11.4 Testing of Random Variation in Model

Testing of random variation is performed to assess the potential “noise” in the DAYSIM simulation of household-generated travel. Because DAYSIM is a person-level simulation of demand, travel patterns of each person in the representative population file is computed in a randomized order. The order of this simulation is varied using a numeric seed value. Changing this seed value generates a different order of stepping through the simulation, and of applying choice probabilities to each person-day activities and travel. This randomization means that the results of one model run may vary somewhat from the results of another run, assuming the “seed” value is varied from one run to the next.

We ran a series of 10 model runs using different seed values using SACSIM19 to estimate random variation of key travel outputs. To measure variation, we compared individual model run output values for vehicles, work tours, other tours, person trips, vehicle trips, transit trips, and VMT against the 10-run average values of these outputs. Specifically, we compared the model runs whose outputs were most different from the 10-run average. We performed this comparison at the region level, for the largest-population RAD, median-population RAD, and smallest-population RAD to observer how the amount of variation changed at different granularity levels. Results are summarized in Table 11-10.

As Table 11-10 shows, random variation increases as the scale of the output decreases. E.g., a “large scale” output like VMT at the region level had a maximum difference from the 10-run average of only -0.06 percent. In contrast, transit trips in the smallest-population RAD had a maximum difference from the 10-run average of about -60 percent while transit trips in the median-population RAD had a maximum difference of about -75 percent.

These large percentage differences, however, are due to the very small absolute number of transit trips taken in these RADs, with an average of 12 transit trips taken in the smallest RAD and 45 transit trips taken in the largest RAD. Therefore, even a small numeric variation in model outputs equates to a large percentage variation. Furthermore, our findings are generally in line with Bradley et al.’s 2003 findings from a random-seed test they performed on San Francisco’s microsimulation model, which utilized 100 model runs[39]. Similar to our SACSIM19 results, they found overall very low random variation at the city level, with greater levels of variation at the TAZ level and when looking at more specific outputs (e.g., estimated tours between two specific neighborhoods as opposed to total tours in the entire city).

[39] Mark Bradley, Joe Castiglione, Joel Freedman, “Systematic Investigation of Variability due to Random Simulation Error in an Activity-Based Microsimulation Forecasting Model”, Transportation Research Record 1831, 2003

Table 11-10 Random Variation of DAYSIM Submodel

Variable	10-Run Average Value	Max % Difference from Average	
		High	Low
Regional Totals			
Vehicles	1,538,828	0.04%	-0.04%
Work Tours	766,727	0.11%	-0.07%
Other Tours	2,260,177	0.08%	-0.04%
Person Trips	8,023,709	0.06%	-0.05%
Vehicle Trips	5,169,100	0.07%	-0.07%
Transit Trips	103,943	0.68%	-0.89%
VMT	38,201,565	0.05%	-0.06%
Largest-Population RAD			
Vehicles	96,277	0.18%	-0.27%
Work Tours	46,909	0.45%	-0.48%
Other Tours	173,890	0.48%	-0.27%
Person Trips	577,242	0.19%	-0.17%
Vehicle Trips	348,582	0.18%	-0.30%
Transit Trips	8,892	3.37%	-2.97%
VMT	2,037,169	0.30%	-0.34%
Median-Population RAD			
Vehicles	13,247	0.54%	-0.51%
Work Tours	5,404	0.74%	-0.87%
Other Tours	16,402	1.00%	-0.77%
Person Trips	58,709	0.75%	-0.79%
Vehicle Trips	40,778	1.03%	-0.76%
Transit Trips	45	30.65%	-76.73%
VMT	368,112	0.98%	-1.03%
Smallest-Population RAD			
Vehicles	4,206	0.97%	-0.93%
Work Tours	1,036	4.17%	-4.32%
Other Tours	4,357	2.18%	-2.32%
Person Trips	14,965	1.52%	-1.20%
Vehicle Trips	9,697	1.89%	-1.36%
Transit Trips	14	56.20%	-60.58%
VMT	174,439	1.88%	-2.01%

Source: SACOG 2020.

Borrowing methodology from Bradley et al's test of San Francisco's microsimulation model, we also charted running averages for each output to see how quickly those outputs converged toward the 10-run average. This test enables model users to better estimate how many times the model needs to be run in order to give a reasonably stable "average" output value.

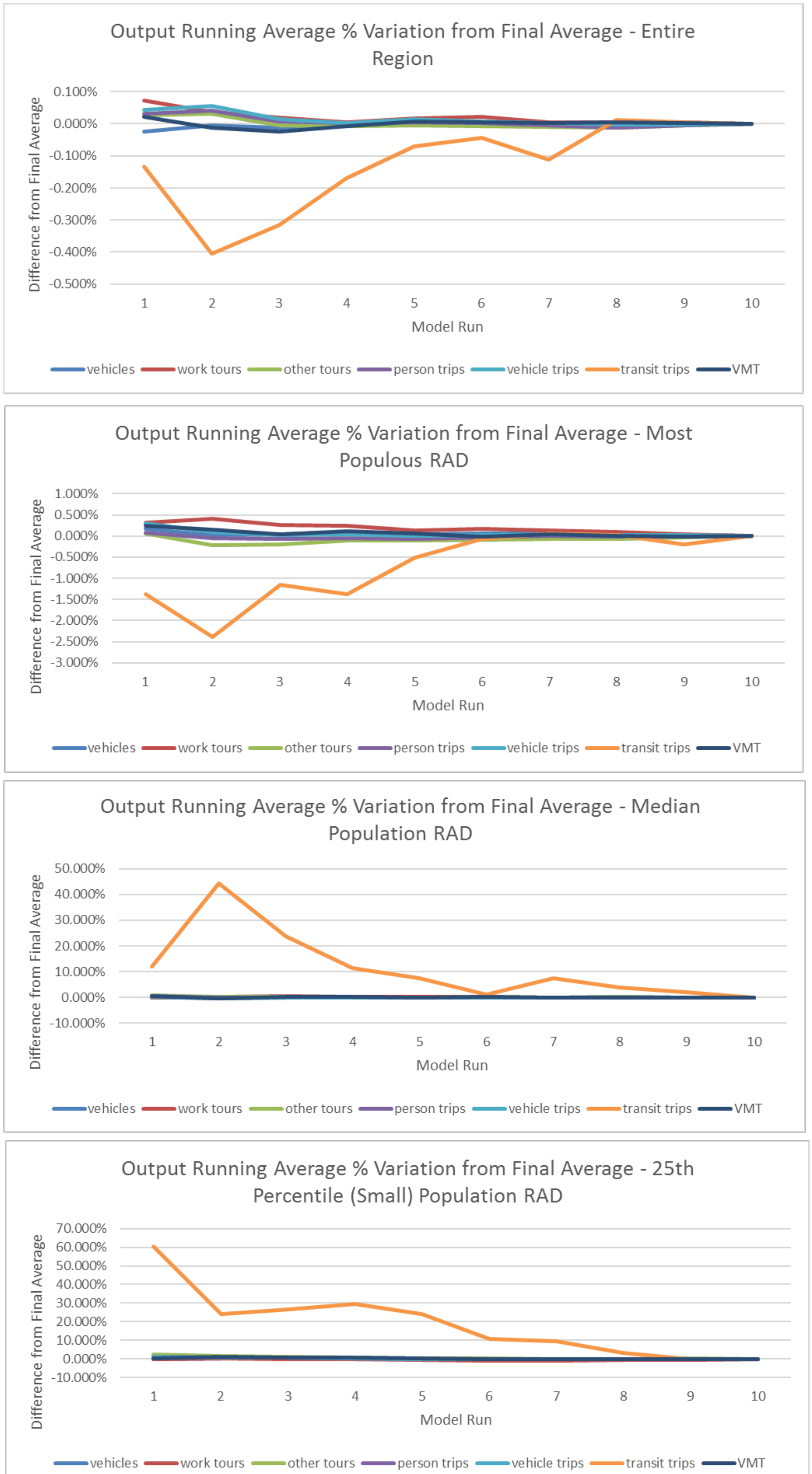
As the charts in Figure 11-6 show, variation is lower and convergence is faster at larger scales. At the region level, the maximum variation from the 10-run average for most outputs is less than +/- 0.1 percent even on the first run, and by the third run is effectively identical to the 10-run average. At the RAD levels, and particularly the smallest RAD level, variation is somewhat higher and convergence somewhat lower because the absolute values of the outputs are smaller and a smaller numeric change equates to a larger percentage change.

Transit variation is higher and takes longer to converge at all levels (region, large-population RAD, medium-population RAD, and small-population RAD), largely due to transit having very small absolute numbers of riders, leading even small output changes to appear as larger percentage changes.

As a general takeaway, the effect of random seed variation on SACSIM19's is generally very small, especially at larger scales. In practice, for region-level estimates a single model run will be sufficient, though seeking estimates at smaller scales (e.g., for modes with fewer trips like transit, looking at trips between a specific pair of RADs or TAZs, etc.) may require taking the average output values from multiple model runs to account for variation. Based on findings from SACSIM19, most values stabilize within five model runs, that is, after five model runs, the running average output values are negligibly different from the 10-run average output values.

When reviewing each figure, it is important to note the vertical scale bar, which is different for each geographic level.

Figure 11-6 Results of Testing Sensitivity to Random Variation



Source: SACOG 2020.