Land Use and Travel Model Integration

Testing The PSRC Land Use Model Response to Transportation Strategies

Innovations in Travel Modeling
May 10-12, 2010

Puget Sound Regional Council
PSRC

Presentation Overview

- Land Use Model Background

- Integration with Travel Model

- Transportation Scenarios Tested

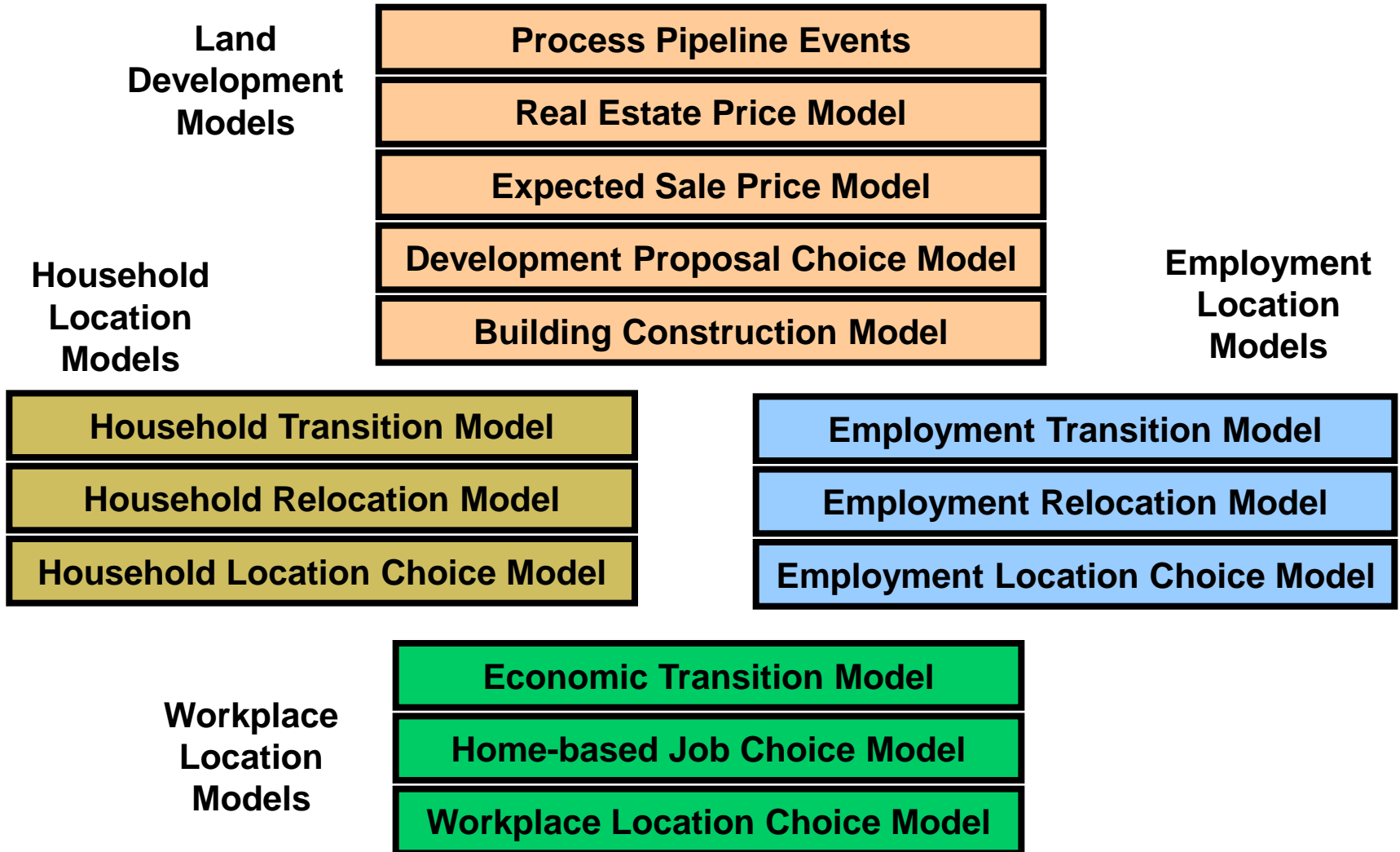- Results

- Future Directions

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Land Use Model Background

PSRC Land Use Model - UrbanSim

- Micro-simulation of actions of actors on parcels and buildings:
  - Households and Workers
  - Jobs
  - Developers / Landowners

- Primary Inputs include:
  - Allowable development (comp plans)
  - Transportation system
  - Major planned developments (pipeline developments)
  - Regional economic forecasts

- Many operating assumptions:
  - Relocation rates
  - SQFT needed per job by sector
  - Construction costs
  - Vacancy rates

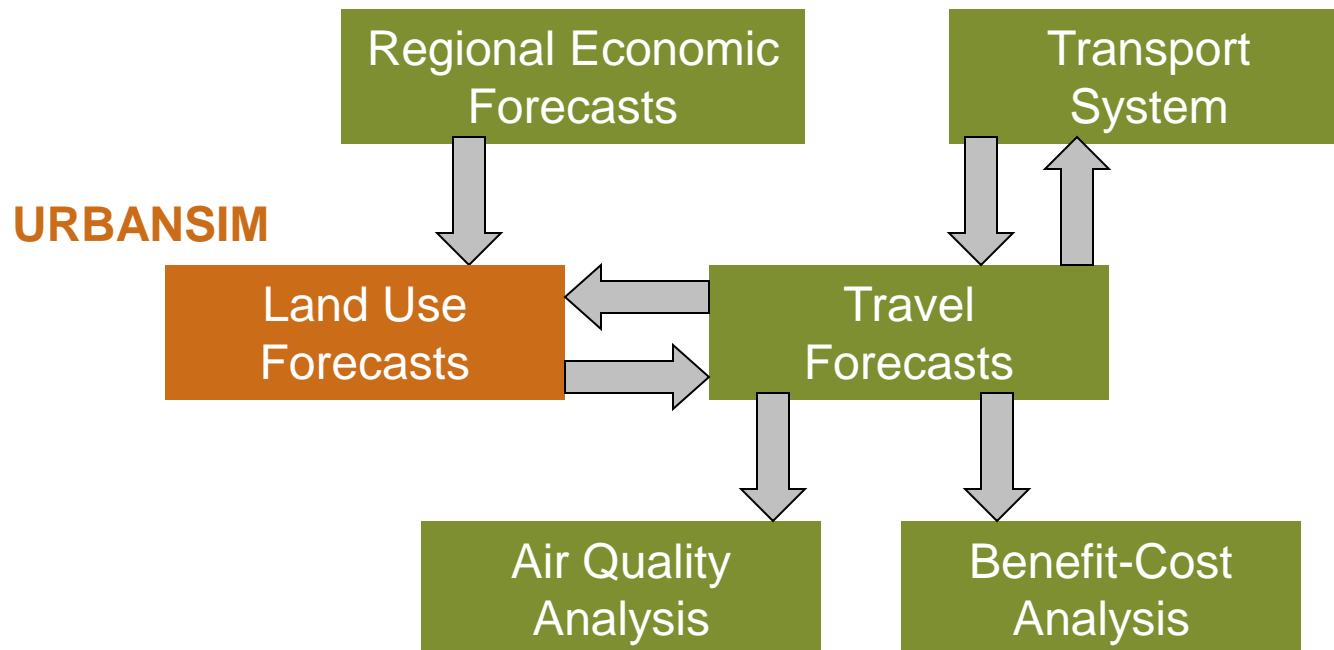- Simulates each year from 2001-2040
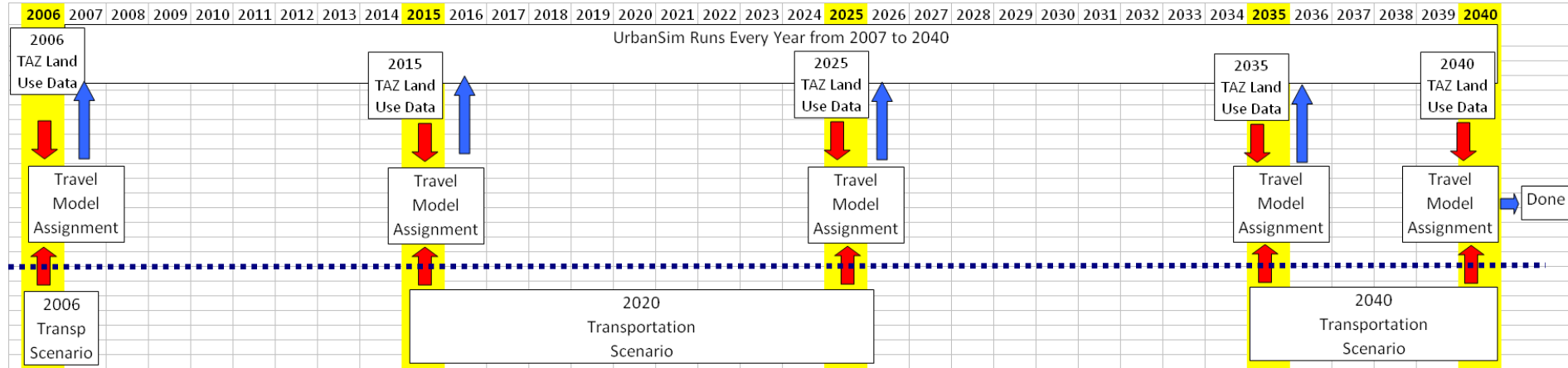
Land Use Model Elements

Land Development Models

- Process Pipeline Events
- Real Estate Price Model
- Expected Sale Price Model
- Development Proposal Choice Model
- Building Construction Model

Household Location Models

- Household Transition Model
- Household Relocation Model
- Household Location Choice Model

Employment Location Models

- Employment Transition Model
- Employment Relocation Model
- Employment Location Choice Model

Workplace Location Models

- Economic Transition Model
- Home-based Job Choice Model
- Workplace Location Choice Model

Integration With Travel Model

PSRC Analysis Framework

Model Handshake – Current Setup

Model Inputs and Integration	Analysis Year				
	2006 (base)	**2015**	**2025**	**2035**	**2040**
Land Use Model Runs, using accessibilities from:	a previous travel model run for land use model run 2006	2006 travel model for land use model runs 2007 through 2015	2015 travel model for land use model runs 2016 through 2025	2025 travel model for land use model runs 2026 through 2035	2035 for land use model runs 2036 through 2040
Travel Model Runs, using population and employment from:	2006 land use model run	2015 land use model run	2025 land use model run	2035 land use model run	2040 land use model run

Accessibility Measures – passed to UrbanSim

Zone-based, measured to a downtown location
- Generalized Cost to Seattle CBD, HBW AM SOV
- Generalized Cost to Bellevue CBD, HBW AM SOV

Zone-based
- Average Travel Time, Trip-weighted, AM, SOV, HBW
- Jobs within 30 minutes travel time, AM, SOV

Person-based, Home to Work Zones
- Network distance from Home to Work
- Log Sum, HBW AM from Home to Work

Accessibility – Model Blocks

		UrbanSim Models			
	Accessibility Measure	Real Estate Price(1)	Household Location Choice	Employment Location Choice(1)	Workplace Location Choice
Zone-Based , Origin Zone to Location					
	Generalized Cost HBW AM SOV to Seattle CBD	16	--	7	--
	Generalized Cost HBW AM SOV to Bellevue CBD	--	--	9	--
Zone-Based, Origin Zone to All Other Zones					
	Average trip-weighted Travel Time, HBW AM SOV,	15	--	7	--
	Jobs within 30 minutes time, AM SOV	12	--	17	--
Person-Based, Home to Work Zones					
	Network Distance from Home to Work	--	X	--	X
	Logsum of HBW AM Trip	--	X	--	X
Grid Cell-based, Proximity to Roadways					
	Distance to Highway	4	--	13	--
	Distance to Arterial	1	--	14	--

(1) – Number of submodels that contain the measure in current specifications, there are 18 sub-models in the Real Estate Price Model, and 17 in the Employment Location Choice Model

Relative Influence of Variables - WLCM

Workplace Location Choice Model
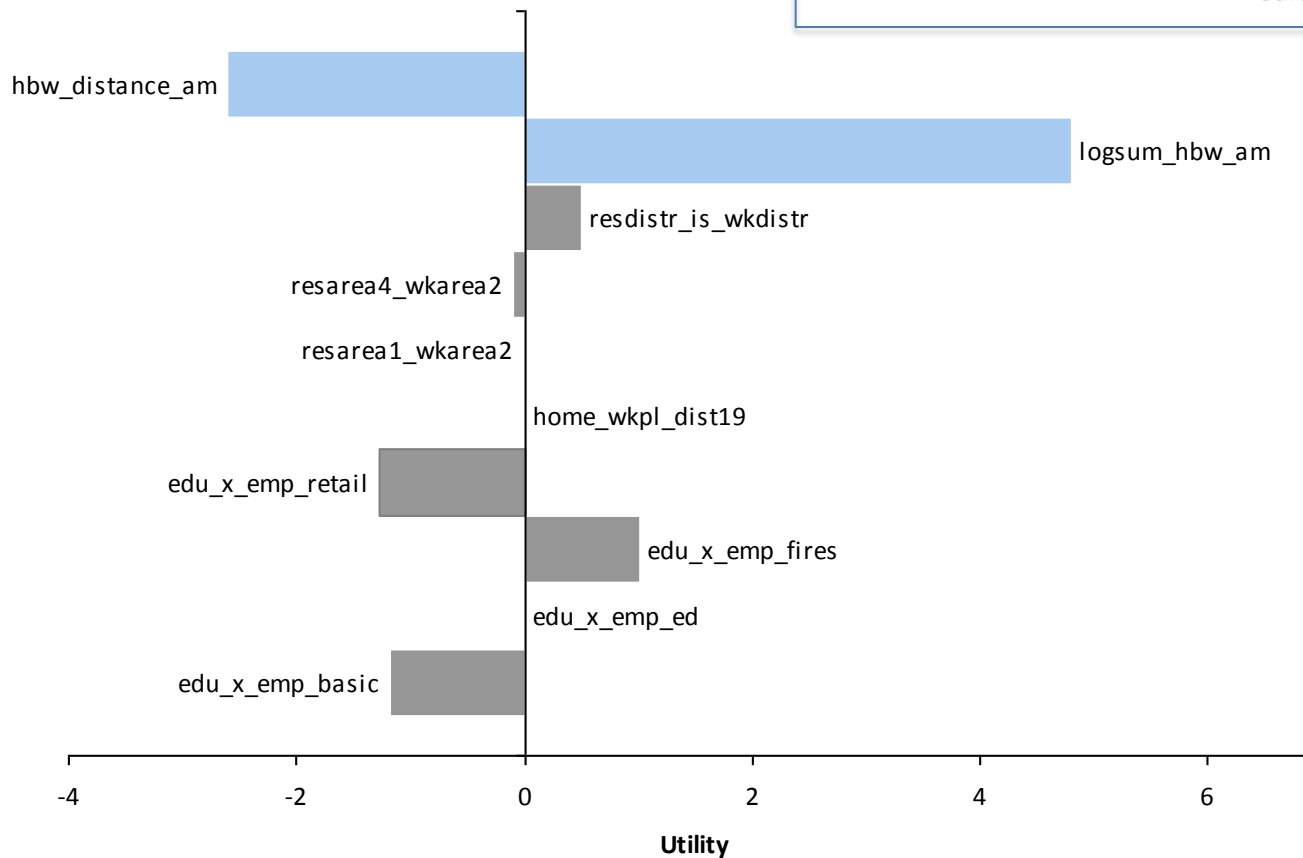
Estimated Parameters $(\boldsymbol{\beta})$

$$\left.\begin{array}{l} \beta_{i1}\,x_{i1}\,+ \\ \beta_{i2}\,x_{i2}\,+ \\ \ldots \\ \beta_{ik}\,x_{ik}\,+ \\ \ldots \end{array}\right.$$

$= \boldsymbol{U_i}$

All variables ($\boldsymbol{x}$) except one held at median value

One variable:
- Use 5th & 95th percentile values
- Calc. Δ $\boldsymbol{U}$ for indication of influence

Relative Influence of Variables - HLCM

Household Location Choice Model

Adj. Likelihood ratio: 0.419

Transportation Scenarios

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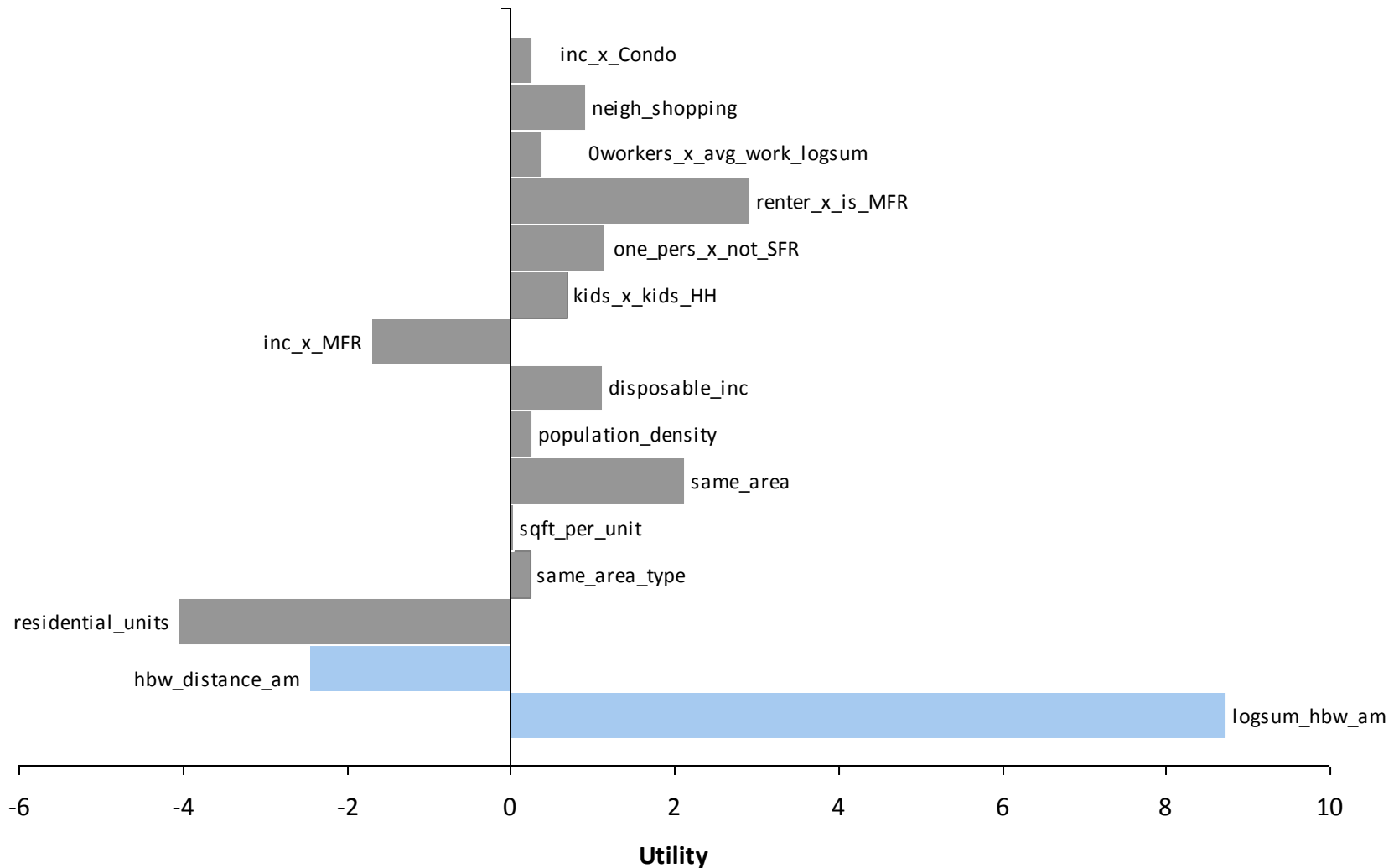
Sensitivity Tests

Base Case Scenario

- Transportation Networks (2020, 2040)

- Modest investments in roads and road-based transit

- Near-term voter-approved rail transit extensions

- Very limited tolling (two bridge crossings)
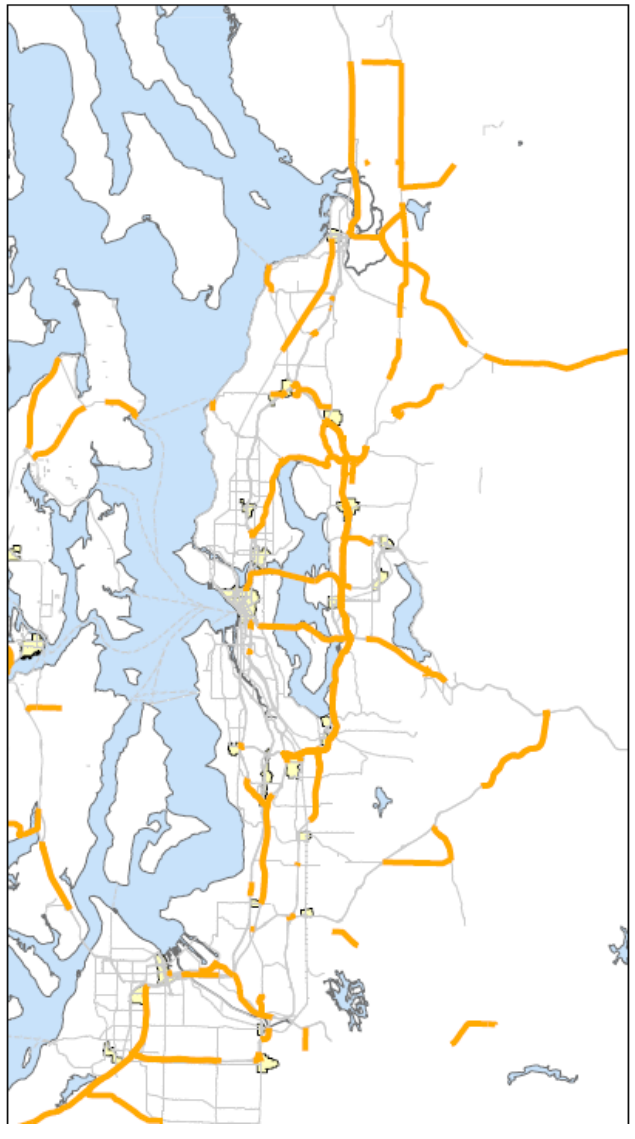
- No real growth in vehicle operating costs

- Modest real growth in parking costs

Alternative Scenarios

- Lower parking costs in selected neighborhoods (zones)

- Higher vehicle operating costs forecast

- Major extensions of rail transit

- Major investments in highway capacity

Alternatives

2020 Daily Parking Charges

Legend
Centers TAZs Parking Charges
Daily 2020

- $1.47 - $5.00
- $5.01 - $10.00
- $10.01 - $15.00
- $15.01 - $20.00
- $20.01 - $25.00
- $25.01 - $29.18
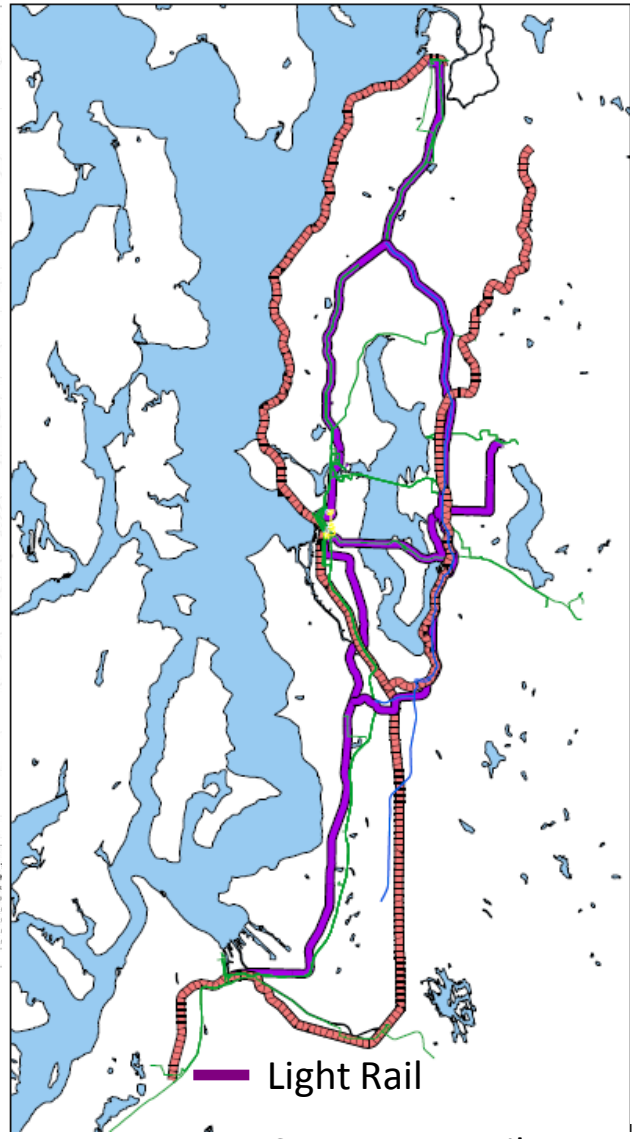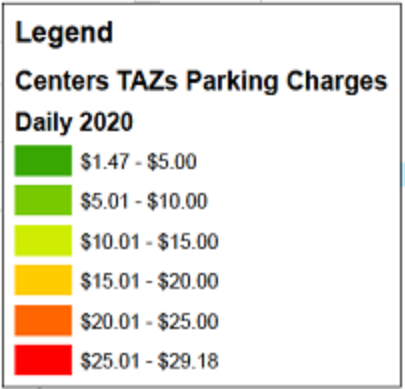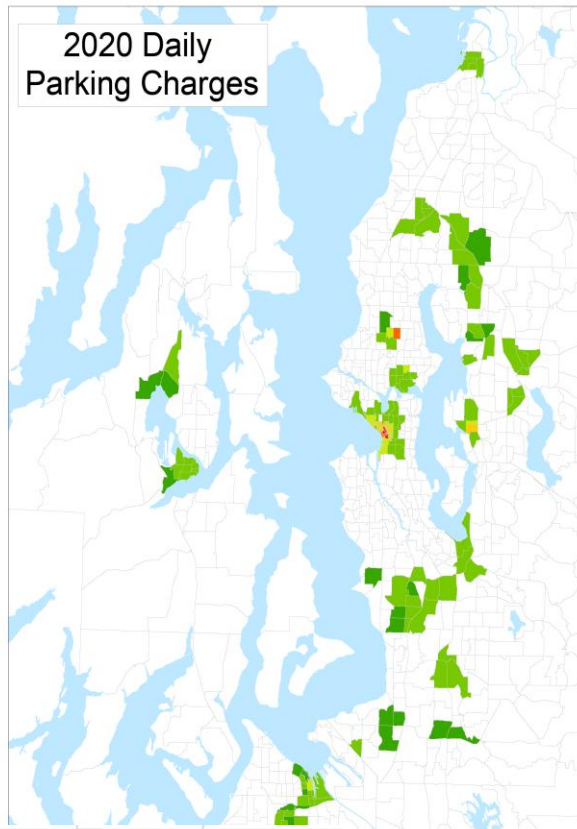
Light Rail

Commuter Rail

Results

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Expectations

- Short-run substitution will minimize the magnitude of cost changes reflected in long-run (location) choices

- Some modest correlation between a composite measure of zonal accessibility and the outputs of the land use model (population, households, employment, work trip locations)

- Higher transportation costs should result in lower site values, and vice versa

- A resorting by willingness to pay for sites may dominate the location choices

Selected Travel Model Statistics

Selected Measures - Travel Model	Base Scenario	Lower Parking Costs	Higher Vehicle Operating Costs	Rail Transit Extension	Highway Capacity
Daily Vehicle Trips	12,207,370	12,282,986	11,871,396	12,211,586	12,261,469
Daily Transit Trips	818,805	772,862	832.134	841,256	814,995
Daily Walk and Bike Trips	2,272,961	2,258,358	2,560,918	2,257,955	2,201,591
Daily VMT	105,976,212	106,312,470	94,195,933	106,185,529	109,787,866
Daily Average Vehicle Speeds	38	38	38	38	40
Trip Lengths					
HBW	13.0	12.9	12.4	13.0	13.1
HBShop	4.5	4.5	3.9	4.5	4.7
HBOther	5.6	5.6	4.9	5.7	5.9

VMT
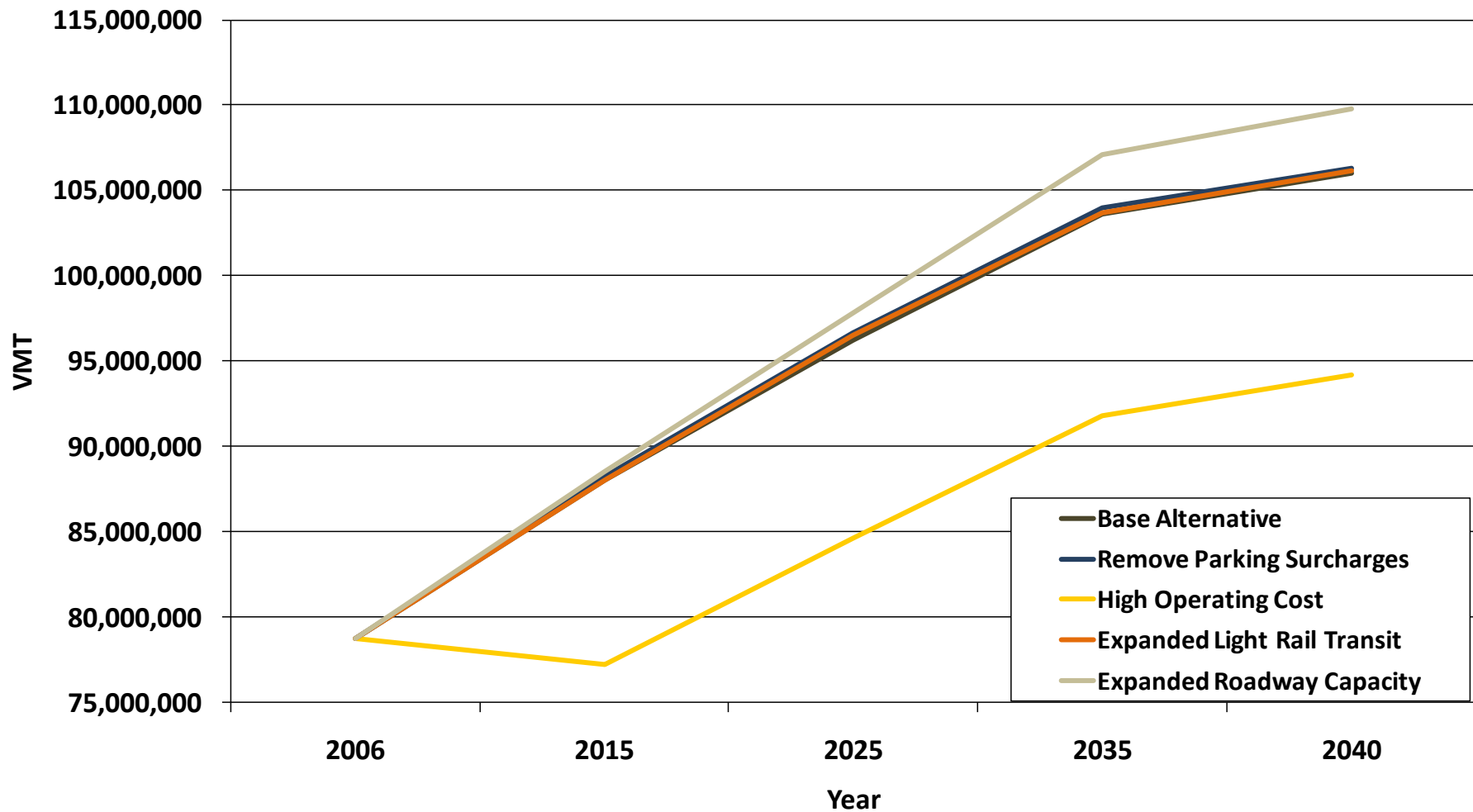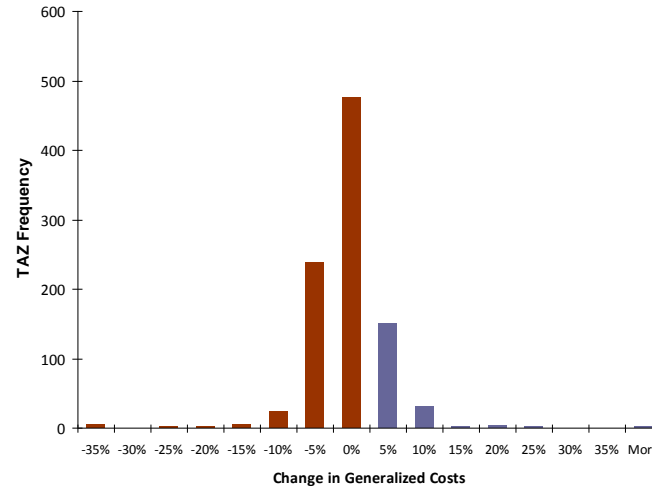
Transit Trips
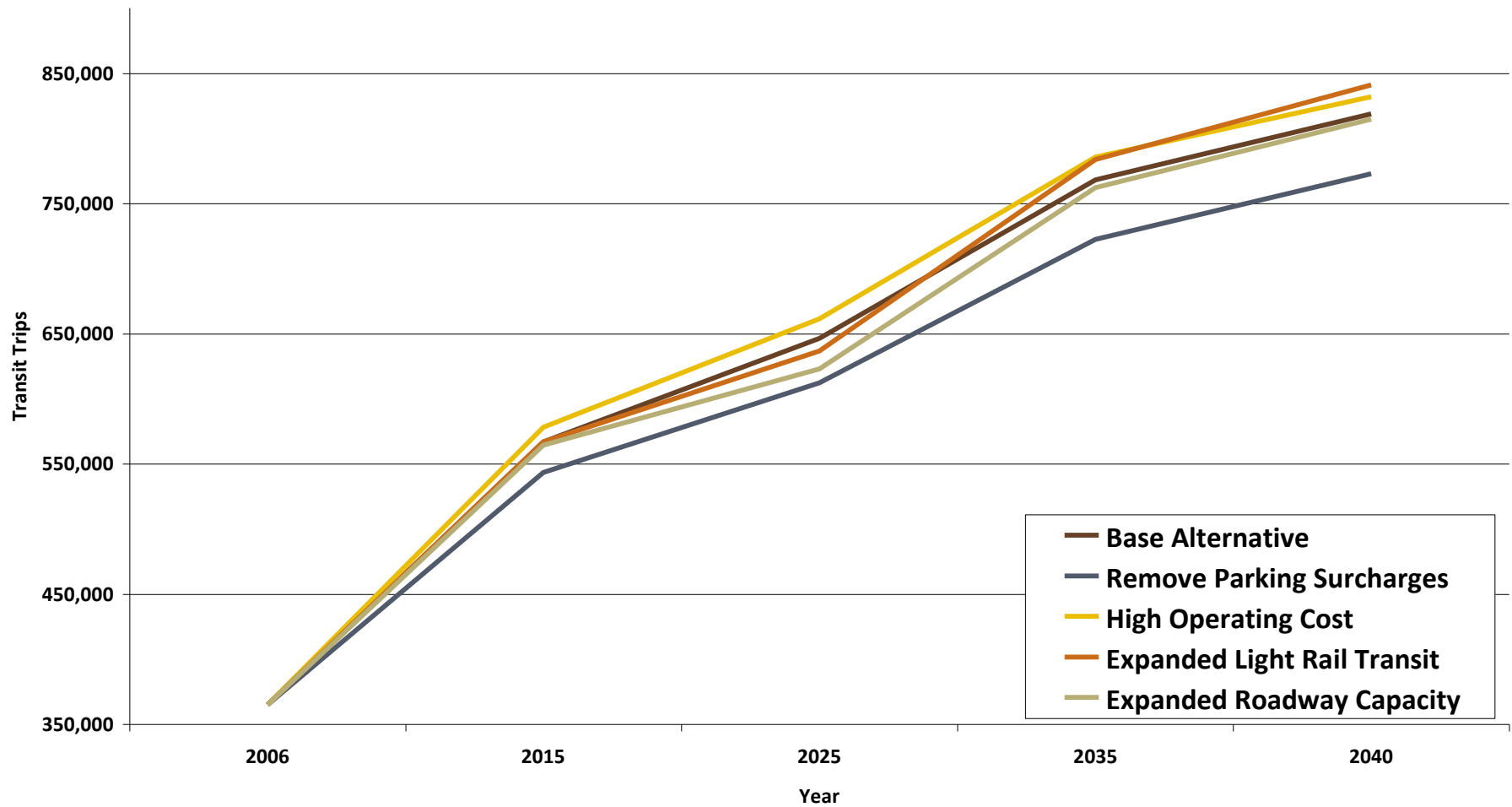
Vehicle Trips
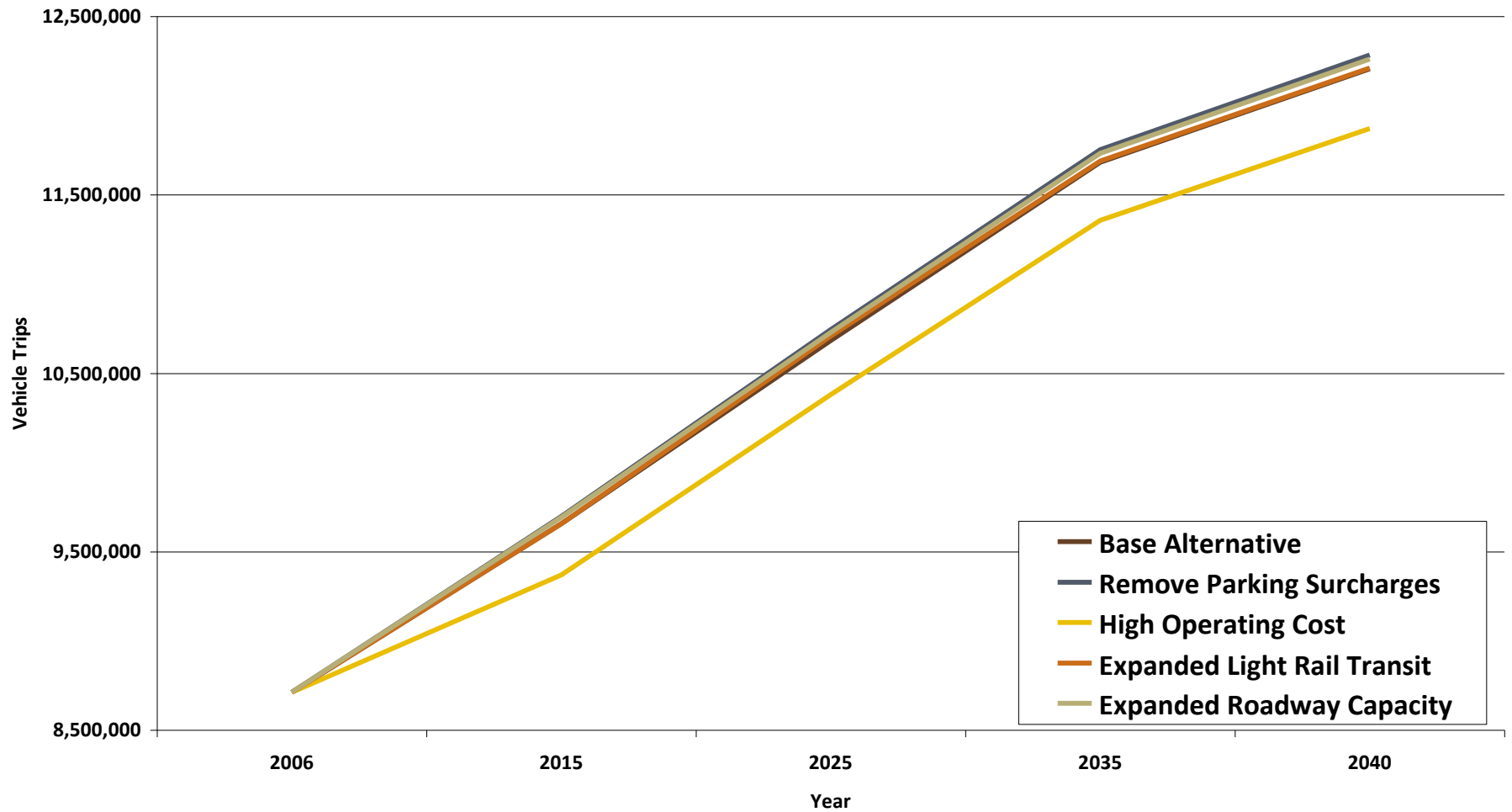
HBW Average Trip Lengths
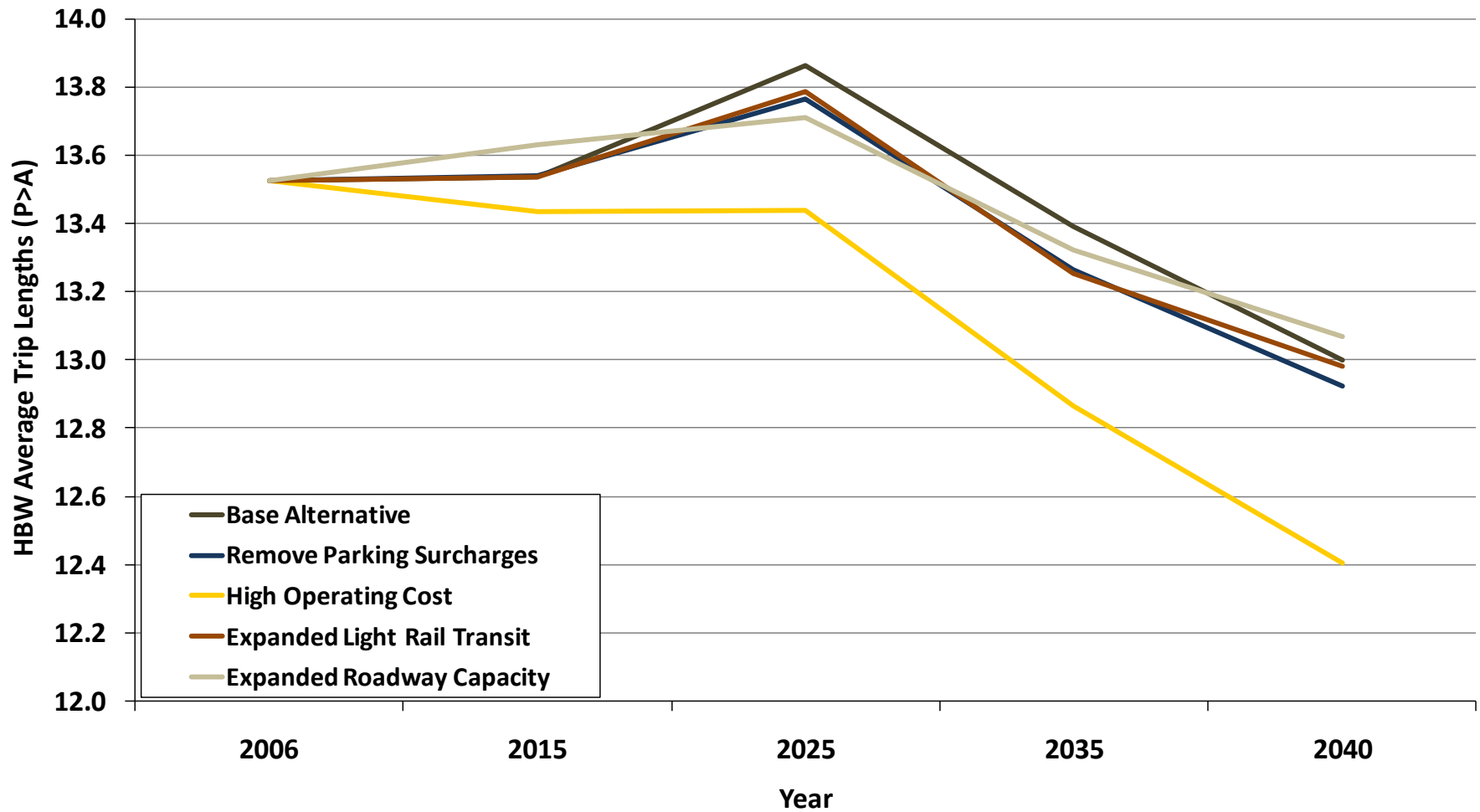
Changes in Access Costs – AM Productions
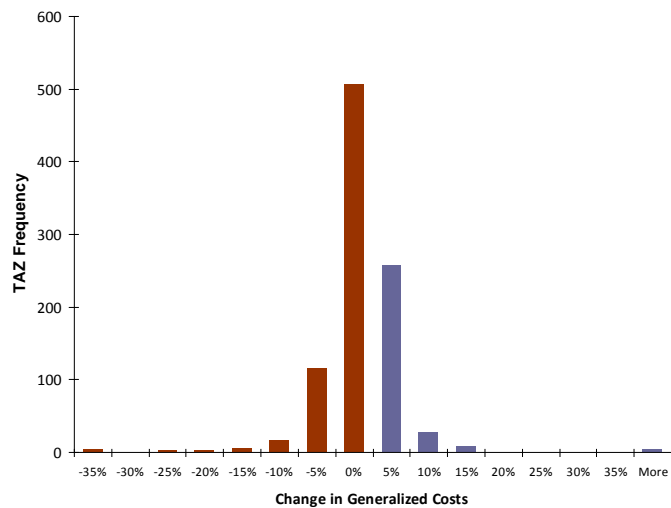
Lower Parking Costs - Zonal Accessibility
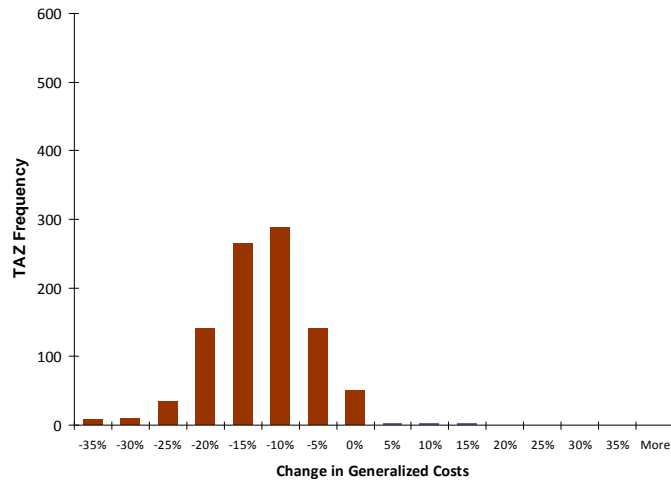
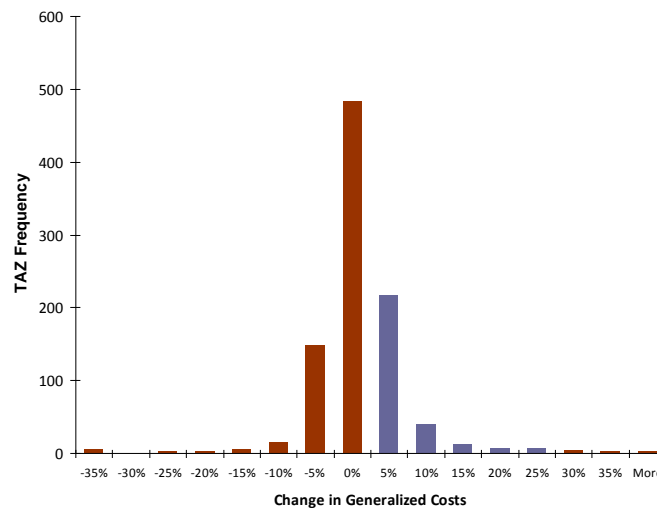**Higher Vehicle Oper. Costs - Zonal Accessibility**

Rail Transit Extensions - Zonal Accessibility

Highway Capacity - Zonal Accessibility

Access Improvement

- A drop in generalized costs of auto travel
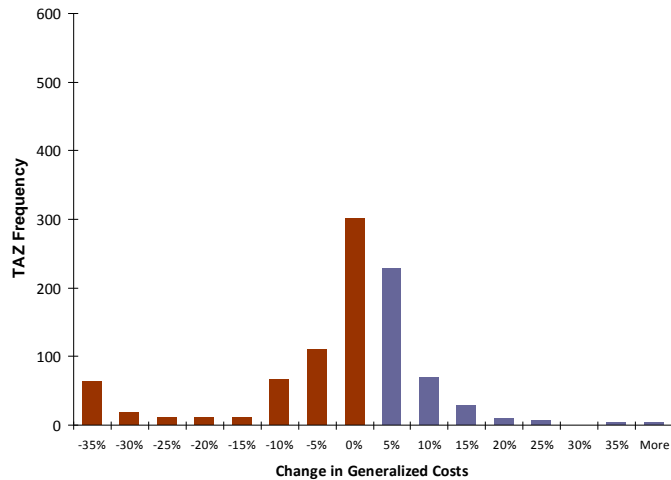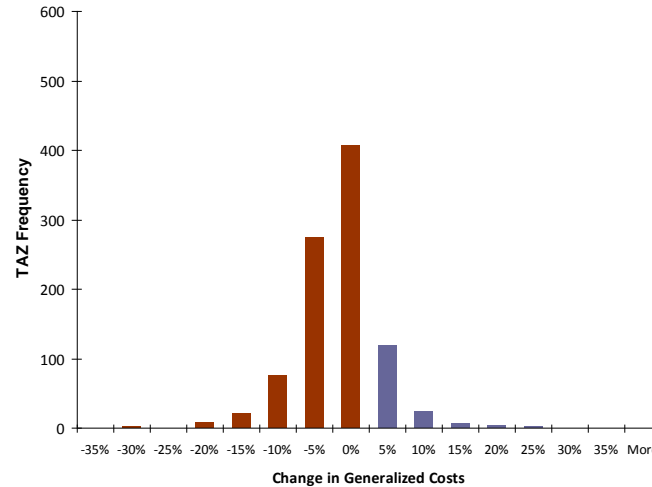- Trip weighted average from each zone to all other zones

Changes in Access Costs – AM Attractions

Lower Parking Costs - Zonal Accessibility
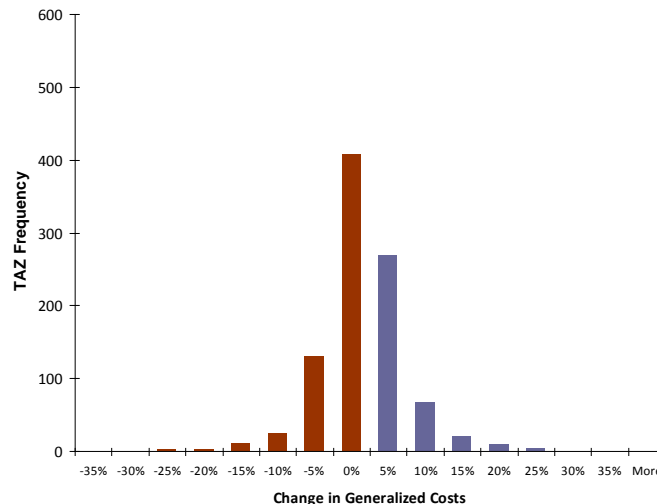

Higher Vehicle Oper. Costs - Zonal Accessibility

Rail Transit Extensions - Zonal Accessibility

Highway Capacity - Zonal Accessibility

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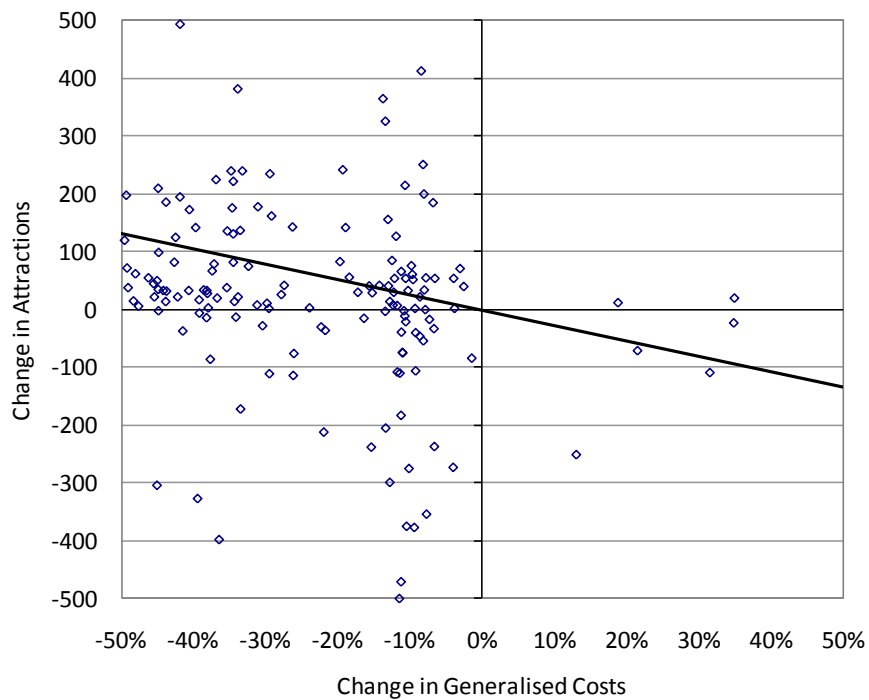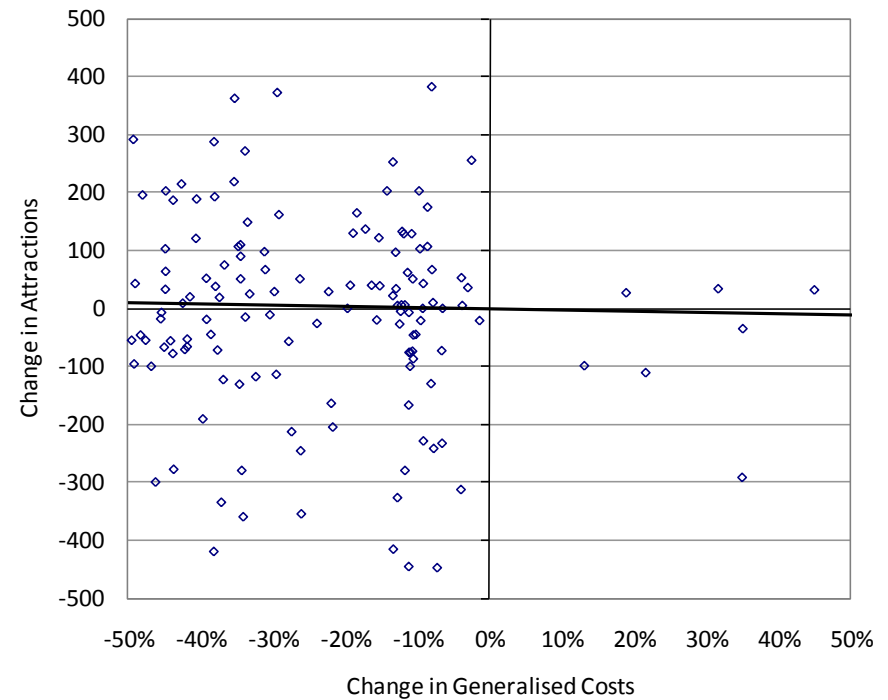- Trip weighted average from each zone to all other zones
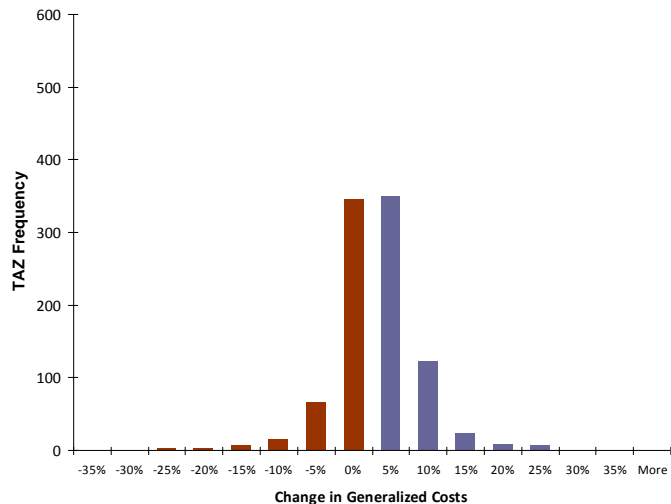
Lower Parking Charges

Workplace Location Choice

- Trip attractions increase in zones with lower parking costs
- Income sensitivity

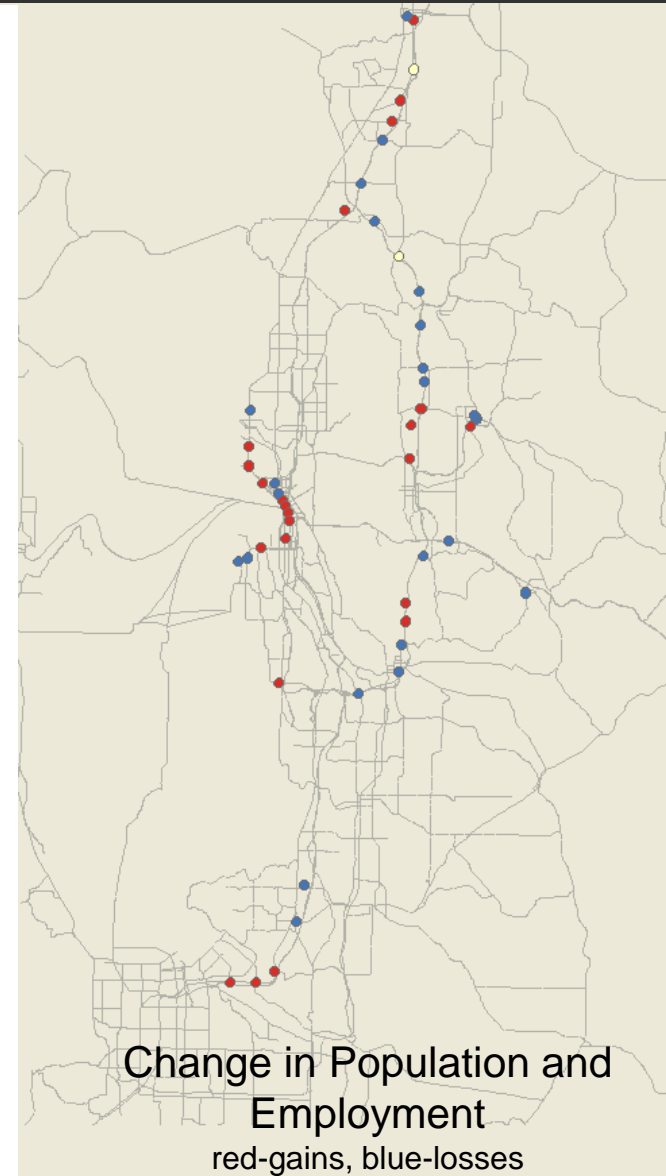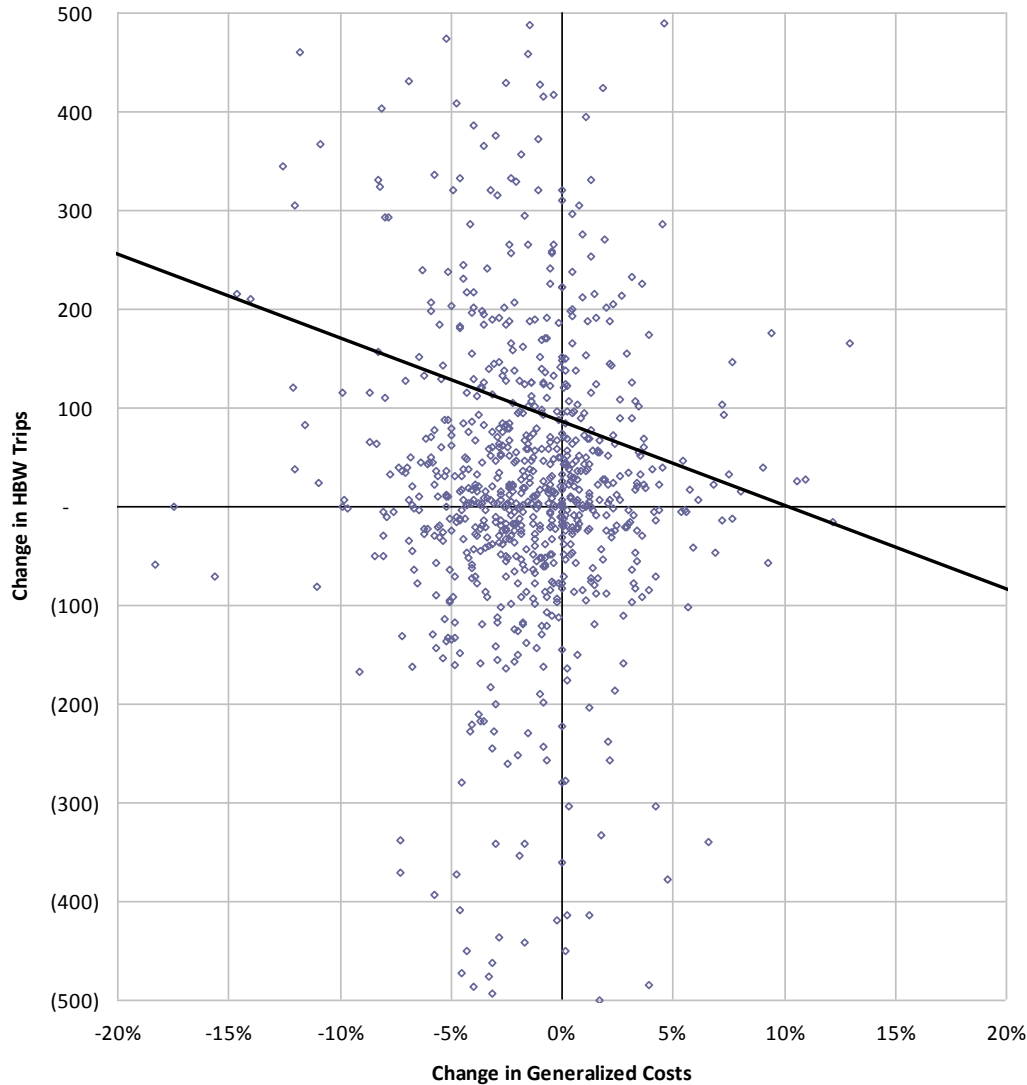**Change in Low Income Attractions**

Change in High Income Attractions

Change in Attractions vs Change in Generalised Costs (Low Income): scatter plot with x-axis from -50% to 50%, y-axis from -500 to 500, showing a downward-sloping trend line.

Change in Attractions vs Change in Generalised Costs (High Income): scatter plot with x-axis from -50% to 50%, y-axis from -500 to 500, showing a nearly flat trend line.

Rail Transit Extensions

Transit Scenario: AM Trip Productions

Change in Population and Employment
red-gains, blue-losses

Increased Highway Capacity

Highway Scenario: AM Trip Attractions

Change in Population
blue-gains, red-losses
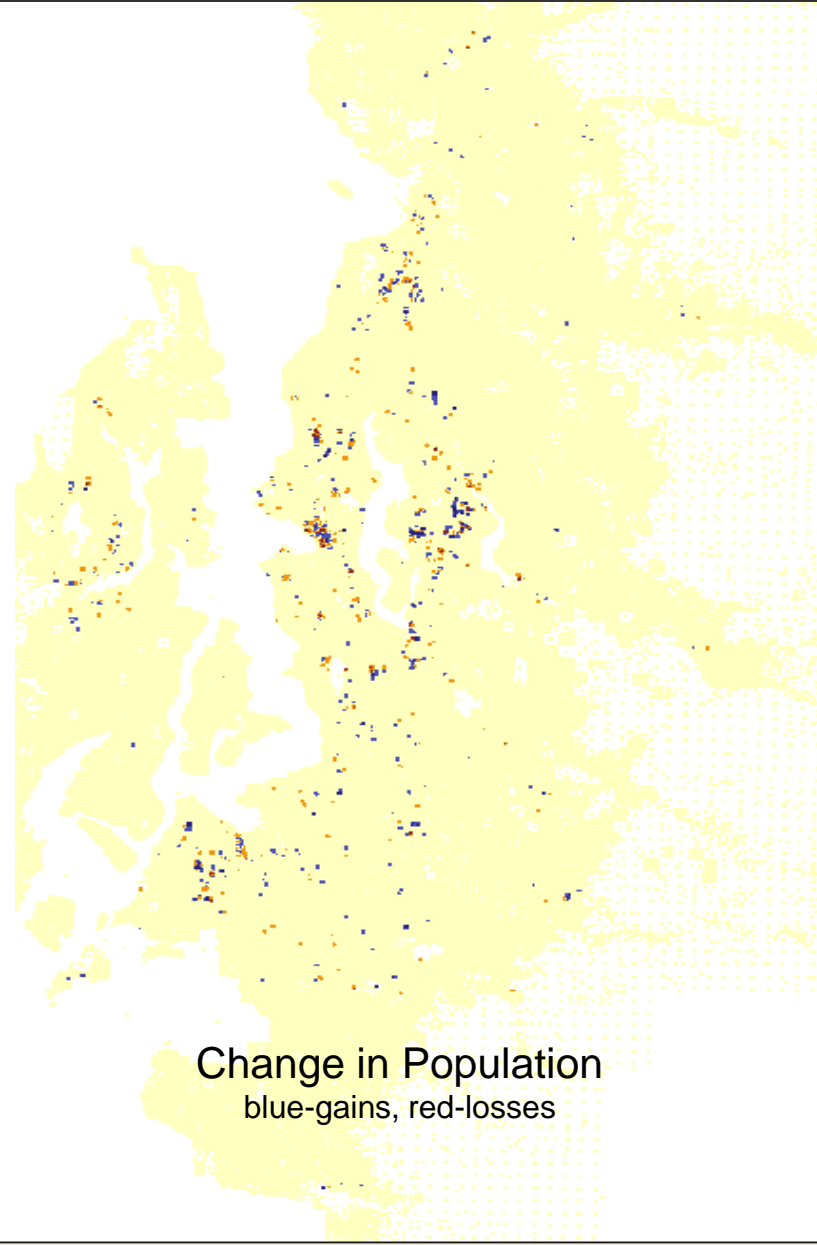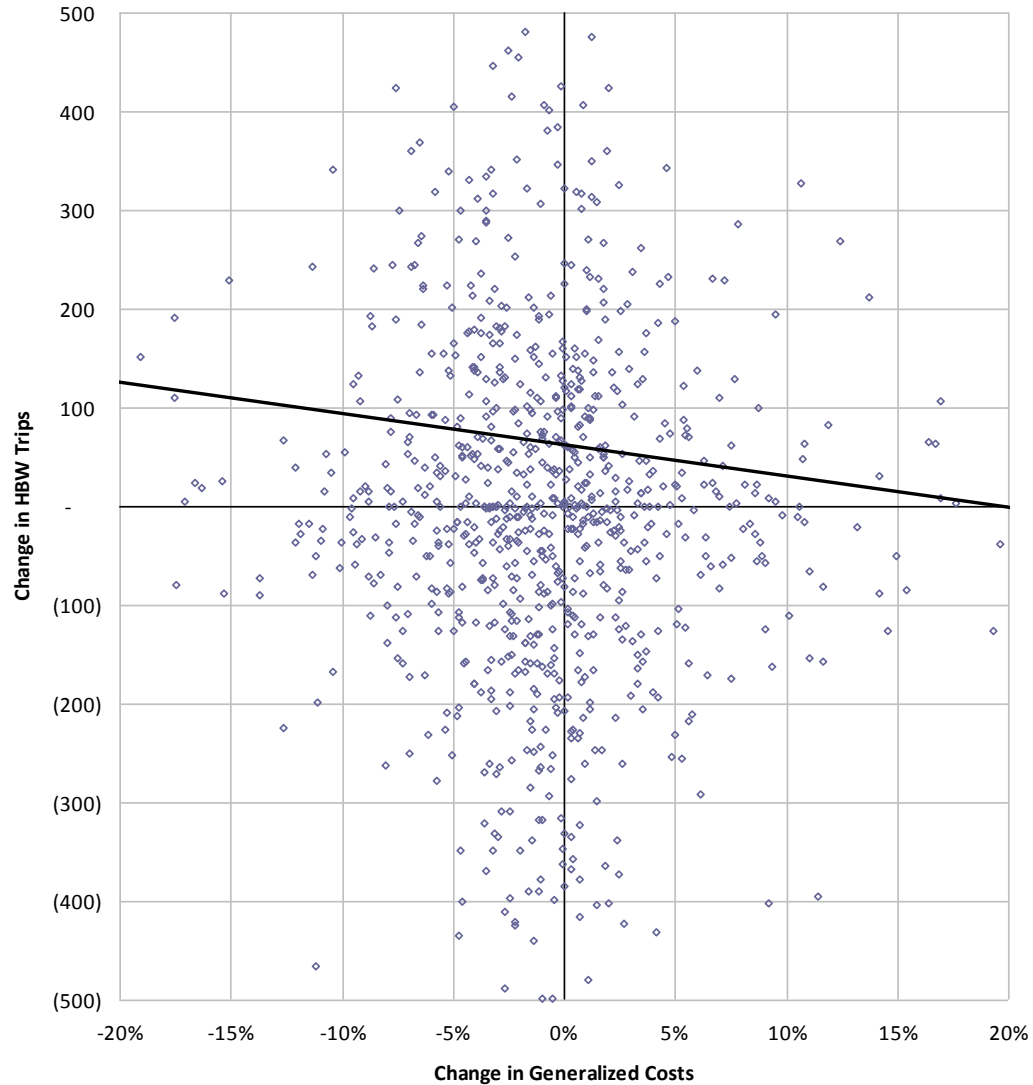
Findings

Land Use Response to Transportation Scenarios

- A modest response is in line with theoretical expectations
- Accessibility measures from the travel model do change across scenarios and reflect route and destination choices (and to a more limited degree mode choice).
- Short-run substitution and activity sorting across sites likely limits the effects on development capital
- The influence of access on site values is probably a central feature in proper simulations. We have not explicitly evaluated site values

Transportation 2040 - Appraisal

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Scenario Appraisal - Data Flow
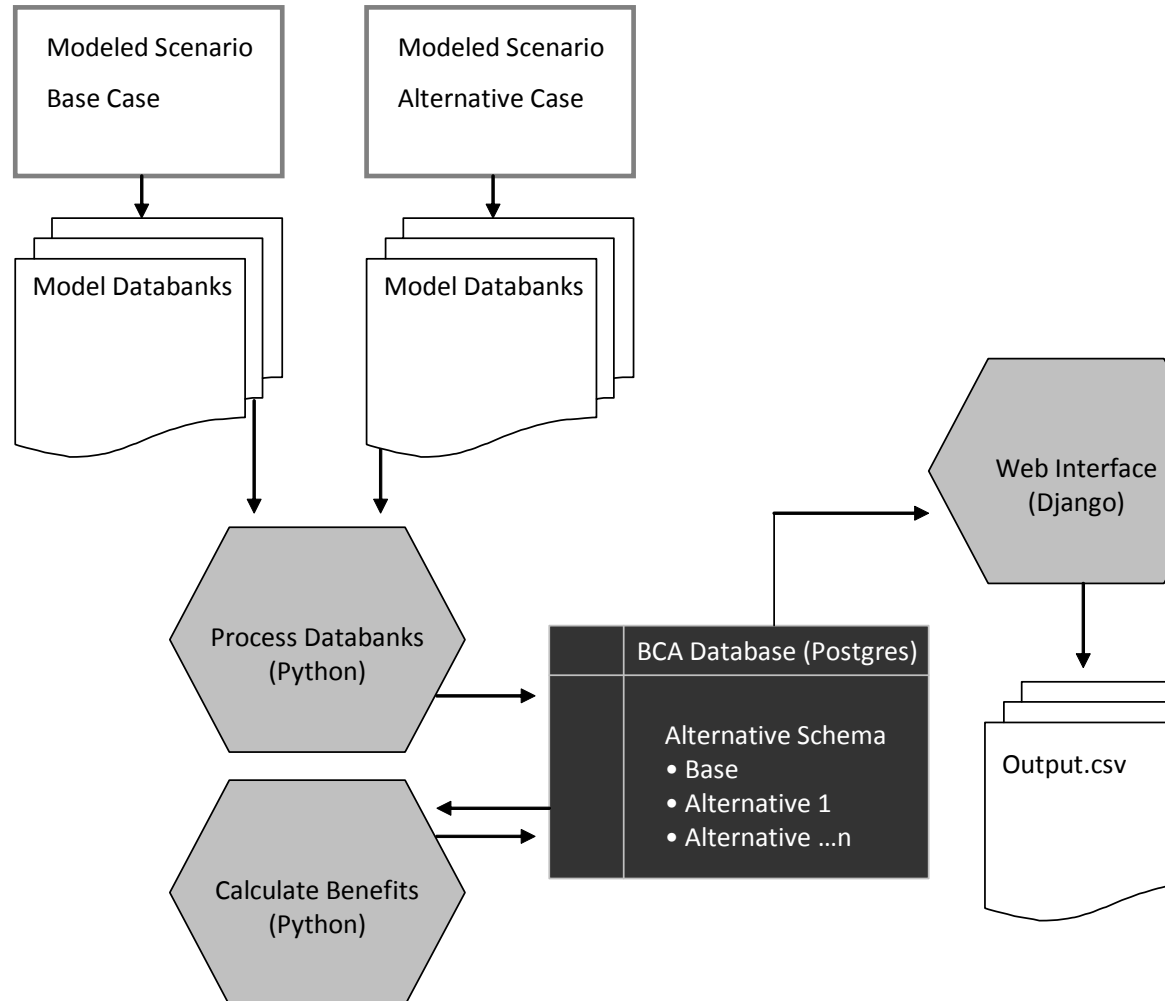
Measures

USER BENEFITS

Travel Time Benefits (cost savings)

Travel Reliability Benefits (cost savings)

Vehicle Operating Benefits (cost savings)

Other User Benefits (cost savings) – parking, fares, tolls

SOCIETAL BENEFITS

Accident Benefits (cost savings)

**Vehicle Emissions Benefits (cost savings)**

IMPLEMENTATION COSTS

Project Capital Costs

Project Operating Costs

T2040 – User Benefits by Type

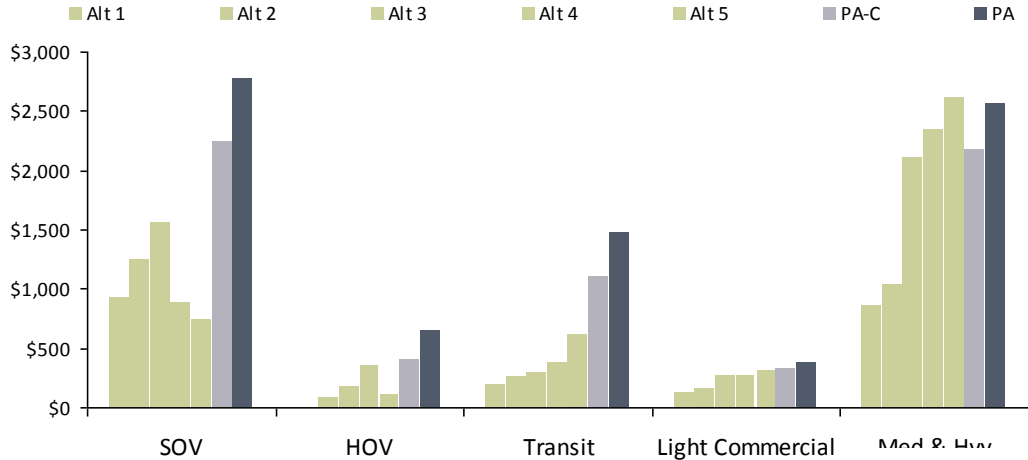**Annual Mobility Benefits by Type Relative to 2040 Baseline**

(benefits in millions of dollars per year)

Legend: Alt 1, Alt 2, Alt 3, Alt 4, Alt 5, PA-C, PA

Categories: Time Savings, Travel Reliability Benefits, Vehicle Operating Cost Savings, Other User Costs
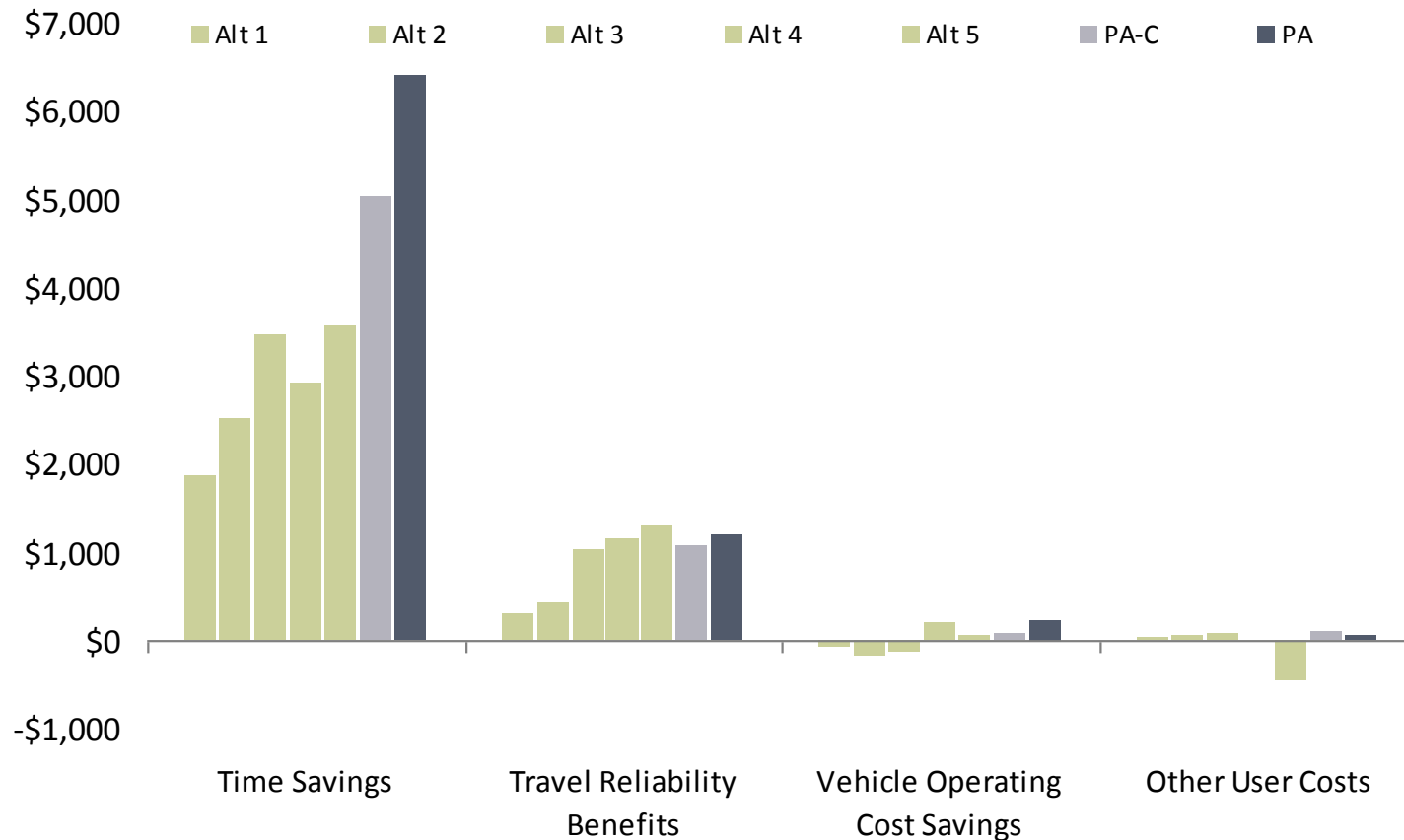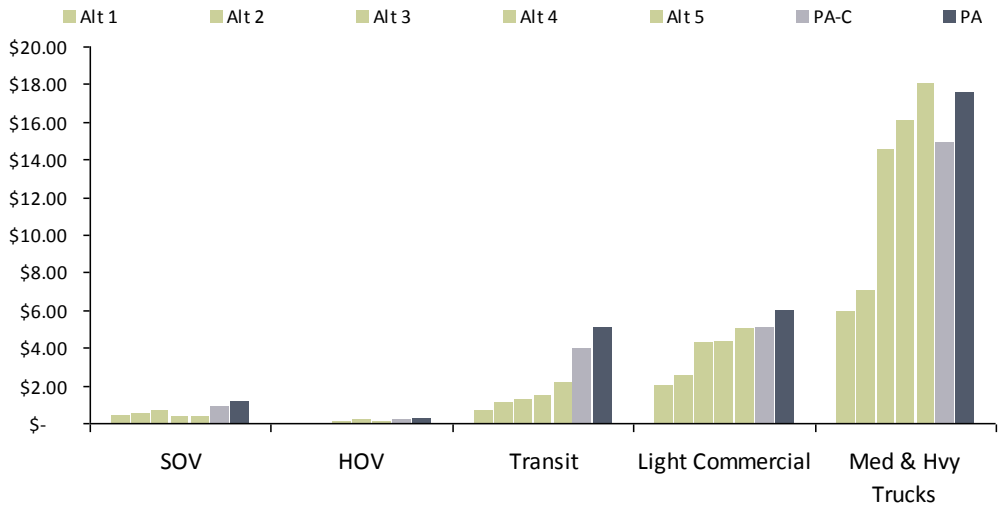
T2040 – User Benefits by User Group

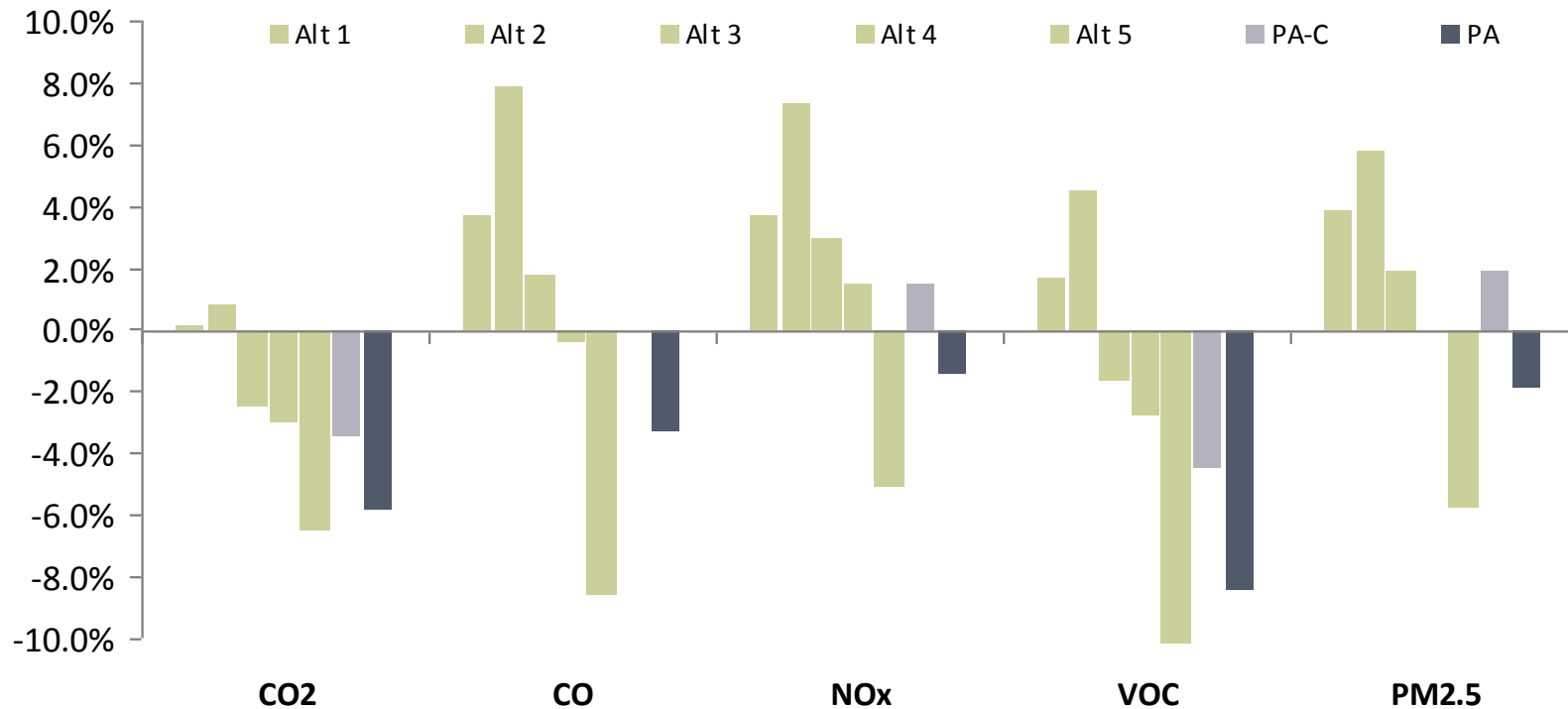**Annual Mobility Benefits Relative to the 2040 Baseline**
(millions of 2008 dollars)

Mobility Benefits per Trip Relative to the 2040 Baseline

T2040 – Change in Vehicle Emissions

Percent Change in Emissions from 2040 Baseline

Future Directions

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Future Directions

Accessibilities Variables
- Revisit the zonal composite variables used in the real estate price and employment location choice models
- Changes to real estate price model to more fully reflect scale of demand <u>and</u> accessibility
- A revised zone structure (from 938 to over 3,500) should reduce aggregation problems
- Activity-based travel model development will open up numerous opportunities for disaggregate access measures

Revisit Integration Structure
- Frequency of travel model runs (currently every 10 forecast years)
- Activity-based model development will necessitate a different approach (interaction between long-run and short-run choices)

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