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# Webinar: Transport Cost Index: A New Comprehensive Performance Measure for Transportation and Land Use

Liming Wang

Portland State University, [limwang@pdx.edu](mailto:limwang@pdx.edu)

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# **Transportation Cost Index: A New Comprehensive Performance Measure for Transportation and Land Use**

**Liming Wang, Portland State University**

**In Collaboration with**

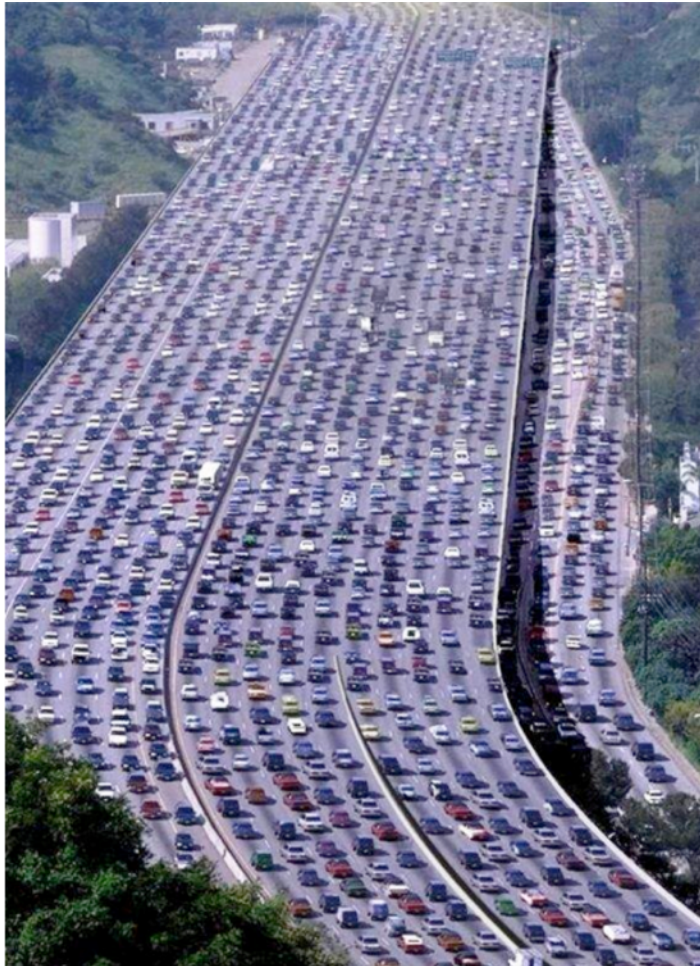
**Jenny Liu, Huajie Yang, Wei Shi (PSU)**

**Bud Reiff (Metro), Brian Gregor (Oregon System Analytics)**

# Outline

- Why we need yet another performance measure (YAPM)?
- Transportation Cost Index: the idea and implementations
- Demo applications
- Ongoing and future work

# Performance Measures: Mobility vs Accessibility



Credit: Paul Waddell

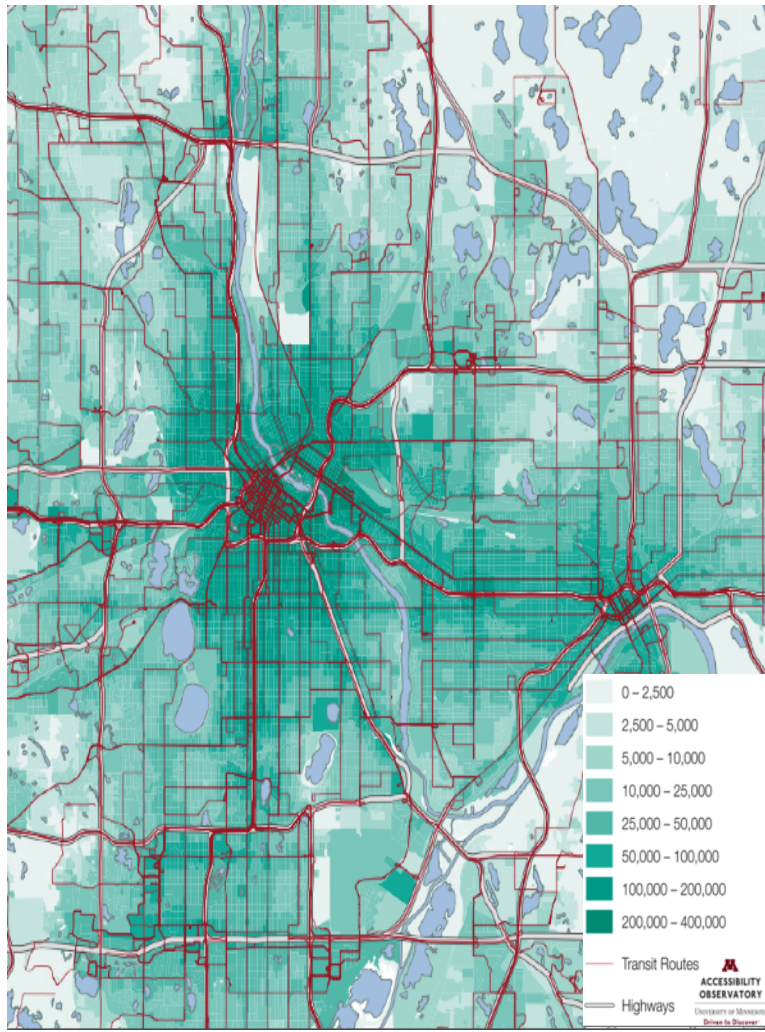
# Need for Accessibility Measures

- As a supplement/replacement of traffic-centric measures: LOS, travel delays
- MAP-21 emphasizes use of performance measures in transportation planning & operation
- State legislations: Oregon Job and Transportation Act (OJTA)

# Existing Accessibility Measures

- Handy and Niemeier, 1997
- Geurs and van Wee, 2004
- NCHRP Report 446, 618, 694, 708 ...

# Market Potential Measures



Employment accessible within 30 minutes by public transit during a.m. peak

- Easy to interpret/understand
- Opportunities, mode, time-of-day and time budget specific

Source: University of Minnesota, Accessibility Observatory



# Utility-based Measures

$$E(CS) = \ln \left( \sum_{m'} \exp(U_{m'kj}) \right) + C$$

Logsum as an accessibility measure

- Elegant, composite measures for all modes; possible to derive net user benefit between scenarios
- Hard to interpret by itself; unable to compare across regions/times (benchmarking)



# Generalized Costs Indicator

**Table 4**  
Generalised costs indicator, for private car, 2007 (2000=100) by type of trip.

Location:	Randstad	107
	Outside Randstad	105
Time of day	Rush hour	109
	Outside rush hour	105
Trip purpose	Business	102
	Commuter	110
	Other	106
Distance (km)	Up to 15	105
	15 to 30	110
	30 to 50	108
	More than 50	104

Per distance generalized costs for motorized trips

- Easy to interpret/understand; able to monitor trends and compare scenarios
- ignores land use system; mode, time-of-day specific

Source: Koopmans, et al, 2013

# H+T® Affordability Index

## Municipality: Portland, OR

Traditional measures of housing affordability ignore transportation costs. Typically a household's second-largest expenditure, transportation costs are largely a function of the characteristics of the neighborhood in which a household chooses to live. [Location Matters](#). Compact and dynamic neighborhoods with walkable streets and high access to jobs, transit, and a wide variety of businesses are more efficient, affordable, and sustainable.

The statistics below are modeled for the Regional Typical Household. Income: \$58,110 Commuters: 1.12 Household Size: 2.55 (Portland-Vancouver-Hillsboro, OR-WA)

### Map of Transportation Costs % Income



### Location Efficiency Metrics

Places that are compact, close to jobs and services, with a variety of transportation choices, allow people to spend less time, energy, and money on transportation.

6%

Percent of location efficient neighborhoods

### Neighborhood Characteristic Scores (1-10)

As compared to neighborhoods in all 955 U.S. regions in the Index

Job  
Access  
6.9

High access to a variety of jobs

Transit  
Access  
8

Very good access to public transportation

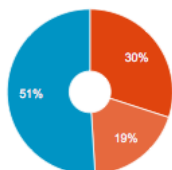
Compact  
Neighborhood  
5.7

Moderate density and walkable

### Average Housing + Transportation Costs % Income

Factoring in both housing and transportation costs provides a more comprehensive way of thinking about the cost of housing and true affordability.

● Housing  
● Transportation  
● Remaining Income



### Transportation Costs

In dispersed areas, people need to own more vehicles and rely upon driving them farther distances which also drives up the cost of living.



**\$10,959**  
Annual Transportation Costs



**1.53**  
Autos Per Household



**17,121**  
Average Household VMT

- Tracks out-of-pocket monetary costs of transportation and adds them to housing costs as a location efficiency measure;
- Ignores time costs; does not track the performance of transportation system except for Auto/Transit mode split and VMT.

Source: Center for Neighborhood Technology (CNT)

# Wish List for YAPM

- A comprehensive measure able to present an overall picture of transportation and land use;
- Fill gaps in policy areas not adequately covered by existing performance measures, such as the equity and compatibility aspects (Reiff and Gregor, 2005)
- Easy to interpret/understand;
- Applicable to use cases ranging from prioritization, scenario evaluation/comparison, to benchmarking and standard;

# Applicability of Performance Measures

Application	Prioritization	Comparison	Long-term Benchmark	Near-term Standard or Threshold
Transportation System Planning / Subarea Plans / Multi-jurisdictional Corridor Planning				
Project / Corridor Planning				
Plan Amendments / Zone changes subject to TPR				
Development Review				

## Selection Criteria:

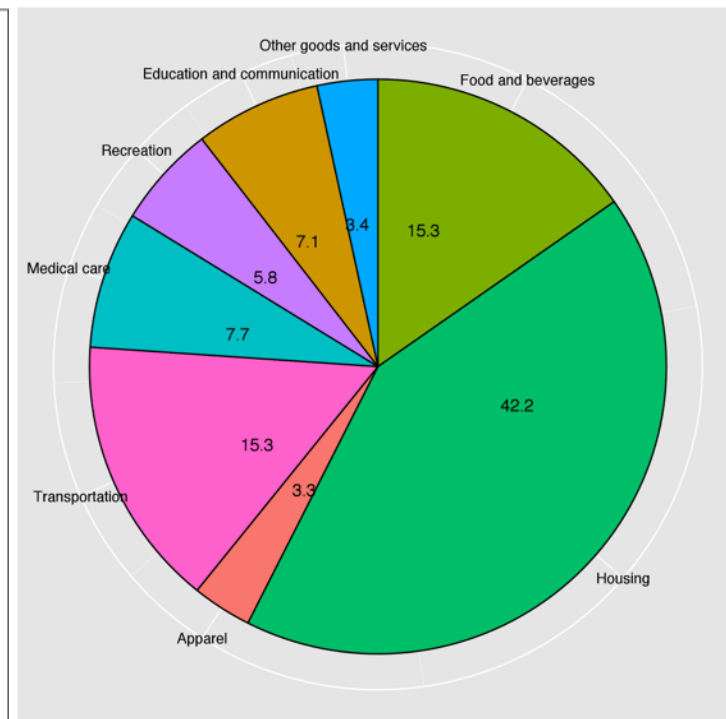
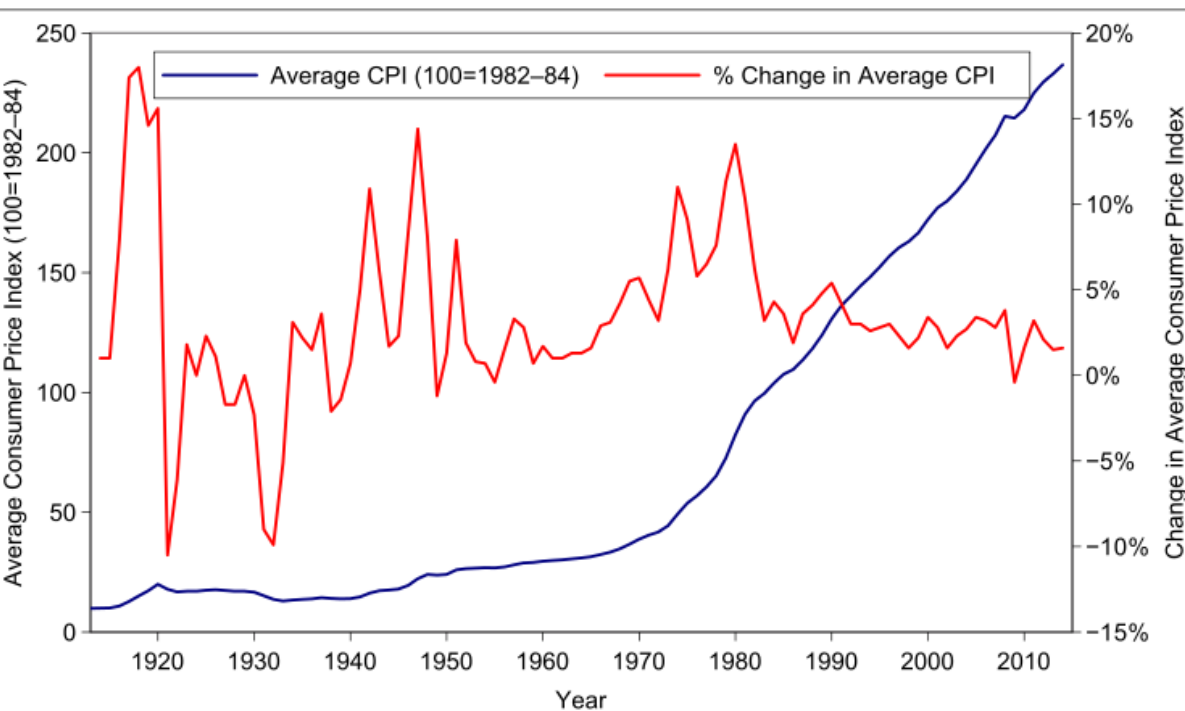
- Easy to apply
- Objective quantitative measure
- Good data availability
- Easy to understand

Source: Kittleson & Associates, Washington County  
Multimodal Performance Measures and Standards

# **TCl: the idea and implementations**

# Consumer Price Index (CPI)

United States Consumer Price Index 1913–2014



# From CPI to Transportation Cost Index (TCI)

Measures changes in the “price level” of a market basket of trips/destinations meeting households’ daily needs:

1. Identify a basket of trips/destinations based on pre-defined groups (e.g. trip purpose categories);
2. Track the costs of accessing trips/destinations in the basket.



# Transportation Cost Index (TCI)

- Comprehensive measure of transportation and land use;
- Able to serve as a performance measure for policy areas including equity, transportation and land use compatibility and balance;
- Easy to interpret/understand;
- Based on widely available data sources, possible for all uses, esp. benchmarking and scenario evaluation/comparison

# Implementation A: Travel Survey-based Method

Relies primarily on input from household activity survey, e.g. Oregon Travel & Activity Survey (OTAS)

1. Construct travel baskets based on activity diaries or a sample of trips/tours that are representative of regional travel pattern, potentially by trip purpose, household size, income group and geography;
2. Track the time and monetary costs of making these trips/tours.

Suitable for prioritization and benchmarking applications.

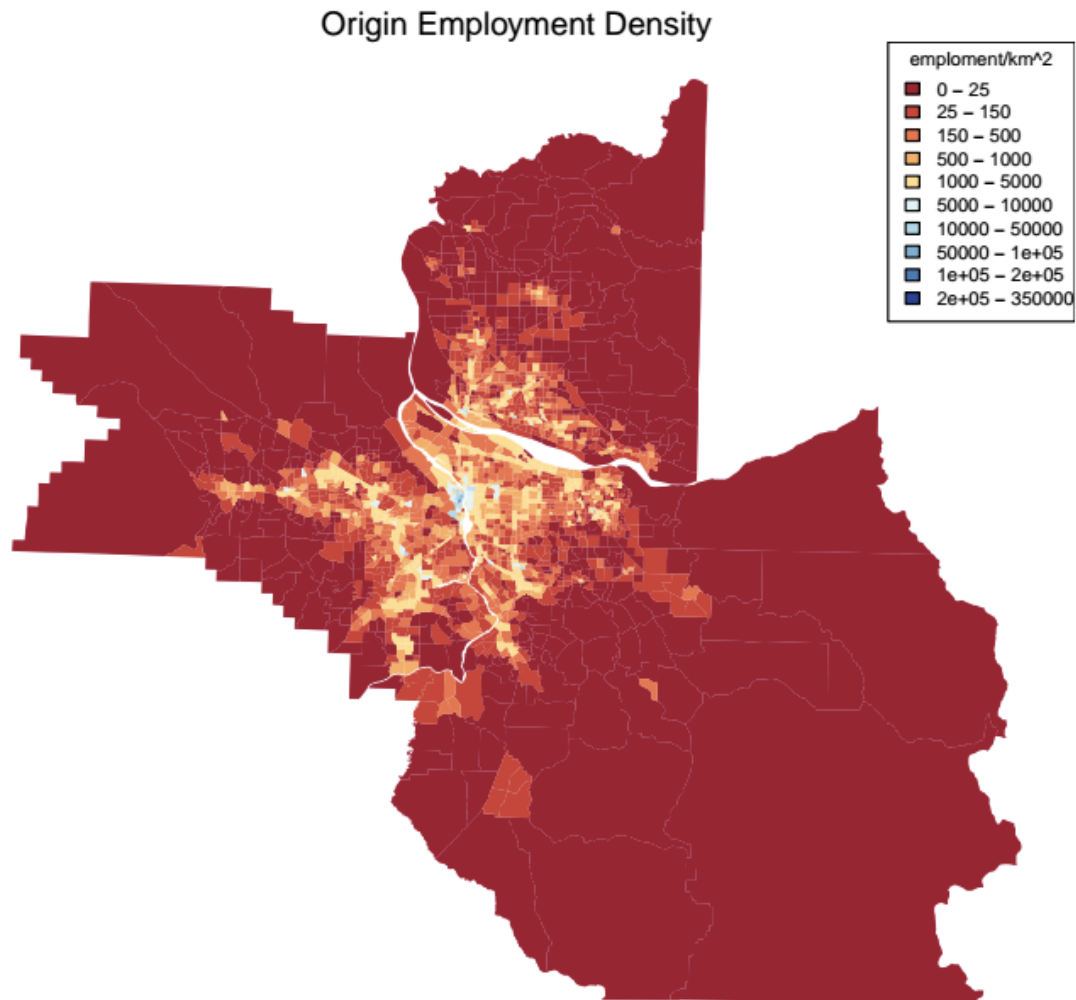
# Implementation B: TDM-based Method

Relies on inputs from travel demand model

- Data readily available for regions w/ TDM;
- Theoretically can calculate the transportation cost for every income group and for every TAZ;

Suitable for scenario evaluation/comparison.

# Implementation B: TDM-based Method



# Calculate Travel Costs: Cost Estimate by Mode

$$C = C_0 + k \cdot TD + w \cdot TT$$

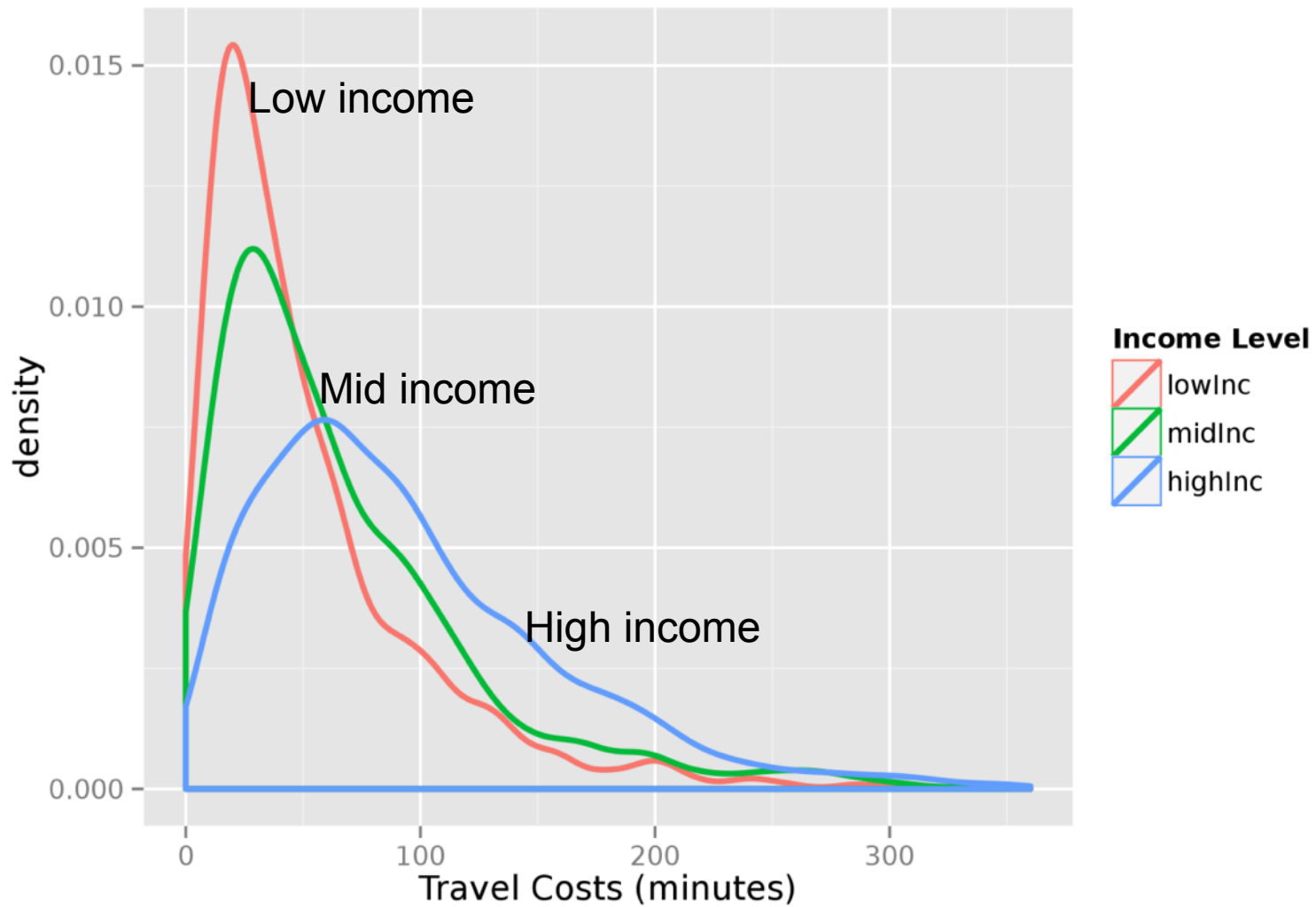
$C_0$  - Constant

$k \cdot TD$  - Monetary costs (Fuel and tire costs, Ownership costs, insurance, etc) of travel

$w \cdot TT$  - Time costs of travel

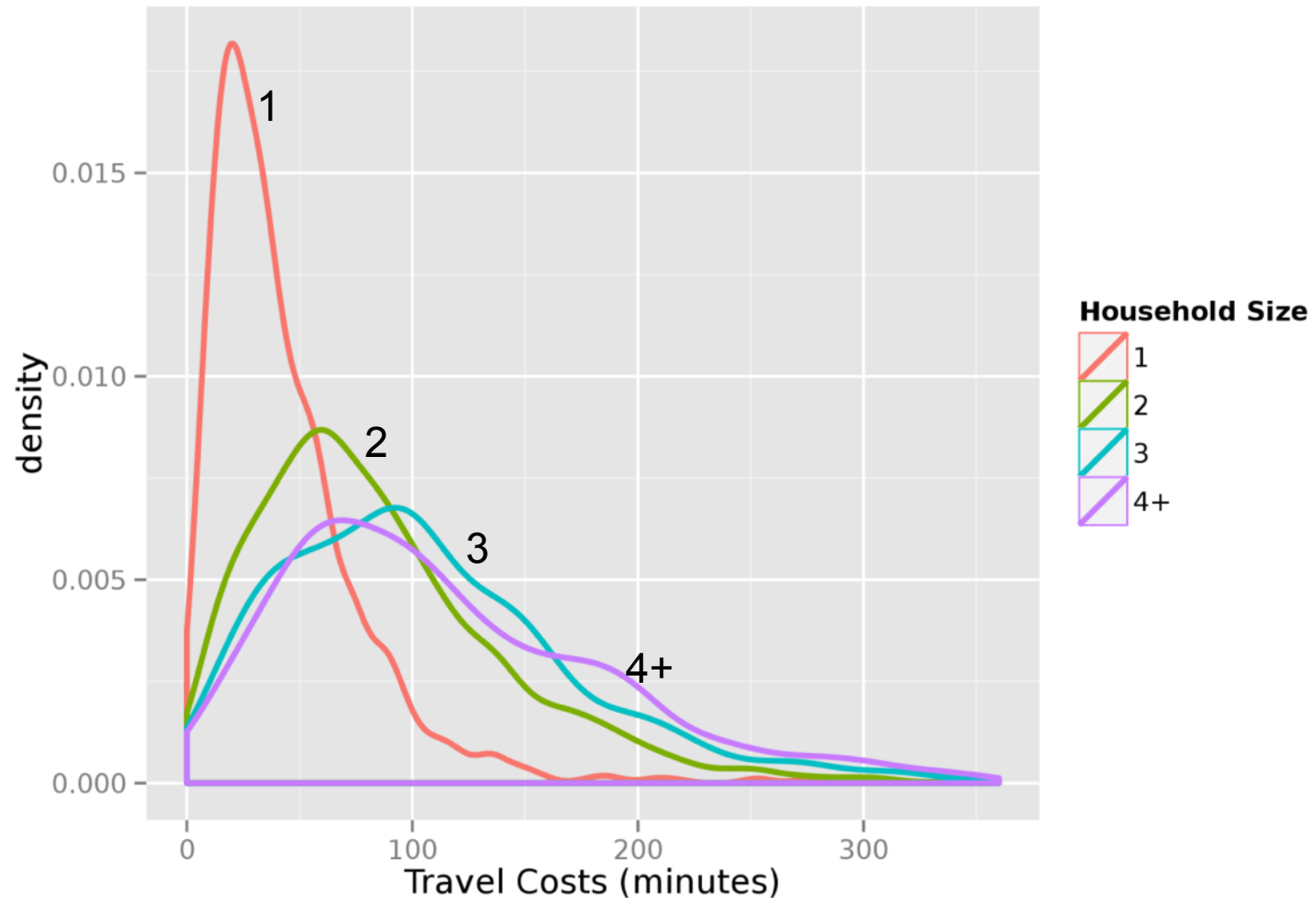
# **Applications and Demonstration**

# Generalized Costs by Household Income Level (Portland, 2011)

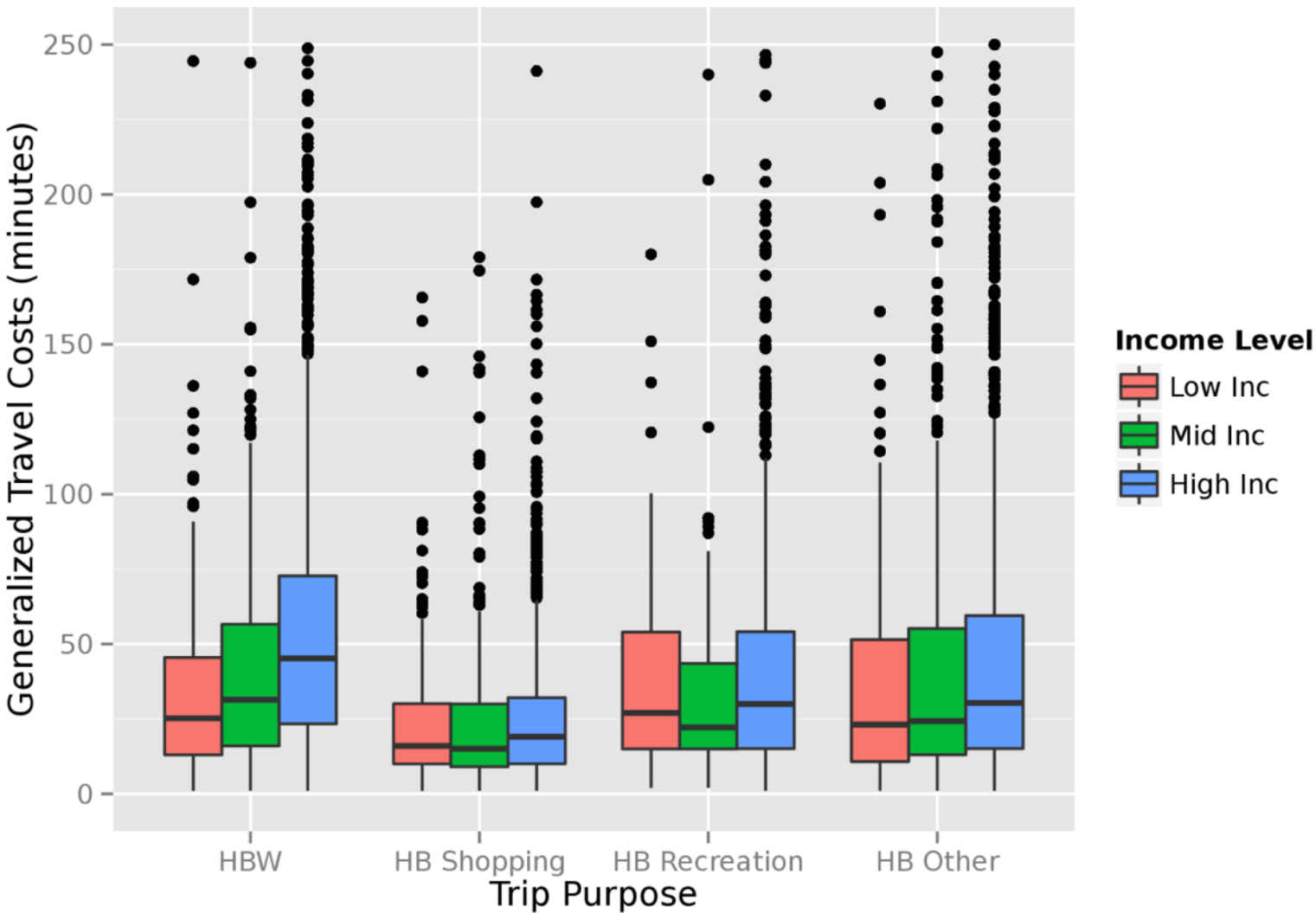




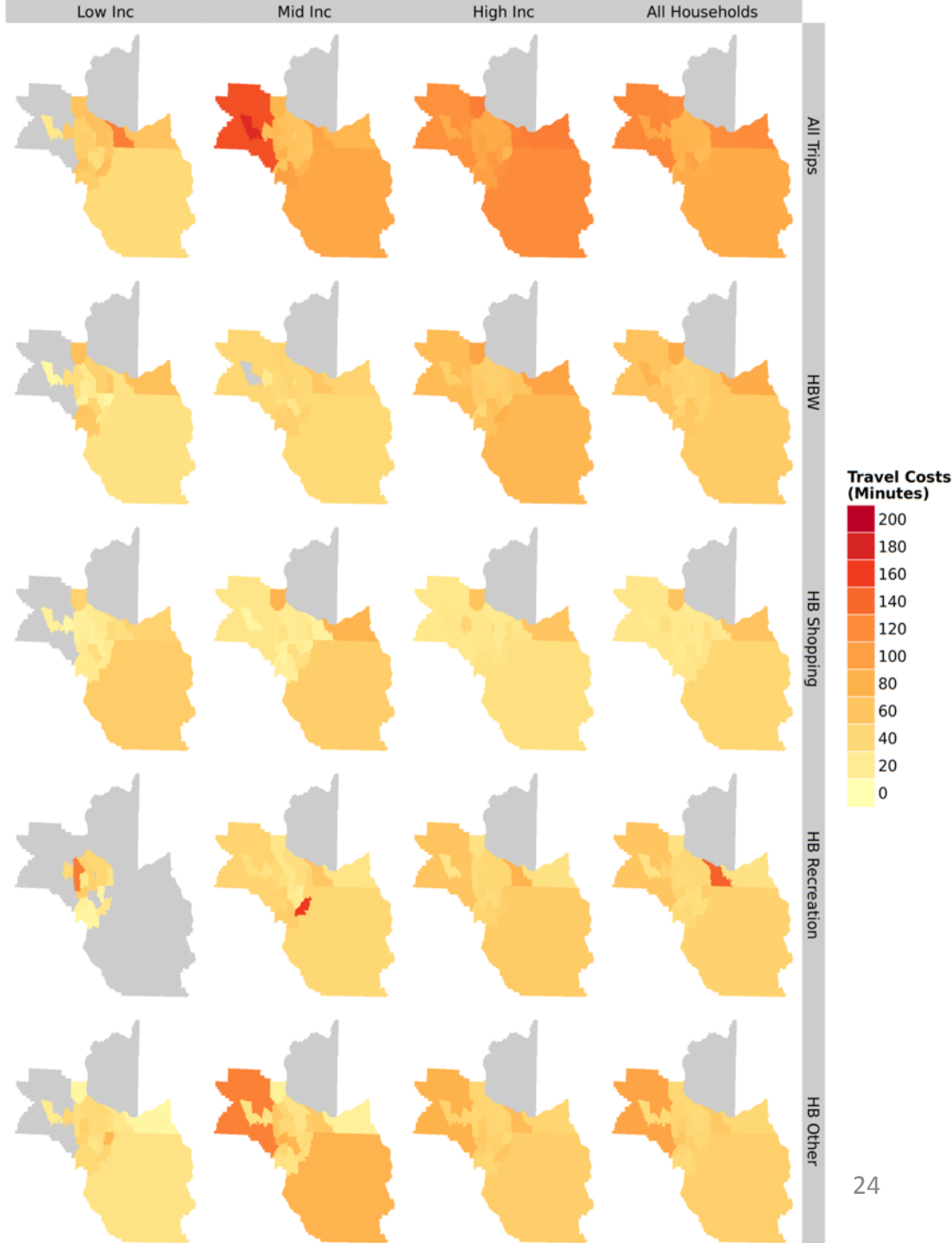
# Generalized Costs by Household Size (Portland, 2011)



# Generalized Costs by Purpose & Income Level (Portland, 2011)

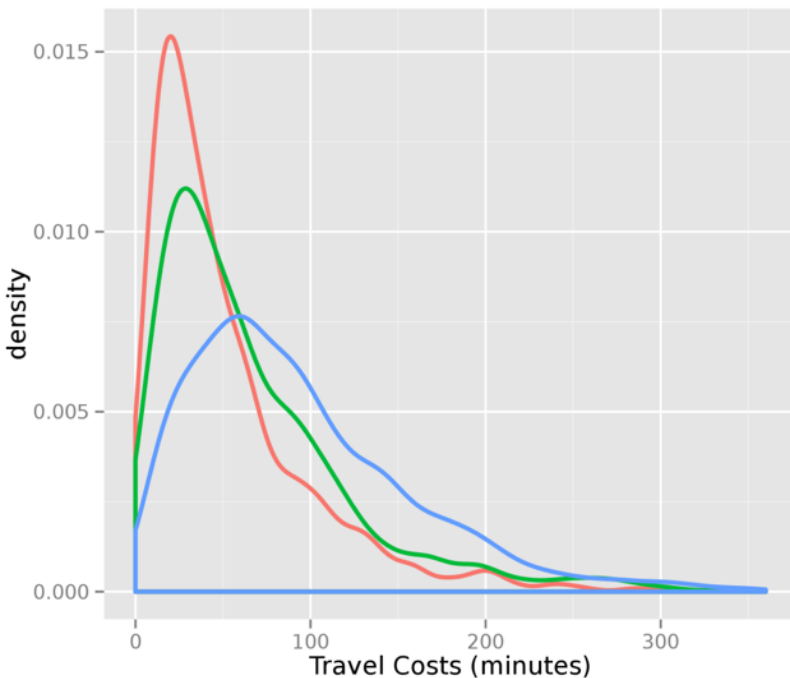


# Generalized Costs by Purpose, Income Level and Transportation Districts (Portland, 2011)

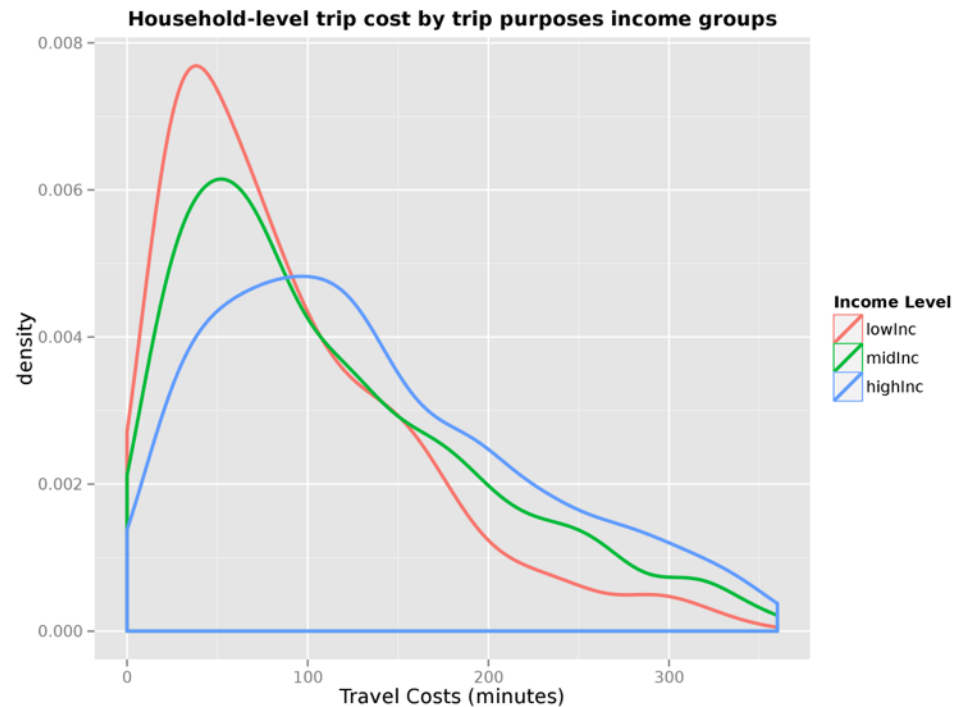


# Generalized Costs by Household Income Level (Portland)

2011

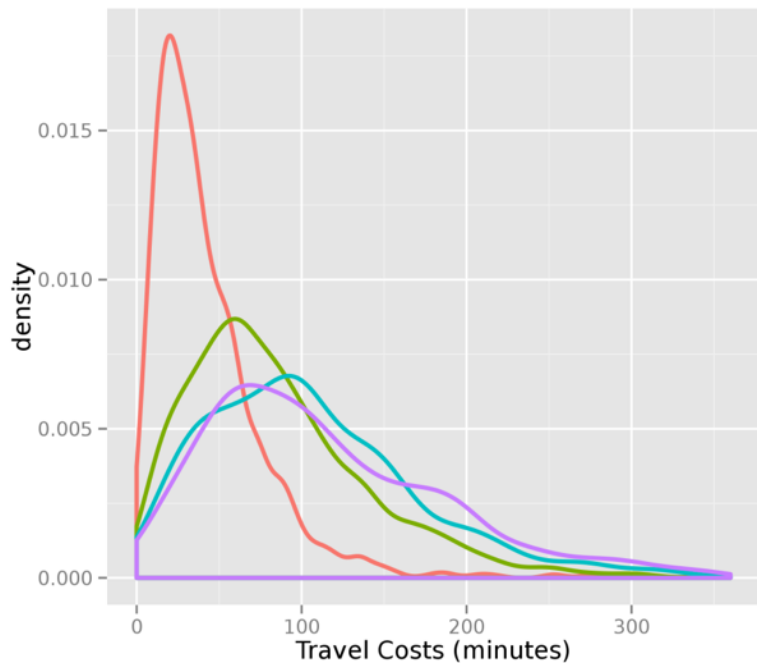


1994

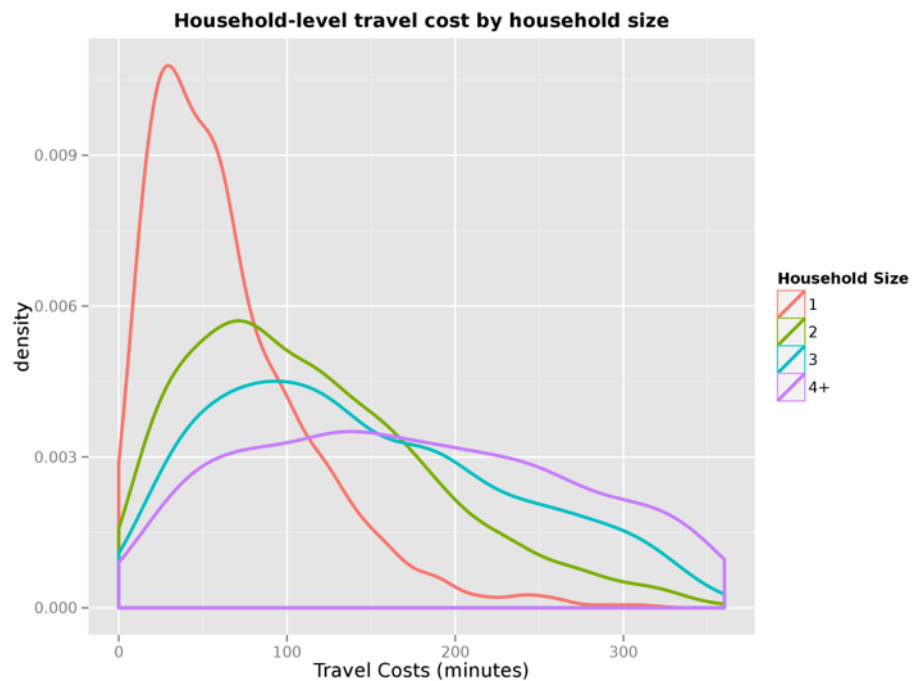


# Generalized Costs by Household Size (Portland)

2011

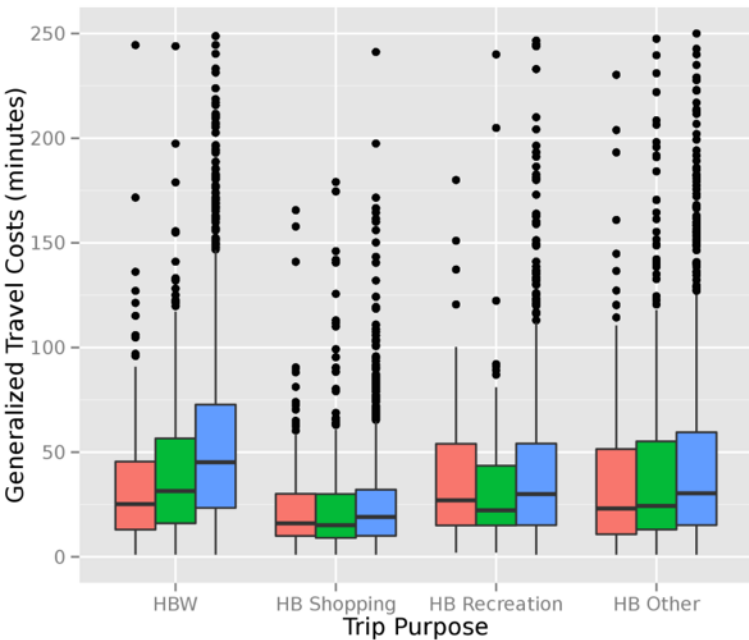


1994

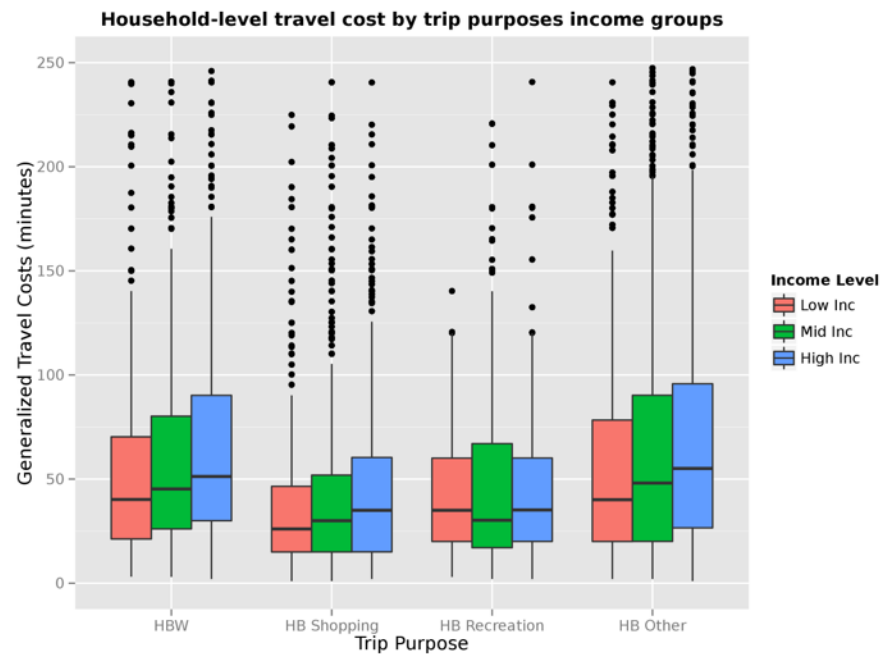


# Generalized Costs by Purpose and Income Level (Portland)

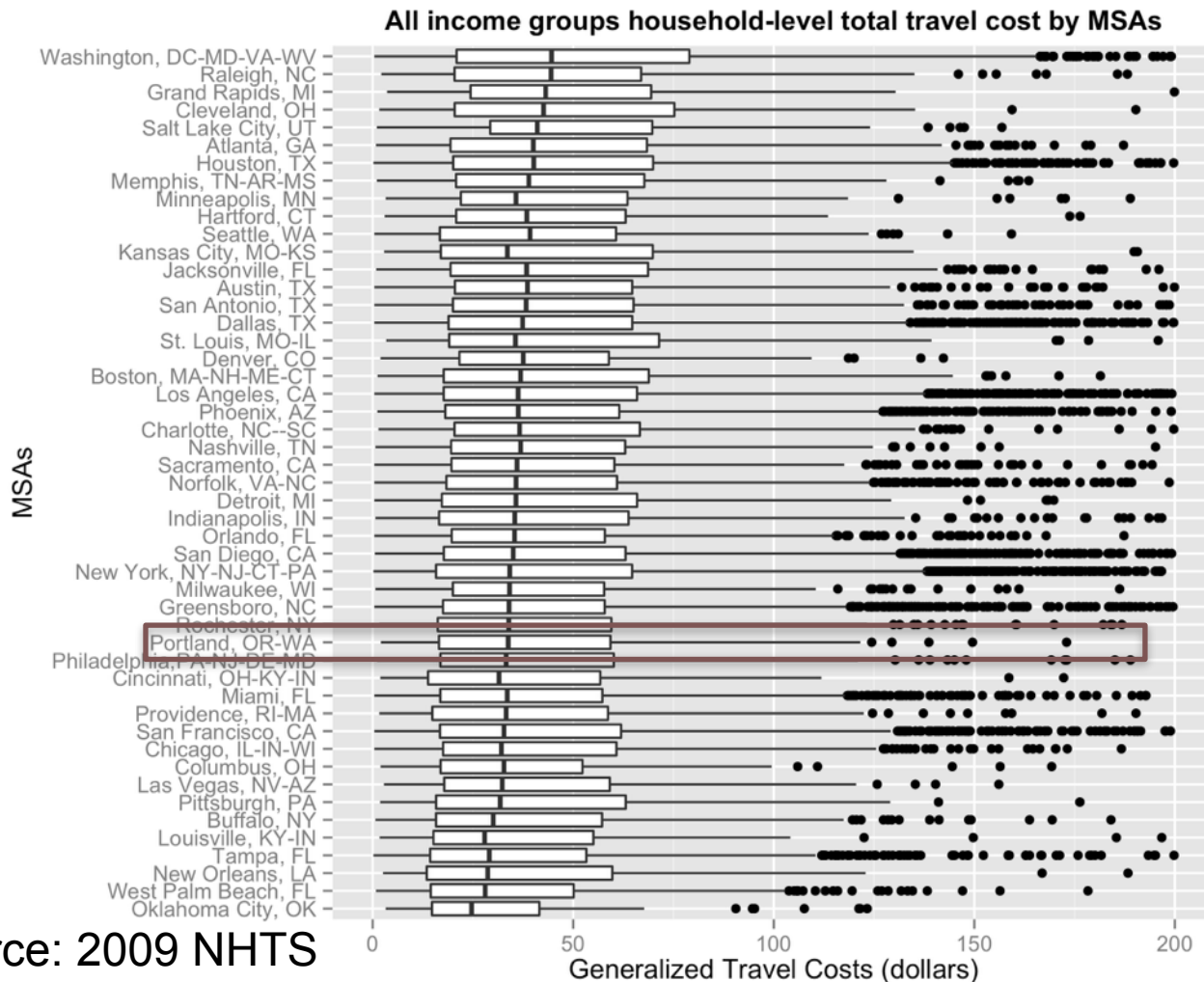
2011



1994



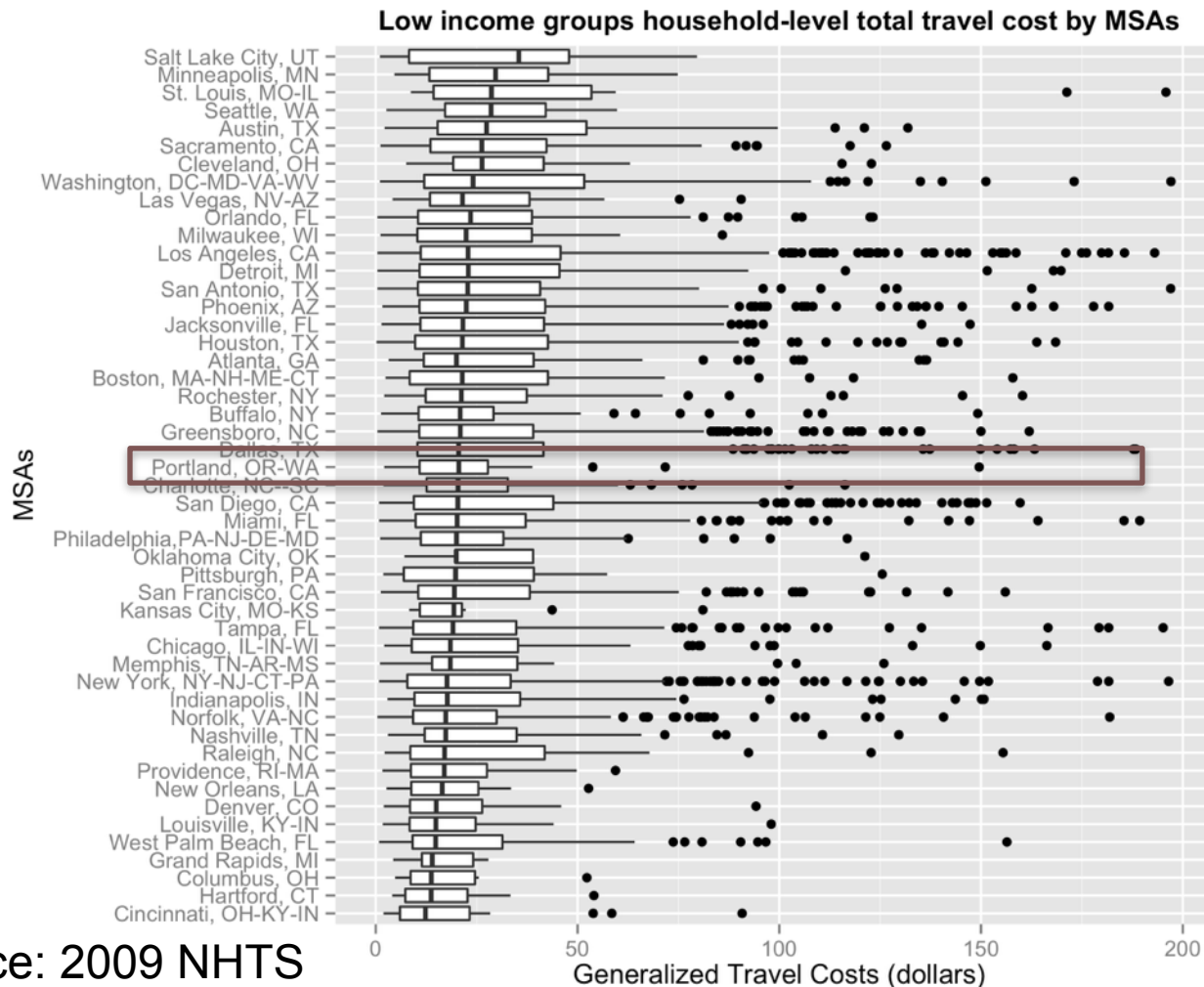
# Transportation Costs by MSA (All households)



Data source: 2009 NHTS



# Transportation Costs by MSA (Low Income)



# Ongoing and Future Work

- Adopted by the Accessibility Indicator Development Team (IDT) as one of indicators for the Oregon Mosaic project mandated by OJTA

# Ongoing and Future Work

- Test TCI usage in public engagement and policy making process
- Reconcile TCIs from the two methods;
- Verify patterns of transportation costs with information from alternative data sources, such as CES;
- Should external costs be included?

# Code and Working Papers

- Code (under active development/testing) available at <http://github.com/cities-lab/tci>
- Working Papers:
  1. Wang, Liming, Bud Reiff, Brian Gregor, Huajie Yang, and Jenny Liu, 2015. Transportation Cost Index: A Comprehensive Multimodal Performance Measure of Transportation and Land Use Systems, presented at the 94th Annual Meeting of Transportation Research Board, Washington, DC, January 11-15, 2015.
  2. Wang, Liming, Huajie Yang and Jenny Liu, Transportation Cost Index as a Performance Measure for Transportation and Land Use Systems: New Approaches and Application in Portland, OR, to be presented at the 95th Annual Meeting of Transportation Research Board, Washington, DC, January 10-14, 2016.

# Acknowledgements



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