

SACSIM23 SENSITIVITY ANALYSIS

SACSIM USER CONFERENCE | SACOG | 9/25/2024

SHAPING A SMARTER
TRANSPORTATION EXPERIENCE™
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AN EMPLOYEE-OWNED COMPANY
With Elite Transportation Group

WHAT IS SENSITIVITY ANALYSIS?

“Ensuring SACSIM is reasonably sensitive to key factors”

- **Demographics**
- **Land use & built environment**
- **Transportation network**

SACSIM



- **Person trips**
- **Vehicle, transit, walk, bike trips**
- **Traffic & VMT**

WHY SENSITIVITY ANALYSIS?

- 1. Establishes model's suitability for comparing future regional planning scenarios**
- 2. Required by California Air Resources Board for Sustainable Communities Strategies**
- 3. Model has changed since SACSIM19...**

SACSIM23 DRAFT OF DEC 2022

- 2020 pre-pandemic
- 2274 TAZs (up from 1503)
- RSG re-estimated choice model parameters using 2018 household travel survey
- Work-at-home model
- Link free-flow speeds from “big data” sources
- Daysim evolution

TYPES OF TESTS

- 1. Cross-sectional**
- 2. Experimental model scenarios**
- 3. Random variation**

Most are similar to tests SACOG did for SACSIM19.

CROSS-SECTIONAL TESTS

Dependent variables

VMT per person

Transit trips per person

Walk trips per person

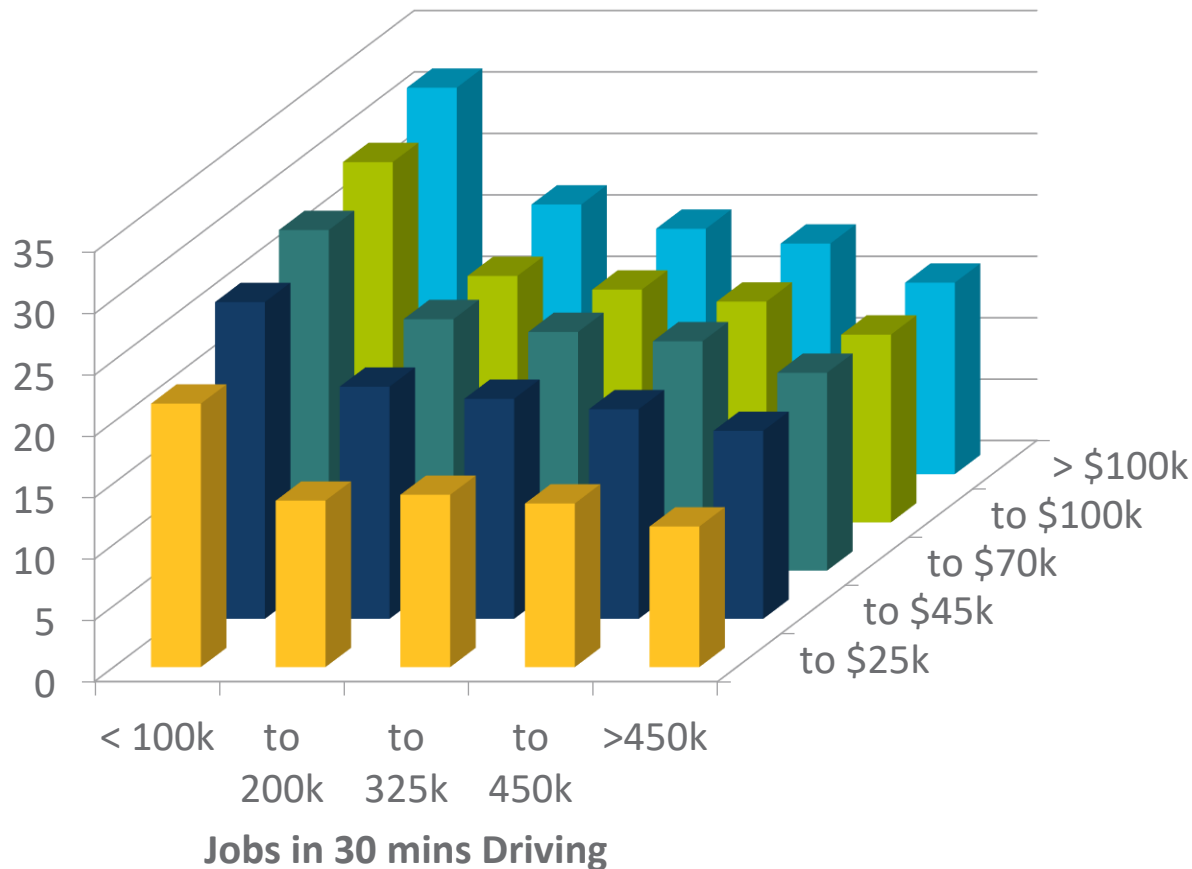
CROSS-SECTIONAL TESTS

Independent variables

Street pattern	= 3- & 4-way intersections in buffer 2
Residential density	= Households in buffer 2
Reg'nl auto accessibility	= Jobs w/in 30 min drive
Reg'nl transit accessibility	= Jobs w/in 30 min transit trip
Proximity to transit	= $\text{Min}(\text{dist to transit stop} - 0.75, 0)$
Mix of land use	= SACOG mix index
Local destination accessibility	= Jobs in buffer 2

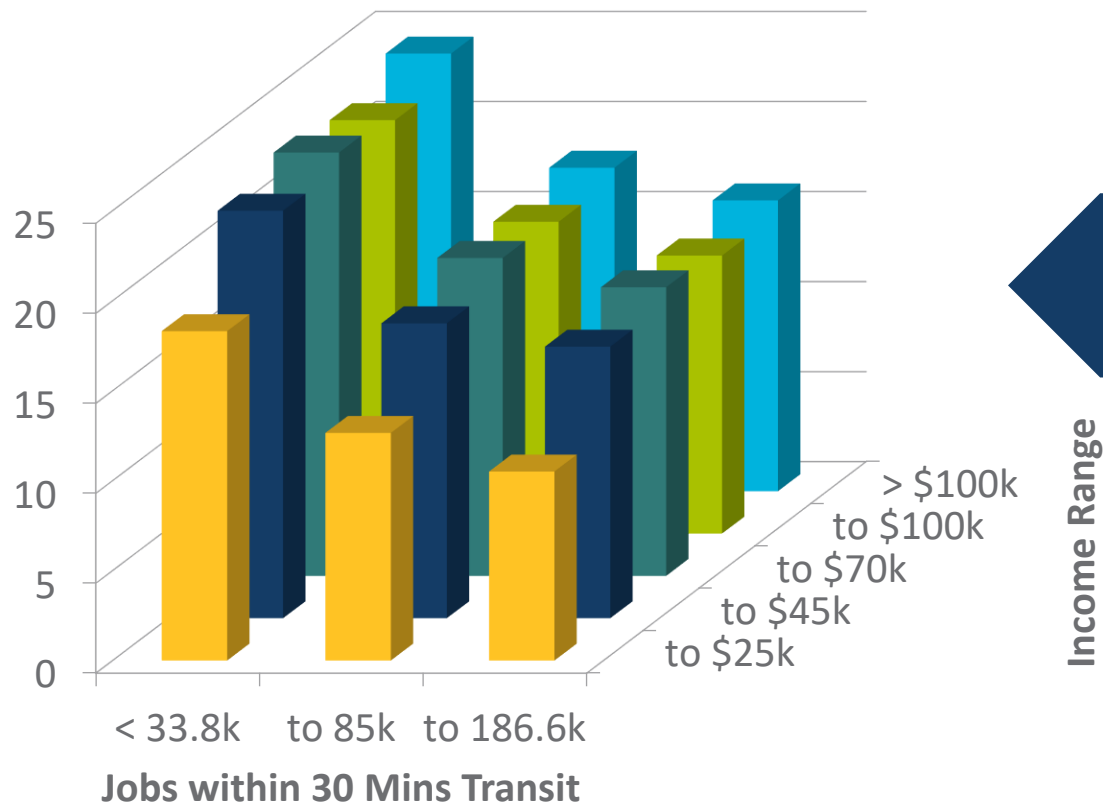
Difficult to define & create scenarios

VMT/PERSON BY AUTO ACCESSIBILITY



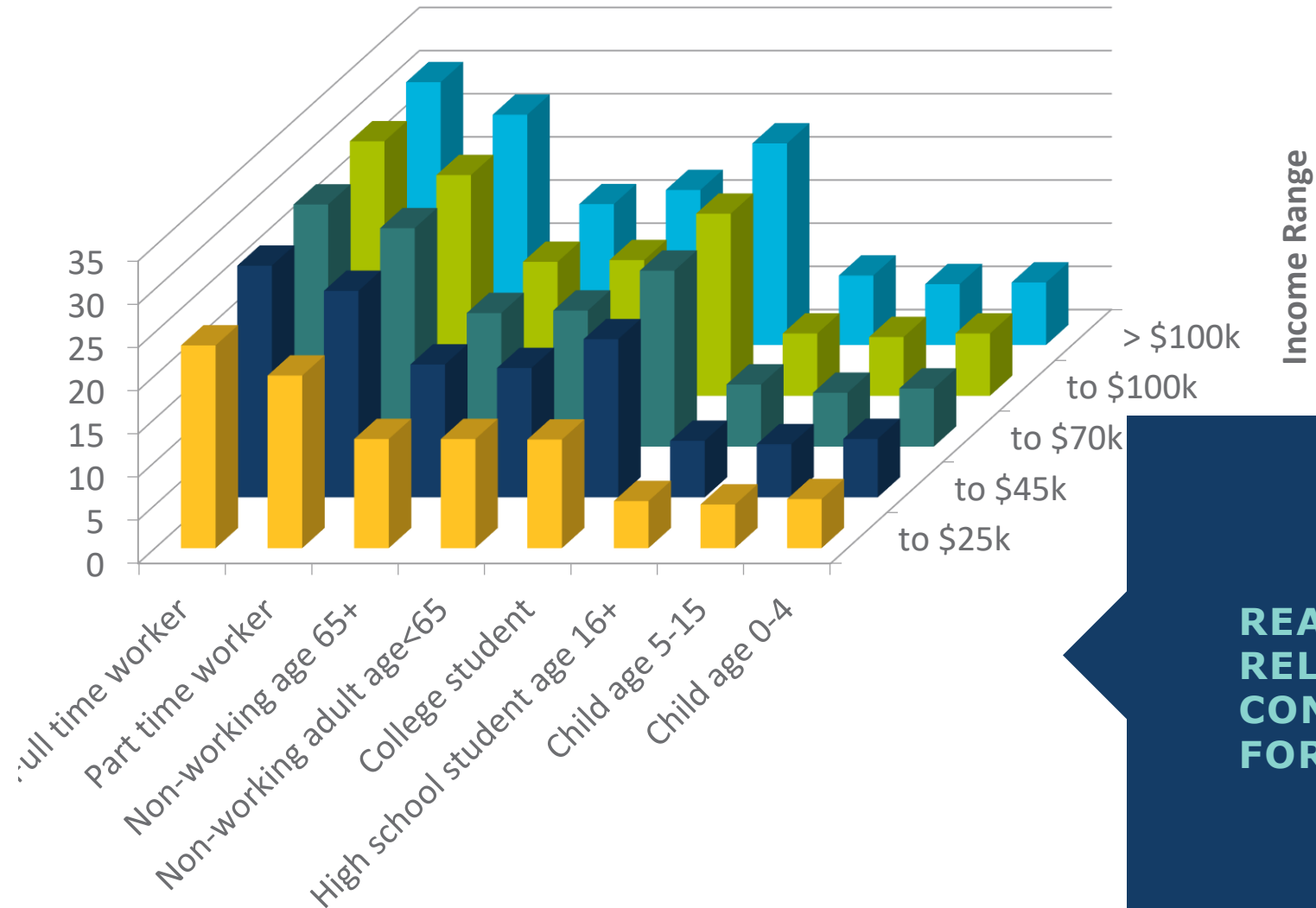
**EXPECTED
NEGATIVE
RELATION,
CONTROLLING
FOR INCOME**

VMT/PERSON BY TRANSIT ACCESSIBILITY



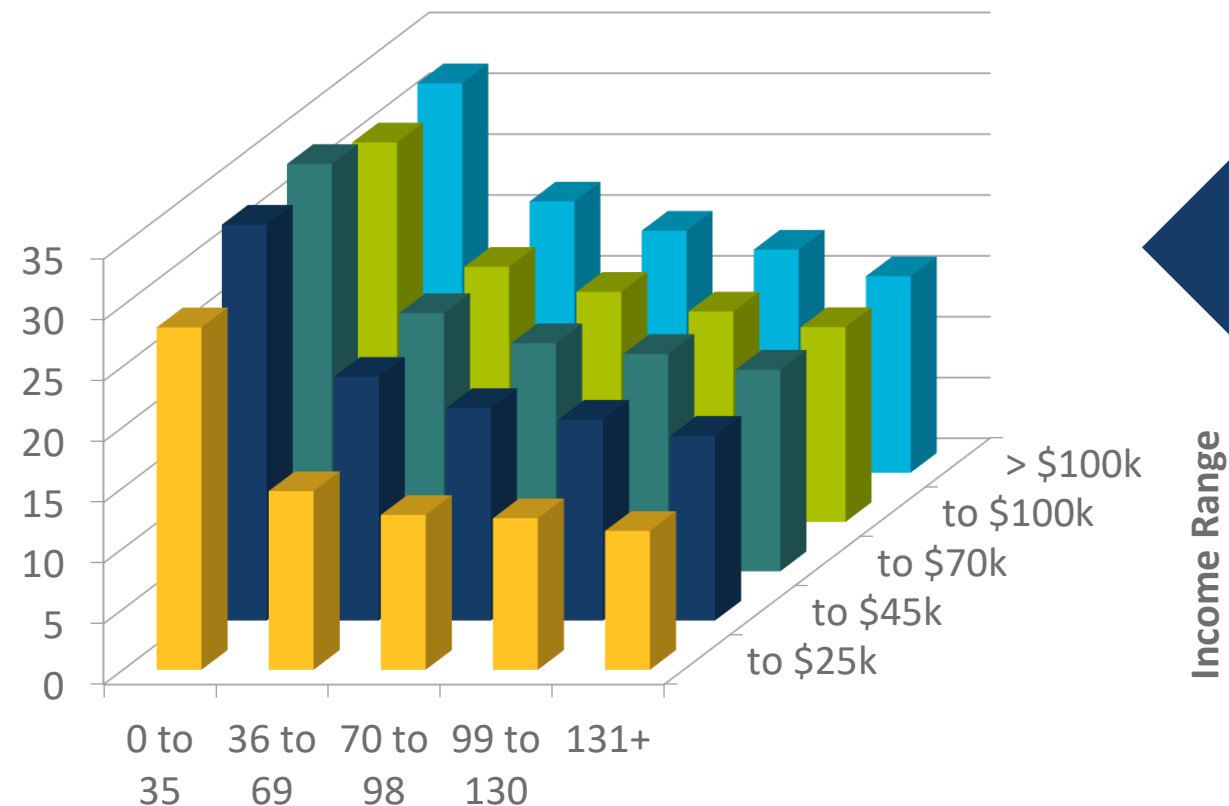
**NEGATIVE
RELATION,
CONTROLLING FOR
INCOME**

VMT/PERSON BY PERSON TYPE



**REASONABLE
RELATION,
CONTROLLING
FOR INCOME**

VMT/PERSON BY NEARBY INTERSECTIONS (STREET PATTERN)



3- and 4-Way Intersections in Buffer 2 of Residence

**NEGATIVE
RELATION,
CONTROLLING FOR
INCOME**

Income Range

MULTIVARIATE REGRESSIONS AND CALCULATED ELASTICITIES

- Similar to SACSIM19 analysis
 - > Demographics plus one test variable
 - > Demographics plus all test variables
- Comparisons to published values
- See the report





**SACSIM IS REASONABLY
SENSITIVE TO LOCAL AND
REGIONAL "D'S",
CONTROLLING FOR
DEMOGRAPHICS.**

EXPERIMENTAL TESTING

- Ran 63 test scenarios of SACSIM
- One input factor changed per scenario
- No intent to be probable, feasible, or recommended

EXPERIMENTAL TESTS

Dependent variables

Person trips

Vehicle trips

VMT

Congested VMT ($v/c > 1$)

Transit person trips

Walk+Bike person trips

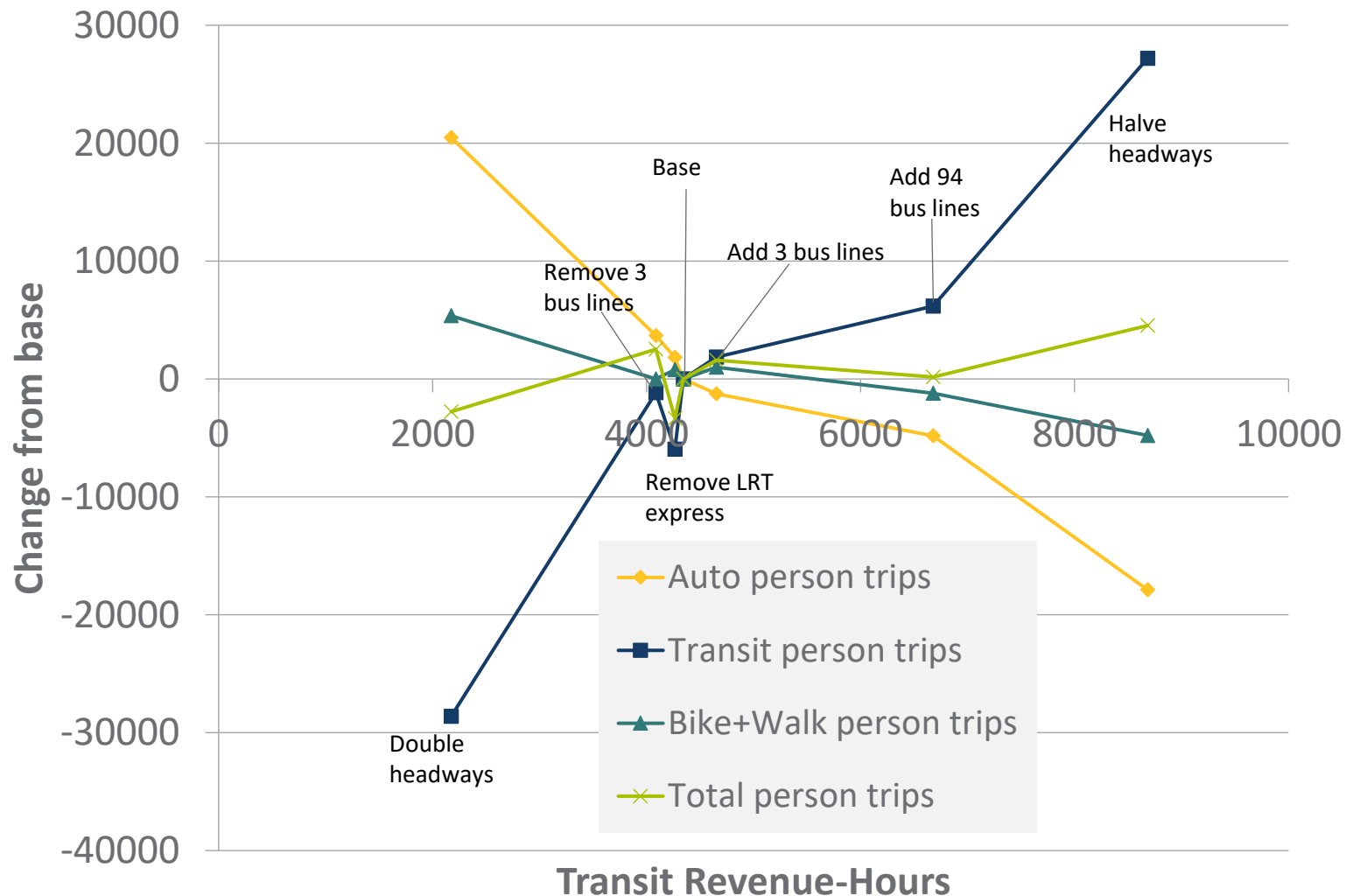
EXPERIMENTAL TESTS

Independent variables

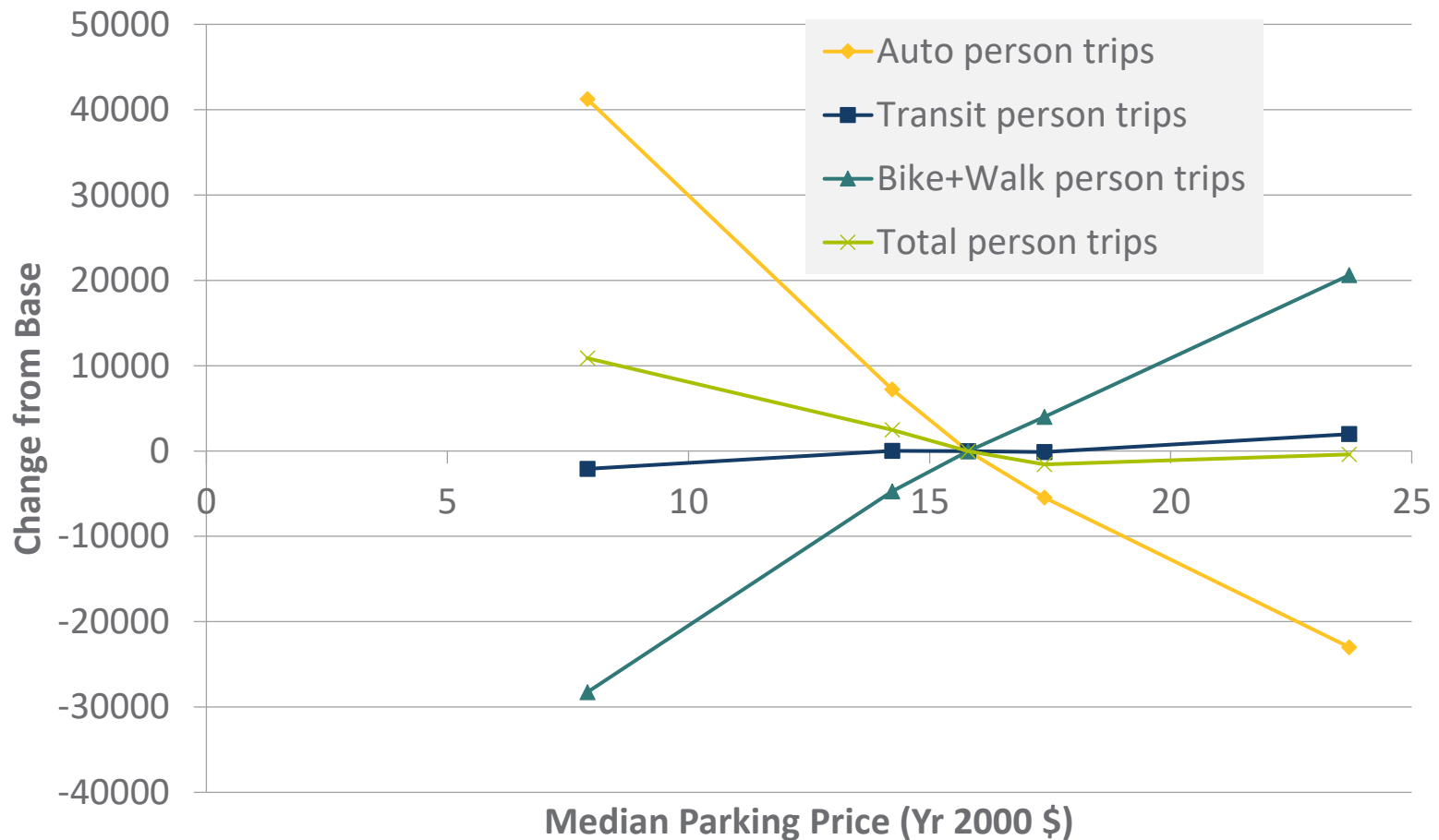
Transit headways	Off-street parking costs
Transit lines (add or remove)	Household income
Transit access	Telework propensity
HOV and managed-lane policy	Highway capacity
Auto operating cost	Highway free-flow speeds
Transit fare	

Red = new

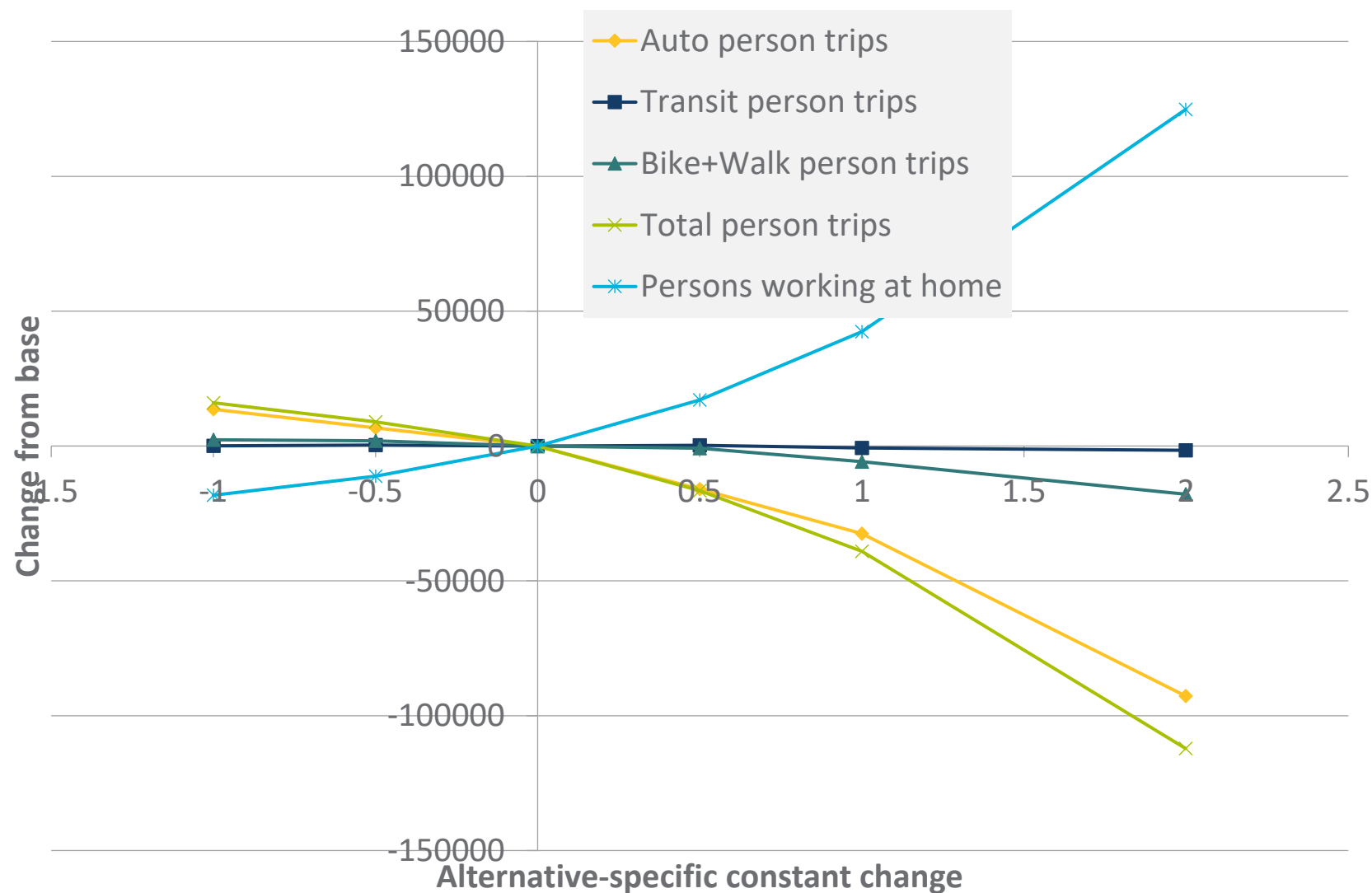
TRANSIT NETWORK SCENARIOS



PARKING PRICE V. TRIPS BEGIN OR END IN DOWNTOWN SACRAMENTO



TELEWORKING



Modeled VMT Elasticities by Component

Location of Capacity Increase (facility type, congestion level)	Elasticity, VMT to lane-miles	Component: Speed to Capacity	Component: VMT to Speed
Sunrise Blvd (arterial, severe)	0.85	1.65	0.51
Watt Ave (arterial, moderate)	0.61	1.23	0.49
El Camino Ave (arterial, uncongested)	0.16	0.33	0.48
SR 51 (freeway, severe)	2.75	3.48	0.79
SR 65 N of Lincoln (highway, moderate)	0.53	0.58	0.91
SR 70,99 in S. Sutter Co. (freeway, uncongested)	0.19	0.31	0.60
Broadway-Franklin “road diet” (arterial, moderate)	-0.16*	0.20*	-0.81*
Blue Oaks Blvd, Roseville (arterial, moderate)	0.18*	1.43	0.13
Arterials -10%	0.14†	0.41†	0.34
Freeways +10%	0.28†	0.40†	0.71
Arterials and Freeway +10%	0.20†	0.37†	0.54
Arterials +10%, Freeways +30%	0.21†	0.33†	0.62

*CHANGES OF VMT AND VEHICLE TRIPS MAY BE INSIGNIFICANT RELATIVE TO RANDOM SAMPLE VARIABILITY.

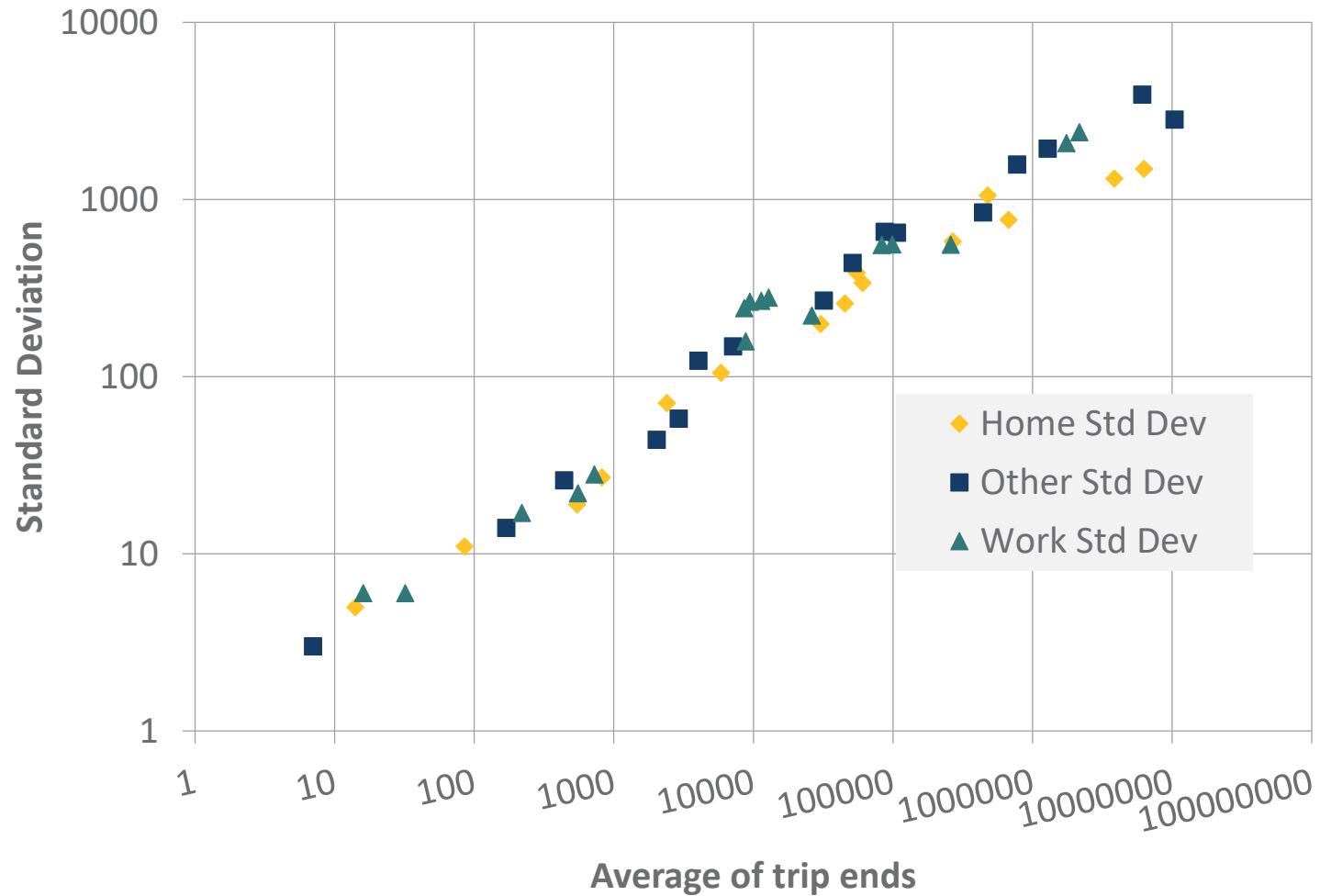
† ELASTICITIES WITH RESPECT TO AGGREGATE CAPACITY IN LANE-MILES TIMES CAPACITY PER HOUR PER LANE.

INDUCED TRAFFIC FROM SACSIM:

- **ADDING CAPACITY TO
CONGESTED ROADS
INDUCES MORE TRAVEL
DEMAND.**
- **ADDING CAPACITY TO
UNCONGESTED ROADS
INDUCES LITTLE.**
- **REMOVING CAPACITY CAN
INCREASE VMT.**

RANDOM VARIATION

Trip ends by activity, for region and 3 selected RADs



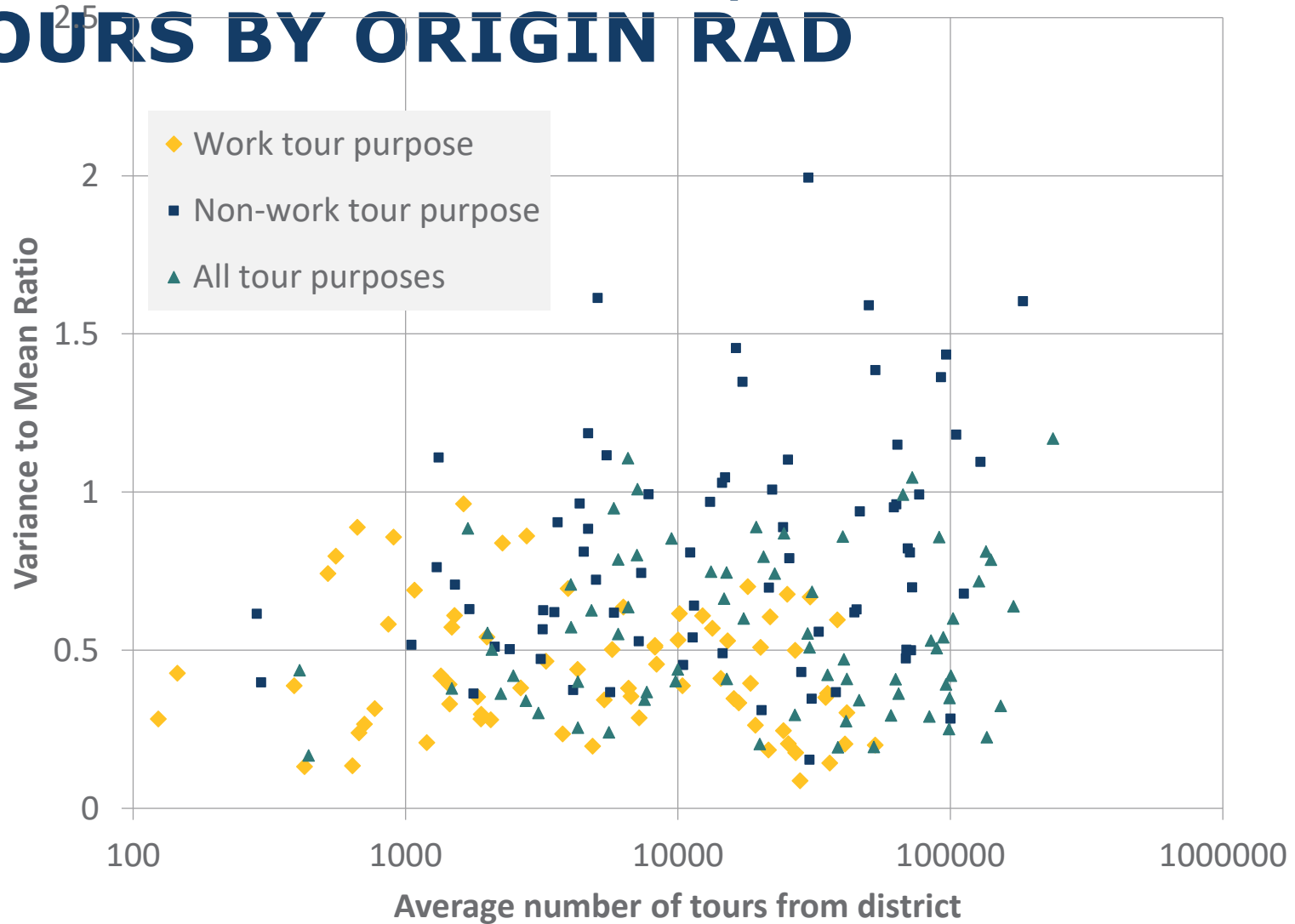
PROBABILITY THEORY

- Variance = [Standard Deviation]²
- Binomial distribution of n independent trials with p = probability of “success”
 - > Average count of “successes” = np
 - > Variance of “successes” = $np(1-p)$
- Particular tours by an ABM are of low individual probability, so $(1-p) \rightarrow 1$
- Approaches Poisson distribution
 - > Variance = np , same as count of “successes”
- Variance to mean ratio VMR = 1 for Poisson process.
- It's why standard deviation $\approx \text{sqrt}(\text{quantity})$ above.

HOW RIGHT IS THE ASSUMPTION OF INDEPENDENCE?

- Every person's day-schedule formation uses independent random draws. But...
- ABM forms feasible and likely day-schedules for people. Tours are inter-dependent. 4 or more tours by a person is disproportionately unlikely: *Lower variance expected at the home.*
- Feedback and worker-job balancing create effect between peoples' choices. *Mostly negative correlation expected.*
- At least 2 trips are formed from each tour. *Expect positive correlation between trips of same tour.*

VARIANCE TO MEAN, HOME-BASED TOURS BY ORIGIN RAD



The scatter plot, titled "WORK-BASED SUB-TOUR, BY RAD", displays the relationship between the average number of tours to a district (x-axis) and the variance to the mean ratio (y-axis). The x-axis is on a logarithmic scale, ranging from 1 to 1,000,000. The y-axis ranges from 0 to 8. The legend identifies four data series: Home-based work tour destinations (yellow diamonds), Home-based non-work tour destinations (dark blue squares), Work-based origin (teal triangles), and Work-based destination (orange circles). The plot shows a general trend where the variance to the mean ratio decreases as the average number of tours increases, with a notable outlier for Home-based work tour destinations at approximately 700 tours and a ratio of 8.5.

Average number of tours to district	Variance to Mean Ratio	Category
1.5	1.0	Work-based origin
3.0	1.7	Work-based destination
7.0	2.1	Work-based destination
10.0	1.9	Work-based origin
15.0	2.9	Home-based work tour destinations
20.0	1.3	Work-based origin
30.0	1.5	Work-based destination
40.0	1.1	Work-based origin
50.0	1.7	Work-based destination
70.0	1.5	Work-based destination
100.0	1.0	Home-based work tour destinations
120.0	2.3	Work-based origin
150.0	1.1	Work-based origin
200.0	2.5	Home-based work tour destinations
250.0	1.0	Work-based destination
300.0	2.2	Work-based origin
400.0	1.0	Home-based non-work tour destinations
500.0	2.6	Home-based work tour destinations
700.0	8.5	Home-based work tour destinations
1000.0	1.8	Home-based work tour destinations
1200.0	2.3	Work-based origin
1500.0	1.0	Home-based non-work tour destinations
2000.0	1.0	Work-based destination
3000.0	2.8	Home-based work tour destinations
4000.0	3.1	Home-based work tour destinations
5000.0	2.7	Home-based work tour destinations
7000.0	4.2	Work-based origin
10000.0	3.2	Work-based destination
15000.0	6.5	Home-based work tour destinations
20000.0	3.2	Home-based work tour destinations
30000.0	5.2	Home-based work tour destinations
40000.0	3.2	Home-based work tour destinations
50000.0	2.4	Home-based work tour destinations
70000.0	2.0	Home-based work tour destinations
100000.0	1.5	Home-based non-work tour destinations
150000.0	1.1	Home-based non-work tour destinations

VMR by TAZ, RAD, county, and region

Tour selection	Average of VMR			
	TAZ	RAD	County	Region
Work tours, home location	0.39	0.44	0.55	0.75
Non-work tours, home location	0.85	0.81	0.83	0.46
Total tours, home location	0.60	0.55	0.47	0.18
Work tours, work location	2.01	1.81	1.17	0.75
Workers, work location	1.88	1.03	1.00	0.02
Home-based non-work, primary destination	1.05	1.02	0.96	0.46
Work-based sub-tours, work location	1.39	1.30	1.25	0.33
Work-based sub-tours, primary destination	1.01	1.20	1.10	0.33

- **SACSIM'S RANDOM NOISE COMPARES REASONABLY TO PROBABILITY THEORY, EXCEPT...**
- **HIGHER WORKPLACE VARIANCE LIKELY FROM WORKER-JOB SHADOW-PRICES NOT EXACTLY SOLVED**

THANK YOU

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