# An exploration of the inter- and intra-regional relationships between the built environment and walking

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# Measuring walkability

Long history of trying to understand the relationship between the built environment travel behavior

One common approach has been the calculation of elasticities of the demand for travel and the built environment. Stevens (2017): *"Yes, compact development does make people drive less,…, but not much less*"

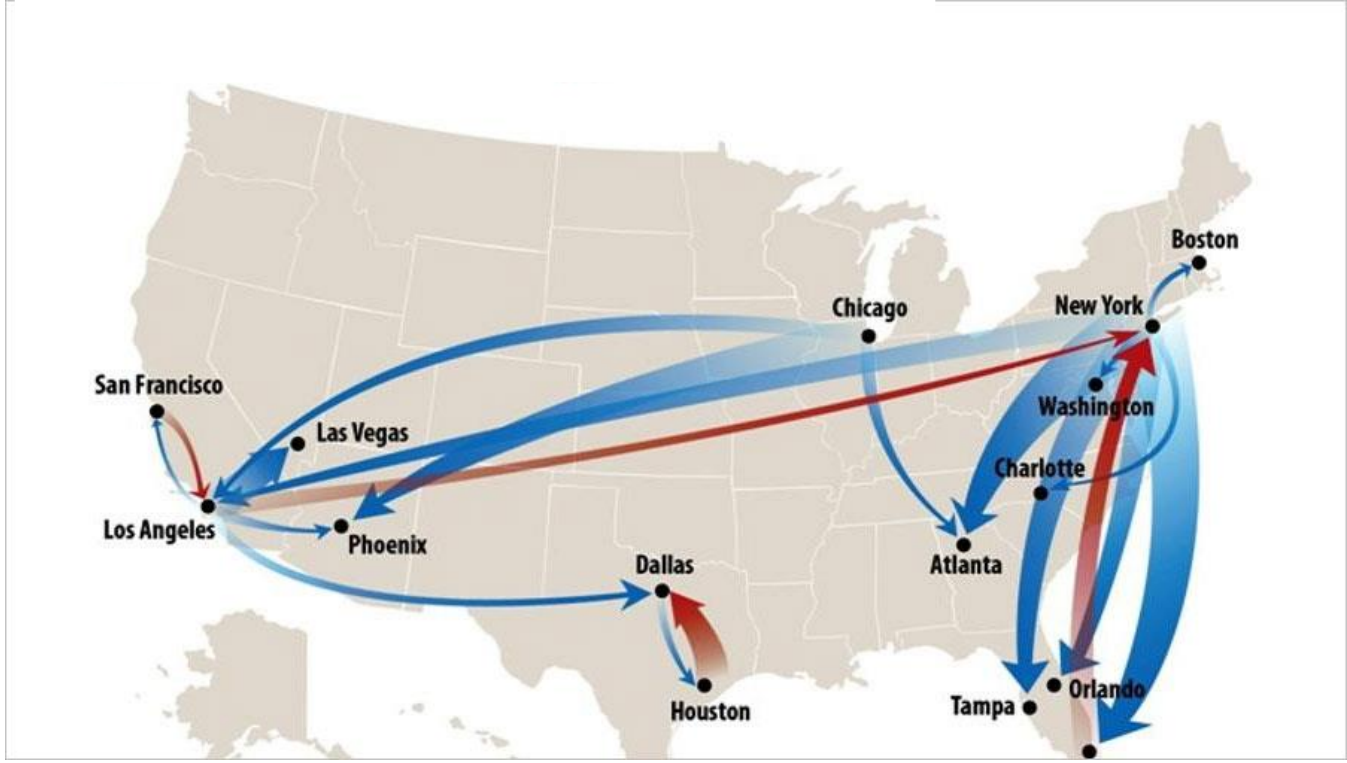
With respect to the pedestrian environment there are many walkability indicators.

Common variables are measures of land use mix, activity density, transit accessibility and connectivity. They use data at a fine-grained scale to provide very localized measures at trip ends, around residential locations, or along routes.

# Transferability

These measures have been used in predictive models to understand the relationship between walking and the built environment

Usually these models are estimated on data from only one region




http://www.ruthvens.com/lakeland-right-1-7-cities-americans-moving/

Controlling for socio-demographics, how transferrable are these findings from one region to the next? Within the same region?

We want to investigate how the variations in urban spatial structure of different cities may impact travel response to walkability?

*How transferable are these measures between regions?*

# Research Approach

We collected different household travel surveys: Seattle, Portland, Los Angeles, San Francisco, and New York City. Data are standardized to have equivalent units, scales, and comparable sets.

The unit of analysis is the Census Block Group, with the exception of New York that we used Census Tracts.

We matched all the trips origins with built environment data from the Census, Employment Survey and OpenStreetMaps

Using a pooled data set, we estimate a binary logit:

$$P(walk\ or\ not\ walk) = \frac{\exp(u)}{\exp(u) + 1}$$

$$u = f(person\ attributes, built\ environment\ attributes)$$

Person attributes (categorical): age, gender, and household income

Built environment attributes (block group level): Population density, employment density, intersection density and avg number street segments per node.

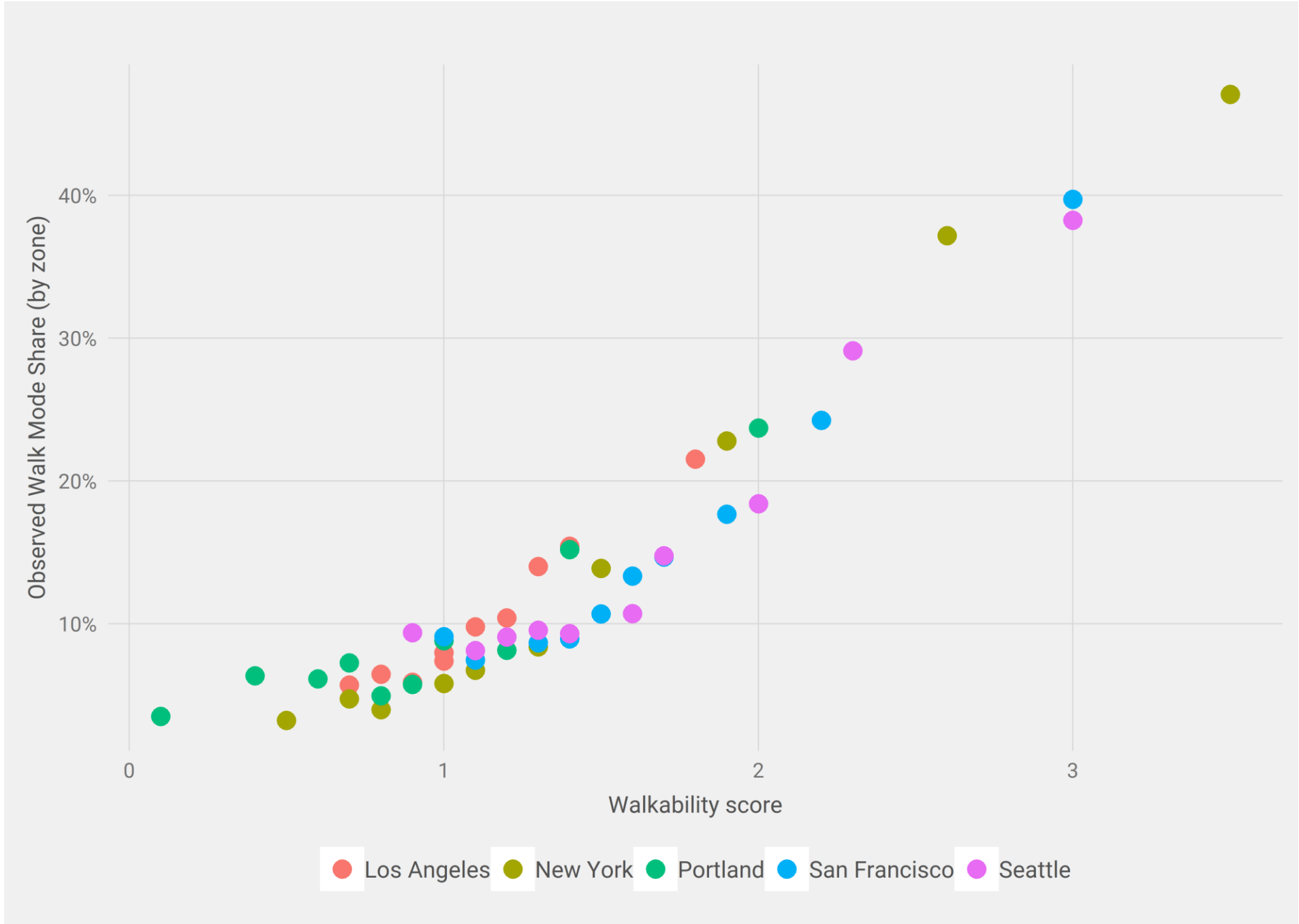
Interaction terms: city and the built environment attributes

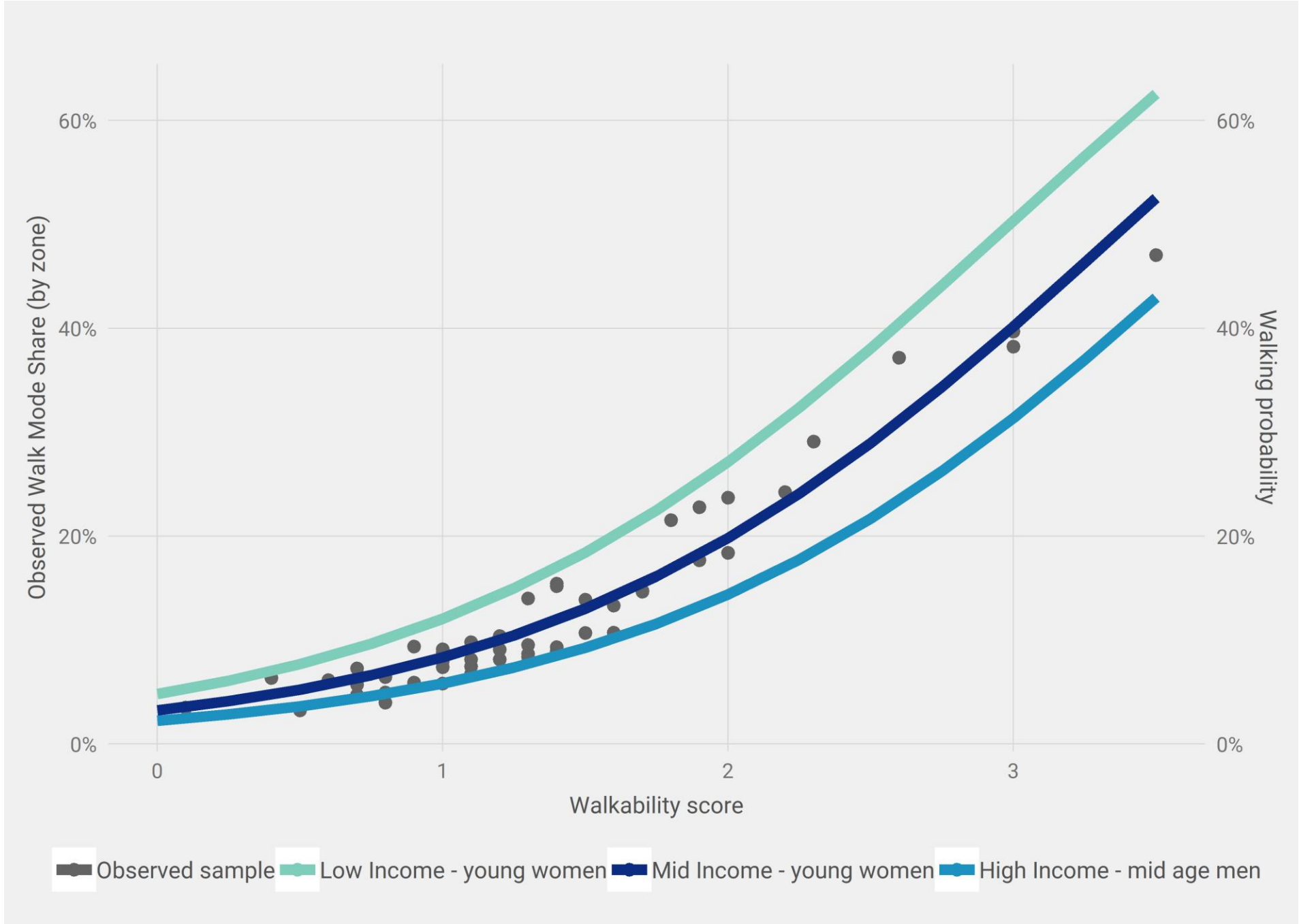
We used weights to expand to the population

The portion of the utility function that deals with the built environment is a measure of walkability

# Pooled data set statistics

| | Los Angeles | New York | Portland | San Francisco | Seattle |
|---|---|---|---|---|---|
| Sample | 66,016 | 125,528 | 51,125 | 39,648 | 44,464 |
| Total Trips | 29M | 67M | 7M | 11M | 12M |
| Walk Share [%] | 11% | 18% | 9% | 16% | 13% |
| Zones | 8212 | 5162 | 1421 | 2891 | 2480 |
| Population [ppl] | 12.7M | 21.7M | 2.2M | 4.3M | 3.4M |
| Avg. Population by Zone [ppl/zone] | 1558 | 4211 | 1567 | 1496 | 1387 |
| Year of survey | 2010-12 | 2011 | 2011 | 2010-12 | 2014 |

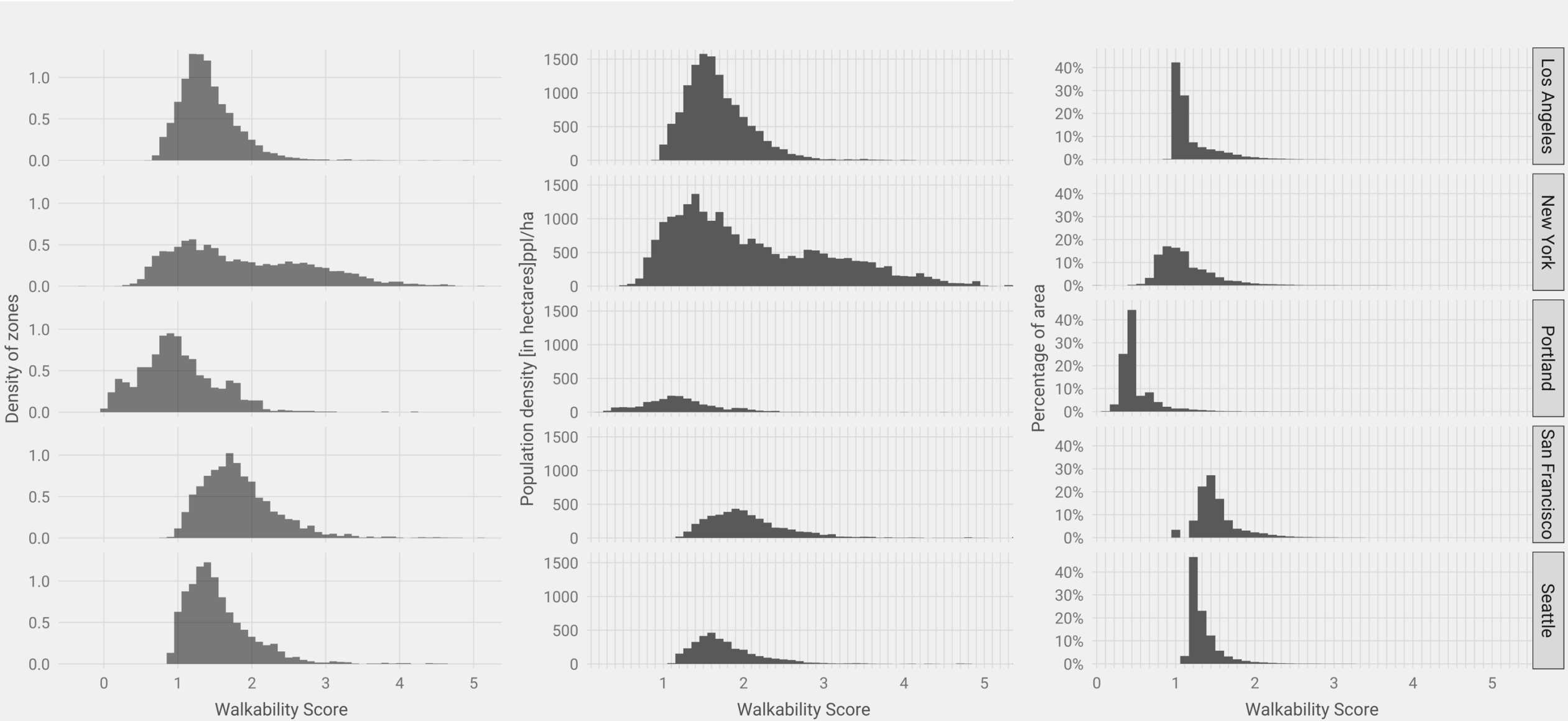

Observed Walk Mode Share (by zone)
40%
30%
20%
10%
0
1
2
3
Walkability score
Los Angeles
New York
Portland
San Francisco
Seattle

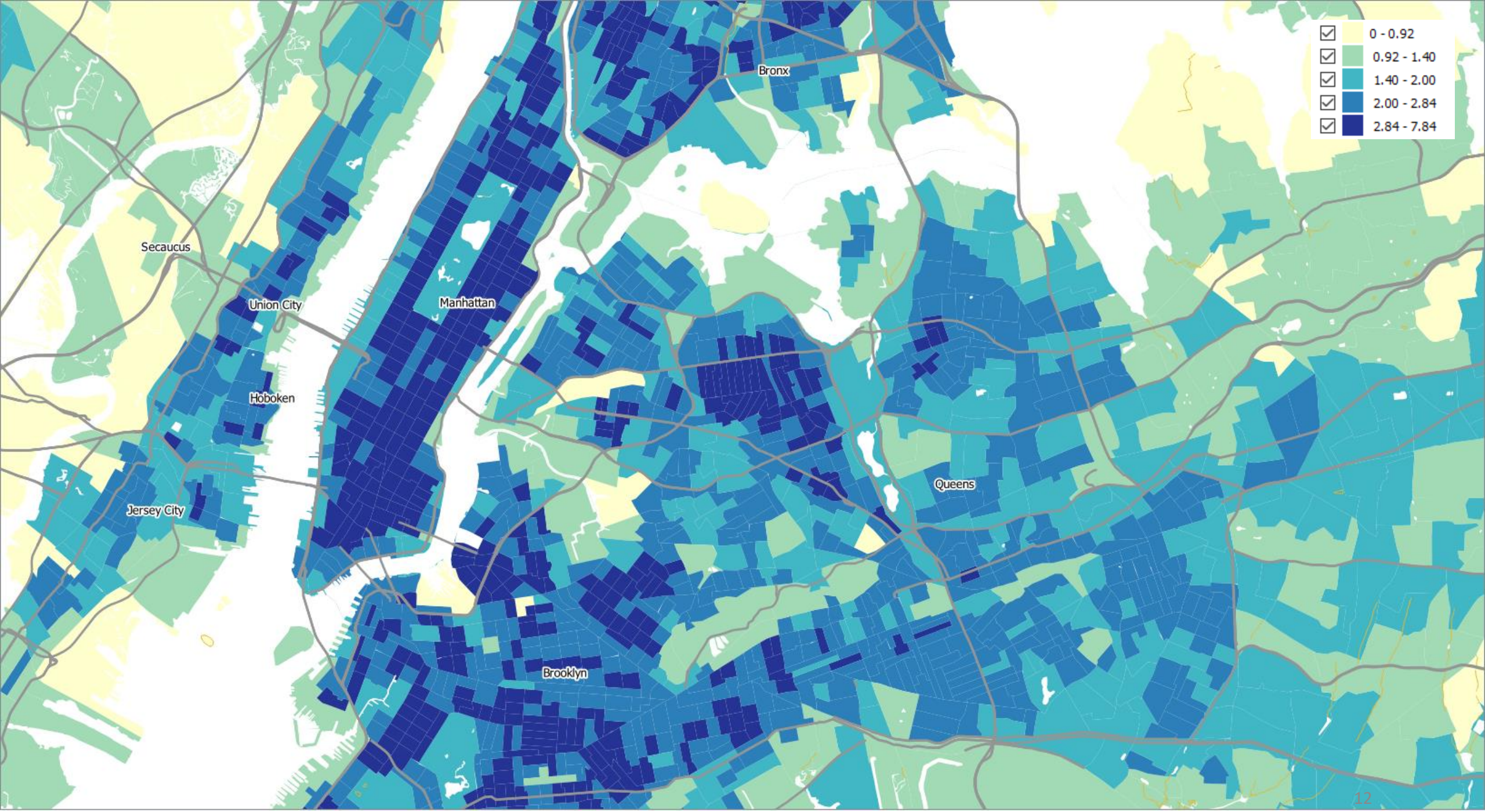

60%
40%
20%
0%
Observed Walk Mode Share (by zone)
Walking probability
0
1
2
3
Walkability score
Observed sample
Low Income - young women
Mid Income - young women
High Income - mid age men

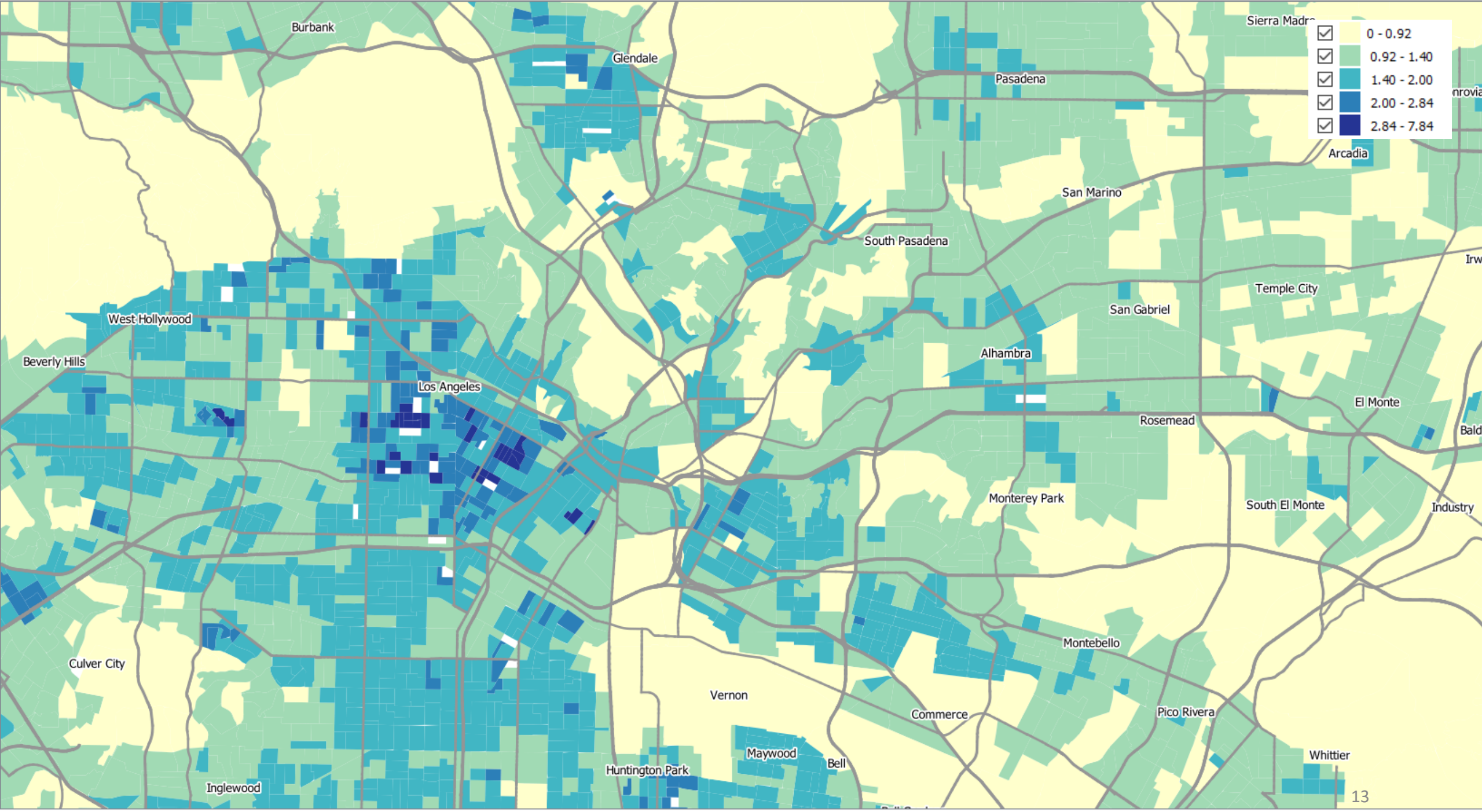
# Transferability and specification of the model

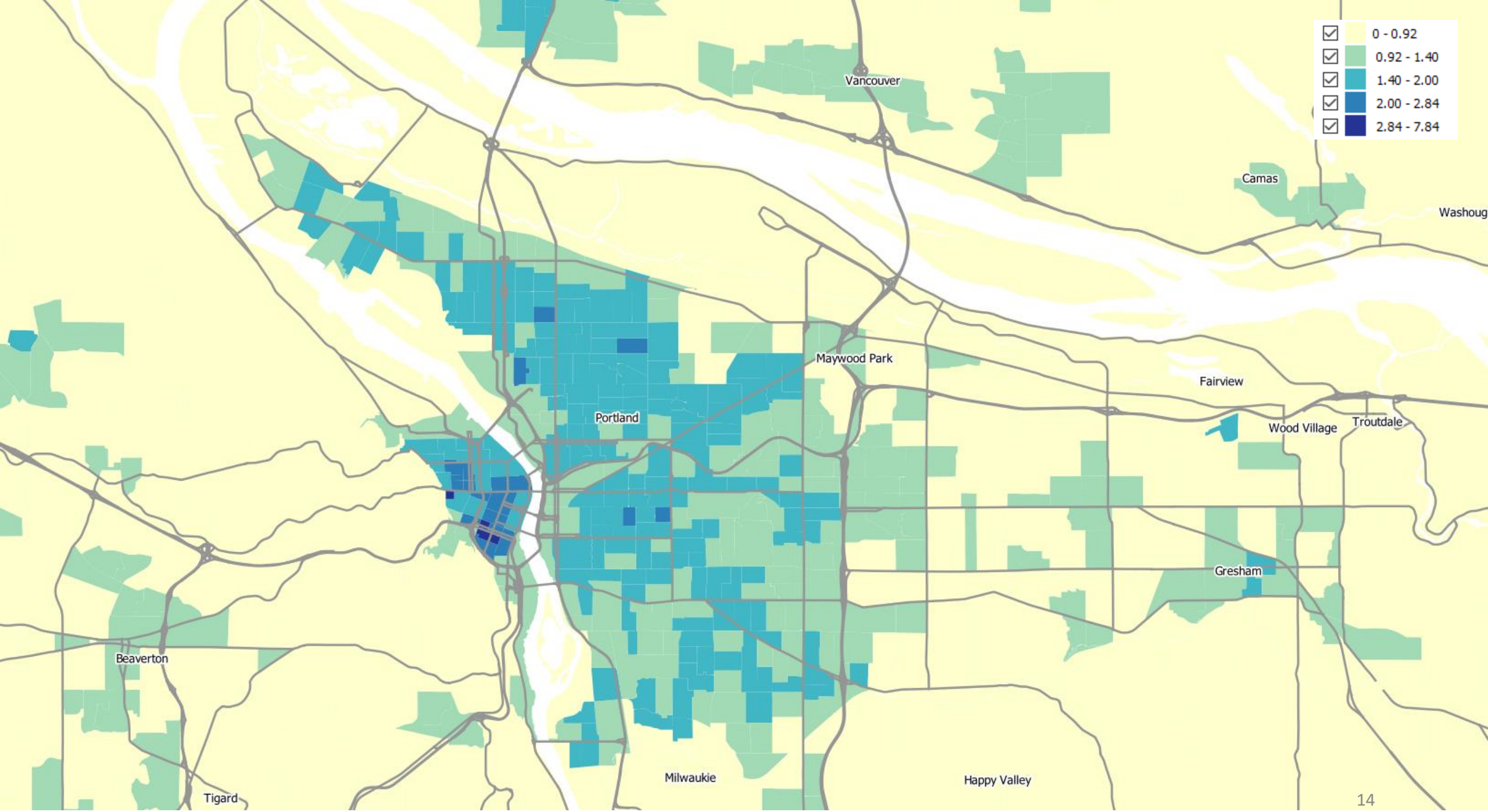
- The relationships are consistent between cities in the US
- The multivariate specification reduce sources of endogeneity in the estimation

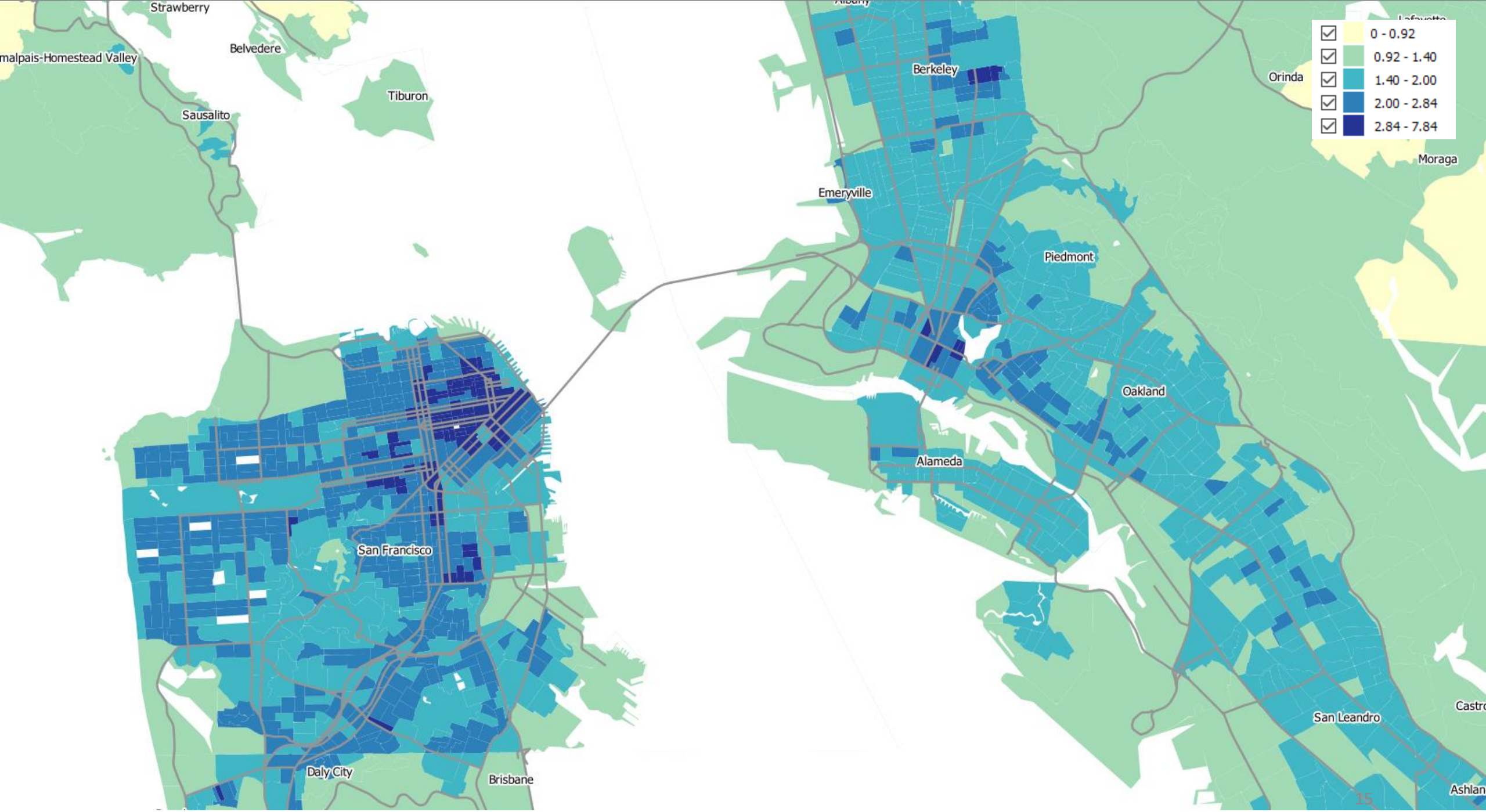
# Distribution of Walkability in the Cities

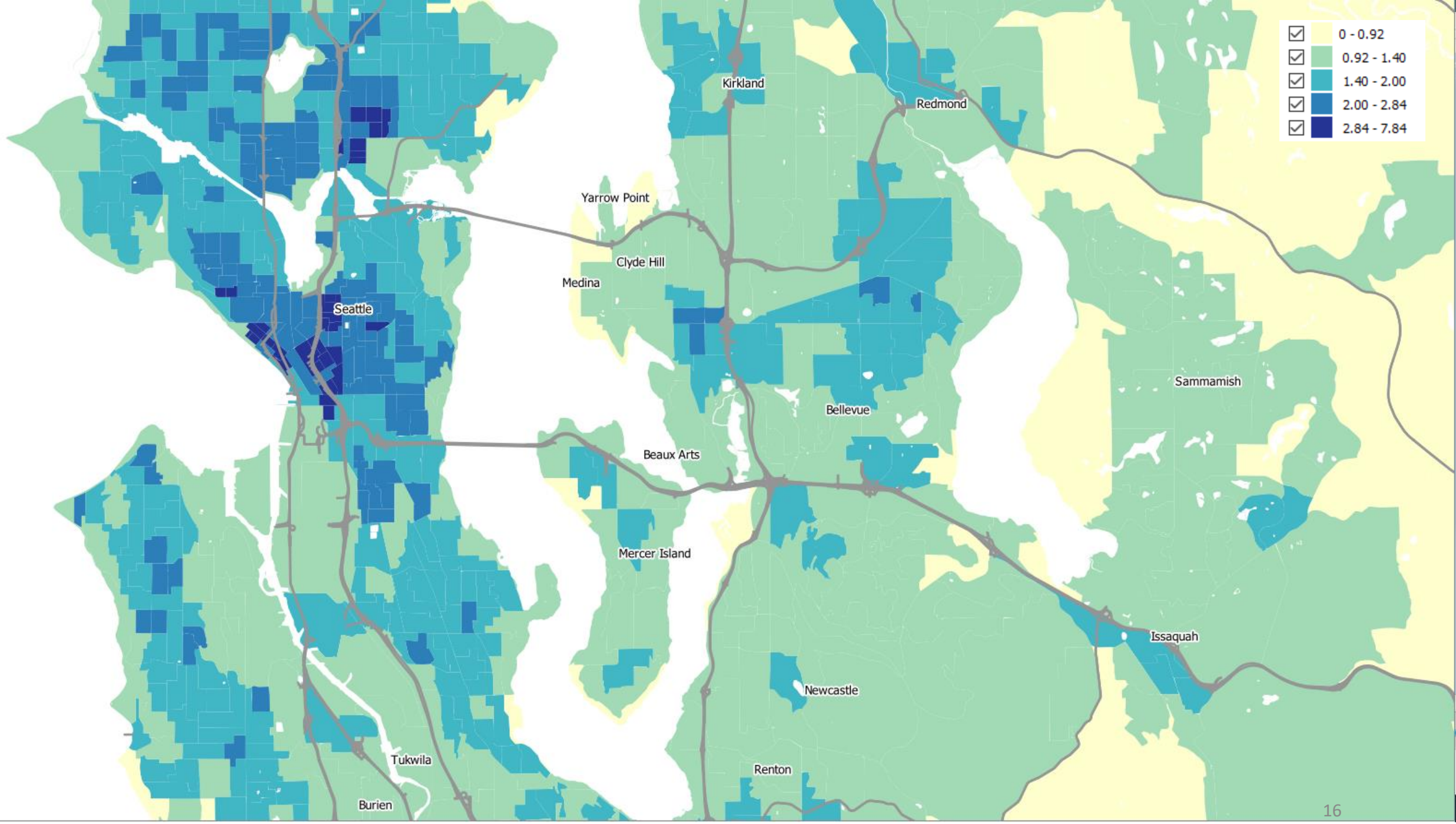


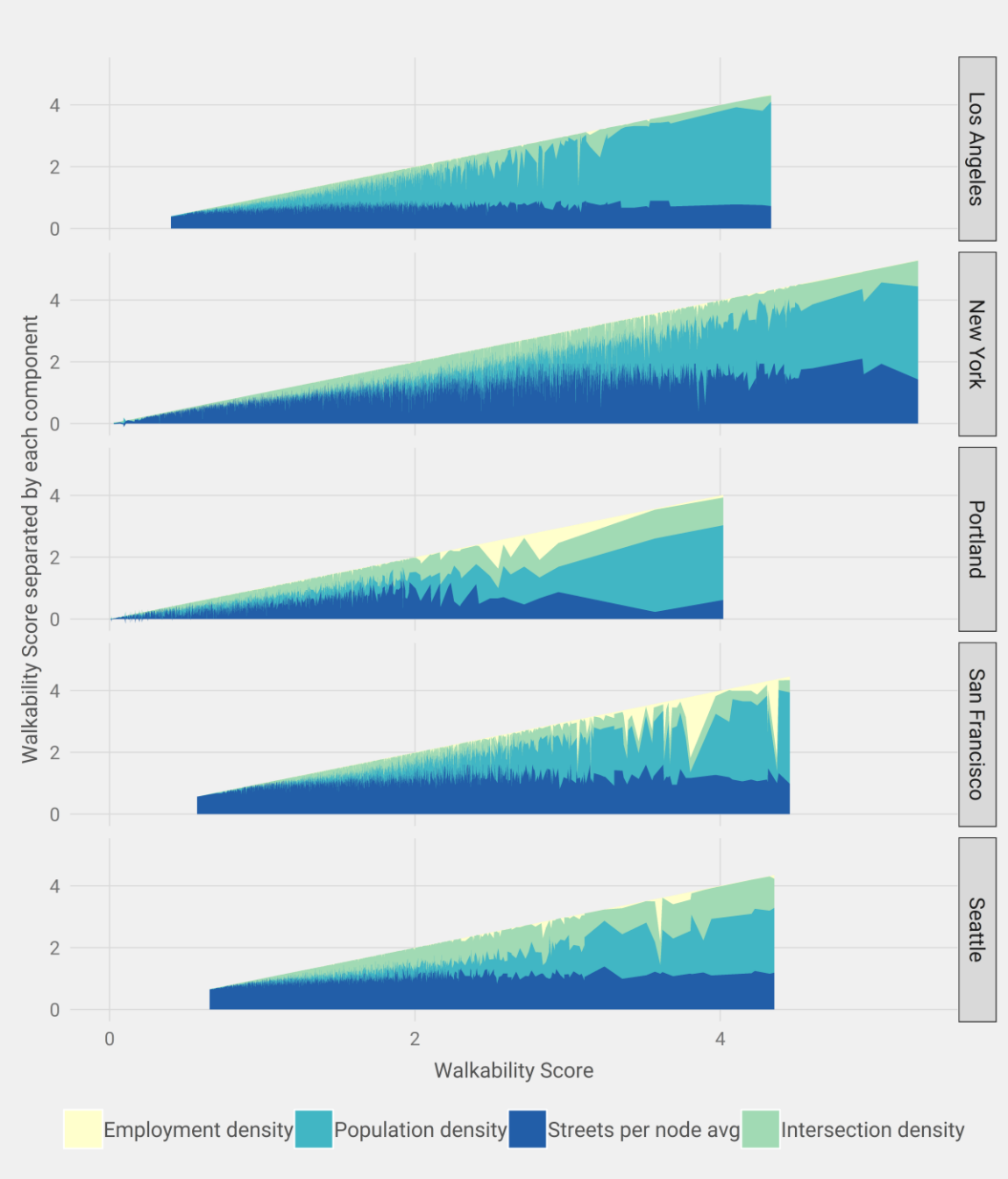

0 - 0.92
0.92 - 1.40
1.40 - 2.00
2.00 - 2.84
2.84 - 7.84
Bronx
Secaucus
Union City
Manhattan
Hoboken
Jersey City
Queens
Brooklyn


0 - 0.92
0.92 - 1.40
1.40 - 2.00
2.00 - 2.84
2.84 - 7.84
Burbank
Glendale
Pasadena
Sierra Madre
Arcadia
San Marino
South Pasadena
Temple City
San Gabriel
Alhambra
West Hollywood
Beverly Hills
Los Angeles
El Monte
Rosemead
Monterey Park
South El Monte
Industry
Montebello
Culver City
Vernon
Commerce
Pico Rivera
Maywood
Bell
Huntington Park
Whittier
Inglewood

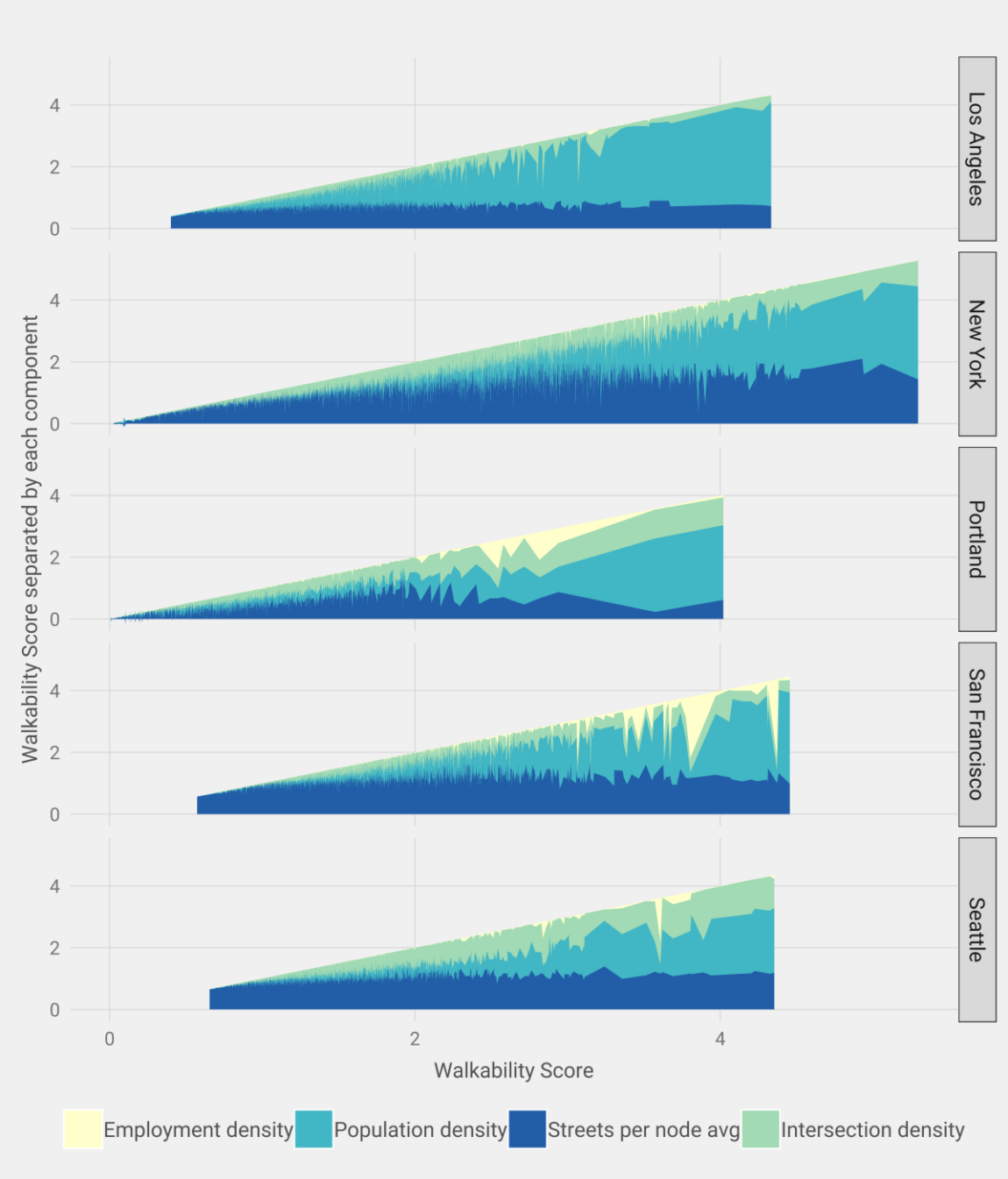

0 - 0.92
0.92 - 1.40
1.40 - 2.00
2.00 - 2.84
2.84 - 7.84
Vancouver
Camas
Washoug
Maywood Park
Fairview
Portland
Wood Village
Troutdale
Gresham
Beaverton
Milwaukie
Happy Valley
Tigard


0 - 0.92
0.92 - 1.40
1.40 - 2.00
2.00 - 2.84
2.84 - 7.84
Strawberry
Belvedere
malpais-Homestead Valley
Tiburon
Sausalito
Berkeley
Orinda
Moraga
Emeryville
Piedmont
Oakland
Alameda
San Francisco
San Leandro
Daly City
Brisbane


0 - 0.92
0.92 - 1.40
1.40 - 2.00
2.00 - 2.84
2.84 - 7.84
Kirkland
Redmond
Yarrow Point
Clyde Hill
Medina
Seattle
Sammamish
Bellevue
Beaux Arts
Mercer Island
Issaquah
Newcastle
Tukwila
Renton
Burien




| Population density | | Employment density | | Streets per node avg | | Intersection density | |
|---|---|---|---|---|---|---|---|
| Mean | Std. dev. | Mean | Std. dev. | Mean | Std. dev. | Mean | Std. dev. |
| | | | | 3.0 | | | |
| | | | | 3.1 | | | |
| | | | | 2.8 | | | |
| | | | | 2.9 | | | |
| | | | | 2.7 | | | |

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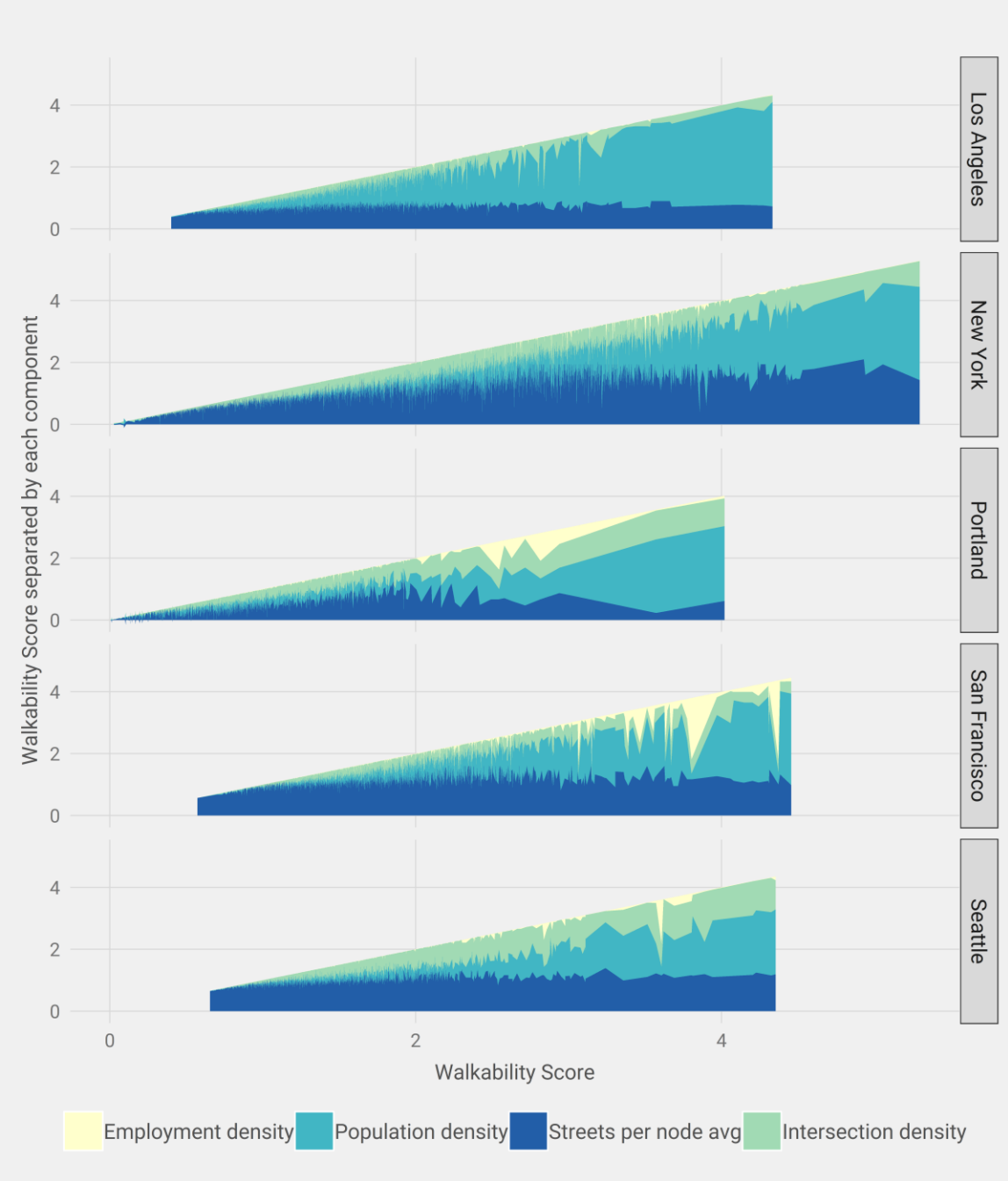
| Mean | Std. dev. | Mean | Std. dev. | Mean | Std. dev. | Mean | Std. dev. |
| 48 | 40 | 12 | 34 | 3.0 | 0.42 | 63 | 40 |
| 94 | 120 | 37 | 189 | 3.1 | 0.40 | 69 | 45 |
| 19 | 17 | 8 | 31 | 2.8 | 0.34 | 64 | 47 |
| 50 | 58 | 19 | 88 | 2.9 | 0.35 | 76 | 46 |
| 21 | 24 | 11 | 70 | 2.7 | 0.35 | 60 | 51 |

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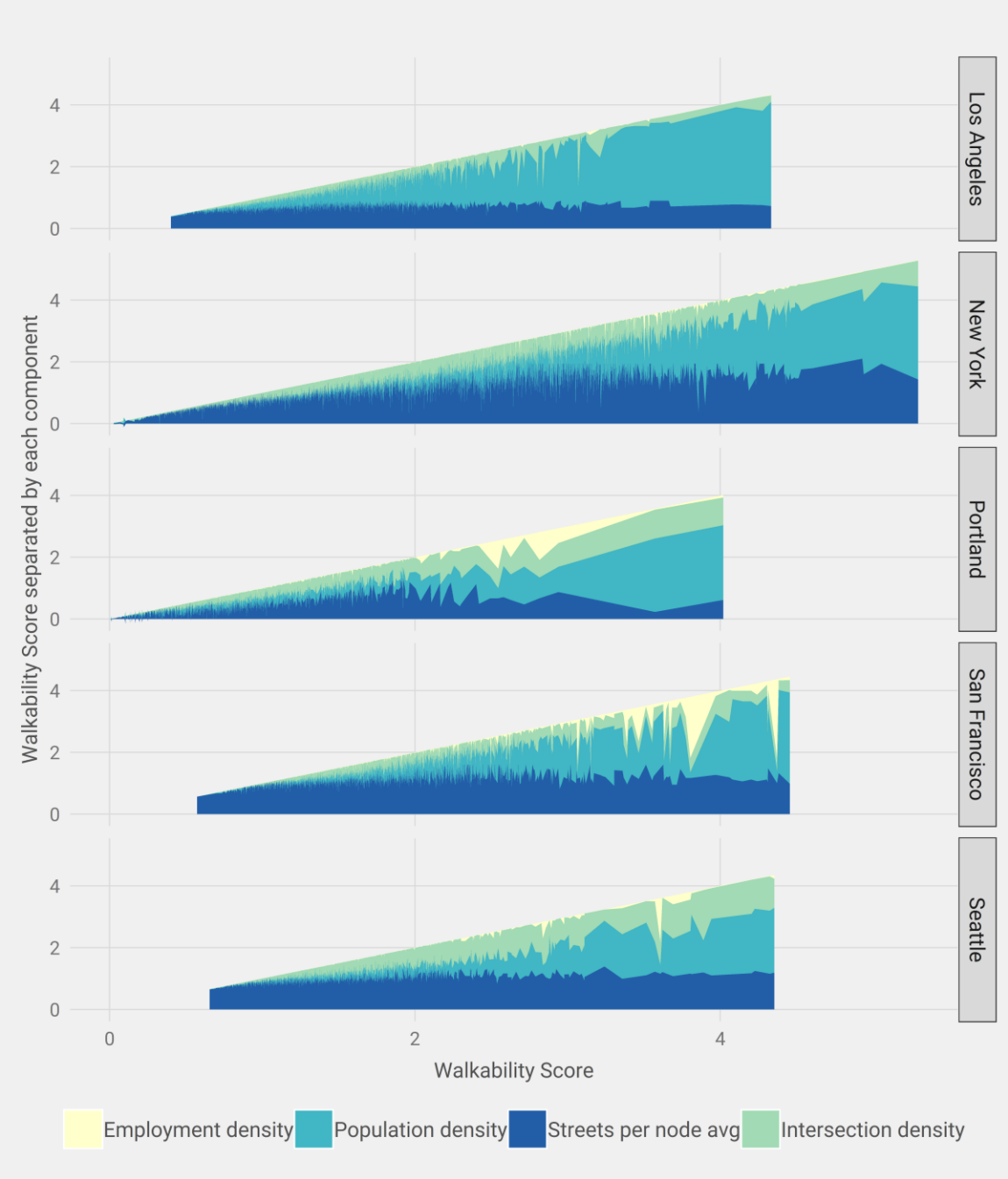


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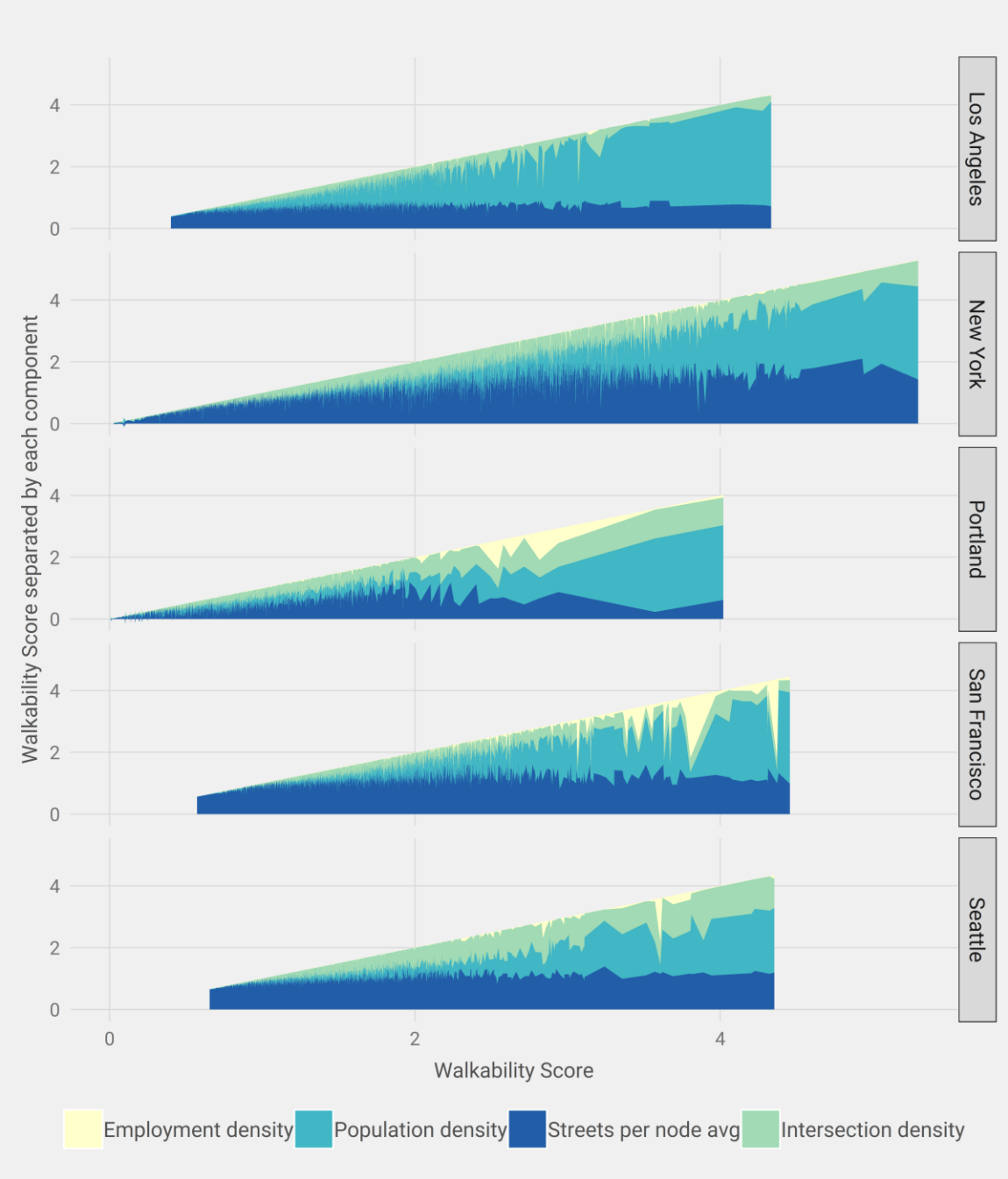


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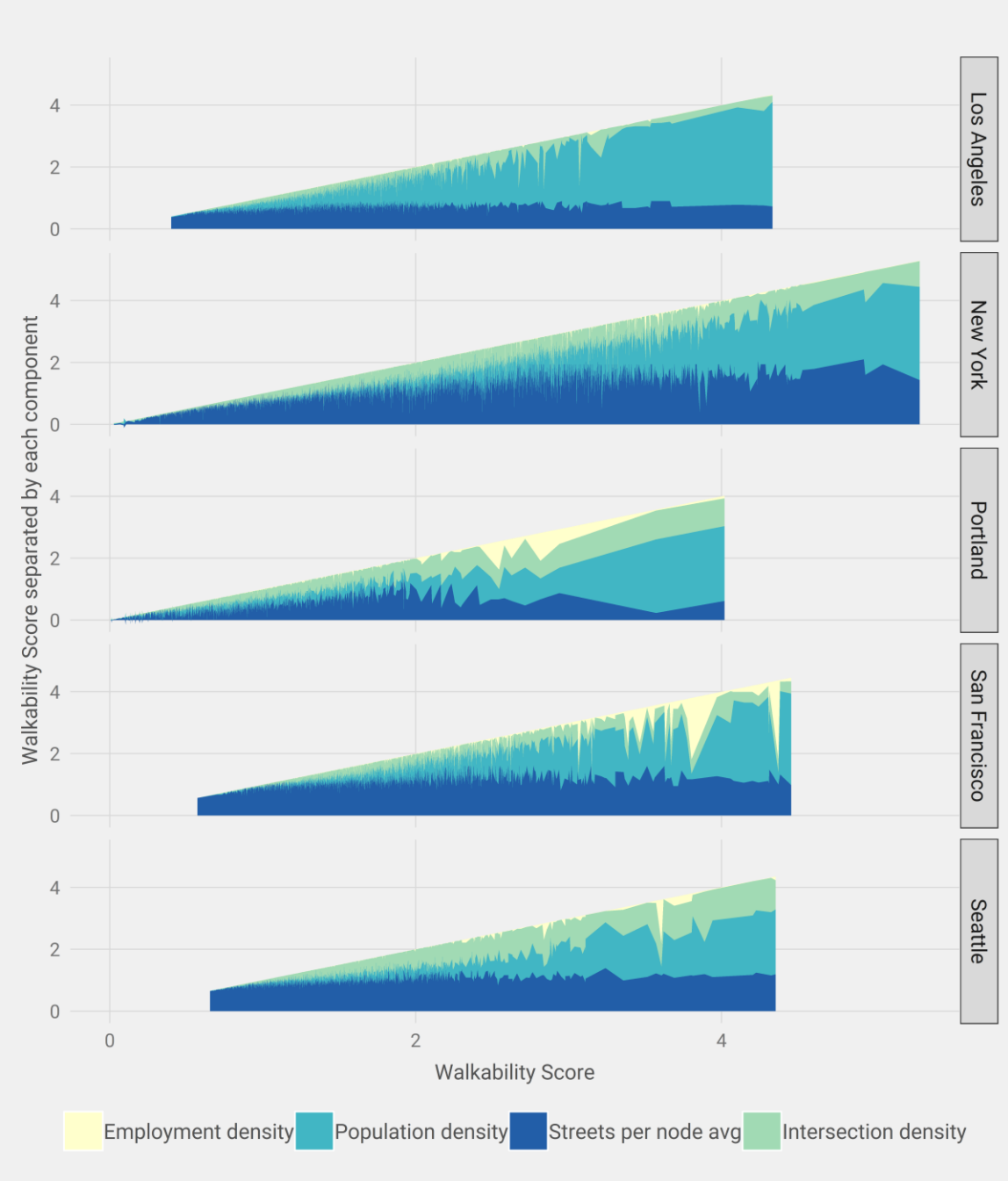


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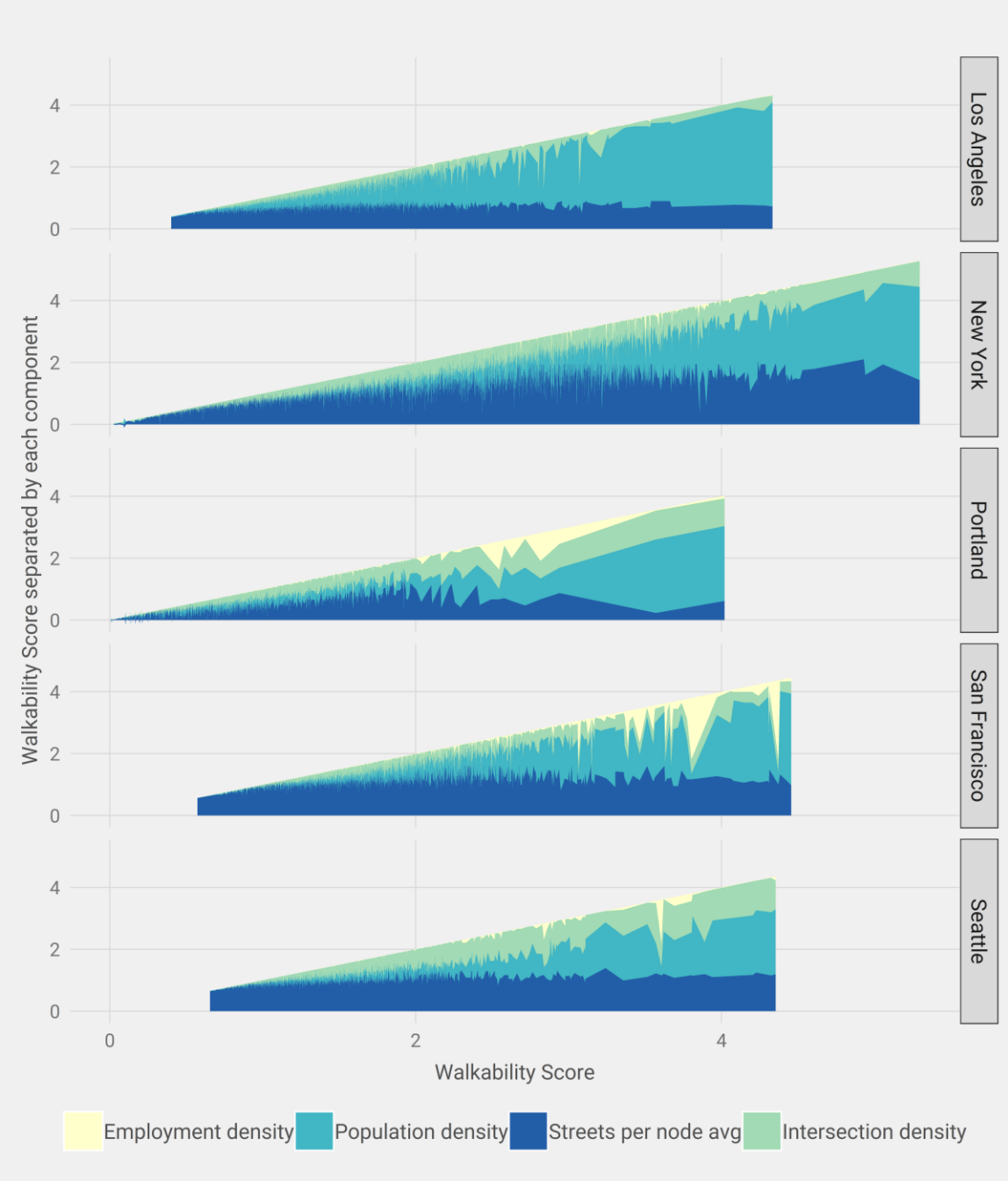


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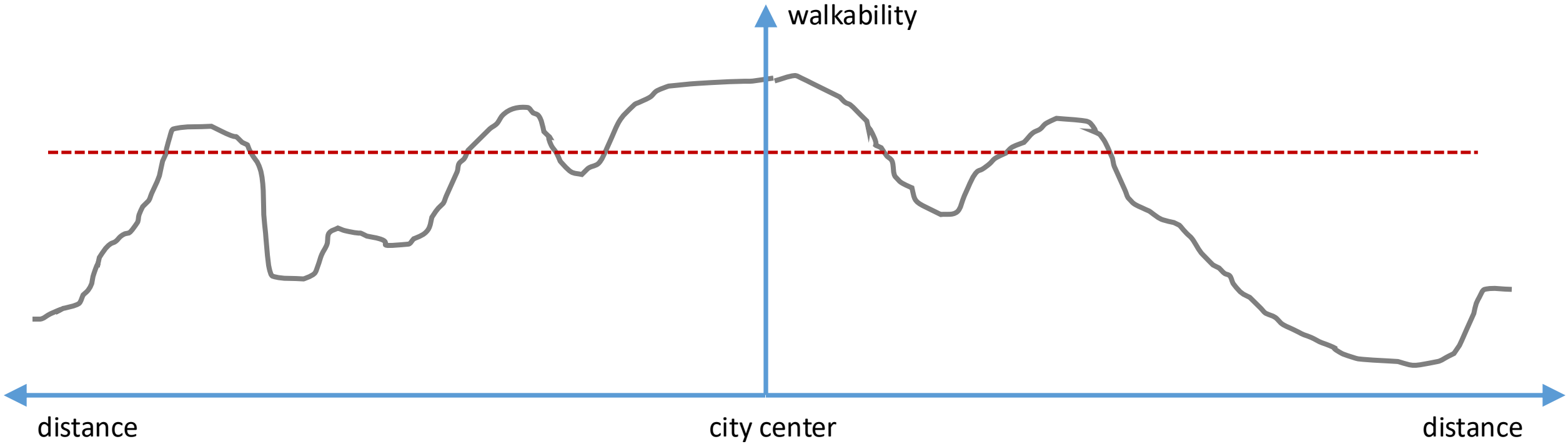
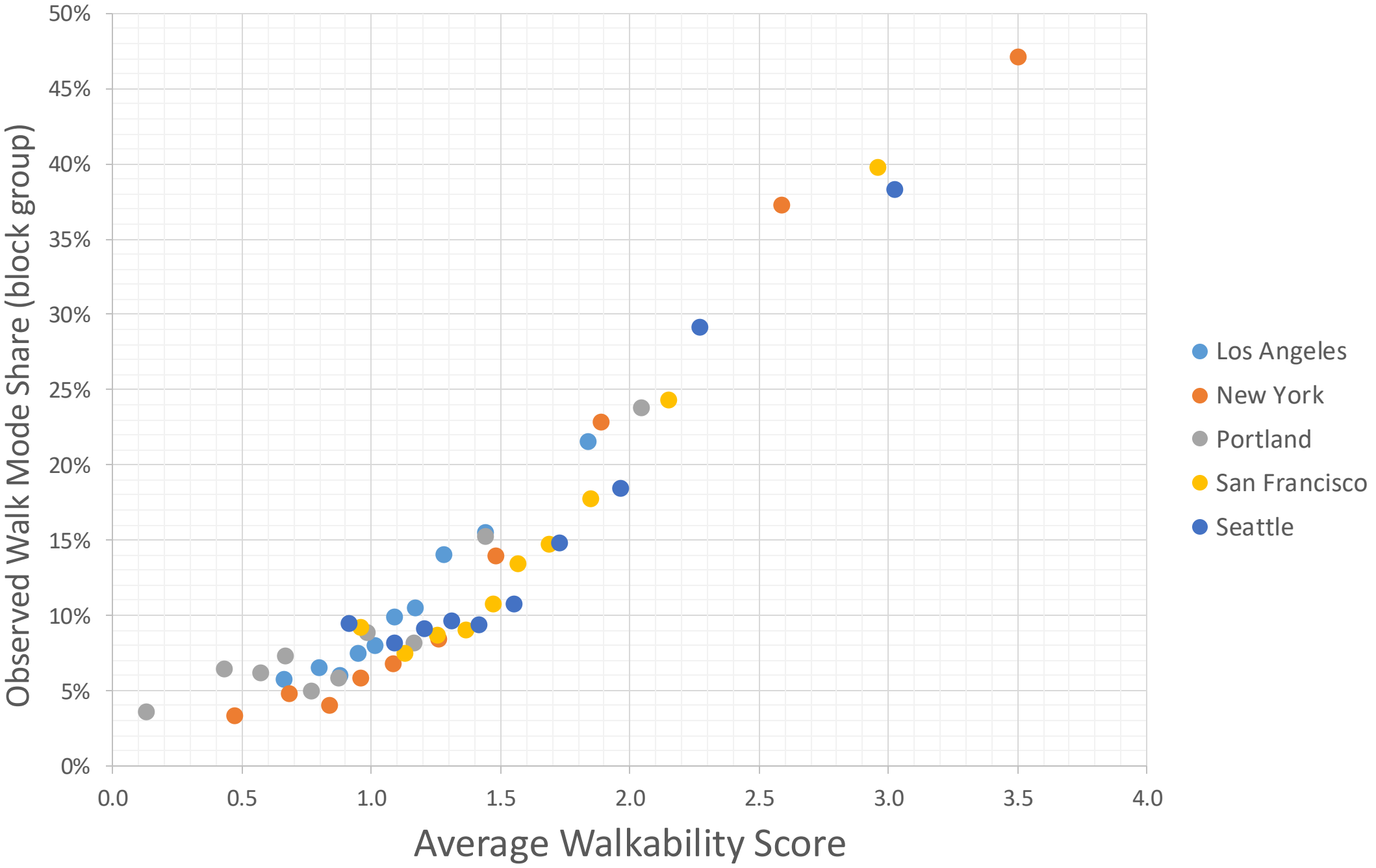
# Conclusions

- General agreement in terms of of relative importance variables and models have consistent results
- But, important differences exist as shown by relative magnitudes and distribution of the various built environment components across cities
- And models still have relatively low explanatory power, as do all behavioral models
- Findings suggest that we may need to consider the spatial arrangement of these characteristics within a region


walkability
distance
city center
distance

# Next steps

- Explore how the gradients of built environment and urban regional structure affects walking
- Add more cities, and more international cities
- Need larger samples in travel surveys (all modes) from highly walkable areas
- Identification of minimum and maximum thresholds (bounds) of influence for the built environment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50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Average Walkability Score
Los Angeles
New York
Portland
San Francisco
Seattle