Disparate Impact and Disproportionate Burden (DI/DB) Policy for Long-Range Transportation Plan (LRTP)

Part 1: Quantifying Uncertainty

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Outline

• What we are doing and why
• Uncertainty in forecasting
• Quantifying uncertainty for the DI/DB Policy
• Findings
Background

• MPO staff developing LRTP DI/DB Policy
  • Applies to major infrastructure projects in LRTP as a group → analyze for Destination 2040
  • Could the build scenario adversely affect minority and/or low-income populations?
• 2018: 3 working group mtgs, 1 public workshop
  o Set of metrics to measure impacts
  o Account for uncertainty in travel model forecasts
  o Need to be confident in predictions
Potential Metrics

- **Accessibility (highway and transit)**
  - Jobs
  - Retail amenities
  - Healthcare facilities
  - Higher education

- **Mobility (highway and transit)**
  - Average travel time

- **Environmental (highway)**
  - Congested VMT
  - Carbon monoxide
Why Study Uncertainty?

Does the difference between no-build and build scenarios exceed the statistical error in the regional forecasting model?

“It's tough to make predictions, especially about the future.” — Yogi Berra
Uncertainty in Forecasting
Sources of Uncertainty in Regional Travel Forecasting

- Forecasting human behavior!
- Projecting to the future! (2040)
- CTPS’s travel model is a complex assembly of data inputs, assumed behaviors, statistical relationships, and algorithms
Effect of Uncertainty on Metrics

Relatively “Low” Variance

-/+ 7%

-/+ 13%

“Low” Variance

Average Travel Time (minutes)

Year

2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040

Expected Value
Lower Bound
Upper Bound
Effect of Uncertainty on Metrics

Relatively “High” Variance

-/+ 7%

-/+ 25%

“High” Variance
Approach to Quantifying Uncertainty

- **Objective:** estimate a forecasting error interval for each metric
- **How?** Test the regional model’s sensitivity...
  - Identify primary sources of uncertainty, vary them, and see how model outputs change
  - Develop a set of meta models that can test many combinations of inputs *quickly* to generate a distribution of outcomes
Steps

1. Identified 18 key drivers of regional model uncertainty
2. Ran experiments varying key inputs, collected metrics
3. Estimated meta models from results of experiments
4. Made 1000s of predictions using meta models
5. Derived forecasting error intervals from predictions
Example of Estimated Meta Model

Average Highway Travel Time
Low-Income and Non-Low-Income

$r^2 = 0.950$; test dev: 0.033, 0.033
Example of Simulated Predictions

Average Highway Travel Time
Low-Income and Non-Low-Income

Forecasting error interval

Number of simulated outcomes

Average minutes per trip

HwyProdTm Low-Income Simulated Distribution

100
50
0
-13.1%
+13.1%
14 16 18 20 22

HwyProdTm NonLow-Income Simulated Distribution

100
50
0
-13.3%
+13.3%
14 16 18 20 22

Average minutes per trip
Hypothetical: Travel Time for Minority Population

No-build scenario output

Build scenario output

15 percent (forecasting error) X 20 minutes = 3 minutes

Is 5 minutes > 3 minutes?
Yes. Projected impact.
Findings (1 of 2)

• Results vary by mode and population group
• Not all metrics are useful for determining whether build scenarios have statistically significant impacts—too much uncertainty
• Highway accessibility metrics have wide forecasting error intervals—high uncertainty
  o Broad network coverage beyond the MPO
  o Future job locations
Findings (2 of 2)

- **Transit access metrics**—low uncertainty
  - Calculation is limited by transit network coverage and walkability
- **Mobility metrics** (average highway and transit travel times)—low uncertainty
- **Environmental metrics** (local exposure to congested VMT and carbon monoxide)—low uncertainty
Summary

• Importance of accounting for model uncertainty in the DI/DB policy
• Staff study quantified uncertainty for proposed metrics
  o Determined some might not be suitable
  o Produced forecasting error intervals to be “plugged” into policy analysis framework
Questions?
RESERVE SLIDES
### 18 key inputs (drivers of uncertainty)

1. Auto operating costs
2. Transit fares
3. Toll costs
4. Value of time
5. Household sizes
6. Job locations
7. Transit mode bias
8. Walk/bike mode bias
9. Trip length sensitivity
10. Transit wait/walk sensitivity
11. Transit service frequency
12. Park-and-ride lot supply
13. Roadway capacities
14. Congestion-delay sensitivity
15. Peak spreading factors
16. Work trip generation
17. Non-work trip generation
18. Truck trip generation