

LEEDing the Way:

Diffusion of LEED housing in Massachusetts

LIORA SILKES

Introduction to GIS, Spring 2019



BACKGROUND

Green buildings, such as those certified through the Leadership in Energy and Environmental Design (LEED) program, provide broad environmental benefits through their lowered use of natural resources and provide personal benefits to their occupants such as better air quality and lowered utility bills. Promoting green building practices — especially in the housing sector — therefore is a matter of equity, in an effort to create a healthy, sustainable, and cost-efficient built environment for all.

As with most new technologies, adoption of green building practices has followed the Diffusion of Innovation Theory, that new technology is first adopted by those with high monetary and social capital before it is used by the general population. Carswell and Smith (2009) found that LEED housing was significantly more likely to be in census tracts with high property values.

A decade later, in an analysis at the state level, Hopkins (2019) found LEED-certified multifamily buildings to be in zip codes with higher incomes in slightly over half of the studied states. This research suggests the LEED-certified housing sector has grown but has not diffused fully. These results point to the need to understand drivers of LEED diffusion at a local level. Based on this previous research, I am asking:

How has the relationship between LEED housing and income in Massachusetts varied since the program began in 2000?

DATA

LEED registration data are from the USGBC LEED Directory, in table form. All entries in the LEED database that were not confidential, were located in Massachusetts, and included any of the terms Hous*, Residen*, family, or home in the Project Type field. This search produced a total of LEED Housing projects in Massachusetts.

Income data are from the American Community Survey 2017 5-year estimates from Factfinder, in table form. I used column HCO3_EST_VC02 of table S1903, Household Mean Income Estimate, for all analyses.

Political boundary data are vector shapefiles from MassGIS.

METHODS

I began by geocoding Massachusetts LEED housing registrations using Google Maps, and I manually geocoded as necessary. I then converted the Google Maps kml file to a shapefile in ArcMap 10.6.1, creating a layer with 473 entries. I then created the Massachusetts census tract map by joining income data to the tracts using FIPS codes. The census tract layer was then clipped to Boston/Cambridge area and LEED registrations within Boston and Cambridge were selected through a spatial query.

Next, spatial joins were used to associate each LEED-registered project with the median income of the census tract it is in and to calculate the total number of LEED housing registrations per census block. I then ran regressions on the relationship between income and

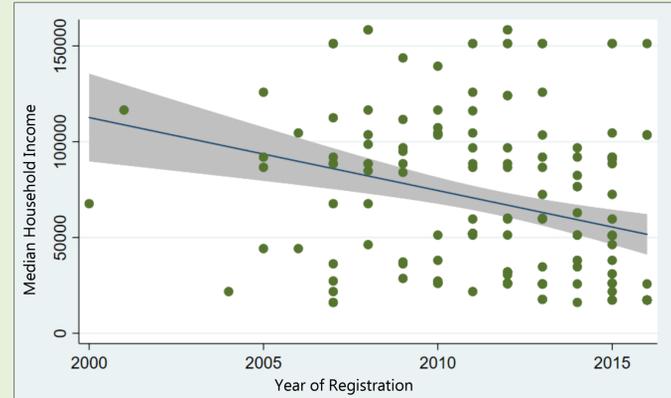


Figure 3: Regression of LEED Registrations by Year of Registration and Median Household Income, Boston and Cambridge. Over the years, LEED housing has become increasingly prevalent and located in census tracts with a range of median incomes.

BOSTON AND CAMBRIDGE

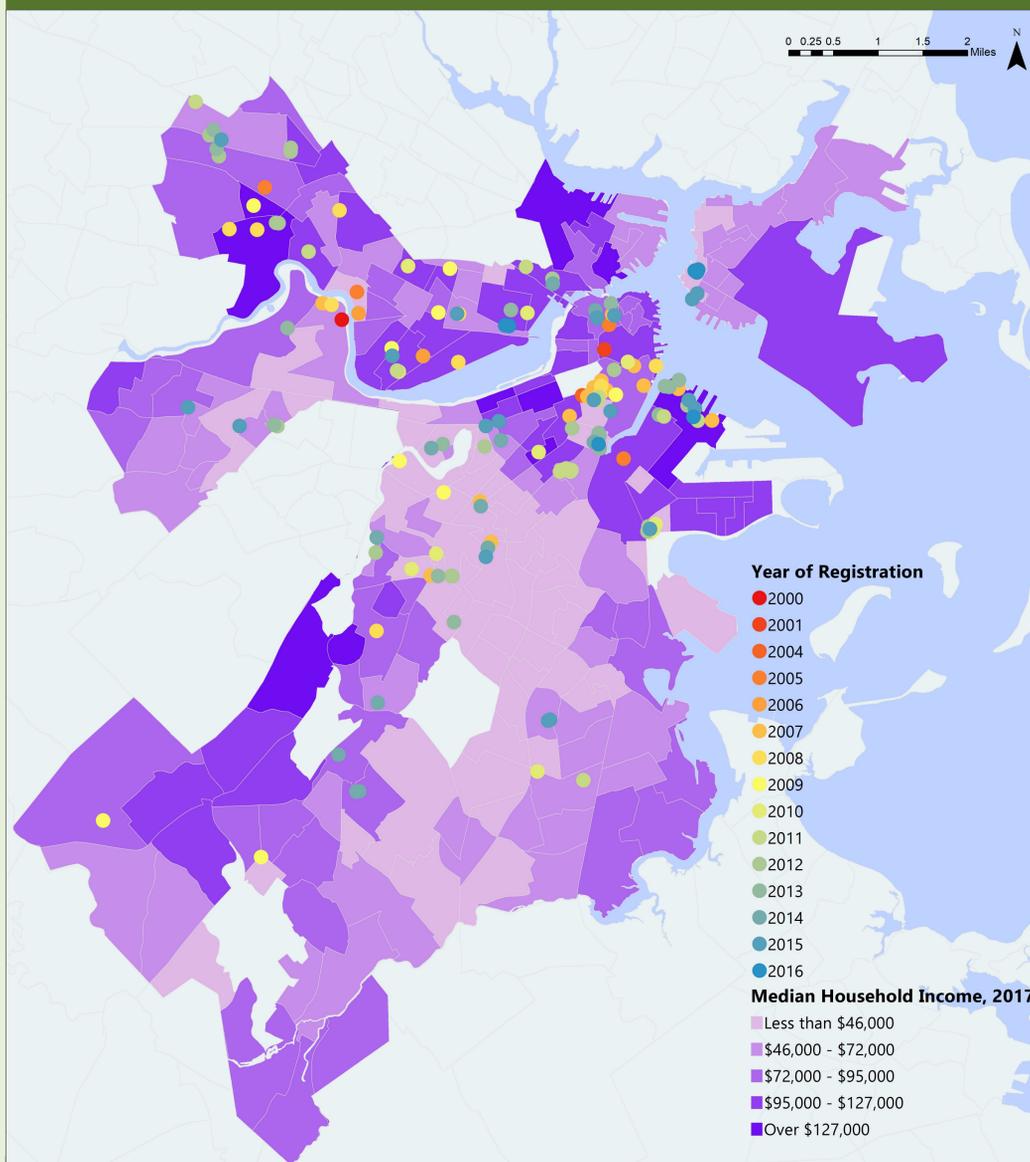


Figure 2: LEED Registrations by Year of Registration and Median Household Income, Boston and Cambridge. These two cities were chosen for in-depth analysis because both city governments enacted sustainable building codes based on LEED standards in the late 2000s.

DISCUSSION

In the last 20 years, LEED certification has gone from a niche benefit of a few buildings in wealthy areas to a common feature of housing that is no longer associated with income, as suggested by the fact that the regression of income and housing count was not significant. The innovation of green building is therefore diffusing as others have theorized.

These findings expand on previous research that has found mixed support for the continued link between income and LEED housing (Hopkins 2019). Hopkins concluded by suggesting future research explore housing trends on more local levels and in context, which this study does. The focus on Boston and Cambridge is notable because both cities established new construction standards based on LEED standards, in 2007 and 2010, respectively (Burke 2010; Cambridge Development Department n.d.).

These findings point to the power of such standards to increase diffusion of green building technology and to ensure its benefits are available to renters and homeowners of all income levels. Policy makers hoping to enact similar policies in their municipality can look to this analysis as an example of how such standards are adopted over time, and further research should explore how diffusion rates have varied in other cities with similar policies.

RESULTS

As shown in Figure 1, LEED housing registrations are clustered in urban areas across the state of Massachusetts. There are limited relationships to income on a state level, but there seems to be a collection of LEED housing in the wealthier census tracts northwest of Boston. The prevalence of green and blue in the LEED housing layer shows that most registrations have occurred in the last few years.

Figure 2 zooms in on Boston and Cambridge and shows that, although many of the first LEED housing registrations were projects located in wealthier census tracts, LEED housing is now increasingly distributed across income groups throughout the two cities. This is shown mathematically in Figure 3 as the two variables have a significant ($p < .001$) but weak ($R^2 = .08$, $\beta = -.29$) negative relationship. At the state level, the relationship remains significant. The relationship between income and housing count is insignificant ($p > .05$) at both the state and local level.

REFERENCES

- Burke, P.M., Nelson, G., & Rickerson, W. (2007). Boston's green affordable housing program: challenges and opportunities. *Legislation and public policy*, 11 32.
- Cambridge Development Department. (n.d.). Sustainable Building Requirements—CDD—City of Cambridge, Massachusetts. Retrieved March 31, 2019, from <https://www.cambridgema.gov/CDD/zoinganddevelopment/sustainableblids>
- Hopkins, E. (2019). Are multi-family LEED-certified buildings biased towards high income areas? An analysis based on theory of innovation diffusion. *International Journal of Technology Management and Sustainable Development*, In Press.
- MassGIS. *CENSUSTRACKS_POLY*. Boston, MA: Bureau of Geographic Information, 2012.
- MassGIS. *NEWENGLAND_POLY*. Boston, MA: Bureau of Geographic Information, 2007.
- U.S. Census Bureau. (2017). *Median Income in the Past 12 months, 2013-2017 American Community Survey 5-Year Estimates*. Retrieved from factfinder.census.gov/.
- USGBC. *LEED Directory*. Downloaded from [usgbc.org](https://www.usgbc.org/) on April 22, 2019.
- Data Projection: Lambert Conformal Conic (NAD1983 State Plane Massachusetts)

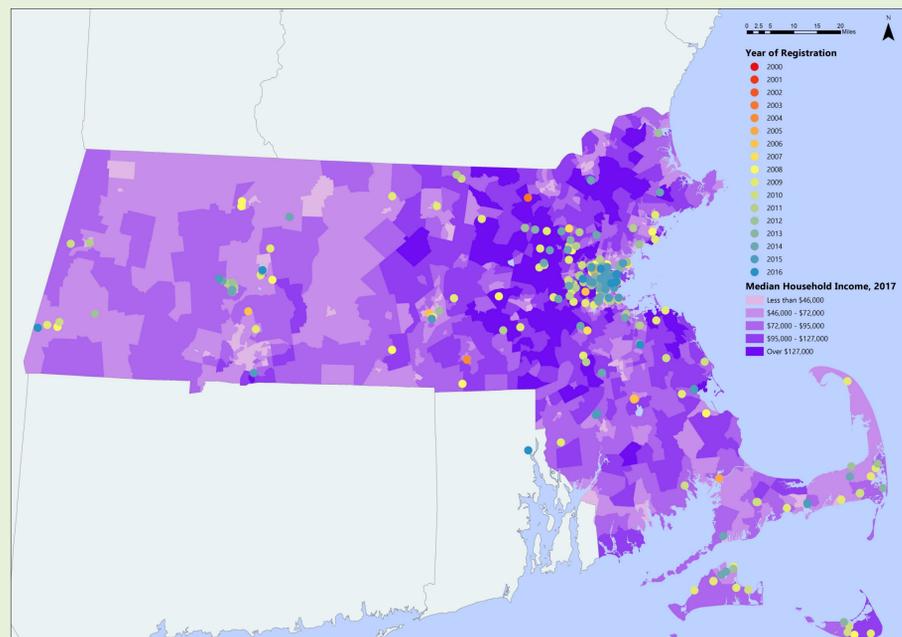


Figure 1: LEED Registrations by Year of Registration and Median Household Income, Massachusetts. At the state level, the most telling feature is that LEED housing is centered on urban areas.