URBAN FREIGHT LAB
UNIVERSITY of WASHINGTON

Building systems of healthy urban goods movement

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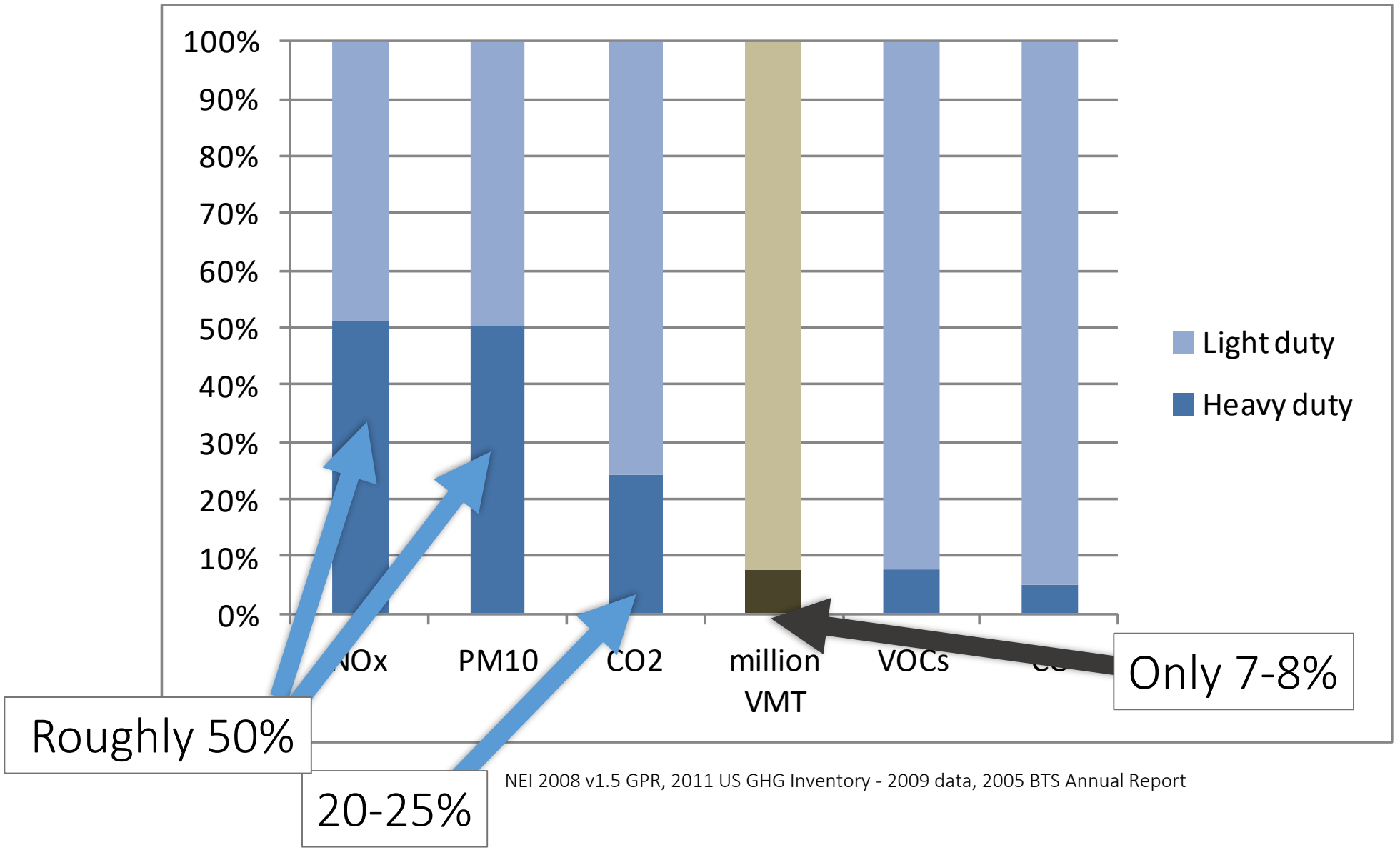
Current City Street – Seattle

Photo Credit Anna Bovbjerg

US Criteria Pollutants Percentage by Vehicle Type



NEI 2008 v1.5 GPR, 2011 US GHG Inventory - 2009 data, 2005 BTS Annual Report

Urban freight transport's disproportionate impacts

Toronto, ON: diesel exhaust represents

55% of all NOx emissions

equating to ~10,000 years of life lost per year

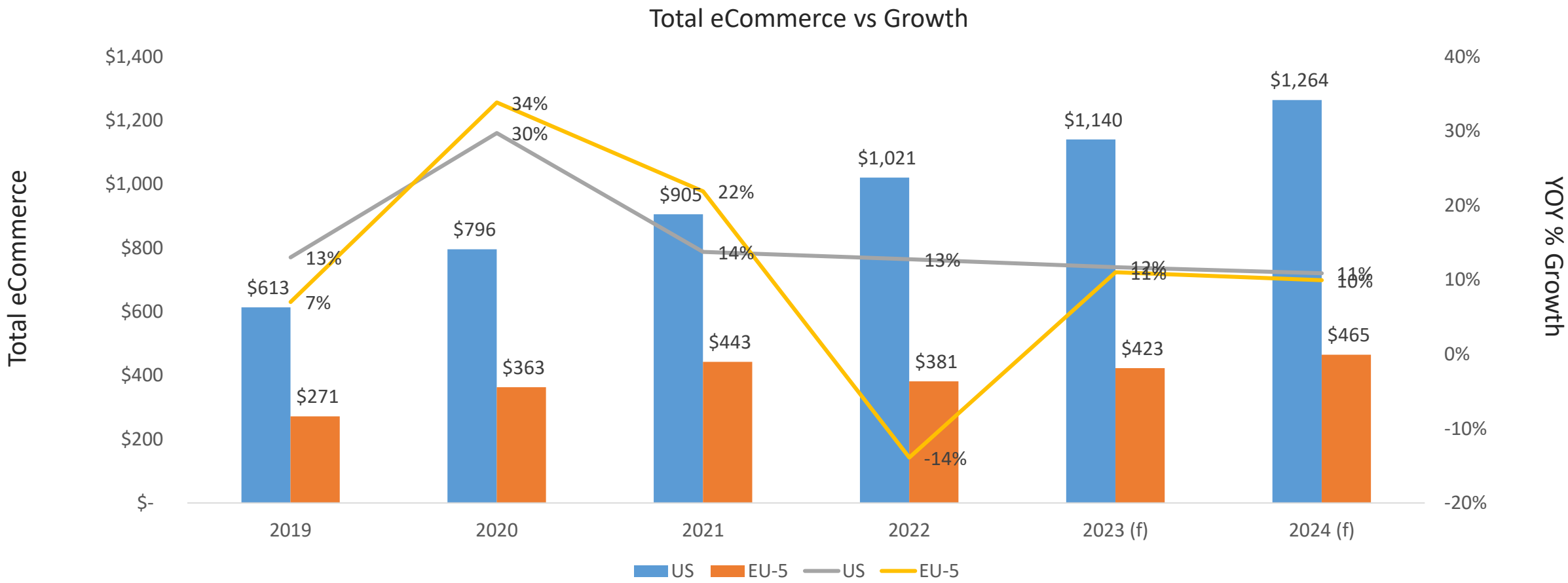
Urban freight related road deaths on city streets increased

28% between 2005 and 2015

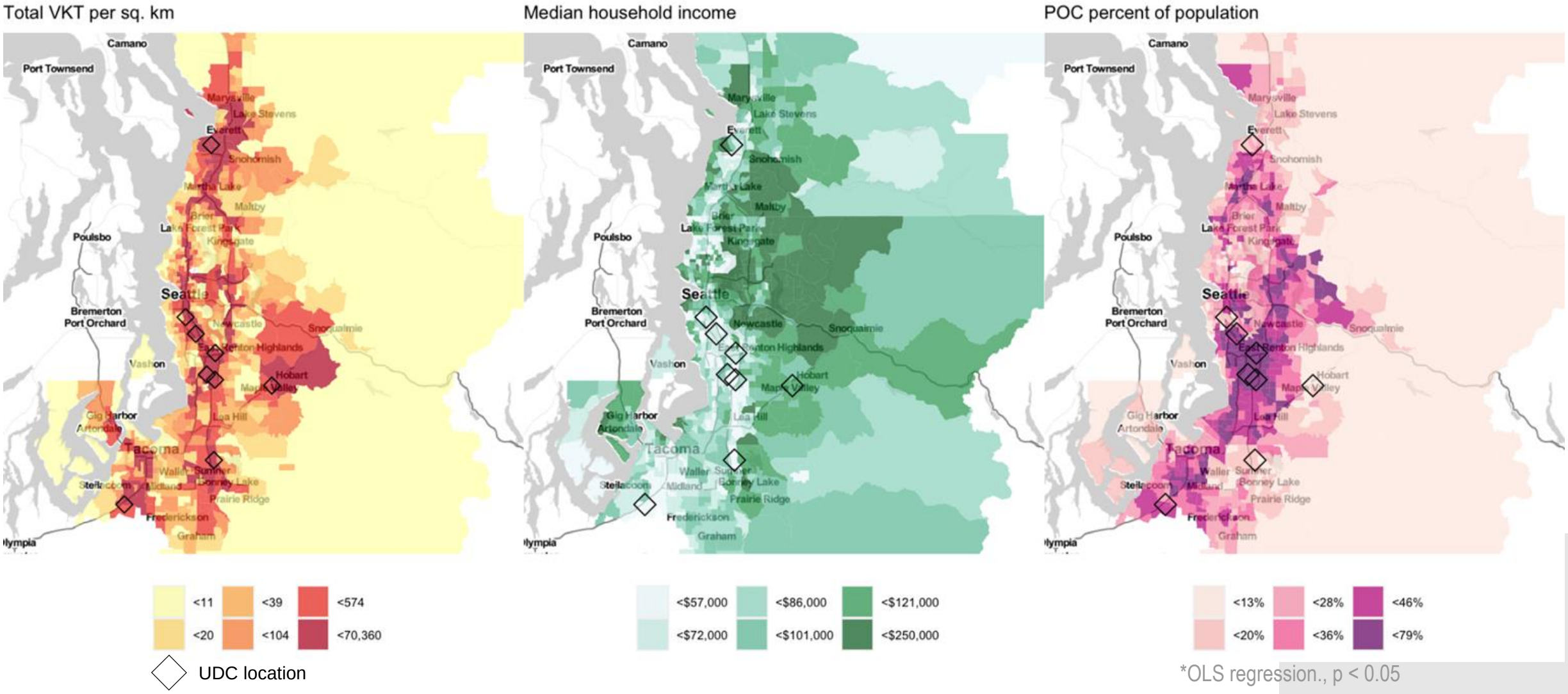
for pedestrians and cyclists

Sources Minet et al., 2020, McDonald et al., 2019

Following the pandemic, ecommerce growth still strong



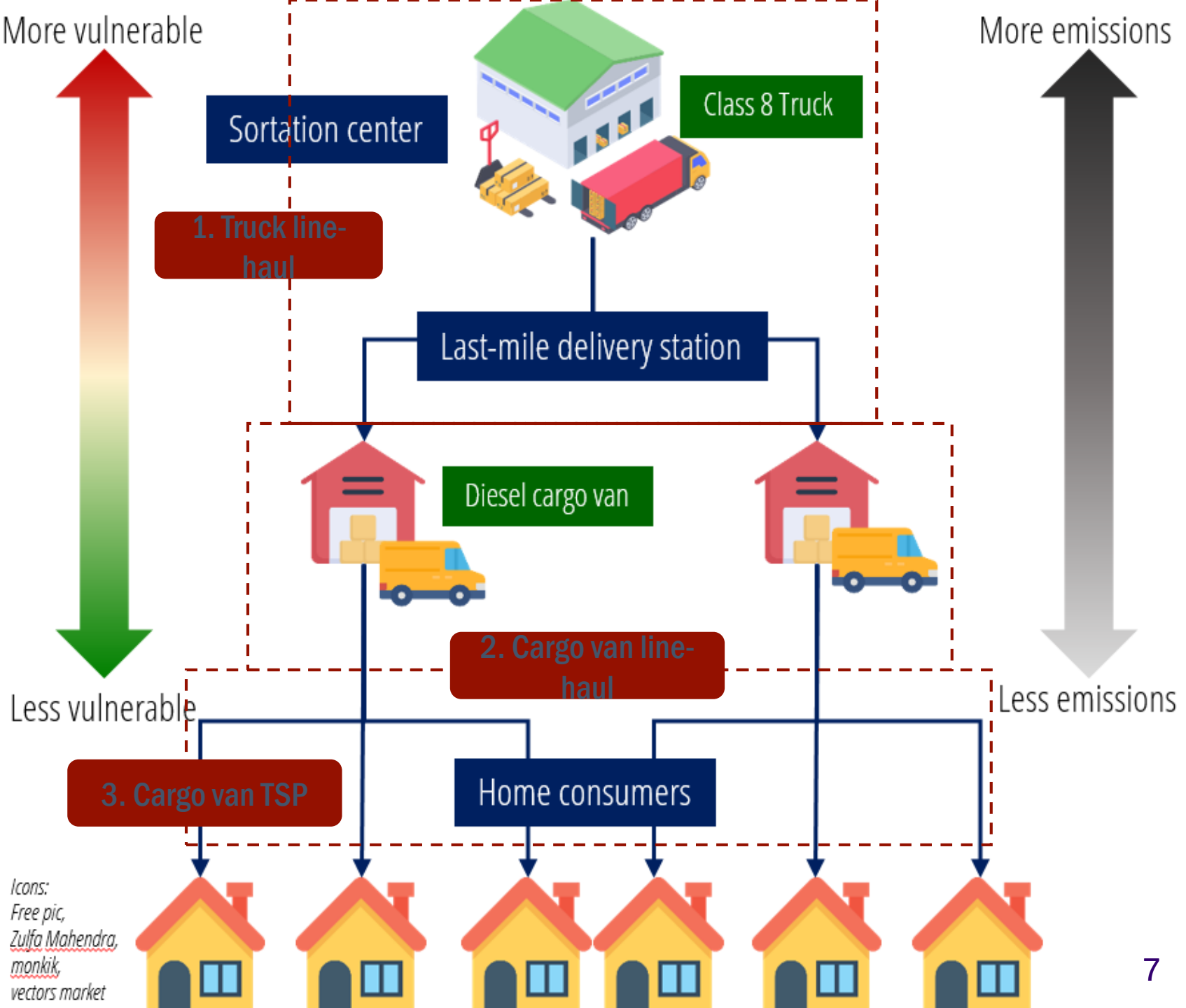
Highway and UDC proximity stronger predictors for delivery traffic than package demand*

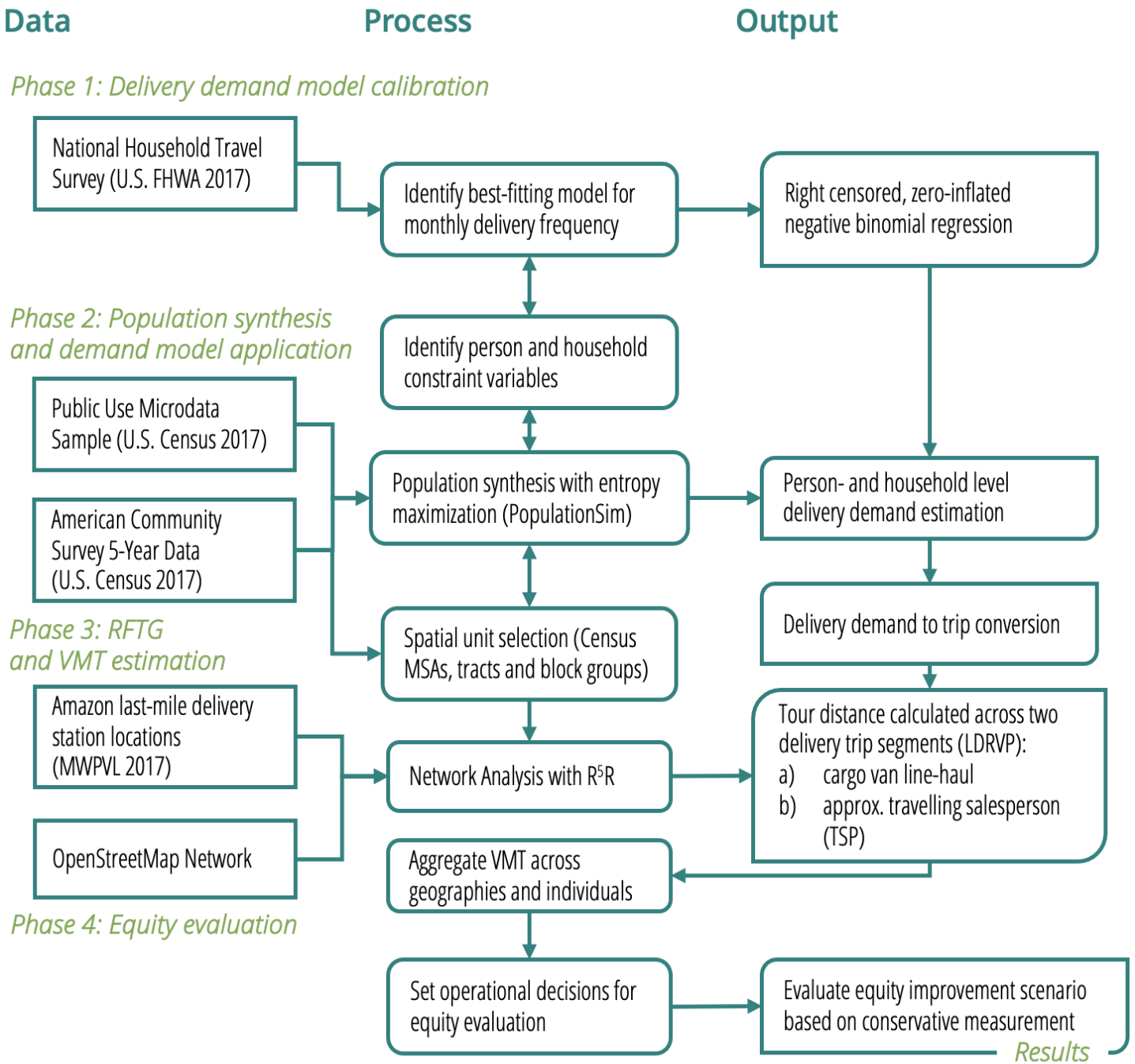


*OLS regression., $p < 0.05$

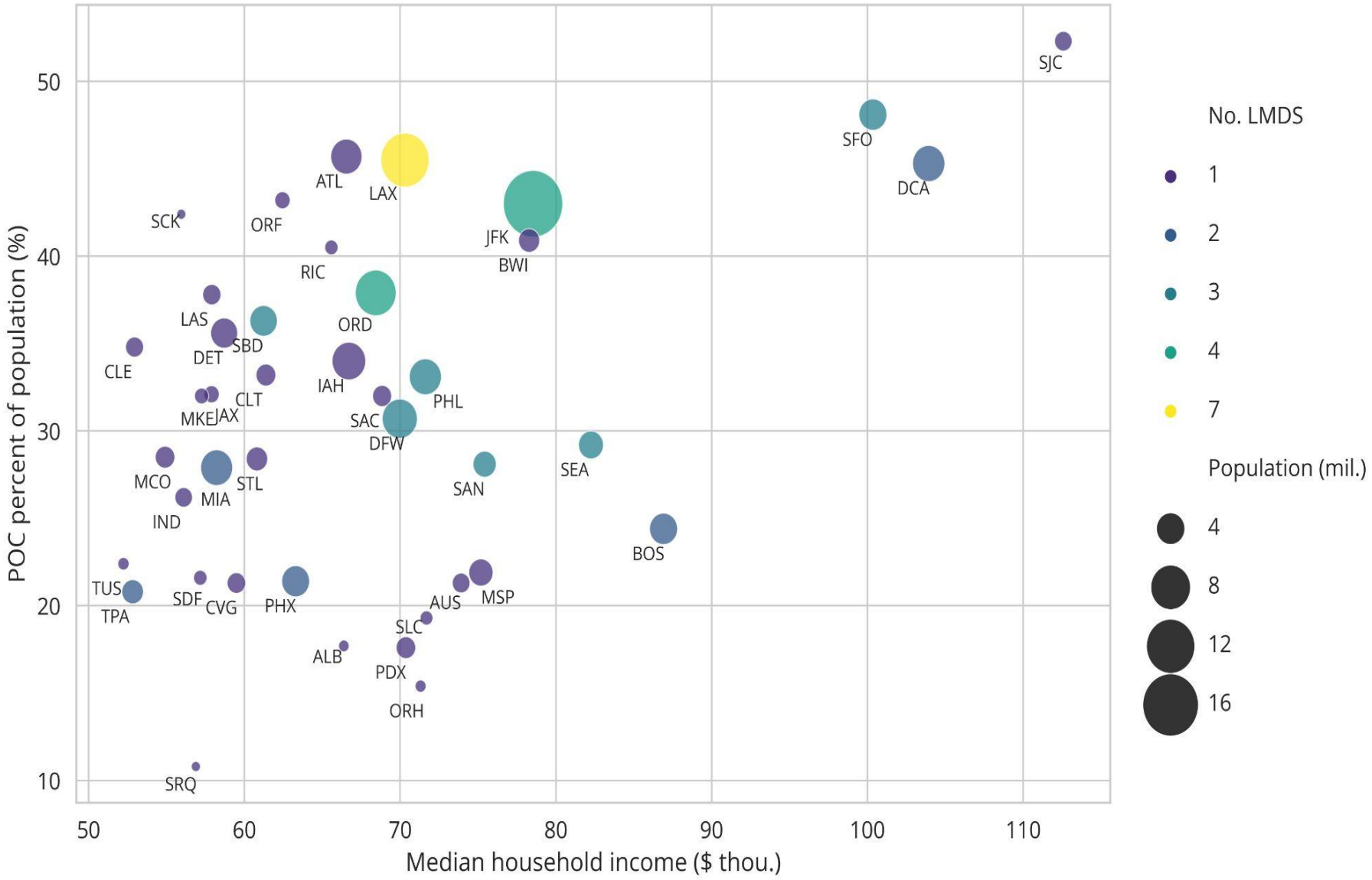
Data and model

- **Data**
  - Amazon UDC locations and package volumes (MWPVL 2021)
  - Demographic data from U.S. Census, ACS 5-year
  - Logit-based delivery assignment based on PSRC travel survey data
  - Network analysis & approx. travelling salesperson (TSP) distance




Data
Process
Output
Phase 1: Delivery demand model calibration
National Household Travel Survey (U.S. FHWA 2017)
Identify best-fitting model for monthly delivery frequency
Right censored, zero-inflated negative binomial regression
Phase 2: Population synthesis and demand model application
Identify person and household constraint variables
Public Use Microdata Sample (U.S. Census 2017)
American Community Survey 5-Year Data (U.S. Census 2017)
Population synthesis with entropy maximization (PopulationSim)
Person- and household level delivery demand estimation
Phase 3: RFTG and VMT estimation
Spatial unit selection (Census MSAs, tracts and block groups)
Delivery demand to trip conversion
Amazon last-mile delivery station locations (MWPVL 2017)
OpenStreetMap Network
Network Analysis with R5R
Tour distance calculated across two delivery trip segments (LDRVP):
a) cargo van line-haul
b) approx. travelling salesperson (TSP)
Aggregate VMT across geographies and individuals
Phase 4: Equity evaluation
Set operational decisions for equity evaluation
Evaluate equity improvement scenario based on conservative measurement
Results

41 MSAs that vary in demographics



By the most conservative estimate, populations of color (POC) exposed to

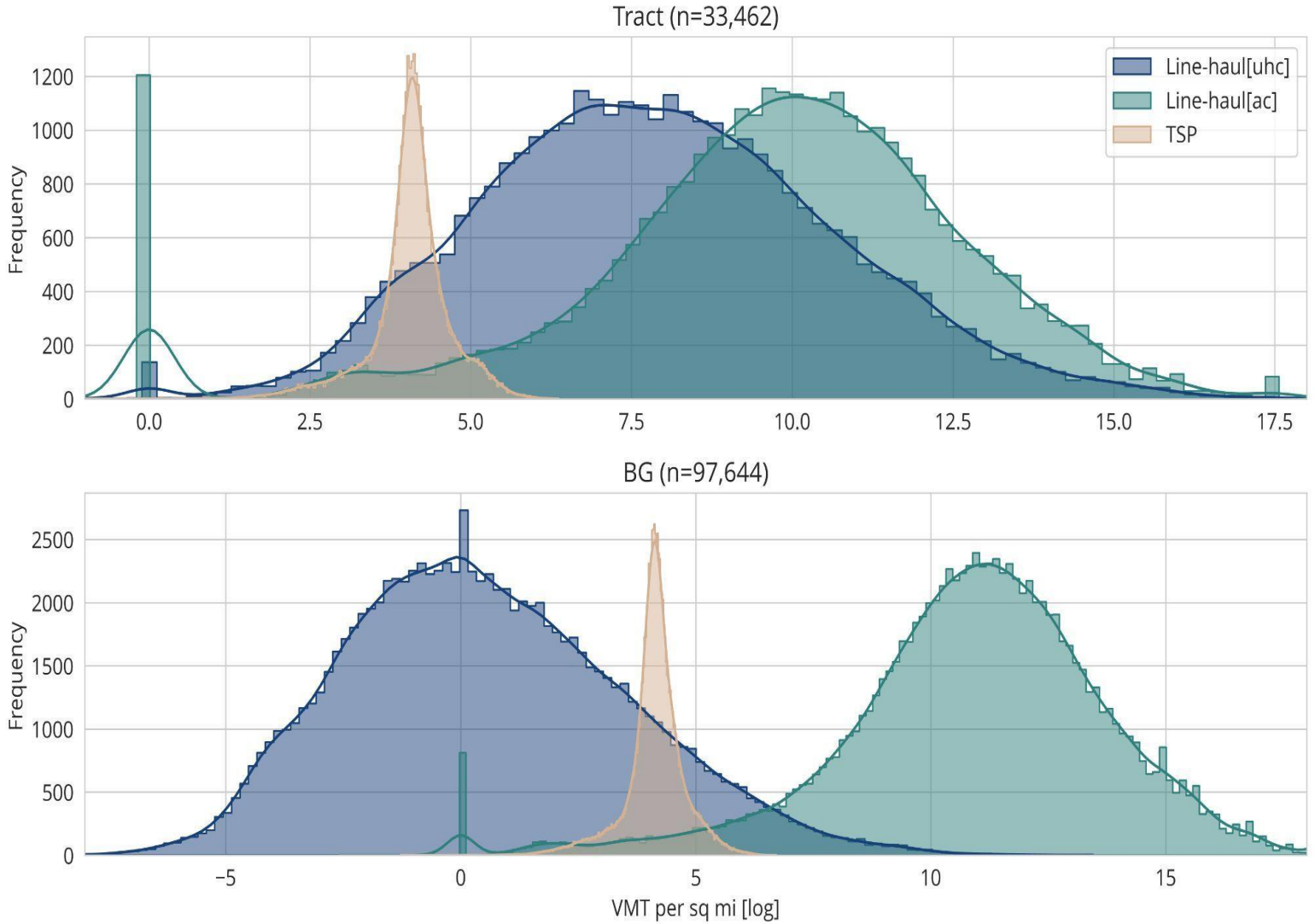
35% more van traffic on average*

despite ordering less than half as many packages

as white populations.

*Kruskall-Wallis H-test, $p < 0.01$

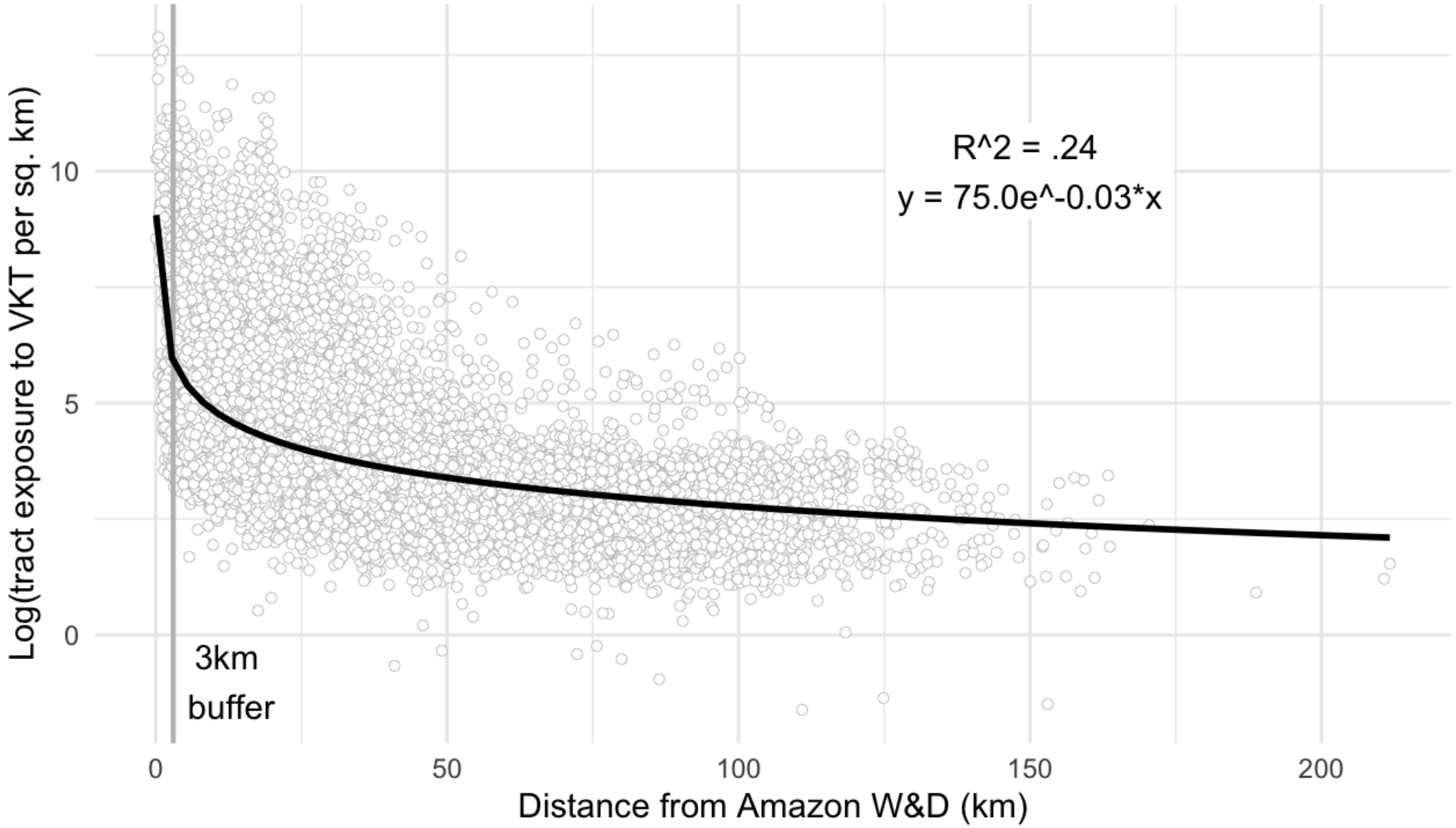
Significant sensitivity to geographical unit of analysis



Some regions have very little line-haul distance and others have a lot

All areas have local delivery miles

Tracts within 3 km of a facility have highest traffic exposure



High "line-haul" impact

Marginal equity benefit

Distribution-oriented solutions

Improving efficiencies here saved
17% more van delivery traffic
for POCs compared to white populations

Truck route management

Multi-use consolidation centers

Receiver-led consolidation

Dynamic routing and load pooling

Multi-use road lanes

Off-hour delivery

Electric trucks

Public sector push

Private sector push

Zero emission delivery zone in wealthy downtown

Common carrier parcel locker/CDPs

Electric vans

Building codes and cargo bays

Dynamic curbside management

Microhub+ cargo bike

Truck depot+ drone/droid

Consumer-oriented solutions

High "TSP" impact

ICONS: Toempong, Prettycons, Itim2101, Freepik, VectorPortal, Futuer Nikita Golubev, Surang, juicy_fish, Iconjam, Muttaqin, Uniconlabs

Warehouse Indirect Source Rule

- Air pollution associated with warehouses is not from the facility itself, but from the trucks and other traffic indirectly associated with their operations.
- ISR is a tool for addressing an "indirect source" of air pollution.
- In 2021, the South Coast Air Quality Management District (SCAQMD) adopted a groundbreaking Indirect Source Rule to address warehouse and distribution center related emissions.
- EPA proposed approval
- An air emissions reduction and mitigation plan requiring warehouse operators to demonstrate emission reductions efforts

Research Needs and Directions

- Comprehensive inventory of policy landscape
- Hear directly from communities on perceptions and preferences
- Quantify multi-factor impacts and add to equity analysis
- Improved understanding of sensitivities and uncertainties

Thank you!

Questions?

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