SOUTHEAST MICHIGAN COUNCIL OF GOVERNMENTS

PHASE II ACTIVITY-BASED MODEL CALIBRATION AND VALIDATION

Technical Memorandum | July 12, 2022

PREPARED FOR:
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1.0 INTRODUCTION

This document describes the calibration, validation, and sensitivity testing results of the Phase II ActivitySim model for the Southeast Michigan Council of Governments (SEMCOG). The Phase II ActivitySim model builds on the results of Phase I, where the team developed a first version of the ActivitySim (ActSim)model for the SEMCOG region by transferring the existing travel model for the San Francisco Bay Area (MTC TM1). Initially, the model was transferred to the SEMCOG region by making only minimal adjustments to the model components to allow the models to work with SEMCOG input data such as land-use data and transport level-of-service matrices (skims). For a description of Phase I resident travel model components, see *Southeast Michigan Council of Governments, Phase I Activity-Based Model Technical Description, RSG, November 22, 2020*. For a description of observed data processing and the calculation of calibration target values, see *Southeast Michigan Council of Governments, Data Processing, RSG, November 15, 2020*. Readers of this report should familiarize themselves with the model specification prior to reading. The final Phase II ActivitySim model specification is available in SEMCOG_Final_Model_Description document. A separate model user’s guide is also available, see SEMCOG_Final_ActSim_User_Guide document.

This document describes the final calibration and validation results for model components, including work location choice, auto ownership, and coordinated daily activity pattern. Several other model components such as tour mode choice, trip mode choice, and intermediate stop frequency were also calibrated to the observed data for SEMCOG region. A combination of household survey and transit on-board survey was used to calibrate the tour mode and trip mode choice models.

Under the Phase I scope, RSG modified the existing SEMCOG TransCAD E7 model implementation to create the auto and transit level-of-service matrices (skims) required by ActivitySim, and auto and transit assignment procedures were modified to use trip tables created from ActivitySim trip lists instead of trip-based model demand. Under the Phase II scope, the development team also implemented internal-external, external-internal, external-external, and airport trip models using a simplified destination choice model in the TransCAD model framework. Furthermore, the ABM development team also integrated the SEMCOG disaggregate tour-based commercial vehicle model (CVM) developed as part of another project for the agency into the TransCAD model framework, where the CV OD demand tables are appended to the ABM OD tables and read in by TransCAD for assignment. The entire model system was implemented with four supply-demand feedback loops (but is currently run with five loops).

RSG implemented a visualization tool to compare ActivitySim outputs against SEMCOG 2015 household travel survey data (in addition to transit onboard survey and census data, where applicable). The tool creates a static HTML dashboard of summary comparisons of various models in the ActivitySim framework. The dashboard is a standalone HTML file that can be opened with an internet browser but does not require an internet connection to open. The dashboard opens to a welcome page, with multiple other pages providing model summary comparison with survey summaries. Users may navigate to different areas of the dashboard using the navigation bar at the top of the page. Figure 1 shows the screen shot of the overview page. Most charts have a drop-down menu to apply filter based on a grouping variable.

FIGURE 1 HTML VISUALIZER OVERVIEW PAGE

The summaries and charts in the dashboard have been grouped based on their order of implementation within ActivitySim. The tab names on the navigation bar bear the name of these groups – Overview, Long Term, Tour Level, and Trip Level. Table 1 presents the list of summaries within each group. In the following sections, we describe the final results of the Phase II model deployment. We also describe daily estimated versus observed traffic assignment results, currently summarized in TransCAD GISDK.

TABLE 1 LIST OF SUMMARIES IN HTML DASHBOARD

GROUP	SUMMARIES
Overview	Totals – household, population, tour, trips, etc. Rates – tour rates, trip rates, etc. Aggregate summaries – household size and person type distribution
Long Term	Auto Ownership, work-from-home, telecommute frequency, Usual work and school location choice, transit pass and subsidy, District-District flow of workers, average mandatory trip lengths, Jobs vs Workers comparison

Tour Level	Tour Summaries – Daily Activity Pattern, mandatory tour frequency, tour rates by person type, non-mandatory tour frequency Joint tours – joint tour frequency and composition and party size summaries Tour destination – non-mandatory trip length frequency, average trip lengths TOD – Tour departure/arrival profile Tour Mode – Tour mode choice
Trip Level	Stop frequency – stop frequency and purpose summaries Stop location – stop location choice summaries TOD – stop and trip departure profiles Trip mode – trip mode choice summaries

2.0 MODEL CALIBRATION RESULTS

This section summarizes the results of the calibrated phase 2 model deployment. For the corresponding visualizer results, see the HTML visualizer on the shared Box (Box.com) dated 2022-12-17.

As continuation of the work of Phase I, the development team further calibrated Auto ownership, Work location choice, joint tour composition, free parking, transit pass and subsidy, and tour mode choice and trip mode choice models. This section, accordingly, first discusses the target data and calibration methodology, and then presents a summary of the calibrated models.

The main stopping criterion in the iterative calibration process was the proximity of the predicted model shares compared to the target data. In most cases, a maximum gap of 1-2 percentage points between predicted and target was considered as an acceptable level of model calibration.

Target Data

All calibration and validation targets are calculated from observed data, including household travel survey and the transit on-board survey data, as described in more detail in the data processing memorandum (*Southeast Michigan Council of Governments, Data Processing, RSG, November 15, 2020)* cited in the introduction section of this report.

There are four primary sources of data used for model calibration and two sources for validation. The first calibration data source is a household travel survey (HTS) conducted in 2015 in the SEMCOG region that gathered household characteristics, demographic information, and full day travel patterns for approximately 19,000 individuals among 12,000 households.

The second calibration data source is the on-board transit survey (OBTS) conducted in 2018-2019 that captures the details of a single transit trip for each of the roughly 18,000 surveyed riders. The transit on-board survey is needed to supplement the low number of transit trips captured by the HTS due to relatively low transit ridership in the SEMCOG region.

The third calibration data source is the transit on-board survey tour sample conducted in 2019. The tour sample recruited about 1,000 riders from transit systems surveyed in the OBTS and asked about their full day travel pattern. The tour sample contains information about the trip distribution for tours that include a transit trip.

The fourth calibration data is Census data that provides specialty checks and supplemental information to the three previously listed surveys. For most purposes, the census data is taken from the American Community Survey (ACS) subsets and provides demographic information in the SEMCOG region. For work commute flows, 2011-2015 data was used since it is the last dataset for which commuting flows are available. For other summaries, 2013-2017 was used since it is more representative of 2015 base-year conditions.

All of the calibration target data use expansion factors that take into account the sampling methodology and attempt to account for differences between the attributes of the survey sample and the full population of the SEMCOG region. Note that the SEMCOG 2015 household travel survey included a GPS sub-sample. Comparison of the sub-sample to the non-GPS survey households revealed a trip under-estimation bias in the non-GPS households. Trip weights were calculated to compensate for this bias, and these weights are used in our calibration targets where appropriate.

For the purpose of validation, the first data source is the count data. The count data used for the ActSim model validation is based on the 2015 count data supplemented with 2017-2019 data provided by SEMCOG. The second source of data is the 2019 national transit database (NTD). This dataset is used to validate the model transit boarding by transit operator.

Calibration Approach

The development team's strategy to calibrate the final models was to introduce alternative-specific constants to achieve a reasonable level of fit to observed data. Alternative-specific constants reflect non-included attributes of the alternative and measurement error. They are adjusted according to the following formula:

$$\text{adjustment} = \ln\left(\frac{observed\ share}{estimated\ share}\right)$$

This adjustment is performed iteratively, where the results are added to the alternative-specific constant from the previous iteration. The adjustment increases or decreases the utility of the alternative based on the under or overestimated share, thus changing the probability of the alternative and ultimately the number of predicted observations. Typically, there is one less alternative-specific constant than number of alternatives; the alternative without a constant is referred to as the 'base' alternative. In some models, the alternative-specific constants are relatively simple, where the constants are not stratified by any attributes of the decision-maker, while in other models, such as the coordinated daily activity pattern model or tour mode choice, the constants are stratified by socio-economic variables. In the case of the coordinated daily activity pattern model, the constants are stratified by person type, while in tour mode choice, constants are stratified by auto sufficiency, income, or geographical district. For a more complete description of each model, see the model specification document referred to above.

Long-Term And Mobility Choice Models

Auto Ownership Model

The initial transferred (MTC TM1) auto ownership model was significantly under-estimating 0-auto households compared to Census ACS data in the SEMCOG region, as shown in Figure 2 (top). A new auto ownership model was estimated using SEMCOG household travel survey. The estimated model is described in the model specification report cited previously. This resolved the 0-auto household under-estimation issue and improved the overall performance of the model. In addition to the alternative-specific constants that were estimated during the model estimation process, calibration constants were also introduced in the model to allow it to more accurately predict the auto ownership shares as show in Figure 2 (bottom). These constants include a set of alternative-specific constants for each household-level car ownership choice (0, 1, 2 ,3 , 4+), and a geographical constant indicating whether a household resides in the Detroit area. The latter constant was added to more accurately represent the share of 0-auto households in the city of Detroit.

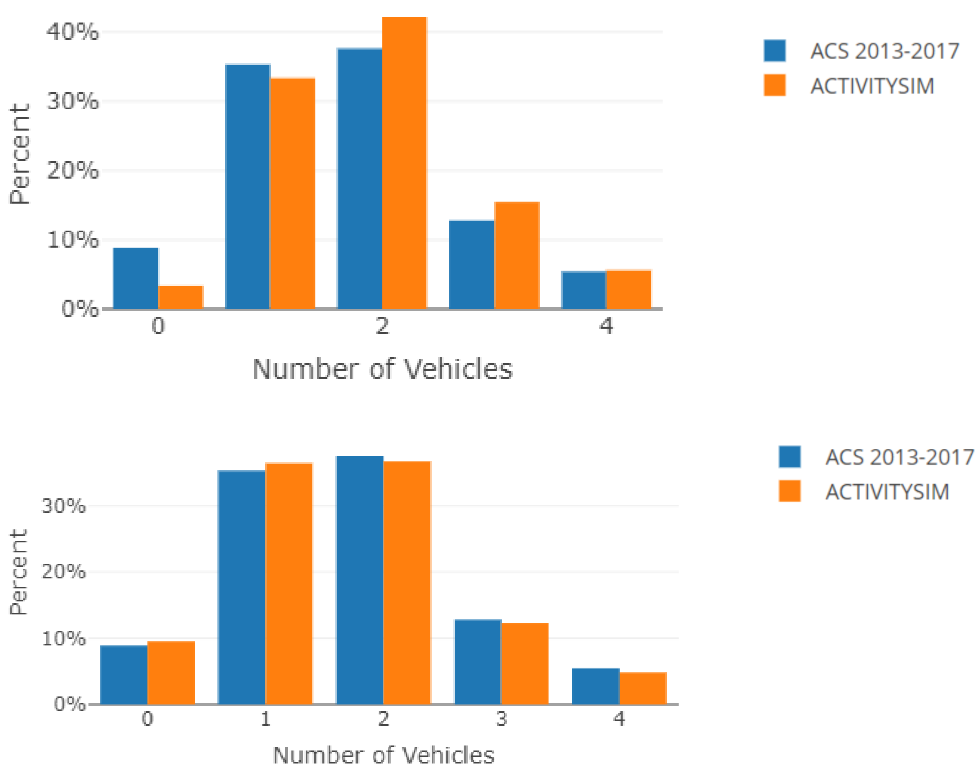


FIGURE 2: AUTO OWNERSHIP COMPARISON (TOP: BEFORE CALIBRATION, BOTTOM: AFTER CALIBRATION)

TABLE 2 COUNTY LEVEL ZERO-AUTO HOUSEHOLDS COMPARISON

		Transferred Model			Estimated Model		
NAME	Census	Model	Difference	% Difference	Model	Difference	% Difference
Livingston	2,280	4,173	1,893	83%	1,715	565	25%
Macomb	21,554	15,700	-5,854	-27%	20,469	1,085	5%
Monroe	3,371	2,115	-1,256	-37%	2,746	625	19%
Oakland	26,965	14,389	-12,576	-47%	26,306	659	2%
St. Clair	4,349	2,536	-1,813	-42%	3,178	1,171	27%
Washtenaw	11,442	7,588	-3,854	-34%	30,302	-18,860	-165%
Wayne	93,939	36,025	-57,914	-62%	100,924	-6,985	-7%
Total	**163,900**	**82,526**	**-81,374**	**-50%**	**185,640**	**-21,740**	**-13%**

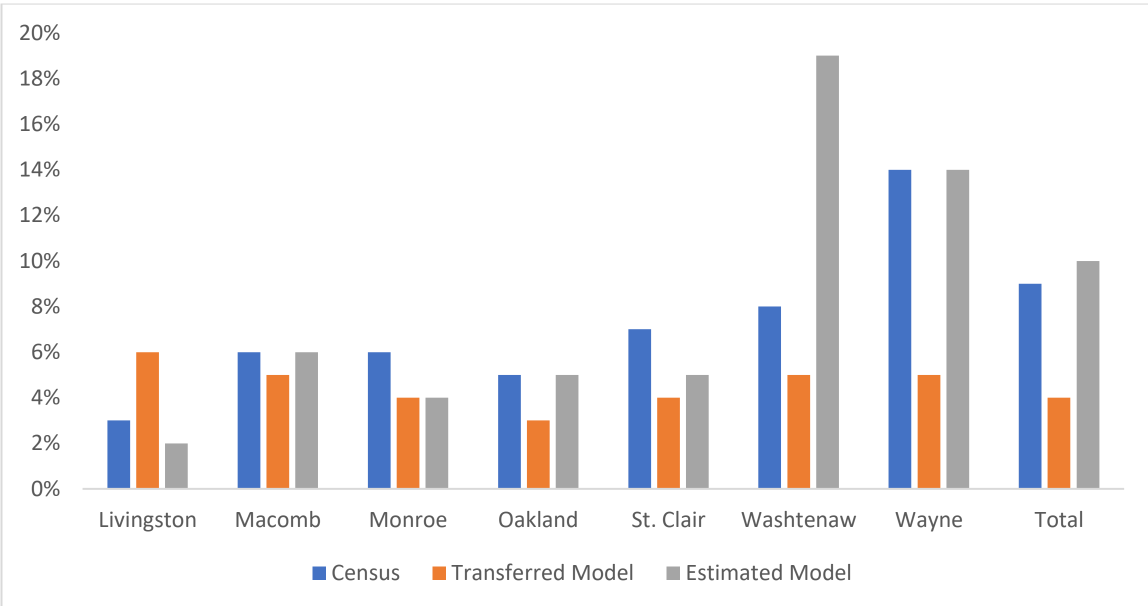
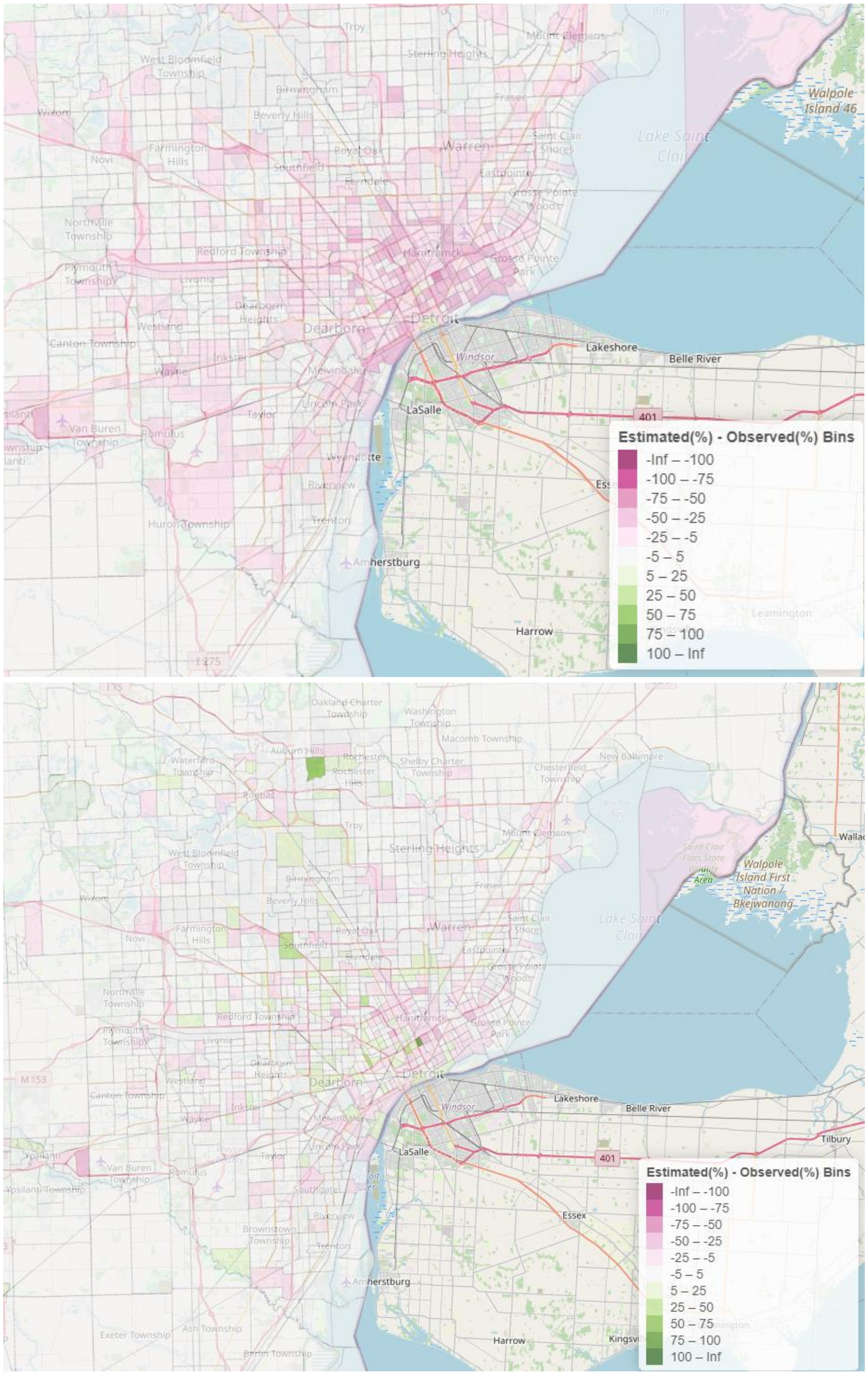


FIGURE 3 PERCENT OF ZERO-AUTO HOUSEHOLDS BY COUNTY

Figure 4 (top) shows that the transferred model especially underestimated the 0-auto households in the City of Detroit This was probably because downtown Detroit and nearby areas have a higher concentration of zero auto households than other parts of the Detroit region. Figure 3 (bottom) shows the improvement in 0-auto household distribution in the region with the new estimated model. Figure 3 shows percentage of zero-auto households by county. The estimated model matches the survey better than the transferred model for almost all counties, especially wayne. However, the model is underestimating zero-auto households in less populated counties: Livingston, Monroe, and St. Clair, and over-estimating in Washtenaw County. More investigation needs to be done to improve county level fit in these cases.

FIGURE 4: ESTIMATED VERSUS OBSERVED 0-AUTO HOUSEHOLDS BY CENSUS TRACT



Telecommute Frequency Model

The telecommute frequency model was originally estimated from the household travel survey (HTS) data for San Diego Association of Governments (SANDAG), and then calibrated to the 2015 SEMCOG HTS data. Table 3 and Figure 5 show the model frequency and percent share compared to the HTS data.

TABLE 3 TELECOMMUTE FREQUENCY MODEL

Variable	Survey		Model	
	Frequency	Percent	Frequency	Percent
1 day a week	77340	3.4%	96715	4.5%
2-3 days a week	41011	1.8%	39477	1.8%
4 days a week	5467	0.2%	4612	0.2%
No telecommuting	2128318	94.5%	2001208	93.4%
Total	2252138	100.0%	2142012	100.0%

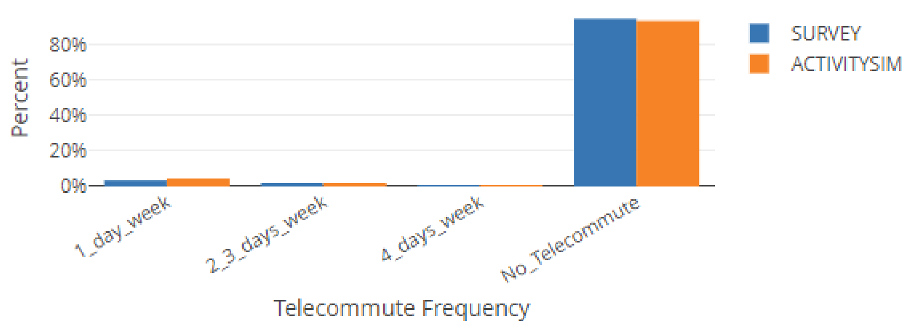


FIGURE 5 TELECOMMUTE FREQUENCY MODEL

Work-from-home Model

The work from home model was originally estimated for the MTC model, and was calibrated to the SEMCOG HTS data. As Table 4 shows, the frequency and share of those who work from home by county in the model and survey are very close.

TABLE 4 WORK FROM HOME MODEL

County	Survey		Model	
	Frequency	Percent	Frequency	Percent
Detroit	16155	6.1%	12073	4.9%
Livingston	5945	6.0%	6248	6.5%
Macomb	17963	4.0%	21996	5.2%
Monroe	3892	5.1%	4502	6.5%
Oakland	42187	6.5%	33393	5.2%
St. Clair	3302	4.1%	4845	6.8%
Washtenaw	13341	6.7%	10230	5.3%
Wayne	28766	5.1%	27520	5.3%
Total	**131552**	**5.5%**	**120807**	**5.3%**

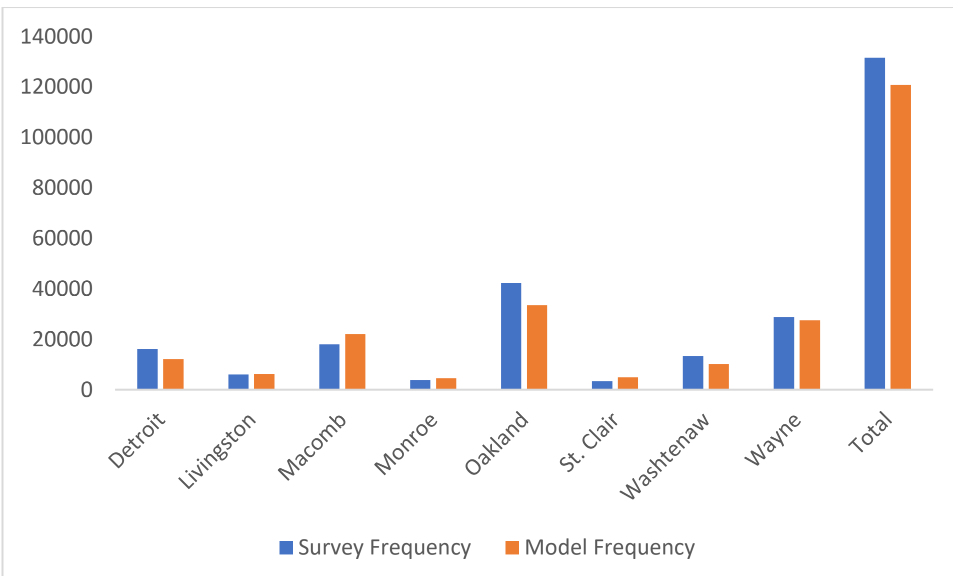


FIGURE 6 WORK FROM HOME MODEL FREQUENCY

Transit Subsidy Model

The transit subsidy model was originally estimated for the MTC model, and was calibrated to the SEMCOG (2005) HTS data. The model calibration was done so that the share of those with transit subsidy within each person type group match the survey data. As **Error! Reference source not found.** and Figure 6 show the frequency and share of those with transit subsidy by person type in the model and survey are very close.

TABLE 5 TRANSIT SUBSIDY MODEL

Person type	Survey		Model	
	Frequency	Percent	Frequency	Percent
Full-time worker	15518	0.9%	17430	1.0%
Part-time worker	4770	1.3%	5480	1.4%
College student	4950	3.4%	8036	3.7%
Non-worker/retiree	40741	3.6%	50178	3.8%
Driving-age student	3568	2.5%	3874	2.7%
Non-driving student	8393	1.1%	7267	1.2%
Pre-schooler	0	0.0%	264	0.1%
Total	**77940**	**1.7%**	**92529**	**2.0%**

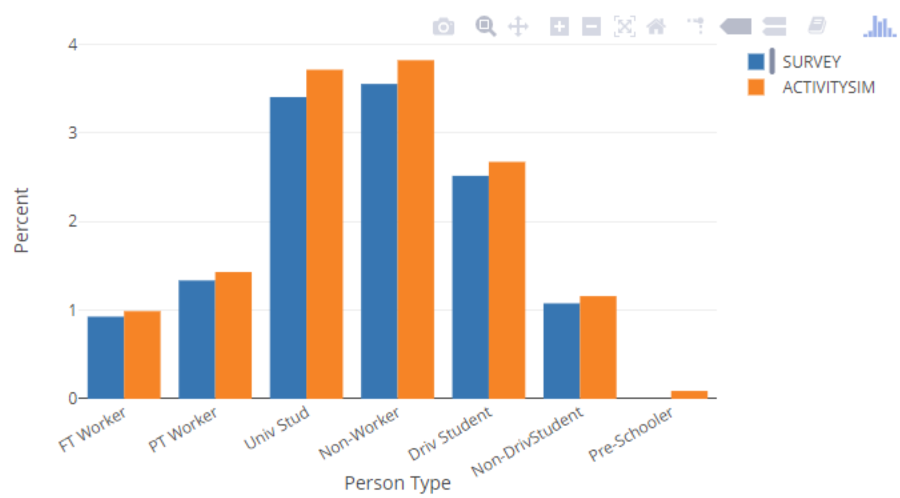


FIGURE 7 TRANSIT SUBSIDY MODEL SUMMARY BY PERSON TYPE

Transit Pass Ownership Model

The transit pass ownership model was originally estimated for the MTC model, and was calibrated to the SEMCOG (2005) HTS data (the last year data was available). The model calibration was done so that the share of transit pass owners within each person type group match the survey data. As Table 6 and Figure 5 show the frequency and share of those who owns transit pass by person type in the model and survey are very close.

TABLE 6 TRANSIT PASS OWNERSHIP MODEL

Person type	Survey		Model	
	Frequency	Percent	Frequency	Percent
Full-time worker	26152	1.6%	27679	1.6%
Part-time worker	13230	3.8%	14386	3.8%
College student	7983	5.8%	12153	5.6%
Non-worker/retiree	72287	6.7%	84645	6.4%
Driving-age student	12711	9.8%	12927	8.9%
Non-driving student	22756	3.0%	18649	3.0%
Pre-schooler	0	0.0%	933	0.3%
Total	**155119**	**3.4%**	**171372**	**3.6%**

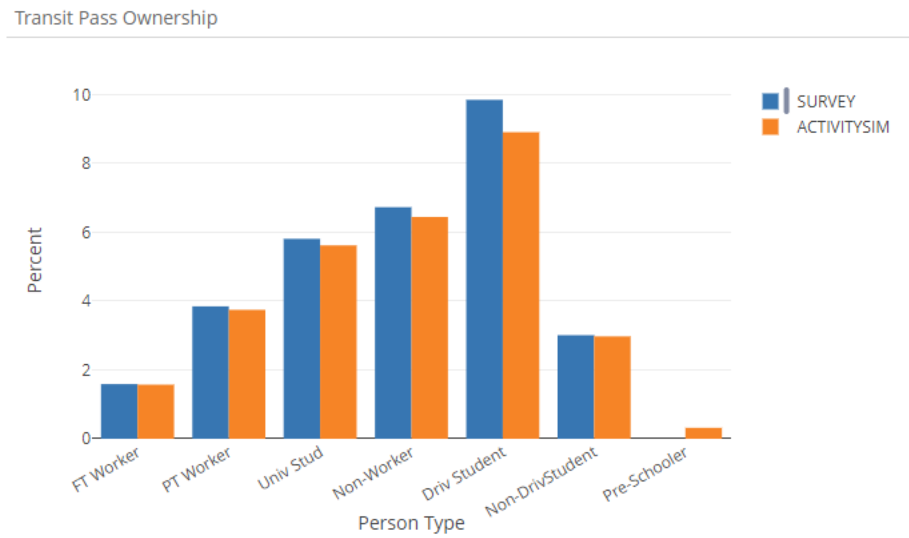


FIGURE 8 TRANSIT PASS OWNERSHIP MODEL SUMMARY BY PERSON TYPE

Mandatory Location Choice

Under the scope of Phase I, Work and school location choice models were estimated using the SEMCOG household travel survey. The resulting work and school location choice models averaged lengths of 11.9 and 4.4 miles, respectively. The university location choice distribution is significantly shorter than the observed distribution; however, the SEMCOG 2015 household travel survey did not collect data on students living in group quarters and probably also under-represents university students living in non-family households. Therefore, we do not believe the observed university location choice distribution and do not recommend calibrating this model to observed household survey data. Note that if student residential location data is made available for University of Michigan and other universities in the region, it would be possible to calibrate student travel more closely.

The development team conducted a calibration to better match the lower average length of the work location choice model to the survey. This process was automated using a Jupyter Notebook.

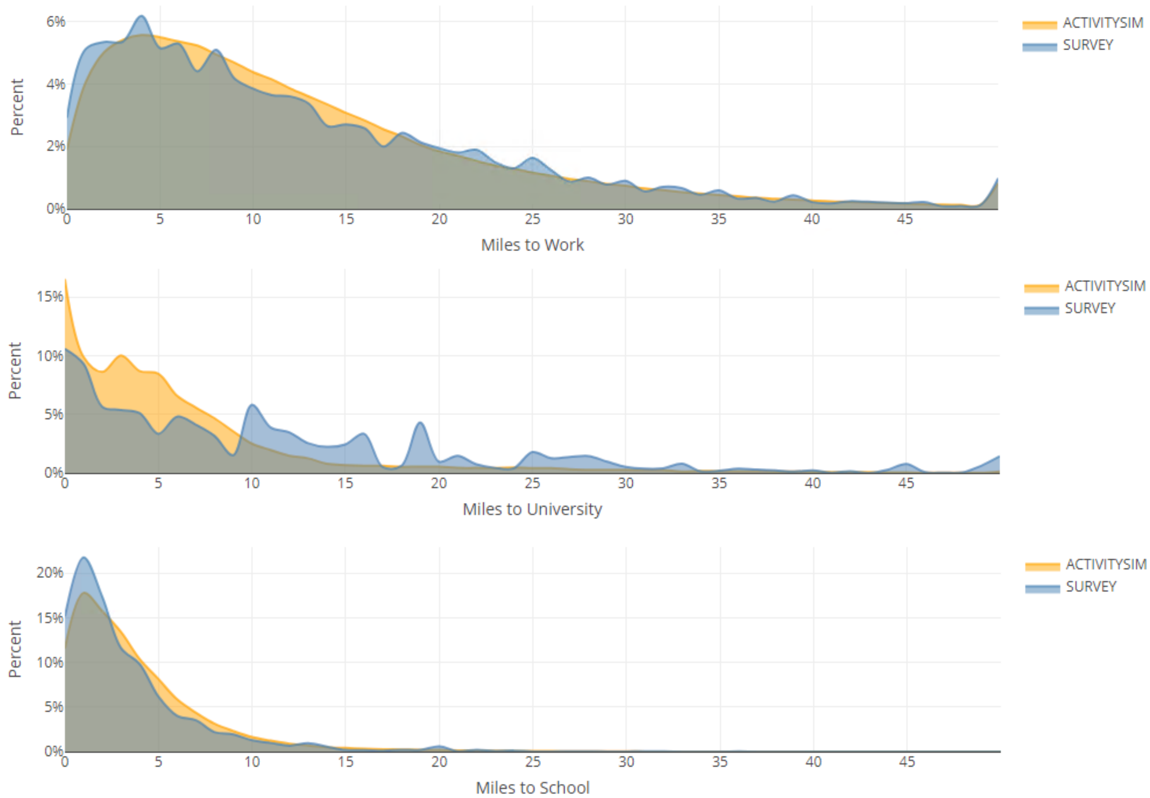


FIGURE 9: MANDATORY LOCATION CHOICE LENGTH FREQUENCY DISTRIBUTION

Table 7, Table 8, and Table 9 show that estimated average distance between home and mandatory locations matches household survey data generally well, though K-12 school length is slightly over-estimated. The trend of tour length by county aligns well with observed data. Note that City of Detroit is broken out from the rest of Wayne County for these summaries.

TABLE 7 WORK TOUR LENGTHS

District	Survey	Model	Difference	Percent Difference
City of Detroit	9.8	10.2	0.4	4%
Livingston	20.7	19.7	-1.1	-5%
Macomb	13.0	12.7	-0.3	-2%
Monroe	17.3	20.7	3.4	20%
Oakland	13.4	12.8	-0.6	-4%
St. Clair	17.6	17.9	0.4	2%
Washtenaw	10.4	12.7	2.3	22%
Rest of Wayne County	13.0	12.7	-0.2	-2%
Total	13.2	13.2	0.0	0%

TABLE 8 UNIVERSITY TOUR LENGTHS

District	Survey	Model	Difference	Percent Difference
City of Detroit	8.2	3.8	-4.4	-53%
Livingston	21.8	28.1	6.3	29%
Macomb	12.5	7.7	-4.8	-39%
Monroe	15.9	13.3	-2.6	-17%
Oakland	17.8	7.7	-10.1	-57%
St. Clair	16.2	15.1	-1.1	-7%
Washtenaw	5.4	2.8	-2.6	-48%
Rest of Wayne County	11.6	7.0	-4.6	-40%
Total	11.8	6.6	-5.2	-44%

TABLE 9 K-12 TOUR LENGTHS

District	Survey	Model	Difference	Percent Difference
City of Detroit	5.0	4.0	-1.0	-19%
Livingston	6.1	6.3	0.2	4%
Macomb	3.3	4.1	0.8	23%
Monroe	4.4	4.7	0.3	7%
Oakland	3.8	4.5	0.8	21%
St. Clair	5.4	5.1	-0.3	-5%
Washtenaw	4.7	4.9	0.3	6%
Rest of Wayne County	3.1	4.0	0.9	31%
Total	3.9	4.4	0.5	12%

Table 11 shows the total number of jobs by district versus workers by work district in 2017 ACS data. The difference between total employment in the land use data versus workers in census in part reflects the fact that the 2017 ACS data is a 5-year average of workers, while the employment data is the sum of all jobs in 2018. In other words, companies that go out of business in a given year, new companies that open in a year, seasonal jobs such as summer employment, temporary retail jobs, etc. are all included in employment data. Additionally, some portions of workers hold multiple jobs. Therefore, one would expect the TAZ-level employment data to be higher than the number of workers in the model.

TABLE 10 MODEL INPUT EMPLOYMENT VS CENSUS WORKERS BY DISTRICT

County	Employment	Census	Disfference	Percent Difference
City of Detroit	336,820	280,272	(56,548)	-17%
Livingston	85,721	49,245	(36,476)	-43%
Macomb	421,451	318,553	(102,898)	-24%
Monroe	58,460	38,058	(20,402)	-35%
Oakland	959,918	636,440	(323,478)	-34%
St. Clair	64,234	47,366	(16,868)	-26%
Washtenaw	256,648	188,037	(68,611)	-27%
Rest of Wayne County	590,971	440,162	(150,809)	-26%
Total	2,774,223	1,998,133	(776,090)	-28%

Table 11 shows estimated versus ACS workers by residence district and work district. To account for the differences in workers by residence district between ACS data and the synthetic population, we scaled the ACS district flows to match model workers by residence district. Also note that ACS data does not separate City of Detroit from Wayne County. We split out City of Detroit from the rest of Wayne County in ACS data by applying the household survey proportion of workers working in City of Detroit versus the rest of Wayne County from the origin county. For example, if the survey data had 30 workers living in Macomb County and working in the City of Detroit, and 70 workers living in Macomb County and working in the rest of Wayne County, then the ACS flow of workers residing in Macomb County and working in Wayne County would be split 30% to City of Detroit and 70% to the rest of Wayne County.

District level calibration constants were added to the workplace location model to better match the ACS district flows. The iterative calibration process was carried out until the difference between model and ACS flows was less than 5,000 in more than 90% of cases. As Table 12 shows, the district level summary shows a good fit to observed data, but there is a notable underestimation in intra-county flows, which needs further investigation and calibration. We also note that the totals across rows (the last row of Table 12) does not correlate with differences between input employment by TAZ and workers by work district shown in Table 11. In addition, Figure 10 shows a scatter plot of district-district flows and labels district pairs that are furthest from the diagonal. The rsquared between estimated and observed worker flows is 0.9879, overall a very good level of fit.

TABLE 11 DISTRICT-DISTRICT FLOW OF WORKERS (ROWS DENOTE HOME COUNTY, COLUMNS DENOTE WORKPLACE COUNTY)

Census County-County Flow (Scaled)									
	Detroit	Livingston	Macomb	Monroe	Oakland	St. Clair	Washtenaw	Wayne	Total
Detroit	111,520	955	33,230	50	50,189	296	2,465	36,418	235,122
Livingston	404	49,350	1,340	86	15,972	0	13,770	9,666	90,588
Macomb	27,998	174	236,034	148	117,480	5,554	549	15,954	403,892
Monroe	1,799	199	912	37,113	1,647	0	6,882	15,751	64,303
Oakland	33,804	9,214	45,434	652	452,134	904	9,107	60,312	611,560
St. Clair	1,095	166	18,356	81	3,257	42,434	556	766	66,712
Washtenaw	3,392	3,877	1,560	1,505	8,889	0	141,496	20,821	181,540
Wayne	57,941	2,346	20,173	3,830	72,330	232	31,247	300,222	488,321
Total	237,953	66,279	357,039	43,465	721,898	49,420	206,073	459,911	2,142,038
Model County-County Flow									
	Detroit	Livingston	Macomb	Monroe	Oakland	St. Clair	Washtenaw	Wayne	Total
Detroit	105,281	1,124	36,098	474	51,469	350	3,283	37,043	235,122
Livingston	3,516	43,008	3,637	372	17,647	123	15,172	7,113	90,588
Macomb	25,359	845	218,533	364	128,294	7,486	1,653	21,358	403,892
Monroe	3,686	438	1,693	31,321	3,816	49	8,884	14,416	64,303
Oakland	35,677	11,986	48,761	1,086	430,420	2,313	12,488	68,829	611,560
St. Clair	1,478	47	21,931	17	3,436	38,926	87	790	66,712
Washtenaw	5,680	5,947	2,678	2,606	13,323	56	127,024	24,226	181,540
Wayne	56,287	3,923	24,774	6,956	74,788	749	37,059	283,785	488,321
Total	236,964	67,318	358,105	43,196	723,193	50,052	205,650	457,560	2,142,038

TABLE 12 DISTRICT-DISTRICT FLOW OF WORKERS (DIFFERENCE)

Difference									
	Detroit	**Livingston**	**Macomb**	**Monroe**	**Oakland**	**St. Clair**	**Washtenaw**	**Wayne**	**Total**
Detroit	-6239	169	2868	424	1280	54	818	625	0
Livingston	3112	-6342	2297	286	1675	123	1402	-2553	0
Macomb	-2639	671	-17501	216	10814	1932	1104	5404	0
Monroe	1887	239	781	-5792	2169	49	2002	-1335	0
Oakland	1873	2772	3327	434	-21714	1409	3381	8517	0
St. Clair	383	-119	3575	-64	179	-3508	-469	24	0
Washtenaw	2288	2070	1118	1101	4434	56	-14472	3405	0
Wayne	-1654	1577	4601	3126	2458	517	5812	-16437	0
Total	-989	1039	1066	-269	1295	632	-423	-2351	0
Percent Difference									
	Detroit	**Livingston**	**Macomb**	**Monroe**	**Oakland**	**St. Clair**	**Washtenaw**	**Wayne**	**Total**
Detroit	-5.6%	17.7%	8.6%	848.0%	2.6%	18.2%	33.2%	1.7%	0.0%
Livingston	770.3%	-12.9%	171.4%	332.6%	10.5%		10.2%	-26.4%	0.0%
Macomb	-9.4%	385.6%	-7.4%	145.9%	9.2%	34.8%	201.1%	33.9%	0.0%
Monroe	104.9%	120.1%	85.6%	-15.6%	131.7%		29.1%	-8.5%	0.0%
Oakland	5.5%	30.1%	7.3%	66.6%	-4.8%	155.9%	37.1%	14.1%	0.0%
St. Clair	35.0%	-71.7%	19.5%	-79.0%	5.5%	-8.3%	-84.4%	3.1%	0.0%
Washtenaw	67.5%	53.4%	71.7%	73.2%	49.9%		-10.2%	16.4%	0.0%
Wayne	-2.9%	67.2%	22.8%	81.6%	3.4%	222.8%	18.6%	-5.5%	0.0%
Total	-0.4%	1.6%	0.3%	-0.6%	0.2%	1.3%	-0.2%	-0.5%	0.0%

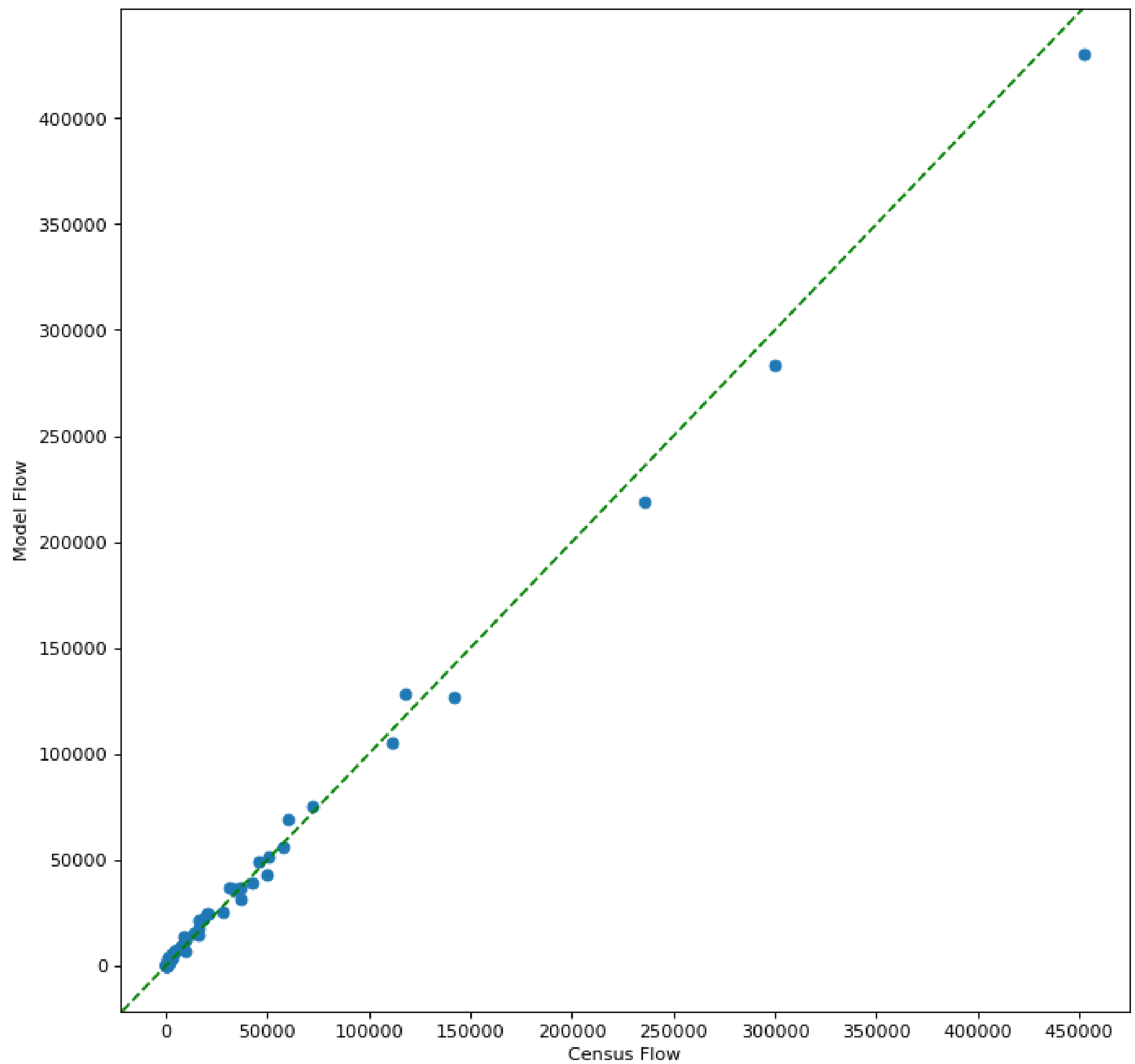


FIGURE 10 DISTRICT-DISTRICT FLOW OF WORKERS (CENSUS VS. MODEL)

Tour Level Models

Coordinated Daily Activity Pattern Model

The coordinated daily activity pattern (CDAP) model predicts the daily activity pattern type for each person in the synthetic population. The activity pattern type is defined as three mutually exclusive categories:

- Mandatory (M): At least one out-of-home work or school activity
- Non-mandatory (N): No out-of-home work or school activities, at least one out-of-home maintenance or discretionary activity
- Home (H): No out-of-home activities, or person is out of the region on the simulation day

Building on the results of Phase I, the CDAP model was further calibrated to more accurately replicate the survey shares. The results, shown in Figure 11, are summarized by person type as follows:

- *Full-time workers*: The model generally matches the survey data well.
- *Part-time workers:* The model generally matches the survey data well.
- *University students:* The model generally matches the survey data well.
- *Non-workers:* The model generally matches the survey data well.
- *Retired persons*: The model generally matches the survey data well.
- *Driving age students*: The model generally matches the survey data well.
- *Non-driving age students:* The model generally matches the survey data well.
- *Pre-school children*: The share of preschoolers with a mandatory activity pattern (daycare) matches survey well, but the share of preschoolers with a non-mandatory activity pattern is over-estimated and home pattern is under estimated.

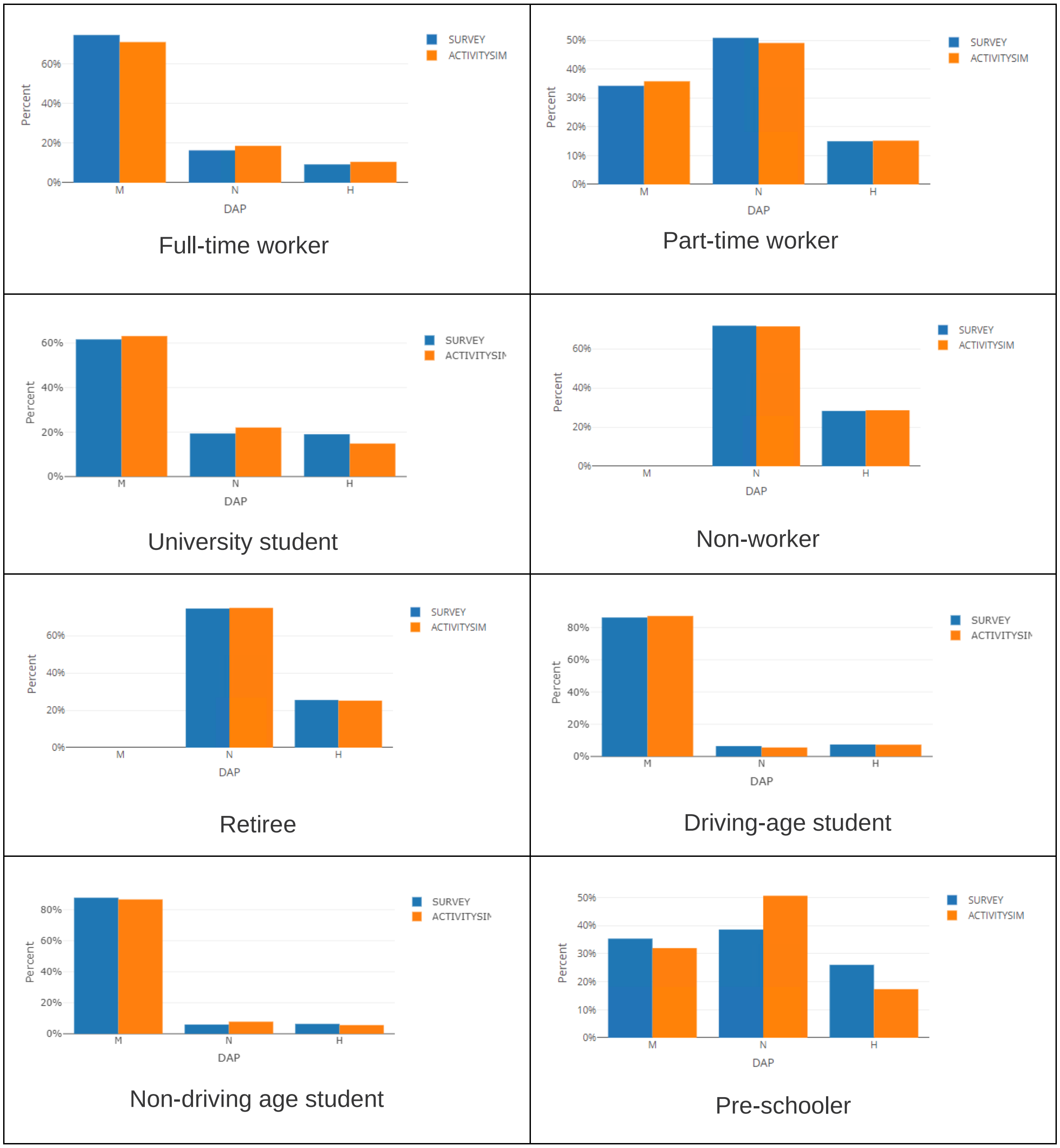


FIGURE 11: COORDINATED DAILY ACTIVITY PATTERN RESULTS

Mandatory Tour Frequency Model

The mandatory tour frequency model predicts the number of work and school tours by each worker or student. As Figure 12 shows, there is a good fit for all person types (who have a mandatory pattern) between model and survey.

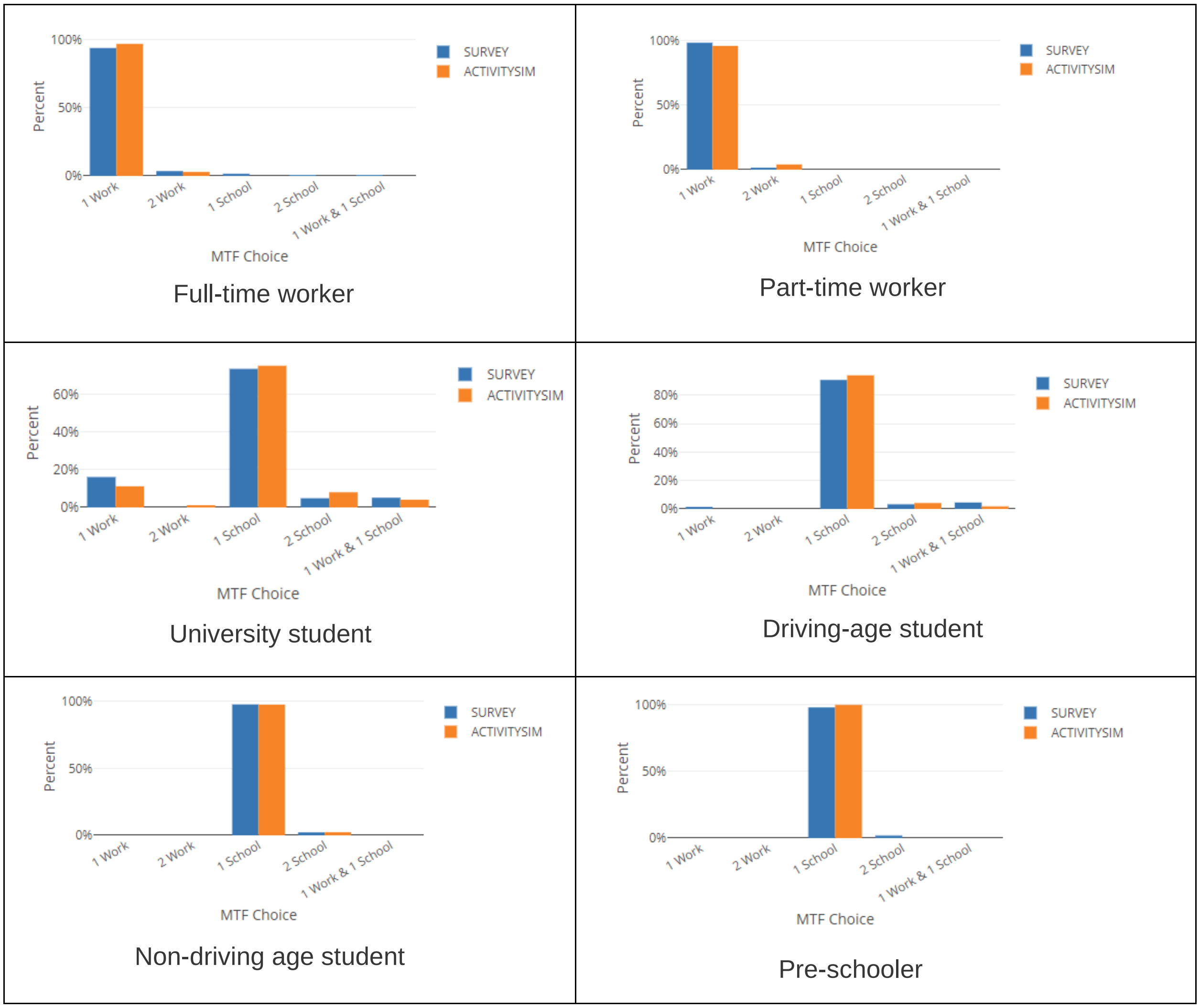


FIGURE 12 MANDATORY TOUR FREQUENCY PATTERNS

Individual Non-Mandatory Tour Frequency Model

Figure 13 shows the estimated versus observed tour rate by person type, for active persons (those without an H CDAP pattern) only. Model Tour rates for most person types show an acceptable level of fit (difference of less than 5%) with the survey, although non-workers and non-driving age students have a slightly higher tour rate, while preschoolers in the model have a slightly lower share. Overall, as mentioned, the match to observed data is very close.

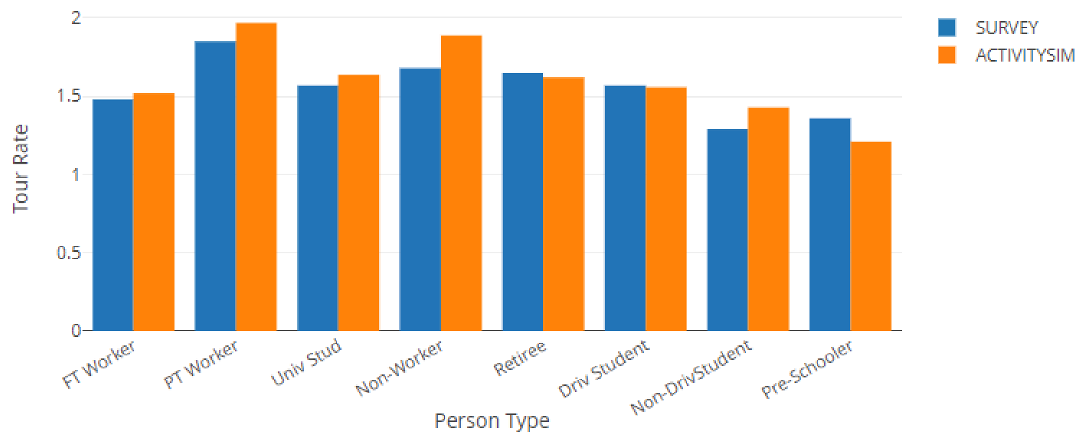


FIGURE 13: ESTIMATED VERSUS OBSERVED TOUR RATE BY PERSON TYPE

Joint Tour Composition Model

Joint tour composition model was calibrated to better match the survey summaries. Figure 14 shows the joint tour composition distribution between the survey and model. As the figure shows, model replicates survey shares well.

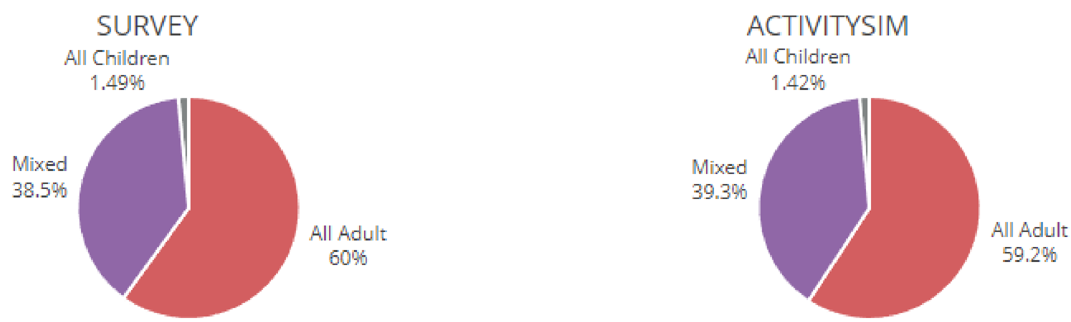


FIGURE 14: ESTIMATED VERSUS OBSERVED JOINT TOURS BY COMPOSITION

Joint Tour Frequency Model

The joint tour frequency model predicts the number of household joint tours by purpose. Figure 13 shows the comparison of joint tour frequency between model and survey. Although the overall fit is close, ActivitySim is somewhat underpredicting the 1 shopping, maintenance, eating out, and other discretionary purpose categories, while over predicting the 1 eating out/1 visiting, 1 eating out/ 1 other discretionary and 2 visiting purposes. A further round of calibration can help with a better match here.

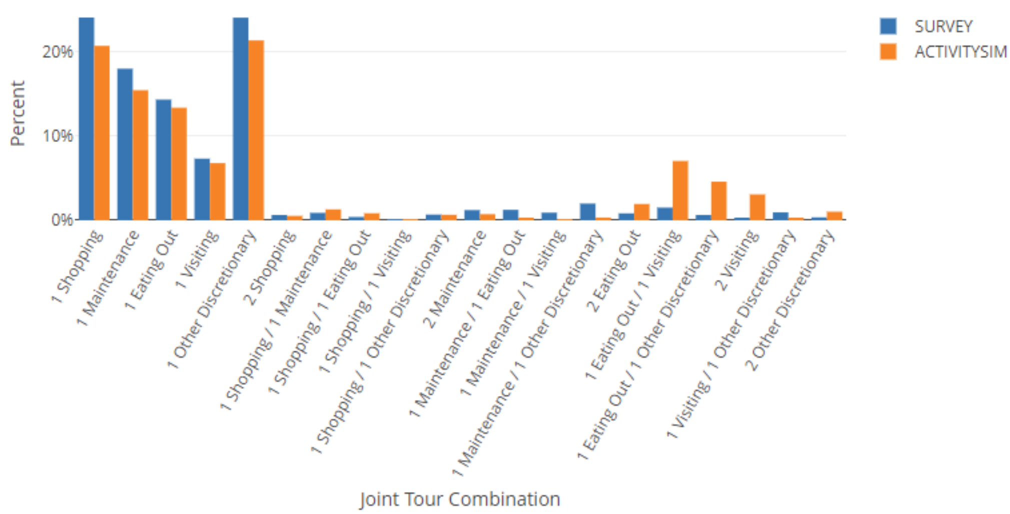
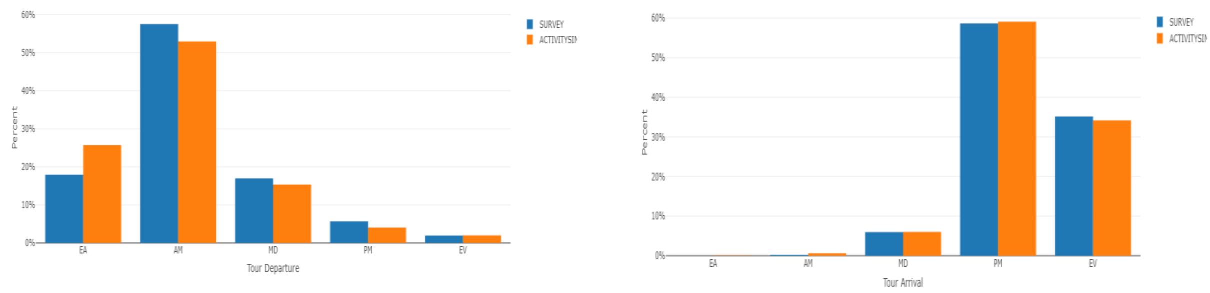


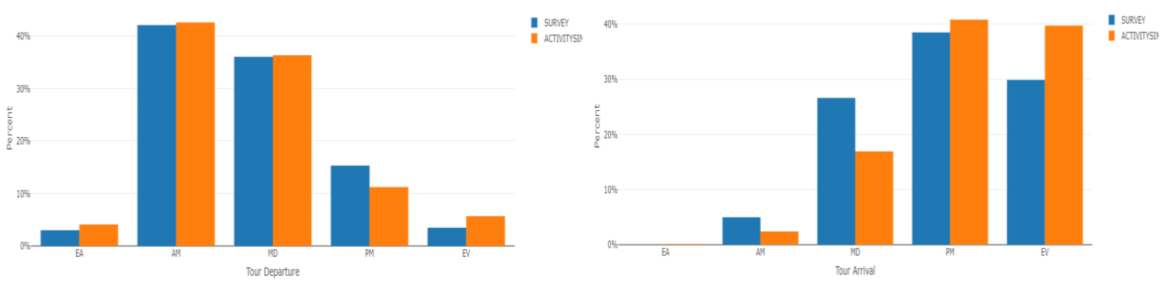
FIGURE 15 JOINT TOUR FREQUENCY MODEL

Tour Time of Day Choice models

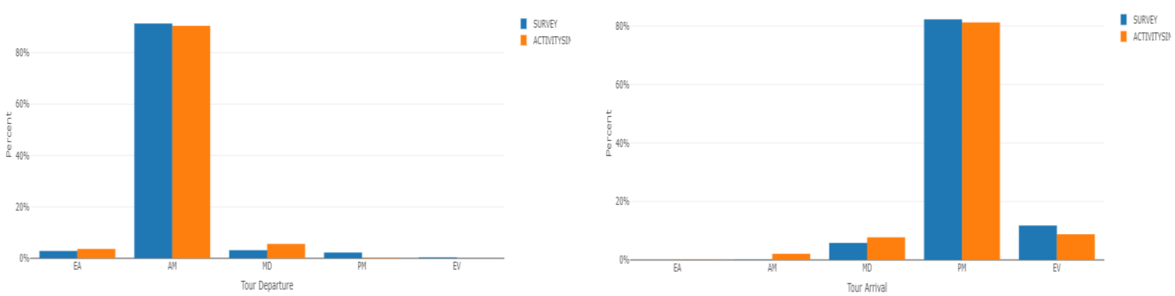
The tour time of day choice models were estimated and calibrated to SEMCOG data. One issue that arose in model validation was the overestimation of the AM flow and the underestimation of the EA flow in the model compared to the count data (refer to Section 3 for further discussion). RSG investigated the sources of this discrepancy, and found that although the model results matched the survey data well, the difference in assignment output and count data still existed. In discussion with SEMCOG and after further data analyses, RSG decided to improve the model validation by calibrating the work tour Time-of-Day model to move 10% of work trips from the AM to the EA period to improve highway assignment goodness of fit by time of day. This calibration (although at the cost of worsening the match between model and survey as shown in work purpose of Figure 16) improved the estimated vs. observed count volumes in these two periods, and SEMCOG and RSG agreed to consider the results as final, and investigate the survey and count data further in the future.



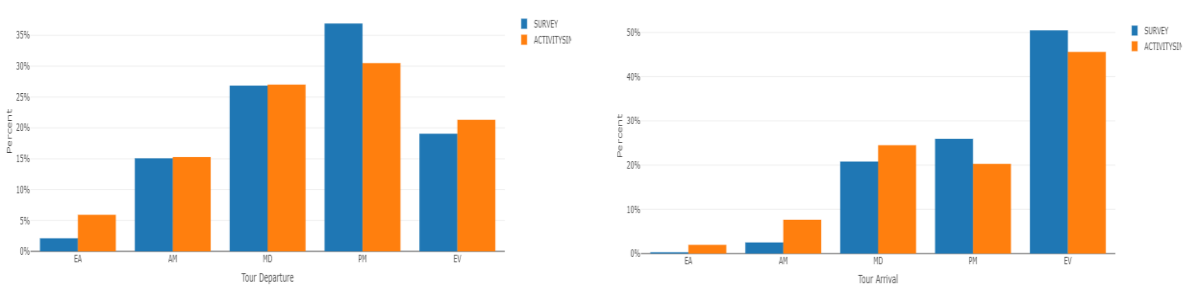
Work purpose



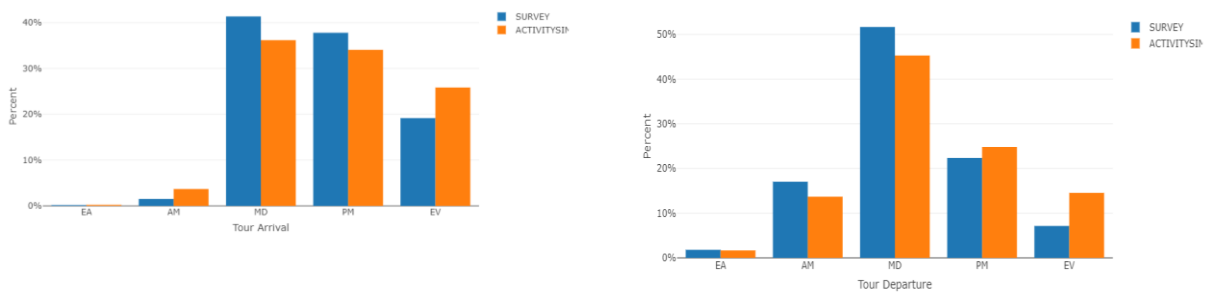
University purpose



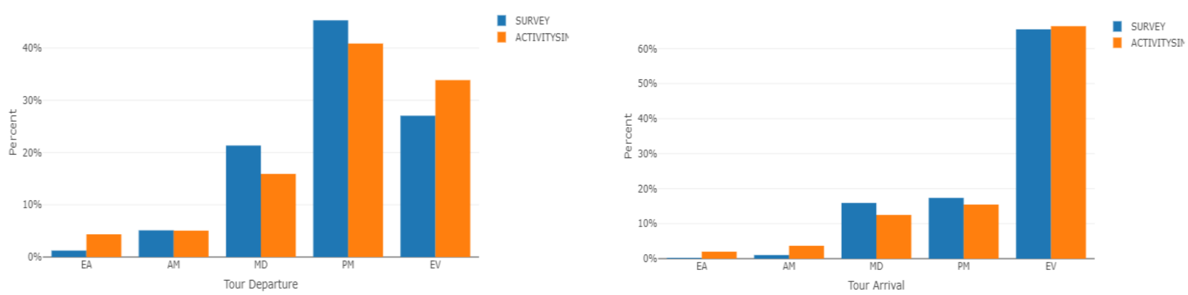
School purpose



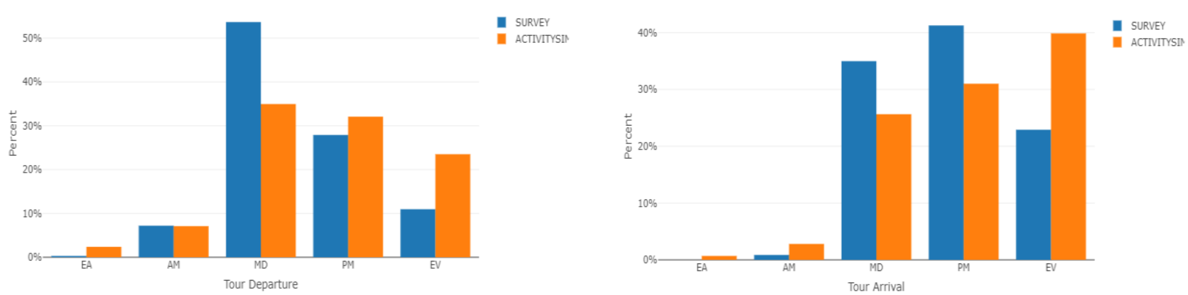
Individual discretionary purpose



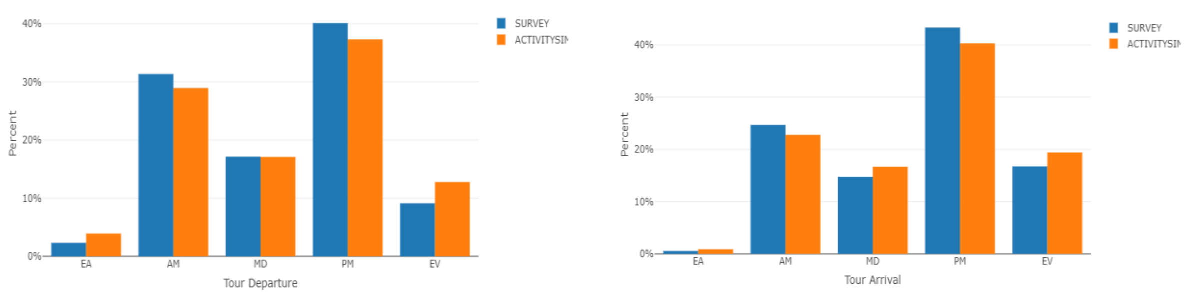
Individual maintenance purpose



Joint discretionary purpose



Joint maintenance purpose



Escort purpose

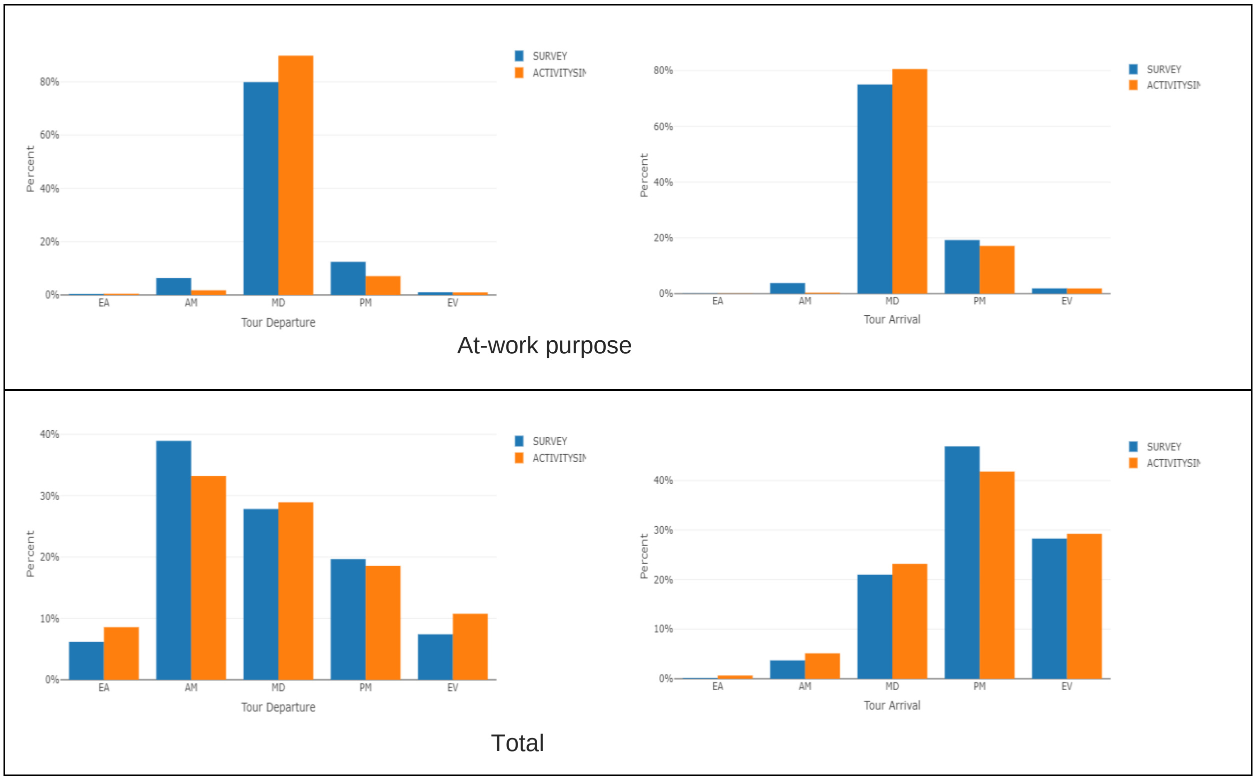


FIGURE 16 TOUR TIME-OF-DAY CHOICE MODELS

Non-Mandatory Tour Destination Choice Models

The non-mandatory tour destination choice models are run for each non-mandatory tour purpose, and the tour length distribution is compared to the survey data. Figure 17 shows the tour length distribution of non-mandatory tour purposes and Table 13 shows the average tour length by purpose. The summaries both show a good fit between survey data and model output.

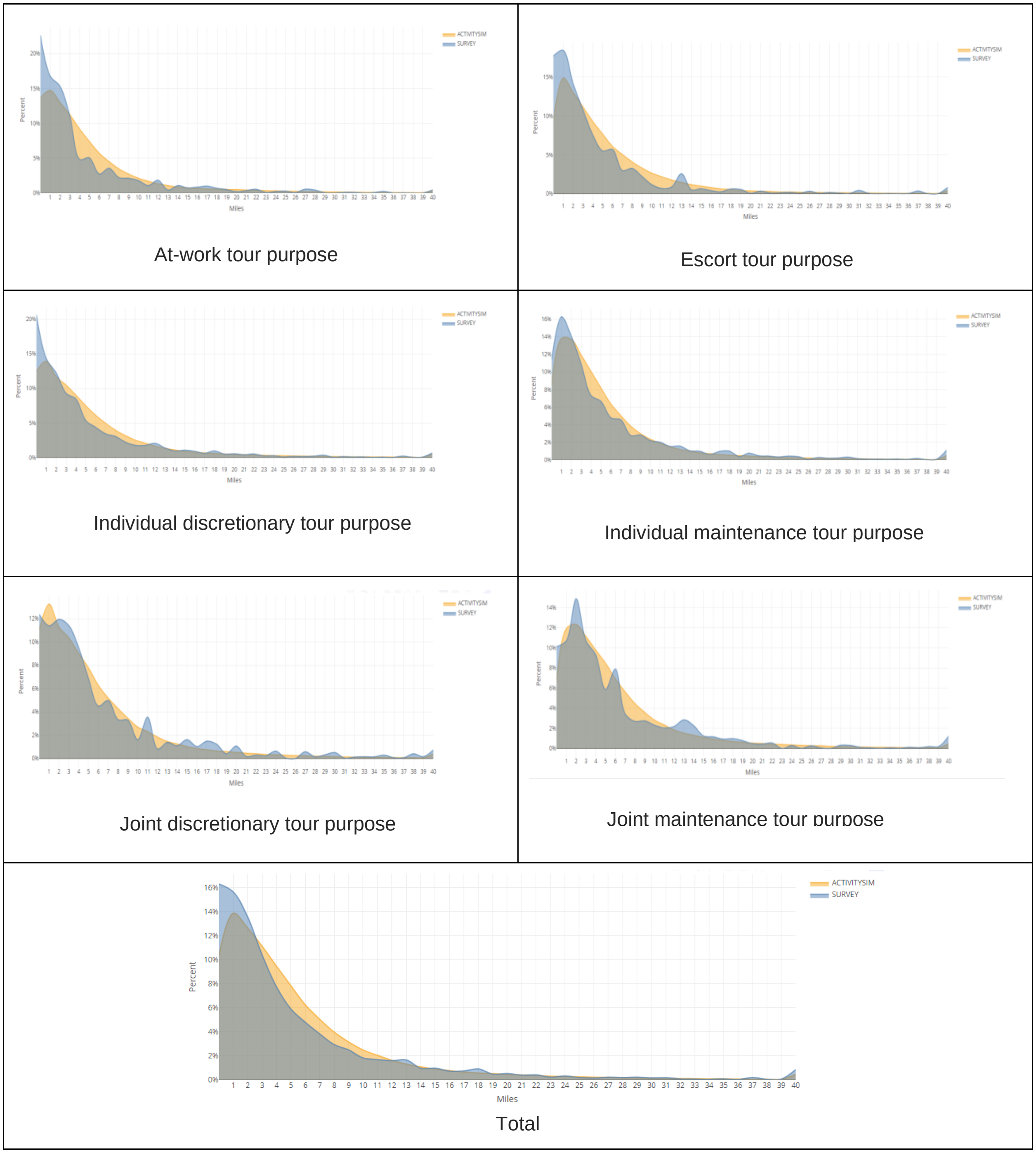


FIGURE 17 NON-MANDATORY TOUR LENGTH DISTRIBUTION

TABLE 13 AVERAGE NON-MANDATORY TOUR LENGTHS (MILES)

Purpose	SURVEY	ACTIVITYSIM	% difference
Escorting	5.12	5.98	17%
Indi-Maintenance	6.48	6.10	-6%
Indi-Discretionary	5.67	6.11	8%
Joint-Maintenance	6.76	6.75	0%
Joint-Discretionary	6.77	6.36	-6%
At-Work	4.92	5.69	16%
Total	5.89	6.13	4%

Tour Mode Choice Model

Figure 18 shows the results of the tour mode choice model compared to observed data. Note that this model had been calibrated several iterations, since the tour mode choice structure was modified for the SEMCOG implementation. Tour mode choice model results by purpose, each compared to the survey, the difference and percent difference have been tabulated in Appendix A. We should note that there are a number of noticeable gaps between survey data and model results especially in zero auto group. This difference is largely due to efforts in validation to better match transit ridership in the Ann Arbor area, but this is an area that could benefit from further future investigations.

The alternative-specific constant adjustments were made by tour purpose, auto sufficiency, income, and tour mode. In Phase I, RSG developed an automated procedure in Python to perform the above calculations iteratively and run the model until it converges. The same process was used in Phase II.

To better match the transit ridership RSG also conducted several transit ridership summaries after the assignment step. Initially, the model was over- or under-estimating ridership on some operators. SMART, for example, showed a higher ridership in the model than the target data. RSG conducted a series of analysis, including investigating transit trip length distribution and transit district-district flows. The results showed that districts 8, 9, 10, and 13 had higher SMART trips than the on-board survey (OBS) data. RSG, therefore, improved SMART ridership by including a negative district-level factor in the tour (and trip) mode choice models for these districts. Furthermore, the M-1 Streetcar and Detroit People Mover (DPM) initially showed lower ridership than the target data. Based on the same transit district-district flows, RSG included a positive constant for districts 1 and 2 (downtown Detroit) in addition to in-vehicle time modifiers (0.8 and 0.7 in tour mode choice for M-1 and DPM respectively, with half of these values in trip mode choice) to improve ridership on these operators.

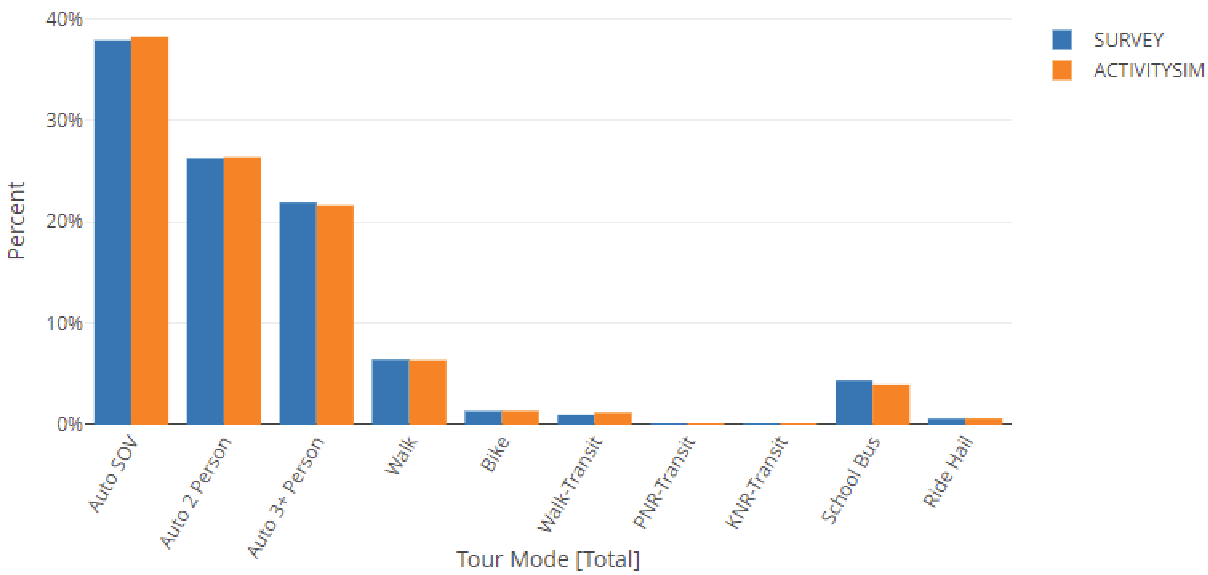
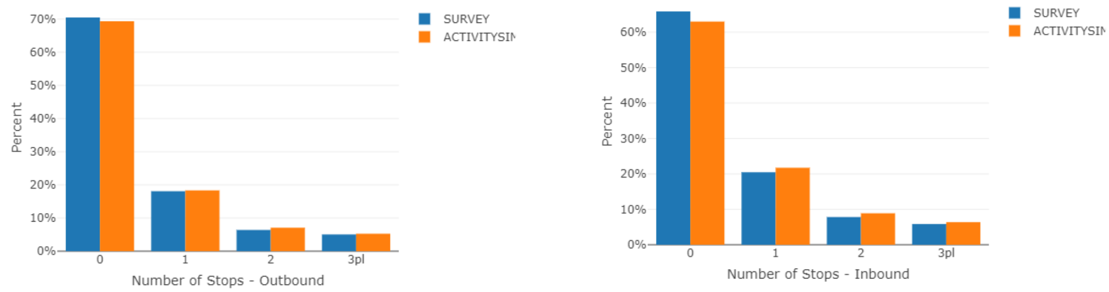


FIGURE 18: ESTIMATED VERSUS OBSERVED TOURS BY TOUR MODE

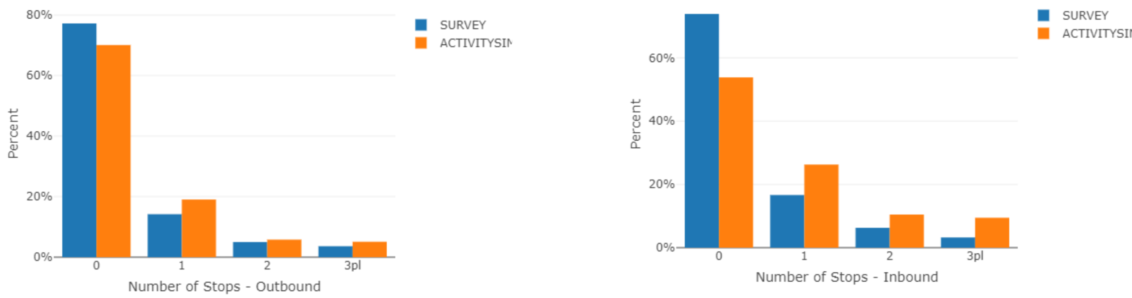
Trip Level Models

Stop Frequency Model

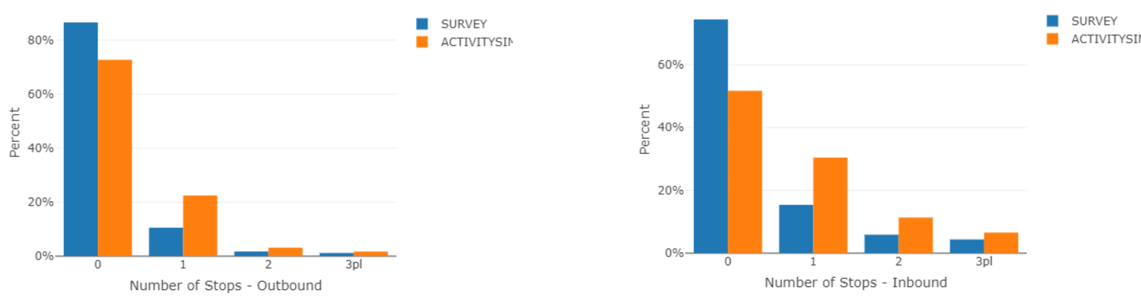
The stop frequency model predicts the number of intermediate stops on each tour by the tour direction (outbound versus inbound). Figure 19 shows a summary of model output compared to survey data. The overall fit between model and survey is quite good, and most purposes also show a good level of fit with survey data. The exceptions include university and school purposes, that may need further calibrations.



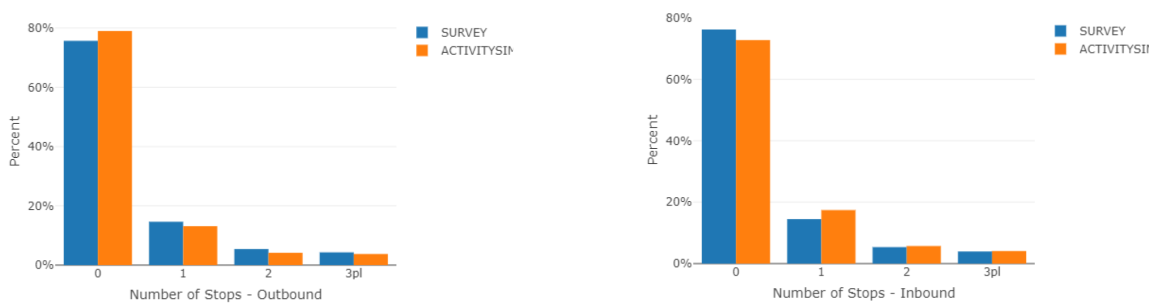
Work purpose



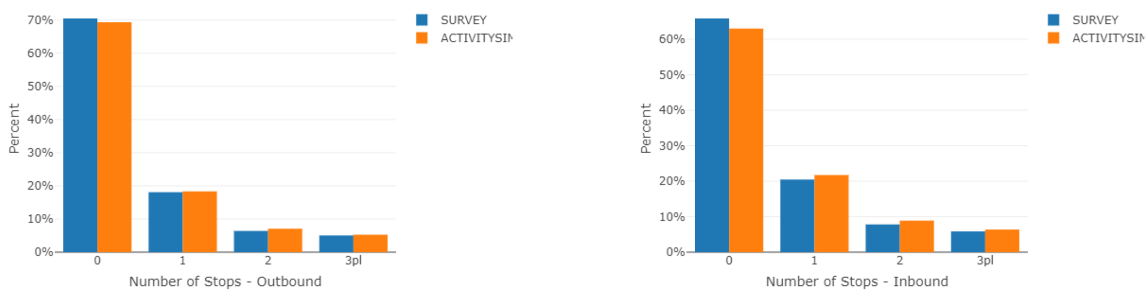
University purpose



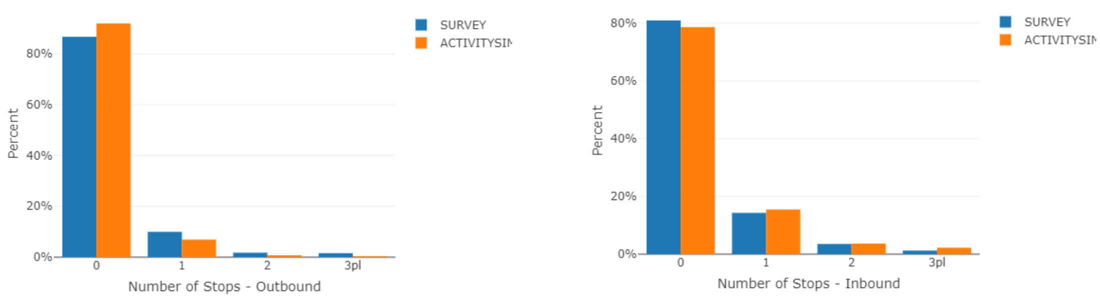
School purpose



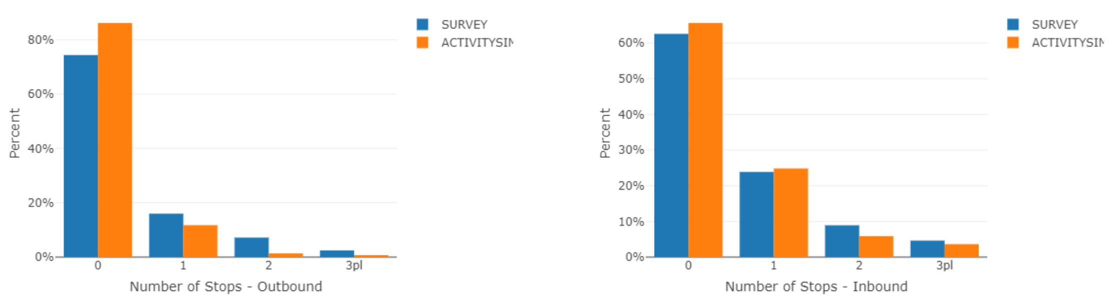
Individual discretionary purpose



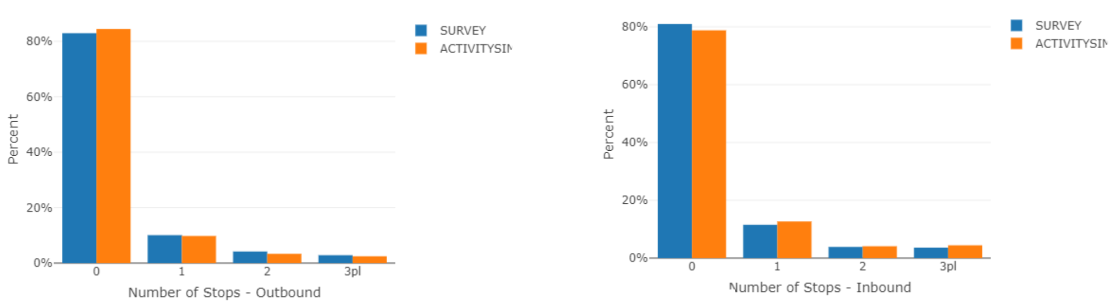
Individual maintenance purpose



Joint discretionary purpose



Joint maintenance purpose



Escort purpose

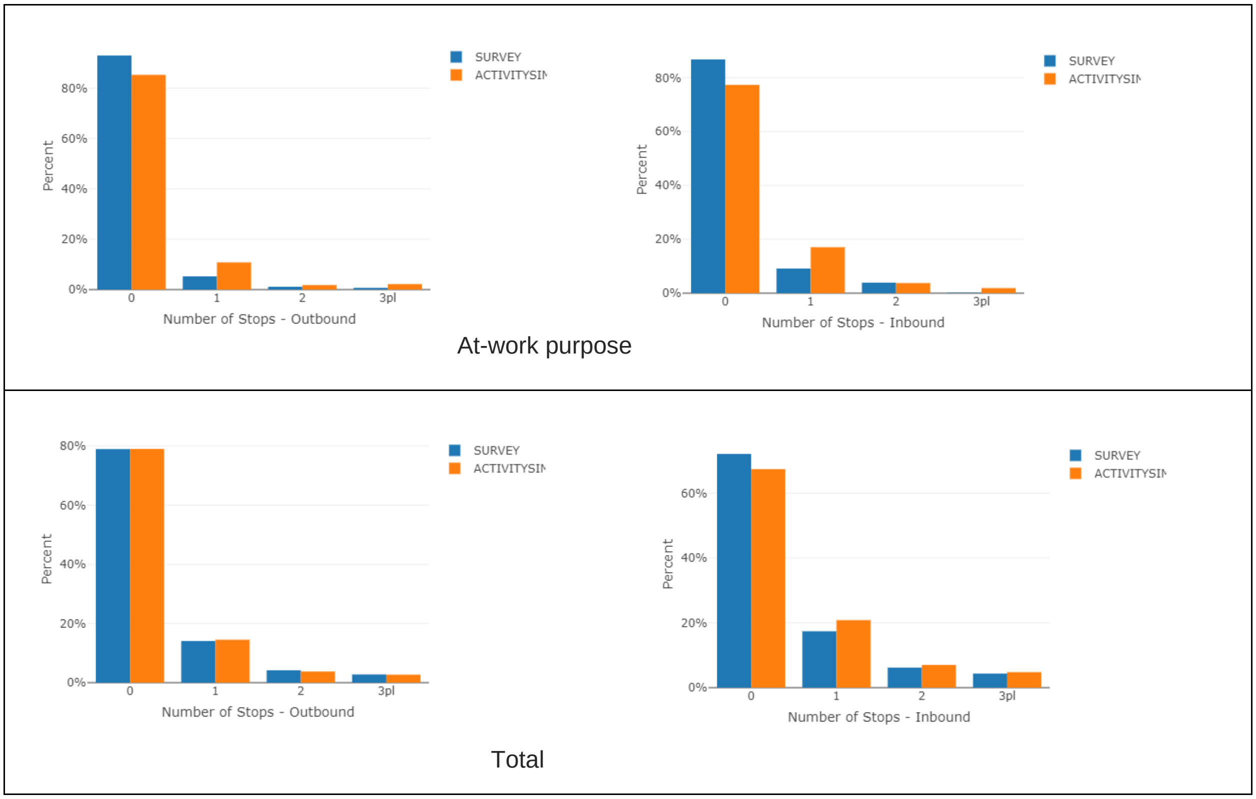
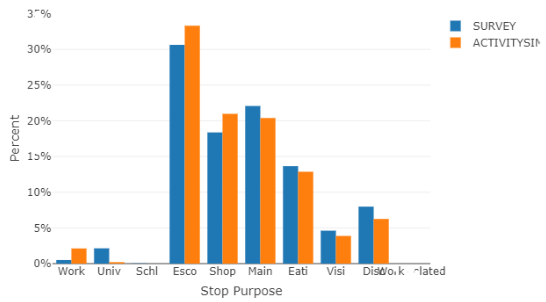


FIGURE 19 STOP FREQUENCY MODEL SUMMARY BY PURPOSE AND DIRECTION

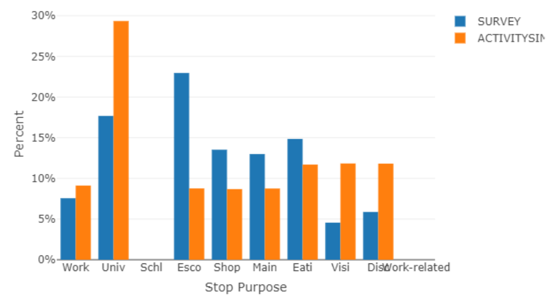
Stop Purpose Model

The intermediate stop purpose model predicts the purpose of all stops by tour purpose. The model was calibrated to SEMCOG data. The overall fit between model and survey data is very good, but a number of purposes show some larger differences. School tour purpose, for instance, does not have any school stop in the model output, while survey data shows approximately 17%. The main reason for this discrepancy is that ActivitySim currently does not allow school stops on school tours, because mechanically they should mostly be intrazonal. Additionally, there's only one school location assigned to each student in the mandatory location choice model. Therefore, when modeling tours, we assume that the school location is the primary destination. We also don't model school-based subtours. In the survey data, there are a number of students who attend two different school locations, like kids who go to a main high school and also a vocational school. Or there are some students who leave high school, go to lunch, and then return to school before going home, which is a school-based subtour. Or some reporting that's incorrect; students reporting sporting events at other schools as school when in fact it should be other discretionary.

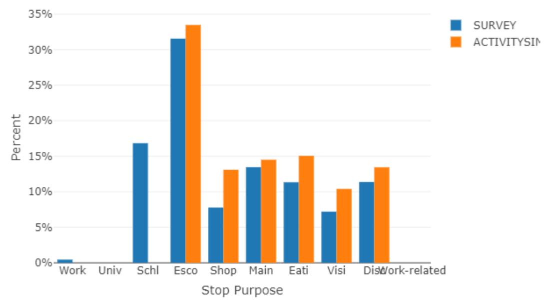
In addition, some of the individual and joint tour purposes show some differences too. These purposes are harder to calibrate, since the trip purpose probability table is not segmented by joint/individual tour category, so both individual and joint discretionary and maintenance tours use the same set of probabilities, making their calibration difficult.



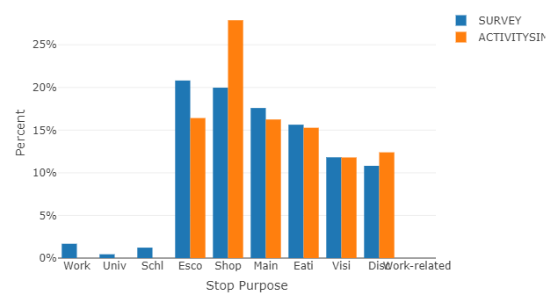
Work purpose



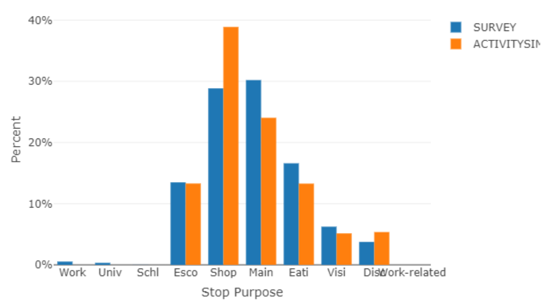
University purpose



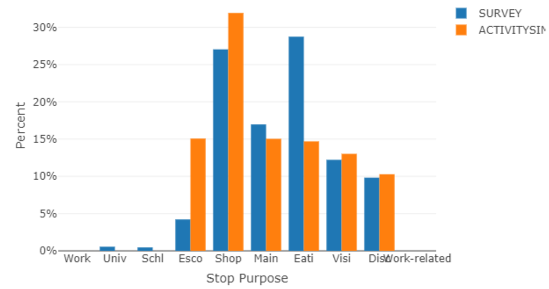
School purpose



Individual discretionary purpose



Individual maintenance purpose



Joint discretionary purpose

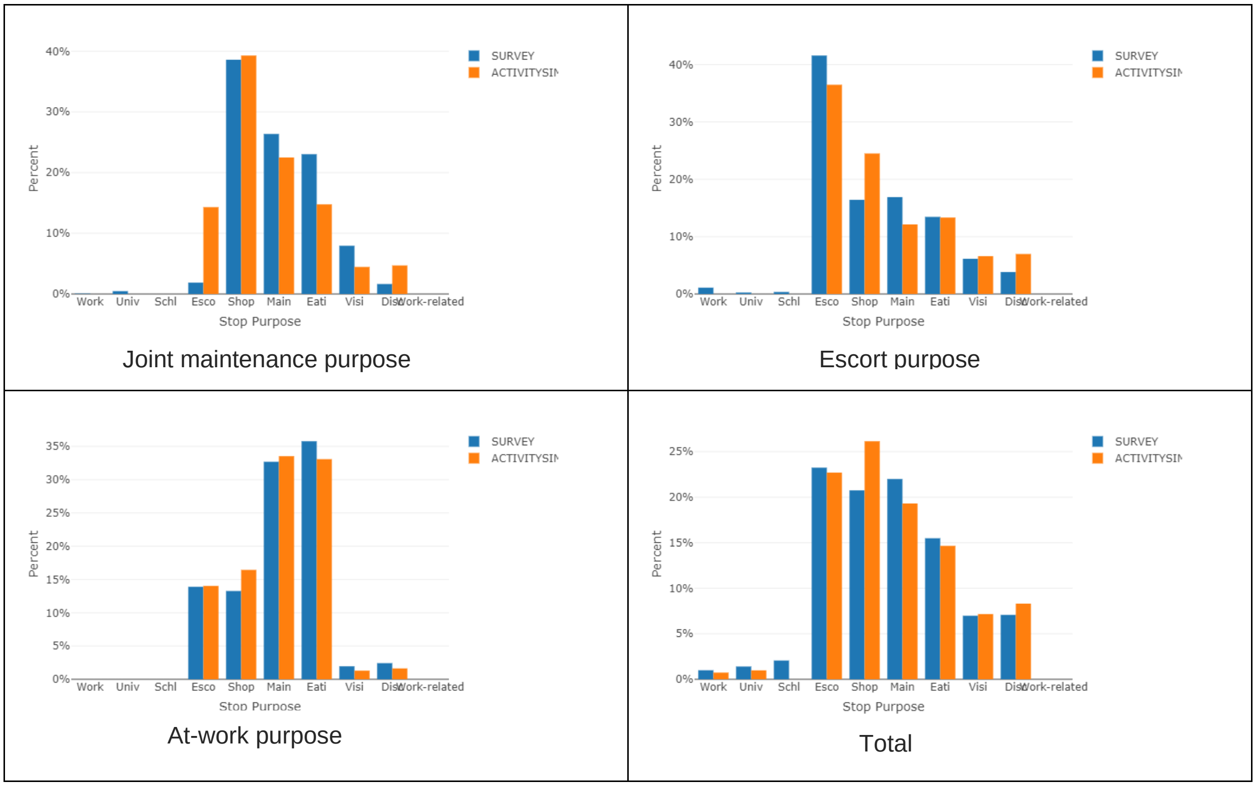
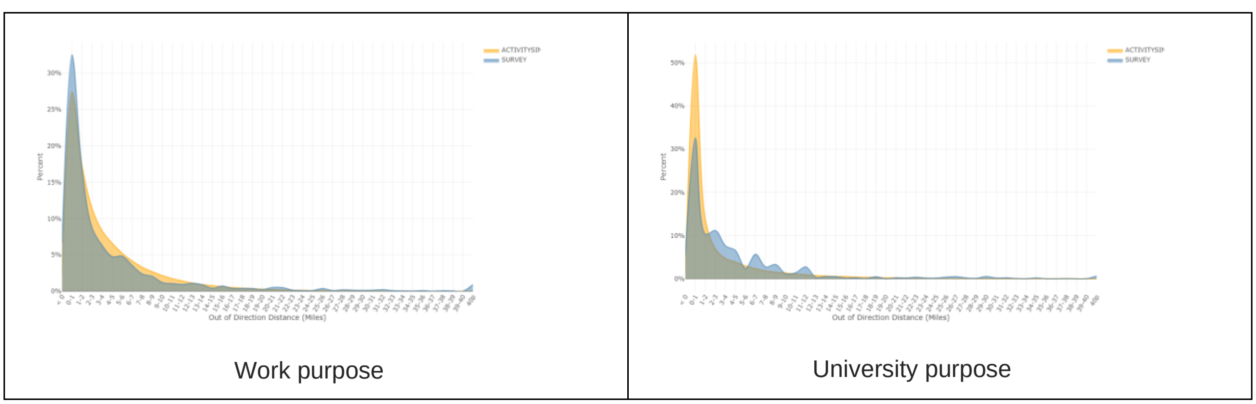
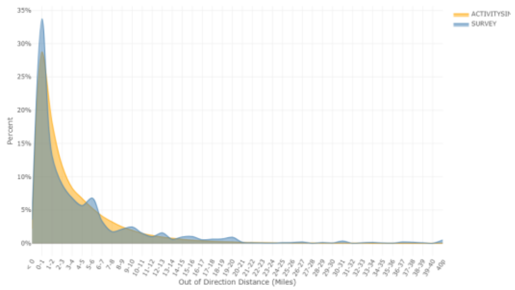


FIGURE 20 STOP PURPOSE MODEL CALIBRATION

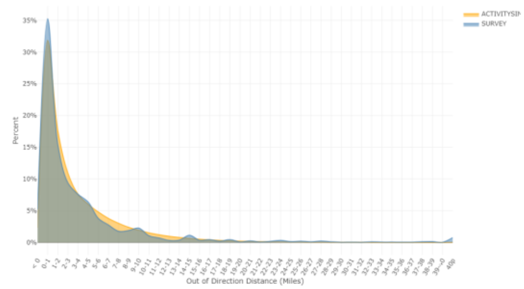
Stop Location Model

Figure 21 shows the distribution of intermediate stops by out of direction distance and tour purpose. As the Figure shows, we are seeing good level of fit between model and survey for most purposes. Overall, the average out-of-direction distance for stops is 3.54 miles and 3.75 miles in the survey and the model, respectively.

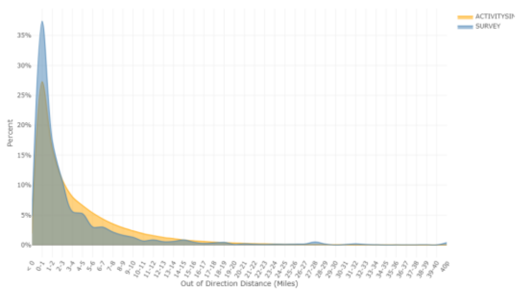




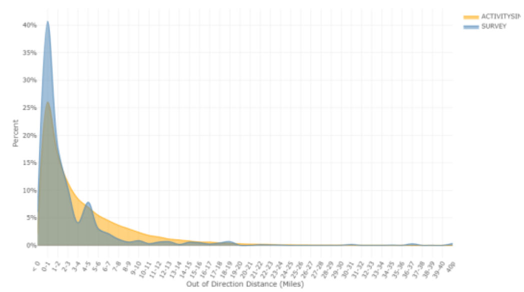
School purpose



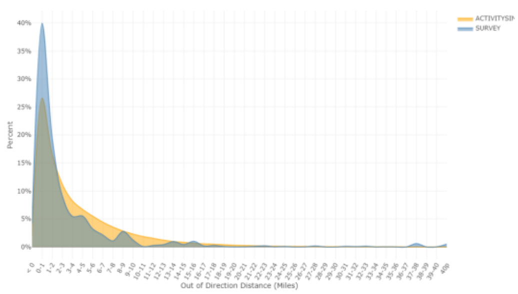
Individual discretionary purpose



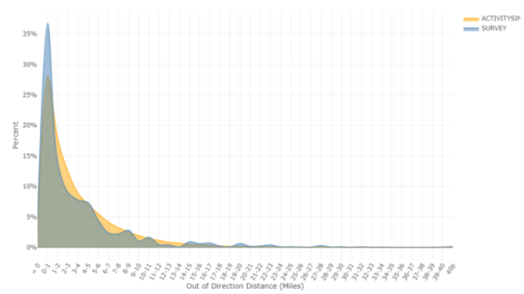
Individual maintenance purpose



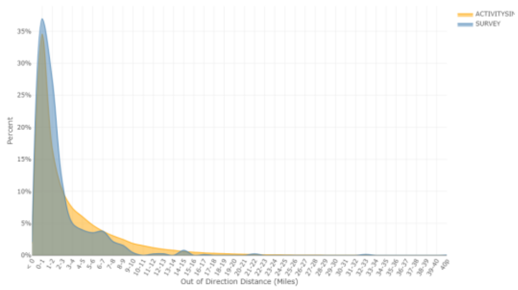
Joint discretionary purpose



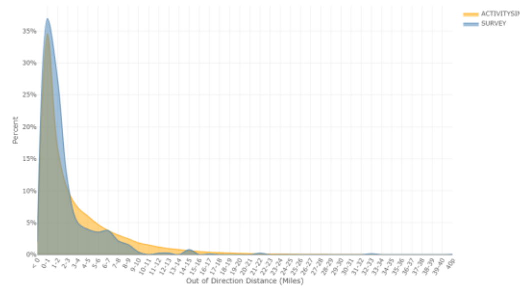
Joint maintenance purpose



Escort purpose



At-work purpose



Total

FIGURE 21 DISTRIBUTION OF INTERMEDIATE STOPS BY OUT OF DIRECTION DISTANCE AND TOUR PURPOSE

Trip Mode Choice Model

Building on the results of Phase I, the trip mode choice model was further calibrated, with Figure 22 showing the results. The trip mode choice models are calibrated by tour purpose and tour mode to observed data from the household travel survey and the on-board transit survey. Trip mode choice model results by purpose, each compared to the survey, the difference and percent difference have been tabulated in Appendix C.

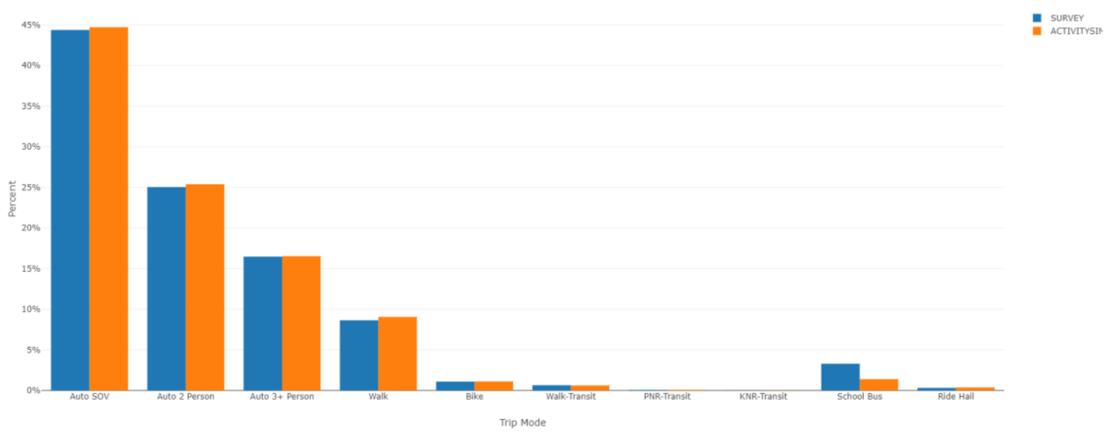


FIGURE 22: ESTIMATED VERSUS OBSERVED TRIPS BY TRIP MODE

3.0 MODEL VALIDATION RESULTS

Highway Validation

Table 14 shows estimated daily vehicle miles of travel (VMT) estimated by the ActivitySim model, while Table 15 shows daily VMT estimated by the SEMCOG E7 trip-based model. The ActSim model is approximately 0.4% lower than the E7 model in total VMT.

TABLE 14 ACTSIM ESTIMATED DAILY VEHICLE MILES OF TRAVEL

Facility type	Urban Business	Urban Fringe	Urban	Suburban	Rural	Total
Interstate Fwy	109,101	391,851	15,727,728	11,785,803	5,710,015	**33,724,498**
Other Fwy	61,279	250,518	5,044,155	3,984,739	3,796,564	**13,137,255**
Principal Arterial	103,209	678,628	18,296,091	14,164,115	1,960,565	**35,202,608**
Minor Arterial	46,789	186,011	7,379,072	11,670,083	5,013,139	**24,295,094**
Major Collector	30,633	135,292	2,475,895	2,079,931	2,976,614	**7,698,365**
Minor Collector	0	0	2,789	11,728	395,560	**410,076**
Local Road	6,438	23,383	53,571	82,019	97,074	**262,485**
Uncertified Road	198	2,395	12,007	4,612	1,458	**20,669**
Ramp	68,911	121,149	1,856,388	954,801	187,192	**3,188,441**
Collector Distributor	0	0	400,973	146,972	0	**547,945**
Centroid Connector	15,664	108,585	3,512,460	4,744,468	1,647,658	**10,028,835**
Total	**442,220**	**1,897,812**	**54,761,130**	**49,629,270**	**21,785,839**	**128,516,271**

TABLE 15 E7 TRIP-BASED MODEL ESTIMATED DAILY VEHICLE MILES OF TRAVEL (E7)

Facility type	Urban Business	Urban Fringe	Urban	Suburban	Rural	Total
Interstate Fwy	109,057	409,826	16,437,145	12,212,964	5,327,394	**34,496,385**
Other Fwy	60,816	245,314	5,324,509	4,050,156	3,657,899	**13,338,694**
Principal Arterial	102,291	702,006	17,948,548	13,837,648	1,884,984	**34,475,478**
Minor Arterial	46,107	207,573	7,080,757	11,329,151	5,223,676	**23,887,264**
Major Collector	30,553	136,958	2,374,538	1,965,627	3,215,464	**7,723,139**
Minor Collector	0	0	2,547	10,189	473,552	**486,288**
Local Road	6,931	29,302	48,484	79,125	112,435	**276,276**
Uncertified Road	255	3,001	17,795	4,193	1,811	**27,056**
Ramp	68,401	122,951	1,778,013	971,463	199,641	**3,140,469**
Collector Distributor	0	0	378,139	118,975	0	**497,115**
Centroid Connector	13,288	132,463	3,390,426	4,470,280	1,862,258	**9,868,716**
Total	**437,699**	**1,989,395**	**54,780,901**	**49,049,772**	**21,959,113**	**128,216,880**

Table 16 shows estimated versus observed volumes by facility type and area type in the ActSim model. The table shows that the modeled volume matches well with the count data in the urban, suburban and rural area types, while it is especially underpredicted in the Urban Business areas. This underestimation in the Urban Business areas is more pronounced in the Major Collector facility types, while the other facilities are generally closer to the target count data.

TABLE 16 ACTSIM ESTIMATED VERSUS OBSERVED VOLUME BY FACILITY AND AREA TYPE (DAILY)

Facility type	Urban Business	Urban Fringe	Urban	Suburban	Rural	Total
Interstate Fwy	75.0%	99.8%	98.6%	93.8%	93.6%	**95.1%**
Other Fwy	--	64.5%	113.9%	112.2%	102.9%	**107.8%**
Principal Arterial	100.9%	101.2%	105.4%	103.5%	108.3%	**104.6%**
Minor Arterial	81.2%	83.8%	95.4%	95.7%	105.1%	**98.3%**
Major Collector	29.4%	83.7%	98.1%	76.1%	89.4%	**86.4%**
Minor Collector	--	--	--	267.4%	111.9%	**115.0%**
Local Road	--	114.8%	--	77.0%	85.3%	**83.8%**
Uncertified Road	--	--	--	--	--	**--**
Ramp	74.3%	85.9%	101.1%	105.8%	118.8%	**102.0%**
Collector Distributor	--	--	90.3%	98.0%	--	**94.2%**
Centroid Connector	--	--	--	--	--	**--**
Total	**77.9%**	**90.9%**	**102.3%**	**99.3%**	**98.7%**	**99.9%**

Table 17 and Table 18 show estimated versus count volumes by time of day period. While the MD, PM, and EV period are, in general, close to the validation target, the EA and AM period are significantly under and over-estimated, respectively. As discussed in Chapter 2, RSG investigated the sources of this discrepancies, and although the results of the model output compared against the HTS data showed a good match, we calibrated work tour Time-of-Day model to move 10% of work trips from the AM to the EA period to improve highway assignment goodness of fit by time of day. This calibration (although at the cost of worsening the match between model and survey) improved the estimated vs. observed count volumes in these two periods, and SEMCOG and RSG agreed to consider the results as final, and investigate the survey and count data further in the future.

TABLE 17 ESTIMATED VERSUS OBSERVED VOLUMES BY PERIOD

	Modeled Volume/Count Volume				
Facility Type	**Early AM**	**AM Peak**	**Midday**	**PM Peak**	**Evening**
Interstate Fwy	59.60%	118.40%	97.10%	100.40%	81.60%
Other Fwy	69.50%	128.90%	120.00%	108.80%	95.00%
Principal Arterial	85.80%	122.40%	108.10%	98.50%	97.00%

Minor Arterial	79.10%	119.40%	99.60%	92.10%	90.40%
Major Collector	52.20%	111.80%	84.90%	88.40%	66.90%
Minor Collector	68.90%	150.20%	116.40%	110.90%	92.40%
Local Road	63.30%	108.60%	92.00%	77.10%	69.10%
Uncertified Road	--	--	--	--	--
Ramp	73.50%	106.70%	110.90%	101.80%	93.40%
Collector Distributor	64.00%	100.80%	100.60%	99.60%	81.20%
Centroid Connector	--	--	--	--	--
Total	**72.70%**	**119.90%**	**103.90%**	**97.60%**	**89.90%**

TABLE 18 ESTIMATED VERSUS OBSERVED VOLUMES (%RMSE)

	Percent Root Mean Squared Error (PRMSE)				
Facility Type	**Early AM**	**AM Peak**	**Midday**	**PM Peak**	**Evening**
Interstate Fwy	53.60%	35.40%	23.70%	21.20%	30.70%
Other Fwy	50.00%	36.90%	36.80%	32.60%	42.90%
Principal Arterial	66.60%	50.70%	37.20%	32.20%	37.90%
Minor Arterial	77.20%	54.10%	44.10%	39.50%	47.30%
Major Collector	130.60%	91.60%	85.10%	73.80%	88.00%
Minor Collector	198.90%	233.60%	210.20%	177.20%	182.60%
Local Road	146.00%	157.90%	142.60%	145.70%	125.30%
Uncertified Road	--	--	--	--	--
Ramp	92.80%	52.70%	53.40%	50.00%	56.30%
Collector Distributor	62.90%	24.70%	39.70%	34.60%	44.70%
Centroid Connector	--	--	--	--	--
Total	**84.20%**	**59.10%**	**46.90%**	**41.30%**	**49.40%**

The overall percent root mean square error (%RMSE) for the ActSim model (39.7%, shown in Table 19), is approximately 1.3% better than the E7 model (Table 20). The ActSim's %RMSE is better for facilities with less than 1k, 20k-30k, 30k-50k, 50k-100k counted volumes, and slightly worse for facilities with 1k-5k and more than 100K counted volumes compared to E7.

TABLE 19 ROOT MEAN SQUARE ERROR BY VOLUME GROUP (ACTSIM)

Volume Group	Links	RMSE	% RMSE
0 - 1,000	432	1,376	**237.1%**
1,000 - 5,000	1,705	2,739	**95.5%**
5,000 - 10,000	1,521	3,644	**50.5%**
10,000 - 20,000	1,531	5,483	**37.8%**
20,000 - 30,000	798	7,031	**28.6%**
30,000 - 50,000	457	8,058	**22.1%**
50,000 - 100,000	86	9,369	**14.0%**
100,000 and up	2	30,890	**26.2%**

All Links	**6,532**	**4,906**	**39.7%**

TABLE 20 ROOT MEAN SQUARE ERROR BY VOLUME GROUP (E7)

Volume Group	Links	RMSE	% RMSE
0 - 1,000	309	1,470	**246%**
1,000 - 5,000	1,276	2,688	**93%**
5,000 - 10,000	1,111	3,568	**50%**
10,000 - 20,000	1,022	5,243	**36%**
20,000 - 30,000	567	7,095	**29%**
30,000 - 50,000	345	9,225	**25%**
50,000 - 100,000	69	12,075	**18%**
100,000 and up	2	28,359	**24%**
All Links	**4,701**	**5,065**	**41%**

Figure 23 shows the screenline map for SEMCOG. ActSim (Table 21) outperforms E7 model (Table 22) on most screenlines (17 out of 22). Overall, the correlation coefficient between estimated and observed volumes on screenlines is 0.995 for ActSim and 0.984 for the E7 model. Cut_01 is significantly under-estimated in both models, although ActSim does better by around 6%. This cutline is in downtown Detroit, and the under-estimate is consistent with the under-estimate noted above in the Urban Business area type. Cut_02a, Cut_02b and Cut_02c are on the border between Wayne and Detroit. The model flow over these cutlines (557,061) is approximately %7 higher than counts (518,326). Similar observations can be made about Cut_09a between Washtenaw-Livingston and Cut_05 between Livingston-Oakland counties.

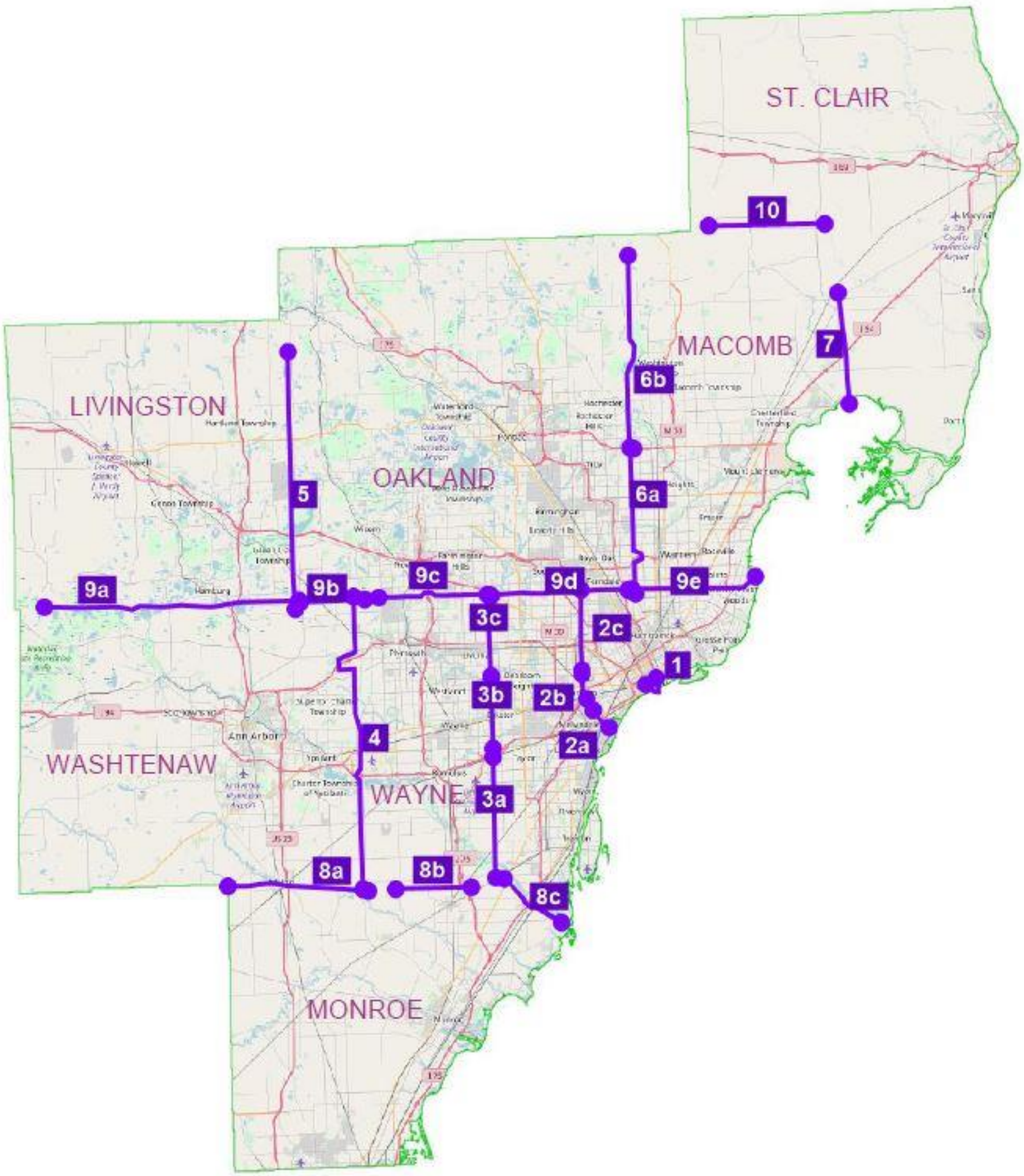


FIGURE 23 SCREENLINE MAP

TABLE 21 ESTIMATED VERSUS OBSERVED VOLUMES ON SCREENLINES (ACTSIM)

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
Cut_01	134,277	169,890	0.79	-21.00%	25
Cut_02a	157,447	119,605	1.32	31.60%	5
Cut_02b	195,722	200,665	0.98	-2.50%	7
Cut_02c	203,892	198,356	1.03	2.80%	21
Cut_03a	99,704	96,794	1.03	3.00%	12
Cut_03b	162,778	144,716	1.12	12.50%	14
Cut_03c	322,293	305,342	1.06	5.60%	14
Cut_04	245,837	258,238	0.95	-4.80%	21
Cut_05	223,657	189,525	1.18	18.00%	14
Cut_06a	693,343	684,523	1.01	1.30%	22
Cut_06b	102,282	82,594	1.24	23.80%	12
Cut_07	83,820	87,731	0.96	-4.50%	8
Cut_08a	76,014	81,144	0.94	-6.30%	9
Cut_08b	44,999	51,185	0.88	-12.10%	5
Cut_08c	84,169	81,216	1.04	3.60%	6
Cut_09a	107,219	102,104	1.05	5.00%	16
Cut_09b	26,061	27,911	0.93	-6.60%	4
Cut_09c	346,582	341,640	1.01	1.40%	13
Cut_09d	746,020	679,299	1.1	9.80%	31
Cut_09e	423,254	378,770	1.12	11.70%	19
Cut_10	32,123	19,070	1.68	68.40%	5
External	652,723	671,785	0.97	-2.80%	99

TABLE 22 ESTIMATED VERSUS OBSERVED VOLUMES ON SCREENLINES (E7)

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
"Cut	124,835	169,889	0.73	-27%	25

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
_01"					
"Cut_02a	170,832	119,605	1.43	43%	5
"Cut_02b	212,649	200,665	1.06	6%	7
"Cut_02c	195,950	198,356	0.99	-1%	21
"Cut_	105,608	96,794	1.09	9%	12

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
03a					
"Cut_03b	162,878	144,716	1.13	13%	14
"Cut_03c	313,132	305,342	1.03	3%	14
"Cut_04"	343,357	287,124	1.2	20%	23
"Cut_0	231,320	189,524	1.22	22%	14

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
5"					
"Cut_06a	695,168	684,523	1.02	2%	22
"Cut_06b	102,358	82,593	1.24	24%	12
"Cut_07"	89,418	87,731	1.02	2%	8
"Cut_0	76,207	81,143	0.94	-6%	9

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
8a					
"Cut_08b	53,767	51,185	1.05	5%	5
"Cut_08c	85,177	81,214	1.05	5%	6
"Cut_09a	115,991	102,102	1.14	14%	16
"Cut_0	25,437	27,911	0.91	-9%	4

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
9b					
"Cut_09c	350,321	341,640	1.03	3%	13
"Cut_09d	780,181	679,299	1.15	15%	30
"Cut_09e	462,689	378,770	1.22	22%	19
"Cut_10	28,193	19,069	1.48	48%	5

Screenline	Model Volume	Count Volume	Model / Count	Pct. Error	Counts
"External	584,716	671,785	0.87	-13%	99

Transit Validation

Transit assignment results were summarized by operator and compared against the 2019 national transit database (NTD). The model's total boarding matches the NTD very well, with most operators in the region showing close matching to the target data. The two operators where model yields poor validation against target data are Lake Erie Transit (LET) and Blue Water Area Transit (BWAT). RSG made multiple efforts to improve ridership on these operators, including checking the network coding, fares, and mode choice models, concluding that the ridership on these routes likely involves specific demographics and markets not fully captured by the mode choice model. RSG, therefore, recommended a future analysis and investigation into the markets serviced by these two operators, and improving the mode choice models according to the findings.

TABLE 23 BOARDINGS BY OPERATOR

OPERATOR	2019 NTD	MODEL	Difference	Percent Difference
Ann Arbor Area Transportation Authority (AAATA)	24,491	23,139	-1,352	-5.5%
Blue Water Area Transit (BWAT)	2,187	388	-1,799	-82.3%
Detroit Department of Transportation (DDOT)	71,429	68,614	-2,815	-3.9%

Detroit People Mover (DPM)	4,413	3,662	-751	-17.0%
Lake Erie Transit (LET)	1,082	49	-1,033	-95.5%
QLINE	3,305	2,572	-733	-22.2%
Suburban Mobility Authority for Regional Transportation (SMART)	29,123	25,746	-3,377	-11.6%
University of Michigan Transit (UMT)	34,262	39,970	5,708	16.7%
TOTAL	170,292	164,140	-6,152	-3.6%

It should be noted that the OBS data is different than the 2019 NTD. For example, DDOT total ridership in the OBS data is 68,372 vs 71,429 in the NTD data. Similarly, the UMT shows 40,109 total ridership in the OBS data while 33,162 in the NTD. Since the model ridership was compared against and calibrated to the NTD operator-level data, comparing the route-by-route ridership in the model against the available route-by-route data in the OBS could prove misguided. In lack of such data at the NTD level, however, we scaled the route-by-route boardings in the OBS data so that total operator-level boarding matches the NTD's and compared them to the model boardings for some operators.

Figure 24 shows the boardings comparison for ridership on the DDOT ConnectTen routes (the 10 highest ridership routes in the DDOT system) between OBS data and model output. The model noticeably overestimates boardings on DDOT 4 and DDOT 8 routes, with the other routes fairly close to the OBS data.

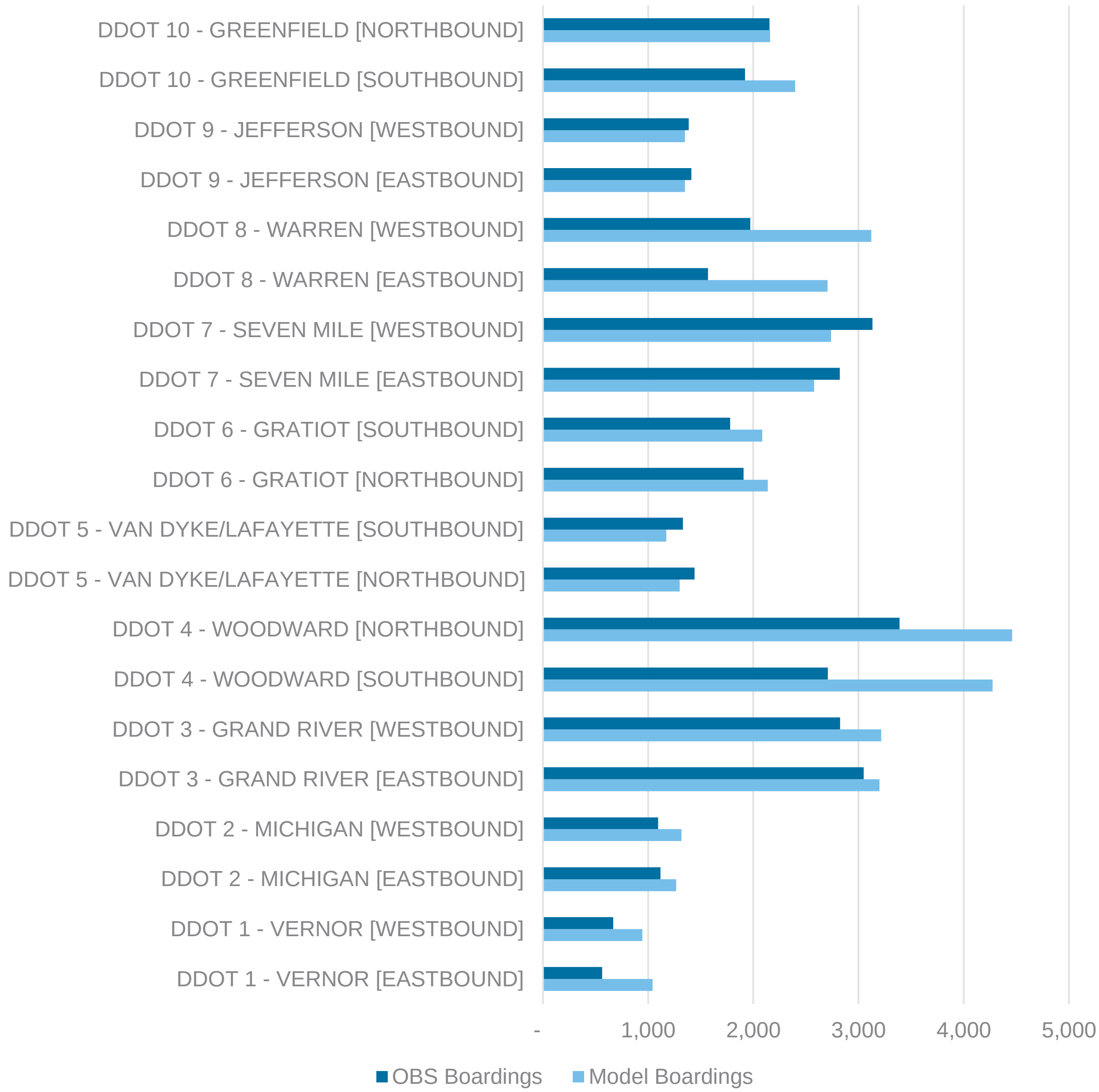


FIGURE 24 DDOT CONNECT TEN BOARDINGS

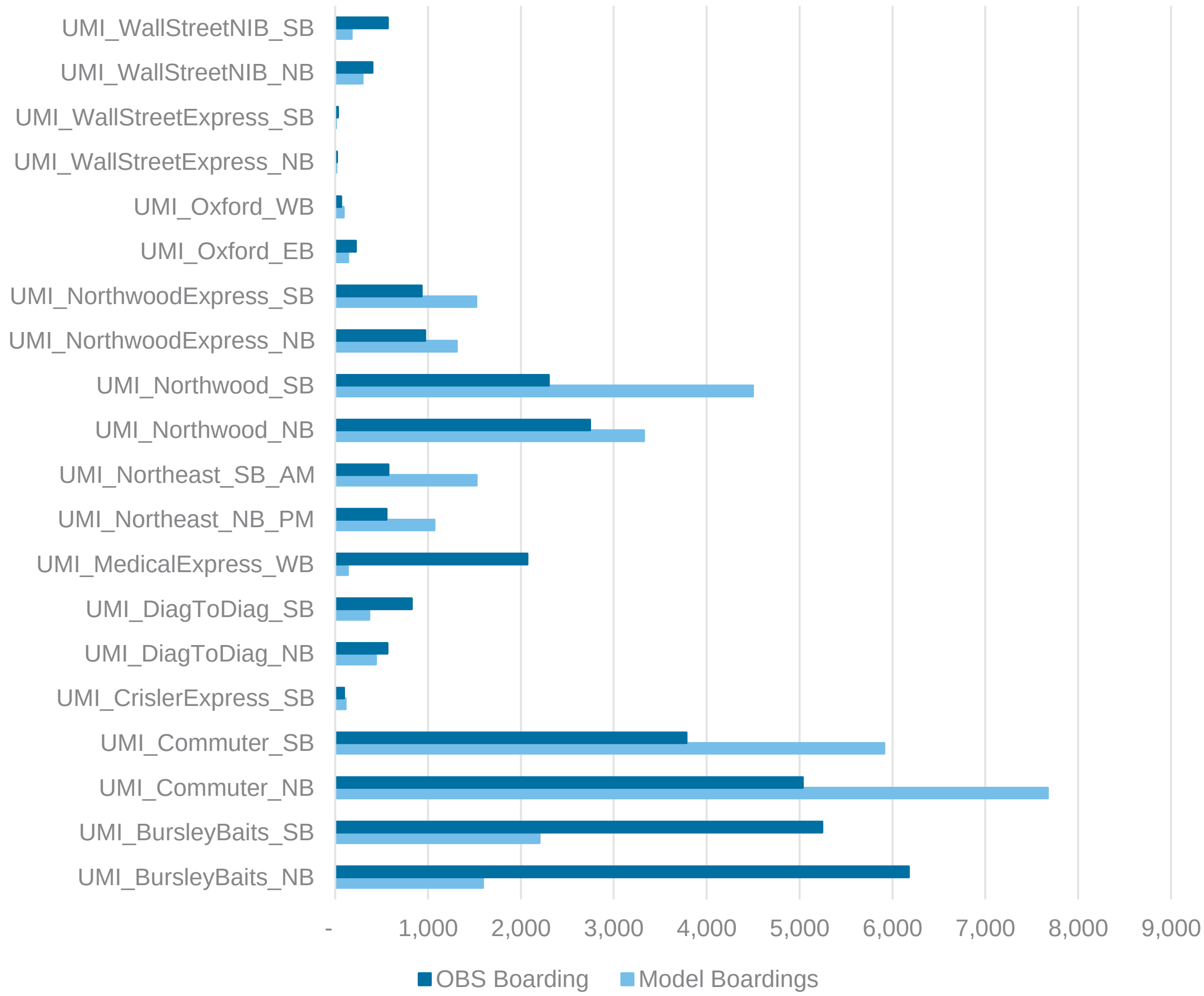


FIGURE 25 UNIVERSITY OF MICHIGAN TRANSIT

4.0 SENSITIVITY TESTING RESULTS

Sensitivity testing is a fundamental component of the development of a new modeling system. Although the activity-based (AB) model being deployed in SEMCOG has been applied in a number of other regions, the project team is interested in analyzing model sensitivities specific to the land-use data, network, and policies of interest in SEMCOG. Sensitivity testing involves systematically varying one or more model inputs to understand how the model responds to those changes. It is fundamentally different from model calibration, which involves comparing goodness-of-fit of model output against observed data using a fixed set of inputs. The purpose of sensitivity testing is to understand model response to *changes* in inputs.

This chapter describes the results of testing the sensitivity of the Phase II SEMCOG ActSim model for three alternatives, as follows:

- A set of sensitivity tests was designed to measure the effects of household income changes on travel behavior. These tests systematically vary household income for the synthetic population residing in TAZs within a one-mile buffer of Woodward Avenue (-50%, -25%, +25%, +50%).
- A new commuter rail line provides service between Ann Arbor and downtown Detroit. The line was coded consistent with previous scenarios tested with the SEMCOG trip-based model.
- Ford Motors purchased and is in the process of renovating the Michigan Central Station in the Corktown neighborhood just west of downtown Detroit. This scenario tests the impact of an additional 5,000 employees in the train station TAZ (238). This test was only done in Phase I of the project.

Each test is described in more detail below. Overall, the model appears to be appropriately sensitive to the inputs tested. In the case of the commuter rail sensitivity test, the project team initially discovered issues that led to changes in the parameters used for transit path-building, ultimately improving the sensitivity of the model system.

4.1 INCOME SHIFT SENSITIVITY TEST

This set of sensitivity tests was designed to measure the effects of household income changes on travel behavior. The tests systematically varied household income for the synthetic population residing in TAZs within a one-mile buffer of Woodward Avenue in order to understand model responses with respect to household income changes. The model was run for four income variants in addition to the base-year model. The variants changed household income (HINCP) by -50%, -25%, +25%, and +50%.

Data Preparation

The first step of the sensitivity tests was to prepare the input data. Preparing input data for the income shift tests was a 2-step process. First, all zones within a one-mile buffer of Woodward Avenue were selected using the TransCAD software (Figure 1). Zones that were partially within the buffer were also selected. Second, for households in the synthetic population that were within these zones, the household income (in continuous dollars) was varied by -50%, -25%, +25%, and +50% using Python.

Model Runs

The full model with four feedback loops were run once for the base scenario and once for each of the income shifts. Shadow pricing was turned on during these model runs. The model runs were performed using both RSG and SEMCOG servers.

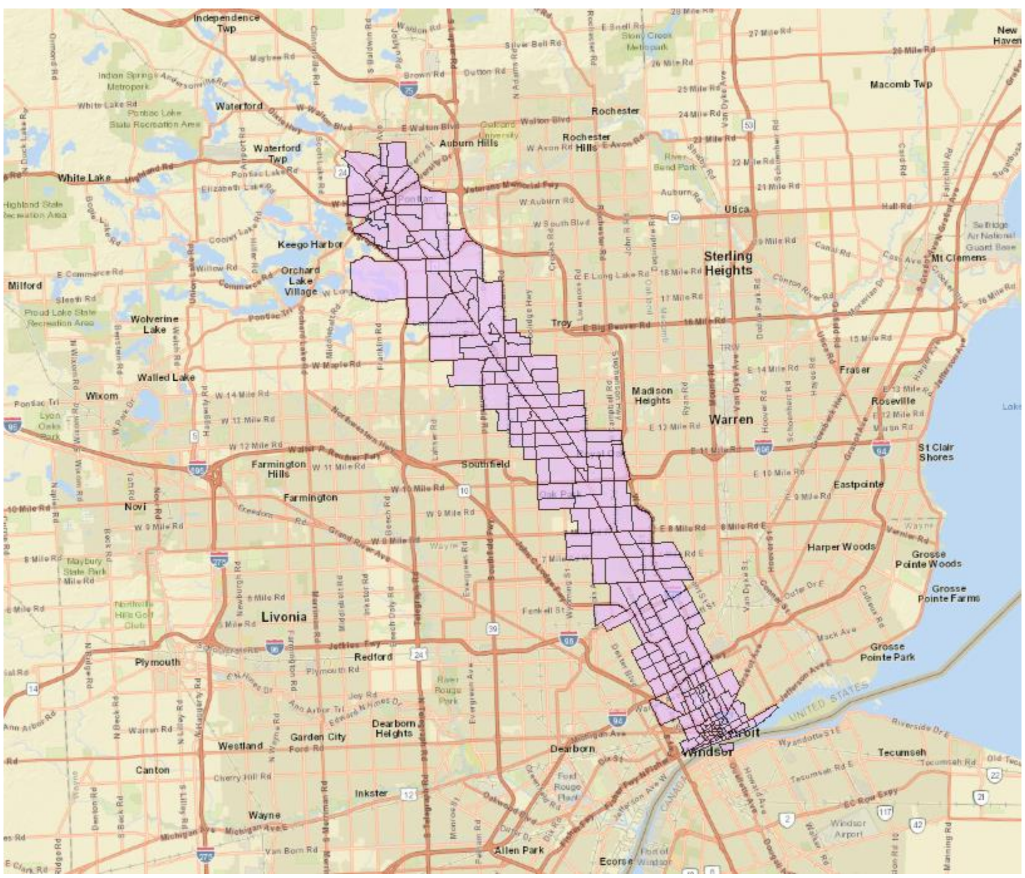


FIGURE 26 ZONES WITHIN 1 MILE OF WOODWARD AVENUE

Results

Auto Ownership

When income was decreased for Woodward zone households, auto ownership decreased and when income was increased, household auto ownership increased. The household auto ownership of 1-auto was least impacted by the income shifts compared to households with zero or more than one auto. The trend of change in auto ownership as shown in

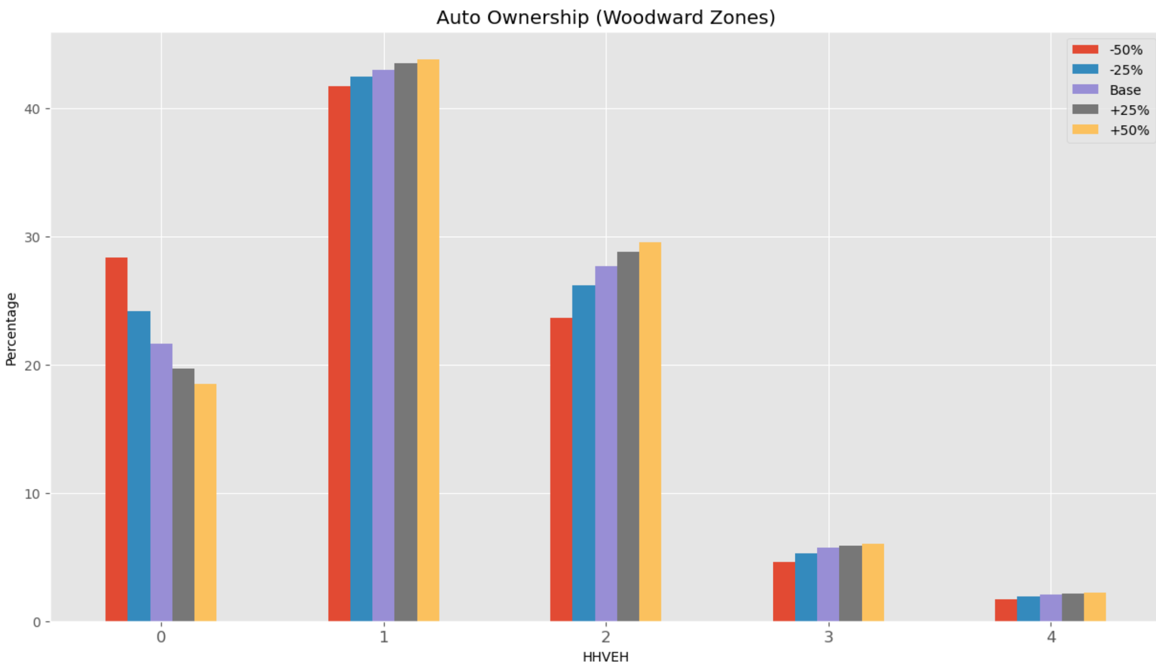


FIGURE 27 and **FIGURE 28** are intuitive and reasonable. The actual values of auto ownership are shown in **TABLE 24.**

The results are by and large in line with Phase I. The only difference of note is in the 1-auto category, where in Phase I, increasing income had resulted in an almost uniform decrease in number of households with 1 automobile (albeit a very small change) across all scenarios, while in Phase II, 1-auto households increase in numbers with increase in income (again, a small change). This smaller change is pointing to the fact that with increased income, 2, 3 and 4+ auto categories become more desirable than 1 auto, therefore rendering the change in this category less pronounced.

TABLE 24 AUTO OWNERSHIP (WOODWARD ZONES)

HOUSEHOLD VEHICLE	-50%	-25%	BASE	+25%	+50%
0	31461	26815	23948	21831	20459

1	46241	47089	47648	48229	48543
2	26202	28993	30677	31886	32712
3	5144	5867	6307	6555	6707
4+	1841	2125	2309	2388	2468

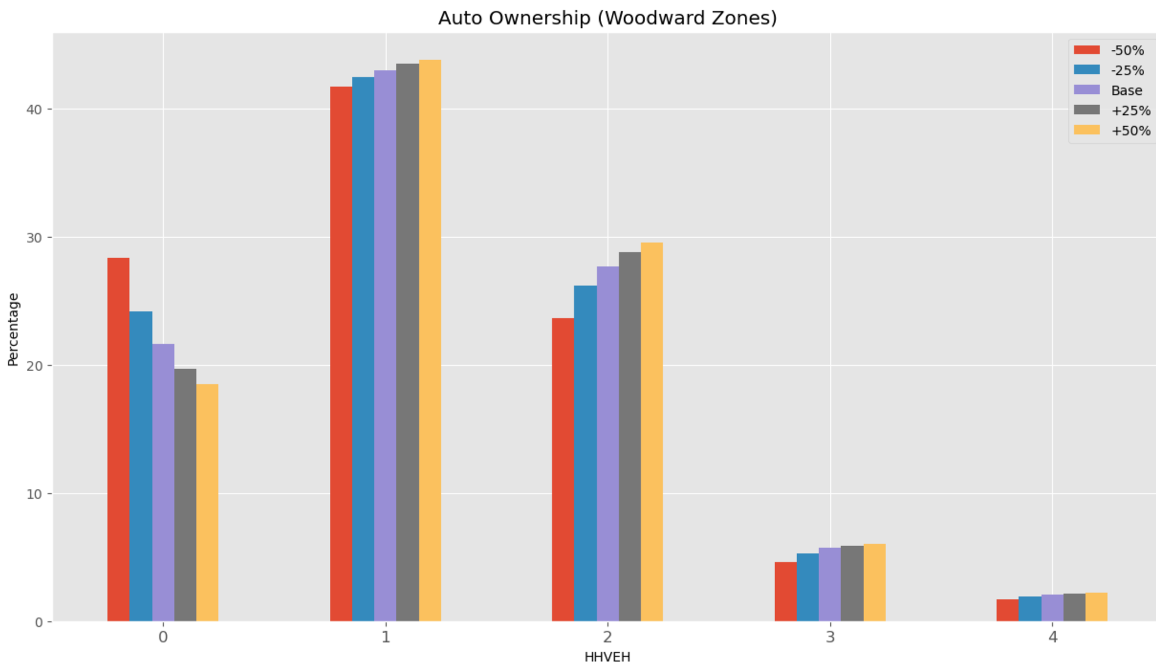


FIGURE 27 AUTO OWNERSHIP (SHARES)

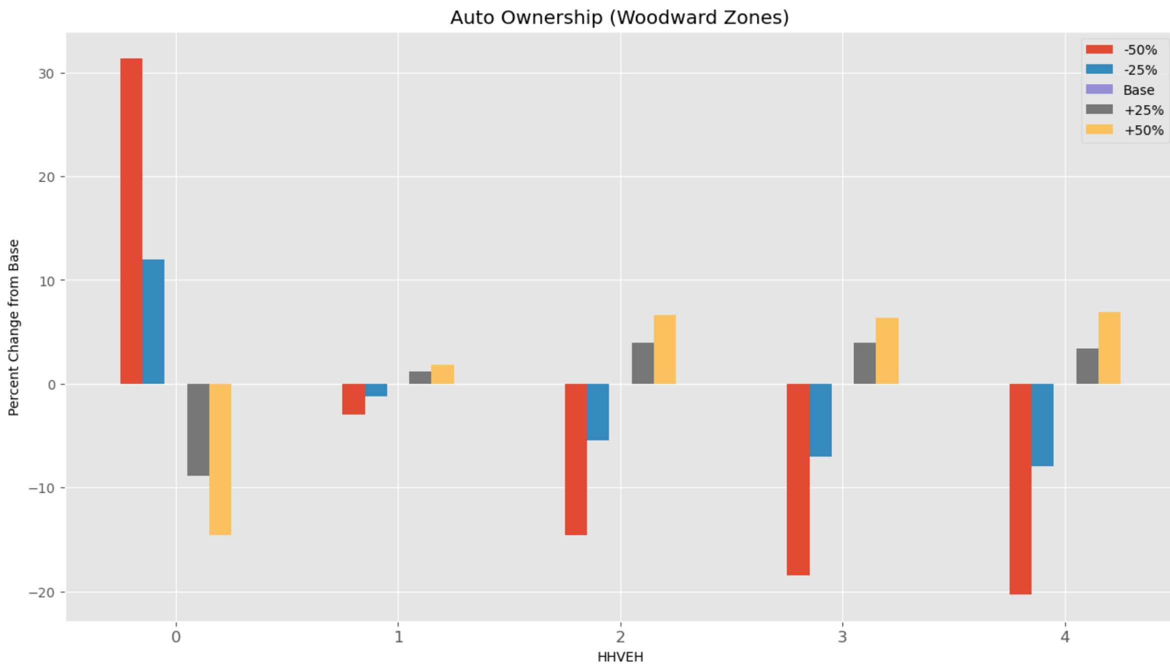


FIGURE 28 AUTO OWNERSHIP (PERCENT CHANGE FROM BASE)

Tours by Purpose

The number of tours by purpose decreased as income was reduced and increased when income was increased. The mandatory purposes were less sensitive to income changes compared to the non-mandatory purposes. This is very intuitive as the nature of non-mandatory purposes makes them more sensitive to income changes. It should also be noted that a person's work status was not affected by income change and did not change between scenarios. Figure 29 shows the percent change from base in tours by purpose for each of the income shift scenarios.

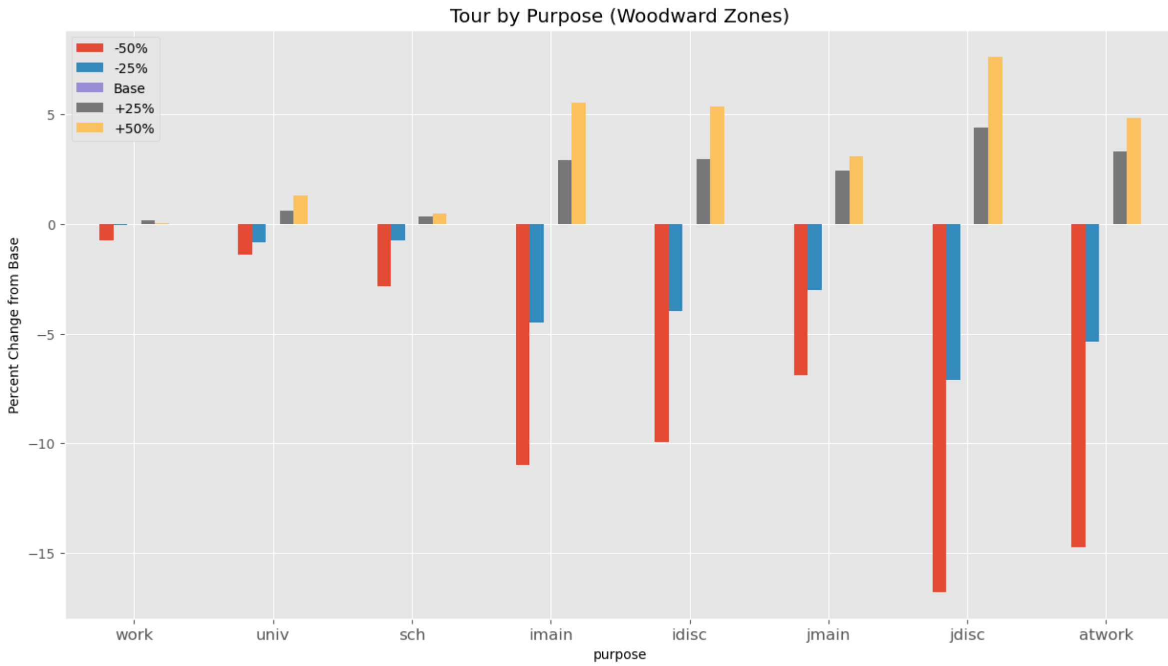


FIGURE 29 TOURS BY PURPOSE (PERCENT CHANGE FROM BASE)

Tours by Mode

Mode choice changes in response to income change is as expected; the share of automobile tours increases as income increases and that of transit modes decreases. Non-motorized modes are less sensitive to income shift, although both walk and bike show small increases in frequency with increase in income. FIGURE 30 shows the percent change from base for tours by mode. This result, however, was not observed in Phase I sensitivity testing, due to that fact that the transit mode shares of the tour mode choice model was calibrated based on income levels in Phase II and resulted in better tour transit mode choice sensitivity to income levels.

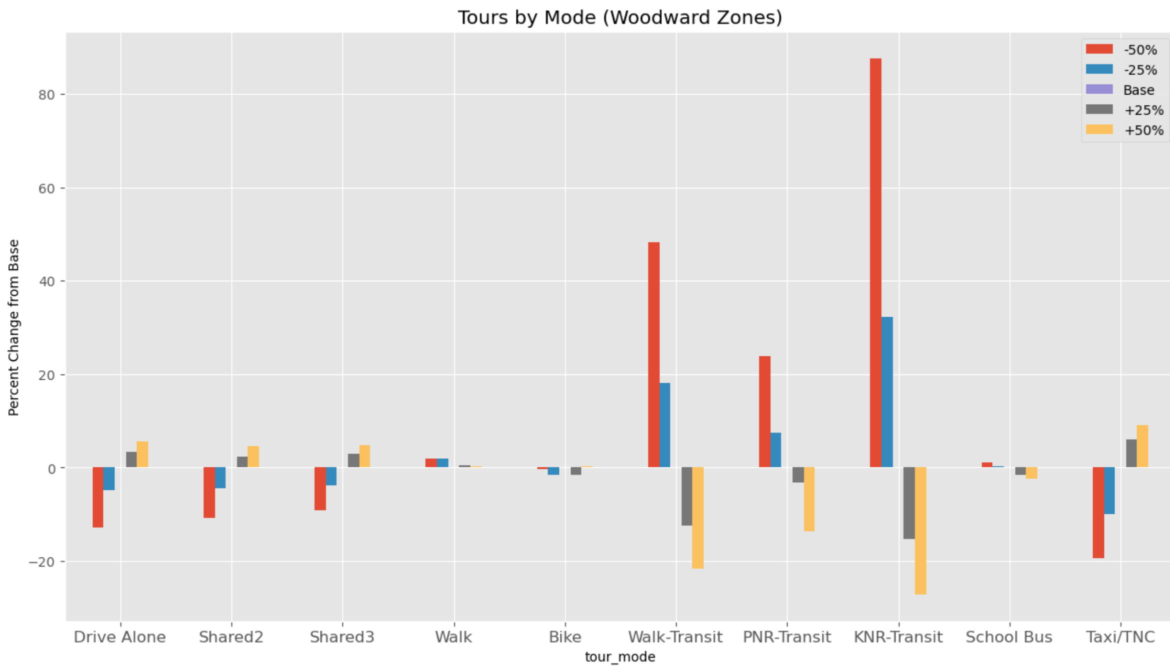


FIGURE 30 TOURS BY MODE (PERCENT CHANGE FROM BASE)

Trips by Purpose

Trips by purpose follow the same trend as tours by purpose. **FIGURE 31** shows the average trips per household by purpose for the income shift runs. The figure shows a percent change from the base scenario.

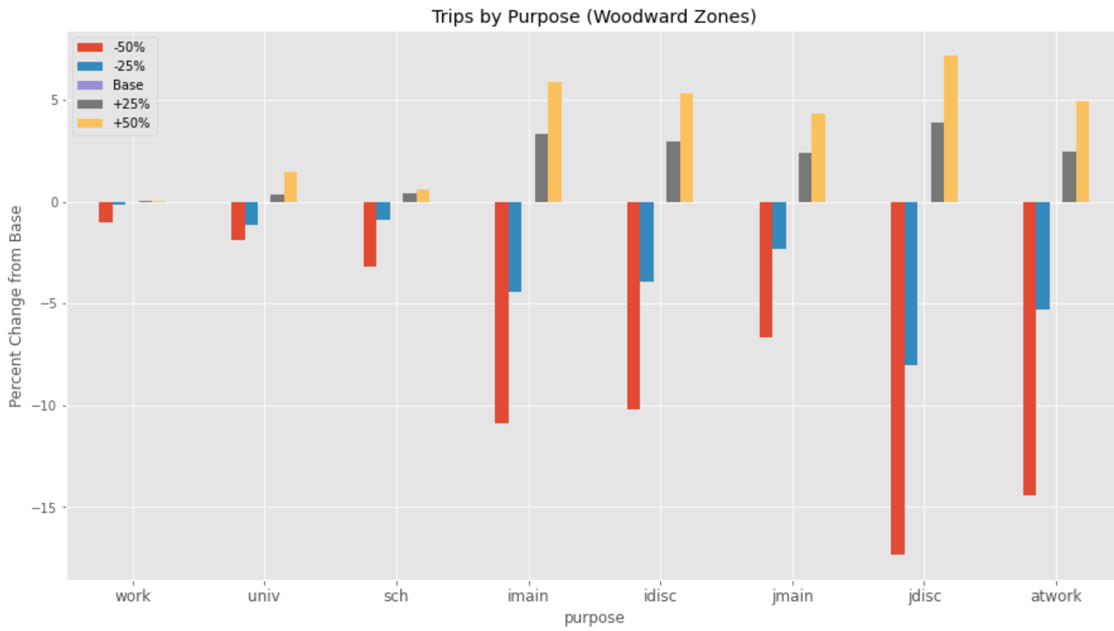


FIGURE 31 AVERAGE TRIPS PER HOUSEHOLD (PERCENT CHANGE FROM BASE)

Tour Lengths

Tour lengths of Woodward zone households were generally increased with increased income and vice versa (**TABLE 25**). In an initial version of the sensitivity testing with a method of shadow pricing originated from CT-RAMP, we observed the work tour lengths increasing in the -50% and -25% income scenarios. This unintuitive observation, however, was resolved after redoing the test with the new simulation-based shadow pricing method.

TABLE 25 TOUR LENGTHS BY PURPOSE

PURPOSE	-50%	-25%	BASE	+25%	+50%
work	8.83	9.1	9.47	9.52	9.61
univ	5.00	5.02	5.03	5.05	5.06
sch	4.3	4.34	4.37	4.39	4.41
imain	4.63	4.72	4.8	4.81	4.84
idisc	4.48	4.58	4.66	4.67	4.69
jmain	5.25	5.32	5.33	5.36	5.4
jdisc	5.07	5.12	5.12	5.12	5.13
atwork	4.99	5.11	5.22	5.28	5.33

VMT

The change in VMT in these tests was intuitive and reasonable. VMT for households with a -50% change in income exhibited a 10% decrease in VMT, while households with a 50% increase in income exhibited a VMT increase close to 5% (Figure 32).

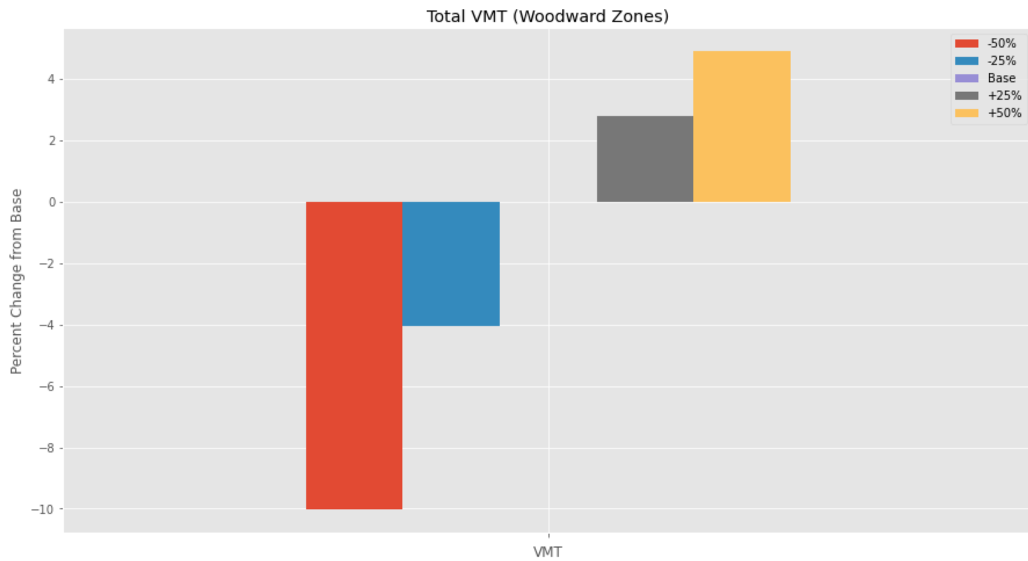


FIGURE 32 VMT (PERCENT CHANGE FROM BASE)

Transit Boardings

The change in transit boardings in response to income shift is very intuitive and reasonable. While total boardings across the region changed maxes out at 5% (**FIGURE 33**), boardings on DDOT Route 4 (ddot_53 in the model) which runs along Woodward Avenue saw changes up to 14% (**FIGURE 34**). The change in boardings is asymmetric; when income is reduced, boardings increase by a larger percentage than boardings decrease when income is increased. In other words, transit boardings are more elastic with respect to income when income is reduced compared to when income is increased.

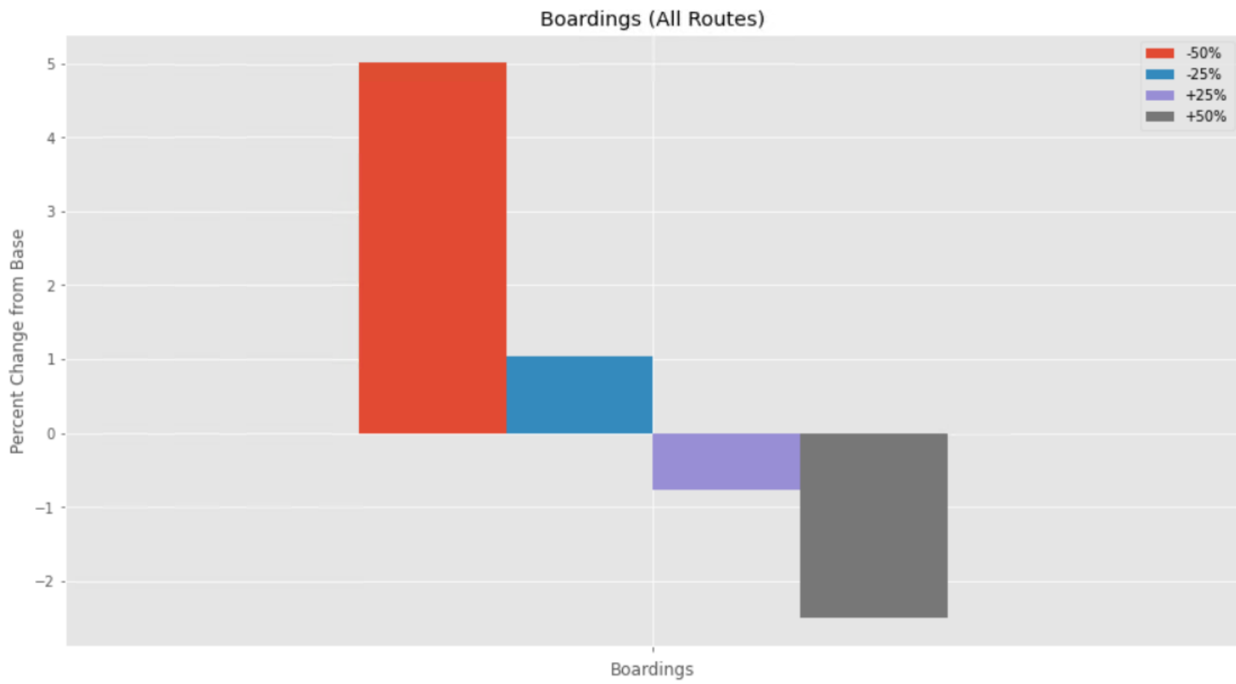


FIGURE 33 BOARDINGS (ALL ROUTES)

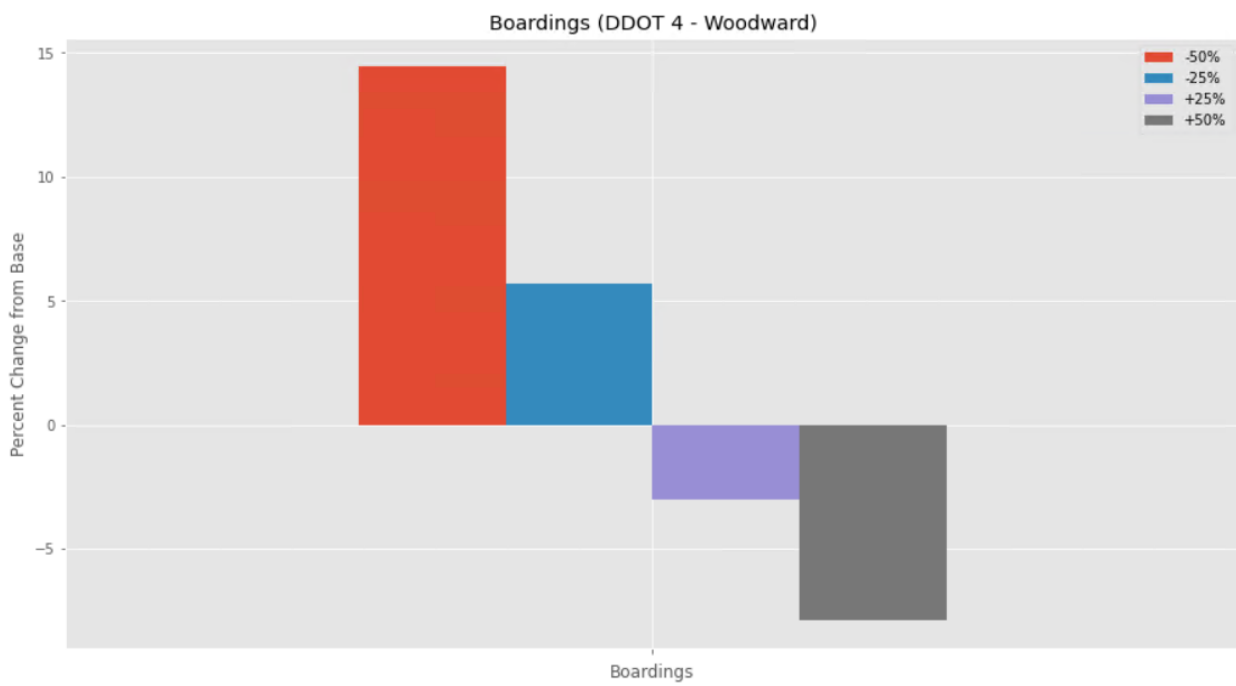


FIGURE 34 BOARDINGS (DDOT 4/DDOT 53)

4.2 COMMUTER RAIL SENSITIVITY TEST

This test was designed to test a commuter rail line from Detroit to Ann Arbor. A previous network coded for RTA was used as a guide for coding the commuter rail line in the base year network. This test analyzes commuter rail boardings on stations by period and by access/egress mode.

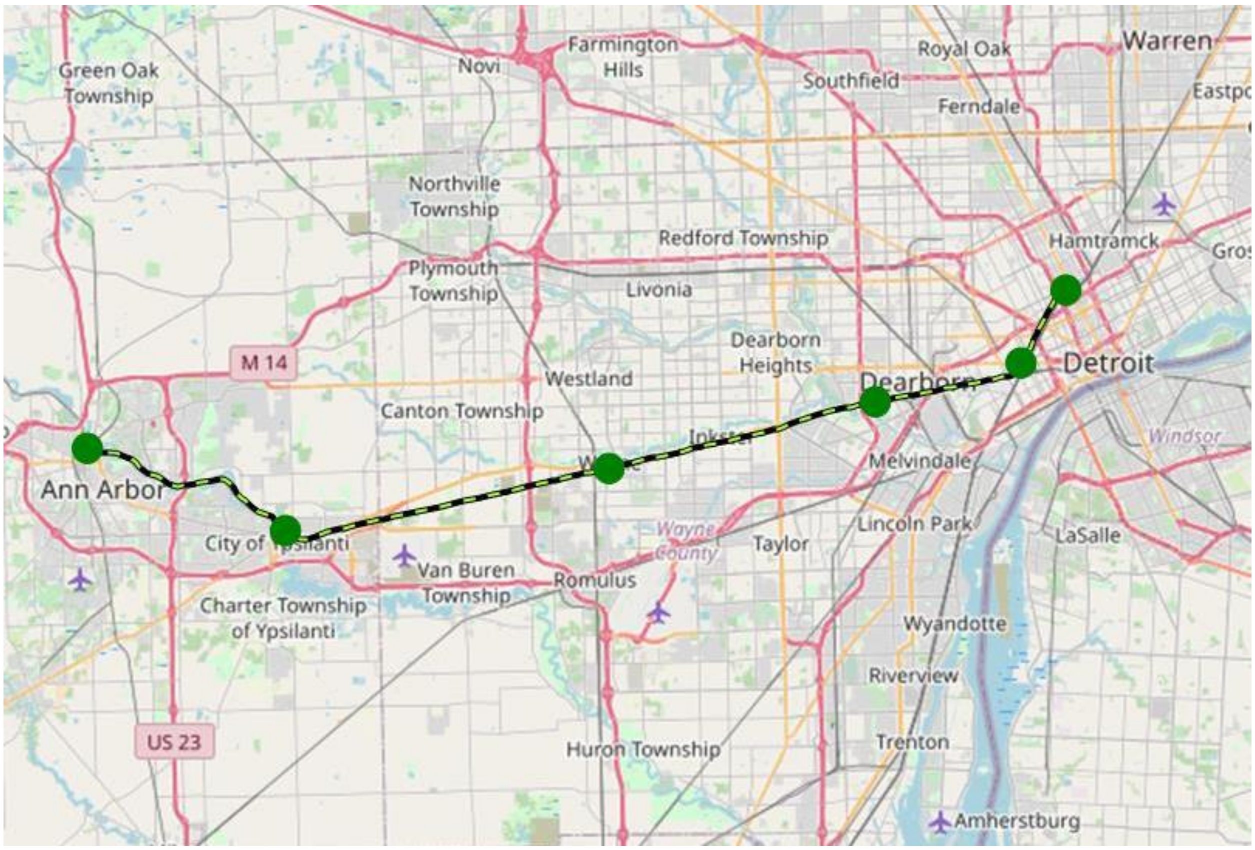


FIGURE 35 ANN ARBOR-DOWNTOWN DETROIT (AADD) COMMUTER RAIL

Network Coding

Six commuter rail stations were coded in TransCAD, shown in green in **FIGURE 35.** The stations are located in Detroit (Baltimore St), Clark St-Michigan Ave, Dearborn (Ford HQ), City of Wayne, Ypsilanti (EMU) and Ann Arbor (UMich). Both walk access and drive access were allowed at all stations.

AM and PM headways for the commuter rail were set to 60 minutes, MD and EV headways were set to 240 minutes and the service was not available during the EA period (headway for EA was set to 999). A zonal fare was used for this service with increments of $1 per station (zone). This means a trip on the commuter rail from Detroit to Ann Arbor will see a fare of $5 (for 5 stations), not including fares from transferred modes.

The initial run of the commuter rail alternative (in Phase I) revealed an issue with the transfer wait time overrides specified by mode in the transit transfer (*ModeXferTable.bin*) file. Initially, the transfer wait time from Streetcar (Q line) to commuter rail was specified as five minutes. This led to illogical transit paths in downtown Detroit; all commuter rail passengers were boarding the Q line in order to avoid the 30 minute initial wait time for commuter rail. One must be careful when setting transfer wait time overrides for infrequent services. They should only be used in the case where both the feeder service and the connecting service are infrequent. When the feeder service is frequent and the connecting service is infrequent, the connecting service should control the transfer wait time and an override should not be used.

Our initial testing also revealed path weights that treat initial wait time, transfer wait time, walk time, and drive time equally at 2.5x in-vehicle time. The revised transit path weights used during the final test are shown in **TABLE 26**.

TABLE 26 TRANSIT PARAMETERS

VARIABLE	VALUE
Max. # of Transfers	3.000
Value of Time	0.111
Fare	1.250
Transfer Fare	0.250
Drive Time Weight	1.500
Initial Wait Time Weight	1.500
Transfer Wait Time Weight	2.500
Dwell Time Weight	1.000
Walk Time Weight	1.500
Max Drive Time	45.000
Transfer Penalty Time	10.000
Max Wait Time	60.000
Min Wait Time	2.000
Layover Time	5.000
Max Access Time	36.000
Max Egress Time	36.000
Max Transfer Time	18.000
Max Total Cost	20.000
Max Walk Access Paths	10.000
Combination Factor	0.100

In this sensitivity testing, we included constants for commuter rail to help better understand potential ridership for the route considering the increased reliability of the system compared to typical bus routes, as well as increased passenger comfort and productivity on board the system. These constants were asserted based on calibrated constants from the San Diego region. These constants lower the negative utility of the commuter rail for trips longer than a certain IVTT (here we have used 10 minutes as the threshold), assuming that shorter trips do not benefit substantially from the increased comfort and productivity levels of commuter rail. Depending on the access mode and length of the tour or trip, the constant discounts the commuter rail travel time by essentially subtracting a portion of the commuter rail IVT from the total transit IVT. The calculations for these constants are done in the tour and trip mode choice preprocessors and are included in the Model description document.

Results

There are approximately 1000 total boardings on the commuter rail line in each direction, for a total ridership of 1985 boardings. Out of this total ridership, approximately 75% happen in the three stations of Ann Arbor, Ypsilanti, and Detroit, pointing to the higher demand for travel from these regions, and also the impact of the added constants improving the commuter rail alternative. Figure 33 shows the access mode shares by direction. The share of direct walk-access is slightly lower in the westbound (WB) direction (12%) compared to the eastbound (EB) direction (15%). Considering that walk access generally occurs in the more urbanized areas (as also confirmed by Figure 36), we see that Ann Arbor, Ypsilanti, and Detroit have the highest number of walk access (77% of all walk access trips. Considering that Downtown Detroit has a stronger transit system allowing for more transfers, the higher number of walk access on the EB direction is likely due to higher walk access in Ann Arbor and Ypsilanti stations. The share of Drive-Access is low in both directions, with the EB direction having 2% compared to the WB direction having 6%. More than half of boardings in both directions are accessing commuter rail by transferring from bus or the Q-line. Most of the boardings (~80%) at the Wayne and Dearborn stops are in the WB direction to Ann Arbor. This could be due to the availability of competing routes in the EB direction from these stops and the lack of competing routes in the WB direction. Figure 34 shows boardings at commuter rail stations by access/egress modes respectively.

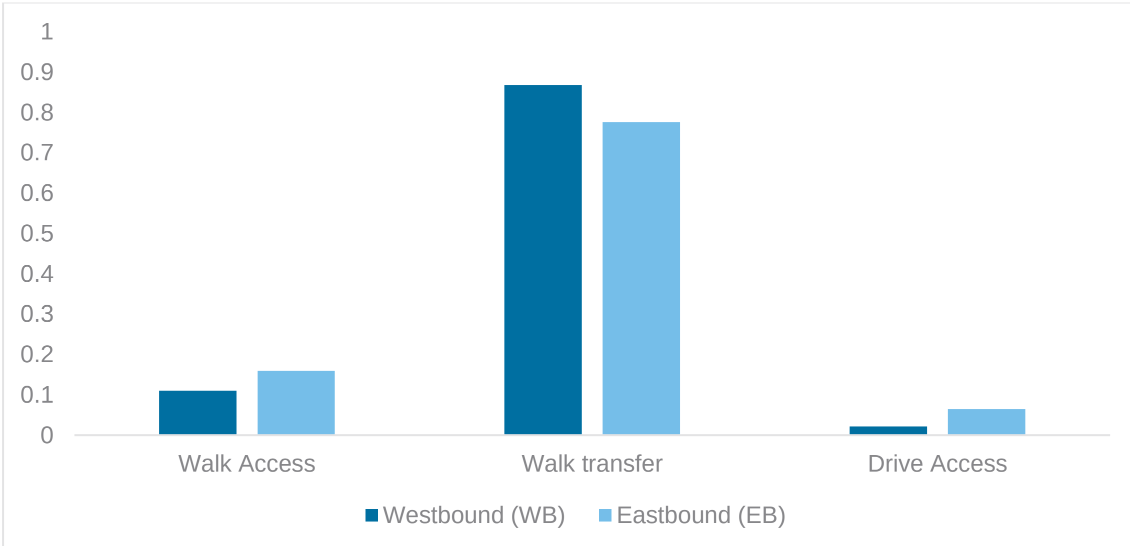


FIGURE 36 ACCESS MODE SHARE BY DIRECTION

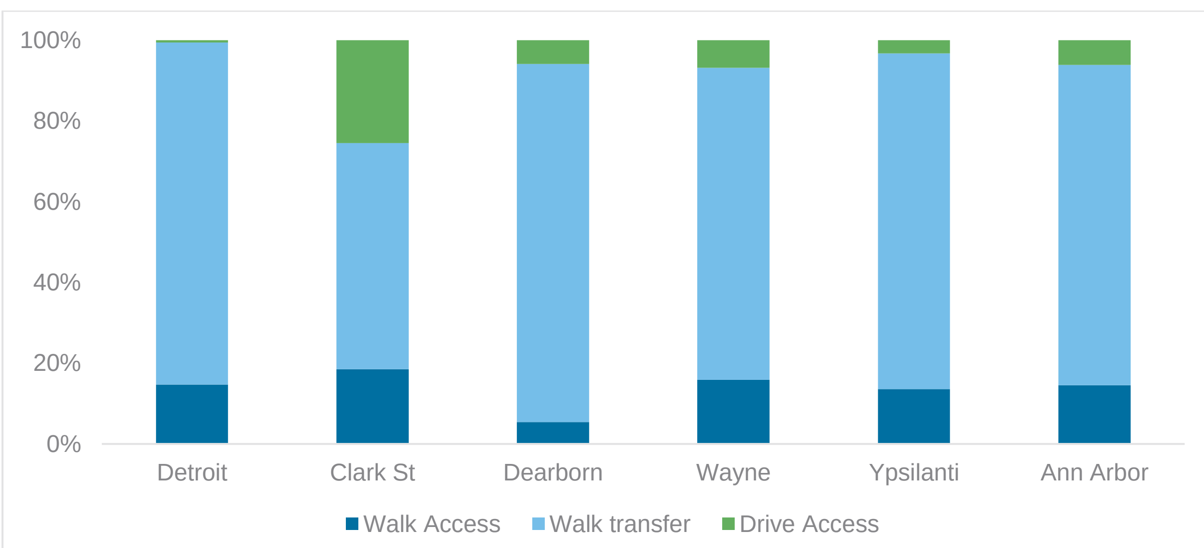


FIGURE 37 ACCESS MODE SHARE BY STATION

Total VMT in the commuter rail scenario was 86,456,183 miles, which is slightly more than 86,079,518 miles in the baseline scenario. Total transit boardings in the commuter rail scenario was 169,415, approximately 3.2% more than the 164,140 boardings in the baseline scenario. Some other transit routes saw increased boardings in the commuter rail scenario as riders transferred to and from these services to the commuter rail. For example, the M1 Streetcar boardings increased by 700, a nearly 28% total increase, as it has a stop close to the Detroit commuter rail station. This also explains the large number of transfer boarding in the Detroit commuter rail station (WB), which is 84% of all boardings at that location (Figure 37).

Boardings on AATA Route 21, which runs close to the Ann Arbor terminus of the commuter rail line, increased significantly from 27 (no commuter rail) to 47 in the commuter rail scenario. Similarly, AATA Route 42, which serves the Ypsilanti stop of the commuter rail, saw a significant increase (29%) in boardings. AATA Route 98 however, lost over half of its boardings in the commuter rail scenario as the route goes through Ypsilanti to Ann Arbor, where the commuter rail is a competing alternative. The SMART Route 200 route, which serves the corridor between the Dearborn and the Wayne stops, saw an increase in boardings especially in the EB direction (64%).

The boarding and alighting trends at the commuter rail stations, as shown in **TABLE 27**, agree with expectation. In the EB direction, most of the boardings happen at the Ann Arbor (UMich) and Ypsilanti (EMU) stations which is intuitive. In the WB direction, the boardings are more distributed instead of being concentrated in Detroit. This is probably because there are no competing routes in the WB direction from Dearborn to Ann Arbor, hence a lot of WB boardings occur at Dearborn and Wayne. Moreover, the increase and decrease in boardings in the bus routes feeding commuter rail stations, and competing routes, also make sense.

Overall, the relatively low ridership modeled in this alternative would place the Ann Arbor to Downtown Detroit commuter rail line around 21nd on the list of commuter rail routes by average weekday ridership (https://en.wikipedia.org/wiki/List_of_United_States_commuter_rail_systems_by_ridership), with similar ridership to the Sonoma-Marin Area Rail Transit (SMART) route, the Downeaster line between Boston and Brunswick Maine, and some of the commuter rail lines in Texas. This is perhaps not unexpected given the relatively low transit mode share in the SEMCOG region (1% of person travel demand).

TABLE 27 COMMUTER RAIL BOARDINGS BY ACCESS/EGRESS MODE

	STOP	LOCATION	On	Off	Walk Access On	Walk Transfer On	Walk Transfer Off	Egress Off	Drive Access On
WB (1500)	94340	DETROIT	503	0	74	426	0	0	3
	94339	CLARK ST	43	0	8	24	0	0	11
	94338	DEARBORN	208	4	7	194	0	4	7
	94337	WAYNE	209	38	17	192	11	27	0
	94344	YPSILANTI	11	476	2	9	191	285	0
	94342	ANN ARBOR	0	458	0	0	150	308	0
		TOTAL	**976**	**976**	**108**	**847**	**352**	**625**	**21**
EB (1501)	94341	ANN ARBOR	343	0	50	273	0	0	21
	94343	YPSILANTI	599	22	81	498	20	2	20
	94332	WAYNE	55	169	25	12	145	24	18
	94331	DEARBORN	11	178	5	0	155	23	6
	94330	CLARK ST	0	80	0	0	42	38	0
	94329	DETROIT	0	560	0	0	512	48	0
		TOTAL	**1009**	**1009**	**161**	**874**	**546**	**135**	**65**

TABLE 28 COMMUTER RAIL BOARDINGS BY TIM OF DAY

			AM		MD		PM		EV		Daily	
	STOP	LOCATION	On	Off	On	Off	On	Off	On	Off	On	Off
WB (1500)	94340	DETROIT	115	0	14	0	136	0	31	0	296	0
	94339	CLARK ST	16	0	14	0	7	0	4	0	41	0
	94338	DEARBORN	129	4	24	1	84	0	23	0	259	5
	94337	WAYNE	72	25	32	8	69	32	12	8	185	35
	94344	YPSILANTI	121	97	20	47	50	154	4	35	195	332
	94342	ANN ARBOR	0	351	0	103	0	116	0	35	0	604
		TOTAL	**452**	**477**	**105**	**159**	**346**	**302**	**73**	**78**	**976**	**976**
EB (1501)	94341	ANN ARBOR	117	0	46	0	273	0	56	0	492	0
	94343	YPSILANTI	147	20	71	7	157	79	76	12	451	117
	94332	WAYNE	17	28	3	20	13	80	1	46	34	173
	94331	DEARBORN	4	58	1	35	7	64	1	26	13	184
	94330	CLARK ST	9	37	1	9	8	28	1	12	20	85
	94329	DETROIT	0	182	0	51	0	190	0	26	0	450
		TOTAL	**294**	**324**	**122**	**122**	**458**	**441**	**136**	**122**	**1010**	**1009**

It is also important to note that given that there is no existing commuter rail line in the SEMCOG region, the model does not understand the non-included attributes of commuter rail. Although we did implement a commuter rail specific constant to help account for the increased level of comfort, reliability, and productivity associated with this mode, future tests can further refine this constants based on access mode as well, to reflect the availability of parking supply at each station, and the relatively higher share of auto access for commuter rail compared to local bus service observed in other existing commuter rail lines.

5.0 CONCLUSIONS

As the results discussed here show, the ActSim model generally replicates observed data well. RSG conducted multiple model calibrations to better align model output with survey and count data. Following the calibration efforts in Phase I of the project and identifying areas of further improvement, RSG focused on calibrating the identified model components. The CDAP model was calibrated to better match the daily activity patterns of the synthetic population, with the results showing that the mandatory (M), non-mandatory (N), and home (H) daily pattern for most person types matching the survey closely.

Another identified model component was the joint tour participation model, where the model calibration reduced the high share of joint tours composed entirely of children, and resulted in a closer match for all categories. Tour mode choice and trip mode choice models were also re-calibrated with the main goal of better matching transit ridership. Overall, we see good model fit with respect to survey and NTD data.

The main observation requiring further attention in the ActSim model is the higher share of model trips in the peak morning (AM) and lower share in the early morning (EA) periods compared to count data. This issue is somewhat perplexing, since the model shows a good level of fit with the survey data. Based on RSG analysis, SEMCOG and RSG agreed to move a portion of work tours from the AM to the EA period. This change improved fit against count data, but did not solve the issue completely. This issue, therefore, should be revisited in the future.

There are, moreover, a few more areas of improvement in need of future attention. In the workplace location model, we see a notable underestimation in intra-county flows, which needs further investigation and calibration. Furthermore, a number of categories in the joint tour frequency model, including 1 eating out/1 visiting, 1 eating out/ 1 other discretionary, and 2 visiting purposes show overestimation which could benefit from further calibration.

Under trip level models, the school stop frequency model shows more discrepancy compared to survey summaries than other purposes.

Sensitivity tests also showed reasonable model behavior in the presence of change in input data. Our first test showed that lower incomes in the Woodward Avenue area resulted in lower vehicles owned, lower VMT, lower non-mandatory tour and trip frequency, and higher transit use, and vice versa. The second test assessed the impact of the addition of a commuter rail connecting downtown Detroit with the city of Ann Arbor, with results showing a modest daily ridership of around 1600, and little change in model VMT.

The model can also benefit from new or more up-to-date data sources. In the wake of the 2021 pandemic, there has been a noticeable change in travel patterns across most regions, and a new household travel survey especially with data on telecommuting and working from home can help estimate new models for ActSim or calibrate the existing ones. Furthermore, a number of models used more outdated data sources for calibration purposes. We used the 2005 HTS data for calibrating the transit pass and subsidy models due to the unavailability of such data in the 2015 HTS, so we recommend any new HTS to collect data on transit subsidies. Similarly, we did not have any observed data on free parking eligibility at work, so data on at-work free parking eligibility would be helpful to further fine-tune the model. Another data source that can benefit the model is a university-specific survey for the Ann Arbor area to better understand the students and travel patterns. We also recommend a time-of-day comparison between any new HTS data and existing counts data to further shed light on the time-of-day issue described above.

APPENDIX A. TOUR MODE CHOICE MODEL RESULTS

TABLE 29 WORK TOUR MODE CHOICE (COUNT)

	Survey				Model			
Tour Mode	Zero Auto	Auto Insufficient	Auto Sufficient	Total	Zero Auto	Auto Insufficient	Auto Sufficient	Total
Drive Alone	5148	60629	889182	954959	6005	65851	869357	941213
Shared2	7517	38215	273503	319235	9497	42174	264868	316539
Shared3+	662	19753	112641	133056	891	21628	109562	132081
Walk	3587	3905	9580	17072	3071	3526	7475	14072
Bike	3486	4721	10330	18537	3895	4598	8551	17044
Walk-Transit	9942	7319	5781	23042	13866	7585	4378	25829
PNR-Transit	0	1136	3748	4884	0	1321	3711	5032
KNR-Transit	554	392	252	1198	850	395	214	1459
School Bus	0	0	0	0	0	0	0	0
Taxi/TNC	733	1235	439	2407	800	1464	284	2548
Total	31629	137305	1305456	1474390	38875	148542	1268400	1455817

TABLE 30 WORK TOUR MODE CHOICE (DIFFERENCE)

	Difference				Percent Difference			
Tour Mode	Zero Auto	Auto Insufficient	Auto Sufficient	Total	Zero Auto	Auto Insufficient	Auto Sufficient	Total
Drive Alone	857	5222	-19825	-13746	17%	9%	-2%	-1%
Shared2	1980	3959	-8635	-2696	26%	10%	-3%	-1%
Shared3+	229	1875	-3079	-975	35%	9%	-3%	-1%
Walk	-516	-379	-2105	-3000	-14%	-10%	-22%	-18%
Bike	409	-123	-1779	-1493	12%	-3%	-17%	-8%
Walk-Transit	3924	266	-1403	2787	39%	4%	-24%	12%
PNR-Transit	0	185	-37	148		16%	-1%	3%

KNR-Transit	296	3	-38	261	53%	1%	-15%	22%
School Bus	0	0	0	0				
Taxi/TNC	67	229	-155	141	9%	19%	-35%	6%
Total	7246	11237	-37056	-18573	23%	8%	-3%	-1%

TABLE 31 UNIVERSITY TOUR MODE CHOICE (DIFFERENCE)

	Survey				Model			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	4217	3706	61112	69035	1274	2283	35722	39279
Shared2	7404	5281	35142	47827	3449	3089	20721	27259
Shared3+	3614	7762	28176	39552	1828	4742	16105	22675
Walk	13535	2498	15985	32018	5875	1062	6613	13550
Bike	2861	858	4235	7954	1381	417	2542	4340
Walk-Transit	7624	2299	5028	14951	14160	3541	9321	27022
PNR-Transit	0	315	881	1196	0	243	792	1035
KNR-Transit	30	19	12	61	16	33	12	61
School Bus	0	0	0	0	0	0	0	0
Taxi/TNC	0	118	201	319	2	120	104	226
Total	39285	22856	150772	212913	27985	15530	91932	135447

TABLE 32 UNIVERSITY TOUR MODE CHOICE (DIFFERENCE)

	Difference				Percent Difference			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	-2943	-1423	-25390	-29756	-70%	-38%	-42%	-43%
Shared2	-3955	-2192	-14421	-20568	-53%	-42%	-41%	-43%
Shared3+	-1786	-3020	-12071	-16877	-49%	-39%	-43%	-43%
Walk	-7660	-1436	-9372	-18468	-57%	-57%	-59%	-58%
Bike	-1480	-441	-1693	-3614	-52%	-51%	-40%	-45%

Walk-Transit	6536	1242	4293	12071	86%	54%	85%	81%
PNR-Transit	0	-72	-89	-161		-23%	-10%	-13%
KNR-Transit	-14	14	0	0	-47%	74%	0%	0%
School Bus	0	0	0	0				
Taxi/TNC	2	2	-97	-93		2%	-48%	-29%
Total	-11300	-7326	-58840	-77466	-29%	-32%	-39%	-36%

TABLE 33 SCHOOL TOUR MODE CHOICE (COUNT)

	Survey				Model			
Tour Mode	Zero Auto	Auto Insufficient	Auto Sufficient	Total	Zero Auto	Auto Insufficient	Auto Sufficient	Total
Drive Alone	258	393	31837	32488	0	426	29381	29807
Shared2	1865	7373	131815	141053	1718	10319	115171	127208
Shared3+	13729	15151	306410	335290	11193	21922	267082	300197
Walk	7676	2179	32755	42610	6275	2898	28809	37982
Bike	0	673	9769	10442	0	1181	8392	9573
Walk-Transit	501	738	1070	2309	586	949	953	2488
PNR-Transit	0	19	16	35	0	16	3	19
KNR-Transit	29	52	29	110	79	17	26	122
School Bus	19504	13907	256146	289557	16283	19713	219159	255155
Taxi/TNC	0	0	0	0	0	0	0	0
Total	43562	40485	769847	853894	36134	57441	668976	762551

TABLE 34 SCHOOL TOUR MODE CHOICE (DIFFERENCE)

	Difference				Percent Difference			
Tour Mode	Zero Auto	Auto Insufficient	Auto Sufficient	Total	Zero Auto	Auto Insufficient	Auto Sufficient	Total
Drive Alone	-258	33	-2456	-2681	-100%	8%	-8%	-8%
Shared2	-147	2946	-16644	-13845	-8%	40%	-13%	-10%
Shared3+	-2536	6771	-39328	-35093	-18%	45%	-13%	-10%

Walk	-1401	719	-3946	-4628	-18%	33%	-12%	-11%
Bike	0	508	-1377	-869		75%	-14%	-8%
Walk-Transit	85	211	-117	179	17%	29%	-11%	8%
PNR-Transit	0	-3	-13	-16		-16%	-81%	-46%
KNR-Transit	50	-35	-3	12	172%	-67%	-10%	11%
School Bus	-3221	5806	-36987	-34402	-17%	42%	-14%	-12%
Taxi/TNC	0	0	0	0				
Total	-7428	16956	-100871	-91343	-17%	42%	-13%	-11%

TABLE 35 IND-MAINTENANCE TOUR MODE CHOICE (COUNT)

	Survey				Model			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	10148	17999	718028	746175	9316	28292	778935	816543
Shared2	16188	24841	464470	505499	15116	39083	496462	550661
Shared3+	14180	15901	379610	409691	12217	25026	406255	443498
Walk	22365	3976	54945	81286	24496	7277	62852	94625
Bike	1243	2154	14941	18338	1235	3217	16854	21306
Walk-Transit	8746	2379	2833	13958	10061	3478	3155	16694
PNR-Transit	0	156	222	378	0	163	218	381
KNR-Transit	228	112	134	474	301	122	195	618
School Bus	0	0	0	0	0	0	0	0
	4940	140	894	5974	4932	222	1022	6176
Total	78038	67658	1636077	1781773	77674	106880	1765948	1950502

TABLE 36 IND-MAINTENANCE TOUR MODE CHOICE (DIFFERENCE)

	Difference				Percent Difference			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	-832	10293	60907	70368	-8%	57%	8%	9%
Shared2	-1072	14242	31992	45162	-7%	57%	7%	9%

Shared3+	-1963	9125	26645	33807	-14%	57%	7%	8%
Walk	2131	3301	7907	13339	10%	83%	14%	16%
Bike	-8	1063	1913	2968		49%	13%	16%
Walk-Transit	1315	1099	322	2736	15%	46%	11%	20%
PNR-Transit	0	7	-4	3		4%	-2%	1%
KNR-Transit	73	10	61	144	32%	9%	46%	30%
School Bus	0	0	0	0				
	-8	82	128	202	0%	59%	14%	3%
Total	-364	39222	129871	168729	0%	58%	8%	9%

TABLE 37 IND-DISCRETIONARY TOUR MODE CHOICE (COUNT)

	Survey				Model			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	8319	13540	425061	446920	8661	23481	489978	522120
Shared2	9389	6560	209318	225267	542	2240	17061	19843
Shared3+	14667	11693	174152	200512	8912	10783	240697	260392
Walk	26823	5918	113286	146027	13697	19279	198841	231817
Bike	1534	2834	18870	23238	34144	11063	140152	185359
Walk-Transit	4047	1265	1717	7029	1442	4777	21685	27904
PNR-Transit	0	100	158	258	4128	2054	1997	8179
KNR-Transit	148	34	85	267	0	186	429	615
School Bus	0	0	0	0	10	4	8	22
Taxi/TNC	482	1028	14611	16121	0	0	0	0
Total	65409	42972	957258	1065639	71536	73867	1110848	1256251

TABLE 38 IND-DISCRETIONARY TOUR MODE CHOICE (DIFFERENCE)

	Difference				Percent Difference			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**

Drive Alone	342	9941	64917	75200	4%	73%	15%	17%
Shared2	-8847	-4320	-192257	-205424	-94%	-66%	-92%	-91%
Shared3+	-5755	-910	66545	59880	-39%	-8%	38%	30%
Walk	-13126	13361	85555	85790	-49%	226%	76%	59%
Bike	32610	8229	121282	162121	2126%	290%	643%	698%
Walk-Transit	-2605	3512	19968	20875	-64%	278%	1163%	297%
PNR-Transit	4128	1954	1839	7921		1954%	1164%	3070%
KNR-Transit	-148	152	344	348	-100%	447%	405%	130%
School Bus	10	4	8	22				
Taxi/TNC	-482	-1028	-14611	-16121	-100%	-100%	-100%	-100%
Total	6127	30895	153590	190612	9%	72%	16%	18%

TABLE 39 JOINT MAINTENANCE TOUR MODE CHOICE (COUNT)

	Survey				Model			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	0	0	0	0	0	0	0	0
Shared2	7320	8606	404428	420354	3442	6112	181126	190680
Shared3+	7305	16175	260678	284159	4412	11569	126292	142273
Walk	4189	5367	47985	57541	2151	2595	15368	20114
Bike	1158	2272	5178	8608	568	1696	2604	4868
Walk-Transit	1428	549	583	2559	1041	225	217	1483
PNR-Transit	0	33	45	78	0	3	5	8
KNR-Transit	45	35	9	89	110	114	8	232
School Bus	0	0	0	0	0	0	0	0
Taxi/TNC	0	456	12638	13093	2	270	5918	6190
Total	21445	33492	731544	786481	11726	22584	331538	365848

TABLE 40 JOINT TOUR MODE CHOICE (DIFFERENCE)

	Difference				Percent Difference			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	0	0	0	0				
Shared2	-3878	-2494	-223302	-229674	-53%	-29%	-55%	-55%
Shared3+	-2893.06	-4606.21	-134386	-141886	-40%	-28%	-52%	-50%
Walk	-2038.17	-2771.8	-32617	-37427	-49%	-52%	-68%	-65%
Bike	-590.054	-576	-2573.83	-3739.88	-51%	-25%	-50%	-43%
Walk-Transit	-386.896	-323.625	-365.8	-1076.32	-27%	-59%	-63%	-42%
PNR-Transit	0	-30	-40	-70		-91%	-89%	-90%
KNR-Transit	65	79	-1	143	144%	226%	-11%	161%
School Bus	0	0	0	0				
	2	-185.765	-6719.61	-6903.38		-41%	-53%	-53%
Total	-9719.17	-10908.4	-400006	-420633	-45%	-33%	-55%	-53%

TABLE 41 AT-WORK SUBTOUR MODE CHOICE (COUNT)

	Survey				Model			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	528	24211	226467	251206	589	21407	224694	246690
Shared2	1293	4041	69007	74341	1713	6617	67203	75533
Shared3+	1230	4434	37381	43045	1577	6833	37847	46257
Walk	1034	2080	44226	47340	1418	2537	42611	46566
Bike	597	0	406	1003	561	19	283	863
Walk-Transit	35	28	59	122	46	20	32	98
PNR-Transit	0	0	4	4	0	0	0	0
KNR-Transit	1	2	0	3	22	93	1	116
School Bus	0	0	0	0	0	0	0	0

	24	203	1136	1363	87	378	1149	1614
Total	4742	34999	378686	418427	6013	37904	373820	417737

TABLE 42 AT-WORK SUBTOUR MODE CHOICE (DIFFERENCE)

	Difference				**Percent Difference**			
Tour Mode	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**	**Zero Auto**	**Auto Insufficient**	**Auto Sufficient**	**Total**
Drive Alone	61	-2804	-1773	-4516	12%	-12%	-1%	-2%
Shared2	420	2576	-1804	1192	32%	64%	-3%	2%
Shared3+	347	2399	466	3212	28%	54%	1%	7%
Walk	384	457	-1615	-774	37%	22%	-4%	-2%
Bike	-36	19	-123	-140	-6%		-30%	-14%
Walk-Transit	11	-8	-27	-24	31%	-29%	-46%	-20%
PNR-Transit	0	0	-4	-4			-100%	-100%
KNR-Transit	21	91	1	113	2100%	4550%	#DIV/0!	3767%
School Bus	0	0	0	0				
	63	175	13	251	263%	86%	1%	18%
Total	1271	2905	-4866	-690	27%	8%	-1%	0%

APPENDIX B. STOP FREQUENCY MODEL RESULTS

TABLE 43 STOP FREQUENCY (WORK)

# Stops	Survey	Model	Survey%	Model%
0	838,887	824,470	56%	56%
1	358,041	356,407	24%	24%
2	158,953	156,532	11%	11%
3	101,846	85,516	7%	7%
4	24,718	23,324	2%	2%
5	10,970	7,934	1%	1%
6	875	1,634	0%	0%
Total	1,494,289	1,455,817	100%	100%

TABLE 44 STOP FREQUENCY (UNIVERSITY)

# Stops	Survey	Model	Survey%	Model%
0	124434	46994	59%	35%
1	43730	44134	21%	33%
2	22803	21919	11%	16%
3	11356	15978	5%	12%
4	4920	4313	2%	3%
5	1575	1371	1%	1%
6	599	738	0%	1%
Total	209416	135,447	100%	100%

TABLE 45 STOP FREQUENCY (SCHOOL)

# Stops	Survey	Model	Survey%	Model%
0	528,983	262,017	66%	34%
1	146,383	288,195	18%	38%
2	73,209	131,181	9%	17%
3	43,963	66,490	5%	9%
4	6,706	11,653	1%	2%
5	1,306	2,452	0%	0%
6	676	563	0%	0%
Total	801,225	762,551	100%	100%

TABLE 46 STOP FREQUENCY (ESCORT)

# Stops	Survey	Model	Survey%	Model%
0	395,653	408,216	69%	68%
1	87,827	102,388	15%	17%
2	47,044	41,993	8%	7%
3	32,720	36,894	6%	6%
4	8,688	7,458	2%	1%
5	1,386	2,779	0%	0%
6	956	1,221	0%	0%
Total	574,275	600,949	100%	100%

TABLE 47 STOP FREQUENCY (INDIVIDUAL MAINTENANCE)

# Stops	Survey	Model	Survey%	Model%
0	540,916	606,377	49%	45%
1	267,175	344,808	24%	26%
2	140,273	193,475	13%	14%
3	102,511	140,282	9%	10%
4	36,036	42,106	3%	3%
5	11,228	14,270	1%	1%
6	7,715	8,235	1%	1%
Total	1,105,855	1,349,553	100%	100%

TABLE 48 STOP FREQUENCY (INDIVIDUAL DISCRETIONARY)

# Stops	Survey	Model	Survey%	Model%
0	629,894	751,413	61%	60%
1	189,260	252,678	18%	20%
2	106,290	127,337	10%	10%
3	74,371	94,375	7%	8%
4	19,291	20,960	2%	2%
5	12,478	5,481	1%	0%
6	2,387	4,007	0%	0%
Total	1,033,971	1,256,251	100%	100%

TABLE 49 STOP FREQUENCY (JOINT MAINTENANCE)

# Stops	Survey	Model	Survey%	Model%
0	107,442	212,931	72%	58%
1	26,992	99,532	18%	27%
2	8,308	32,939	6%	9%
3	4,568	14,861	3%	4%
4	511	4,070	0%	1%
5	-	1,249	0%	0%
6	803	266	1%	0%
Total	148,625	365,848	100%	100%

TABLE 50 STOP FREQUENCY (JOINT DISCRETIONARY)

# Stops	Survey	Model	Survey%	Model%
0	107,442	321084	60%	73%
1	26,992	83643	21%	19%
2	8,308	22286	10%	5%
3	4,568	10888	7%	2%
4	511	1903	1%	0%
5	-	546	0%	0%
6	803	113	0%	0%
Total	148,625	440,463	100%	100%

TABLE 51 STOP FREQUENCY (ATWORK)

# Stops	Survey	Model	Survey%	Model%
0	193,926	277,586	81%	66%
1	29,863	94,021	12%	23%
2	11,538	27,237	5%	7%
3	3,034	14,128	1%	3%
4	660	2,764	0%	1%
5	-	1,095	0%	0%
6	-	906	0%	0%
Total	239,021	417,737	100%	100%

APPENDIX C. TRIP MODE CHOICE MODEL RESULTS

TABLE 52 WORK TRIP MODE CHOICE (MODEL)

Model											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi/TNC	Total
Drive Alone	2574970	298922	113985	0	0	0	0	0	0	0	2987877
Shared2	2089	554162	93298	0	0	3601	0	0	0	1084	654234
Shared3+	1996	0	150996	0	0	3310	0	0	0	98	156400
Walk	64936	31681	11147	31969	0	24552	0	0	0	1834	166119
Bike	0	0	0	0	38540	0	0	0	0	0	38540
Walk-Transit	1673	410	222	0	0	31998	0	0	0	0	34303
PNR-Transit	0	0	0	0	0	0	10005	0	0	0	10005
KNR-Transit	0	0	0	0	0	0	0	2911	0	0	2911
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	2	426	178	0	0	1562	59	7	0	3713	5947
Total	2645666	885601	369826	31969	38540	65023	10064	2918	0	6729	4056336

TABLE 53 WORK TRIP MODE CHOICE (SURVEY)

Survey											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi/TNC	Total
Drive Alone	2586180	298893	114229	0	0	0	0	0	0	0	2999302
Shared2	0	554236	94147	0	0	15057	0	0	0	1225	664665
Shared3+	0	0	147612	0	0	12543	0	0	0	220	160375
Walk	13810	10604	2336	36019	0	92807	0	0	0	2158	157734
Bike	0	0	0	0	39352	0	0	0	0	0	39352
Walk-Transit	0	0	0	0	0	44711	0	0	0	0	44711
PNR-Transit	0	0	0	0	0	0	9766	0	0	0	9766
KNR-Transit	0	0	0	0	0	0	0	2397	0	0	2397
School Bus	0	0	0	0	0	0	0	0	0	0	0

Taxi	0	0	0	0	0	2805	0	0	0	6703	9508
Total	2599990	863733	358324	36019	39352	167923	9766	2397	0	10306	4087810

TABLE 54 WORK TRIP MODE CHOICE (DIFFERENCE)

Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	-11210	29	-244	0	0	0	0	0	0	0	-11425
Shared2	2089	-74	-849	0	0	-11456	0	0	0	-141	-10431
Shared3+	1996	0	3384	0	0	-9233	0	0	0	-122	-3975
Walk	51126	21077	8811	-4050	0	-68255	0	0	0	-324	8385
Bike	0	0	0	0	-812	0	0	0	0	0	-812
Walk-Transit	1673	410	222	0	0	-12713	0	0	0	0	-10408
PNR-Transit	0	0	0	0	0	0	239	0	0	0	239
KNR-Transit	0	0	0	0	0	0	0	514	0	0	514
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	2	426	178	0	0	-1243	59	7	0	-2990	-3561
Total	45676	21868	11502	-4050	-812	-102900	298	521	0	-3577	-31474

TABLE 55 WORK TRIP MODE CHOICE (PERCENT DIFFERENCE)

Percent difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi/TNC	Total
Drive Alone	-0.27	0.00	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.28
Shared2	0.05	0.00	-0.02	0.00	0.00	-0.28	0.00	0.00	0.00	0.00	-0.26
Shared3+	0.05	0.00	0.08	0.00	0.00	-0.23	0.00	0.00	0.00	0.00	-0.10
Walk	1.25	0.52	0.22	-0.10	0.00	-1.67	0.00	0.00	0.00	-0.01	0.21
Bike	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	0.00	-0.02
Walk-Transit	0.04	0.01	0.01	0.00	0.00	-0.31	0.00	0.00	0.00	0.00	-0.25
PNR-Transit	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
KNR-Transit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
School Bus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Taxi	0.00	0.01	0.00	0.00	0.00	-0.03	0.00	0.00	0.00	-0.07	-0.09
Total	1.12	0.53	0.28	-0.10	-0.02	-2.52	0.01	0.01	0.00	-0.09	-0.77

TABLE 56 UNIVERSITY TRIP MODE CHOICE (MODEL)

	Survey										
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	118191	17406	9900	0	0	0	0	0	0	0	145497
Shared2	813	63346	14127	0	0	4269	0	0	0	0	82555
Shared3+	107	0	43250	0	0	571	0	0	0	0	43928
Walk	6885	7137	4783	41766	0	60831	0	0	0	199	121601
Bike	0	0	0	0	15058	0	0	0	0	0	15058
Walk-Transit	5542	3449	3160	0	0	29885	0	0	0	0	42036
PNR-Transit	0	0	0	0	0	0	1892	0	0	0	1892
KNR-Transit	0	0	0	0	0	0	0	122	0	0	122
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	7	9	0	0	20	178	0	0	477	691
Total	131538	91345	75229	41766	15058	95576	2070	122	0	676	453380

TABLE 57 UNIVERSITY TRIP MODE CHOICE (SURVEY)

	Model										
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	193648	26184	16054	0	0	0	0	0	0	0	235886
Shared2	0	95321	21898	0	0	12199	0	0	0	0	129418
Shared3+	0	0	66974	0	0	1525	0	0	0	0	68499
Walk	4457	5296	3065	49657	0	96059	0	0	0	621	159155
Bike	0	0	0	0	21905	0	0	0	0	0	21905
Walk-Transit	0	0	0	0	0	29010	0	0	0	0	29010
PNR-Transit	0	0	0	0	0	0	2391	0	0	0	2391
KNR-Transit	0	0	0	0	0	0	0	121	0	0	121

School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	64	144	0	0	474	682
Total	198105	126801	107991	49657	21905	138857	2535	121	0	1095	647067

TABLE 58 UNIVERSITY TRIP MODE CHOICE (DIFFERENCE)

Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	-75457	-8778	-6154	0	0	0	0	0	0	0	-90389
Shared2	813	-31975	-7771	0	0	-7930	0	0	0	0	-46863
Shared3+	107	0	-23724	0	0	-954	0	0	0	0	-24571
Walk	2428	1841	1718	-7891	0	-35228	0	0	0	-422	-37554
Bike	0	0	0	0	-6847	0	0	0	0	0	-6847
Walk-Transit	5542	3449	3160	0	0	875	0	0	0	0	13026
PNR-Transit	0	0	0	0	0	0	-499	0	0	0	-499
KNR-Transit	0	0	0	0	0	0	0	1	0	0	1
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	7	9	0	0	-44	34	0	0	3	9
Total	-66567	-35456	-32762	-7891	-6847	-43281	-465	1	0	-419	-193687

TABLE 59 UNIVERSITY TRIP MODE CHOICE (PERCENT DIFFERENCE)

Percent Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	-12	-1	-1	0	0	0	0	0	0	0	-14
Shared2	0	-5	-1	0	0	-1	0	0	0	0	-7
Shared3+	0	0	-4	0	0	0	0	0	0	0	-4
Walk	0	0	0	-1	0	-5	0	0	0	0	-6
Bike	0	0	0	0	-1	0	0	0	0	0	-1
Walk-Transit	1	1	0	0	0	0	0	0	0	0	2
PNR-Transit	0	0	0	0	0	0	0	0	0	0	0
KNR-Transit	0	0	0	0	0	0	0	0	0	0	0

School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	0	0	0	0
Total	-10	-5	-5	-1	-1	-7	0	0	0	0	-30

TABLE 60 SCHOOL TRIP MODE CHOICE (MODEL)

Model											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	93185	24219	6660	0	0	0	0	0	0	0	124064
Shared2	341	340937	158997	0	0	1560	0	0	221303	0	723138
Shared3+	103	0	724172	0	0	405	0	0	247264	0	971944
Walk	57	30970	45031	93102	0	1716	0	0	70955	0	241831
Bike	0	0	0	0	23584	0	0	0	0	0	23584
Walk-Transit	48	183	586	0	0	3205	0	0	0	0	4022
PNR-Transit	0	0	0	0	0	0	37	0	0	0	37
KNR-Transit	0	0	0	0	0	0	0	244	0	0	244
School Bus	0	0	0	0	0	0	0	0	255113	0	255113
Taxi	0	1	3	0	0	1	1	0	0	0	6
Total	93734	396310	935449	93102	23584	6887	38	244	794635	0	2343983

TABLE 61 SCHOOL TRIP MODE CHOICE (SURVEY)

Survey											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	100705	22199	6339	0	0	0	0	0	0	0	129243
Shared2	0	399546	181654	0	0	8688	0	0	123375	0	713263
Shared3+	0	0	836723	0	0	4355	0	0	136015	0	977093
Walk	0	24494	33065	106295	0	8688	0	0	34266	0	206808
Bike	0	0	0	0	26486	0	0	0	0	0	26486
Walk-Transit	0	0	0	0	0	4479	0	0	0	0	4479
PNR-Transit	0	0	0	0	0	0	70	0	0	0	70
KNR-Transit	0	0	0	0	0	0	0	219	0	0	219

School Bus	0	0	0	0	0	0	0	0	623563	0	623563
Taxi	0	0	0	0	0	0	0	0	0	0	0
Total	100705	446239	1057781	106295	26486	26210	70	219	917219	0	2681224

TABLE 62 SCHOOL TRIP MODE CHOICE (DIFFERENCE)

Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	-7520	2020	321	0	0	0	0	0	0	0	-5179
Shared2	341	-58609	-22657	0	0	-7128	0	0	97928	0	9875
Shared3+	103	0	-112551	0	0	-3950	0	0	111249	0	-5149
Walk	57	6476	11966	-13193	0	-6972	0	0	36689	0	35023
Bike	0	0	0	0	-2902	0	0	0	0	0	-2902
Walk-Transit	48	183	586	0	0	-1274	0	0	0	0	-457
PNR-Transit	0	0	0	0	0	0	-33	0	0	0	-33
KNR-Transit	0	0	0	0	0	0	0	25	0	0	25
School Bus	0	0	0	0	0	0	0	0	-368450	0	-368450
Taxi	0	1	3	0	0	1	1	0	0	0	6
Total	-6971	-49929	-122332	-13193	-2902	-19323	-32	25	-122584	0	-337241

TABLE 63 SCHOOL TRIP MODE CHOICE (PERCENT DIFFERENCE)

Percent Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	-0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.2
Shared2	0.0	-2.2	-0.8	0.0	0.0	-0.3	0.0	0.0	3.7	0.0	0.4
Shared3+	0.0	0.0	-4.2	0.0	0.0	-0.1	0.0	0.0	4.1	0.0	-0.2
Walk	0.0	0.2	0.4	-0.5	0.0	-0.3	0.0	0.0	1.4	0.0	1.3
Bike	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	-0.1
Walk-Transit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PNR-Transit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KNR-Transit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

School Bus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-13.7	0.0	-13.7
Taxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	-0.3	-1.9	-4.6	-0.5	-0.1	-0.7	0.0	0.0	-4.6	0.0	-12.6

TABLE 64 IND-MAINTENANCE TRIP MODE CHOICE (MODEL)

	Model										
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	2502215	463541	154518	0	0	0	0	0	0	0	3120274
Shared2	3441	1078544	322985	0	0	1325	0	0	0	215	1406510
Shared3+	668	0	743061	0	0	231	0	0	0	14	743974
Walk	66604	25818	24528	227554	0	27325	0	0	0	2298	374127
Bike	0	0	0	0	51666	0	0	0	0	0	51666
Walk-Transit	2353	1622	1153	0	0	18714	0	0	0	0	23842
PNR-Transit	0	0	0	0	0	0	748	0	0	0	748
KNR-Transit	0	0	0	0	0	0	0	1233	0	0	1233
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	368	252	169	0	0	90	14	3	0	16593	17489
Total	2575649	1569777	1246414	227554	51666	47685	762	1236	0	19120	5739863

TABLE 65 IND-MAINTENANCE TRIP MODE CHOICE (SURVEY)

	Survey										
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	2344955	454663	153932	0	0	0	0	0	0	0	2953550
Shared2	0	984597	302301	0	0	12817	0	0	0	1879	1301594
Shared3+	0	0	700698	0	0	2117	0	0	0	290	703105
Walk	27550	10617	10565	194124	0	74710	0	0	0	13072	330638
Bike	0	0	0	0	44981	0	0	0	0	0	44981
Walk-Transit	0	0	0	0	0	27338	0	0	0	0	27338
PNR-Transit	0	0	0	0	0	0	763	0	0	0	763
KNR-Transit	0	0	0	0	0	0	0	957	0	0	957

School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	903	39	0	0	13130	14072
Total	2372505	1449877	1167496	194124	44981	117885	802	957	0	28371	5376998

TABLE 66 IND-MAINTENANCE TRIP MODE CHOICE (DIFFERENCE)

Difference											
Trip Mode	Drive Alone	Shared2	Shared3 +	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	157260	8878	586	0	0	0	0	0	0	0	166724
Shared2	3441	93947	20684	0	0	-11492	0	0	0	-1664	104916
Shared3+	668	0	42363	0	0	-1886	0	0	0	-276	40869
Walk	39054	15201	13963	33430	0	-47385	0	0	0	-10774	43489
Bike	0	0	0	0	6685	0	0	0	0	0	6685
Walk-Transit	2353	1622	1153	0	0	-8624	0	0	0	0	-3496
PNR-Transit	0	0	0	0	0	0	-15	0	0	0	-15
KNR-Transit	0	0	0	0	0	0	0	276	0	0	276
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	368	252	169	0	0	-813	-25	3	0	3463	3417
Total	203144	119900	78918	33430	6685	-70200	-40	279	0	-9251	362865

TABLE 67 IND-MAINTENANCE TRIP MODE CHOICE (PERCENT DIFFERENCE)

Percent Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	2.9	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Shared2	0.1	1.7	0.4	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	2.0
Shared3+	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Walk	0.7	0.3	0.3	0.6	0.0	-0.9	0.0	0.0	0.0	-0.2	0.8
Bike	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Walk-Transit	0.0	0.0	0.0	0.0	0.0	-0.2	0.0	0.0	0.0	0.0	-0.1

PNR-Transit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
KNR-Transit	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
School Bus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Taxi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
Total	3.8	2.2	1.5	0.6	0.1	-1.3	0.0	0.0	0.0	-0.2	6.7

TABLE 68 IND-DISCRETIONARY TRIP MODE CHOICE (MODEL)

Model											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	1452665	134581	47084	0	0	0	0	0	0	0	1634330
Shared2	1629	571671	133933	0	0	322	0	0	0	2663	710218
Shared3+	926	0	444697	0	0	155	0	0	0	5899	451677
Walk	55009	41586	42233	409807	0	12299	0	0	0	18679	579613
Bike	0	0	0	0	61372	0	0	0	0	0	61372
Walk-Transit	1497	530	467	0	0	9189	0	0	0	0	11683
PNR-Transit	0	0	0	0	0	0	1227	0	0	0	1227
KNR-Transit	0	0	0	0	0	0	0	44	0	0	44
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	232	76	75	0	0	35	3	0	0	29259	29680
Total	1511958	748444	668489	409807	61372	22000	1230	44	0	56500	3479844

TABLE 69 IND-DISCRETIONARY TRIP MODE CHOICE (SURVEY)

Survey											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	1274622	132988	46884	0	0	0	0	0	0	0	1454494
Shared2	0	501816	117819	0	0	4840	0	0	0	4306	628781
Shared3+	0	0	396237	0	0	2420	0	0	0	9041	407698
Walk	19835	17605	19488	318486	0	60779	0	0	0	19778	455971
Bike	0	0	0	0	52038	0	0	0	0	0	52038
Walk-Transit	0	0	0	0	0	13678	0	0	0	0	13678
PNR-Transit	0	0	0	0	0	0	518	0	0	0	518
KNR-Transit	0	0	0	0	0	0	0	535	0	0	535

School Bus	0	0	0	0	0	0	0	0	0	0	0
taxi	0	0	0	0	0	608	0	16	0	23123	23747
Total	1294457	652409	580428	318486	52038	82325	518	551	0	56248	3037460

TABLE 70 IND-DISCRETIONARY TRIP MODE CHOICE (DIFFERENCE)

Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	178043	1593	200	0	0	0	0	0	0	0	179836
Shared2	1629	69855	16114	0	0	-4518	0	0	0	-1643	81437
Shared3+	926	0	48460	0	0	-2265	0	0	0	-3142	43979
Walk	35174	23981	22745	91321	0	-48480	0	0	0	-1099	123642
Bike	0	0	0	0	9334	0	0	0	0	0	9334
Walk-Transit	1497	530	467	0	0	-4489	0	0	0	0	-1995
PNR-Transit	0	0	0	0	0	0	709	0	0	0	709
KNR-Transit	0	0	0	0	0	0	0	-491	0	0	-491
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	232	76	75	0	0	-573	3	-16	0	6136	5933
Total	217501	96035	88061	91321	9334	-60325	712	-507	0	252	442384

TABLE 71 IND-DISCRETIONARY TRIP MODE CHOICE (PERCENT DIFFERENCE)

Percent Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	5.86	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.92
Shared2	0.05	2.30	0.53	0.00	0.00	-0.15	0.00	0.00	0.00	-0.05	2.68
Shared3+	0.03	0.00	1.60	0.00	0.00	-0.07	0.00	0.00	0.00	-0.10	1.45
Walk	1.16	0.79	0.75	3.01	0.00	-1.60	0.00	0.00	0.00	-0.04	4.07
Bike	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.31
Walk-Transit	0.05	0.02	0.02	0.00	0.00	-0.15	0.00	0.00	0.00	0.00	-0.07
PNR-Transit	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02
KNR-Transit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	-0.02

School Bus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taxi	0.01	0.00	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.20	0.20
Total	7.16	3.16	2.90	3.01	0.31	-1.99	0.02	-0.02	0.00	0.01	14.56

TABLE 72 JOINT TRIP MODE CHOICE (MODEL)

	Model										
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	0	0	0	0	0	0	0	0	0	0	0
Shared2	0	1058628	25456	0	0	34	0	0	0	3012	1087130
Shared3+	0	0	724553	0	0	1894	0	0	0	5709	732156
Walk	0	19504	20360	129759	0	2650	0	0	0	13286	185559
Bike	0	0	0	0	21889	0	0	0	0	0	21889
Walk-Transit	0	678	127	0	0	1069	0	0	0	0	1874
PNR-Transit	0	0	0	0	0	0	34	0	0	0	34
KNR-Transit	0	0	0	0	0	0	0	743	0	0	743
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	8	0	0	0	0	0	21	0	12519	12548
Total	0	1078818	770496	129759	21889	5647	34	764	0	34526	2041933

TABLE 73 JOINT TRIP MODE CHOICE (MODEL)

	Model										
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	0	0	0	0	0	0	0	0	0	0	0
Shared2	0	1075060	31710	0	0	5110	0	0	0	4518	1116398
Shared3+	0	0	698583	0	0	8044	0	0	0	6650	713277
Walk	0	6426	9002	123866	0	22720	0	0	0	13821	175835
Bike	0	0	0	0	19284	0	0	0	0	0	19284
Walk-Transit	0	0	0	0	0	3084	0	0	0	0	3084
PNR-Transit	0	0	0	0	0	0	140	0	0	0	140
KNR-Transit	0	0	0	0	0	0	0	166	0	0	166
School Bus	0	0	0	0	0	0	0	0	0	0	0

Taxi	0	0	0	0	0	0	0	0	0	14587	14587
Total	0	1081486	739295	123866	19284	38958	140	166	0	39576	2042772

TABLE 74 JOINT TRIP MODE CHOICE (DIFFERENCE)

Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	0	0	0	0	0	0	0	0	0	0	0
Shared2	0	-16432	-6254	0	0	-5076	0	0	0	-1506	-29268
Shared3+	0	0	25970	0	0	-6150	0	0	0	-941	18879
Walk	0	13078	11358	5893	0	-20070	0	0	0	-535	9724
Bike	0	0	0	0	2605	0	0	0	0	0	2605
Walk-Transit	0	678	127	0	0	-2015	0	0	0	0	-1210
PNR-Transit	0	0	0	0	0	0	-106	0	0	0	-106
KNR-Transit	0	0	0	0	0	0	0	577	0	0	577
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	8	0	0	0	0	0	21	0	-2068	-2039
Total	0	-2668	31201	5893	2605	-33311	-106	598	0	-5050	-839

TABLE 75 JOINT TRIP MODE CHOICE (PERCENT DIFFERENCE)

Percent Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Shared2	0.0%	-0.8%	-0.3%	0.0%	0.0%	-0.2%	0.0%	0.0%	0.0%	-0.1%	-1.4%
Shared3+	0.0%	0.0%	1.3%	0.0%	0.0%	-0.3%	0.0%	0.0%	0.0%	0.0%	0.9%
Walk	0.0%	0.6%	0.6%	0.3%	0.0%	-1.0%	0.0%	0.0%	0.0%	0.0%	0.5%
Bike	0.0%	0.0%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%
Walk-Transit	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	0.0%	0.0%	0.0%	0.0%	-0.1%
PNR-Transit	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
KNR-Transit	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
School Bus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Taxi	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	-0.1%	-0.1%

Total	0.0%	-0.1%	1.5%	0.3%	0.1%	-1.6%	0.0%	0.0%	0.0%	-0.2%	0.0%

TABLE 76 AT-WORK TRIP MODE CHOICE (MODEL)

Model											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	605034	20486	7840	0	0	0	0	0	0	0	633360
Shared2	0	166179	30568	0	0	0	0	0	0	23	196770
Shared3+	4055	0	76471	0	0	84	0	0	0	583	81193
Walk	14642	4224	1910	125868	0	163	0	0	0	187	146994
Bike	0	0	0	0	2296	0	0	0	0	0	2296
Walk-Transit	2	146	2	0	0	8	0	0	0	0	158
PNR-Transit	0	0	0	0	0	0	0	0	0	0	0
KNR-Transit	0	0	0	0	0	0	0	309	0	0	309
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	1	0	3139	3140
Total	623733	191035	116791	125868	2296	255	0	310	0	3932	1064220

TABLE 77 AT-WORK TRIP MODE CHOICE (SURVEY)

Survey											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	605034	20486	7840	0	0	0	0	0	0	0	633360
Shared2	0	166179	30568	0	0	0	0	0	0	23	196770
Shared3+	4055	0	76471	0	0	84	0	0	0	583	81193
Walk	14642	4224	1910	125868	0	163	0	0	0	187	146994
Bike	0	0	0	0	2296	0	0	0	0	0	2296
Walk-Transit	2	146	2	0	0	8	0	0	0	0	158
PNR-Transit	0	0	0	0	0	0	0	0	0	0	0
KNR-Transit	0	0	0	0	0	0	0	309	0	0	309
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	0	0	1	0	3139	3140
Total	623733	191035	116791	125868	2296	255	0	310	0	3932	1064220

TABLE 78 AT-WORK TRIP MODE CHOICE (DIFFERENCE)

Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	-2660	423	552	0	0	0	0	0	0	0	-1685
Shared2	0	4473	2652	0	0	0	0	0	0	-67	7058
Shared3+	4055	0	7914	0	0	-15564	0	0	0	-6304	-9899
Walk	10755	4022	1690	-3637	0	-15485	0	0	0	-299	-2954
Bike	0	0	0	0	-285	0	0	0	0	0	-285
Walk-Transit	2	146	2	0	0	-229	0	0	0	0	-79
PNR-Transit	0	0	0	0	0	0	-7	0	0	0	-7
KNR-Transit	0	0	0	0	0	0	0	303	0	0	303
School Bus	0	0	0	0	0	0	0	0	0	0	0
Taxi	0	0	0	0	0	-67	0	1	0	81	15
Total	12152	9064	12810	-3637	-285	-31345	-7	304	0	-6589	-7533

TABLE 79 AT-WORK TRIP MODE CHOICE (PERCENT DIFFERENCE)

Percent Difference											
Trip Mode	Drive Alone	Shared2	Shared3+	Walk	Bike	Walk-Transit	PNR-Transit	KNR-Transit	School Bus	Taxi	Total
Drive Alone	-0.25	0.04	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.16
Shared2	0.00	0.42	0.25	0.00	0.00	0.00	0.00	0.00	0.00	-0.01	0.66
Shared3+	0.38	0.00	0.74	0.00	0.00	-1.45	0.00	0.00	0.00	-0.59	-0.92
Walk	1.00	0.38	0.16	-0.34	0.00	-1.44	0.00	0.00	0.00	-0.03	-0.28
Bike	0.00	0.00	0.00	0.00	-0.03	0.00	0.00	0.00	0.00	0.00	-0.03
Walk-Transit	0.00	0.01	0.00	0.00	0.00	-0.02	0.00	0.00	0.00	0.00	-0.01
PNR-Transit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KNR-Transit	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.03
School Bus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Taxi	0.00	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	0.00	0.01	0.00
Total	1.13	0.85	1.20	-0.34	-0.03	-2.92	0.00	0.03	0.00	-0.61	-0.70

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