gross residential density, population density, network density and street intersection density, which have shown high significance in previous studies. These are not significant to the trips of work by below median income households living in the Boston Metropolitan Area.

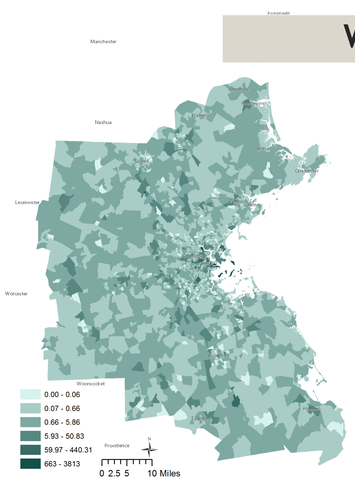
Conventional wisdom holds that high road network density, leads to less time spent on trips. This doesn't hold true for the case of Greater Boston Area. Below median income households, residing in areas with medium road network density that spend relatively high time in the region on shopping trips.

Data Sources: Massachusetts Travel Survey, 2010, MassDOT
Smart Location Database, 2013, US EPA

Cartographer: Divya S. Gandhi
Advanced GIS UEP - 0294, Fall 2017

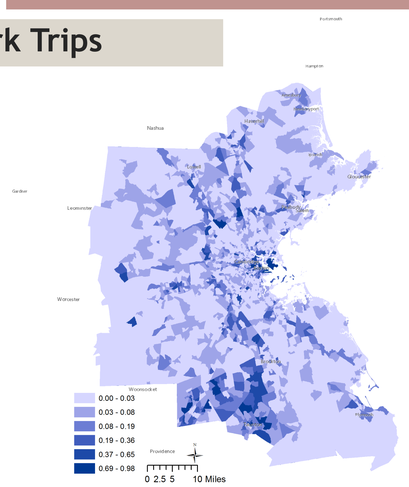
Explanatory Spatial Variables

Work Trips



Map_1

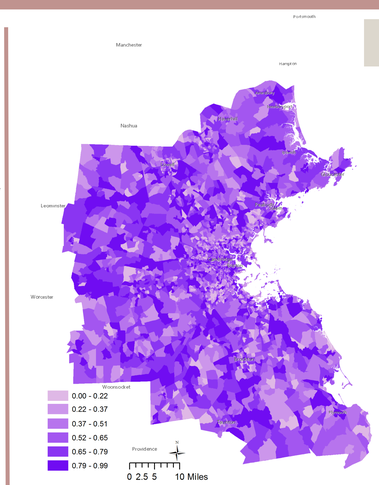
Total employment/Jobs per Household



Map_2

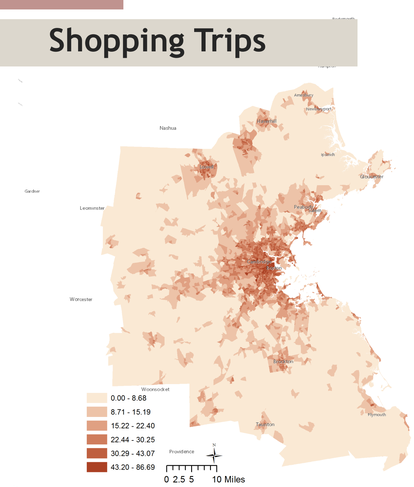
Regional Diversity—Population and Total Employment

Shopping Trips



Map_3

Employment and Household Entropy



Map_4

Total Road Network Density