FROM OWNERSHIP TO SHARED USE

THE SPATIAL PATTERMS OF zipcar IN BOSTON AREA

INTRODUCTION

Urbanization along with issues in scarce resources, shortage of space, increasing energy cost and pollution require people to rethink personal vehicle ownership. Carsharing, a sustainable concept provides temporary automotive access for people seeking ways to use a private car while relieving them the cost of purchase and maintenance. Previous research has confirmed the way carsharing transforms the expenses on vehicle ownership into payments directly linked to trip distance and duration, which has filled in the gap of limited carrying capacity and inflexibility in other transit modes.

This paper pursues a predictive exploration of Zipcar, the largest North American carsharing operator with 1 million members across 500 cities in 9 countries. A multiple regression was undertaken to quantify the spatial relationship between the Zipcar users, and their demographics and neighborhood characteristics. The primary focus is to identify whether Zipcar is determined by the local community, and thereby confirm that carsharing impacts energy use, carbon emissions, and vehicle ownership, and it could be used to provide more affordable and equitable mobility options and result in a cleaner transportation system.

METHODOLOGY

A Hot Spot Analysis and tools measuring geographic distributions were conducted to identify the study area— Zipcar membership hot spots with 99% confidence level as well as within three standard distance (including 99% members) MAP1.

To predict the impacts of Zipcar required the indicators of pertinent variables and the calculation of their respective value. The following twenty-eight variables were identified as potentially significant to Zipcar membership. A spatial ordinary least square (OLS) regression model was built to determine the respective correlation of these variables. Then seven variables with probability below 0.1 were extracted to compare the neighborhood clustering with dependent variable using Bivariate Local Moran's I (BiLISA) MAP2-9.

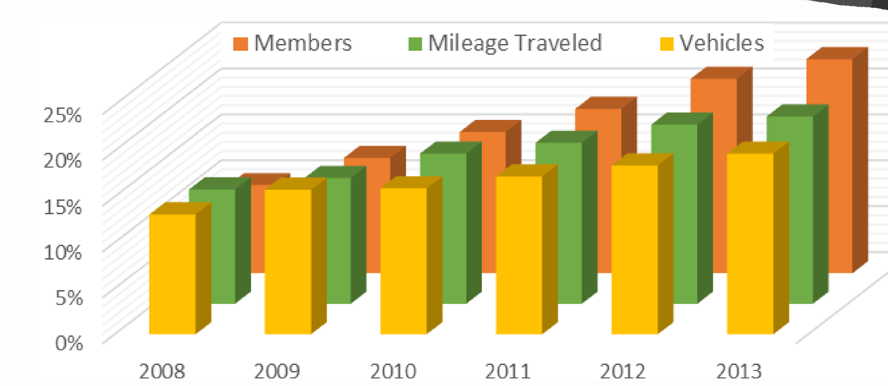
Indicator	Variable	Coefficient	Std. Error	Prob.
Dependent Variable (Y)				
Zipcar	% membership in 2013 MAP2			
Independent Variables				
Vehicle Ownership	% no vehicle households	-0.0085	0.0049	0.0861
	% 1 vehicle households	0.0034	0.0045	0.4470
	% 2 or more vehicles households MAP3	-0.0086	0.0036	0.0173
Commute Mode to Work	% drive alone	0.0761	0.0656	0.2456
	% carpooling	0.0743	0.0658	0.2588
	% public transit	0.0762	0.0655	0.2452
	% walk	0.0786	0.0655	0.2305
	% bike	0.1089	0.0655	0.0961
	% other (taxicab, motorcycle, etc.)	0.0797	0.0657	0.2252
	% work at home	0.0772	0.0655	0.2384
Income	% workers earning less $1250/mon	0.0001	0.0003	0.6455
	% workers earing $1250 to $3333/mon	0.0002	0.0004	0.6990
	% workers earning above $3333/mon MAP4	0.0006	0.0002	0.0128
Employment	% retail jobs	-8.3707e	5.5923e	0.1344
	% office jobs MAP5	-4.9566e	1.3346e	0.0002
	% industrial jobs	3.3146e	2.5431e	0.1888
	% service jobs	3.3465e	1.6837e	0.0425
	% environmental jobs	1.0435e	3.956e	0.0083
Density	Gross employment density MAP6	6.4982e	2.2500e	0.0039
Diversity	Employment and household entropy	-0.0050	0.0067	0.2848
	Regional diversity (jobs/pop) MAP7	-0.0300	0.0172	0.0814
Design	Auto network density	-0.0002	0.0002	0.3815
	Multi network density	0.0003	0.0002	0.0927
	Pedestrian network density MAP8	0.0002	0.0001	0.0194
Transit	% employment within 1/4 mile of transit stop	0.0025	0.0021	0.2347
	% employment within 1/2 mile of transit stop	-6.2215e	0.0017	0.3713
Destination Accessibility	% auto-accessibility regional destinations	2.424e	7.4657e	0.7454
	% transit-accessible regional destinations MAP9	-6.2218e	2.9733e	0.0364

RESULTS

The Zipcar memberships and its vehicles have grown steadily in MA during the six years from 2008 to 2013. The mean center and standard distance could help measure the degree to which Zipcar memberships are concentrated, as well as confirmed the result of Hot Spot Analysis, which provided only hot spots and thereby identified the study in Boston area.

The result of spatial error model explains more than 89% of the variance in Zipcar memberships. With spatial error violate the assumption that error terms are uncorrelated and coefficients are inefficient. Half of estimated coefficients are significant at $p < 0.1$. The model indicates greater number of Zipcar members have a significant positive effect on working population with high-wage, or those biking to work, having jobs in service and environmental fields, and areas with employment density, or at least pedestrian-network density.

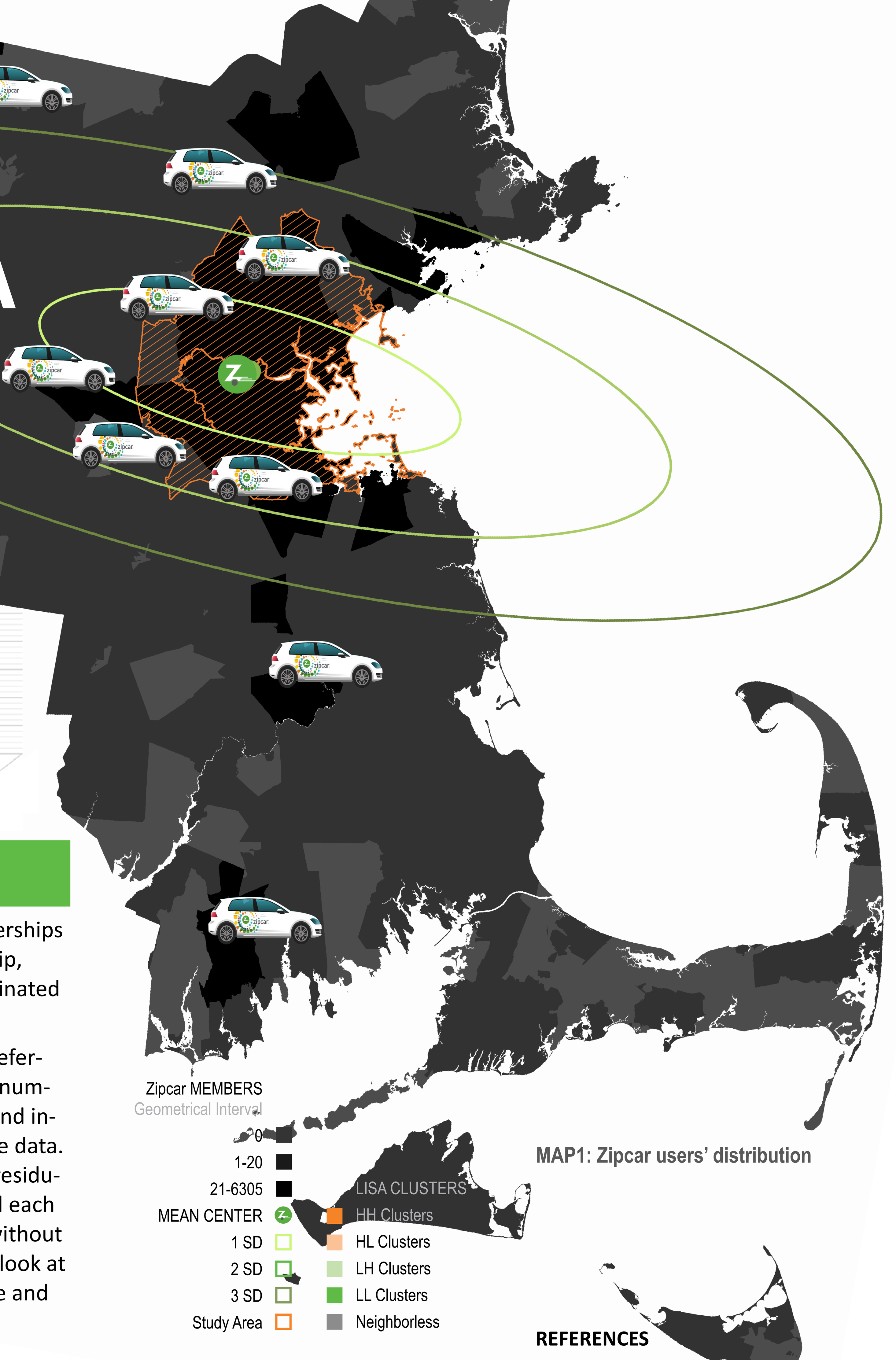
The BiLSA cluster maps show locations with significant local spatial autocorrelation by type of association. The results point to some potential effects of Zipcar on demographics and the existing transit network to work. Moreover, these suggest interesting locations that Zipcar users mostly cluster in densely employment area like Cambridge and Back Bay.



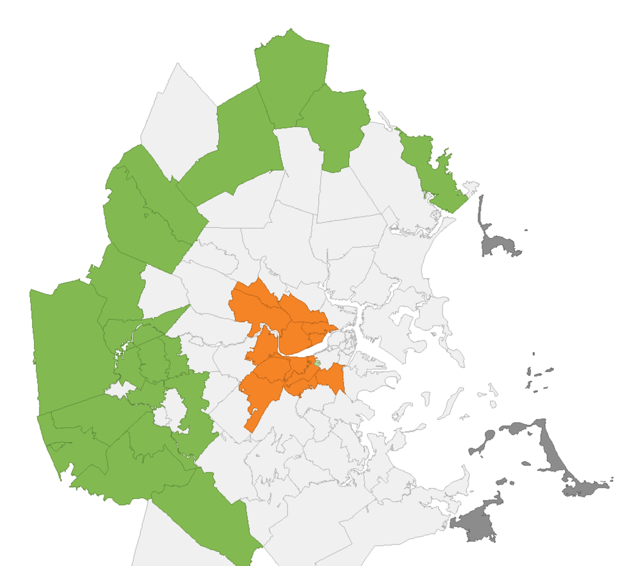
CONCLUSION

Overall, the regression indicated that Zipcar memberships has a positive, significant effect on vehicle ownership, holding everything else constant. This effect is dominated by measures at the zip-coded neighborhood level.

The regression model provides a general frame of reference for understanding the effect of the increasing number of Zipcar memberships, but it could be biased and inconsistent estimates due to the spatial nature of the data. Future analysis should be to examine whether the residuals are homoscedastic and normally distributed and each indicator is linearly related to dependent variable without multicollinearity. In addition, it is also important to look at other variables such as places with parking pressure and mixed use land.

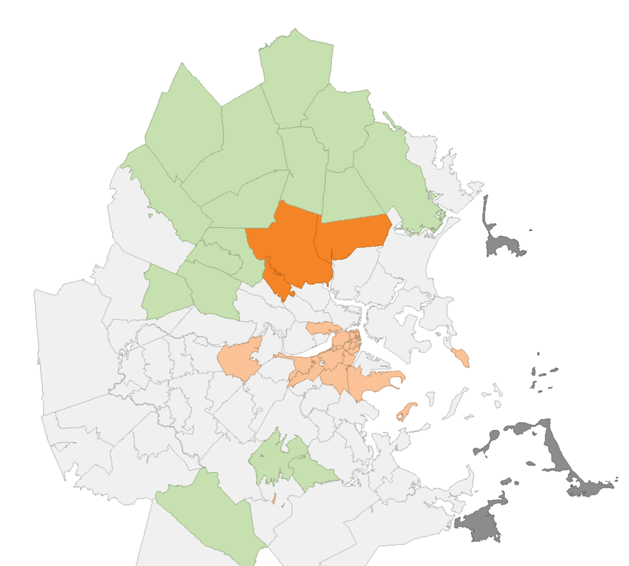


MAP1: Zipcar users' distribution



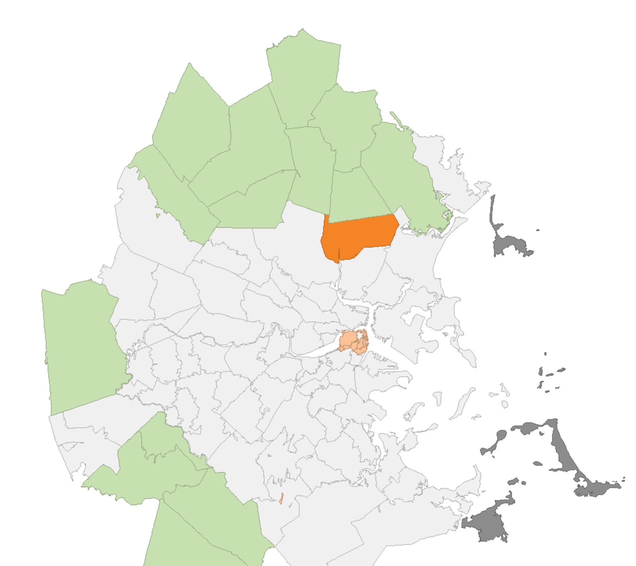
MAP2: Zipcar membership Clusters

HH clusters are located in Cambridge and Back Bay area; LL clusters are around the peripheral area



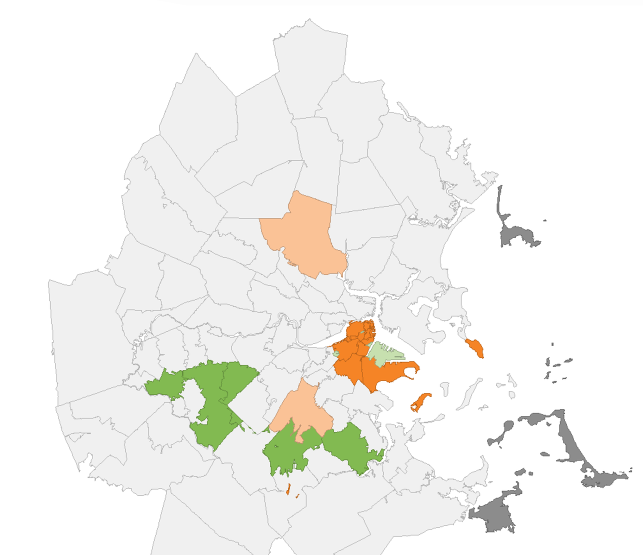
MAP3: BiLISA Cluster of Y and households with 2 or more vehicles

HH clusters of Zipcar users and car owners are overlaid in Medford and Malden



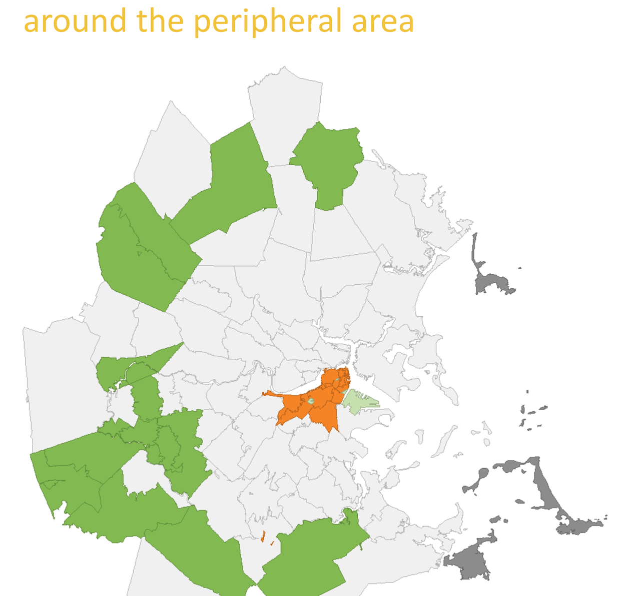
MAP4: BiLISA Cluster of Y and high-wage workers

The HH clusters are located in Malden, a comparably new developing area



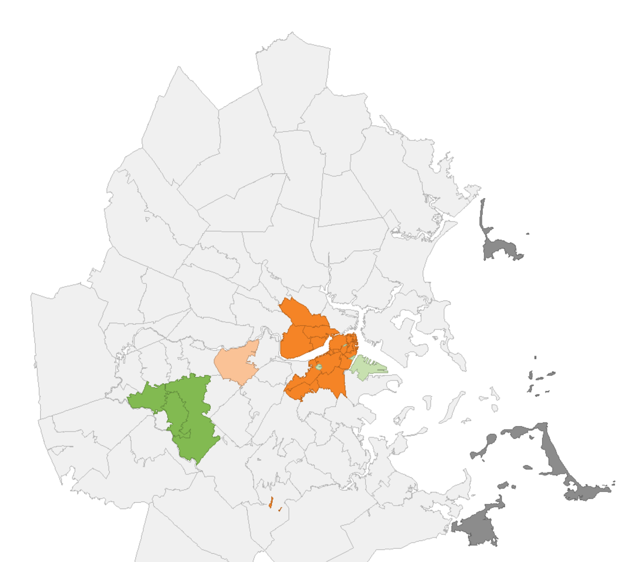
MAP5: BiLISA Cluster of Y and office jobs

HH clusters are overlaid in downtown Boston, while LL clusters are spread around Newton



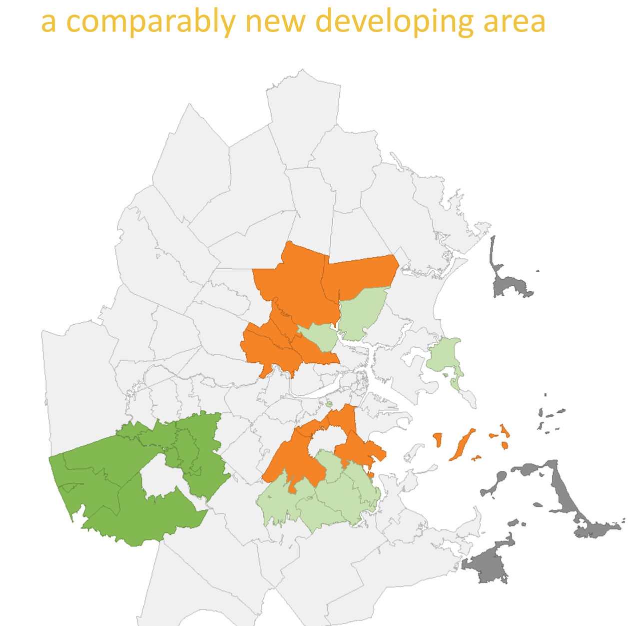
MAP6: BiLISA Cluster of Y and employment density

The clusters of employment density and Y are highly correlated



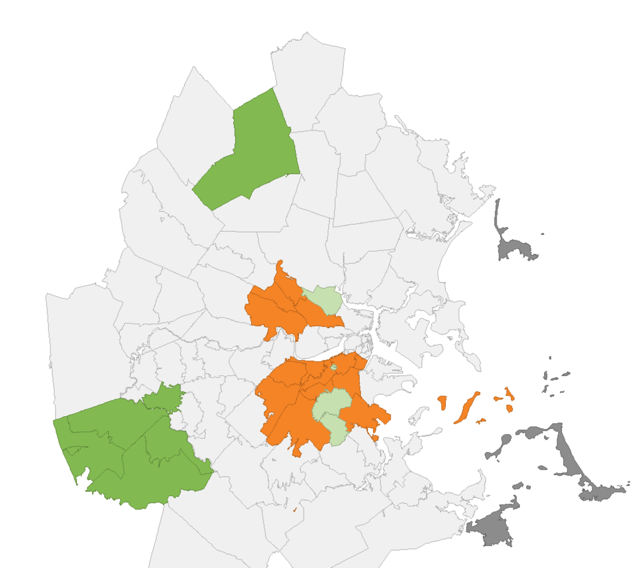
MAP7: BiLISA Cluster of Y and regional diversity (jobs/pop)

HH clusters are around the lower reaches of Charles river



MAP8: BiLISA Cluster of Y and pedestrian network density

It is interesting the HH pedestrian network clusters are not in downtown area



MAP9: BiLISA Cluster of Y and transit-accessibility regional destinations

Transit-accessible destinations are those area with bus and MBTA stops

REFERENCES

1. Duncan Michael. 2011. "The cost saving potential of carsharing in a US context." Transportation, Vol.39-2 pp.363-382.
2. Jennifer L. Kent & Robyn Dowling. 2013. "Puncturing Automobility? Carsharing Practices." Journal of Transport Geography, Vol.32, pp.86-92.
3. Kevin Ramsey and Alexander Bell. 2014. "Smart Location Database Version 2.0 User Guide." Provided by U.S Environmental Protection Agency (EPA) Smart Growth Program.
4. Tai Stillwater, Patricia L. Mokhtarian, and Susan A. Shaheen. 2008. "Carsharing and the Built Environment: A GIS-Based Study of One U.S. Operator." Institute of Transportation Studies, University of California Davis

DATA SORCES

MassGIS, ACS, EPA, MAPC Data Browser

PROJECTION

NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001

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