

SCAG Modeling Task Force
Wednesday January 27, 2021

Quantifying the Potential Employment Accessibility Benefits of Shared Automated Mobility Services: SCAG Region Case Study

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Key Findings

1. Young and low income workers may receive largest employment accessibility benefits from SAMS modes
2. Higher benefits of SAMS in suburban and rural areas than dense urban areas
3. Magnitude of benefits is heavily dependent on the service price of SAMS
4. Most of the benefits from the SAMS modes come from the SAMS only mode
 - Rather than the SAMS plus Transit mode

Background

Many commuters face challenges accessing employment opportunities that limit their economic potential and quality of life

- High parking cost and limited parking
- Long commute distance
- Poor transit service



Background

Shared AV mobility service or SAMS can help address these employment accessibility challenges as they:

- nearly eliminate the need to park in high parking cost areas and
- allow carless travelers or non drivers including persons with physical disabilities to enjoy the accessibility benefits of personal vehicle travel.



Study Objectives

- Provide a monetary measure of employment accessibility benefits from SAMS
- Capture the key employment accessibility benefits of SAMS modes
- Incorporate heterogeneity in the population of workers



Study Assumptions

- Two new modes: SAMS only and SAMS plus Transit
- Impact mode choice and subsequent destination choice
- No change in residential and workplace locations and road network travel times
- Lower cost than ridesourcing services and personal vehicle and no parking cost
- Travel time similar to personal vehicle but with minimal wait times

SAMS only



SAMS plus Transit



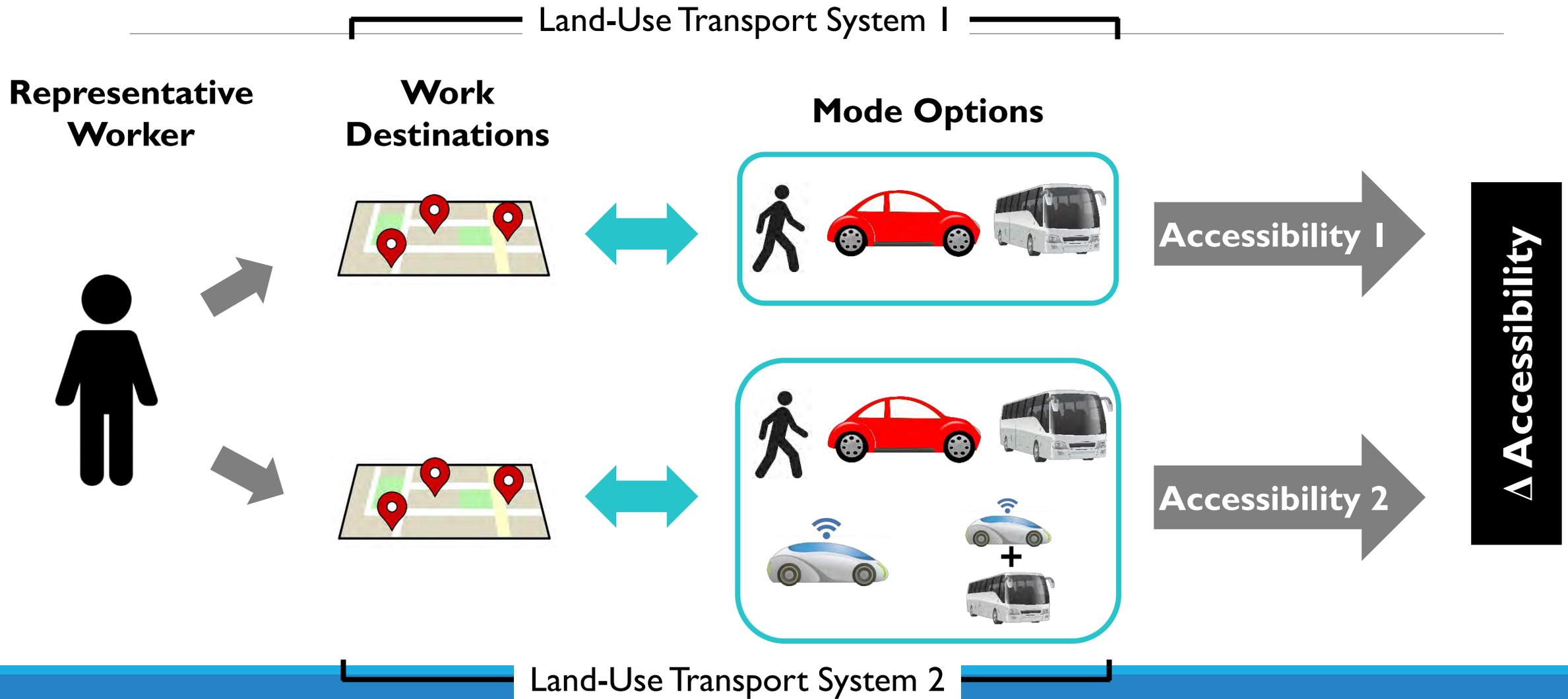
Accessibility

- **Definition**
 - Employment accessibility is the extent to which land-use and transport systems, particularly the available commute modes, enable individual workers to reach employment opportunities (motivated by Geurs and van Wee, 2004; Ben-Akiva and Lerman, 1979; Hansen, 1959)
- **Measures**
 - Distance (or travel time or travel cost) to the nearest destination of interest (e.g., bus stop, freeway interchange, school, hospital, retail job, office job, etc.)
 - Cumulative activities/opportunities of a specific type within a specified distance or travel time or travel cost (known as the “isochrone” or “contour” measure)
 - Gravity/entropy model denominators (known as Hansen’s measure (Hansen, 1959))
 - Expected maximum random utility-based measure (e.g., logit model “logsums” (Ben-Akiva and Lerman, 1979))

Literature Review

- Meyer et al. (2017)
 - Focus on accessibility benefits arising from reductions in network travel times
 - Use the gravity model denominator
- Milakis et al. (2018)
 - Survey international experts on their opinions about AVs impacts on accessibility
 - Expectation is that AVs will have wide-ranging impacts on land-use, transportation, and temporal components of travel
- Childress et al. (2015)
 - Also use destination-mode choice model logsums
 - Also, find little difference in impact of AVs between low-income and high-income household

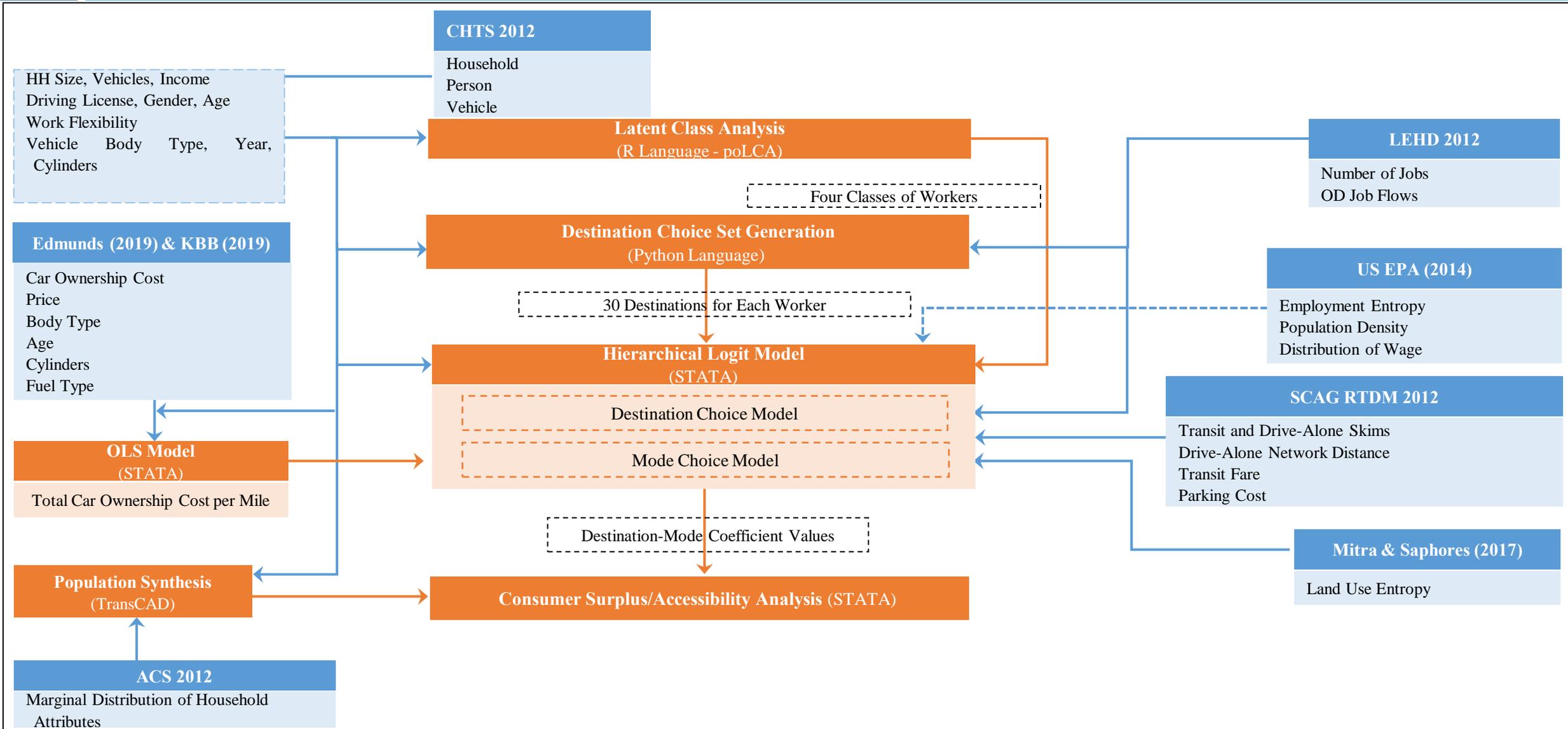
Conceptual Framework



Research Hypothesis

- Study has two main hypotheses that involve interrelationship between
 - Two new SAMS commute modes
 - Spatial distribution of employment opportunities in specific sectors
 - The characteristics of workers
- Hypothesis 1: New commute modes with attributes similar to SAMS+Transit and SAMS-only will provide **substantial** improvements in employment accessibility for workers
- Hypothesis 2: The benefits of the SAMS modes will vary across the working population

Methodological Overview



Data

Study Area is Southern California Association of Government (SCAG) Region

Socio-Economic Data

- 2012 California Household Travel Survey (CHTS)
- 2012 American Community Survey (ACS)

Mode Attribute

- SCAG Travel Demand Model Skim Matrices
- 2012 California Household Travel Survey (CHTS)
- Kelley Blue Book and Edmunds

Employment and Demographic Data

- 2012 Longitudinal Employer-Household Dynamics (LEHD)
- US EPA's Smart Location Database
- Mitra and Saphores (2017)

Clustering Workers

Method

- Latent Class Analysis (LCA) is used to cluster workers based on their sociodemographic attributes.
- The posterior probability that individual n belongs to a specific class c can be calculated as

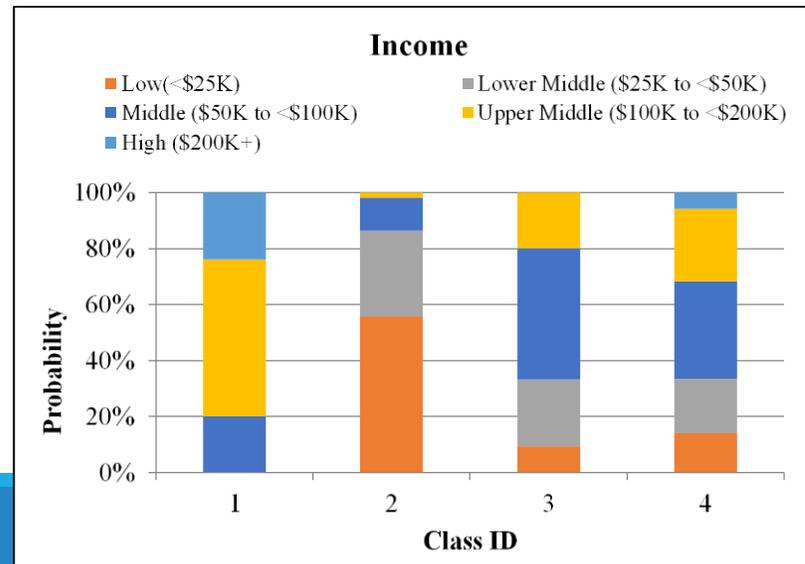
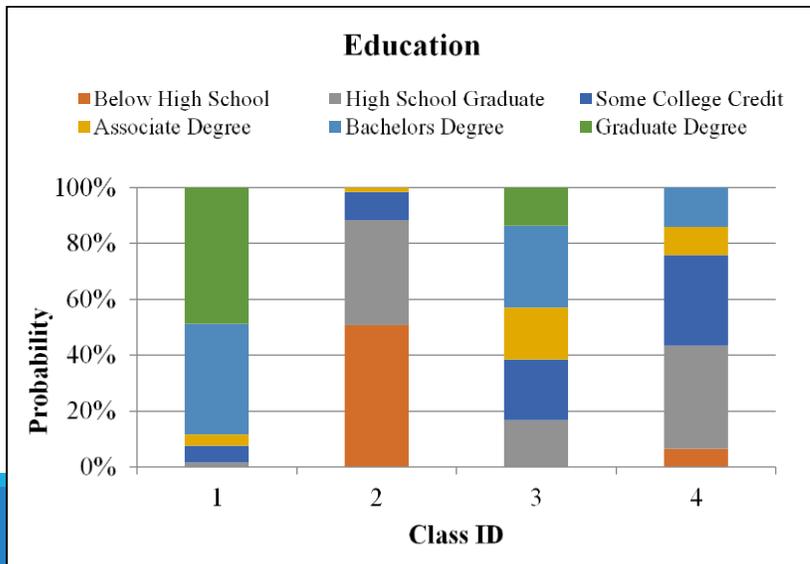
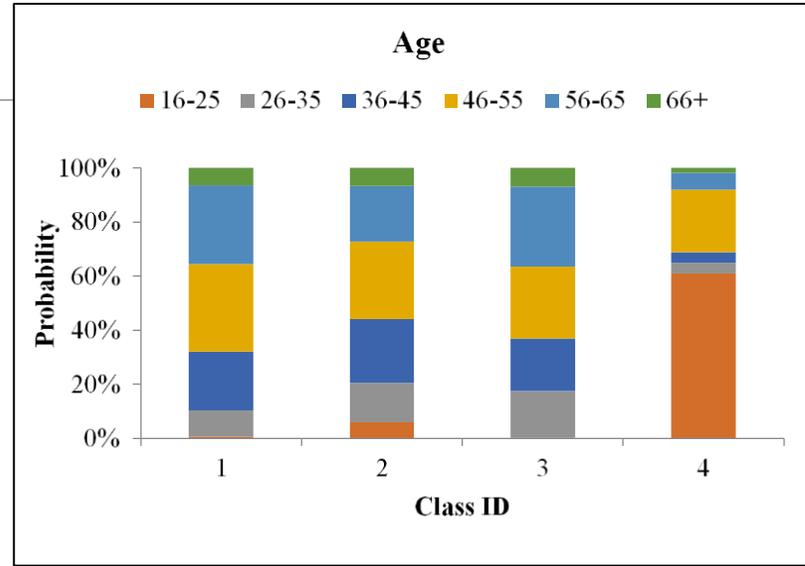
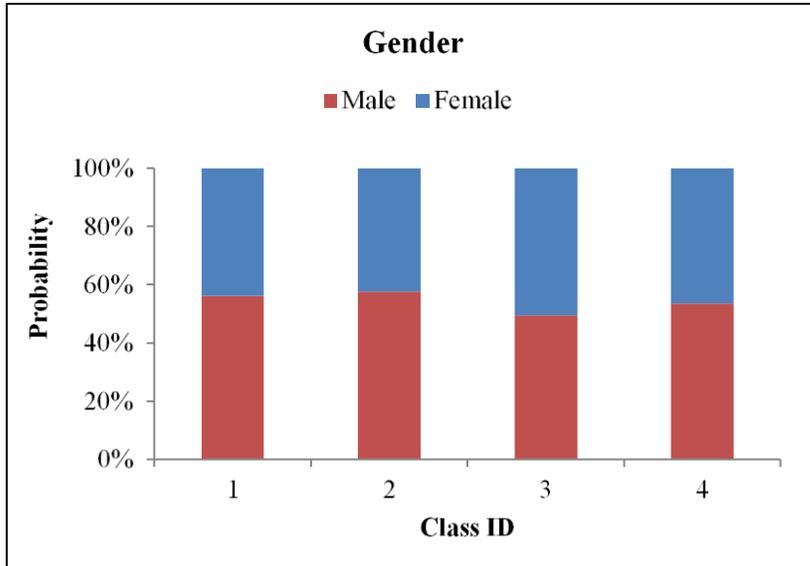
$$\hat{P}(c_n|Y_n) = \frac{p_c f(Y_n; \pi_c)}{\sum_{c' \in C} p_{c'} f(Y_n; \pi_{c'})} \quad (1)$$

Numerator = The probability an individual produces a specific set of outcomes on the manifest variables conditional on class membership

Denominator = The probability density function across all classes

Clustering Workers

Results



Class Description

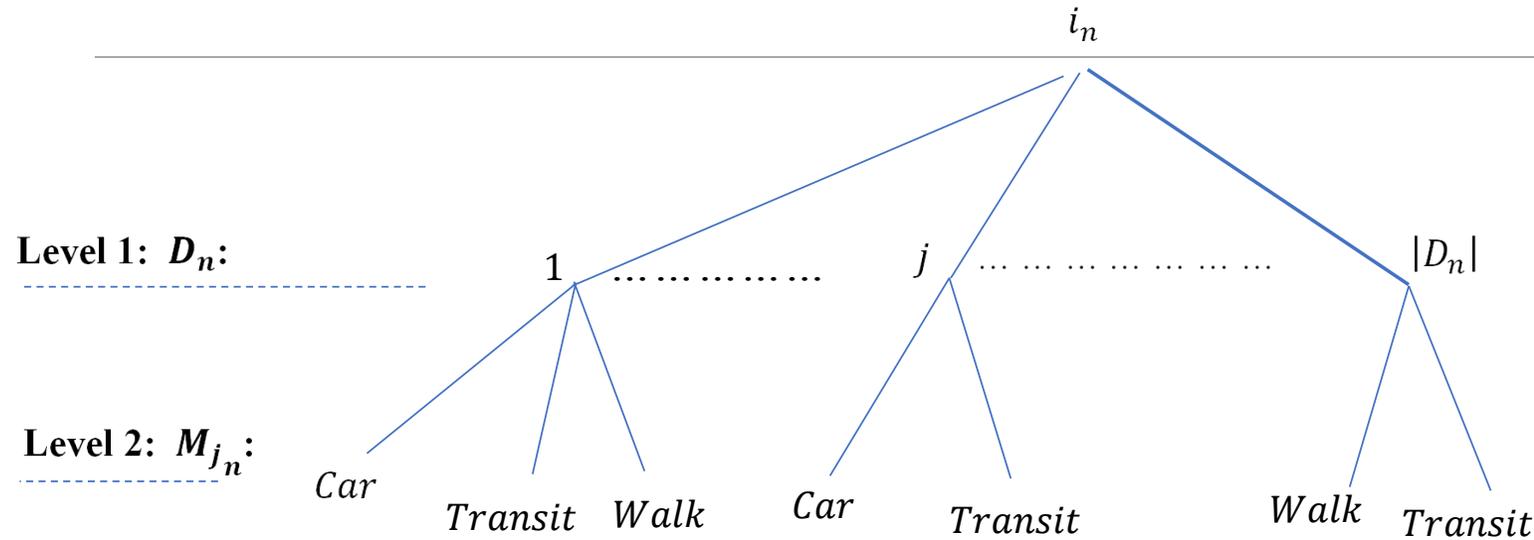
- Class 1** – Graduate/Bachelors degree holders and Upper Middle/High income
- Class 2** – Below High School education and Low/Lower Middle-income group
- Class 3** – Female and Middle income
- Class 4** – Age 16 to 25 years and High School/Some College education

Class Share

- Class 1** – 32%
- Class 2** – 8%
- Class 3** – 50%
- Class 4** – 10%

Measuring Accessibility

Hierarchical Destination Mode Choice Model and Logsum Approach



$$P_j^{i_n} = \frac{e^{\mu I_j^{i_n} + \sum_{b \in AD} \beta_b \cdot X_{bj}}}{\sum_{k \in D_n} e^{\mu I_k^{i_n} + \sum_{b \in AD} \beta_b \cdot X_{bk}}} \quad (2)$$

$$P_{m|j}^{i_n} = \frac{e^{V_{m|j}^{i_n}}}{\sum_{m' \in M_{j_n}} e^{V_{m'|j}^{i_n}}} \quad (3)$$

$$Accessibility_n = CS_n = \frac{1}{\alpha} \ln \sum_{j \in D_n} e^{\mu I_j^{i_n} + \sum_a X_{aj} \beta_a} + C \quad (4)$$

$$\Delta Accessibility = \Delta CS = \frac{1}{\alpha} \left[\ln \left(\sum_{j,m} e^{V_{jm}^1} \right) - \ln \left(\sum_{j,m} e^{V_{jm}^0} \right) \right] \quad (5)$$

Mode Choice Model Results

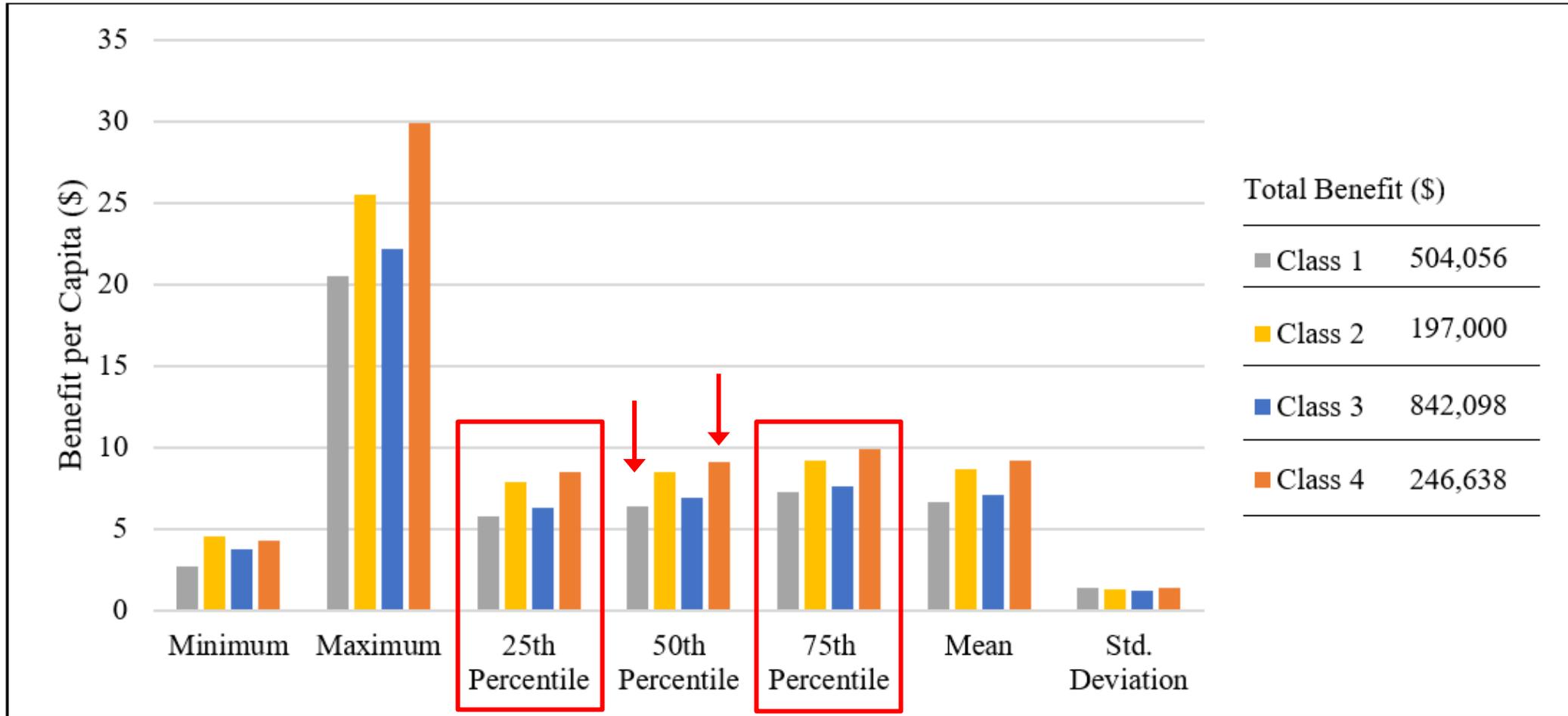
Parameters	Coefficients	
Total Access and Egress Time (mins)	-0.021***	
Total Wait Time (mins)	-0.017	
Total Travel Time (mins)	-0.029***	
Total Travel Cost (\$)	-0.088***	
	Mode (Base: Walk)	Drive Alone
Constant	-1.004**	-0.088
Gender: female	0.565***	0.581***
HH Size	0.109*	0.044
HH Vehicle per Driver: high (base: low)	1.201***	0.031
	HH Income (base: low)	
HH Income: lower middle	-0.117	-0.334
HH Income: middle	0.282	-0.522*
HH Income: upper middle	0.244	-0.686**
HH Income: high	0.021	-1.488***
	Work Flexibility (base: no)	
Work Flexibility: low	-0.587***	-0.455**
Work Flexibility: high	-0.378	-0.408
Land Use Entropy at Destination	1.582	0.961*
Population Density at Destination (persons/acre)	-0.013*	0.001

Mode Choice Model Results

Parameters	Coefficients			
	Class 1 (N=3,766)	Class 2 (N=849)	Class 3 (N=5,663)	Class 4 (N=1,078)
Log of Distance	-0.733***	-0.668***	-0.718***	-0.917***
Retail Jobs	0.143***	0.112*	0.138***	0.356***
Office Jobs	0.029***	---	0.025***	---
Industrial Jobs	0.052***	0.082***	0.055***	0.049***
Service Jobs	0.024**	0.044**	---	---
Entertainment Jobs	0.133***	0.118***	0.162***	0.159***
Education Jobs	0.091***	---	0.080***	0.106***
Health Jobs	0.133***	---	0.104***	0.095***
Public Administration Jobs	-0.022***	0.011*	-0.018***	---
Medium Wage Workers (%)	-0.013***	0.034***	0.011***	---
High Wage Workers (%)	0.026***	---	0.023***	---
Employment Entropy	0.276*	---	0.515***	---
Mode Choice Logsum	0.371***	0.554***	0.427***	0.618***

Employment Accessibility Improvements in SCAG

Benefits across Worker Classes



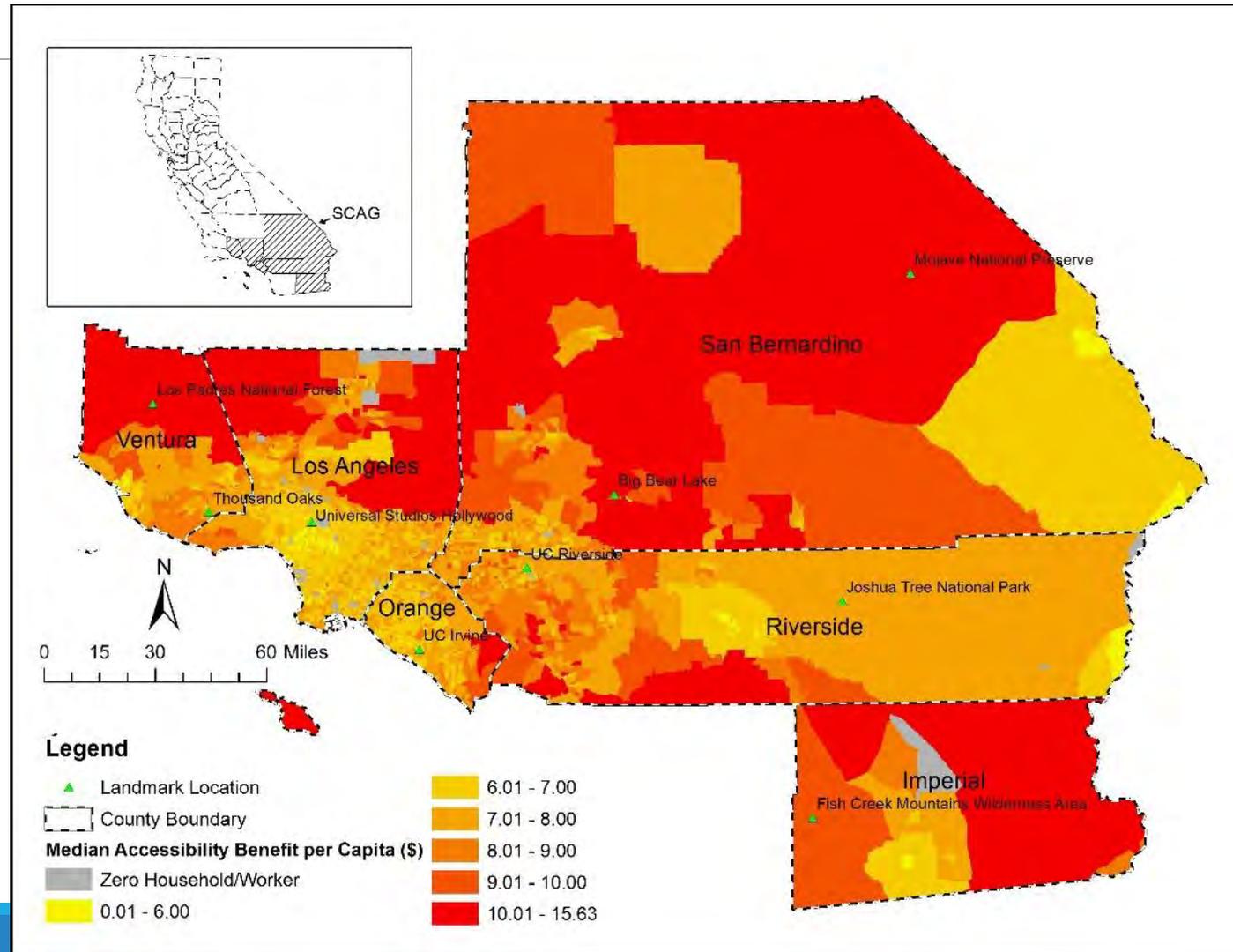
Employment Accessibility Improvements in SCAG

Benefits from each SAMS Mode



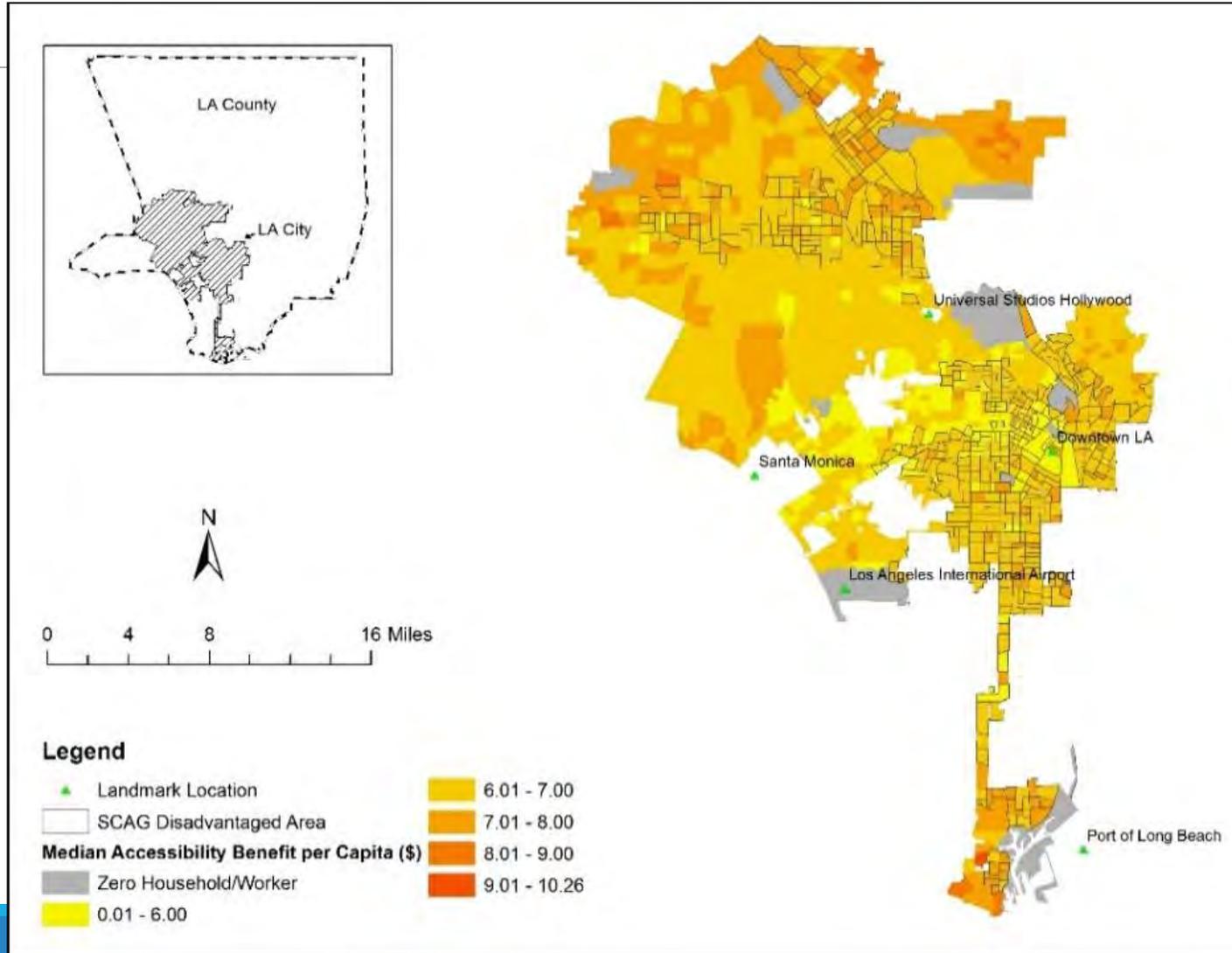
Employment Accessibility Improvements

Spatial Distribution of Benefits in SCAG



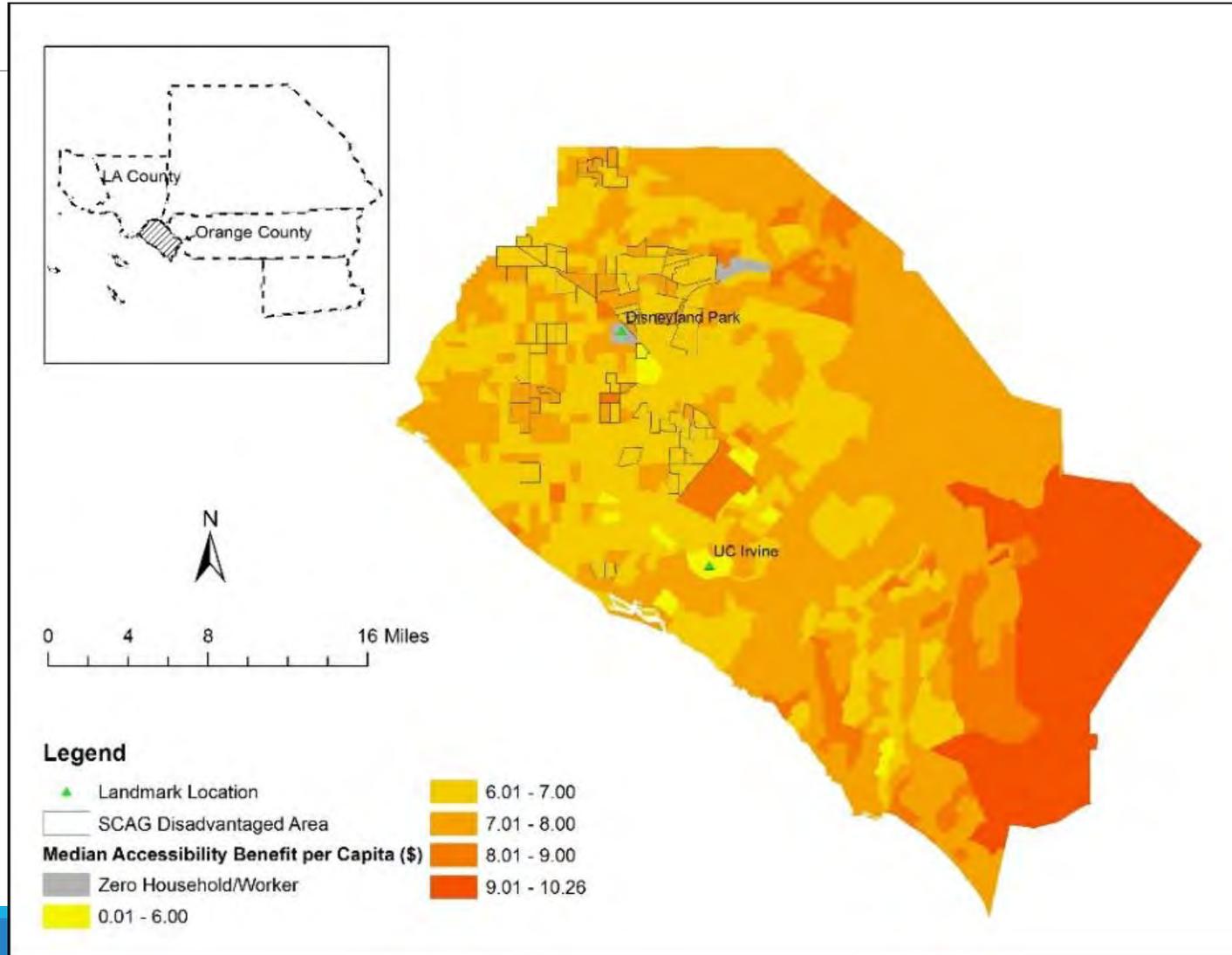
Employment Accessibility Improvements in SCAG

Spatial Distribution of Benefits in Los Angeles County



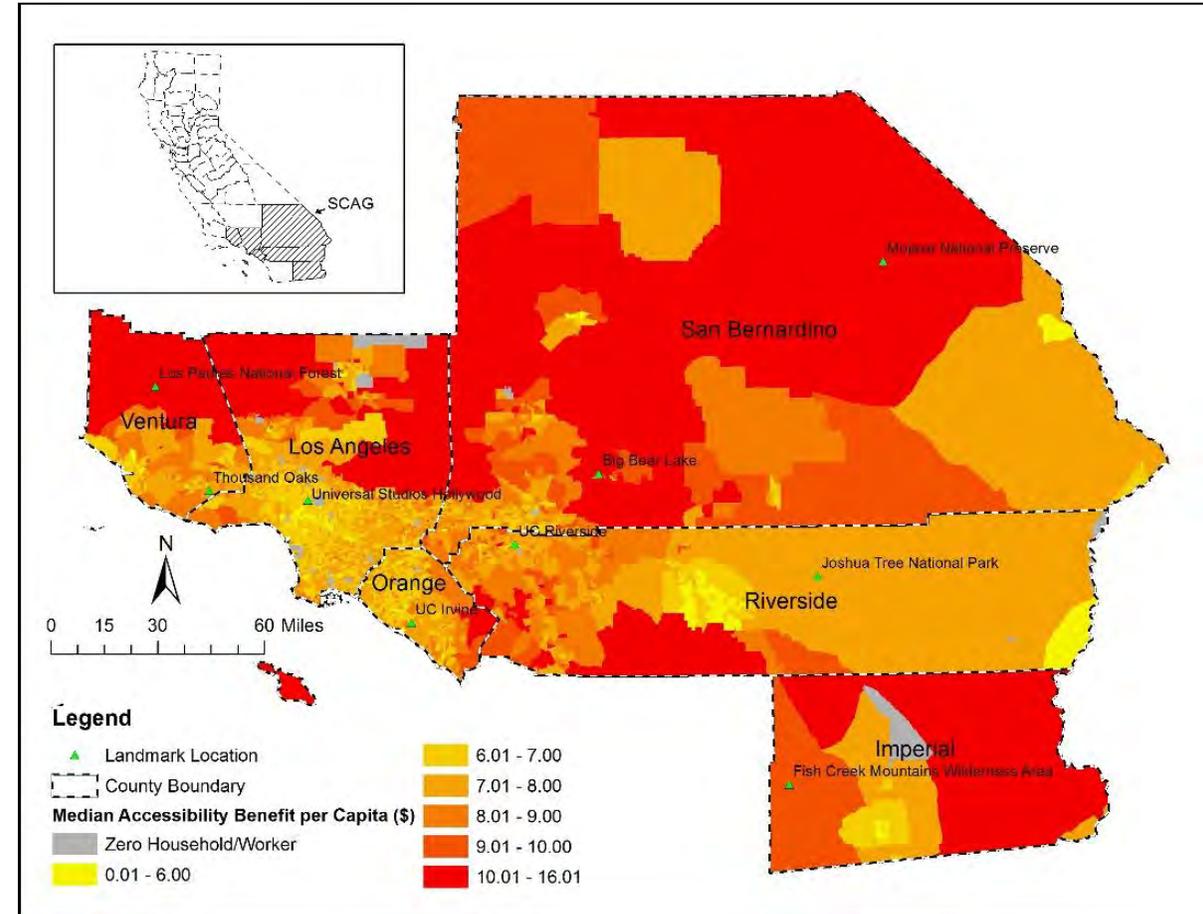
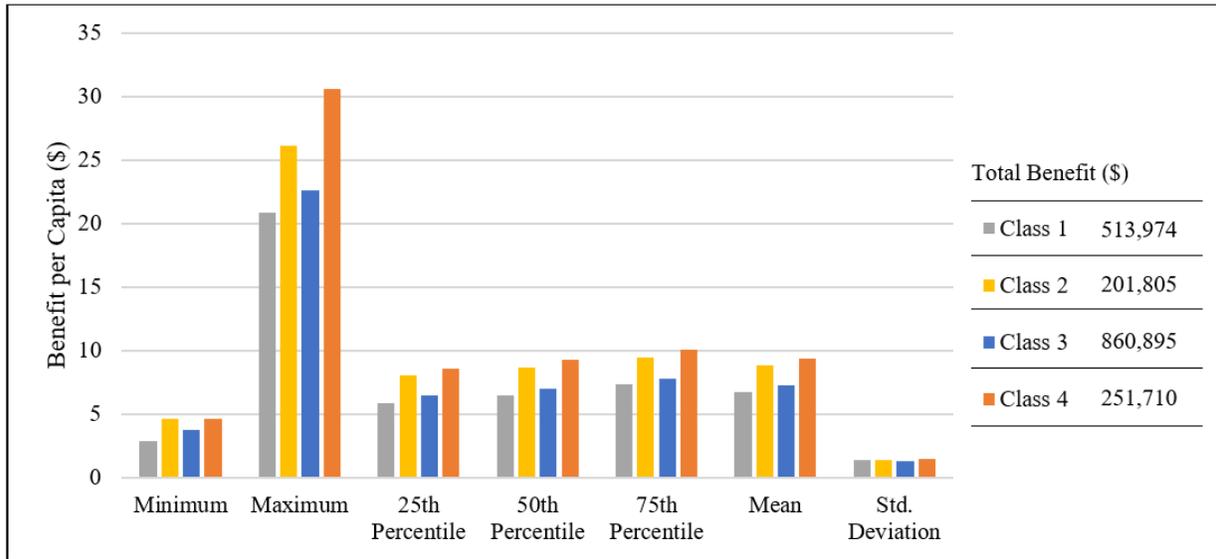
Employment Accessibility Improvements in SCAG

Spatial Distribution of Benefits in Orange County



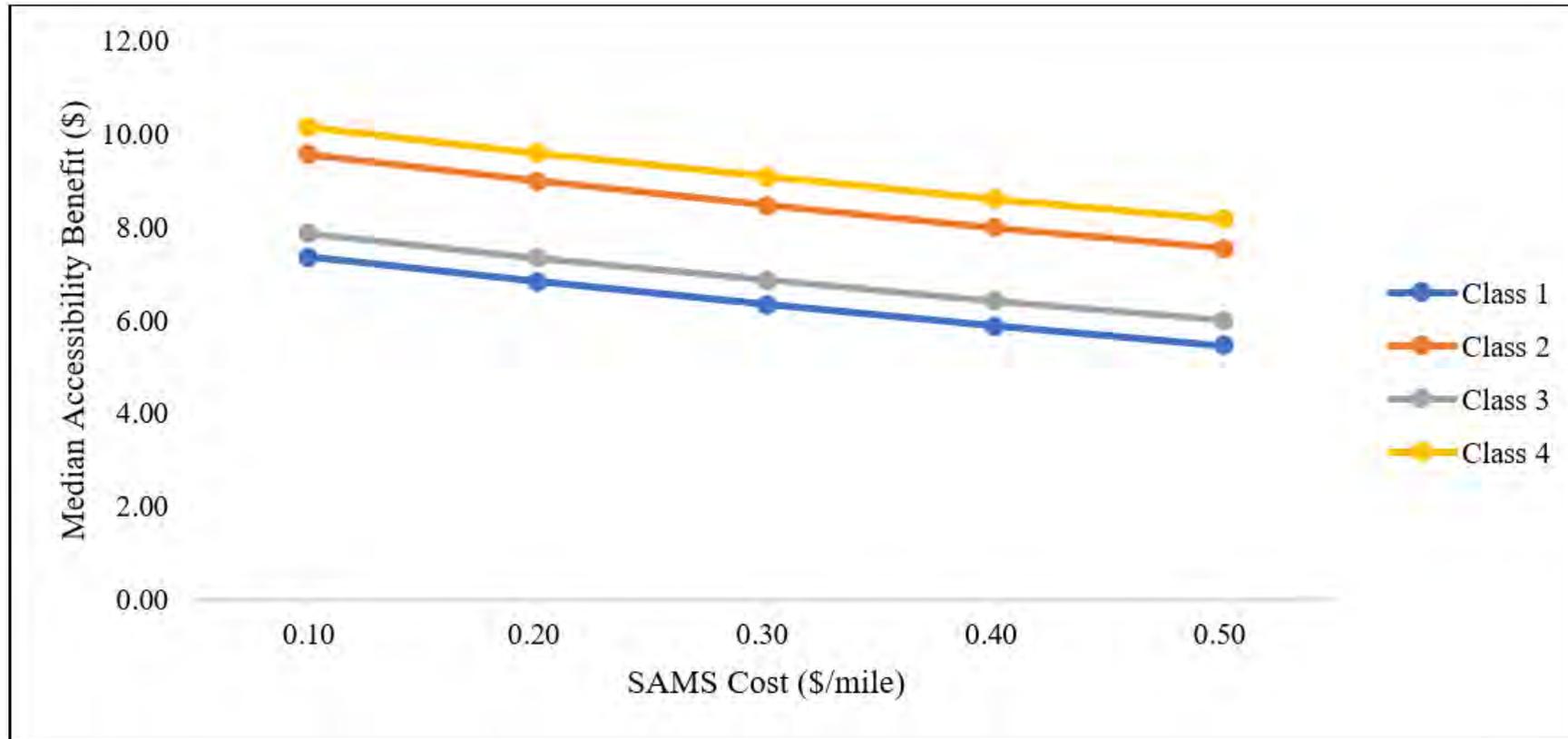
Employment Accessibility Improvements in SCAG

Density Dependent SAMS Wait Time



Employment Accessibility Improvements in SCAG

Accessibility Benefits with Changes in SAMS Costs



Conclusion

Limitations

- Aggregate nature of modal attributes
- Homogeneity of preferences for employment opportunities within each worker class
- Sequential estimation of hierarchical destination mode choice model

Future Research

- Capturing spatial competition for jobs
- Integrating hierarchical destination mode choice model with location choice
- Capturing how accessibility improvements from SAMS modes may induce persons to enter or return to workforce

Questions/Comments: Michael Hyland (hylandm@uci.edu)

The authors would like to acknowledge:

The State of California for funding the research

Southern California Association of Governments (SCAG) for supporting with data

Thank You

