VCMPO Model Calibration
and
Home Based Travel Survey

Technical Memorandum
Number Five

Model Coefficients and Trip Factors

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November 2002

Introduction

The primary purpose of the household travel characteristics survey was to collect data that can be used to formulate, calibrate, and validate existing and planned travel demand model structures. As such, the survey used statistical methods to ensure the best use of limited resources and to develop accurate models.

Data was collected to characterize demographics of household and travel patterns of household members. The survey data was analyzed to calibrate the travel forecasting models and to estimate model coefficients for:

- Trip Generation (various trip production models)
- Trip Distribution (friction factors)
- Mode Choice and Auto Occupancy Rates
- Traffic Assignment Factors (CONFAC: peak hour to daily ratios)

Additionally, travel characteristics data may be used to enhance existing models and formulate new travel forecasting methods. This report provides highlights of the methodology, results of statistical analysis, and recommendations. More information on the survey sample selection, procedures, and survey findings can be found in earlier technical memoranda.

Trip Generation Rates

Trip generation is the process used to determine the number of person trips that originate (productions) in a specific zone and the number of person trips that terminate (attractions) in that zone. These trip characteristics have also been related to the socioeconomic characteristics of an area. The Florida Department of Transportation (FDOT) developed the Florida Standard Urban Transportation Modeling Structure (FSUTMS) that provides a standard trip generation model to be used in any urban area in Florida.

Trip generation models predict urban trip making behavior by translating urban activity characteristics into numbers of trips. Trip generation is the first, and in many respects, the most influential stage in simulating travel behavior. These models typically incorporate three attributes of land use: intensity, location, and character. Intensity determines the amount of activity in a given zone and is usually stated as number of households or employees. The location of land use suggests the spatial distribution of activities. Nonresidential land use is characterized by type of activity (e.g., industrial, commercial, and service employment). Residential land use is typically defined as type of dwelling unit (e.g., single family, transient, multi-family).

Trip-making characteristics are usually divided into three classes: family attributes, family assets, and modal accessibility. "Family attributes" are defined as characteristics like family size that are not a direct result of economic or spatial factors. "Assets" are defined as the economic resources of a family (e.g., income, auto ownership). "Modal accessibility" reports the level of transportation service available to a family and is measured in terms of auto ownership and network characteristics like distance to transit lines or the major street system.

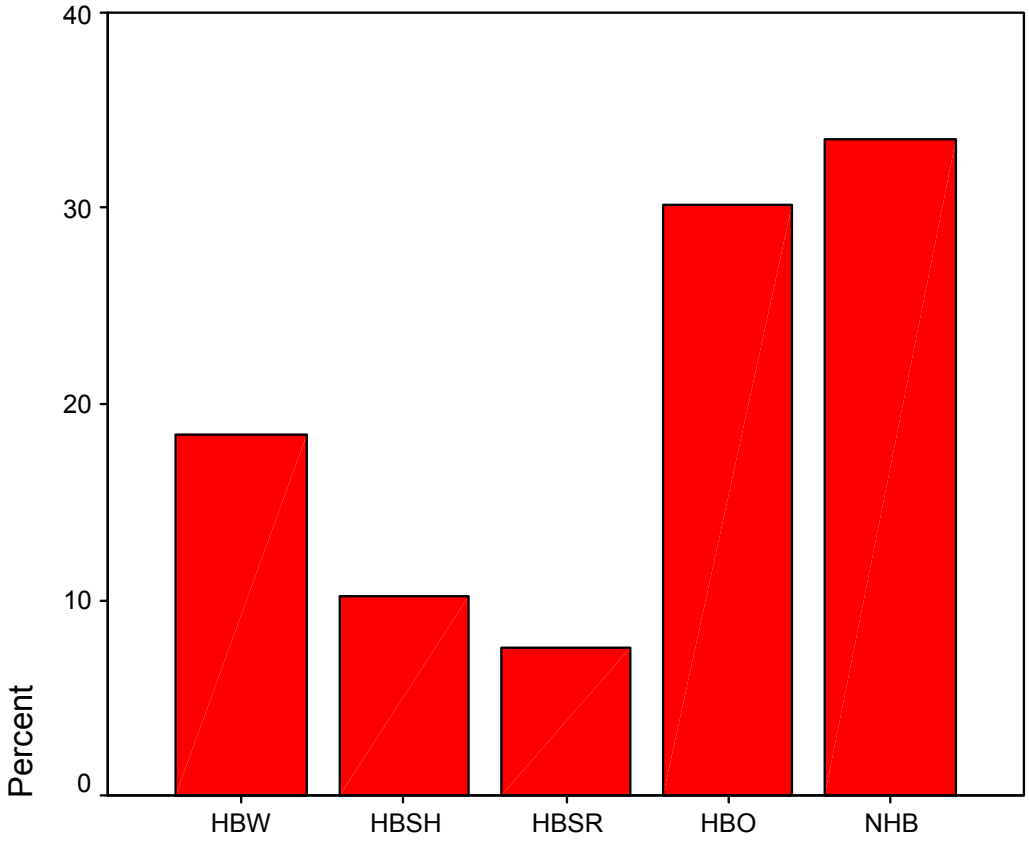
Trip Purpose

Table 5-1 and Figure 5-1 show the FSUTMS trip purpose distribution from the weighted survey trip log database. The Non Home Based (NHB) trip purpose was the largest category (33.6%) for Volusia County. The second largest category was Home Based Other (HBO) trips (30.2%), followed by Home Based Work (HBW) trips (18.5%), Home Based Shopping (HBSH) trips (10.1%), and Home Based Social Recreation (HBSR) trips (7.6%).

Table 5-1
Model Coefficients and Trip Factors
Trip Purpose

Trip Purpose	Survey Trips	Percent	97 Model Trips	Percent
Home Based Work	2,500	18.5%	315,215	20.4%
Home Based Shopping	1,371	10.1%	261,300	16.9%
Home Based Social Recreation	1,025	7.6%	260,241	16.8%
Home Based Other	4,083	30.2%	377,442	24.4%
Non-Home Based	4,541	33.6%	330,261	21.4%
TOTAL	13,381	100.0%	1,544,459	100.0%

Figure 5-1
Model Coefficients and Trip Factors
Trip Purpose



Sample Household Characteristics

Table 5-2 and Figure 5-2 show the dwelling unit distribution of surveyed households who had completed their trip logs. About 80% of respondents live in single-family homes and 20% live in multi-family dwelling units.

Table 5-2
Model Coefficients and Trip Factors
Dwelling Unit Type

Dwelling Unit Type	Households	Percent (%)
Single Family DU	857	78.8
Multi Family DU	231	21.2
Total	1,088	100.0

Figure 5-2
Model Coefficients and Trip Factors
Dwelling Unit Type

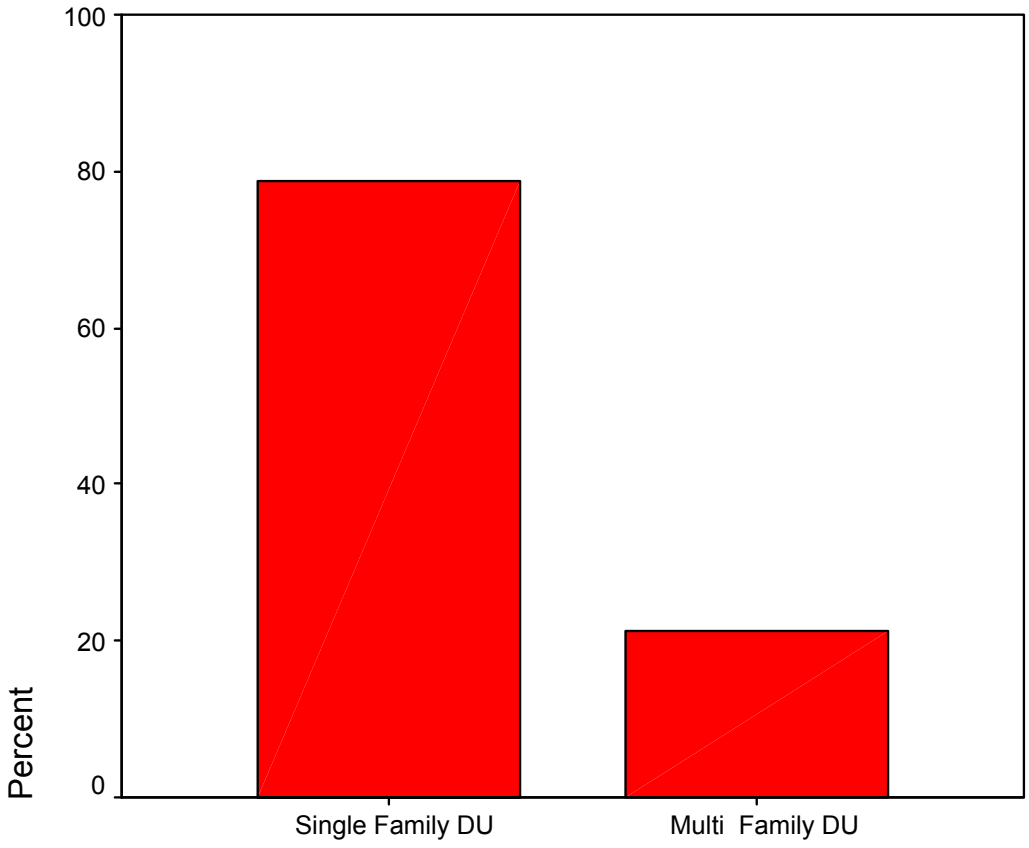
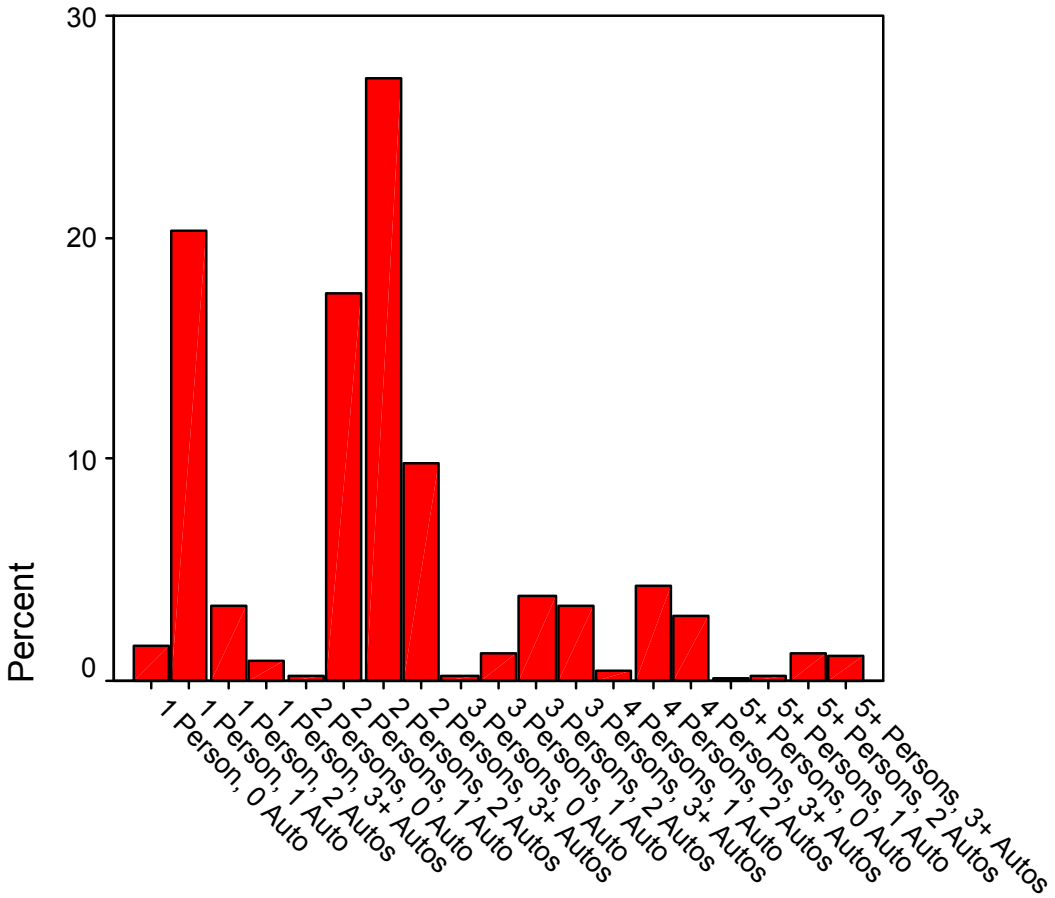


Table 5-3 and Figure 5-3 show the distribution of surveyed households who had completed their trip logs over the cross-classification strata with respect to auto ownership and persons per dwelling unit. The "2 persons and 2 autos" household category was the largest surveyed sample (27.2%). The second largest group was "1 person and 1 auto" household (20.3%). The smallest category were found to be "5+ persons and 0 auto" household (0.1%).

Table 5-3
Model Coefficients and Trip Factors
Sample Households Distribution

Category	Households	Percent (%)
1 Person, 0 Auto	17	1.5
1 Person, 1 Auto	225	20.3
1 Person, 2 Autos	38	3.4
1 Person, 3+ Autos	10	.9
2 Persons, 0 Auto	2	.2
2 Persons, 1 Auto	194	17.5
2 Persons, 2 Autos	301	27.2
2 Persons, 3+ Autos	108	9.8
3 Persons, 0 Auto	2	.2
3 Persons, 1 Auto	14	1.3
3 Persons, 2 Autos	42	3.8
3 Persons, 3+ Autos	38	3.4
4 Persons, 1 Auto	5	.5
4 Persons, 2 Autos	47	4.2
4 Persons, 3+ Autos	33	3.0
5+ Persons, 0 Auto	1	.1
5+ Persons, 1 Auto	3	.3
5+ Persons, 2 Autos	14	1.3
5+ Persons, 3+ Autos	13	1.2
Total	1,107	100.0

Figure 5-3
Model Coefficients and Trip Factors
Sample Households Distribution



Florida's Standard Trip Generation Model Structure
The Current VCUATS Model, which utilizes the standard trip generation model structure, uses the cross-classification technique for calculating trip productions and the trip rate equations for calculating trip attractions. The trip generation model estimates the number of daily person trips produced in, and attracted to, specified zones for each of seven trip purpose categories. These categories include: home based work, home based shopping, home based social/recreation, home based other, non-home based, truck/taxi, and internal/external trips.

Dwelling unit type, trip purpose, auto ownership, and persons per dwelling unit stratify the cross-classification trip rates used in calculating trip production. The strata used for the model are as follows:

- Type of Dwelling Unit (DU):
  a. Single Family Unit
  b. Multi-Family Unit

c. Hotel/Motel Unit

- Trip Purpose:
  a. Home based Work (HBW)
  b. Home based Shopping (HBSH)
  c. Home based Social/Recreation (HBSR)
  d. Home based Other (HBO)
  e. Non-Home based (NHB)
  f. Truck and Taxi (T/T)
  g. Internal-External (I-E)

- Auto Ownership:
  a. 0 Auto per Dwelling Unit
  b. 1 Auto per Dwelling Unit
  c. 2 or more Autos per Dwelling Unit

- Household Size:
  a. 1 Person per Dwelling Unit
  b. 2 Persons per Dwelling Unit
  c. 3 Persons per Dwelling Unit
  d. 4 Persons per Dwelling Unit
  e. 5 or more Persons per Dwelling Unit

For the four home based trip purposes, the cross-classification procedure is used to determine trip production rates. The total number of trips produced for a given zone is determined by applying the appropriate trip generation rate to the number of occupied dwelling units in each classification cell, and then summing the trips for each class of dwelling unit in the zone.

Table 5-4 shows the standard cross-classification rates used in the 1997 VCUATS trip generation model for the four (4) home based trip production types: Home based Work (HBW), Home based Shopping (HBSH), Home based Social/Recreation (HBSR), and Home based Other (HBO).

As non-home-based person trip productions are not a function of households, they are not calculated based on the same independent variables as home-based trip purposes. Rather, the trip generation model first calculates non-home-based trip attractions and assumes that, for each zone, non-home-based productions are equal to attractions. Unlike the first five purposes, which are calculated as person trips, Truck/Taxi and Internal-External trips represent vehicle trips. Table 5-5 shows the 1997 VCUATS model trip attraction equations.

Table 5-4
Model Coefficients and Trip Factors
1997 VCUATS Trip Production Rates

HOMEBASED WORK

Single Family					Multi-Family					Hotel/Motel				
	AUTOS/DU					AUTOS/DU					AUTOS/DU			
		0	1	2+			0	1	2+			0	1	2+
PERS/DU	1	0.52	0.65	1.37	PERS/DU	1	0.20	0.59	1.56	PERS/DU	1	0.33	0.33	0.33
	2	1.04	1.43	2.60		2	0.45	0.85	2.02		2	0.26	0.26	0.26
	3	1.49	1.95	3.19		3	0.72	1.17	2.41		3	0.20	0.20	0.20
	4	1.82	2.28	3.38		4	1.04	1.30	2.67		4	0.13	0.13	0.13
	5	2.02	2.47	3.45		5	1.30	1.43	2.80		5	0.13	0.13	0.13

HOMEBASED SHOPPING

Single Family					Multi-Family					Hotel/Motel				
	AUTOS/DU					AUTOS/DU					AUTOS/DU			
		0	1	2+			0	1	2+			0	1	2+
PERS/DU	1	0.39	1.04	1.17	PERS/DU	1	0.39	0.65	0.85	PERS/DU	1	0.39	0.39	0.39
	2	0.45	1.37	1.63		2	0.45	1.63	1.82		2	1.69	1.69	1.69
	3	0.52	1.56	1.89		3	0.52	1.95	2.15		3	2.60	2.60	2.60
	4	0.59	1.69	2.08		4	0.59	2.15	2.41		4	3.25	3.25	3.25
	5	0.59	1.69	2.21		5	0.59	2.21	2.54		5	3.77	3.77	3.77

HOMEBASED SOCIAL/RECREATION

Single Family					Multi-Family					Hotel/Motel				
	AUTOS/DU					AUTOS/DU					AUTOS/DU			
		0	1	2+			0	1	2+			0	1	2+
PERS/DU	1	0.26	0.85	1.11	PERS/DU	1	0.39	0.85	0.98	PERS/DU	1	0.78	0.78	0.78
	2	0.33	1.11	1.37		2	0.45	1.37	1.56		2	2.15	2.15	2.15
	3	0.39	1.43	1.69		3	0.52	1.89	2.15		3	3.51	3.51	3.51
	4	0.52	1.76	2.15		4	0.59	2.47	2.86		4	5.07	5.07	5.07
	5	0.59	2.21	2.73		5	0.72	3.45	3.97		5	7.67	7.67	7.67

HOMEBASED OTHER

Single Family					Multi-Family					Hotel/Motel				
	AUTOS/DU					AUTOS/DU					AUTOS/DU			
		0	1	2+			0	1	2+			0	1	2+
PERS/DU	1	0.26	0.78	0.91	PERS/DU	1	0.33	1.04	1.23	PERS/DU	1	0.65	0.65	0.65
	2	0.39	1.43	1.56		2	0.59	1.56	1.95		2	1.56	1.56	1.56
	3	0.72	2.41	2.86		3	0.91	2.08	2.99		3	2.73	2.73	2.73
	4	1.30	3.58	4.62		4	1.43	2.73	4.42		4	4.29	4.29	4.29
	5	2.08	5.14	6.96		5	2.21	3.90	6.05		5	5.72	5.72	5.72

Table 5-5
Model Coefficients and Trip Factors
1997 VCUATS Trip Attraction Equations

Trip Purpose	Rate	Independent Variable
Home-based Work Trip	= 1.80	* Total Employment
Home-based Shopping Trip	= 6.10	* Commercial Employment
Home-based Social/Recreation Trip	= 0.50 1.50 1.50	* Total Dwelling Units + * Commercial Employment + * Service Employment
Home-based Other Trip	= 0.20 1.30 1.30 1.30	* Total Dwelling Units + * Commercial Employment + * Service Employment + * School Enrollment
Non-home based Trip	= 0.30 2.90 1.40	* Total Dwelling Units + * Commercial Employment + * Service Employment
Truck and Taxi (T/T) Trip	= 0.30 0.45	* Dwelling Units + * Total Employment
I-E Attractions for Each Zone *Where: R =*	= Total I-E Productions * (R) $\frac{\text{Total Zonal Internal Trip Attractions}}{\text{Total Study Area Trip Attraction}}$	

Dwelling Unit Trip Production Rates

The total number of home-based trips produced for a given zone is determined by applying the appropriate trip production rate to the number of occupied dwelling units in each classification and summing the trips for all classes of dwelling units in the zone.

A new category of auto ownership (3 or more autos) was added to reflect the additional mobility of high auto ownership households, as evidenced in the survey and Census 2000. According to U.S. Census 2000, about 13% households have 3 or more autos in Volusia County. Therefore it would be recommended to include a 3 or more autos category in trip generation model to better reflect trip-making behavior of high auto ownership households. Auto ownership categories are as follows:

- 0 Auto per Dwelling Unit (A0)
- 1 Auto per Dwelling Unit (A1)
- 2 Autos per Dwelling Unit (A2)
- 3 or more Autos per Dwelling Unit (A3)

Table 5-6 and Table 5-7 shows the number of samples in each strata used for the trip generation rate analysis (trip purpose, auto ownership, and persons per dwelling unit) for single-family dwelling units and multi-family dwelling units respectably. As shown in Table 5-7, there are not enough samples to analyze the trip production rates for multi-family dwelling units. More than 80% of strata have either no sample or less than ten samples. Therefore new trip production rates for multi-family dwelling units could not be recommended and that the current trip generation rates be used for these categories.

Table 5-8 shows new cross-classification trip production rates for single-family dwelling units only. These rates are estimated based on a statistical analysis on the data collected from the Volusia County household travel characteristics survey and are graphically presented in Figure 5-4.

Figure 5-5 through Figure 5-8 show the statistical confidence intervals for the estimated average trip production rates at 95 % significance level for each trip purpose. In Figure 5-9, the new estimated trip production rates were compared to the currently used trip production rates in the 1997 validated VCUATS model. It was found that overall trip production rates are a bit lower than 1997 model rates except zero car households. As a result these new trip rates will reduce the number of trips generated in Volusia County. However, the validity and reasonableness of a travel demand model need to be checked not only by trip generation model alone but other model components as well. An example would be the trip length in the trip distribution model and the auto occupancy rates in the mode choice model.

Table 5-6
Model Coefficients and Trip Factors
Sample Size for Single Family Dwelling Units

Person/DU	Auto Ownership				Total
	0 Car	1 Car	2 Car	3+ Car	
1 Person	5	147	35	7	194
2 Persons	0	125	248	97	470
3 Persons	1	9	38	35	83
4 Persons	0	5	42	32	79
5+ Persons	1	3	14	13	31
Total	7	289	377	184	857

Table 5-7
Model Coefficients and Trip Factors
Sample Size for Multi-Family Dwelling Units

Person/DU	Auto Ownership				Total
	0 Car	1 Car	2 Car	3+ Car	
1 Person	5	76	3	3	87
2 Persons	0	67	50	11	128
3 Persons	0	5	3	3	11
4 Persons	0	0	4	1	5
5+ Persons	0	0	0	0	0
Total	5	148	60	18	231

Table 5-8
Model Coefficients and Trip Factors
New Trip Production Rates for Single Family Dwelling Units

Trip Purpose	Person/DU	Auto Ownership			
		0 Car	1 Car	2 Car	3+ Car
HBW	1 Person	0.36	0.56	0.84	1.43
	2 Persons	0.57	0.91	1.42	1.92
	3 Persons	0.63	1.35	1.74	2.40
	4 Persons	1.26	1.81	2.29	2.99
	5+ Persons	1.95	2.38	2.90	3.35
HBSH	1 Person	0.23	0.39	0.64	0.88
	2 Persons	0.51	0.62	1.22	1.68
	3 Persons	0.85	1.08	1.56	2.07
	4 Persons	1.05	1.56	1.99	2.48
	5+ Persons	1.43	2.09	2.59	2.94
HBSR	1 Person	0.18	0.30	0.50	0.69
	2 Persons	0.36	0.49	0.96	1.32
	3 Persons	0.59	0.85	1.37	1.88
	4 Persons	0.73	1.23	1.56	1.95
	5+ Persons	1.12	1.87	2.03	2.24
HBO	1 Person	0.58	1.16	1.24	1.48
	2 Persons	1.04	2.07	2.36	2.58
	3 Persons	1.45	2.90	3.16	3.24
	4 Persons	1.72	3.44	4.05	4.24
	5+ Persons	1.95	3.89	4.52	5.03
TOTAL	1 Person	1.35	2.41	3.22	4.48
	2 Persons	2.48	4.09	5.96	7.50
	3 Persons	3.52	6.18	7.83	9.59
	4 Persons	4.76	8.04	9.89	11.66
	5+ Persons	6.45	10.23	12.04	13.56

Figure 5-4
Model Coefficients and Trip Factors
New Trip Production Rates (Standard FSUTMS Model)

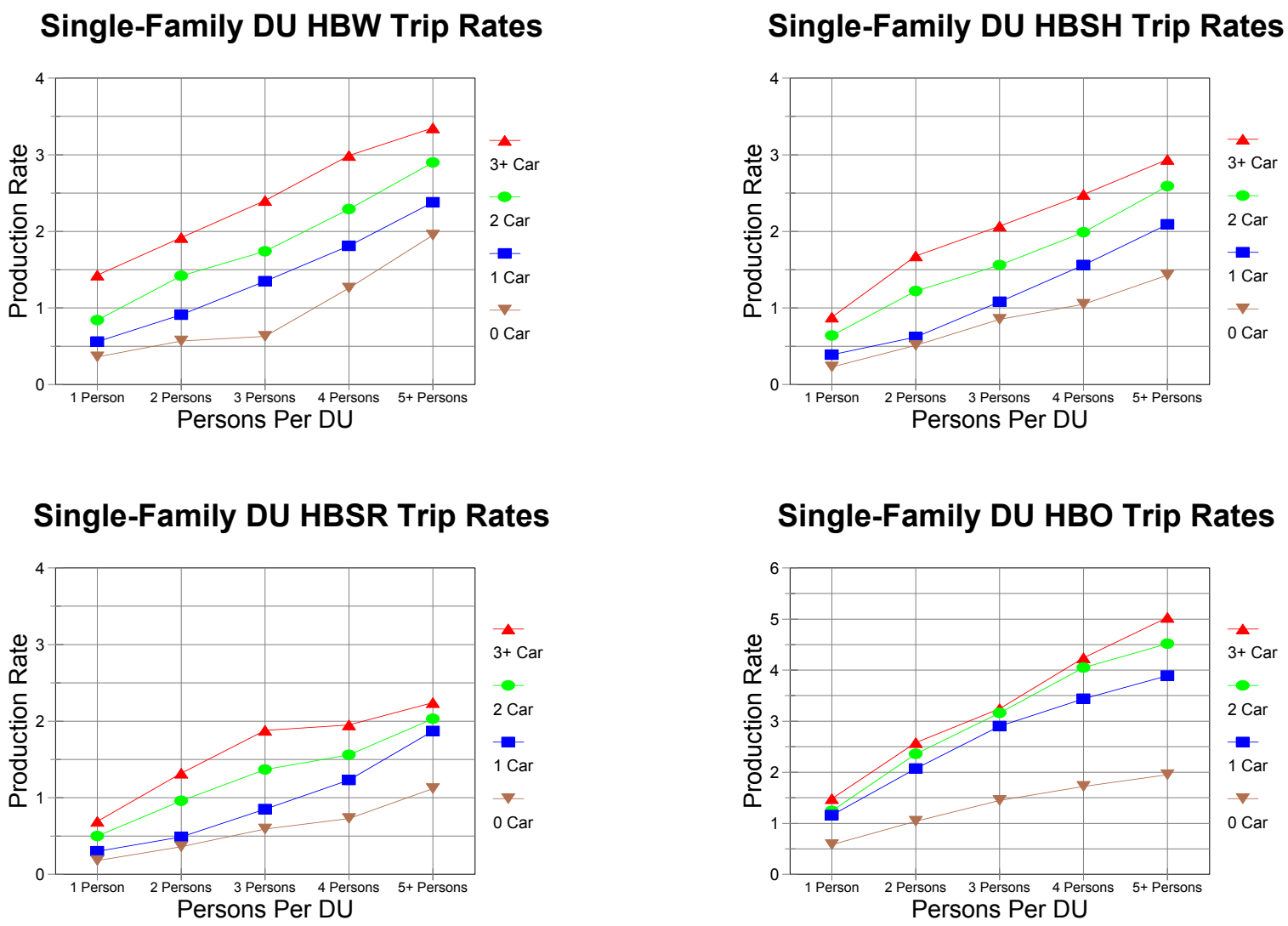


Figure 5-5
Model Coefficients and Trip Factors
Confidence Intervals of Trip Rates for 0 Car Household

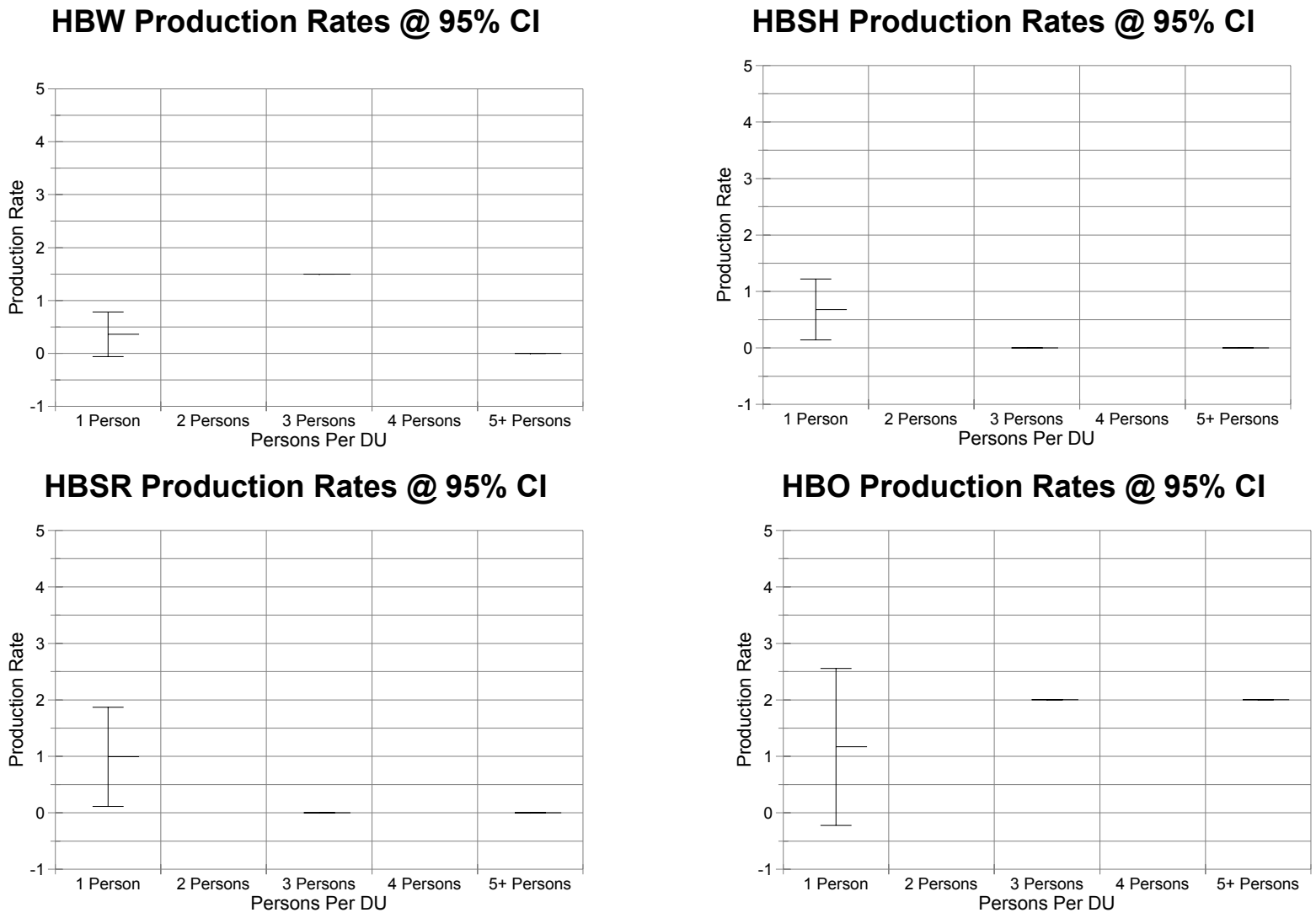


Figure 5-6
Model Coefficients and Trip Factors
Confidence Intervals of Trip Rates for 1 Car Household

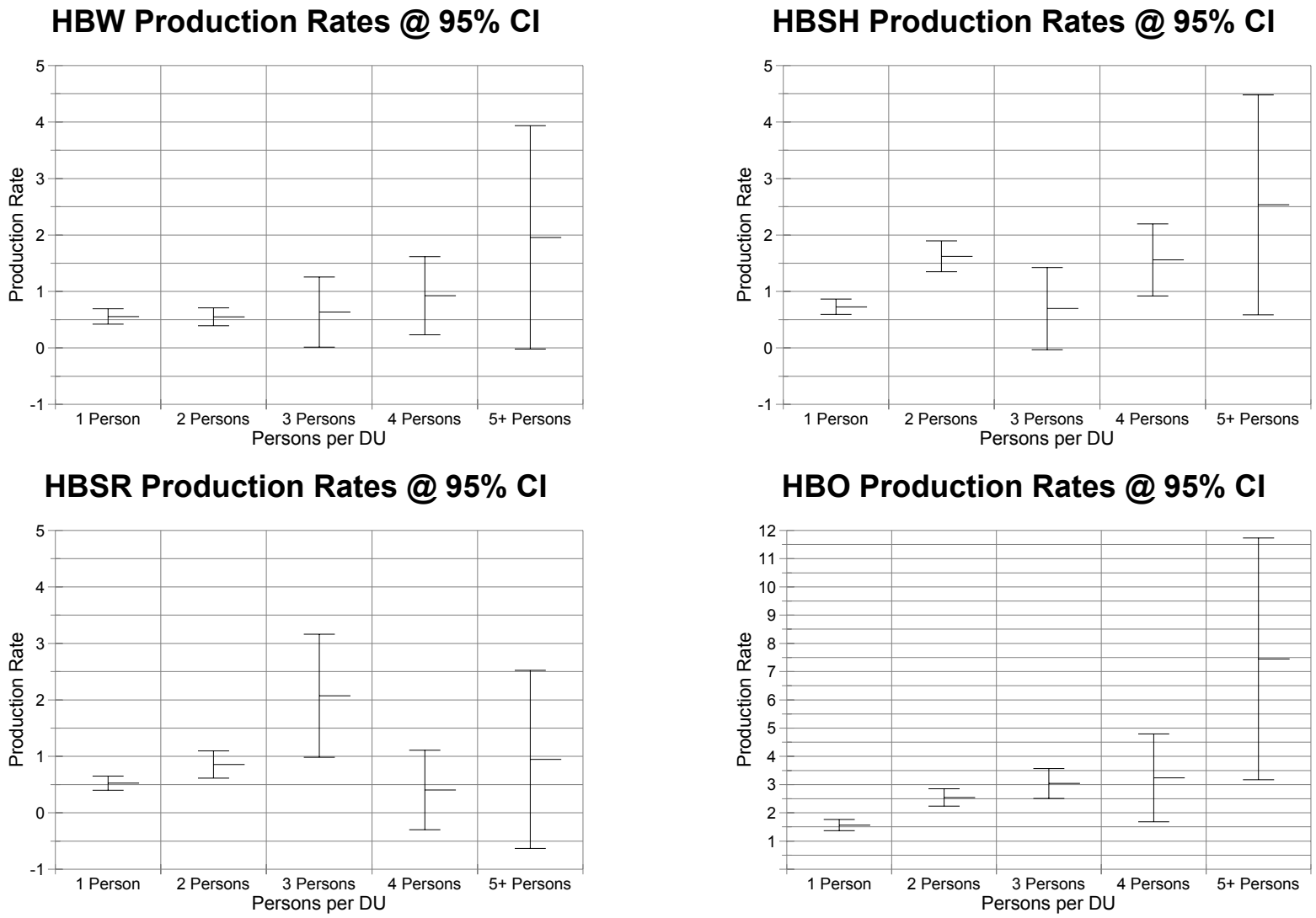


Figure 5-7
Model Coefficients and Trip Factors
Confidence Intervals of Trip Rates for 2 Car Household

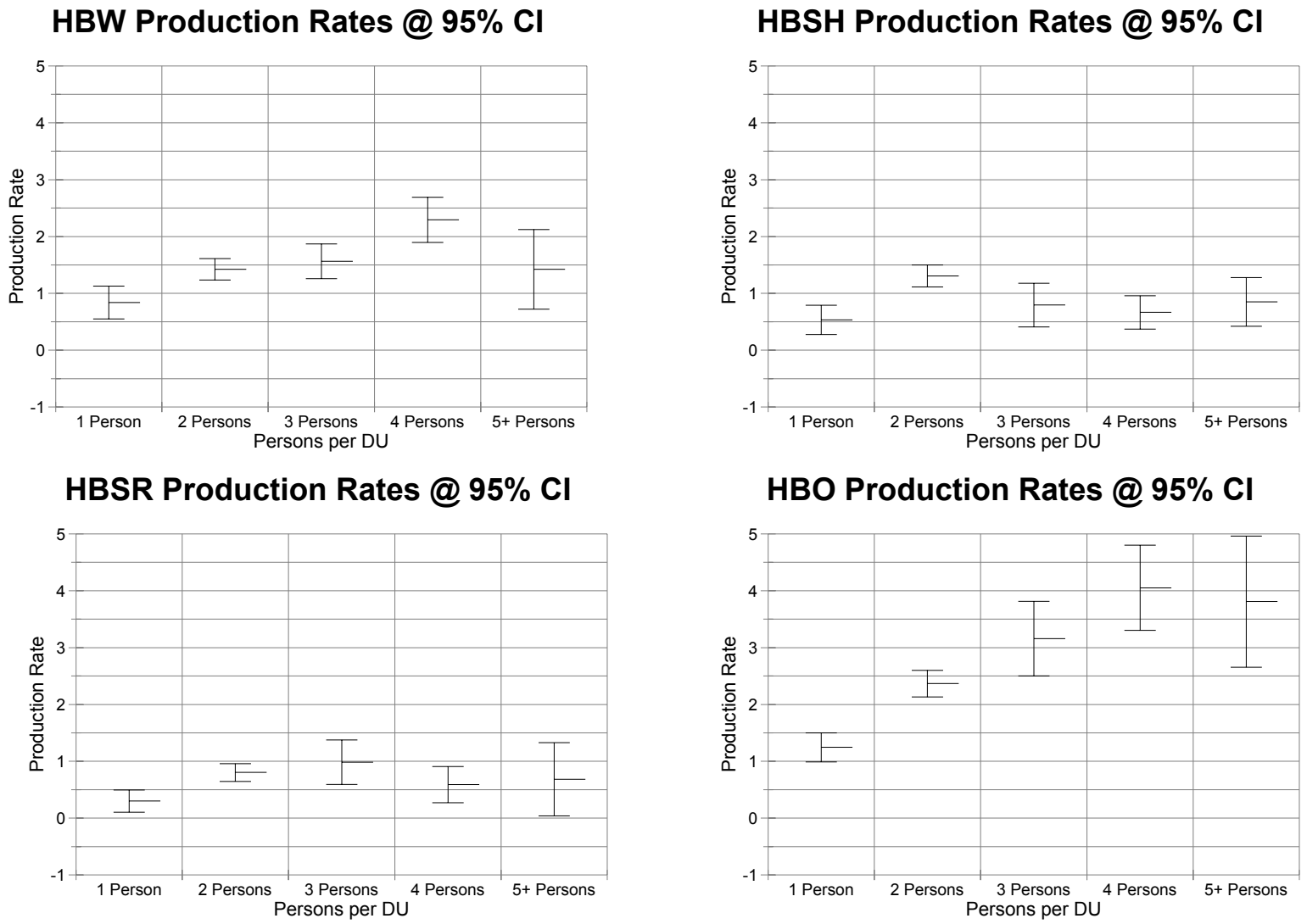


Figure 5-8
Model Coefficients and Trip Factors
Confidence Intervals of Trip Rates for 3+ Car Household

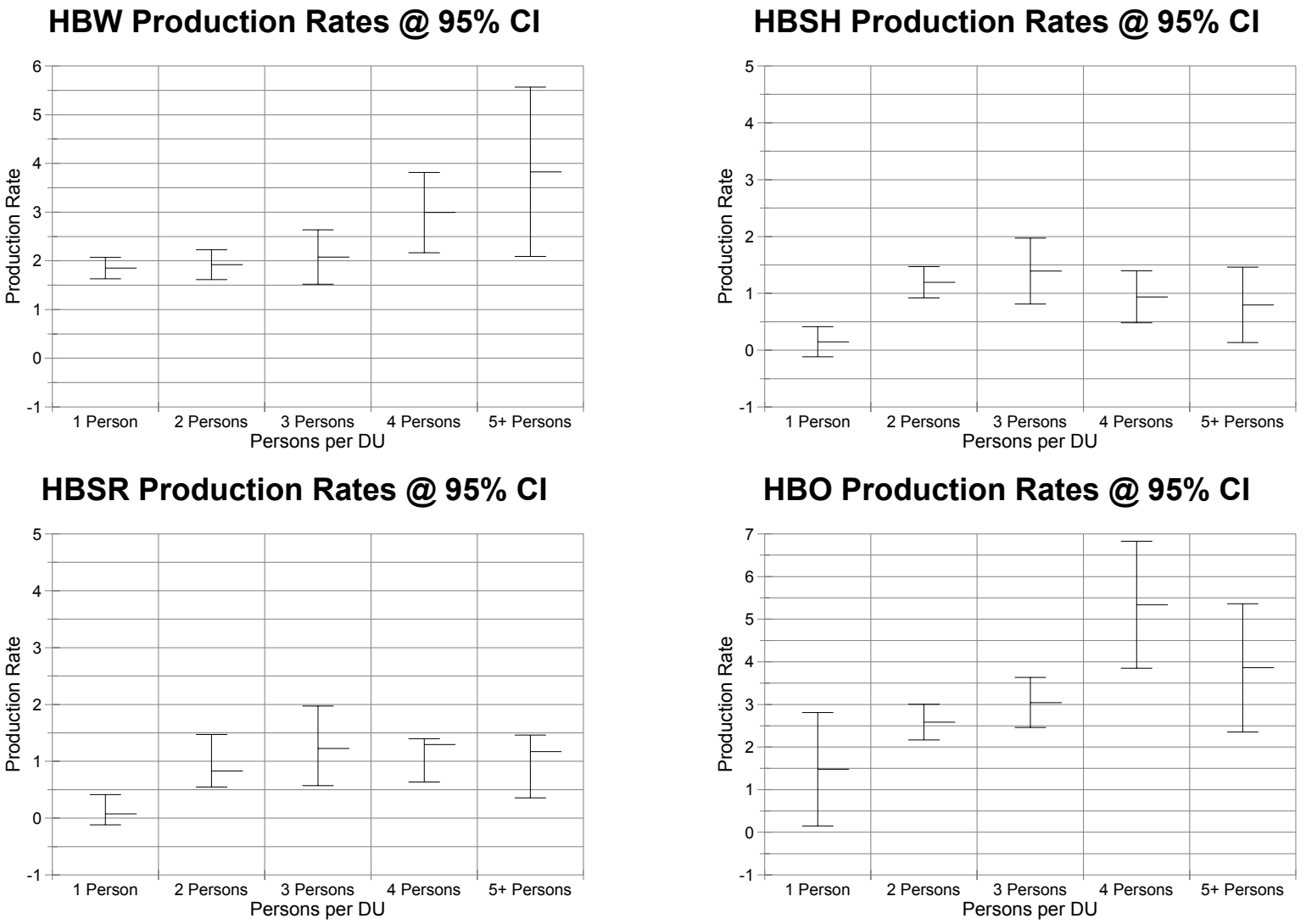
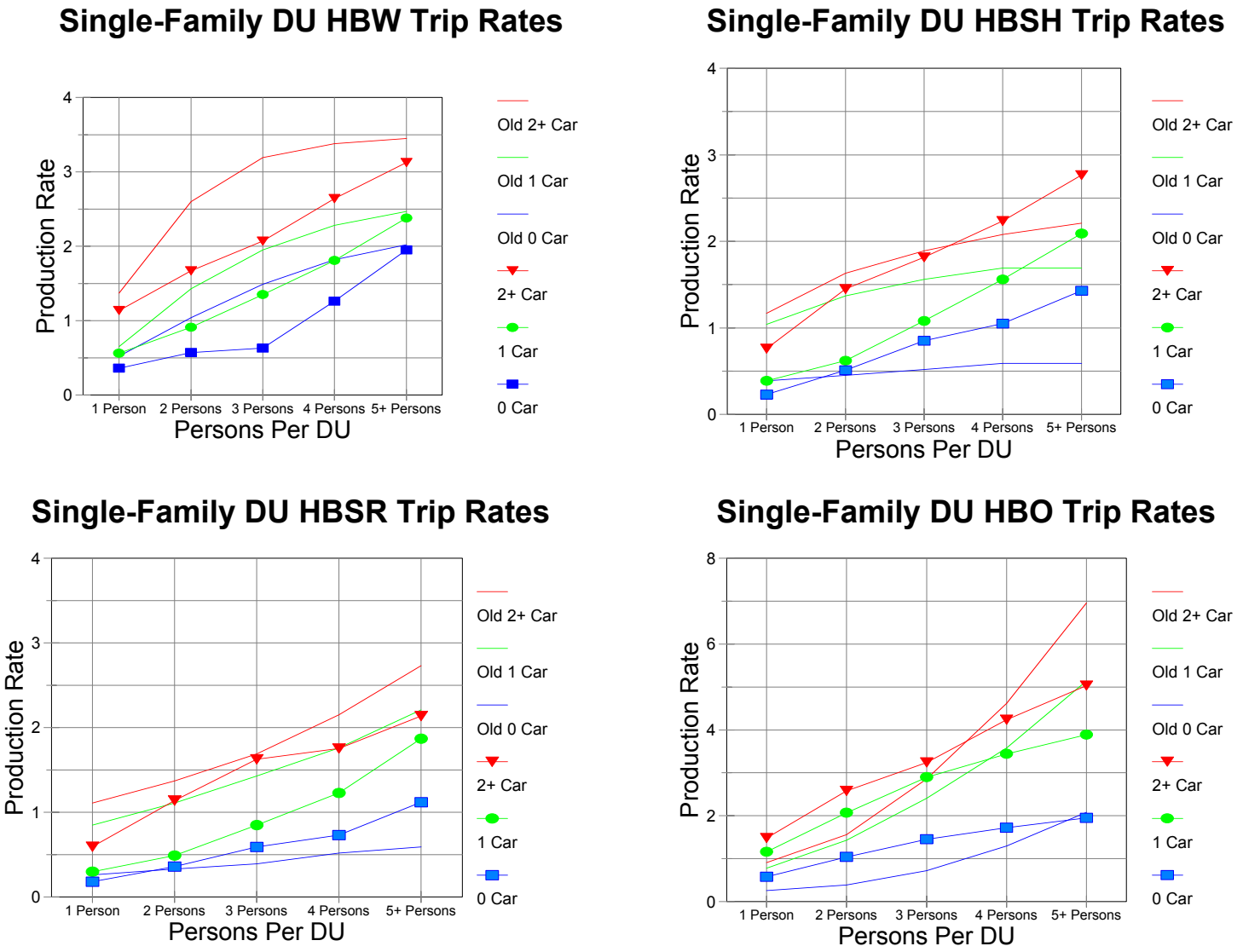


Figure 5-9
Model Coefficients and Trip Factors
New Trip Production Rates (Comparison with Current Rates)



Lifestyle Model

Users of the standard FSUTMS trip generation model had previously recognized that some of the characteristics of Florida, such as a large proportion of retired persons, were not considered in the model. As a result, the standard trip generation model would often over-estimate the number of work trips for these households while under-estimating trips for other purposes. This enhancement better reflects the demographic character of Volusia County where there are a significant proportion of retired households.

Volusia County household travel characteristics survey data were compiled and analyzed to support the review of almost every aspect of the trip generation model. Nationally recognized for its innovation, the lifestyles model was developed from the Volusia County household survey data.

All occupied dwelling units have been classified into three categories based upon lifestyle characteristics of residents in Volusia County:

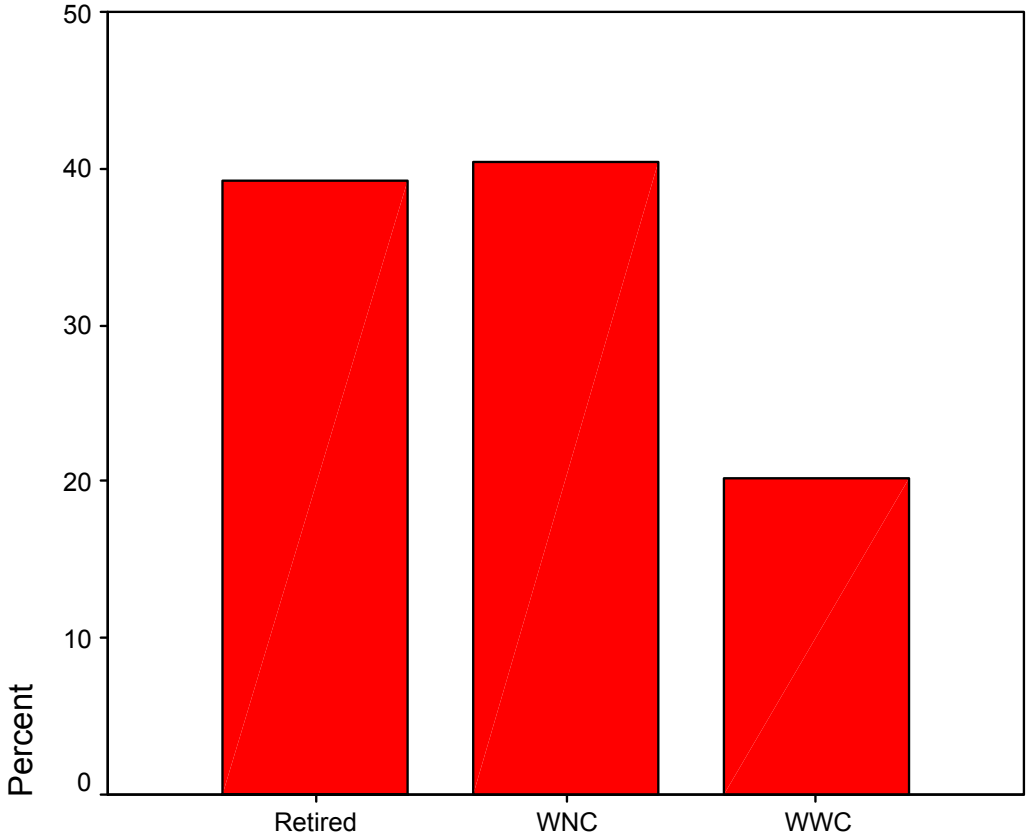
- **Retired Households:** Households that include at least one retired household member and no full-time employed household members.
- **Working Households with No Children:** Households, other than retired households, with no household members under the age of 16.
- **Working Households with Children:** Households, other than retired households, with at least one household member under the age of 16.

Table 5-9 and Figure 5-10 show the lifestyle distribution of weighted survey households who had completed their trip logs. About 40% of the households surveyed are retired household (39.3%). 40.3% of surveyed households are working households with no children and the remaining 20.3% are working households with children.

Table 5-9
Model Coefficients and Trip Factors
Lifestyle Sample Distribution

Lifestyle	Households	Percent (%)
Retired HH	418	39.3
Working HH without Children	430	40.4
Working HH with Children	216	20.3
Total	1,064	100.0

Figure 5-10
Model Coefficients and Trip Factors
Lifestyle Sample Distribution



Retired: Retired Households
WNC: Working Households with No Children
WWC: Working Households with Children

Table 5-10 and Figure 5-11 show the distribution of surveyed households who had completed their trip logs over the cross-classification strata with respect to auto ownership and lifestyle. A "retired and 1 car" household was the largest surveyed sample (19.0%). The second largest category was " Working Households with No Children and 2 cars" household (17.7%). The smallest category was "Working Households with Children and 0 car" household (0.1%).

Table 5-10
Model Coefficients and Trip Factors
Distribution of Surveyed Households

Lifestyle/Auto Ownership		Household	Percent (%)
Retired	0 Car	8	0.8
	1 Car	202	19.0
	2 Car	142	13.4
	3+ Car	65	6.1
No Child Working	0 Car	17	1.6
	1 Car	118	11.1
	2 Car	188	17.7
	3+ Car	108	10.1
With Child Working	0 Car	1	0.1
	1 Car	45	4.2
	2 Car	113	10.6
	3+ Car	56	5.2
Total		1,064	100.0

Figure 5-11
Model Coefficients and Trip Factors
Distribution of Surveyed Households

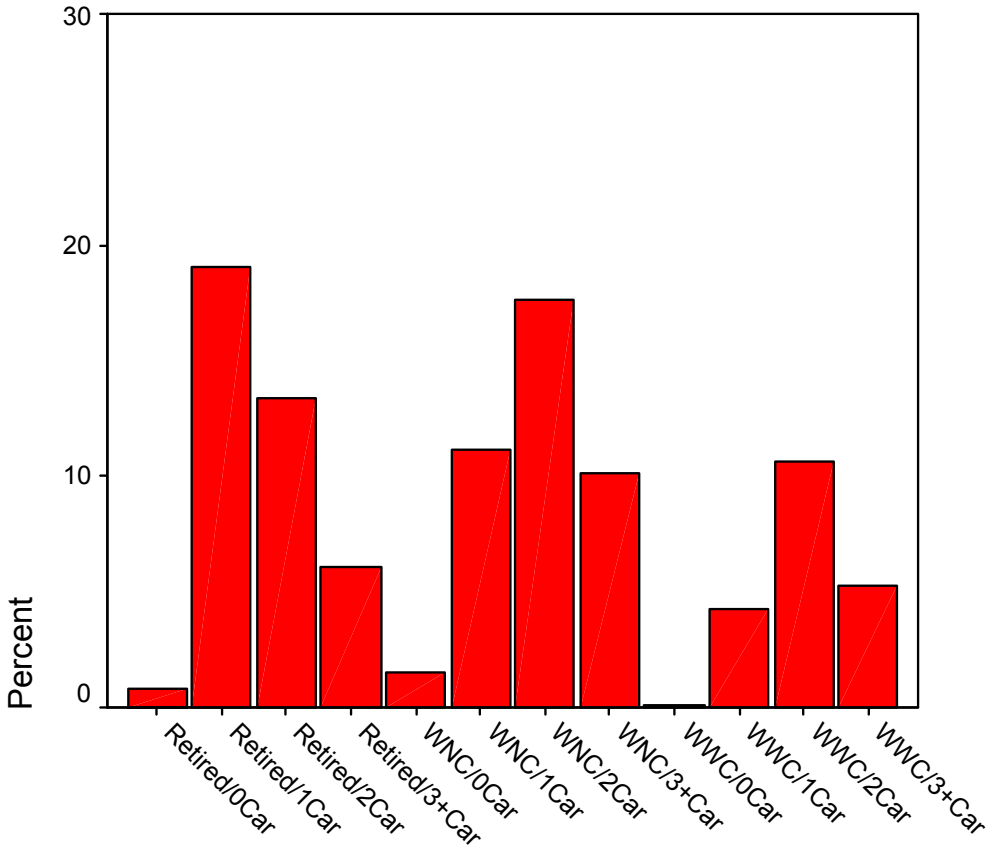


Table 5-11 shows the new recommended cross-classification trip production rates for a lifestyle model. These rates are based on a statistical analysis of the data collected from the household travel survey and are graphically presented in Figure 5-12.

Figure 5-13 through Figure 5-15 show the statistical confidence intervals for the estimated average trip production rates at 95 % significance level for each trip purpose. In Figure 5-16, the new estimated lifestyle model trip production rates were compared to the trip production rates used in 1999 TBRPM (Tampa Bay Regional Planning Model) lifestyle model.

Table 5-11
Model Coefficients and Trip Factors
Recommended Life Style Model Trip Production Rates

Trip Purpose	Auto Ownership	Permanent Resident Households		
		Retired	Working with No Children	Working with Children
Home-Based Work	0	0.07	0.59	0.45
	1	0.14	1.34	1.32
	2	0.35	1.85	1.72
	3+	1.03	2.44	2.07
Home-Based Shopping	0	1.21	0.32	0.63
	1	1.67	0.57	1.11
	2	2.25	0.70	1.72
	3+	2.58	1.06	2.07
Home-Based Social/ Recreation	0	0.07	0.05	0.07
	1	1.08	0.31	0.44
	2	1.56	0.40	0.82
	3+	1.88	0.45	0.93
Home-Based Other	0	1.84	1.36	2.00
	1	2.35	1.43	3.51
	2	2.50	1.56	3.87
	3+	3.01	2.19	4.12

The Volusia County Household Travel Survey strongly indicated that other variables may be more statistically significant in determining trip production rates by purpose than used in traditional FSUTMS variables (dwelling unit type, household size and number of available vehicles). An extensive investigation was conducted to determine which independent variables were most important for predicting trip productions in the region.

The investigation examined such variables as employment status, age of householders, income, traditional dwelling unit type, household size and number of available vehicles. The survey particularly indicated lifestyle as an important factor. This investigation revealed that trip production in the Volusia County could best be predicted using a cross classification model based on two variables: lifestyle and number of vehicles available. The lifestyle model better reflects the demographic character of Volusia County where there are a significant proportion of retired households.

For the lifestyle variables to be usable in the models, it is essential they be derived from data that is readily obtainable from reliable sources, particularly the U.S. Census data. The lifestyles defined above do not directly correspond with information included in the Census. However these variables could be approximated using available Census data as follows:

- Retired Households: Households in which the householder is age 65 or over.
- Working with Children Households: Households in which the householder was under age 65 and at least one household member is age 17 or under.
- Working with No Children Households: Households in which the householder was under age 65 and no member of household are age 17 or under.

Figure 5-12
Model Coefficients and Trip Factors
New Trip Production Rates (Lifestyle Model)

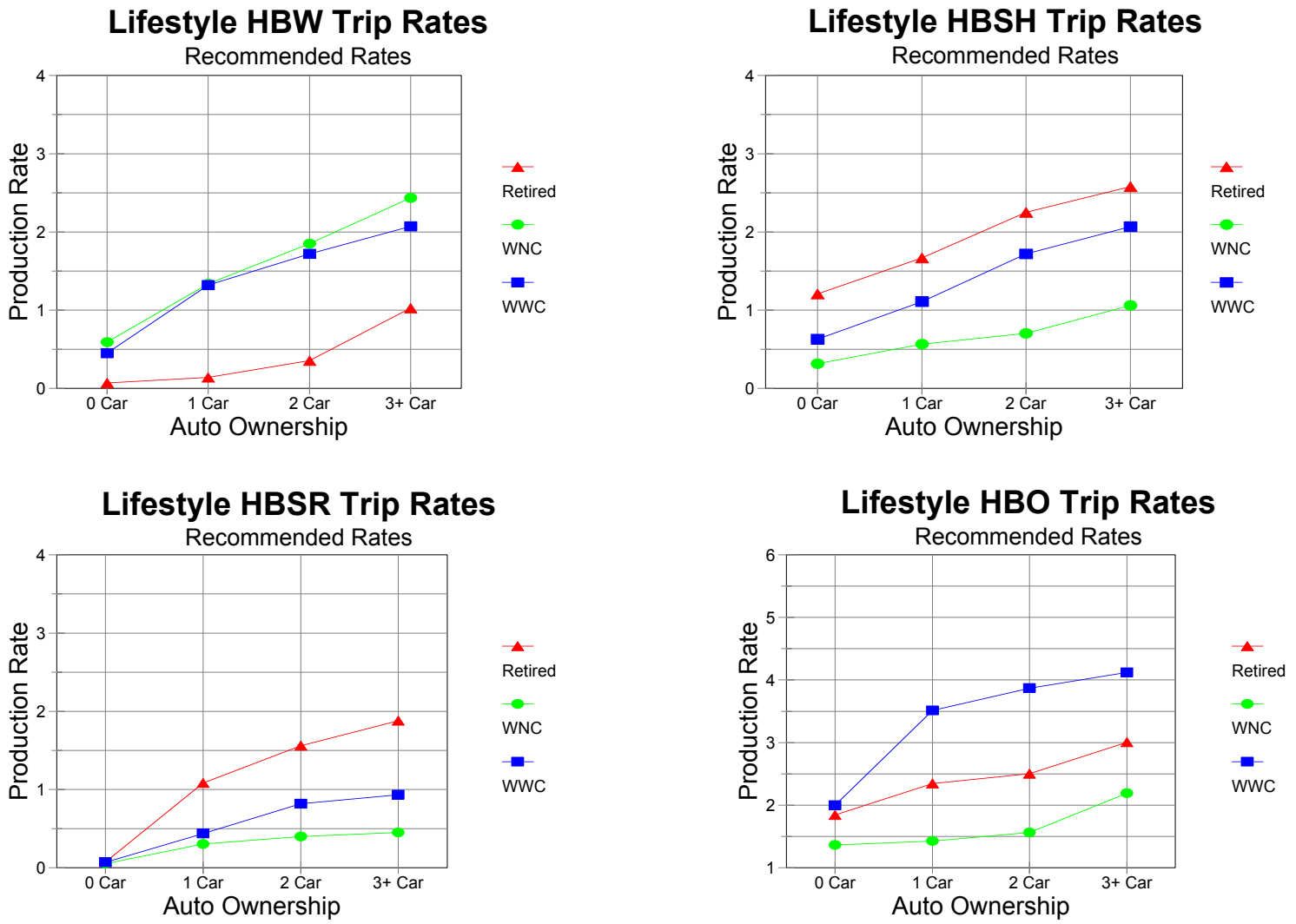


Figure 5-13
Model Coefficients and Trip Factors
Confidence Intervals of Trip Rates for Retired Household

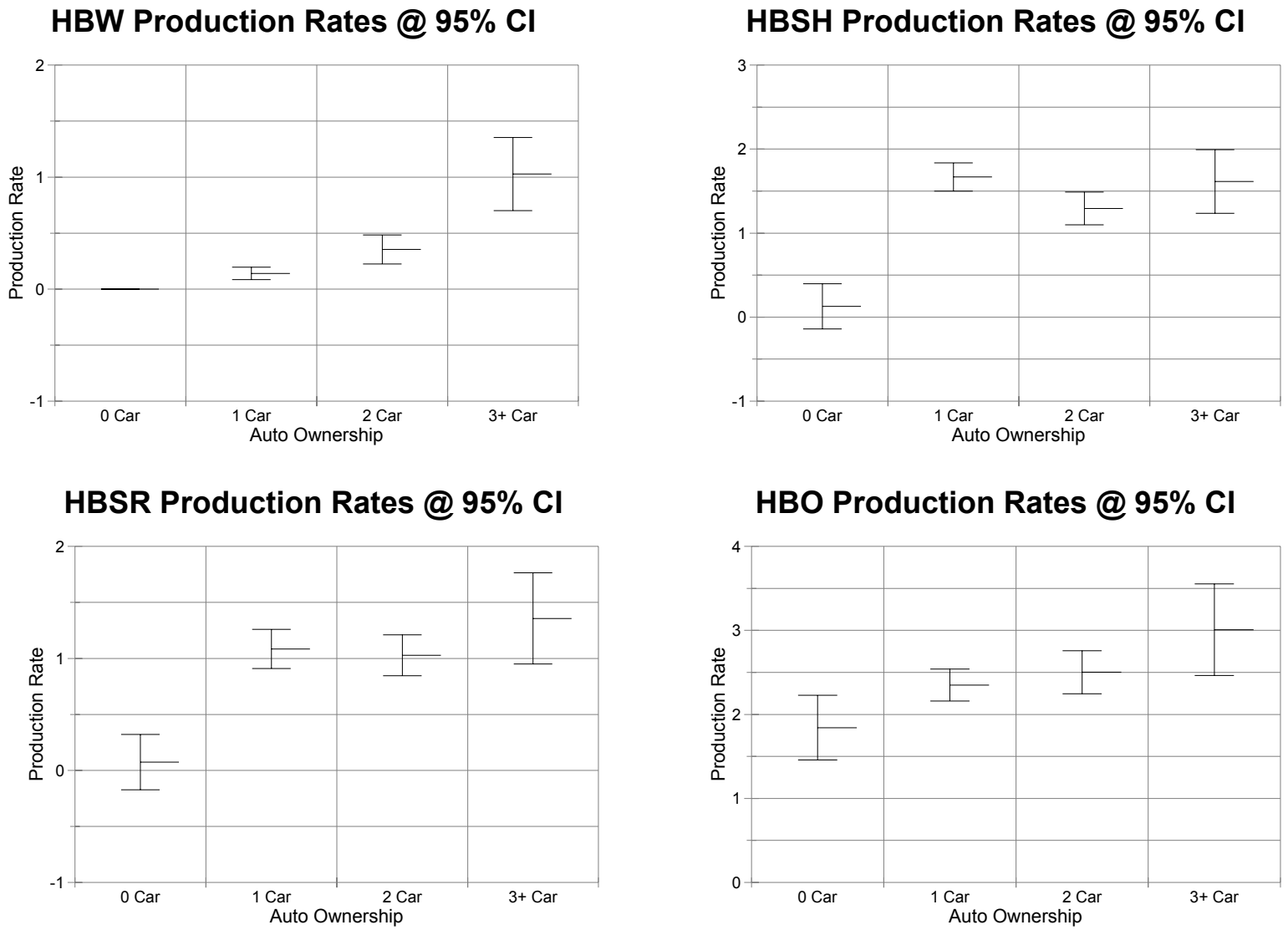


Figure 5-14
Model Coefficients and Trip Factors
Confidence Intervals of Trip Rates for Working Households with No Children (WNC)

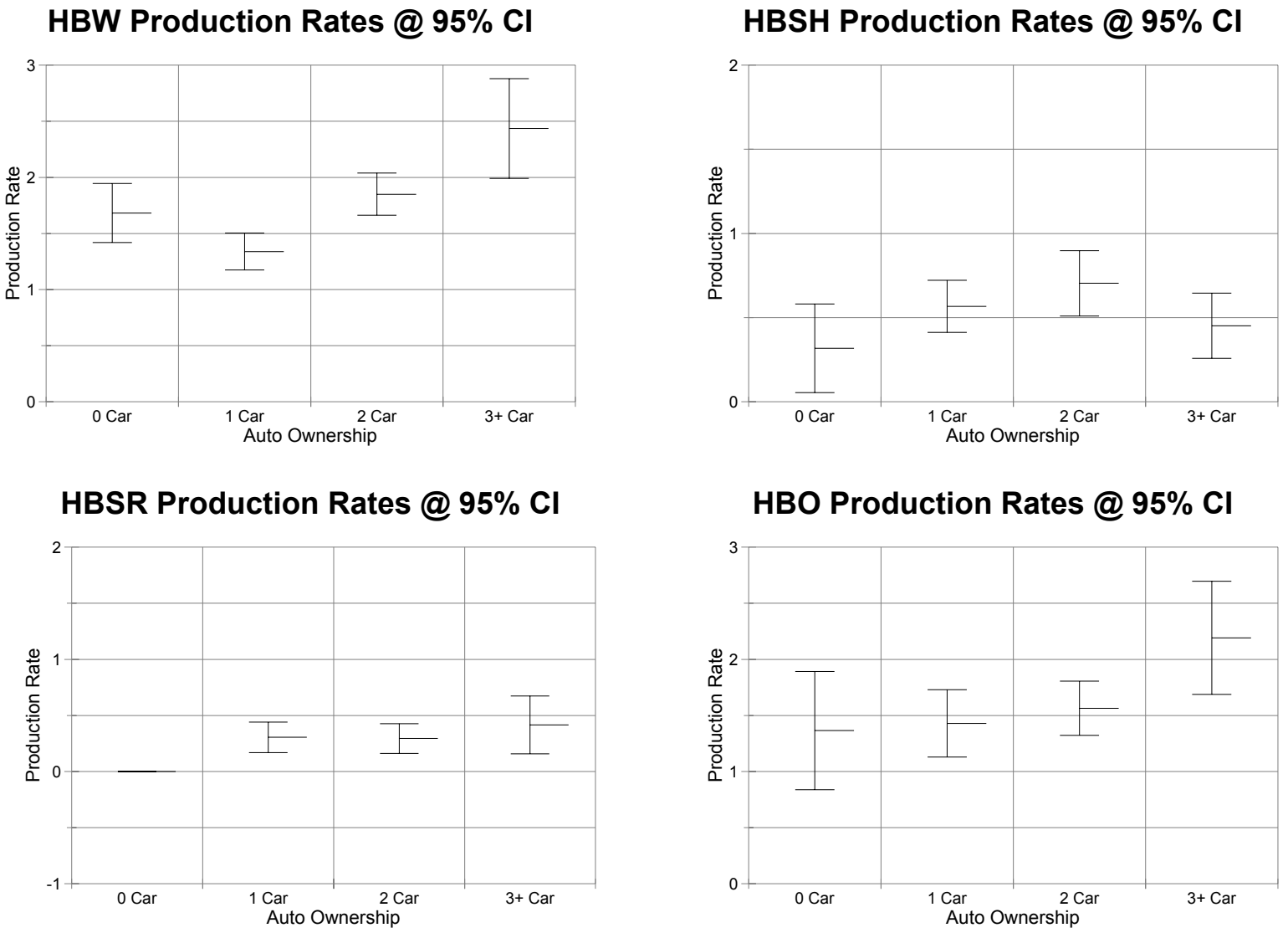


Figure 5-15
Model Coefficients and Trip Factors
Confidence Intervals of Trip Rates for Working Households with Children (WWC)

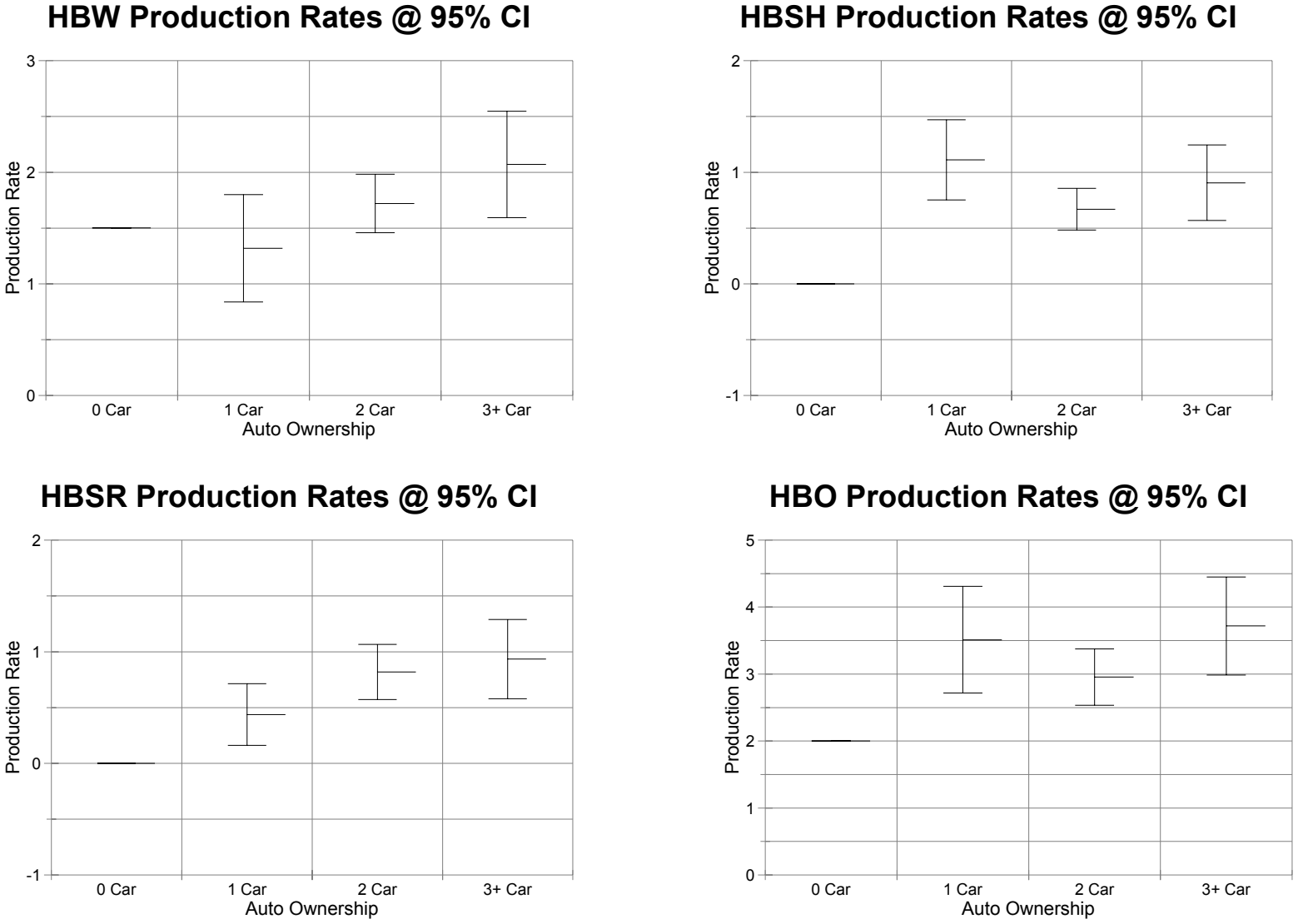
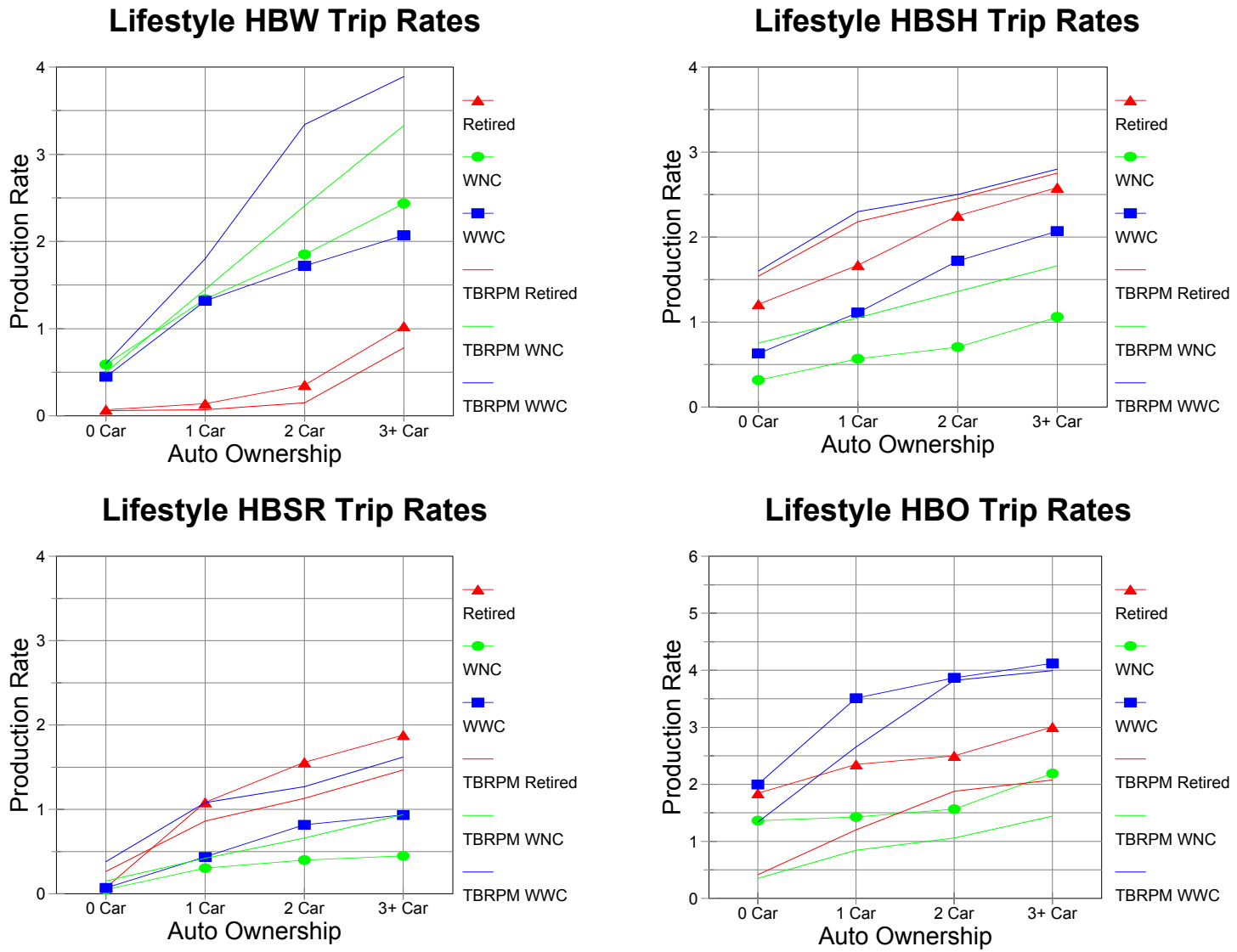


Figure 5-16
Model Coefficients and Trip Factors
New Trip Production Rates (Comparison with TBRPM Model)



Trip Distribution Friction Factors

Trip distribution is the matching of trip productions with trip attractions. In FSUTMS this is accomplished through the use of a gravity model. The gravity model is based upon the concept that the desirability of traveling to a particular zone is directly related to the amount of activity in each potential destination zone, and inversely related to the perceived spatial separation (the highway impedance) between the production and the attraction zones. This spatial separation is measured in terms of travel time.

In FSUTMS trip distribution model, the inverse relationship to highway impedance is expressed by *"friction factors"* and is assumed to be nonlinear. The friction factor is an exponent of highway impedance (travel time) analogous to the square of the distance that appears in the Newtonian gravity equation.

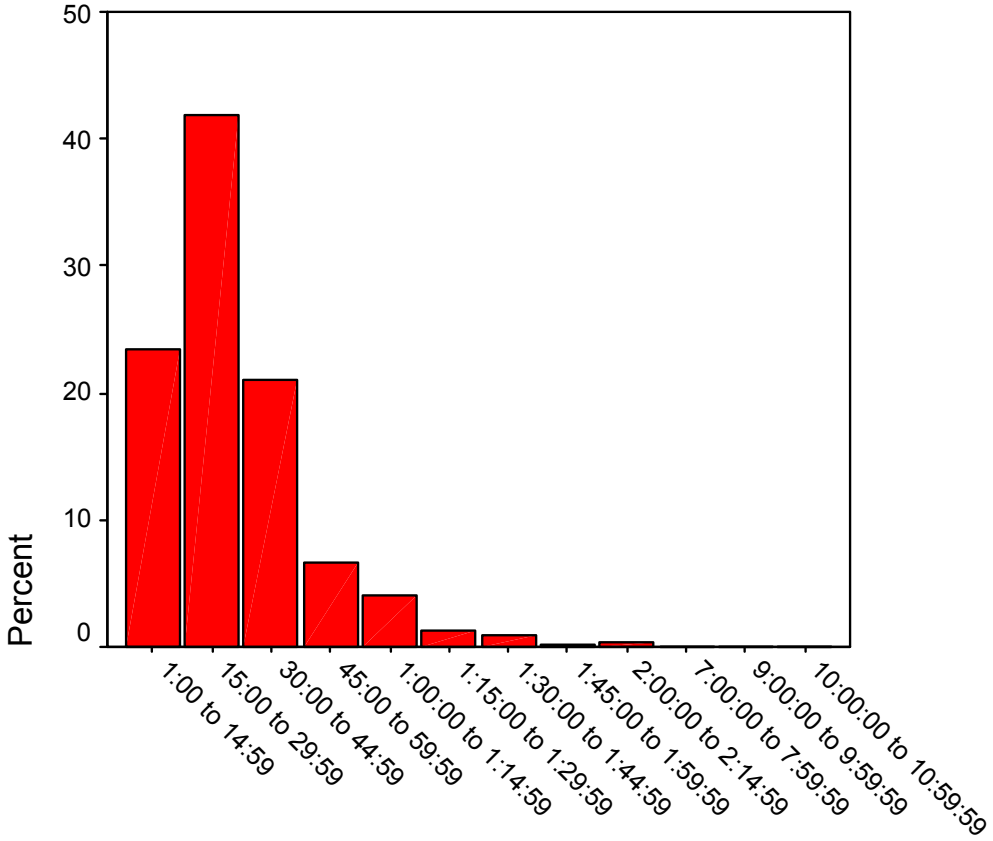
Trip Length Frequency Distribution: Home Based Work Trips

As shown in Table 5-12 and Figure 5-17, the reported travel time of 15 – 30 minutes was the most common trip length for Home Based Work trips (41.7%), followed by 1 – 15 minutes (6.9%). The average reported travel time of 25.42 minutes is in line with the levels experienced in most household travel characteristics surveys in urban areas. According to the U.S. Census 2000, the mean travel time to work in Volusia County is 25.4 minutes (Table 5-DP-3 of U.S. Census 2000).

Table 5-12
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Work Trips

Travel Time	Trips	Percent (%)
1:00 to 14:59	465	23.5
15:00 to 29:59	827	41.8
30:00 to 44:59	417	21.1
45:00 to 59:59	131	6.6
1:00:00 to 1:14:59	82	4.1
1:15:00 to 1:29:59	27	1.4
1:30:00 to 1:44:59	17	.9
1:45:00 to 1:59:59	2	.1
2:00:00 to 2:14:59	7	.4
7:00:00 to 7:59:59	1	.1
9:00:00 to 9:59:59	1	.1
10:00:00 to 10:59:59	1	.1
Total	1,978	100.0

Figure 5-17
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Work Trips



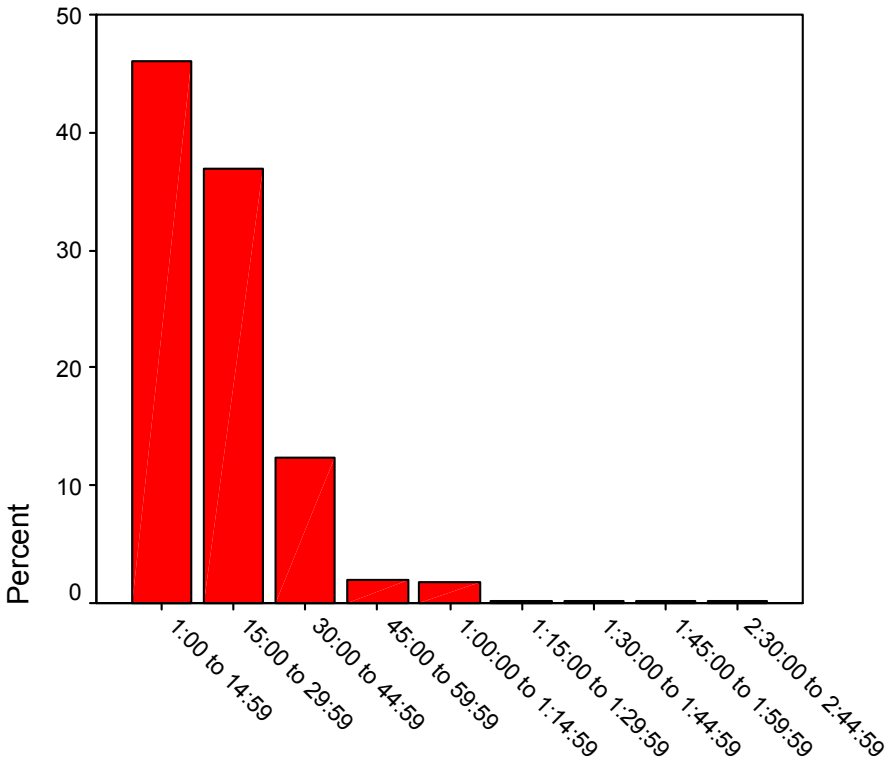
Trip Length Frequency Distribution: Home Based Shopping Trips

As shown in Table 5-13 and Figure 5-18, the reported travel time of 1 – 15 minutes was the most common trip length for Home Based Shopping trips (46.1%), followed by 15 – 30 minutes (37.0%). The average reported travel time of 17.13 minutes is in line with the levels experienced in most household travel characteristics surveys in urban areas.

Table 5-13
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Shopping Trips

Travel Time	Trips	Percent (%)
1:00 to 14:59	761	46.1
15:00 to 29:59	611	37.0
30:00 to 44:59	205	12.4
45:00 to 59:59	34	2.1
1:00:00 to 1:14:59	29	1.8
1:15:00 to 1:29:59	3	.2
1:30:00 to 1:44:59	4	.2
1:45:00 to 1:59:59	2	.1
2:30:00 to 2:44:59	3	.2
Total	1,652	100.0

Figure 5-18
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Shopping Trips



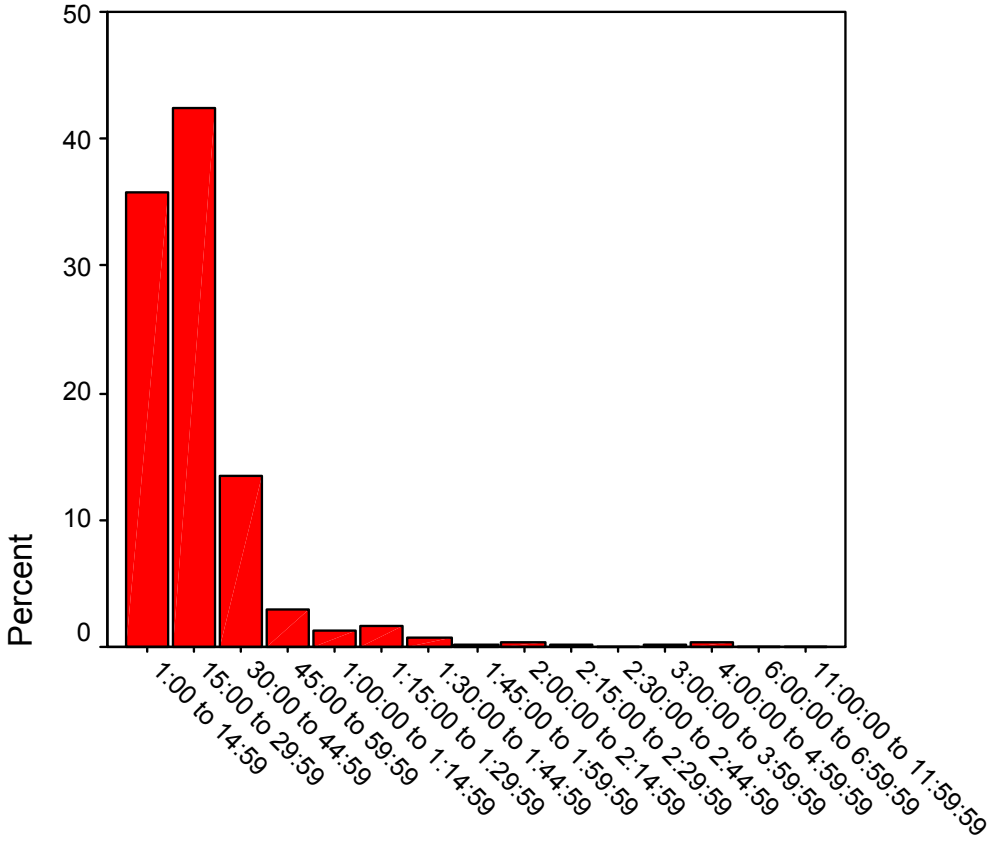
Trip Length Frequency Distribution: Home Based Social Recreation Trips

As shown in Table 5-14 and Figure 5-19, the reported travel time of 15 – 30 minutes was the most common trip length for Home Based Social Recreation trips (42.5%), followed by 1 – 15 minutes (35.8%). The average reported travel time of 22.08 minutes is in line with the levels experienced in most household travel characteristics surveys in urban areas.

Table 5-14
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Social Recreation Trips

Travel Time	Trips	Percent (%)
1:00 to 14:59	404	35.8
15:00 to 29:59	480	42.5
30:00 to 44:59	153	13.5
45:00 to 59:59	33	2.9
1:00:00 to 1:14:59	15	1.3
1:15:00 to 1:29:59	19	1.7
1:30:00 to 1:44:59	8	.7
1:45:00 to 1:59:59	3	.3
2:00:00 to 2:14:59	4	.4
2:15:00 to 2:29:59	2	.2
2:30:00 to 2:44:59	1	.1
3:00:00 to 3:59:59	2	.2
4:00:00 to 4:59:59	4	.4
6:00:00 to 6:59:59	1	.1
11:00:00 to 11:59:59	1	.1
Total	1,130	100.0

Figure 5-19
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Social Recreation Trips



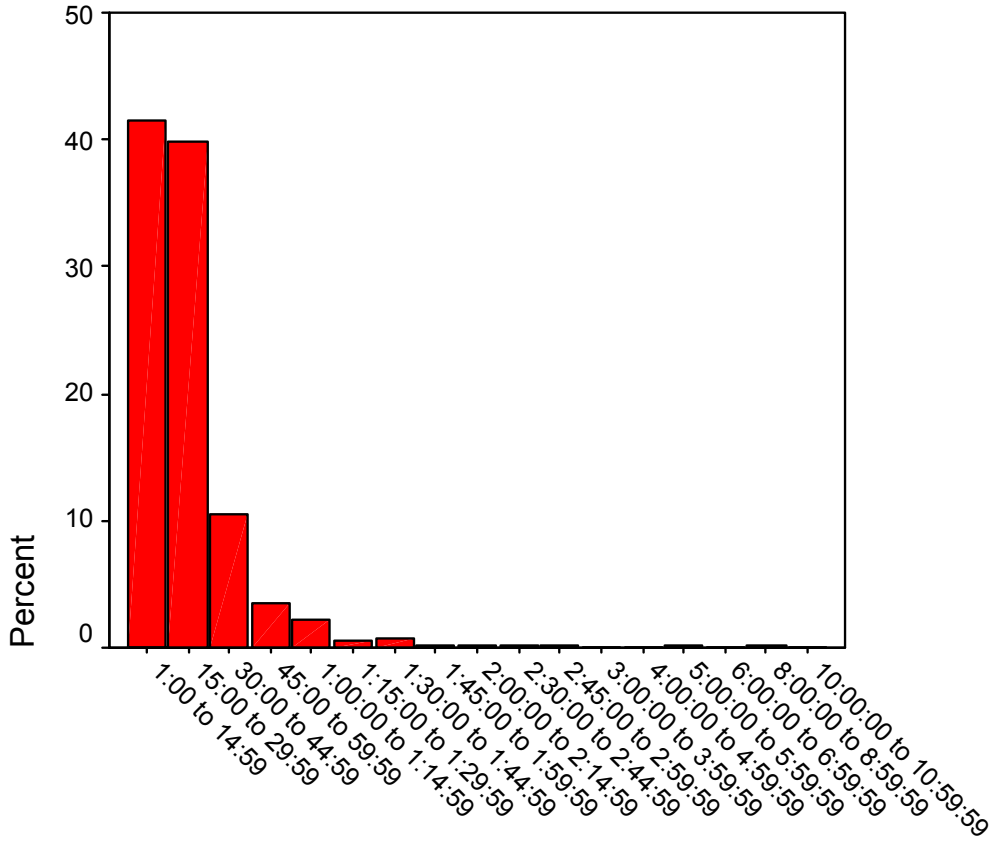
Trip Length Frequency Distribution: Home Based Other Trips

As shown in Table 5-15 and Figure 5-20, the reported travel time of 1 – 15 minutes was the most common trip length for Home Based Work trips (41.6%), followed by 15 – 30 minutes (39.8%). The average reported travel time of 20.77 minutes is in line with the levels experienced in most household travel characteristics surveys in urban areas.

Table 5-15
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Work Trips

Travel Time	Trips	Percent (%)
1:00 to 14:59	1,743	41.6
15:00 to 29:59	1,670	39.8
30:00 to 44:59	438	10.4
45:00 to 59:59	144	3.4
1:00:00 to 1:14:59	95	2.3
1:15:00 to 1:29:59	25	.6
1:30:00 to 1:44:59	34	.8
1:45:00 to 1:59:59	7	.2
2:00:00 to 2:14:59	9	.2
2:30:00 to 2:44:59	5	.1
2:45:00 to 2:59:59	4	.1
3:00:00 to 3:59:59	1	.0
4:00:00 to 4:59:59	3	.1
5:00:00 to 5:59:59	4	.1
6:00:00 to 6:59:59	3	.1
8:00:00 to 8:59:59	8	.2
10:00:00 to 10:59:59	1	.0
Total	4,194	100.0

Figure 5-20
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Home Based Work Trips



Trip Length Frequency Distribution: Non-Home Based Trips

As shown in Table 5-16 and Figure 5-21, the reported travel time of 1 – 15 minutes was the most common trip length for Home Based Work trips (47.8%), followed by 15 – 30 minutes (32.4%). The average reported travel time of 19.22 minutes is in line with the levels experienced in most household travel characteristics surveys in urban areas.

Table 5-16
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Non-Home Based Trips

Travel Time	Trips	Percent (%)
1:00 to 14:59	2,116	47.8
15:00 to 29:59	1,433	32.4
30:00 to 44:59	496	11.2
45:00 to 59:59	186	4.2
1:00:00 to 1:14:59	78	1.8
1:15:00 to 1:29:59	35	.8
1:30:00 to 1:44:59	29	.7
1:45:00 to 1:59:59	12	.3
2:00:00 to 2:14:59	11	.2
2:15:00 to 2:29:59	5	.1
2:30:00 to 2:44:59	6	.1
3:00:00 to 3:59:59	4	.1
4:00:00 to 4:59:59	7	.2
5:00:00 to 5:59:59	3	.1
6:00:00 to 6:59:59	1	.0
8:00:00 to 8:59:59	1	.0
Total	4,423	100.0

Figure 5-21
Model Coefficients and Trip Factors
Trip Length Frequency Distribution: Non-Home Based Trips

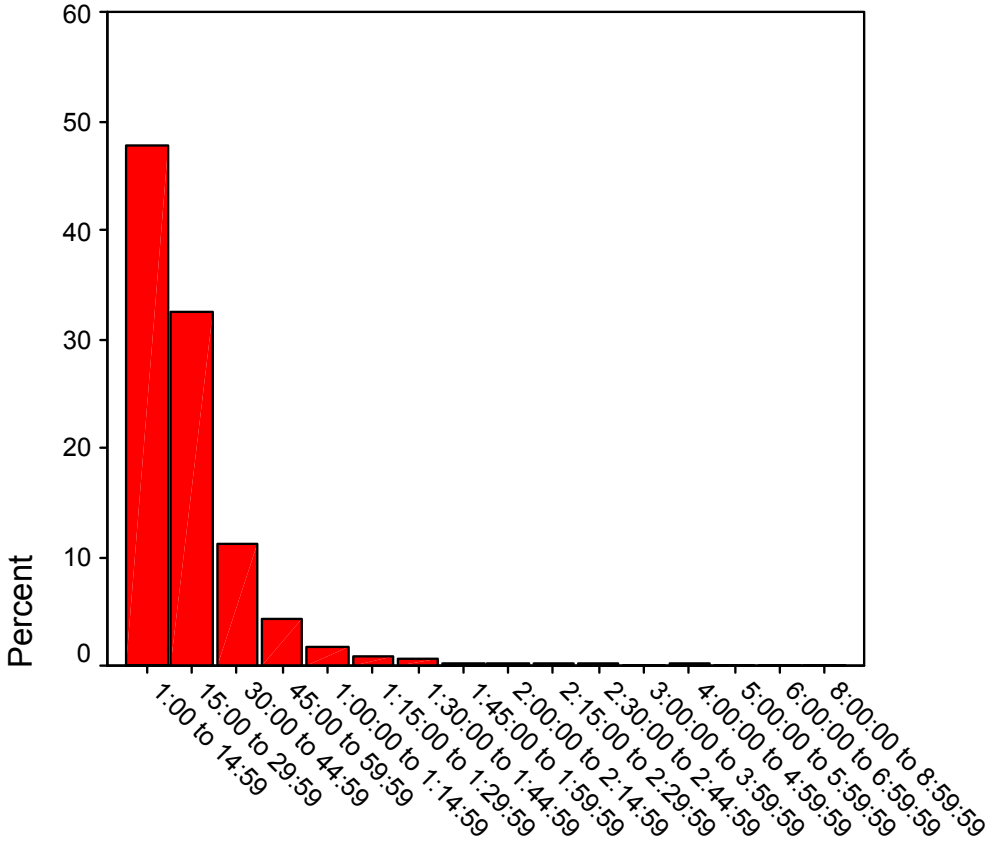


Table 5-17 shows the statistical analysis summary of average reported travel times, standard deviation, and sample size from the survey. The survey was of sufficient sample size to warrant great confidence in their results, and in the validity of the average reported travel times by FSUTMS trip purpose.

Table 5-17
Model Coefficients and Trip Factors
Summary Statistics of Average Reported Travel Times (Minutes)

Trip Purpose	Average Travel Time	Standard Deviation	Sample Size
Home based Work (HBW)	25.42	26.39	1,982
Home based Shopping (HBSH)	17.13	13.85	1,652
Home based Social/Recreation (HBSR)	22.08	32.19	1,130
Home based Other (HBO)	20.77	31.58	4,194
Non-Home based (NHB)	19.22	23.51	4,423

Formulation and Estimation of Friction Factors
Common functional forms for the friction factor include:

- Power function: t_{ij}^{-b}
- Exponential function: $e^{(-b\ tij)}$
- Gamma function: $t_{ij}^{a} \times e^{(-b\ tij)}$

Where,

t_{ij} = Travel time between zone i and zone j
a,b = Coefficients (model parameters) to be estimated
e = exponential approximately equal to 2.7183.

In all cases, the function must be empirically calibrated in order to estimate the value of coefficients (model parameters), which enables the model to "best fit" observed data. The Gamma function is an obvious generalization of the Exponential function and is the function recommended in many transportation planning practices.

A number of different functional forms for friction factors were tested and a Curve Estimation analysis was performed using "Analyze-Regression-Curve Estimation" function in the SPSS Window Version 11.0 software package. It was determined that a Gamma function enables the model to "best fit" observed data. In addition, the simple functional form allows for easy calibration and easy modification if it is implemented in the VCUATS Trip Distribution Model.

The use of Gamma function appears necessary when some observers noticed slight inadequacies in the Exponential function when used to model urban trips. A particular problem is that there are fewer short trips than what the exponential function would lead us to believe. This is probably due in part, to non-reporting by the traveler of very short trips. A statistical estimation method was performed to derive the coefficients of the Gamma function using the reported travel times from the surveyed trip logs in Volusia County. The coefficients were estimated using "Analyze-Regression-Nonlinear" function in the SPSS Window Version 11.0 software package.

As provided in Table 5-18, for each FSUTMS trip purpose the coefficient (model parameter) values of "*a*" and "*b*" of a proposed Gamma function model were estimated by performing a non-linear regression analysis using the surveyed trip logs.

Table 5-18
Model Coefficients and Trip Factors
Estimated Coefficient Value in the Gamma Function Model

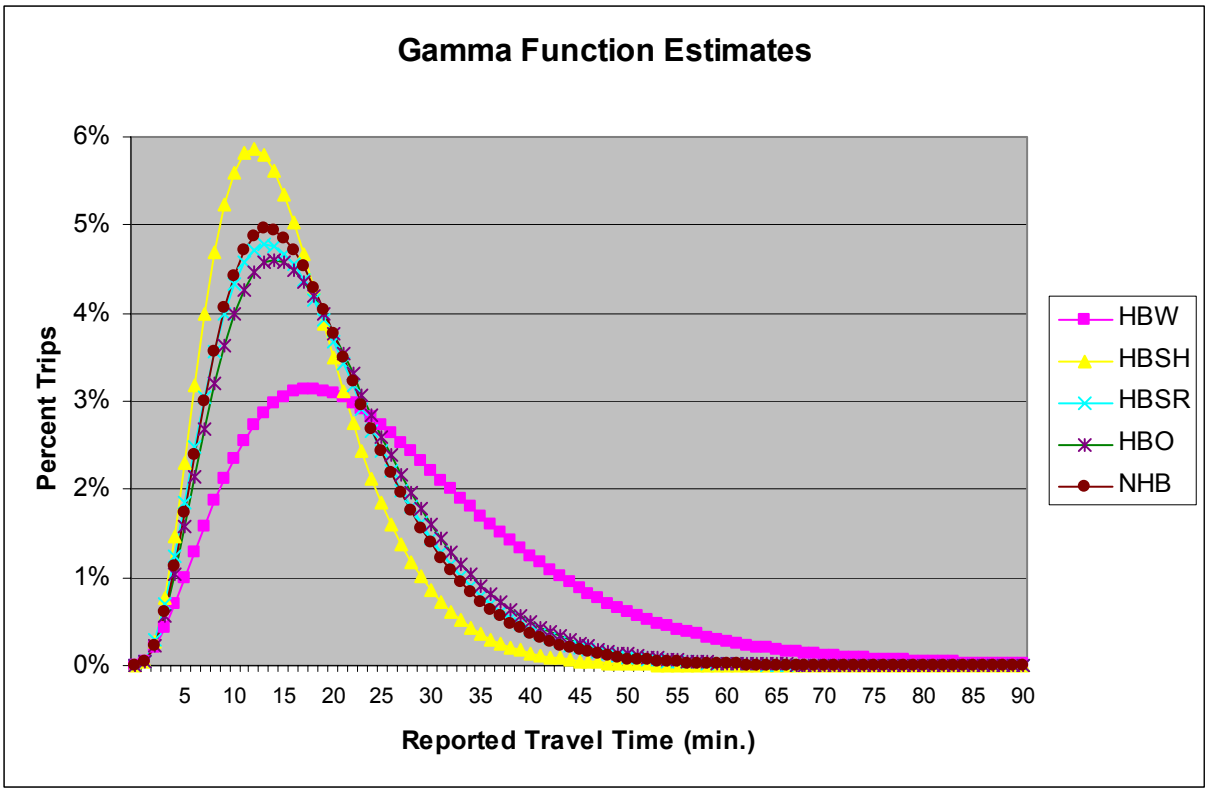
Trip Purpose	*a*	*b*
Home based Work (HBW)	2.095	-0.118
Home based Shopping (HBSH)	3.241	-0.272
Home based Social Recreation (HBSR)	2.686	-0.203
Home based Other (HBO)	2.777	-0.198
Non-Home based (NHB)	2.921	-0.218

Based on Table 5-18, the proposed friction factors for the VCUATS trip distribution model can be summarized as follows:

- Home Based Work: $t_{ij}^{2.095} \times e^{(-0.118tij)}$
- Home Based Shopping: $t_{ij}^{3.241} \times e^{(-0.272tij)}$
- Home Based Social Recreation: $t_{ij}^{2.686} \times e^{(-0.203tij)}$
- Home Based Other: $t_{ij}^{2.777} \times e^{(-0.198tij)}$
- Non Home Based: $t_{ij}^{2.921} \times e^{(-0.218tij)}$

Using the coefficient values in Table 5-18, the trip length frequency distributions for five (5) trip purposes were calculated (estimated). The estimation results are also illustrated graphically in Figure 5-22.

Figure 5-22
Model Coefficients and Trip Factors
Estimated Trip Frequency Distribution



In addition, Figures 23 to Figures 27 show the estimated trip frequency distribution as compared to the observed (reported) trip frequency distribution from the survey and 1997 VCUATS model trip frequency distribution (uncongested skims).

The distribution of home-based work trips is the most important to the transportation modeling process. It is the purpose that usually determines peak-hour usage, and is often the trip for which facilities are designed. For work trips, the estimated average travel time from the survey (mean congested travel time) for home-based work trips is 23 minutes. This compares favorably with reported average trip lengths from the 2000 U.S. Census, which is 25 minutes for the Volusia County. This indicated that the estimated average travel time from the survey perform much better than the average travel time from the 1997 VCUATS model, which is 15 minutes, way shorter than 2000 Census average home-based work travel times.

The model (Gamma function) estimated trip length is a bit shorter than the reported trip lengths from the household surveys. This is reasonable given how travelers perceive and report time (usually rounded up to the nearest 5 minute increment). Based on a comparison of census information, other studies conducted around Florida and other urban models, it appears that the reported trip length on the household surveys indicates perceived trip duration and is overstated for all trip purposes.

The reasonableness of the trip lengths by trip purposes was assessed by comparing the survey results with the results from the 1997 VCUATS model, other validated models in Florida, and the travel characteristic survey results from other urban areas in Florida. Table 5-19 shows the comparison of trip length in minutes by trip purpose.

Table 5-19
Model Coefficients and Trip Factors
Average Trip Length Comparisons (Minutes)

Survey//Model	HBW	HBSH	HBSR	HBO	NHB
2002 Volusia Survey (Estimates)	23.20	15.60	18.19	19.05	17.95
2002 Volusia Survey (Reported)	25.42	17.13	22.08	20.77	19.22
1997 VCUATS Model	15.25	13.65	12.86	14.95	10.48
2000 Southeast FL Travel Survey	29.59	16.73	19.88	20.33	20.64
2000 Tampa Bay Survey	28.46	22.62	23.95	25.95	24.15
1999 TBRPM Model	21.32	15.70	16.50	16.05	15.69
Other FL Surveys	14-23	11-18	14-21	13-18	13-17
Other FL Models	14-24	12-19	13-18	12-19	11-15

The best distribution information by purpose is for home-based work. Usually, it is expected that home-based shopping trips are shorter in duration than home-based work trips. Additionally, these trips should have a much smaller variance, or deviation than work trips. The estimated average travel time from the survey for home-based shopping trips is 16 minutes, an average much shorter than for work trips.

As urban development patterns and transportation infrastructure are unique to each urban area, trip length frequency distributions are unique to each urbanized area, as well. Usually, it is expected that, like home-based shopping trips, home-based social/recreation trips are shorter in duration than home-based work trips. However, they should be longer than general shopping trips. Additionally, these trips should have a much smaller variance or deviation than work trips. The estimated average travel time from the survey for home- based social/recreation trips is 18 minutes. As expected, the mean trip length for these trips is shorter than that for work trips.

The home-based other trip purpose represents a significant number of trips in the survey trip logs. The estimated average travel time from the survey for home-based other trips is 19 minutes.

Non-home-based trips represent the largest number of trips in the survey trip logs. The estimated average travel time from the survey for non-home-based trips is 18 minutes. As expected, this travel time is shorter than that for work trips.

The percent changes of average trip length from 1997 VCUATS model to 2002 Volusia County travel survey are 52.1% for HBW, 14.3% for HBSH, 41.4% for HBSR, 27.4% for HBO, and 71.28% for NHB. As a result the longer trip lengths will increase VHT (Vehicle Hours Traveled) in Volusia County. The model assigned volumes multiplied by travel times equals VHT. These are useful measures of system demand that provide insight into other network attributes, such as fuel consumption and emissions. However it should be noted that validity and

reasonableness of a travel demand model need to be checked not only by trip distribution model (trip length) alone but other model components as well such as trip generation rates in trip generation model and auto occupancy rates in mode choice model.

Figure 5-23
Model Coefficients and Trip Factors
Comparison of Trip Frequency Distribution: Home Based Work

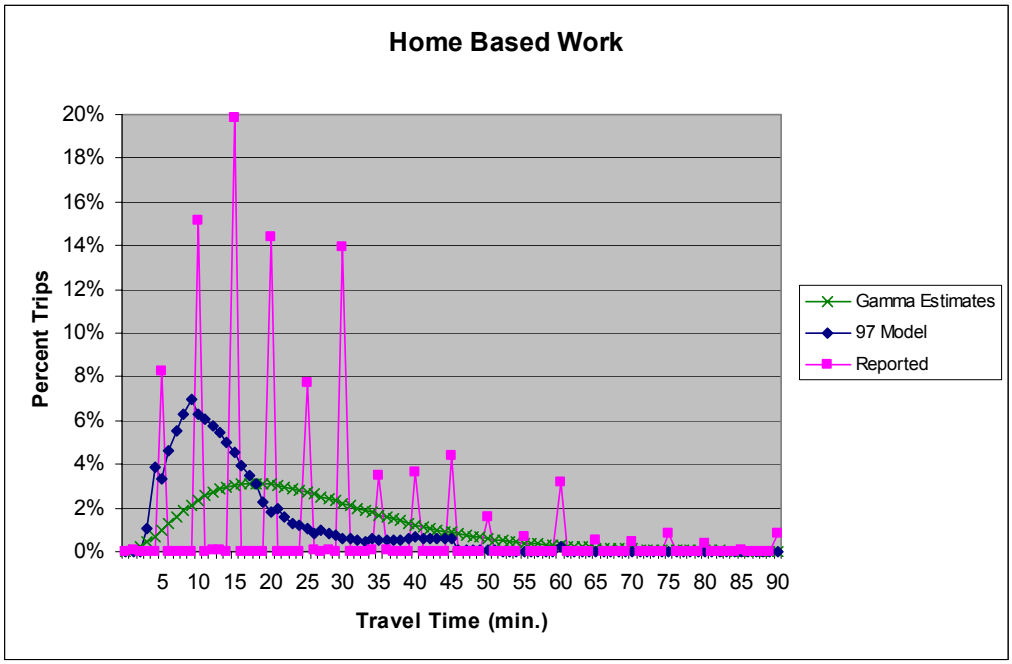


Figure 5-24
Model Coefficients and Trip Factors
Comparison of Trip Frequency Distribution: Home Based Shopping

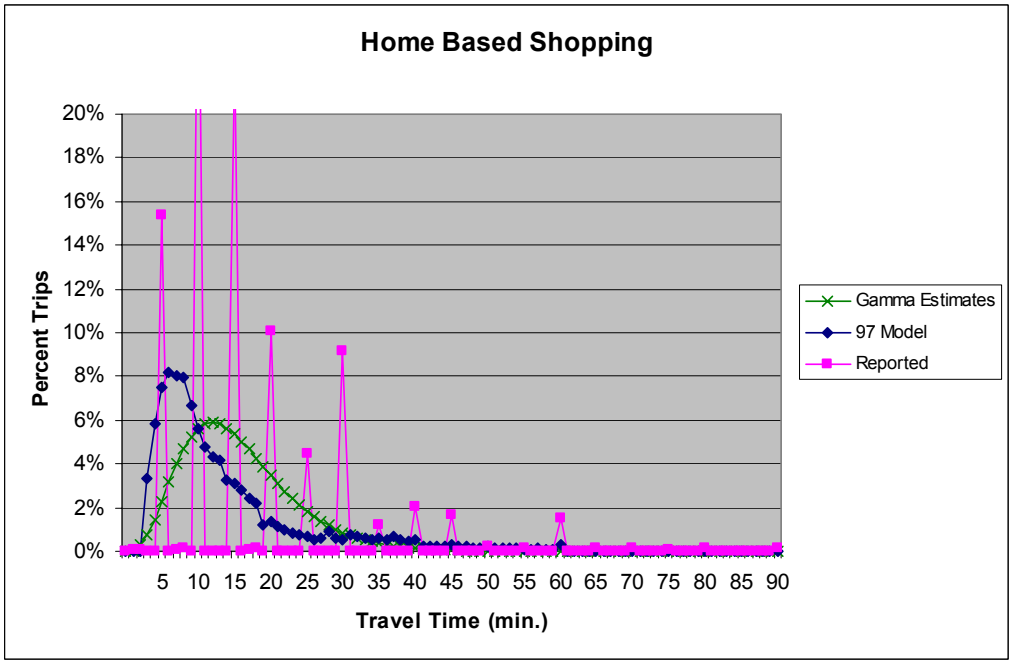


Figure 5-25
Model Coefficients and Trip Factors
Comparison of Trip Frequency Distribution: Home Based Social Recreation

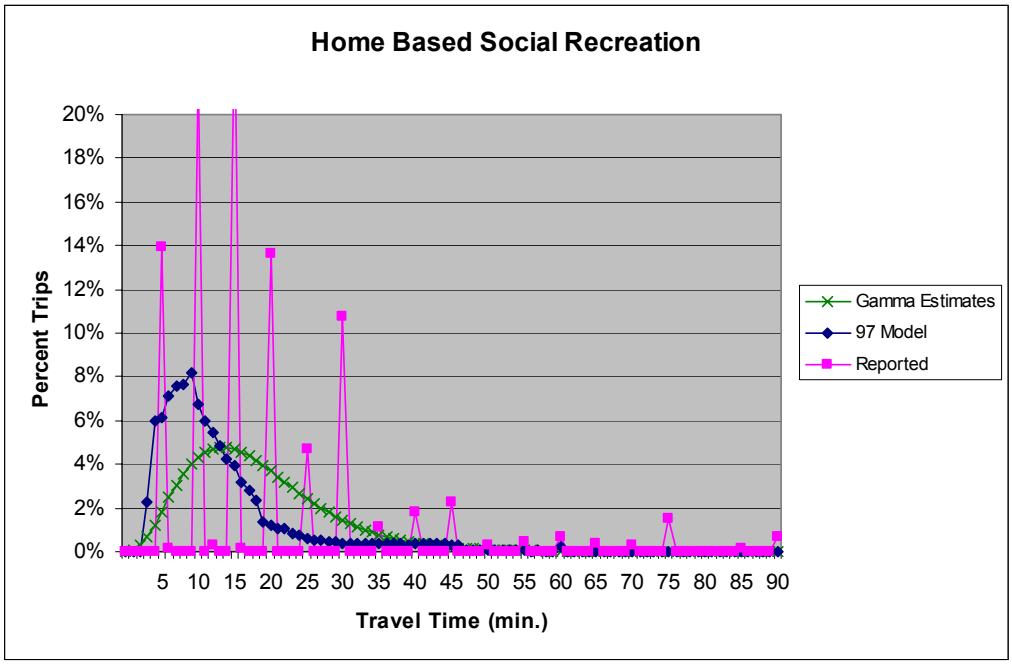


Figure 5-26
Model Coefficients and Trip Factors
Comparison of Trip Frequency Distribution: Home Based Other

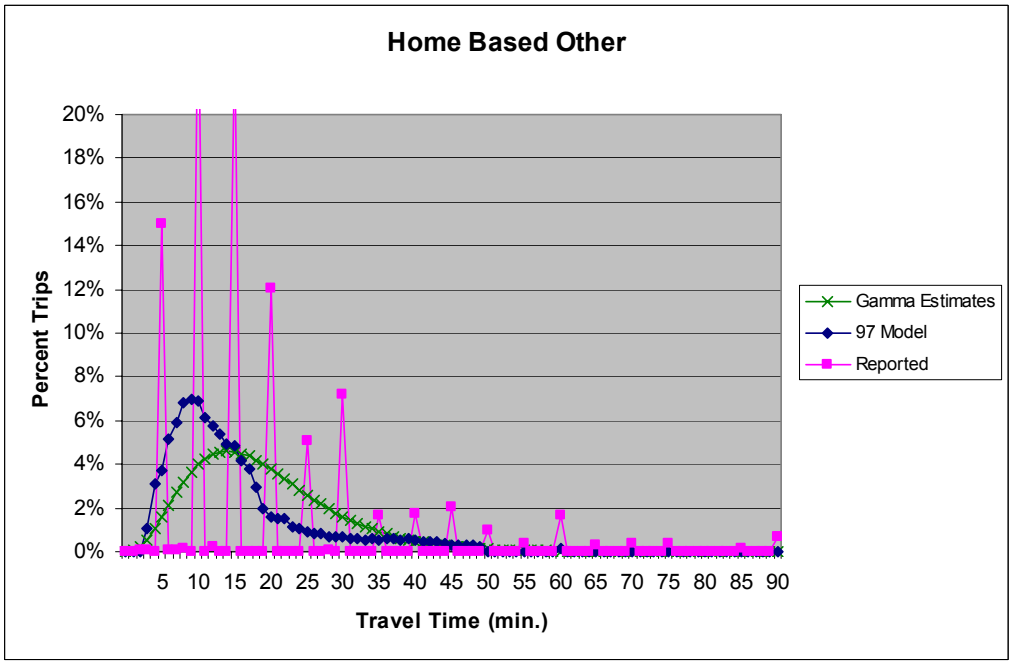
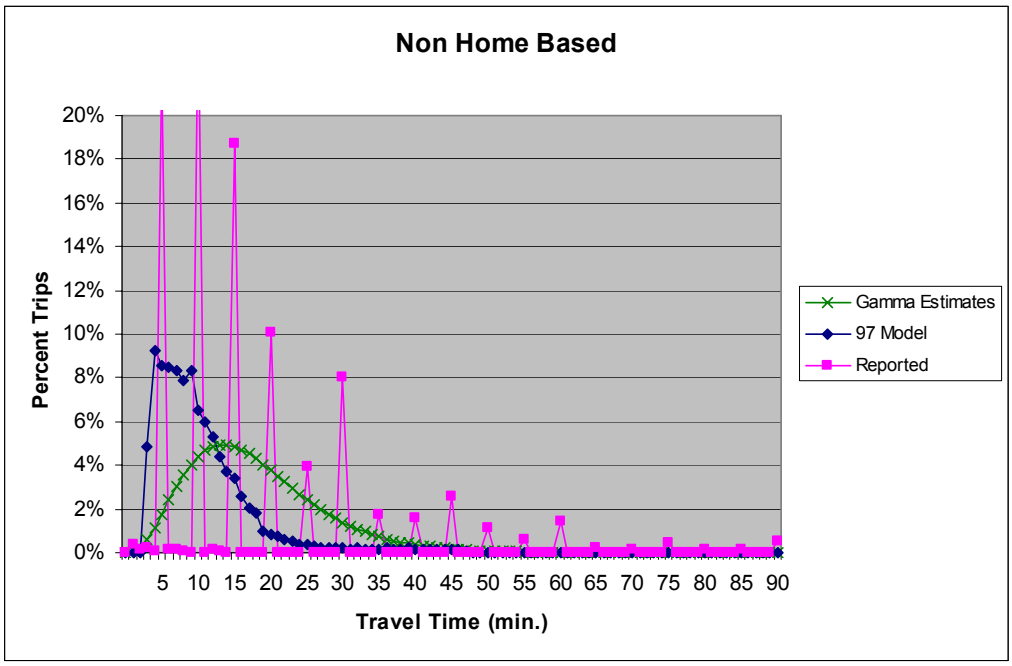


Figure 5-27
Model Coefficients and Trip Factors
Comparison of Trip Frequency Distribution: Non-Home Based



Calibration of Trip Distribution Friction Factors

In order to calibrate the gravity model to replicate the observed (reported) trip length frequency distribution, friction factors are adjusted via an iterative process based on the following formula:

$$F_n = F_{n-1} \times (PW_o / PW_e)$$

Where,

F_n = Friction Factor for iteration n
PW_o = Observed (Reported) percent of trips at that minute of travel time
PW_e = Estimated percent of trips at that minute of travel time.

New recommended friction factors for each person trip purpose for use of the VCUATS trip distribution model are provided in Table 5-20.

Table 5-20
Model Coefficients and Trip Factors
New Recommended Initial Friction Factors

Travel Time	HBW	HBSH	HBSR	HBO	NHB
1	1	1	1	1	1
2	1	1	1	1	1
3	107	99	77	70	222
4	173	192	137	128	413
5	245	301	203	195	636
6	319	414	271	266	871
7	392	520	334	334	1099
8	461	611	391	397	1304
9	524	682	438	452	1479
10	581	731	474	496	1617
11	630	758	501	531	1717
12	672	766	516	554	1779
13	706	756	523	567	1807
14	733	733	521	572	1803
15	752	698	512	568	1773
16	765	656	497	557	1720
17	772	608	478	541	1651
18	773	558	455	520	1568
19	770	506	430	495	1476
20	761	456	403	469	1378
21	749	407	375	440	1277
22	734	360	347	411	1176
23	716	317	319	381	1076
24	696	277	292	352	979
25	673	241	266	323	887
26	649	209	242	296	799
27	625	180	218	269	717
28	603	154	197	244	641
29	573	132	176	221	571
30	546	112	158	199	507
31	490	95	141	179	448
32	460	80	125	160	395
33	438	67	111	143	347
34	413	57	98	127	305
35	388	47	87	113	267
36	364	40	76	100	233
37	351	33	67	89	203
38	329	27	59	79	176
39	287	23	52	69	153
40	279	19	45	61	132
41	263	15	39	53	114
42	254	13	34	47	98
43	240	10	30	41	85
44	205	9	26	36	73
45	173	7	22	31	62
46	158	6	19	27	54

Table 5-20
Model Coefficients and Trip Factors
New Recommended Initial Friction Factors (continued)

Travel Time	HBW	HBSH	HBSR	HBO	NHB
47	128	4	15	21	39
48	102	3	13	18	33
49	67	3	11	16	29
50	52	2	9	18	34
51	40	2	8	18	34
52	22	1	7	12	18
53	10	1	6	12	15
54	9	1	5	8	13
55	8	1	4	6	11
56	5	1	4	6	9
57	3	0	3	5	8
58	3	0	3	4	6
59	3	0	2	4	2
60					

Mode Choice and Auto Occupancy Rates

The mode choice model produces estimates of how many person trips will travel by each available mode. The mode choice model does this by determining the probability of using each available mode for traveling between each pair of zones, and then using those probabilities to stratify trips among available modes.

In the MODE modeling step, the person trip tables for the home based work (HBW), home based non-work (HBNW), and non-home based (NHB) trip purposes from the trip distribution (DISTRIB) step are multiplied by the auto occupancy factors (AOFAC in the PROFILE.MAS) to convert the person trips to vehicle trips. The HBNW trip purpose includes home based shopping (HBSH), home-based social/recreation (HBSR) and home based other (HBO) trip purposes.

Mode Choice Model Methodology and Operation
This section describes the methodologies used and the operation of the VCUATS mode choice model**.** Unlike the multi-purpose, multi-period model contained in the basic FSUTMS package, the VCUATS mode choice model is structured in a nested logit form rather than in a single, unnested form. The nested structure allows for submodal trade offs to be fairly sensitive to service measures while lessening the impact on other less related sub-modes. The mode choice model operates for purposes: home based work (HBW), home based non-work (HBNW), non-home based (NHB), and Airport (APT).

Default Mode Choice Model
The default mode choice model, which is run prior to the initial highway assignment, estimates initial auto occupancies in order to allocate trips between LOV and HOV categories. Unlike the final mode choice model which includes the additional special purposes, the default mode choice model operates for only three trip purposes: home based work, home based non-work, and nonhome based. The analysis is performed using default transit splits with work and non-work auto occupancies estimated using unconstrained highway speeds. The regional mode splits for the default mode choice model are as follows:

- Home Based Work 1.3%
- Home Based Non-Work 0.4%
- Non-Home Based 0.2%

The default mode choice model is designed to develop a reasonable, preliminary allocation between LOV and HOV for the initial equilibrium assignment and capacity-restrained speed determination.

Mode Choice Model Operation
For the purposes of the Volusia County Urban Area Transportation Study, the mode choice model has been divided into three (3) parts, a work mode choice model, a non-work mode choice model, and a special purpose model for the airport. There are actually five (5) purposes, with resident and tourist purposes for the airport special purposes. Each pair is treated the same way as the HBNW/NHB application of the model, with the resident purpose using the same logic as HBNW and the tourist purpose using the NHB logic.

The mode choice model assumes that work trips occur in the peak period and are subject to congested travel conditions, and non-work trips occur in the off-peak period and are subject to uncongested travel conditions. Therefore, the work mode choice model uses the congested impedance skims where the nonwork mode choice model uses the free-flow impedance skims.

Congested travel times are estimated by a default mode choice and an initial highway assignment in the Trip Distribution Step of the model chain. The default mode choice model is a simplified version of the final mode choice model. It uses reasonable, accurate assumptions of estimated modal shifts. The vehicle trip tables created by the default mode choice model are assigned to the highway network. The loaded network is then "skimmed" to create a congested travel time matrix used by the mode choice model.

Although the 1997 VCUATS model network has no high occupancy vehicle (HOV) facilities, the model is structured so that the estimation of highway trips by auto occupancy category is sensitive to different impedances from low occupancy vehicle (LOV) and HOV networks. Thus, the model is capable of responding to relative differences in LOV and HOV network performances and has the ability to shift trips from one mode to another. HOV skims are developed by the model; however, because there are no coded HOV facilities in the 1996 network, the HOV skims are equal to non-HOV skims in 1997. The VCUATS mode choice model's calibrated coefficients were based on the 1997 VOTRAN bus company ridership figures.

Calibration of Nested-Logit Mode-Choice Model for Florida

A research project was conducted by Mohamed Abdel-Aty, Ph.D., P.E., at the University of Central Florida. The initial objective of this research effort was to develop a universal nested-logit mode-choice model for the State of Florida. After intensive investigation of mode-choice modeling in the state, the research team discovered that the foundation for the models was flawed and that basing a universal model on flawed models would be of questionable benefit. Therefore, the focus of the project was modified. New models based on actual Florida travel data were warranted and were possible because of a recently completed major survey in Southeast Florida. The research team sought to calibrate nested-logit mode-choice models, based on Florida travel data, for different trip purposes, and to use those models to replace the ones currently used in the state.

Generally, the nested-logit mode-choice model is applied by a set of three model parameters. These model parameters include nesting coefficients, mode-specific constants, and level-of-service coefficients. So far, the common practice in developing a mode-choice model in Florida is to borrow coefficients from other cities (e.g., Minneapolis/St. Paul). Then, the model is implemented by (1) adjusting the modal bias coefficients (constants of the utility equation) to replicate the transit ridership data and (2) examining the validation results to identify any additional adjustments to coefficients or other parameters that were appropriate. The validity of such an approach is questionable, especially considering that the basis for nested-logit mode-choice models in Florida was the Miami model, which was originally borrowed from Minneapolis, which in turn was borrowed from Shirley Highway. This situation stressed the need to develop a Florida model based on Florida travel data.

Data from the 1999 travel survey conducted in Southeast Florida were used in the calibration of the models. Two separate surveys were used in the estimation process. The first was the on-board transit survey, and the second was the household survey. In conducting the 1999 Southeast Florida surveys, the sampling methodology used in the household travel survey was different from the one used in the on-board transit survey. In the household travel survey, sequences of decision makers were drawn and their choice behaviors were observed. In contrast, in the on-board transit survey, sequences of chosen alternatives were drawn and the characteristics of the decision makers selecting those alternatives were observed.

Researchers adopted a weighted exogenous sampling maximum likelihood (WESML) methodology to estimate the models. The weights are the ratio of population market shares to the sample (survey data) market shares. The modeling estimation approach was based on the estimation of two nested-logit models, one of which was based on the on-board transit survey and the other of which was based on the household travel survey. The two models were linked through the use of inclusive value of transit. The transit section of the model was calibrated using the full information weighted exogenous sampling maximum likelihood (FI-WESML) approach. The FI-WESML estimation is the most efficient statistical approach because different nesting levels are estimated simultaneously rather than sequentially, as is the case with a limited information approach. The overall model was also calibrated using Full Information Maximum Likelihood (FIML).

The models developed within this project would constitute the basis for such a universal model. As a result, of the development of this universal model, researchers recommended that the models used in Miami, Orlando, Tampa, Jacksonville, and Volusia should be re-validated based upon the new model coefficients.

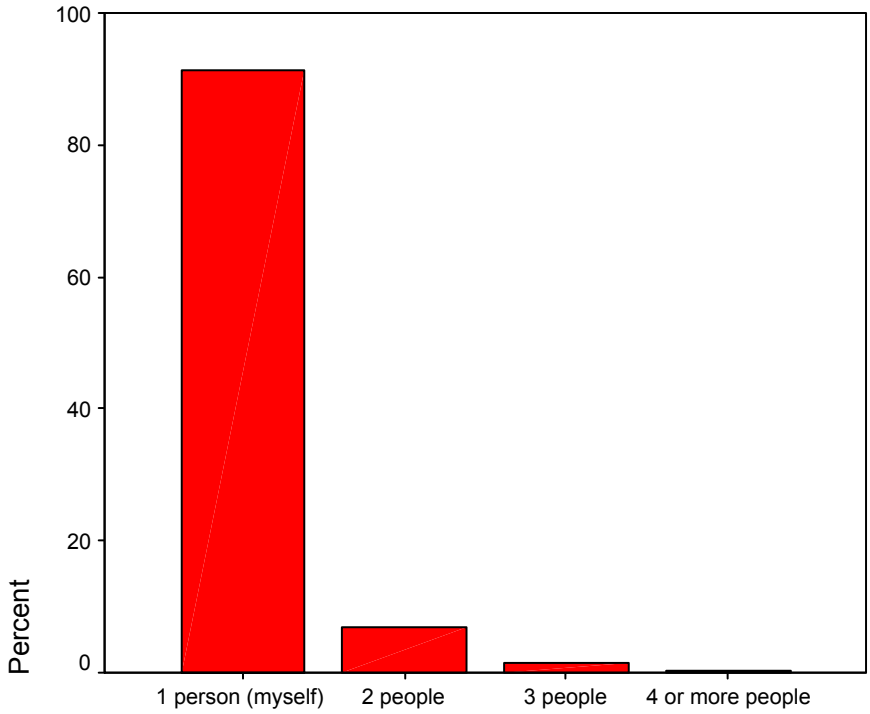
Auto Occupancy Rate: Home Based Work Trips

One person per vehicle was the most common occupancy for person vehicle trips for Home Based Work trips (91.3%), followed at a distant second by two people per vehicle (6.9%). The average auto occupancy rate for home-based work trips was 1.108**,** which is consistent with auto occupancy rates for most urban areas.

Table 5-21
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Work Trips

Auto Occupancy	Trips	Percent (%)
1 person (myself)	1,810	91.3
2 people	136	6.9
3 people	29	1.5
4+ people	7	.4
Total	1,982	100.0

Figure 5-28
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Work Trips



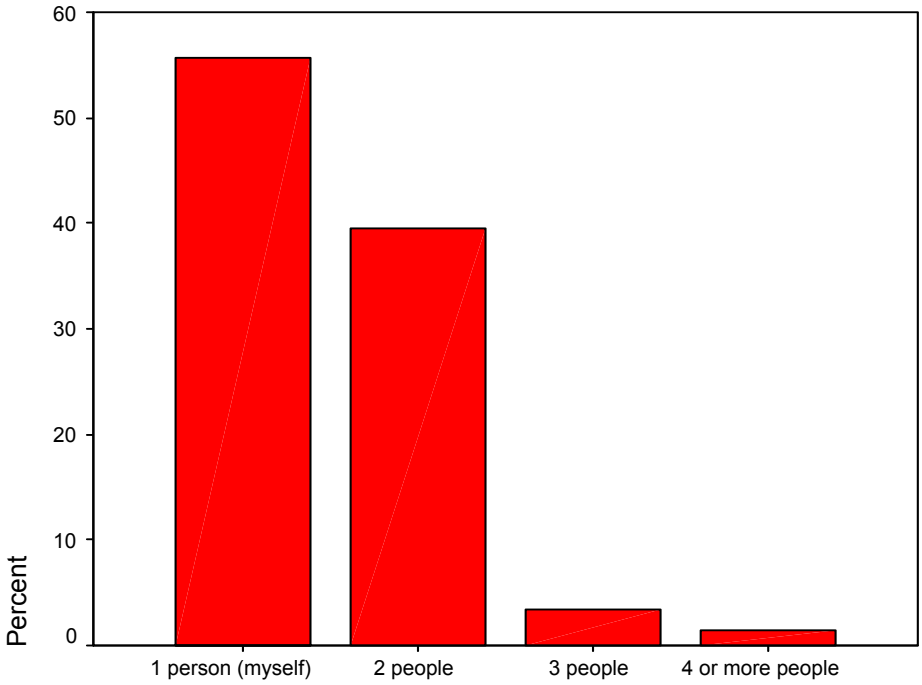
Auto Occupancy Rate: Home Based Shopping Trips

One person per vehicle was the most common occupancy for person vehicle trips for Home Based Shopping trips (55.7%), followed by two people per vehicle (39.5%). The proportion of two people per vehicle is significant as compared to Home Based Work trips. The average auto occupancy rate for home based shopping trips was 1.507**,** which is consistent with auto occupancy rates for most urban areas.

Table 5-22
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Shopping Trips

Auto Occupancy	Trips	Percent (%)
1 person (myself)	920	55.7
2 people	653	39.5
3 people	55	3.3
4 or more people	24	1.5
Total	1,652	100.0

Figure 5-29
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Shopping Trips



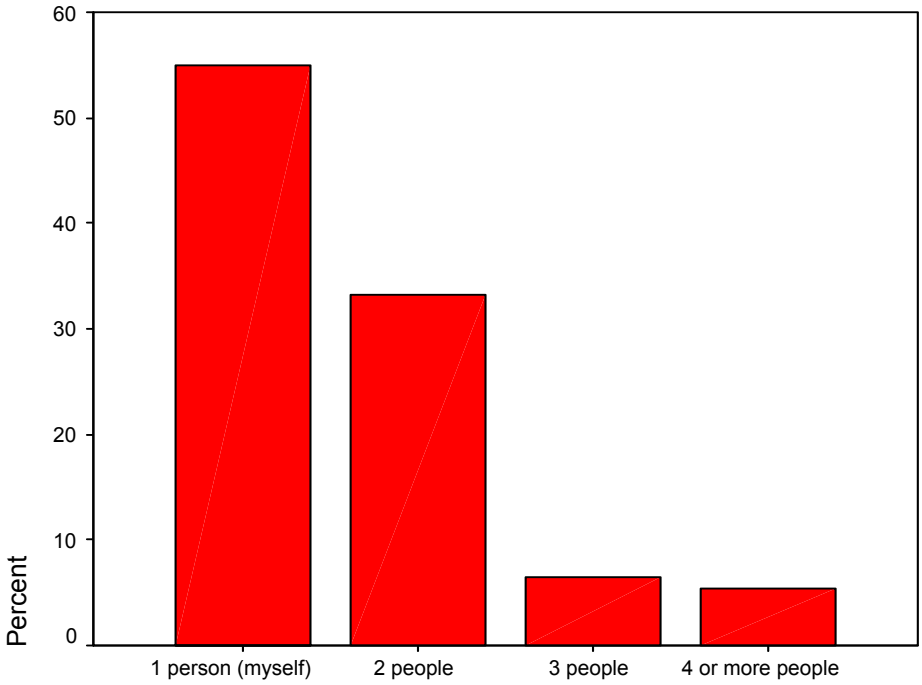
Auto Occupancy Rate: Home Based Social Recreation Trips

One person per vehicle was the most common occupancy for person vehicle trips for Home Based Social Recreation trips (55.0%), followed by two people per vehicle (33.2%). The proportion of two people per vehicle is significant compared to Home Based Work trips. As expected the proportion of more than three people per vehicle (about 12%) is also significant compared to other trip purposes. The average auto occupancy rate for home based social recreation trips was 1.648**,** which is consistent with auto occupancy rates for most urban areas.

Table 5-23
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Social Recreation Trips

Auto Occupancy	Trips	Percent (%)
1 person (myself)	621	55.0
2 people	375	33.2
3 people	73	6.5
4+ people	61	5.4
Total	1,130	100.0

Figure 5-30
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Social Recreation Trips



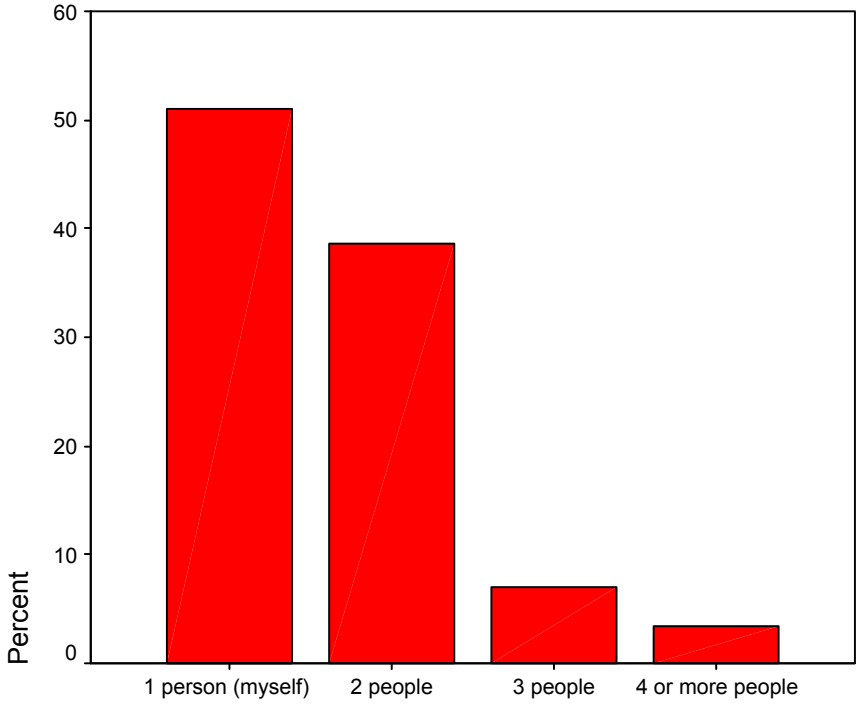
Auto Occupancy Rate: Home Based Other Trips

One person per vehicle was the most common occupancy for person vehicle trips for Home Based Other trips (51.0%), followed by two people per vehicle (38.7%). The proportion of two people per vehicle is significant compared to Home Based Work trips. The proportion of more than three people per vehicle (about 10.4%) is also significant. The average auto occupancy rate for home based other trips was 1.730**,** which is consistent with auto occupancy rates for most urban areas.

Table 5-24
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Other Trips

Auto Occupancy	Trips	Percent (%)
1 person (myself)	2,137	51.0
2 people	1,623	38.7
3 people	292	7.0
4+ people	142	3.4
Total	4,194	100.0

Figure 5-31
Model Coefficients and Trip Factors
Auto Occupancy Rate: Home Based Other Trips



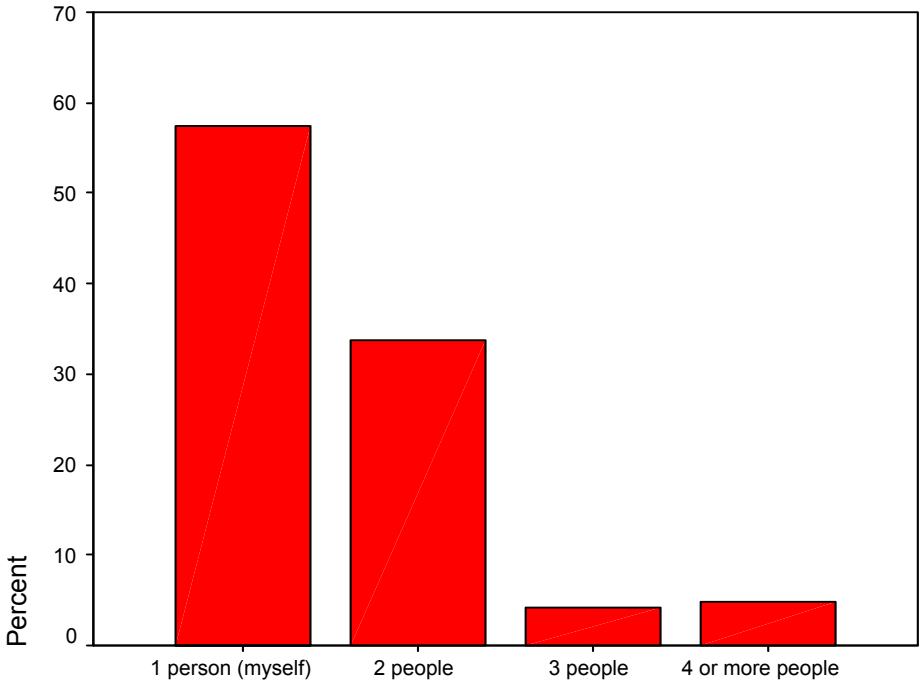
Auto Occupancy Rate: Non-Home Based Trips

One person per vehicle was the most common occupancy for person vehicle trips for Home Based Social Recreation trips (57.4%), followed by two people per vehicle (33.7%). The proportion of two people per vehicle is significant compared to Home Based Work trips. As expected the proportion of more than three people per vehicle (about 9%) is also significant. The average auto occupancy rate for non-home based trips was 1.668**,** which is consistent with auto occupancy rates for most urban areas.

Table 5-25
Model Coefficients and Trip Factors
Auto Occupancy Rate: Non-Home Based Trips

Auto Occupancy	Trips	Percent (%)
1 person (myself)	2,538	57.4
2 people	1,491	33.7
3 people	185	4.2
4+ people	209	4.7
Total	4,423	100.0

Figure 5-32
Model Coefficients and Trip Factors
Auto Occupancy Rate: Non-Home Based Trips



New Recommended Auto Occupancy Factors (AOFAC)

Table 5-26 shows the statistical analysis summary of average auto occupancy rate, standard deviation, and sample size from the survey. The survey was of sufficient sample size to warrant great confidence in their results, and in the validity of the average auto occupancy rates by FSUTMS trip purpose.

Table 5-26
Model Coefficients and Trip Factors
Summary Statistics of Auto Occupancy Rates

Trip Purpose	Average Rates	Standard Deviation	Sample Size
Home based Work (HBW)	1.108	0.384	1,982
Home based Shopping (HBSH)	1.507	0.641	1,652
Home based Social/Recreation (HBSR)	1.648	0.949	1,130
Home based Other (HBO)	1.730	2.542	4,194
Non-Home based (NHB)	1.668	2.084	4,423

The new recommended auto occupancy factors (AOFAC) are shown in Table 5-27. The auto occupancy rate is the average number of occupants in a vehicle for each trip purpose. The auto

occupancy factor is the inverse, or reciprocal, of the auto occupancy rate. The auto occupancy factors are applied to factor the person trips into vehicle trips for each trip purpose.

Table 5-27
Model Coefficients and Trip Factors
New Recommended Auto Occupancy Factors (AOFAC)

Trip Purpose	Average Rates	AOFAC
Home based Work (HBW)	1.108	0.903
Home based Shopping (HBSH)	1.507	0.664
Home based Social/Recreation (HBSR)	1.648	0.607
Home based Other (HBO)	1.730	0.578
Non-Home based (NHB)	1.668	0.600
All Person Trips (Trip Purpose Average)	1.532	0.670

Comparison of Auto Occupancy Rates

The auto occupancy rates derived from the Volusia County household travel survey were compared with those auto occupancy rates used in other Florida models and other Florida travel characteristics surveys is shown in Table 5-28.

Table 5-28
Model Coefficients and Trip Factors
Comparison of Auto Occupancy Rates

Model / Survey	HBW	HBSH	HBSR	HBO	NHB
2002 Volusia Household Survey	1.108	1.507	1.648	1.730	1.668
1997 VCUATS Model	1.370	1.916	1.916	1.916	1.431
1999 TBRPM Model	1.093	1.409	1.489	1.629	1.297
1996 Tampa Bay Household Survey	1.093	1.400	1.489	1.612	1.276
1992 LCTCS	1.110	1.490	1.450	1.420	1.480
1987 OUTCS	1.180	1.750	1.810	1.810	1.740
1985 PPHTCE	1.100	1.400	1.700	1.500	1.500
1986 SEFITS	1.140	1.600	1.840	1.710	1.650
1988 TUTCE	1.130	1.410	1.630	1.590	1.490
1985 Gainesville	1.100	1.430	1.430	1.430	1.410
1990 Martin	1.150	1.720	1.720	1.720	1.720
1990 Pensacola	1.070	1.620	1.840	1.840	1.750
1990 Indian Rivers	1.100	1.650	1.650	1.650	1.500
1990 Broward	1.120	N/A	N/A	N/A	1.720

Notes:
TBRPM: Tampa Bay Regional Planning Model
LCTCS: Lee County Urban Travel Characteristics Study
TUTCE: Tallahassee Urban Travel Characteristics Evaluation Study
TUTCE: Tallahassee Urban Travel Characteristics Evaluation Study
OUTCS: Orlando Urban Travel Characteristics Study
SEFITS: Southeast Florida Internal Travel Study
PPHTCE: Pasco, Pinellas, Hillsborough Travel Characteristics Evaluation Study

The auto occupancy factor is the inverse, or reciprocal, of the auto occupancy rate. The auto occupancy factors were applied to factor the person trips into vehicle trips for each trip purpose. The percent changes of average trip length from 1997 VCUATS model to 2002 Volusia County travel survey are –19.1% for HBW, -21.4% for HBSH, -14.0% for HBSR, -9.7% for HBO, and 16.6% for NHB. As a result the lower auto occupancy rates would increase the model vehicle volumes loaded onto the network in Volusia County. However the validity and reasonableness of a travel demand model need to be checked not only by mode choice model (auto occupancy) alone but other model components. An example would be the trip generation rates in the trip generation model and the trip length in the trip distribution model.

Traffic Assignment Factors

The final step in the transportation demand modeling process is the traffic assignment. Traffic assignment involves both the highway assignment (HASSIGN) model and transit assignment (TASSIGN) model.

Highway assignment represents the allocation of the highway trips resulting from the mode split step onto the predicted congested path of the highway network. The inputs for the highway assignment model are dependent on results produced by previous modeling steps, such as the external, trip generation, highway network, highway path, trip distribution, and the mode choice and auto occupancy models.

Transit assignment is the process of allocating the transit trips estimated in the mode choice model to the transit network. These assigned transit trips can be identified by all transit modes that were used in traveling to a destination. Transit trips are measured by route and represent unlinked trips by mode. Transit trips are allocated independently of highway trips.

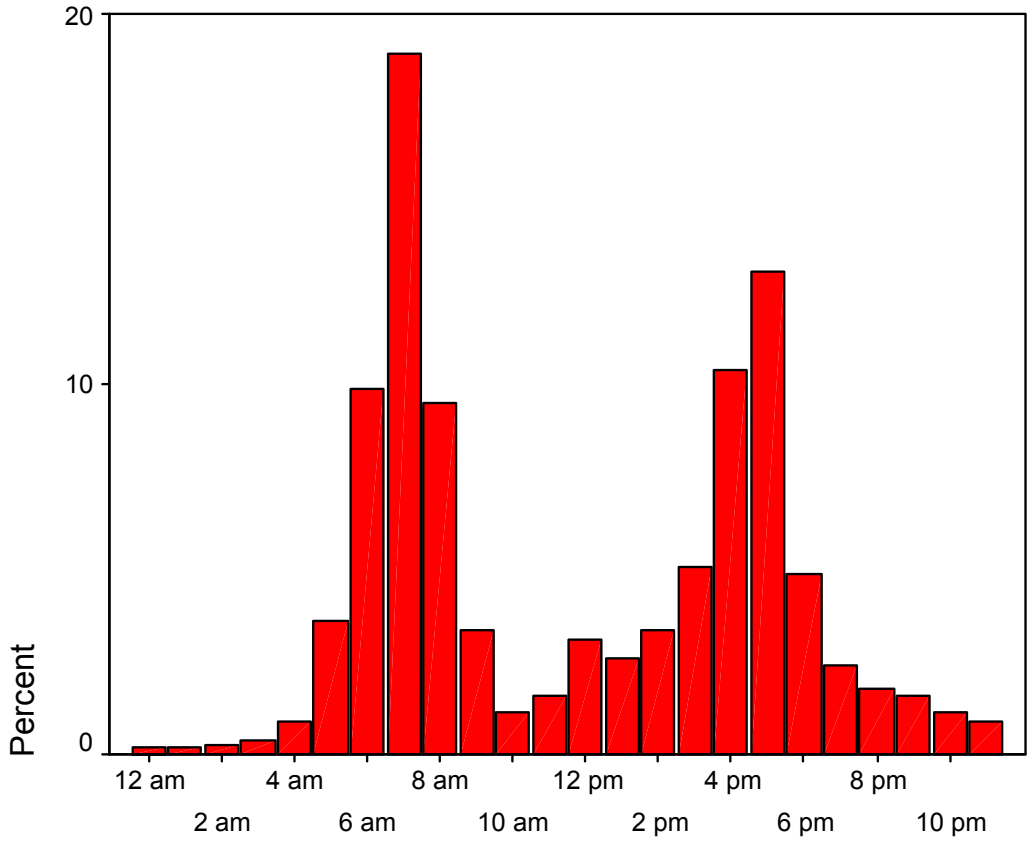
The Ratio of Peak Hour to Daily Traffic (CONFAC)
Capacity restraint factors involve the conversion of daily traffic volumes to peak hour traffic volumes and the determination of volume to capacity ratios. The ratio of peak hour to daily traffic (CONFAC) of 10.0 percent was used in the 1997 VCUATS Model as it reflects the peak hour to daily traffic characteristics of the Volusia County area.

Trip Start Time: Home Based Work Trips
As shown in Table 5-29 and Figure 5-33, the highest travel hour (hour in which the greatest number of trips began) for the weighted Home Based Work trips is 7 AM (18.9%). The highest three consecutive morning travel hours are 6-9AM for Volusia County (38.3%). The morning peak hour percentage is higher than expected. The highest afternoon travel hour is 5 PM (13.0%). The afternoon peak hour carries roughly two-thirds of the peak morning hour traffic.

Table 5-29
Model Coefficients and Trip Factors
Trip Start Time: Home Based Work Trips

Start Time	Trips	Percent (%)
12 am	4	.2
1 am	4	.2
2 am	5	.3
3 am	7	.4
4 am	18	.9
5 am	71	3.6
6 am	196	9.9
7 am	375	18.9
8 am	188	9.5
9 am	67	3.4
10 am	23	1.2
11 am	31	1.6
12 pm	62	3.1
1 pm	51	2.6
2 pm	66	3.3
3 pm	100	5.0
4 pm	206	10.4
5 pm	258	13.0
6 pm	96	4.8
7 pm	48	2.4
8 pm	35	1.8
9 pm	31	1.6
10 pm	22	1.1
11 pm	18	.9
Total	1,982	100.0

Figure 5-33
Model Coefficients and Trip Factors
Trip Start Time: Home Based Work Trips



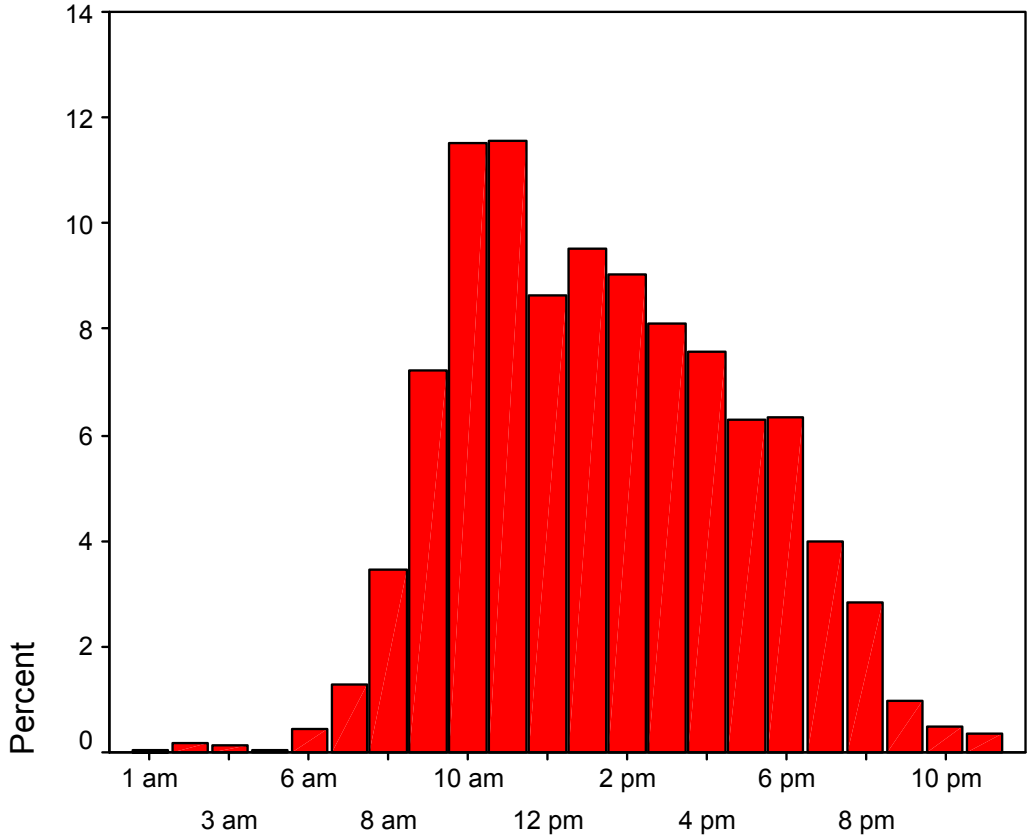
Trip Start Time: Home Based Shopping Trips

As shown in Table 5-30 and Figure 5-34, the highest travel hour (hour in which the greatest number of trips began) for the weighted Home Based Shopping trips is 11 AM (11.6%). The highest three consecutive peak travel hours are 10 AM – 1 PM for Volusia County. The highest afternoon travel hour is 1 PM (9.5%).

Table 5-30
Model Coefficients and Trip Factors
Trip Start Time: Home Based Shopping Trips

Start Time	Trips	Percent (%)
1 am	1	.1
2 am	3	.2
3 am	2	.1
5 am	1	.1
6 am	7	.4
7 am	21	1.3
8 am	57	3.5
9 am	119	7.2
10 am	190	11.5
11 am	191	11.6
12 pm	143	8.7
1 pm	157	9.5
2 pm	149	9.0
3 pm	134	8.1
4 pm	125	7.6
5 pm	104	6.3
6 pm	105	6.4
7 pm	66	4.0
8 pm	47	2.8
9 pm	16	1.0
10 pm	8	.5
11 pm	6	.4
Total	1,652	100.0

Figure 5-34
Model Coefficients and Trip Factors
Trip Start Time: Home Based Shopping Trips



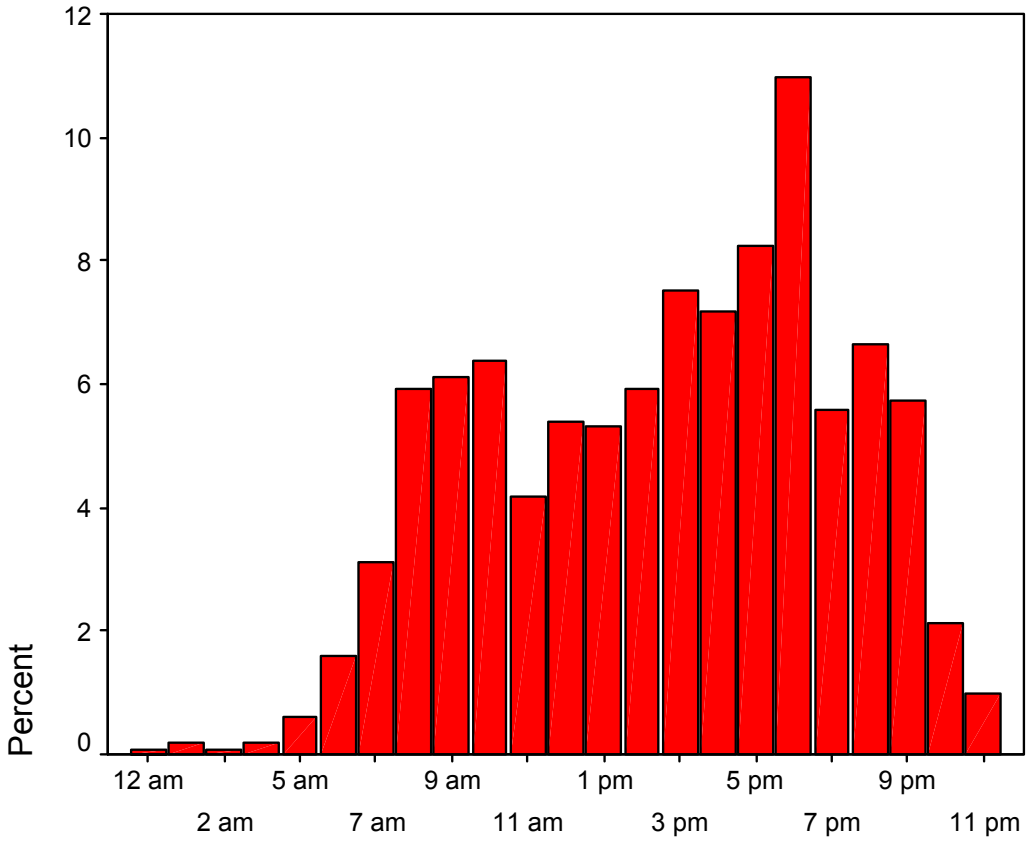
Trip Start Time: Home Based Social Recreation Trips

As shown in Table 5-31 and Figure 5-35, the highest travel hour (hour in which the greatest number of trips began) for the weighted Home Based Social Recreation trips is 6 PM (11.0%). The highest three consecutive peak travel hours are 4 AM – 6 PM for Volusia County. For social-recreational trip purpose, the peak hour percentages are relatively evenly distributed compared to other trip purposes as expected.

Table 5-31
Model Coefficients and Trip Factors
Trip Start Time: Home Based Social Recreation Trips

Start Time	Trips	Percent (%)
12 am	1	.1
1 am	2	.2
2 am	1	.1
4 am	2	.2
5 am	7	.6
6 am	18	1.6
7 am	35	3.1
8 am	67	5.9
9 am	69	6.1
10 am	72	6.4
11 am	47	4.2
12 pm	61	5.4
1 pm	60	5.3
2 pm	67	5.9
3 pm	85	7.5
4 pm	81	7.2
5 pm	93	8.2
6 pm	124	11.0
7 pm	63	5.6
8 pm	75	6.6
9 pm	65	5.8
10 pm	24	2.1
11 pm	11	1.0
Total	1,130	100.0

Figure 5-35
Model Coefficients and Trip Factors
Trip Start Time: Home Based Social Recreation Trips



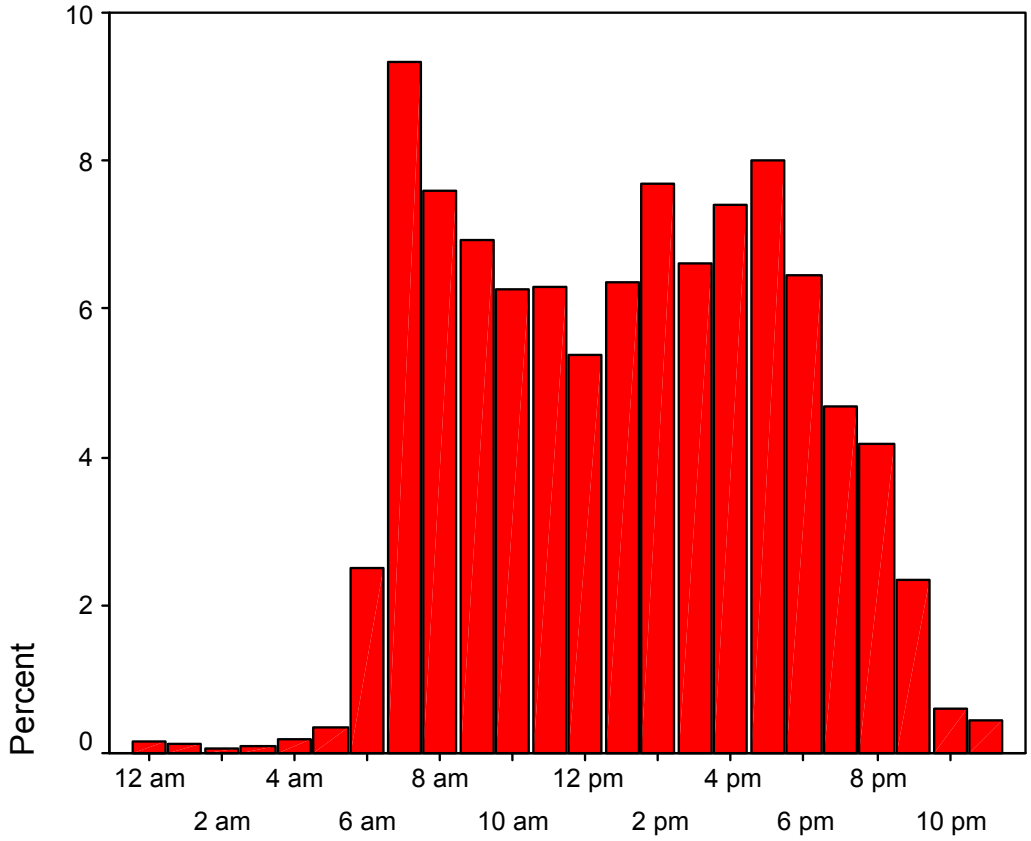
Trip Start Time: Home Based Other Trips

As shown in Table 5-32 and Figure 5-36, the highest travel hour (hour in which the greatest number of trips began) for the weighted Home Based Other trips is 7 AM (9.3%). The highest afternoon travel hour is 5 PM (8.0%). For Home Based Other trip purpose, the peak hour percentages are relatively evenly distributed compared to other trip purposes as expected.

Table 5-32
Model Coefficients and Trip Factors
Trip Start Time: Home Based Other Trips

Start Time	Trips	Percent (%)
12 am	6	.1
1 am	5	.1
2 am	2	.0
3 am	4	.1
4 am	8	.2
5 am	14	.3
6 am	105	2.5
7 am	392	9.3
8 am	318	7.6
9 am	290	6.9
10 am	263	6.3
11 am	264	6.3
12 pm	225	5.4
1 pm	267	6.4
2 pm	323	7.7
3 pm	277	6.6
4 pm	311	7.4
5 pm	336	8.0
6 pm	271	6.5
7 pm	197	4.7
8 pm	175	4.2
9 pm	98	2.3
10 pm	25	.6
11 pm	18	.4
Total	4,194	100.0

Figure 5-36
Model Coefficients and Trip Factors
Trip Start Time: Home Based Other Trips



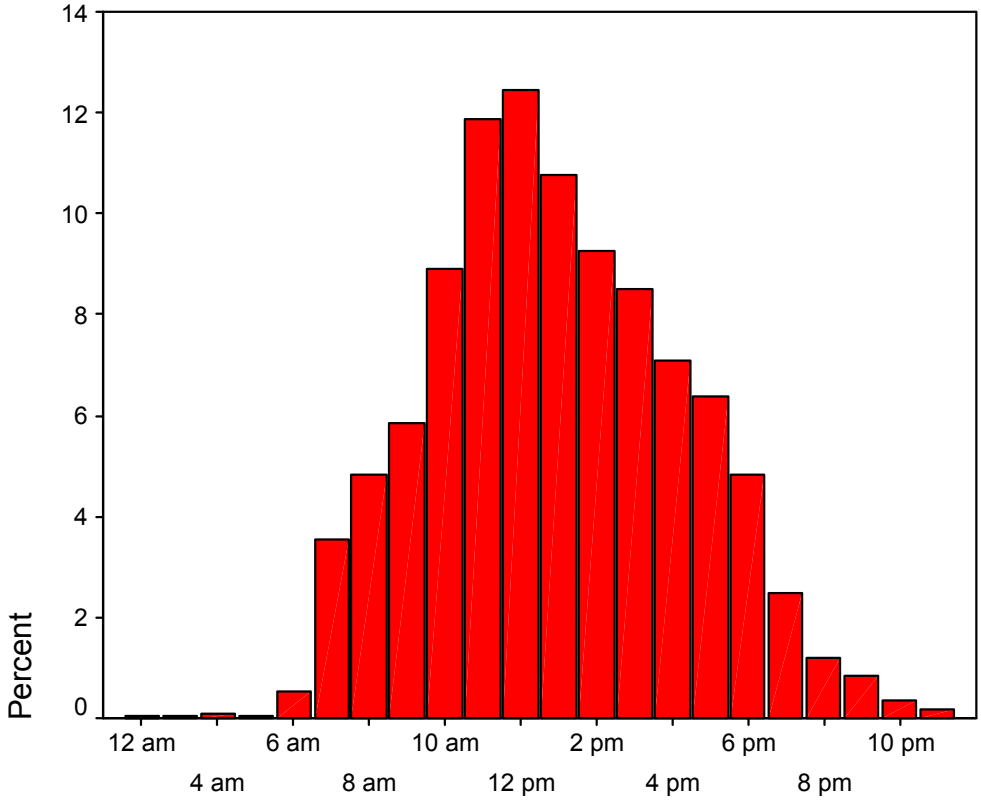
Trip Start Time: Non-Home Based Trips

As shown in Table 5-33 and Figure 5-37, the highest travel hour (hour in which the greatest number of trips began) for the weighted Non Home Based trips is 12 PM (11.9%). The highest three consecutive peak travel hours are 11 AM – 1 PM, as expected.

Table 5-33
Model Coefficients and Trip Factors
Trip Start Time: Non-Home Based Trips

Start Time	Trips	Percent (%)
12 am	1	.0
1 am	1	.0
4 am	3	.1
5 am	1	.0
6 am	24	.5
7 am	157	3.5
8 am	213	4.8
9 am	259	5.9
10 am	393	8.9
11 am	525	11.9
12 pm	550	12.4
1 pm	476	10.8
2 pm	410	9.3
3 pm	377	8.5
4 pm	313	7.1
5 pm	283	6.4
6 pm	214	4.8
7 pm	110	2.5
8 pm	52	1.2
9 pm	38	.9
10 pm	15	.3
11 pm	8	.2
Total	4,423	100.0

Figure 5-37
Model Coefficients and Trip Factors
Trip Start Time: Non-Home Based Trips



Recommendation of New CONFAC

New recommended ratios of peak hour to daily traffic (CONFAC) for each trip purpose are shown in Table 5-34. These new recommended CONFAC factors were based upon extensive analysis efforts on the Volusia County Home Based Travel Survey. These new factors reflect the most current peak hour to daily traffic characteristics of the Volusia County area.

As shown in Table 5-34, the biggest CONFAC was estimated to be 0.189 for Home Based Work trips while the smallest was estimated to be 0.093 for Home Based Other trips. An average CONFAC value of 0.126 was derived for all trip purpose where as CONFAC value of 0.100 was used in the 1997 VCUATS Model.

Table 5-34
Model Coefficients and Trip Factors
New Recommended CONFAC

Trip Purpose	Peak Hour Percent	CONFAC
Home based Work (HBW)	18.9%	0.189
Home based Shopping (HBSH)	11.6%	0.116
Home based Social/Recreation (HBSR)	11.0%	0.110
Home based Other (HBO)	9.3%	0.093
Non-Home based (NHB)	12.4%	0.124
All Trip Purpose (Trip Purpose Average)	12.6%	0.126

The bigger CONFAC would not change daily trip tables, but it might reduce the number of vehicle volumes loaded onto the network. In FSUTMS, a daily capacity is defined as (Hourly Capacity/CONFAC)*UROAD. Therefore a bigger CONFAC would reduce daily capacity, which in turn reduces loaded volumes onto the network since the reduced capacity may cause more delays and more congestions.

Capacity restraint factors involve the conversion of daily traffic volumes to peak hour traffic volumes and the determination of volume to capacity ratios. These factors include peak hour to daily ratios (CONFAC) and capacity factors (CAPFAC). The CONFAC reflects the peak hour to daily traffic characteristics of the Volusia County. The capacity factor (CAPFAC) provides sufficient capacity restraint to the peak hour traffic for diversions of traffic to other highway facilities and for the highway assignment (HASSIGN) model to simulate accurately. In addition, the damping factor regulates the amount of speed adjustment made after obtaining a speed value from the speed/flow curve, and is used to reduce the oscillations in iterative capacity restraint.

In order to evaluate reasonableness of the new recommended ratios of peak hour to daily traffic (CONFAC), it is necessary to perform a model validation. The peak season traffic counts need to be compared with the simulated traffic volumes by highway facility type. Similarly, the peak season traffic counts need to be compared with the estimated traffic volumes by the highway area type. To determine whether there is any problem in the traffic assignment, it is important to evaluate volume over count ratios relative to the percentage of links with counts, and the number of links in each category of facility type and area type. The estimated traffic volumes on each individual screenline also need to be compared with the counts to determine if simulation results were inconsistent in any area of the county. Results of these analyses will show the accuracy of the estimated traffic volumes in comparison with the peak season traffic counts.