CAMBRIDGE SYSTEMATICS

Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study

Interregional Model System Development

final

report

prepared for

Metropolitan Transportation Commission and the California High-Speed Rail Authority

prepared by

Cambridge Systematics, Inc.

with

Mark Bradley Research and Consulting

August 2006

www.camsys.com

draft report

Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study

Interregional Model System Development

prepared for

Metropolitan Transportation Commission and the California High-Speed Rail Authority

prepared by

Cambridge Systematics, Inc.
555 12th Street, Suite 1600
Oakland, CA 94607

with

Mark Bradley Research and Consulting

date

August 2006

Table of Contents

1.0 Introduction 1-1
1.1 Purpose of The Report 1-1
1.2 Overall Model Design 1-1
1.3 Contents of The Report 1-4

2.0 Data for Model Estimation 2-1
2.1 Travel Surveys 2-1
Air, Rail, and Auto Passenger Surveys 2-1
Air Passenger Surveys 2-1
Rail Passenger Surveys 2-2
Auto Passenger Surveys 2-2
Caltrans Household Travel Survey 2-4
Urban Area Household Travel Surveys 2-5
2.2 Highway and Transit Networks 2-8
Highway Network 2-8
Air Networks 2-10
Conventional Rail Networks 2-12
Urban Area Transit Networks 2-13
Area Type 2-15
2.3 Socioeconomic Data 2-19

3.0 Interregional Models 3-1
Model Component Linkages 3-3
Accessibility Measures 3-1
Logsum Measures 3-2
3.1 Trip Frequency Models 3-3
Model Structure 3-3
Model Specification 3-4
Accessibility 3-6
Regional Dummy Variables 3-7
Estimation Results 3-7
3.2 Party Size Models 3-13
Model Structure 3-13
Model Specification 3-13
Alternative-Specific Constants 3-13

Household Income 3-13
Household Size 3-14
Number of Household Vehicles 3-14
Trip Purpose 3-14
Estimation Results 3-14
3.3 Destination Choice Models 3-15
Model Structure 3-15
Segmentation by Length 3-16
Trip Purposes 3-16
Model Specification 3-17
Travel Impedance 3-17
Distance 3-17
Area Type 3-19
Location/Region 3-19
Location Interaction Variables 3-20
Size Functions 3-22
Estimation Results 3-23
3.4 Access/Egress Mode Choice Models 3-27
Model Structure 3-27
Model Specification 3-27
Estimation Results 3-28
3.5 Main Mode Choice Models 3-34
Model Structure 3-34
Model Specification 3-35
Estimation Results 3-36
3.6 Model Application 3-38

List of Tables

Table 2.1 Air, Rail, and Auto Passenger Surveys by Mode, Distance, and Purpose 2-3

Table 2.2 Caltrans Travel Surveys of Interregional Trips by Mode, Distance, and Purpose 2-4

Table 2.3 SCAG Travel Surveys of Interregional Trips by Mode, Distance, and Purpose 2-6

Table 2.4 MTC Travel Surveys of Interregional Trips by Mode, Distance, and Purpose 2-6

Table 2.5 SACOG Travel Surveys of Interregional Trips by Mode, Distance, and Purpose 2-7

Table 2.6 Total of All Survey Interregional Trips by Mode, Distance, and Purpose 2-7

Table 2.7 Speeds (Miles Per Hour) by Area Type and Functional Classification 2-9

Table 2.8 Capacities (Per Lane Per Hour) by Area Type and Functional Classification 2-10

Table 2.9 California Airport Demand for In-State Travel 2-10

Table 2.10 Socioeconomic Data Classifications 2-19

Table 2.11 Traffic Analysis Zones 2-20

Table 3.1 Frequency of Trip Frequency in the Combined Surveys 3-4

Table 3.2 Trip Frequency Models – Long Trips 3-9

Table 3.3 Trip Frequency Models for Long Trips 3-11

Table 3.4 Trip Frequency Models for Short Trips 3-12

Table 3.5 Party Size Estimation Dataset 3-13

Table 3.6 Business/Commute Party Size Model 3-15

Table 3.7 Recreation/Other Party Size Model 3-15

Table 3.8 Estimation Data by Purpose, Length, and Source 3-16

Table 3.9 Destination Choice Models for Long Trips 3-24

Table 3.10 Destination Choice Models for Short Trips 3-25

Table 3.11 Access and Egress Mode Choice Shares 3-28

Table 3.12 Access Mode Choice Models 3-29
Table 3.13 Egress Mode Choice Models 3-31
Table 3.14 Overall Choice Shares in SP Data 3-35
Table 3.15 Main Mode Choice Models 3-37

List of Figures

Figure 1.1 California Urban Areas and HSR Station Locations 1-2
Figure 1.2 Integrated Modeling Process 1-4
Figure 2.1 New Statewide Model Highway Network.....2-9
Figure 2.2 New Statewide Model Transit Network.....2-14
Figure 2.3 Transit Network in Southern California 2-15
Figure 2.4 Statewide Area Types 2-16
Figure 2.5 Northern California Area Types 2-17
Figure 2.6 Southern California Area Types.....2-18
Figure 3.1 Interregional Model Structure.....3-1
Figure 3.2 Market Segments in Each Model 3-4
Figure 3.3 Model Component Linkages 3-1
Figure 3.4 Net Effect of Distance on Trips in Destination Choice Models 3-18
Figure 3.5 Regions for Destination Choice Models.....3-20
Figure 3.6 Regions for Destination Choice Models.....3-21
Figure 3.7 Access/Egress Nested Model Structure 3-27
Figure 3.8 Main Mode Choice Nested Model Structure.....3-34
Figure 3.10 Model Application Structure Outline.....3-39
Figure 3.11 Interregional Model Purpose/Distance Segmentation.....3-40

1.0 Introduction

1.1 PURPOSE OF THE REPORT

The focus of this report is on the development of the interregional models for the Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study. These interregional models are estimated from a combination of existing and new household and intercept traveler surveys collected in California. There is a full set of new interregional models, including trip frequency, party size, and destination and mode choice models. These models are segmented by trip purpose, distance, and location of the interregional trip households.

This report does not include validation or forecasting using these interregional travel models; that is the subject of the next phase of the project. It also does not include the development, validation, or forecasting of the urban travel models, which will determine high-speed rail ridership within the urban areas of California. The urban models are derived from existing urban models, with enhancements to include forecasting of the high-speed rail mode. These models will be validated along with the interregional travel models to confirm their reliability, and will be included in the forecasting activities. The urban model documentation will, therefore, be included in the model validation and forecasting reports, and will be presented to the peer review at the third peer review panel meeting, along with the validation and forecasting of the interregional travel models.

1.2 OVERALL MODEL DESIGN

The model design for the Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study includes the following components:

- Urban travel;
- Interregional travel;
- External travel; and
- Trip assignment.

Urban trips include all trips with both ends in one of the three urban areas with more than one proposed high-speed rail station. These areas are the San Francisco Bay Area, Greater Los Angeles, and San Diego regions. Sacramento is also considered to ensure that this capability is available for future purposes. The metropolitan planning organizations (MPO) representing these areas are the Metropolitan Transportation Commission (MTC), the San Diego Association of Governments (SANDAG), the Southern California Association of Governments

(SCAG), and the Sacramento Area Council of Governments (SACOG). These urban areas are presented in Figure 1.1.

Figure 1.1 California Urban Areas and HSR Station Locations

Interregional trips include all trips with both ends in California and whose origin and destination are in different urban areas (or different counties outside the urban areas) having proposed high-speed rail stations.

External trips include trips with one end outside California and one end in an urban area with a proposed high-speed rail station.

We recognize that some urban trips may be longer than some interregional trips by this definition and vice-versa. However, these definitions do clearly fit in with urban and statewide planning definitions, and do identify most interregional trips as those that begin or end outside an urban area. One example of an anomaly is a trip from Modesto to San Jose (defined as an interregional trip), which is similar in distance to a trip from Palmdale to Los Angeles (defined as an urban trip). Even taking these anomalies into consideration, there was consensus that the definition of urban and interregional trips fit well with most trips in the system, and that the models proposed for each would adequately address the behavioral nature of each trip type. In addition, as discussed below, we have segmented the interregional trips into short trips (less than 100 miles) and long trips (longer than 100 miles) to help address this issue.

During the design and data collection of interregional trips through intercept surveys at air and rail stations, we decided to focus the resources of data collection on travel within California. As a result, there are no data on external travel that may access the high-speed rail system in California. We will separately estimate external travel from Mexico into California through Tijuana, especially on the Tijuana Trolley system.

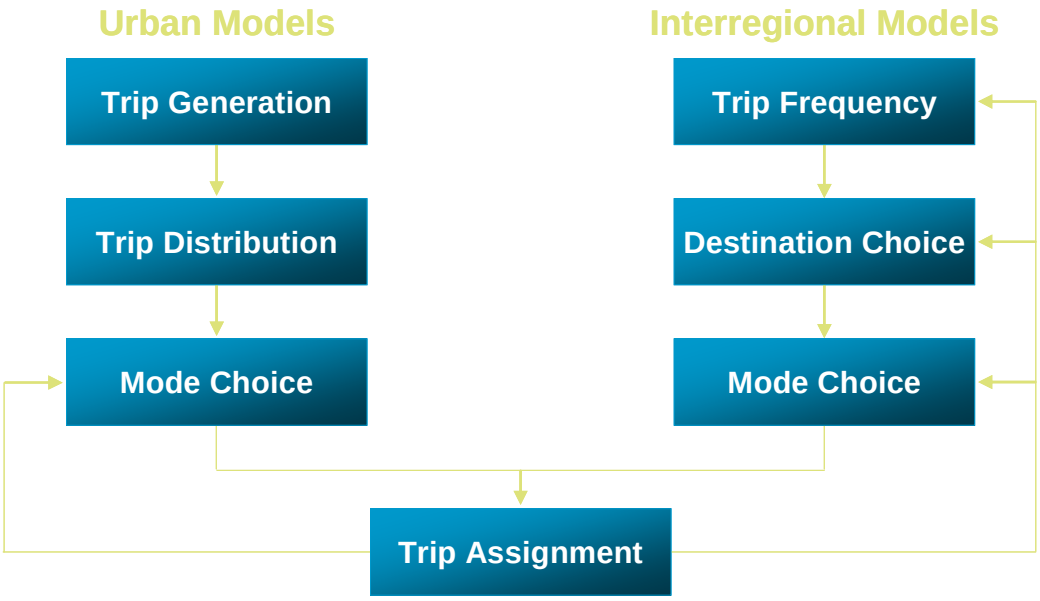
Trip assignment includes the merging of the urban, interregional, and external trips into modal trip tables that are assigned to highway, rail, and air networks. These assignments will be validated in the base year and forecast year to evaluate reasonableness and accuracy compared to observed data sources. The model base year is 2005, but we will also prepare a year 2000 model run to compare with data sources that are from that year. Sensitivity tests will also be performed to ensure that the models capture behavioral changes to key parameters, such as time and cost. As mentioned above, the interregional trips are the focus of this report, while the urban, external, and assignment model components will be reported in the next phase of the project.

The California interregional models will explicitly model peak and off-peak travel for both urban and interregional trip movements. Consistent with most urban and statewide models, this model will estimate average weekday riders for the high-speed rail system. These average weekday riders will be converted to average annual riders using annualization factors developed from available high-speed rail systems around the world. To the extent possible, we will use available data by trip purpose to develop annualization factors.

The integrated modeling process for the development of the statewide model is presented in Figure 1.1. This process shows that the accessibility of the system

(represented by travel time) is included in the mode choice models and in the interregional trip frequency and destination choice models. This feature allows us to estimate the induced travel for the interregional travel market.

Figure 1.2 Integrated Modeling Process



1.3 CONTENTS OF THE REPORT

There are three sections in this report: the introduction, a discussion of data sources, and descriptions of each model component. Data sources include travel surveys, highway and transit networks, and socioeconomic data. Model components include trip frequency, party size, destination choice, access and egress mode choice, and main mode choice models.

This report builds on several other reports developed in earlier stages of this project:

- *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study Model Design, Data Collection and Performance Measures*, Cambridge Systematics, Inc., with Mark Bradley Research & Consulting and Corey, Canapary & Galanis Research, June 2005;
- *High-Speed Rail Study Survey Documentation*, prepared for Cambridge Systematics, Inc., and the Metropolitan Transportation Commission by Corey, Canapary & Galanis Research, December 2005; and
- *Bay Area/California High-Speed Rail Ridership and Revenue Forecasting Study Socioeconomic Data, Transportation Supply, and Base Year Travel Patterns Data*, Cambridge Systematics, Inc., December 2005.

These reports are available from MTC or the CHSRA.

2.0 Data for Model Estimation

A variety of travel survey data sources, highway and transit networks, and socioeconomic data were used for model estimation of the interregional travel models. These sources are summarized below. Data sources developed for use in model validation of the urban and interregional travel models will be reported in the next phase of the project.

2.1 TRAVEL SURVEYS

Air, Rail, and Auto Passenger Surveys

A combination of intercept surveys and household surveys was conducted to obtain the new data needed for the study. The survey data includes revealed-preference (RP) and stated-preference (SP) mode choice data from air, rail, and auto trip passengers. These surveys were coordinated and conducted by Corey, Canapary & Galanis Research (CC&G) of San Francisco.

In total, 3,172 surveys were conducted on this project. This includes:

- 1,234 airline passenger intercept surveys;
- 430 rail passenger intercept and telephone surveys; and
- 1,508 auto trip telephone surveys.

Air Passenger Surveys

Airline passenger surveys were conducted at six key airports throughout California. The surveys were conducted on the following dates:

- Sacramento Airport – Conducted August 17 to 18, 2005;
- San Jose Airport – Conducted August 24 to 25, 2005.
- San Francisco Airport – Conducted September 20 to 22, 2005;
- Fresno Airport – Conducted for October 13, 2005;
- Oakland Airport – Conducted November 1, 2005 (outside the security area); and
- San Diego Airport – Conducted November 9, 2005 (outside the security area).

Surveying was conducted inside the terminals at boarding gates at Sacramento (SMF), San Jose (SJC), San Francisco (SFO), and Fresno (FAT) airports. Surveying was conducted outside the security areas at Oakland (OAK) and San Diego (SAN) airports. In the airports where surveying was done at the boarding gates, teams of surveyors were assigned to specific flights that were going to targeted

destination airports in California. Potential respondents at Oakland and San Diego were approached, and asked their travel destinations. California-bound travelers were administered the survey.

Mailback envelopes with postage paid were offered to respondents who did not complete the questionnaire in time to give it back to surveyor at the airport. Most surveys completed at the SMF, SJC, SFO, and FAT airports were collected at the airport from passengers who filled them out while waiting for their planes. Nearly all of the surveys distributed at OAK and SAN were mailed back by respondents. This is because passenger at these two airports did not have a significant amount of time to complete the survey outside the security area.

Rail Passenger Surveys

The rail passenger survey was conducted using two methodologies: 1) as an on-board self-administered survey similar to the air passenger survey; and 2) as a telephone survey conducted among qualified users of existing rail services. On-board surveys were conducted on two commuter rail systems on the following dates:

- Altamont Commuter Express (ACE) Trains – Conducted October 11, 2005; and
- Metrolink Trains – Conducted November 10, 2005.

Telephone surveys were conducted using a rider database from Amtrak that included riders from the following services:

- Capitol Corridor;
- Pacific Surfliner; and
- San Joaquins.

Rail passenger intercept (on-board) surveys were conducted on-board the Altamont Commuter Express (ACE) and Metrolink trains. Teams of surveyors were assigned to specific routes that were traveling across targeted regions served by this system. For example, on the Metrolink trains, routes that traveled between the San Diego and Los Angeles region were targeted. Mailback envelopes with postage paid were offered to respondents who did not complete the questionnaire in time to give it back to surveyor on the train.

Auto Passenger Surveys

To capture the mode choice decisions of interregional travelers who have chosen to use autos, a Random Digit Dial (RDD) sample of household surveys was conducted among residents of the study area. A stratified sampling approach was utilized. This entailed dividing the State into the relevant regions, and setting a targeted number of completes for households within each region.

The final target quotas for the retrieval surveys were:

- A minimum of 120 responses from 9 regions = 1,080 plus;
- 120 additional responses from some combination of the six smaller areas (Bakersfield, Tulare/Visalia, Fresno, Merced, Modesto/Stockton, Sacramento); plus
- 250 additional responses from some combination of the three larger areas (San Diego, Los Angeles, San Francisco Bay).

The final retrievals by region are as follows:

- San Diego (158);
- Los Angeles (243);
- Bakersfield (144);
- Tulare County/Visalia (98);
- Fresno (149);
- Merced (155);
- San Francisco Bay Area (283);
- Modesto/Stockton (145); and
- Sacramento (133).

The actual number of retrieval surveys conducted was a total of 1,508.

Table 2.1 presents a summary of the air, rail, and auto passenger surveys collected for this project. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the interregional travel models.

Table 2.1 Air, Rail, and Auto Passenger Surveys by Mode, Distance, and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	138	611	27	–	–	**776**
Commute	4	15	8	–	–	**27**
Recreation	805	228	80	–	–	**1113**
Other	159	82	15	–	–	**256**
Short Trips						
Business	43	14	46	–	–	**103**
Commute	6	0	159	–	–	**165**
Recreation	146	2	27	–	–	**175**
Other	54	1	8	–	–	**63**
Total	**1,355**	**953**	**370**	**–**	**–**	**2,678**

Caltrans Household Travel Survey

The California Statewide Travel Survey was conducted in 2000-2001 for weekday travel[1]. This survey was an activity-based survey and included all in-home activities and travel completed in accessing activity locations over a 24-hour period. The survey of 17,040 households was conducted in each of the 58 counties throughout the State. The survey reported 8.6 total trips per household.

The survey was conducted by NuStats Research and Consulting, who surveyed randomly selected households using the telephone recruitment/diary mail-out/telephone trip retrieval method. These data were used in this study as disaggregate data so expansion and adjustment factors developed for the survey were not utilized. This includes adjustment factors developed from Global Positioning System (GPS) surveys conducted to identify trip under-reporting and those developed to account for changes in travel behavior due to the September 11, 2001, attacks on the World Trade Center and Pentagon, which severely disrupted travel throughout the U.S. The survey was conducted in waves, with the fall 2000 and spring 2001 waves completed before 9/11 and the fall 2001 wave completed before and after 9/11.

Table 2.2 presents a summary of the California Department of Transportation (Caltrans) household travel surveys filtered for interregional travel. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the interregional travel models.

Table 2.2 Caltrans Travel Surveys of Interregional Trips by Mode, Distance, and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	110	9	–	–	–	**119**
Commute	181	–	1	–	4	**186**
Recreation	175	–	–	1	3	**179**
Other	122	3	1	5	7	**138**
Short Trips						
Business	271	–	2	2	–	**275**
Commute	854	–	9	9	7	**879**
Recreation	550	–	–	1	3	**554**
Other	465	–	–	14	11	**490**
Total	**2,728**	**12**	**13**	**32**	**35**	**2,820**

[1] State of California, Department of Transportation, Division of Transportation System Information, Office of Travel Forecasting and Analysis, Statewide Travel Analysis Branch, *2000-2001 California Statewide Travel Survey Weekday Travel Report*, June 2003.

Urban Area Household Travel Surveys

There are three urban area household travel surveys that were used to supplement the statewide travel survey for interregional travel:

- Southern California Association of Governments (SCAG)[2];
- Bay Area Metropolitan Transportation Commission (MTC)[3]; and
- Sacramento Area Council of Governments (SACOG)[4].

The SANDAG survey was obtained and reviewed but did not have sufficient geocoding of interregional travel to retain these trips for use in this study.

The SCAG survey was a large-scale regional household travel survey conducted in six counties in Southern California. The survey was conducted using Random Digit Dial (RDD) methods for six sample types (base, Caltrans, Regional Statistical Area Augment, Weekend, Mode User Augment, and a GPS sample). Data collection was conducted during spring 2001, fall 2001, and spring 2002. After data quality and cleaning, a total of 16,939 households completed the survey.

Table 2.3 presents a summary of the SCAG household travel surveys filtered for interregional travel. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the interregional travel models.

---

[2] NuStats Research and Consulting, *Year 2000 Post-Census Regional Travel Survey Final Report of Survey Methodology*, prepared for the Southern California Association of Governments, June 30, 2003.

[3] Metropolitan Transportation Commission, *San Francisco Bay Area Travel Survey 2000 Regional Travel Characteristics Report Volume I,* August 2004.

[4] NuStats Research and Consulting, *2000 Sacramento Area Household Travel Survey Final Report,* prepared for the Sacramento Area Council of Governments, November 2000.

Table 2.3 SCAG Travel Surveys of Interregional Trips by Mode, Distance, and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	–	–	–	16	5	**21**
Commute	21	–	–	–	1	**22**
Recreation	42	–	–	–	1	**43**
Other	15	–	–	–	2	**17**
Short Trips						
Business	39	–	–	–	–	**39**
Commute	120	–	–	–	2	**122**
Recreation	53	–	–	–	1	**54**
Other	25	–	–	–	–	**25**
Total	**315**	**–**	**–**	**16**	**12**	**343**

Table 2.4 presents a summary of the MTC/BATS household travel surveys filtered for interregional travel. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the interregional travel models.

Table 2.4 MTC Travel Surveys of Interregional Trips by Mode, Distance, and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	6	–	–	1	3	**10**
Commute	24	–	–	1	15	**40**
Recreation	55	–	–	2	18	**75**
Other	38	–	1	1	10	**50**
Short Trips						
Business	22	–	–	1	15	**38**
Commute	156	–	–	–	99	**255**
Recreation	117	–	2	2	47	**168**
Other	44	–	2	9	32	**87**
Total	**462**	**–**	**5**	**17**	**239**	**723**

The SACOG survey was conducted in six counties in California (Sacramento, Yolo, Yuba, Sutter, Placer, and El Dorado) from February to June 2000. A total of 3,942 households completed the survey over a 24-hour period. The survey collected data on randomly selected households using a telephone recruit, mail-out and telephone retrieval method of collection.

Table 2.5 presents a summary of the SACOG household travel surveys filtered for interregional travel. These are presented by trip purpose, mode, and distance to demonstrate the contribution to each market segment used in the interregional travel models.

Table 2.5 SACOG Travel Surveys of Interregional Trips by Mode, Distance, and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	60	–	–	1	9	**70**
Commute	33	–	–	–	54	**87**
Recreation	37	–	–	–	1	**38**
Other	31	–	–	2	72	**105**
Short Trips						
Business	6	–	–	–	–	**6**
Commute	-	–	–	–	–	**–**
Recreation	7	–	–	–	1	**8**
Other	3	–	–	–	1	**4**
Total	**177**	**–**	**–**	**3**	**138**	**318**

A full summary of the combined surveys by mode and purpose is presented in Table 2.6. There are 6,882 trip records of interregional travel in this combined dataset that was used (in part or in full) to estimate the interregional travel models described in the next section.

Table 2.6 Total of All Survey Interregional Trips by Mode, Distance, and Purpose

	Drive	Air	Rail	Bus	Other	Total
Long Trips						
Business	314	620	27	18	17	**996**
Commute	263	15	9	1	74	**362**
Recreation	1114	228	80	3	23	**1448**
Other	365	85	17	8	91	**566**
Short Trips						
Business	381	14	48	3	15	**461**
Commute	1136	0	168	9	108	**1421**
Recreation	873	2	29	3	52	**959**
Short Other	591	1	10	23	44	**669**
Total	**5,037**	**965**	**388**	**68**	**424**	**6,882**

2.2 HIGHWAY AND TRANSIT NETWORKS

Highway Network

The representation of highway network supply is primarily determined by the level of detail in the highway network and the attributes associated with the roadway system, such as lanes, distances, speed, and capacity. The full description of the development of these networks will be described in a separate report on network coding (Task 7). The highway network was constructed by incorporating network detail from each of the urban model networks into the California statewide model network. A brief summary of these networks is provided here.

Beginning with the existing statewide highway network, detail was added using the following regional models:

- In the Metropolitan Transportation Commission (MTC) region, the entire highway network was incorporated into the model;
- In the Southern California Association of Governments (SCAG) region, the entire highway network was incorporated into the model;
- In the San Diego Association of Governors (SANDAG) region, highway network was incorporated only within a five-mile radius of the three proposed high-speed rail stations;
- In the Sacramento Area Council of Governors (SACOG) region, highway network was incorporated only within a five-mile radius of the proposed high-speed rail station; and
- In the Kern County region, highway network was incorporated only within a five-mile radius of the proposed high-speed rail station.

Figure 2.1 shows the highway network in CUBE software. The new highway network includes 4,667 zones, 127,600 links, and 206,150 nodes.

Roadway and area type classifications from the various regional models have been consolidated. Speed and capacity definitions by functional class and area type are different for each regional model. These values are based on local conditions in each region and modifications made during model validation. To take advantage of the work done in each region, values from the individual models were kept intact instead of developing a new lookup table based on area type and functional class. Tables 2.7 and 2.8 show the range of values by area type and roadway classification.

Figure 2.1 New Statewide Model Highway Network

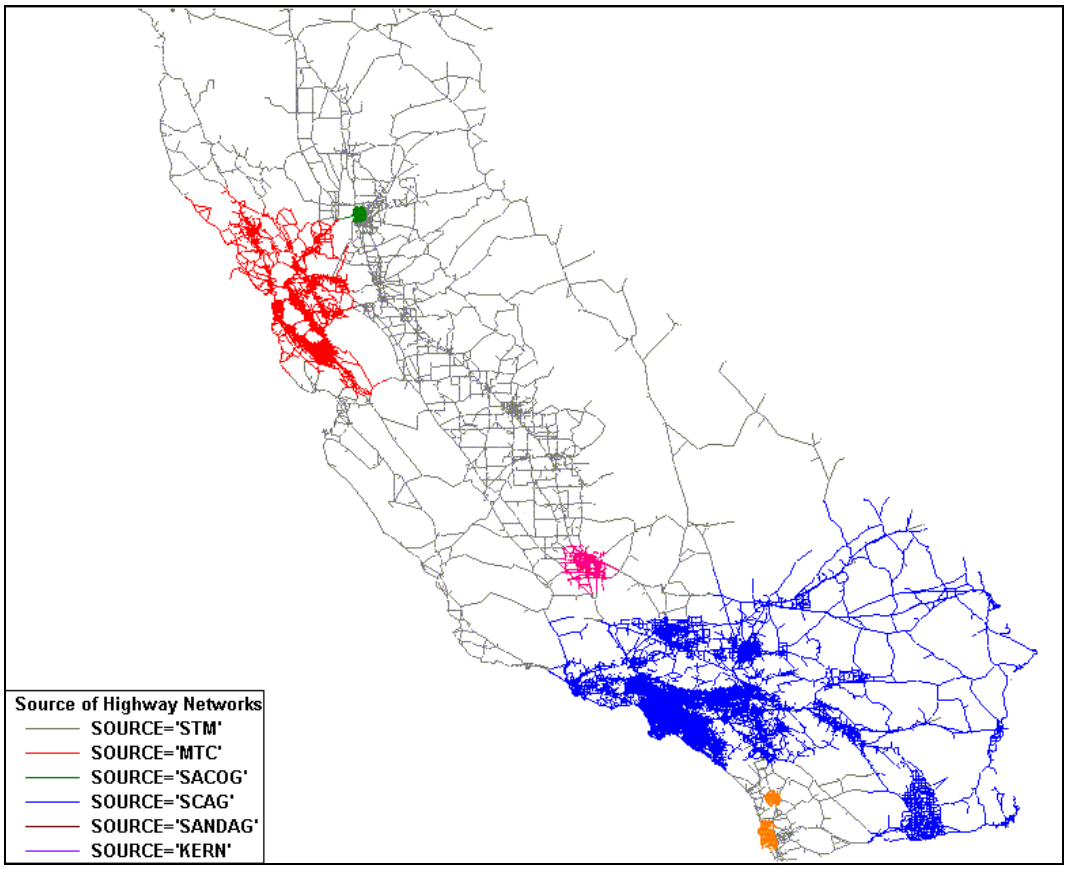


Table 2.7 Speeds (Miles Per Hour) by Area Type and Functional Classification

No.	Functional Class	Area Type		
		Urban	Suburban	Rural
1	Freeway	55-65	60-70	60-70
2	Expressway	40-60	45-60	40-65
3	Major Arterial	30-50	35-60	40-60
4	Minor Arterial	20-50	25-50	25-55
5	Collectors	20-35	25-45	25-55
7	Ramps	20-45	20-45	35-40
8	Freeway-Freeway Connector	40-50	50-55	50-55

Table 2.8 Capacities (Per Lane Per Hour) by Area Type and Functional Classification

No.	Functional Class	Area Type		
		Urban	Suburban	Rural
1	Freeway	1,750-2,100	1,750-2,100	1,950-2,100
2	Expressway	900-1,800	900-1,900	900-1,900
3	Major Arterial	800-1,800	800-1,900	800-1,900
4	Minor Arterial	700-1,800	700-1,800	700-1,800
5	Collectors	550-1,600	700-1,600	700-1,600
7	Ramps	500-1,600	600-1,600	1,250-1,600
8	Freeway-Freeway Connector	1,700-2,000	1,800-2,000	1,800-2,000

Air Networks

The State of California has 28 airports that offer commercial airline passenger service between California cities and elsewhere. Of these, 18 airports represent more than 99 percent of the in-state demand, so these 18 airports were selected to represent the air network for the statewide model. Table 2.8 lists these airports and provides estimates of their numbers of annual passenger boardings in 2000 and 2005. Since the events of September 11, 2001, air demand in California (and elsewhere) has declined overall, but the biggest decline was in 2002 and 2003, and since 2003, air demand has been increasing. The dramatic increase in demand at Long Beach airport is due to the beginning of service by Jet Blue.

Table 2.9 California Airport Demand for In-State Travel

Airport Code	City	Airport Name	2000 In-state Boardings	2005 In-state Boardings	Percent Change
OAK	Oakland	Metropolitan Oakland International	2,357,530	2,608,620	10.7%
LAX	Los Angeles	Los Angeles International	2,647,460	1,724,530	-34.9%
SMF	Sacramento	Sacramento International	1,573,400	1,649,350	4.8%
SAN	San Diego	San Diego International	1,791,980	1,548,700	-13.6%
SJC	San Jose	Norman Y. Mineta San Jose International	1,930,520	1,502,460	-22.2%
SNA	Santa Ana	John Wayne Airport-Orange County	1,253,290	1,130,960	-9.8%
BUR	Burbank	Bob Hope	1,219,680	1,038,020	-14.9%

ONT	Ontario	Ontario International	962,780	884,530	-8.1%
SFO	San Francisco	San Francisco International	1,961,320	812,670	-58.6%

Table 2.9 California Airport Demand for In-State Travel (continued)

Airport Code	City	Airport Name	2000 In-state Boardings	2005 In-state Boardings	Percent Change
LGB	Long Beach	Long Beach/Daugherty Field	260	233,250	89611.5%
PSP	Palm Springs	Palm Springs International	89,190	88,910	-0.3%
ACV	Arcata/Eureka	Arcata	29,200	35,790	22.6%
FAT	Fresno	Fresno Yosemite International	26,390	22,340	-15.3%
SBA	Santa Barbara	Santa Barbara Municipal	84,950	22,150	-73.9%
MRY	Monterey	Monterey Peninsula	19,380	21,270	9.8%
MOD	Modesto	Modesto City County-Harry Sham Field	6,080	3,720	-38.8%
BFL	Bakersfield	Meadows Field	5,940	3,130	-47.3%
OXR	Oxnard	Oxnard	6,260	2,280	-63.6%
All		**Total**	**15,965,610**	**13,332,680**	**-16.5%**

Source: Federal Aviation Administration Ten Percent Ticket Sample

Conventional Rail Networks

Year 2000 passenger rail services consist of a variety of intraregional and interregional services. Passenger rail services are also subdivided by mode – metro rail (i.e., BART), conventional rail (both intercity and commuter services), and light rail:

- The San Diego Region has two rail operators – San Diego Trolley (light rail) and the Coaster (conventional rail).
- The SCAG region has metro, conventional, and light-rail services. The Los Angeles Metropolitan Transportation Authority (MTA) operates metro and light-rail services. The Southern California Regional Rail Authority (SCCRA) operates Metrolink conventional commuter rail services. The MTA Rail system is comprised of the Metro Blue, Green, Red, and Gold Lines. The Metro Red Line subway operates between Union Station, the Mid-Wilshire area, Hollywood, and the San Fernando Valley. The remaining light-rail lines are the Blue Line (Long Beach to Los Angeles), the Green Line (Norwalk to Redondo Beach), and the Gold Line (Los Angeles Union Station [LAUS] to Pasadena).
- Within the MTC region, metro, conventional, and light-rail services are provided. Services include BART, Caltrain, Muni Metro, and Santa Clara VTA light-rail systems. In 2000, the BART system consisted of 39 stations serving four East Bay lines (Fremont, Dublin/Pleasanton, Pittsburg/Bay

Point, and Richmond), as well as the Daly City/Colma line through San Francisco and the West Bay. In 2002, BART service was extended south of Colma to San Francisco Airport and to Millbrae, and four new stations were added. San Francisco rail and cable car routes include the five light-rail (metro) lines that operate in the Market Street subway, three cable car routes, and the historic trolley line operating on Market Street. Santa Clara light-rail lines have been extended to East San Jose (Alum Rock) and to Winchester (Vasona line) since 2000.

- Also in the MTC region, Caltrain currently operates 86 daily trains between San Jose and San Francisco, including three daily peak periods, peak direction round trips to Gilroy. Trains run to San Francisco an average of every 12 minutes during peak periods, and 30 minutes during off-peak periods. Since the year 2000, Baby Bullet trains have been introduced, significantly reducing San Jose to San Francisco Express train travel times.
- The SACOG region's rail services are limited to the Sacramento RT light-rail system. Since 2000, two RT extensions have come on-line. In 2003, the South Line extension was implemented. This new extension resulted in RT running two lines for the first time. More recently, the Folsom extension became operational. The Folsom Line is an extension of the existing line that operates along the U.S. 50 corridor.
- Interregional rail services are all conventional rail systems. These include the Capitol Corridor, Altamont Commuter Express (ACE), Surfliner, and San Joaquin systems.

Urban Area Transit Networks

The Statewide model intercity routes have been updated to include urban area transit networks from the MTC, SACOG, SCAG, SANDAG, and Kern regional systems. In addition, local transit services serving areas around high-speed rail stations in Stanislaus, Merced, and San Joaquin Counties were added. Figure 2.2 shows the transit network detail for the intercity routes and the regional transit in the MTC area. Figure 2.3 shows the transit routes for Southern California.

Figure 2.2 New Statewide Model Transit Network

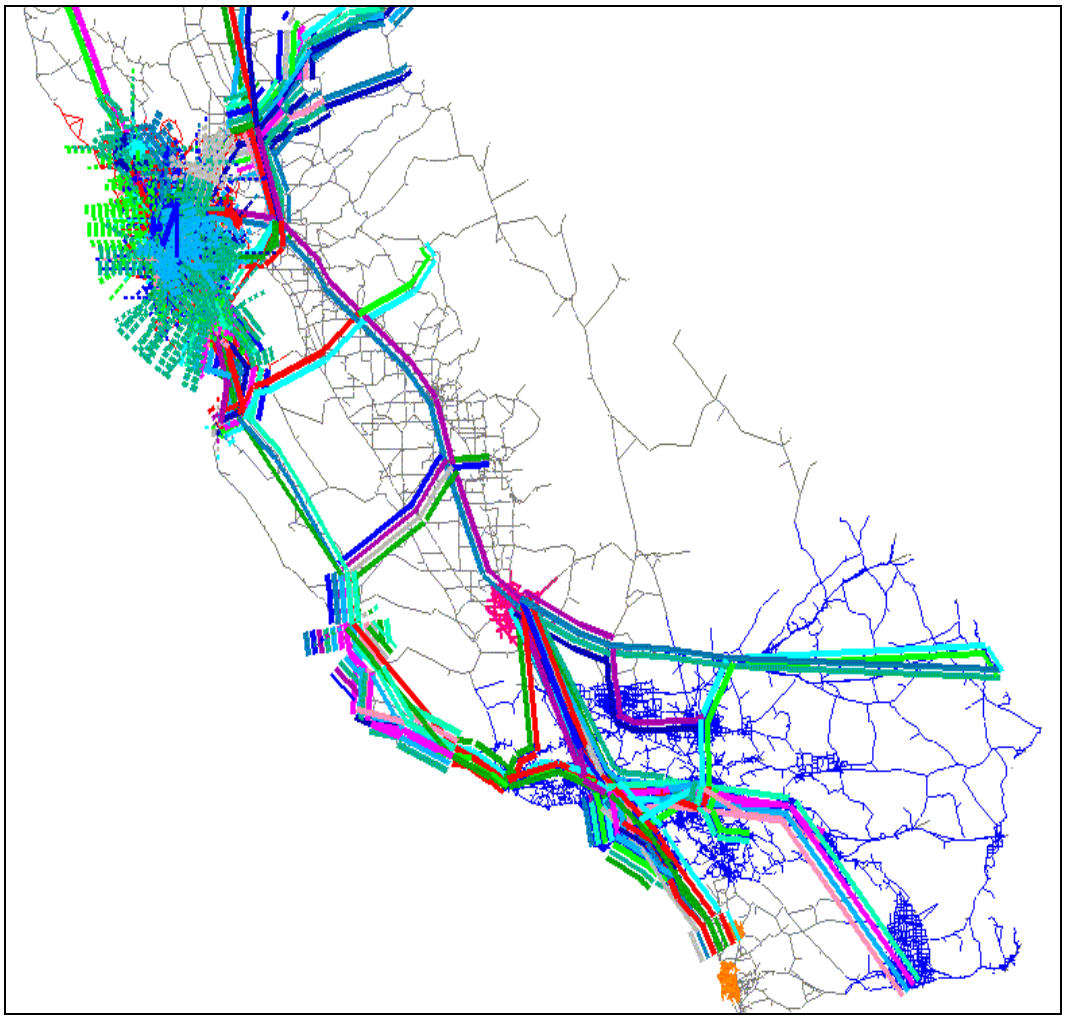
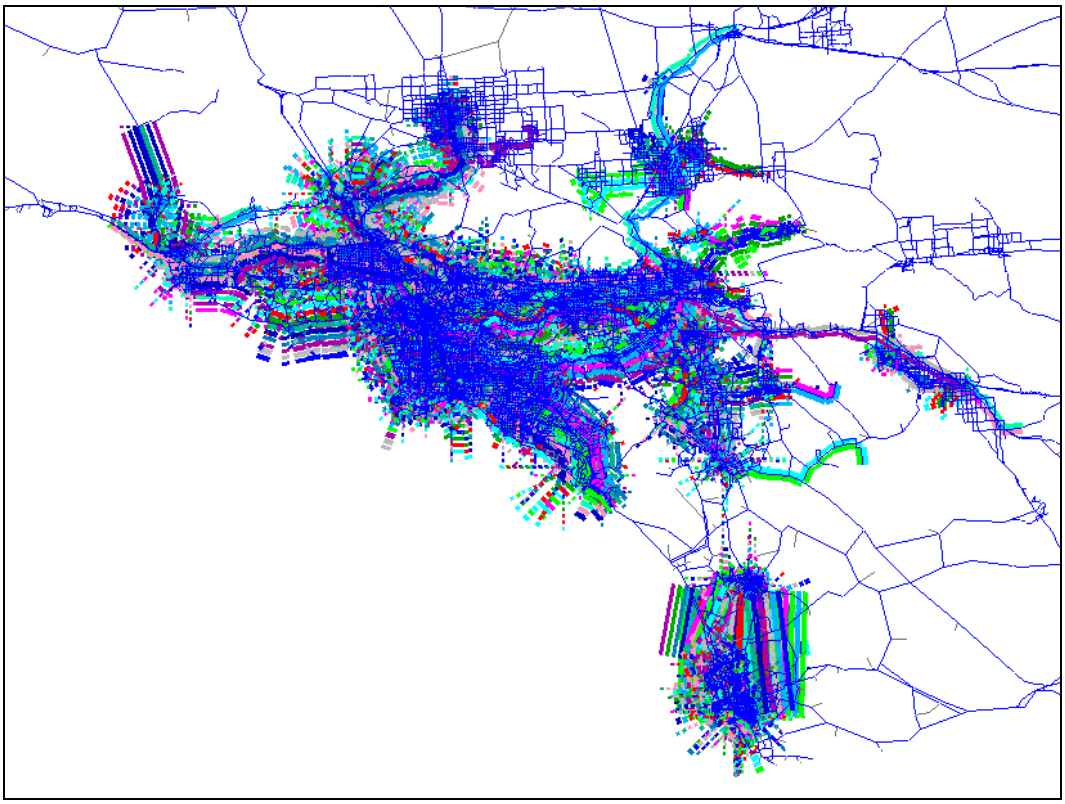


Figure 2.3 Transit Network in Southern California



Area Type

The area type used in the HSR models was based on the Caltrans Statewide Model (STM) socioeconomic data, processed to represent a zonal population and employment density for each zone. The area type is defined as follows:

- Rural – Less than 1,000 persons per square mile;
- Low suburban – 1,000 to 6,000 persons per square mile;
- High suburban – 6,000 to 10,000 persons per square mile;
- Urban – 10,000 to 20,000 persons per square mile; and
- Urban Core – More than 20,000 persons per square mile.

Persons per square mile are based on either the population or employment in a zone, whichever is higher. These area types are presented in Figure 2.4. Additional maps are provided for northern California (in Figure 2.5) and southern California (in Figure 2.6) for a better representation of the more urbanized areas.

Figure 2.4 Statewide Area Types

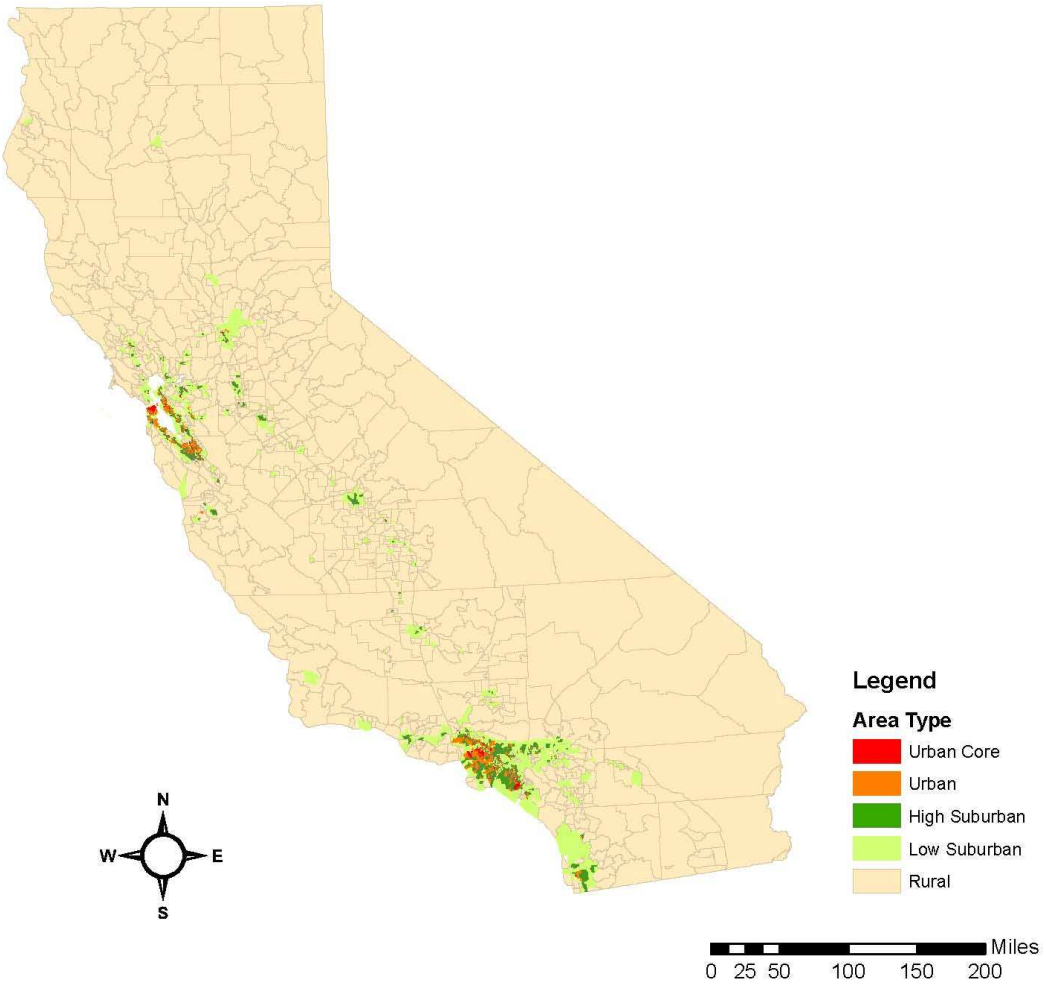


Figure 2.5 Northern California Area Types

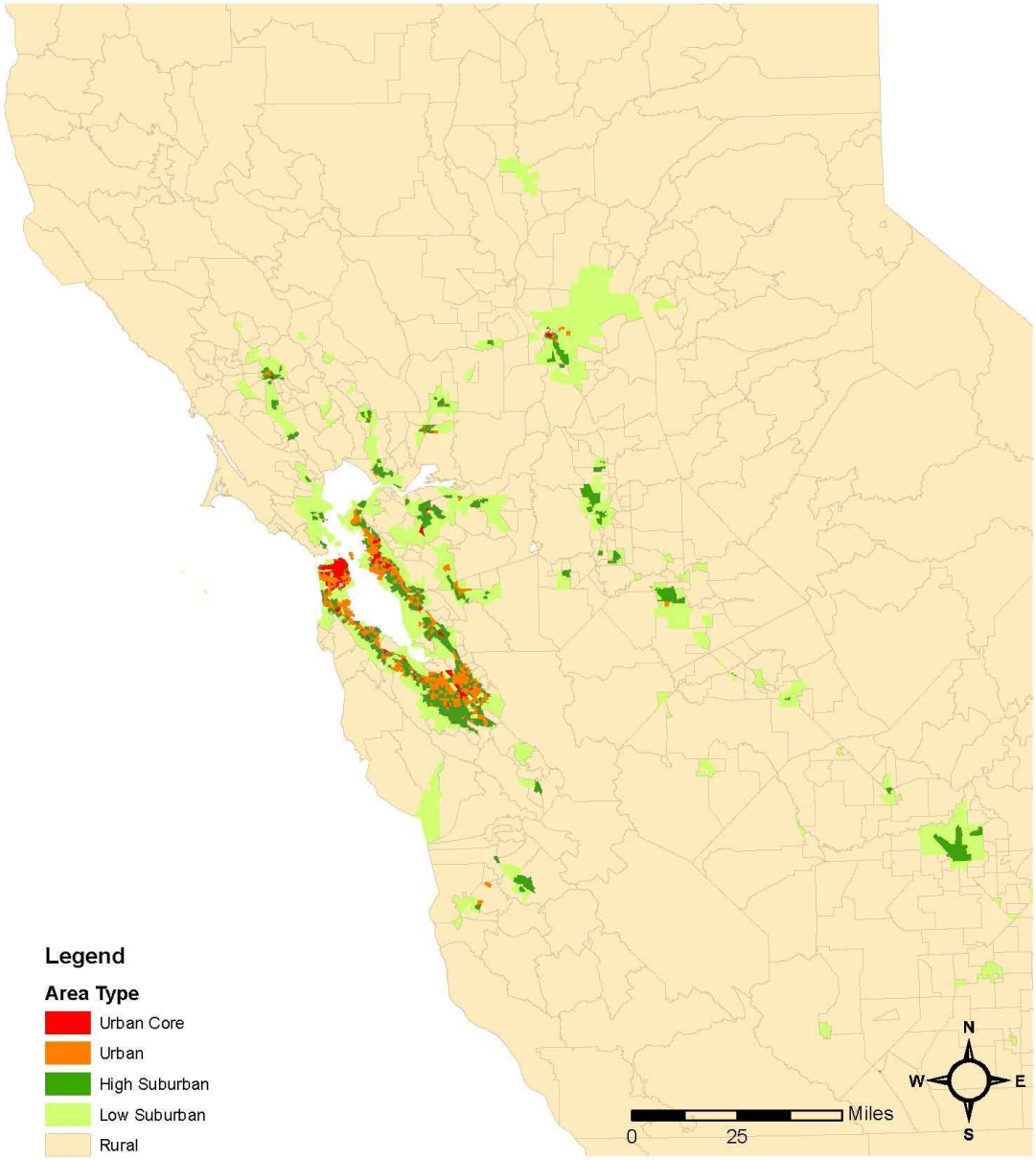
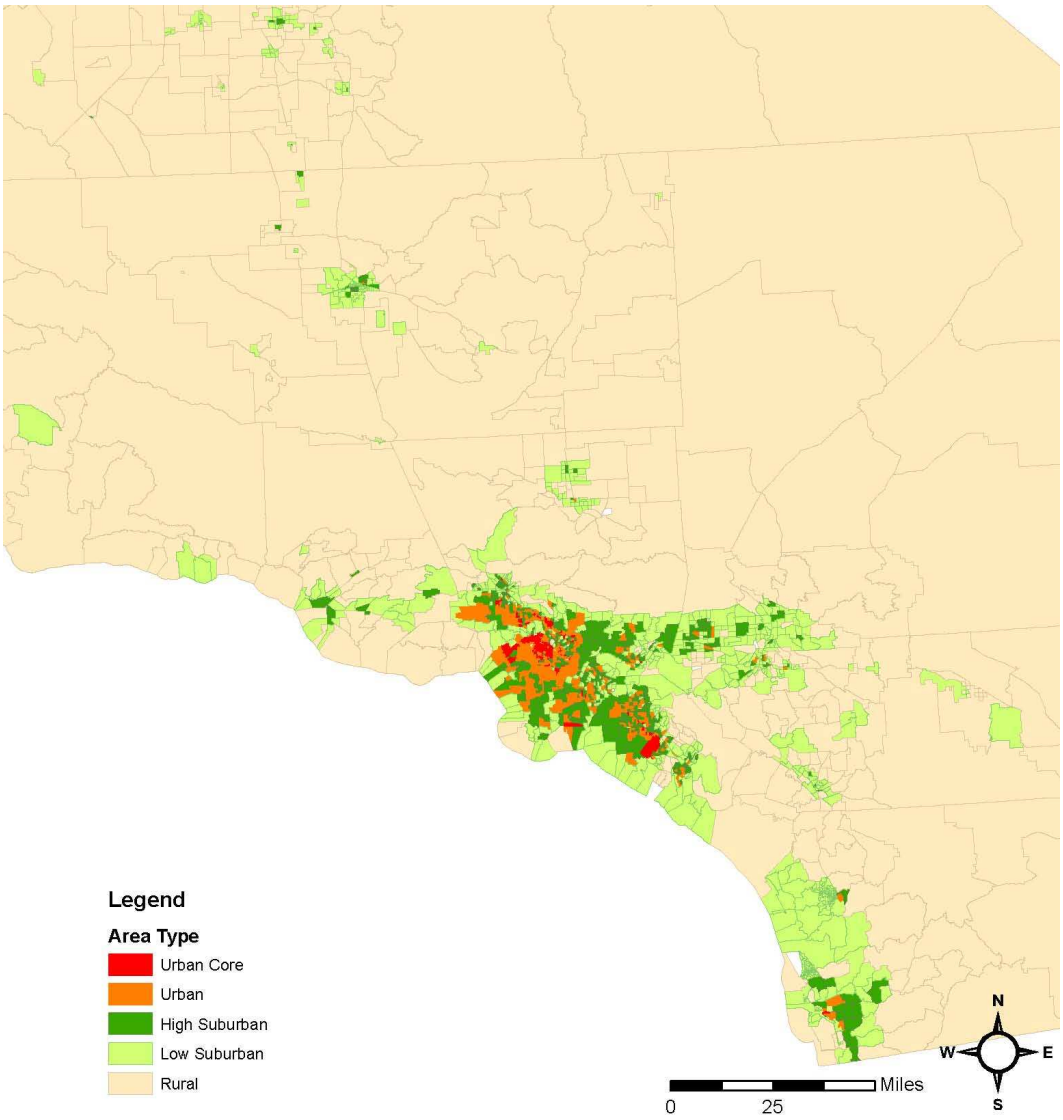


Figure 2.6 Southern California Area Types



2.3 SOCIOECONOMIC DATA

For model application, socioeconomic data are being developed by combining urban area socioeconomic data by traffic analysis zone from the urban models with the Caltrans statewide model socioeconomic data and the U.S. Census Bureau data. These data have slightly different household classifications and categories, so some processing of these data is necessary. In addition, we developed household classification models to forecast household classifications that were not being developed by one of the existing sources. Table 2.10 describes the list of socioeconomic data that are being developed to support the interregional and urban models for the base and forecast years. Summary totals for these data in the year 2000 are shown in Table 2.10.

Table 2.10 Socioeconomic Data Classifications

	Category	2000 California Total
Household		
Size	1 person	**2,704,585**
	2 persons	**3,385,735**
	3 persons	**1,831,480**
	4+ persons	**3,590,220**
Income group	Low (<$35,000)	**4,249,200**
	Medium ($35,000)	**3,948,834**
	High (>$75,000)	**3,313,986**
Number of workers	0 worker	**2,901,170**
	1 worker	**4,317,905**
	2+ workers	**4,292,945**
Car ownership and worker category	0 car	**1,083,945**
	0 < cars < workers	**873,700**
	cars >= workers	**9,554,370**
Total Households		**11,512,020**
Employment		
Type	Retail	**2,293,524**
	Service	**5,760,849**
	Other	**7,214,346**

Total Employment	**15,268,719**

Source: 2000 Census Transportation Planning Package for California.

The household classification model uses joint distributions of households in the travel demand models and Census Public Use Microdata Sample (PUMS) data to stratify the marginal distributions of households provided by the statewide and urban area models. Household income categories will be converted to 2005 dollars.

The traffic analysis zones used in this modeling system are derived from the Caltrans Statewide Model and disaggregated within select urban areas to provide more detail around high-speed rail stations. Table 2.11 presents a comparison of the number of zones in the original Caltrans Statewide Model and the new statewide modeling system developed for this study for each of 14 regions.

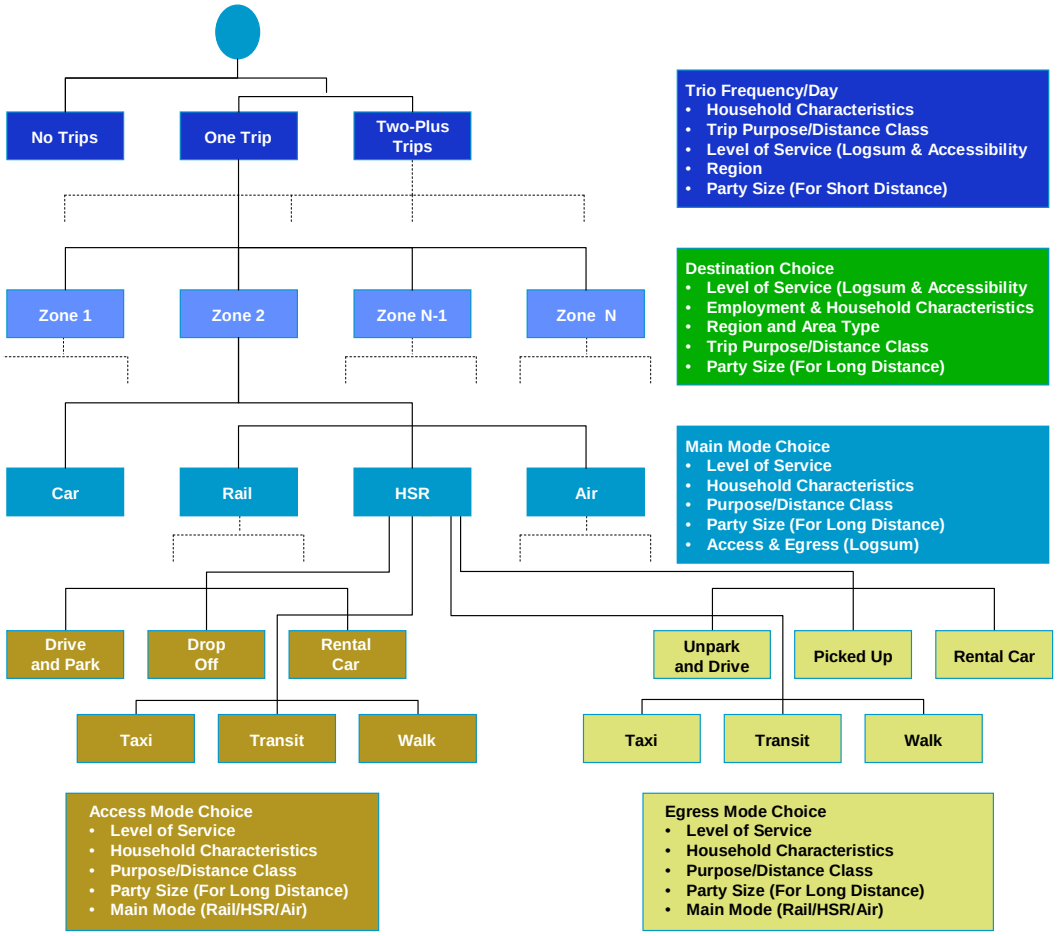
Table 2.11 Traffic Analysis Zones

Region	Region Number	Number of Caltrans Model Zones	Number of HSR Model Zones
AMBAG	1	49	49
Central Coast	2	26	26
Far North	3	111	111
Fresno/Madera	4	123	123
Kern	5	89	166
South SJ Valley	6	128	128
Merced	7	42	42
SACOG	8	173	209
SANDAG	9	94	538
San Joaquin	10	97	97
Stanislaus	11	36	36
W. Sierra Nevada	12	24	24
MTC	13	291	1,454
SCAG	14	664	1,664
Total		**1,947**	**4,667**

3.0 Interregional Models

The interregional models are comprised of four sets of models: trip frequency, destination choice, main mode choice, and access/egress mode choice. The structure and contents of the interregional modeling system is presented in Figure 3.1.

Figure 3.1 Interregional Model Structure



The trip frequency model component predicts the number of interregional trips that individuals in a household will make based on the household's characteristics and location. The destination choice model component predicts the destinations of the trips generated in the trip frequency component based on zonal characteristics and travel impedances. The mode choice components predict the modes that the travelers would choose based on the mode service levels and characteristics of the travelers and trips. The mode choice models include a main mode choice, where the primary interregional mode is selected,

and access/egress components, where the modes of access and egress for the air and rail trips are selected.

Because of the way that the model components will be linked, model development occurs in the reverse order of model application:

- **Access and egress mode choice models –** The choice of mode to and from airports, conventional rail stations, and HSR stations. The available modes include drive and park, picked-up/dropped off, rental car, taxi, transit and walk. This will be based on the actual and hypothetical access and egress modes reported in the SP surveys – either 4 or 6 observations per respondent. (Note: We are assuming that the path building process for the main modes will do an adequate job assigning stations and airports, but, if not, this may need to be a joint station and mode choice model.
- **Main mode choice models –** The choice of main mode, from among car, air, conventional rail, and HSR. This is based on the 4 hypothetical SP responses for each respondent in the SP surveys. This model uses information from the access and egress mode choice component for each mode (except car).
- **Destination choice models –** The choice of destination zone outside the region. The model is segmented for destinations within and beyond 100 miles, and the alternatives are all TAZs applicable for the distance segments. For the long-distance model, we use a 2-stage structure of predicting "macro-zone" and then TAZ, because that seems to be more behaviorally realistic. The model input data are a mix of trips from the statewide survey and the SP survey. The models use information from the mode choice model components, calculated for each TAZ as the key measure of impedance between zones.
- **Trip frequency models –** The choice of number of interregional trips to make during a person-day (0, 1, or 2) for a given purpose/distance segment. The Statewide survey diary-days are the data source. The models use information from the destination choice model component calculated across all possible TAZs as a measure of zone accessibility.

The market segmentations used for the models are:

- Purpose:
  - Business (peak period);
  - Commute (peak period);
  - Recreation (off-peak period); and
  - Other (off-peak period).

- Distance range/residence area type:
  - Less than 100 miles, from large MPO regions;
  - Less than 100 miles, from small MPO regions; and
  - More than 100 miles.
- Household size – 1 person, 2 people, 3 people, more than 4 people.
- Household income range – Low, medium, or high.
- Household auto-ownership – 0, 1, 2+.
- Household number of workers – 1) no workers, 2) 1 worker, 3) 2+ workers.
- Party size: Traveling alone, traveling with others.

The distance ranges of less than or greater than 100 miles were determined by reviewing the trip length distributions from the surveys and judgment about behavior for short versus long trips. Party size is a segmentation variable primarily for the Recreation and Other segments, because it has a large effect on the travel cost of the car mode versus the other modes, and thus on the choices throughout the model chain.

These market segments vary by model component to take advantage of additional detail in some areas or aggregation of market segments in other areas. The market segments in each model component are presented in Figure 3.2.

Model Component Linkages

The trip frequency, destination choice and mode choice models all use accessibility or impedance measures as inputs to the logit choice equations. For each model component, these measures are calculated from subsequent model components and as a result, were not available during the initial model estimation. So, for each model component, a substitute accessibility or impedance measure was calculated to use for initial model estimation, then replaced with the actual measure. These linkages are presented in Figure 3.3.

Figure 3.2 Market Segments in Each Model

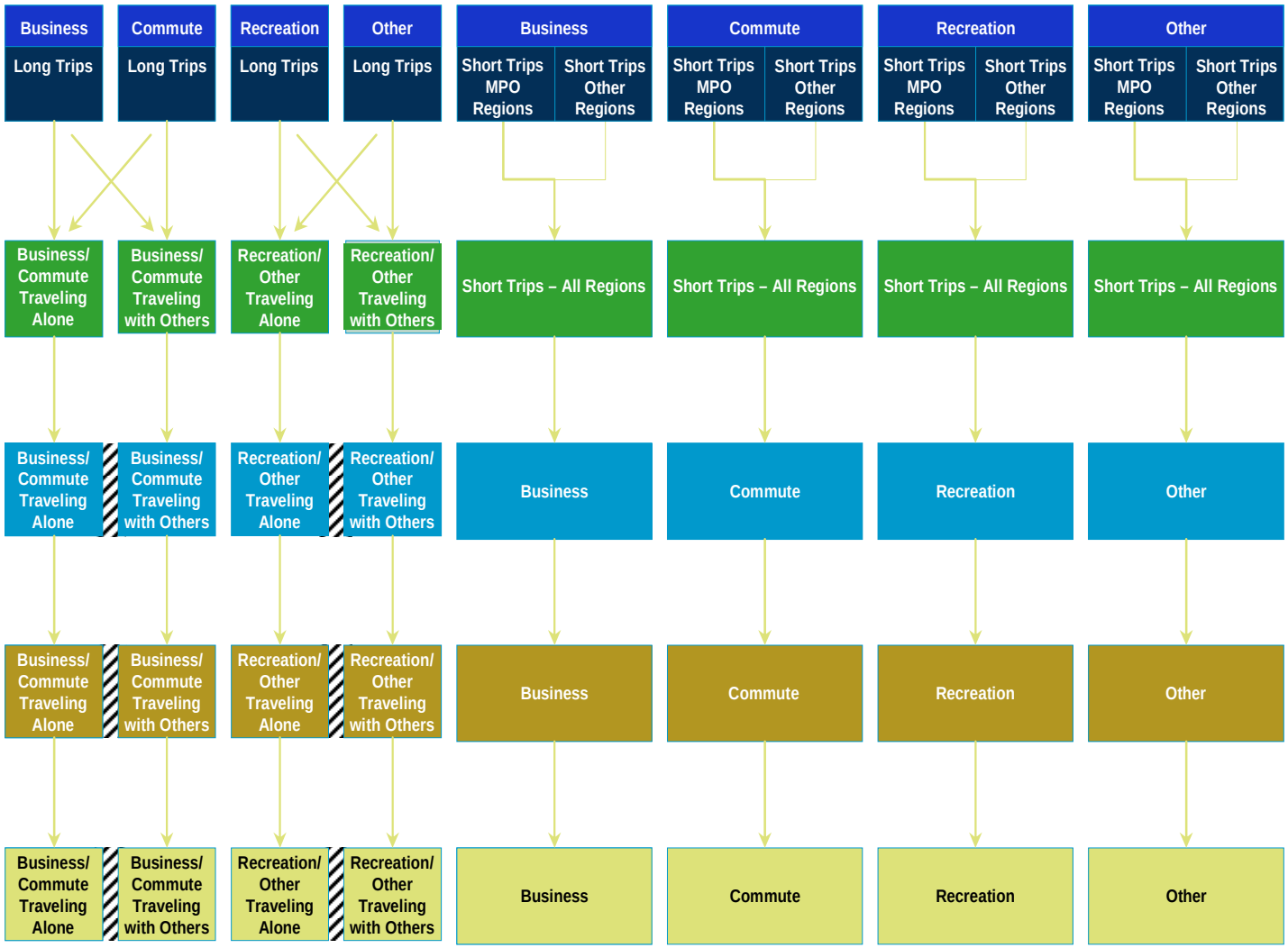
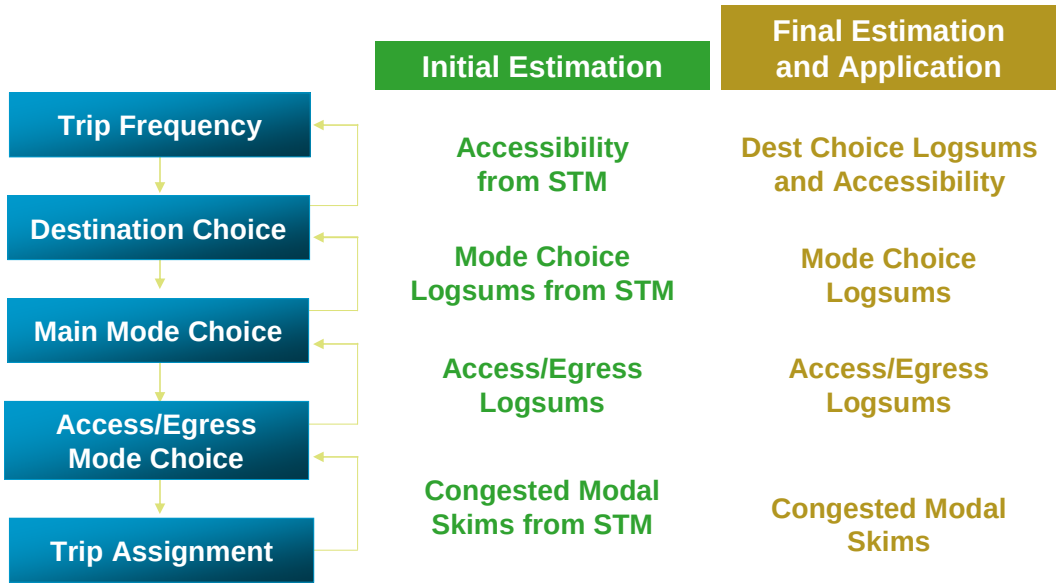


Figure 3.3 Model Component Linkages



Accessibility Measures

In the development of the trip frequency models, accessibility measures were estimated for all trips to approximate the destination choice logsum measure. In the final models, accessibility measures were retained for intraregional trips because the intraregional models maintained by the MPOs do not include destination choice models, which are necessary to produce logsum measures. Accessibility measures for interregional trips were replaced with logsum measures from the destination choice models in the final models, as described below. There were four accessibility measures calculated, as follows:

- Auto peak work trip accessibility

$$A_{peak_auto} = LN\left[1 + \sum_d TotalEmp_d * \exp\left(\underline{-2 * Time_{peak_auto}} / Time_{peak_mean}\right)\right]$$

- Auto off-peak non-work trip accessibility

$$A_{offpeak_auto} = LN\left[1 + \sum_d (Households_d + RetailEmp_d + ServiceEmp_d) * \exp\left(\underline{-2 * Time_{offpeak_auto}} / Time_{offpeak_mean}\right)\right]$$

- Non-Auto peak work trip accessibility

$$A_{peak_nonauto} = LN\left[1 + \sum_d TotalEmp_d * \exp\left(\underline{-2 * Time_{peak_nonauto}} / Time_{peak_mean}\right)\right]$$

- Non-Auto off-peak non-work trip accessibility

$$A_{offpeak_nonauto} = LN\left[1 + \sum_{d}(Households_{d} + RetailEmp_{d} + ServiceEmp_{d}) * \exp\left(\underline{-2 * Time_{offpeak_nonauto}} / Time_{offpeak_mean}\right)\right]$$

Where:

$TotalEmp_d$ = total employment at the destination zone;

$Households_d$ = total households at the destination zone;

$RetailEmp_d$ = retail employment at the destination zone;

$ServiceEmp_d$ = service employment at the destination zone;

$Time_{peak_auto}$ = highway travel time during the peak (based on congested time) from the origin zone to the destination zone;

$Time_{peak_nonauto}$ = transit travel time during the peak (based on congested time) from the origin zone to the destination zone;

$Time_{offpeak_auto}$ = highway travel time during the off-peak (based on free-flow travel time) from the origin zone to the destination zone;

$Time_{offpeak_nonauto}$ = transit travel time during the off-peak (based on free-flow travel time) from the origin zone to the destination zone;

$Time_{peak_mean}$ = average travel time from the origin zone to all possible destination zones during the peak period, calculated from the average of survey respondents travel time based on peak network times; and

$Time_{offeak_mean}$ = average travel time from the origin zone to all possible destination zones during the off-peak period, calculated from the average of survey respondents travel time based on off-peak network times.

Logsum Measures

Logsum measures are a means to estimate a weighted average of travel time and cost that can be fed back from one component to another. A summary of the logsum measures for each model component is as follows:

- Trip frequency models use "logsum" measures from the destination choice models, which are intended to capture the fact that it is easier to make relevant interregional trips from some zones than from other zones. For initial model estimation, a synthesized network zone accessibility measure was used.
- Destination choice models use logsum measures from the main mode choice models that are intended to provide measures of the composite impedance across all modes of travel between each of the zones. For initial model estimation, a mode choice logsum calculate from the Caltrans statewide model was used.

- Main mode choice models use a logsum from the access/egress mode choice models. This was estimated prior to the main mode choice models, so a substitute measure was not necessary.

This allows higher level model components to reflect accessibility measured accurately from lower level models.

3.1 TRIP FREQUENCY MODELS

Model Structure

Although we maintained the multinomial logit model structure for these models, over the course of trip frequency model estimation several decisions were made about details of the model structure. These model structure decisions are described below:

- **Decision Unit –** After exploring using a "household-day" and a "person-day," we decided to use "person-day" as the decision unit. The aggregation of people to households did not provide enough non-zero interregional trip households to outweigh the cost of losing decision units (since there are fewer households than people in the surveys).
- **Segmentation by Length –** To differentiate between the type of trip that could be undertaken on a daily basis and one that is more likely a special trip, we decided to model short (less than 100 miles) and long (100 miles or greater) interregional trips separately. This 100 mile cutoff was determined based on an evaluation of the trip length frequency distributions of interregional trips for each trip purpose.

Although we had initially tested models with separate frequency choices of zero, one, two, and three or more interregional trips per person day, the decision to segment the trip frequency models both by length and purpose limited the number of choices in the choice set to *zero*, *one*, or *two or more* interregional trips per person-day. The frequency of trips in the survey for each of these 8 market segments is provided in Table 3.1.

Table 3.1 Frequency of Trip Frequency in the Combined Surveys

	Number of Interregional Person-Day Trips		
Model	**0**	**1**	**2+**
Business	216,509	186	107
Long Trips	108,313	57	31
Short Trips	108,196	129	76
Recreation	216,159	494	149
Long Trips	108,233	134	34
Short Trips	107,926	360	115
Commute	215,910	697	195
Long Trips	108,273	100	28
Short Trips	107,637	597	167
Other	216,321	364	117
Long Trips	108,287	95	19
Short Trips	108,034	269	98

Model Specification

We estimated 12 models for trip frequency, based on 4 trip purposes (business, commute, recreation, and other) and 2 distance segments (long trips and short trips). The model specifications for these models are described below:

- **Constraining Variable Coefficients –** In preliminary model specifications, we included 0, 1, 2, and 3 or more interregional trips per day as individual choices, with unique variable coefficients for each. Because of smaller sample sizes in each of our market segments (trip purpose and trip type), we constrained the final model specification to set variable coefficients on one-trip and two-trip choices are set to be equal. This overcame some illogical individual variable coefficients for each market segment, but allowed us to keep all 12 market segments and retain separate choices for interregional travel. In addition, the alternative-specific-constants are still estimated individually. For instance, the effect of household size on the utility of making one interregional trip in a day is constrained to equal the effect of household size on the utility of making two interregional trips in a day, but the overall utility of those two choices are different because the constants are different.
- **Variables Explored and Expected Signs –** The variables that we explored in the final model specifications were restricted to the types of variables that we

can forecast in the future. The most notable restriction is that all socio-demographic data are at the household level. While we have explored several person-level variables, discussion here will be limited to those variables that are "forecastable." It is important to note that the effect of certain variables on *interregional* travel is not necessarily the same as it is for general travel.

- **Alternative-Specific Constants –** Alternative-specific constants (ASC) for each choice are included in each model specification. These represent the combined effect of variables that are not included in the model (those that cannot be captured and/or forecasted). Small alternative-specific constants are desirable and can signify that the variables within the model are doing a good job predicting the outcome. However, because interregional travel is rare for most people, it is not surprising that constants on this type of travel would be significantly negative.

Household characteristics were developed to support a series of additional variables in the trip frequency models, as follows:

- **Household Size/Household Size is Greater than Two –** These variables can act as a proxy for having a family. Since traveling long distances with children can be difficult, we expect these variables' effects on interregional travel to be negative – especially for long trips.
- **Household Workers –** As the number of workers in a household increases in a household, it is more likely that one of them will make an interregional work-related trip. We expect a positive effect of the number of workers in a household on interregional commute and business trips. On the other side, having more workers in a household limits the availability of time and flexibility for discretionary-type interregional travel (controlling for income). Therefore, we expect the number of workers to have a negative effect on recreation and other type interregional trips.
- **Zero-Worker Household –** This dummy variable serves as a proxy for limited available discretionary spending for interregional travel (no workers can mean little or no income) and for retirees, who may have limited mobility and vehicle-driving capabilities, and for other households with limited available discretionary spending for interregional travel. We expect a strongly negative sign on the effect of a zero-worker household on one's propensity to make a commute or business trip.
- **Household Vehicles –** We expect the effect of the number of vehicles in a household to have a positive effect on all types of interregional trips, because vehicles are probably indicative of overall household mobility.
- **Number of Vehicles Less than Number of Workers –** We expect this measure of vehicle unavailability to have a negative effect on all types of interregional trips.

- **Zero-Vehicle Household –** The general expected sign for this variable is negative. After accounting for the number of vehicles per households, though, this variable is insignificant in the models.

Household income is included in the models based on three income categories: low-income households are less than $35,000; medium-income households are from $35,000 to $75,000; and high-income households are more than $75,000. The income variables are described as follows:

- **Households by Income Group –** As a general rule, we expect travel to increase as income increases.
- **Missing Income Households –** We have also included a dummy variable for an un-coded income in every model that we estimated because income is not captured in every survey record. This dummy variable is used during model estimation, but is not included in the final model specification for model application. As this is the case, we would like the missing income dummy parameter to be small in all cases.

Accessibility

As discussed above, the trip frequency models include measures that capture the accessibility of all relevant travel opportunities from travelers' home zones. For each residence, we calculated three peak/work and three off-peak/non-work accessibility measures for destinations in 1) their home region, 2) outside their region, within 100 miles of home, and 3) over 100 miles from home. The final model specifications rely on synthesized accessibility measures for the within home region destinations and on logsums calculated from the destination choice models for the remaining accessibility measures. The synthesized accessibility measure is necessary within the home region since the urban area models are not destination choice models (they are gravity models) and are therefore not able to produce logsums for the destination choices within the region. Logsums are a means to produce a weighted average of all potential destinations.

We calculated the accessibility to jobs, goods, and services within one's region of residence ("Regional Accessibility"). If there is a high accessibility level within a region, it is less likely that one needs to travel outside of the region. Therefore, we expect this variable to have a negative effect on all interregional travel. These measures try to capture the potential substitution between trips of different lengths.

We also calculated logsum measures for areas outside the region of residence. Because our models estimate short and long trips separately, the logsum measures are included only for the relevant distance class. For example, if we are estimating destination choice for long trips, then the logsum measure is measured only for trips over 100 miles. If there are more places outside your region to travel, then you are more likely to travel outside the region and the coefficient on this accessibility measure is positive.

Regional Dummy Variables

We have included regional dummy variables for MTC, SANDAG, SACOG, and SCAG regions in many of the interregional trip frequency models. We expect that, on balance, those living within the large metropolitan areas will be less likely to leave and make an interregional trip because there is a lot to offer within the region. However, the geographic locations of the regions vis-à-vis one another and the interregional connectedness of certain regions will affect the size and direction of these parameters.

Estimation Results

The ASCs for the one long distance interregional trip per day and the two long distance interregional trips per day choices are large and negative compared to the zero trips per day base for both business and commute trips. In all cases, the two trip constants are more negative than the corresponding one trip constants, as we would expect.

The household characteristics and location variables differ among the trip-purpose-specific model specifications, as we selected what we judged to be the best models for each purpose from the different estimation results. Of note, for the long distance models:

- The commute and business models have a strongly negative no workers variable as we would expect. These models also have an increasing probability of travel as the fraction of workers in the household increase.
- Household size variables for 1-person and 3-person households are negative and significant for the recreation and other long trip models.
- Income has a positive effect on long distance business, commute, and other purpose travel, as expected, but not on recreation travel.
- The SACOG region dummy variable coefficients are positive and significant for all purposes. This may mean that there are fewer opportunities for intraregional travel for Sacramento residents, so there is a greater tendency to make interregional trips.
- The SANDAG, SCAG, and MTC dummy location variables are negative for a business and commute trip, which means that residents of these regions are less likely to make interregional work trips than other residents. This is due to increased business opportunities in these regions.
- SANDAG and MTC residents are more likely to make interregional travel for recreation and other purposes than other residents.
- The MTC coefficient is positive for both long distance recreation and other trip purpose trips. This is probably due to the tourist and other attractions in the Bay Area.
- The long distance accessibility measures for long distance trips were all positive in the initial models, as expected, but relatively small. In the final

model estimations using logsum measures, these were constrained to provide a more reasonable estimate than was produced in the estimation stage.

- The within-region accessibility measures are all strongly negative, indicating a strong trip length substitution effect.
- The outside-region short-distance accessibility measures are significant and positive, but very small. The only exception is the recreation logsum measure, which is the same as the long distance coefficient.

Table 3.2 presents the estimation results of the trip frequency models for long trips in each of the four trip purposes: business, commute, recreation, and other. For the most part, only those variables that are significant at the 95-percent level are retained in the models, except in the case of the accessibility variable, where all three variables were retained in all models due to its importance from a policy perspective. The accessibility variable allows induced travel to be estimated from the trip frequency models, which is an important component of the overall ridership estimates.

Table 3.2 Trip Frequency Models – Long Trips

Purpose	Business		Recreation		Commute		Other	
Variable	**Coeff.**	**T-Stat**	**Coeff.**	**T-Stat**	**Coeff.**	**T-Stat**	**Coeff.**	**T-Stat**
Alternative Specific Constants								
ASC-One	-5.7689	-5.12	-2.4	-2.29	-2.965	-3.27	-1.1654	-1.14
ASC-Two	-6.72	-5.94	-4.0679	-3.89	-4.1972	-4.59	-3.4956	-3.36
Household Variables								
Household Size					-0.3227	-5.36		
HH Workers					0.4365	4.39	-0.2583	-3.32
HH Vehicles	0.2095	2.45	0.2015	2.98			0.2157	3.05
HH Dummy Variables								
Household Size is Greater than 2	-0.418	-2.76	-0.5233	-4.14			-0.3316	-2.45
HH Vehicles is less than HH Workers			-0.8207	-2.01				
No Workers in HH	-1.9903	-4.4			-5.6443	-2.17		
Region								
SACOG	1.2277	6.33	0.8962	4.93	1.1783	5.75	2.286	14.51
SANDAG			0.9075	2.82				
SCAG	-0.532	-1.93			-0.8618	-2.63		
MTC			0.6398	3.3	-1.8169	-4.07	0.7615	3.44
Accessibility								
Within Region	-0.3296	-4.54	-0.4879	-10.5	-0.436	-5.58	-0.5073	-9.33
Outside Region, Within 100 Miles	-0.0008764	-0.26	0.0498	1.75	0.0235	0.93	0.0115	0.39
Long-Distance, Over 100 Miles Away	0.1927	1.59	0.1451	1.55	0.212	2.44	0.0745	0.8
Income								
Medium Income ($35,000 to $75,000)	1.0667	3.29						
High Income (Greater than $75,000)	1.4799	4.52					0.4649	3.31
No Income Coded	1.4652	4.05	-0.0471	-0.25	-0.0479	-0.2	-0.0361	-0.17
Model Statistics								
Log-Likelihood Constants Only	-1,542		-2,134		-1,768		-2,044	
Log-Likelihood Model	-1,436		-2,041		-1,524		-1,867	
R-Squared (with respect to constants)	0.0687		0.0436		0.1380		0.0866	

*Peak Hour Accessibility for Commute Trips, All other are off-peak/service-retail.

Table 3.3 presents the estimation results of the trip frequency models for short trips for each of the four trip purposes: business, commute, recreation, and other. Of note in these models:

- The ASCs for the small region models are insignificant for all purposes.
- The household size coefficients are negative and significant for recreation and commute models, and the small region business trip purpose model also has a household-size-greater-than-two dummy variable coefficient that is negative and significant.
- The worker coefficients behave as expected for the business and commute models, with workers significantly positive for business and commute trips and significantly negative for other trips from small regions.
- The income coefficients are all of the correct sign and relative magnitudes.
- The interregional accessibility (logsum) measure coefficients are all positive and business and recreation coefficients are significant. This indicates that improved accessibility for interregional travel will increase the likelihood of making an interregional trip. The intraregional accessibility measures are all negative, so improved accessibility within a region will diminish the likelihood of making an interregional trip.

The overall fit of the trip frequency models is strong for business trips but low for the other purposes, as exhibited by the log-likelihood reductions compared to the constants-only models. While this is obviously of concern, trip frequency model levels of fit seem to have been generally low for previous similar modeling efforts.

Table 3.3 Trip Frequency Models for Long Trips

	Business		Commute		Recreation		Other	
Observations	108,401		108,401		108,401		108,401	
Final log-likelihood	-1,168.3		-1,823.7		-2,048.8		-1,865.3	
Rho-squared (0)	0.99		0.99		0.98		0.98	
Rho-squared(const)	0.08		0.10		0.04		0.09	
Variable	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**
Level of Service								
Intraregion accessibility	-0.128	-1.5	-0.217	-4	-0.4	-6	-0.532	-7.4
Mode/destination choice logsum	0.466	1.5	0.123	0.6	0.656	2.8	0.159	0.6
Household Characteristics								
Medium income	0.527	1.5	0.188	0.8				
High income	1.139	3	0.291	1.1	-0.246	-1.3	0.393	2.1
Missing income[1]	0.955	2.3	0.34	1.1	0.282	1.3	0.158	0.7
Fewer cars than workers in HH	-0.412	-1	-0.457	-1.6	-0.922	-2.4	-0.915	-2.2
No cars in HH								
Fraction of HH who are workers	0.537	1.9	1.274	5.8				
No workers in HH	-2.098	-3.4	-2.668	-3.7			0.372	2.4
Household size								
1 person household							-0.424	-2
3+ person household					-0.482	-3.9	-0.379	-2.8
Location Variables								
SACOG resident	0.976	3.7	0.918	4.7	1.084	4.4	2.527	10.3
SANDAG resident	-0.704	-1.1	-0.419	-1	1.344	3.5	0.92	1.8
SCAG resident	-1.176	-3.6	-1.644	-6.3	-0.031	-0.1	0.259	0.8
MTC resident	-1.372	-3.6	-0.729	-2.9	1.011	3.4	1.134	3.4
Constants[2]								
1 trip	-15.67	-2.3	-6.48	-1.4	-3.416	-3.1	-0.493	-0.4
2+ trips	-16.3	-2.4	-7.914	-1.7	-5.083	-4.6	-2.823	-2.4

[1]Missing income not used in model application.

[2]Will be modified during model calibration.

Table 3.4 Trip Frequency Models for Short Trips

Observations	104,667		104,667		104,754		104,754	
Final log-likelihood	-1,704.1		-5,000.7		-3,619.6		-2,744.8	
Rho-squared (0)	0.985		0.957		0.969		0.976	
Rho-squared(const)	0.101		0.166		0.109		0.124	
Variable	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**
Level of Service								
Intraregion accessibility	-0.329	-5.3	-0.176	-6	-0.438	-8.4	-0.536	-9.2
Mode/destination choice logsum	0.205	4.4	0.262	11.8	0.262	7.5	0.22	6.3
Household Characteristics								
Medium income	0.331	1.2	1.045	6	0.355	2.5		
High income	0.835	3.1	1.523	8.6	0.432	2.8		
Missing income[1]	0.446	1.4	0.696	3.4	0.137	0.8		
Fewer cars than workers in HH	-0.947	-2.4	-0.225	-1.6				
No cars in HH					-1.27	-2.5	-0.736	-1.6
Fraction of HH who are workers	1.153	5	1.57	13				
No workers in HH	-0.863	-2.5	-2.163	-5.9	0.493	4.8		
Household size					-0.136	-3.5		
1 person household					-0.401	-2.6		
3+ person household								
Location Variables								
SACOG resident	-0.977	-3.3	-2.736	-12.4	-1.241	-5.6	-1.177	-4.4
SANDAG resident	-0.88	-2.2	-1.446	-5.5	-1.802	-3.9	-0.66	-1.7
SCAG resident	-1.969	-8.6	-1.524	-10.9	-1.16	-5.3	-1.265	-4.8
MTC resident	-1.275	-5.3	-1.982	-17.1	-0.25	-1.3	-0.524	-2.3
Constants[2]								
1 trip	-4.946	-6.7	-8.242	-15.2	-2.881	-4.3	-0.845	-1.4
2+ trips	-5.513	-7.5	-9.07	-16.7	-3.787	-5.7	-1.624	-2.6

[1]Missing income not used in model application.

[2]Will be modified during model calibration.

3.2 PARTY SIZE MODELS

Model Structure

The party size model was estimated as a simple binomial choice model between traveling alone and traveling in a group. Two separate models were estimated, one for business and commute trips and one for recreation and other trips. The estimation dataset was the stated-preference (SP) survey, which had considerably more complete data on party size compared to the household travel surveys. Table 3.4 shows the party size characteristics of the estimation dataset. The overwhelming tendency for recreation/other interregional trips to be with another person compared to business/commute demonstrates the need to model the party size of these trip purpose categories separately.

Table 3.5 Party Size Estimation Dataset

	Business/Commute	Recreation/Other
Traveled alone	576	372
Traveled in a group	236	1,012

Model Specification

A variety of combinations of household variables available for model estimation were tested in the party size models. In the end, we kept the model specification with fewer variables because these were the most intuitive and did not sacrifice the overall fit of the model.

Alternative-Specific Constants

Traveling alone was the base alternative in the model estimation for both models. Alternative-specific constants should reflect any effect that is not captured within the explanatory variables. The alternative-specific constants in the business/commute model are negative, reflecting the general tendency to travel alone for these trip purposes. The positive constant in the recreation/other model reflects a tendency to travel with a companion that is not captured in the explanatory variables.

Household Income

Income was tested and is insignificant in all cases for the recreation/other party size model. However, high income had a positive effect on traveling alone in the business/commute model relative to the lower income classes. This makes sense, as most people who carpool do so to save money.

Household Size

Having a one-person household has a very negative effect on making any type of interregional trip with another person. If there is nobody in the household to travel with, then it makes sense that a traveler would generally go alone. Household size has a positive effect on traveling in a group for the recreation/ other purpose but no effect (other than the negative one-person household effect) on business and commute trip party sizes. It makes sense that recreation trips are more of a family/household event and therefore the size of your family/ household would have an effect on your travel party size for this trip purpose, but not necessarily for business/commute trips, where party-size may be determined primarily by your workplace characteristics.

Number of Household Vehicles

If one's use of a vehicle is constrained, then they will likely take a "group" mode of transportation including HOV. Therefore it is no surprise that having "no vehicles" makes an individual more likely to travel in a larger party – they have less individual travel choices and relatively more group travel choices.

Trip Purpose

A trip purpose dummy was included in each model. In the business/commute model it indicated that people are more likely to travel in groups for business trips relative to commute trips. If one has to make a long commute trip it may be unlikely that they find a carpool buddy that lives in their area. It is also unlikely that their spouse works in the same area. This makes business trips relatively more likely to be group travel than commute trips. In the recreation/other model, the recreation dummy variable indicates that recreation trips are more likely to encourage group travel than other trips. This sign makes sense because recreation activities are often undertaken in a group, so they would likely travel to the recreation-destination as a group as well.

Estimation Results

Table 3.5 presents the business/commute party size model estimation results. The variables in this model are described in the previous section. All variables are significant at the 95-percent level, except the commute trip purpose variable, which was kept in the model because it is intuitive and useful to separate business from commute trips in this manner.

Table 3.6 Business/Commute Party Size Model

Variables (For Party Size GT 1)	Coefficients	T-Stat
A.S.C. TWO	-0.3217	-2.620
High Income	-0.7337	-4.490
One Person HH	-1.2219	-4.310
No Vehicles in HH	-1.097	-2.150
Commute Trip	-0.6765	-1.450
Model Statistics		
Log-Likelihood Constants Only	-489	
Log-Likelihood Model	-470	
R-Squared (with respect to constants)	0.0404	

Table 3.6 presents the recreational/other party size model results. The variables in this model are also described in the previous section. All variables are significantly different than zero. As expected, the one-person household variable is the most significant variable.

Table 3.7 Recreation/Other Party Size Model

Variables (For Party Size GT 1)	Coeff.	T-stat
A.S.C. TWO	0.6804	3.060
Household Size	0.1402	2.340
One Person HH	-1.5459	-7.850
Recreation Trip	0.3016	1.900
Model Statistics		
Log-Likelihood Constants Only	-806	
Log-Likelihood Model	-735	
R-Squared (with respect to constants)	0.1025	

3.3 DESTINATION CHOICE MODELS

Model Structure

The destination choice models were estimated with a simple multinomial logit model structure using ALOGIT software. The dataset used for the trip frequency models (comprised of interregional trips from the California Statewide survey, the SCAG survey, the SACOG survey and the MTC/BATS survey) was

combined with the stated-preference (SP) survey (used in the mode choice models) to produce a combined estimation dataset for the destination choice estimation models. The addition of the SP dataset significantly increased the number of "long" (more than 100 miles) trips in the dataset (by nature, the household surveys are generally better at capturing the more typical "short" trips). Table 3.7 shows the distribution of trips in the estimation data across trip purposes, length, and survey. This table demonstrates the number of samples in each market segment available for model estimation.

Table 3.8 Estimation Data by Purpose, Length, and Source

	Caltrans	BATS	SACOG	SCAG	SP	Total
Long Trips						
Business	119	10	70	21	780	**1,000**
Commute	186	40	87	22	32	**367**
Recreation	179	75	38	43	1,125	**1,460**
Other	138	50	105	17	259	**569**
Short Trips						
Business	275	38	6	39	268	**626**
Commute	879	255	-	122	198	**1,454**
Recreation	554	168	8	54	384	**1,168**
Other	490	87	4	25	116	**722**
Total	**2,820**	**723**	**318**	**343**	**3,162**	**7,366**

Segmentation by Length

We modeled interregional destination choice separately for "short" (less than 100 miles) and "long" (100 miles or greater) trips. Since the trip frequency models already differentiate between the two, we can use this information as a valuable input to the destination choice models. This not only constrains an individual's choice set based on destinations being greater or less than 100 miles, but it recognizes that an individual may value different trip characteristics for different distance-categories of travel.

Trip Purposes

The short trip destination choice models used all four trip purposes modeled in the trip frequency step: business, commute, recreation, and other. Due to sample size considerations, only two aggregate trip purposes were estimated for the long trip destination choice models: business/commute and recreation/other.

Model Specification

Travel Impedance

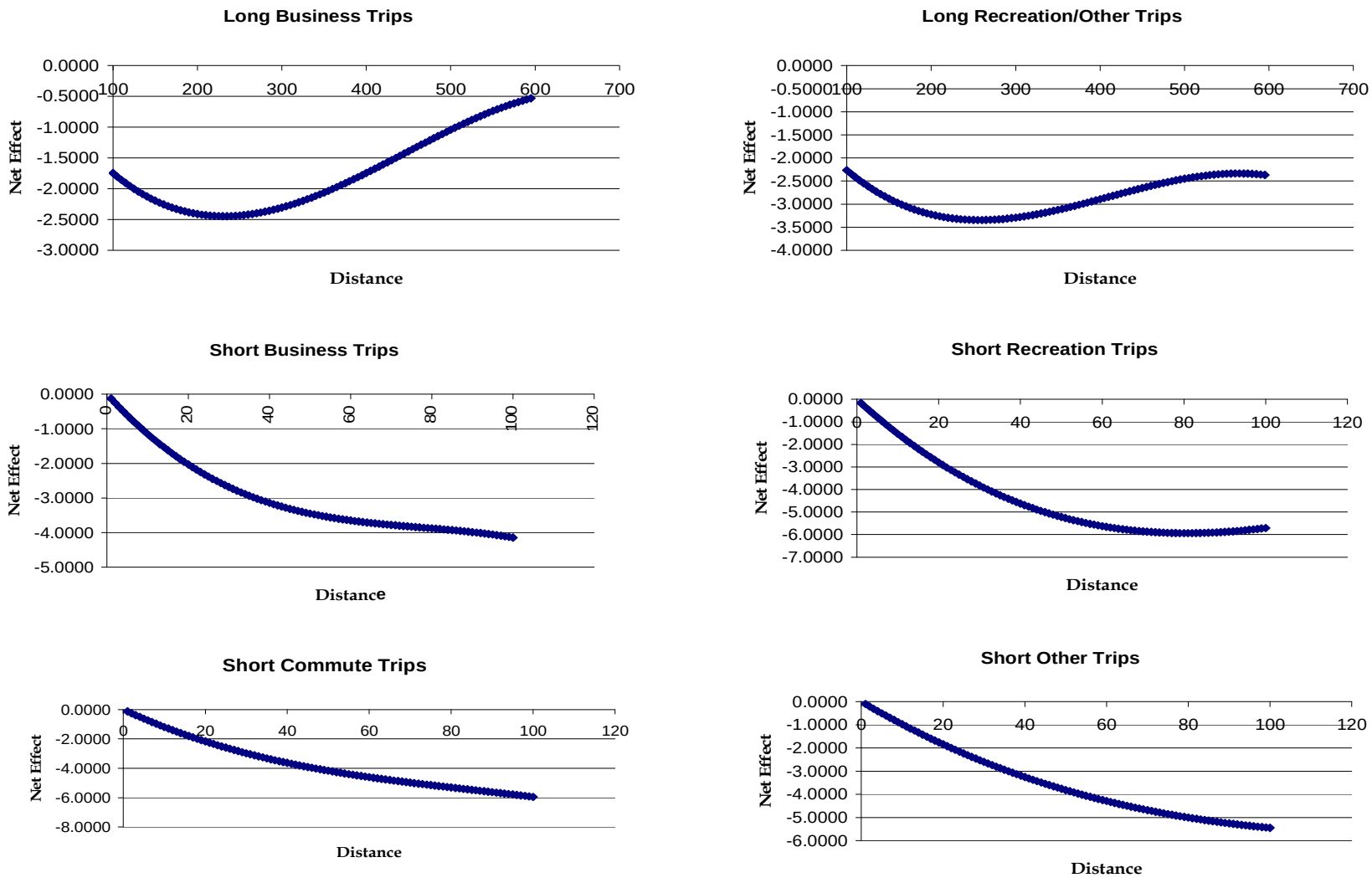
The models presented here use multimodal composite impedance from the statewide model (mode choice model logsum) broken up into four different categories: home-based-work, home-based-recreation, home-based-other, and work-based-other. We have included an appropriate impedance variable in every specification and expect there to be a positive relationship between the impedance that this variable represents, and destination choice.

This variable measures the combined utility of all available modal choices and level of service characteristics. The coefficient turned out to be positive and significant at the 95 percent confidence level in the destination choice models, indicating that the destination zone is more attractive if it is better accessible.

Distance

In all of the destination choice models presented, we have used a distance power series including *distance, distance-squared*, and *distance-cubed*. While common sense would say that all distance coefficients should be negative, one cannot analyze the distance coefficients individually, but as their collective impact. Graphs illustrate the collective impact of all three distance coefficients on one's destination choice in Figure 3.4. Further caution should be used in interpretation because a great deal of the impedance between origin-destination pairs is captured within the travel impedance term and coefficient. Therefore it is not wrong for the collective effect of distance to be either positive or negative. It should be noted that since we are estimating separate models for "short" and "long" trips, that the "short" trips are automatically capped at 100 miles from the origin. All short trip distance functions show a decreasing function up to 100 miles, which is consistent with our expectations. One example for short recreation trips is shown in Figure 3.4. Both long trip distance functions show a decreasing function from 100 miles to about 250 miles and then an increasing function for trips greater than 250 miles.

Figure 3.4 Net Effect of Distance on Trips in Destination Choice Models



Area Type

Each possible destination zone could have one of three basic area-types assigned to it: *Rural*, *Suburban,* or *Urban* (as defined in the California Statewide Model). In the destination choice models we chose "Suburban" to be the base. Additionally, we created several interaction terms to capture whether travelers were starting and ending in the same area type: *Rural to Rural*, *Suburban to Suburban*, *Urban to Urban*. We expect that the sign on Urban to Urban to be positive, and the sign on Rural to Rural and Suburban to Suburban to be negative or close to zero.

Location/Region

A total of 25 variables indicating the general geographic region were assigned to each zone. They were: *AMBAG, Central Coast, Far North, Fresno/Madera, Kern, South SJ Valley, Merced, SACOG, SANDAG, San Joaquin, Stanislaus, W. Sierra Nevada, Alameda, Contra Costa, Napa, Sonoma, Marin, San Francisco, San Mateo, Santa Clara, Solano, Imperial, Los Angeles, Orange, Riverside, San Bernardino,* and *Ventura*. We chose two of these variables as base variables for the model: SACOG in the north and Orange in the south. Since they are similar, Marin, Napa, and Sonoma were combined together into one variable to simplify the estimation process. In many of the models, there were no records to Imperial County or San Bernardino County, so these two variables were also dropped from estimation. Figure 3.6 shows these destination regions used in the location type variable.

Figure 3.5 Regions for Destination Choice Models

Location Interaction Variables

Similar to the area type interaction variables, the location type interaction variables allow us to relate where you want to go, to where you currently are. We tested four origin-destination location type interaction variables for all the "long" destination choice models: *LA to/from San Francisco*, *Sacramento to/from San Francisco*, *San Francisco to/from San Diego*, and *Sacramento to/from LA*. Due to the distances between many of these locations, we were only able to test Sacramento to/from San Francisco in the "short" destination choice models. The recreation/other "long" model did not have any records of people traveling to/from Sacramento and LA so this variable was dropped from that specification.

Since all of these locations are major population centers and destinations in the state we generally expect them to have a synergistic quality between them that these variables represent, and thus have positive coefficients (although it makes sense that this may not occur for all trip purposes).

Figure 3.6 Regions for Destination Choice Models

Size Functions

Size functions are used measure the amount of activity that occurs at each destination zone and incorporate this into the utility of alternative variables. This type of variable is frequently used in destination choice models to account for differences in zone sizes and employment levels.

Four size variables are used in these models: retail employment, service employment, other employment, and households. Other employment is used as the base size variable for business and commute trips and is constrained to 1.0 while retail and service are further segmented by household income levels – low, medium, high, and missing. Households are used as the base size variable for recreation and other trips.

Income is used as a per person variable as an interaction between employment and income to show that different income levels of the destination choices will affect the attractiveness of the zone for particular travelers. For commute trips, short and long, as income increases, retail employment has a bigger impact on destination choice than service employment.

For example:

U(1) = p70*dist(1) + p80*(dist(1)*dist(1)) + p90*(dist(1)*dist(1)*dist(1)) + p91*log(dist(1) + 0.001) + p23*wolsum(1) + p35*urb(1) + p37*rur(1)

.... rest of utility functions

size(1) = oth(1) + p100*retlinc(1)+p101*retminc(1)+p102*rethinc(1) + p103*serlinc(1)+p104*serminc(1)+p105*serhinc(1)

.... rest of size functions

This translates into the following utility for first alternative:

V(1) = p70*dist(1) + p80*(dist(1)*dist(1))+p90*(dist(1)*dist(1)*dist(1))+ p91*log(dist(1)+0.001) + p23*wolsum(1) + p35*urb(1)+p37*rur(1) + L_S_M * log {oth(1) + exp(p100)*retlinc(1) + exp(p101)*retminc(1) + exp(p102)*rethinc(1) + exp(p103)*serlinc(1) + exp(p104)*serminc(1) + exp(p105)*serhinc(1)}

Where:

dist = Distance from a congested time path (miles)

wolsum = Work-based other logsum

urb = Urban area type

rur = Rural area type

oth = Other Employment

retlinc = Retail Employment * Low Income

retminc = Retail Employment * Medium Income

rethinc = Retail Employment * High Income

serlinc = Service Employment * Low Income

serminc = Service Employment * Medium Income

serhinc = Service Employment * High Income

L_S_M = Log Size Multiplier (constrained to 1 by default).

Estimation Results

Table 3.9 presents the model estimation results of the destination choice models for long trips by trip purpose: business/commute, and recreation/other. Table 3.10 presents the model estimation results of the destination choice models for short trips by trip purpose: business, commute, recreation, and other. All variables have the sign and size we expect, except for the coefficient of rural-to-rural for recreation/other trips, which is positive when we expect it to be negative, but it is not significantly different than zero.

Table 3.9 Destination Choice Models for Long Trips

	Business		Other	
Observations	1,342		1,922	
Initial log-likelihood	-12,102.6		-17,029.0	
Final log-likelihood	-11,475.4		-16,219.3	
Rho-squared	0.052		0.048	
	Coef	**T-stat**	**Coef**	**T-stat**
Level of Service				
Mode choice logsum[1]	0.107	5.1	0.103	6.7
Mode choice logsum[2]	0.107	constrained	0.103	constrained
Distance (miles)	-0.024	-8.5	-0.031	-11.7
Distance squared/100	0.0070	8.9	0.0087	10.8
Distance cubed/10000	-0.0005	-8.0	-0.0007	-9.5
Area type				
Urban destination	0.724	6.7	0.810	9.5
Rural destination	0.222	2.0	0.607	6.8
Urban to urban	-0.010	-0.1	-0.096	-0.8
Suburban to suburban	-0.185	-1.5	-0.029	-0.3
Rural to rural	-0.112	-0.7	-0.036	-0.3
Destination District				
AMBAG	0.154	0.8	-0.347	-2.1
Central Coast	-1.357	-3.9	-1.316	-5.1
Far North	0.190	1.0	-0.295	-2.0
Fresno	1.379	9.2	1.012	8.3
Kern	1.028	5.9	0.612	4.3
Merced	1.416	8.0	0.790	5.2
S. San Joaquin	0.882	3.2	0.408	1.7
SANDAG	-0.001	0.0	0.080	0.6
San Joaquin	-0.280	-1.1	0.360	2.3
Stanislaus	-1.264	-3.0	-0.256	-1.2
W. Sierra Nevada	1.114	4.4	-0.406	-1.4
Alameda	-1.277	-6.1	-0.983	-6.0
Contra Costa	-0.276	-1.4	-0.415	-2.5
Marin/Sonoma/Napa	-0.354	-1.8	-0.522	-3.0
San Francisco	-1.350	-6.2	-1.433	-7.2
San Mateo	-1.190	-4.6	-1.263	-5.5
Santa Clara	-1.213	-6.1	-0.912	-5.7
Solano	0.298	1.4	-0.671	-2.8
Los Angeles	-1.135	-6.5	-1.125	-8.4
Orange	-1.624	-7.2	-2.433	-10.4
Riverside	-2.606	-5.5	-2.001	-7.8
San Bernardino	-2.020	-6.0	-1.898	-8.1
Ventura	-1.191	-3.4	-1.638	-5.3
Regional Interactions				
MTC to SCAG	0.651	4.0	0.607	4.8
MTC to SANDAG	0.321	1.6	0.107	0.7
SACOG to SCAG	0.068	0.2	-0.515	-1.8
SACOG to SANDAG	-0.454	-1.1	0.390	1.5
SCAG to MTC	0.256	1.6	0.153	1.0
SCAG to SACOG	-0.538	-1.3	0.089	0.3
SANDAG to MTC	0.364	1.9	0.200	1.2
SANDAG to SACOG	0.208	0.7	-0.285	-1.0
Size variables (exponentiated)				
Other employment	1.000	constrained		
Households			1.000	constrained
Retail employment-low income	2.889	2.1	0.960	-0.1
Service employment - low income	1.728	1.5	0.287	-3.6
Retail employment -med income	9.318	4.9	0.850	-0.4
Service employment - med income	2.292	1.8	0.373	-3.3
Retail employment -high income	7.338	5.6	1.385	0.8
Service employment - high income	2.525	2.8	0.393	-2.4
Retail employment -missing income[3]	100.000	0.1	0.001	-0.1
Service employment - missing income[3]	100.000	0.1	0.433	-1.4

[1]Estimated without distance terms.

[2]Constrained in final model.

[3]Not used in application.

Table 3.10 Destination Choice Models for Short Trips

Observations	Business		Commute		Recreation		Other	
Observations	397		1,153		865		556	
Initial log-likelihood	-2,718.8		-8,133.9		-5,933.8		-3,756.4	
Final log-likelihood	-2,452.5		-7,199.4		-5,105.5		-3,082.2	
Rho-squared	0.098		0.115		0.140		0.179	
	Coef	**T-stat**	**Coef**	**T-stat**	**Coef**	**T-stat**	**Coef**	**T-stat**
Level of Service								
Mode choice logsum[1]	0.751	10.5	0.664	10.3	2.081	23.0	2.739	24.1
Mode choice logsum[2]	0.751	constrained	0.664	constrained	1.000	constrained	1.000	constrained
Distance (miles)	-0.130	-3.7	-0.130	-6.1	-0.167	-7.9	-0.104	-4.0
Distance squared/100	0.155	2.3	0.116	2.7	0.139	3.3	0.061	1.1
Distance cubed/10,000	-0.067	-1.7	-0.045	-1.8	-0.030	-1.2	-0.011	-0.3
Area type								
Urban destination	0.760	3.8	0.872	7.4	0.502	3.8	0.419	2.3
Rural destination	0.036	0.2	0.126	1.1	0.081	0.6	0.190	1.1
Urban to urban	-0.499	-1.6	-0.019	-0.1	-0.142	-0.7	0.457	1.9
Suburban to suburban	0.253	1.1	-0.055	-0.4	0.051	0.3	-0.016	-0.1
Rural to rural	-0.505	-1.8	-0.075	-0.5	0.336	1.9	0.245	1.0
Destination District								
AMBAG	0.878	3.3	0.425	2.3	0.396	2.2	0.617	2.7
Central Coast	-2.214	-2.2	-2.460	-4.6	-1.190	-3.0	-1.010	-2.1
Far North	0.678	2.4	0.170	0.8	0.349	1.9	0.961	4.7
Fresno	-0.300	-1.0	0.297	1.8	-0.132	-0.8	0.283	1.4
Kern	0.114	0.4	0.532	3.2	0.147	0.8	0.169	0.7
Merced	0.783	3.2	1.052	7.0	-0.038	-0.2	-0.004	0.0
S. San Joaquin	1.317	4.0	1.017	4.3	0.346	1.4	0.311	1.0
SANDAG								
San Joaquin	0.234	0.9	0.391	2.5	-0.146	-0.8	-0.181	-0.8
Stanislaus	-0.076	-0.2	0.088	0.3	-0.323	-1.2	-0.168	-0.4
W. Sierra Nevada	1.744	5.5	1.153	5.1	0.257	0.8	0.531	1.4
Alameda	-1.159	-3.9	-0.524	-3.4	-1.551	-7.3	-0.646	-2.6
Contra Costa	-0.619	-2.3	-0.086	-0.6	-0.858	-4.8	-0.509	-2.3
Marin/Sonoma/Napa	-0.767	-2.7	-0.211	-1.4	-1.617	-7.1	-1.654	-4.9
San Francisco	-0.993	-3.3	-0.893	-5.1	-2.274	-7.2	-1.680	-4.4
San Mateo	-0.894	-2.6	-0.379	-2.2	-1.864	-5.3	-1.232	-3.2
Santa Clara	-1.129	-4.4	-1.016	-6.6	-0.856	-5.1	-0.810	-3.5
Solano	-1.102	-1.8	0.113	0.5	-1.627	-3.5	-0.422	-0.9
Los Angeles	-1.391	-5.5	-1.717	-9.7	-1.335	-8.8	-1.885	-8.2
Orange								
Riverside	-1.538	-1.5	-0.646	-1.5	-1.827	-3.1	-2.094	-2.1
San Bernardino					-0.991	-2.5	-0.113	-0.3
Ventura	-0.846	-0.8	-0.131	-0.3	-0.602	-1.2	-0.001	0.0
Regional Interactions								
MTC to SCAG								
MTC to SANDAG								
SACOG to SCAG								
SACOG to SANDAG								
SCAG to MTC								
SCAG to SACOG								
SANDAG to MTC								
SANDAG to SACOG								
Size variables (exponentiated)								
Other employment	1.000	constrained	1.000	constrained				
Households					1.000	constrained	1.000	constrained
Retail employment-low income	1.039	0.0	9.826	3.7	1.160	0.3	0.000	0.0
Service employment - low income	3.414	2.1	3.022	1.7	0.069	-1.0	0.228	-2.4
Retail employment -med income	2.050	1.2	3.196	4.1	0.897	-0.2	0.000	0.0
Service employment - med income	0.945	-0.1	1.059	0.2	0.489	-2.0	0.373	-2.2
Retail employment -high income	23.243	3.1	10.257	6.1	0.855	-0.2	2.737	1.8
Service employment - high income	2.724	0.9	3.047	2.9	0.169	-1.4	0.367	-0.8
Retail employment -missing income[3]	1.763	0.6	2.249	1.3	1.877	0.8	1.331	0.4
Service employment - missing income[3]	0.204	-0.7	0.779	-0.4	0.311	-0.8	0.000	-0.1

[1]Estimated without distance terms.

[2]Constrained in final model.

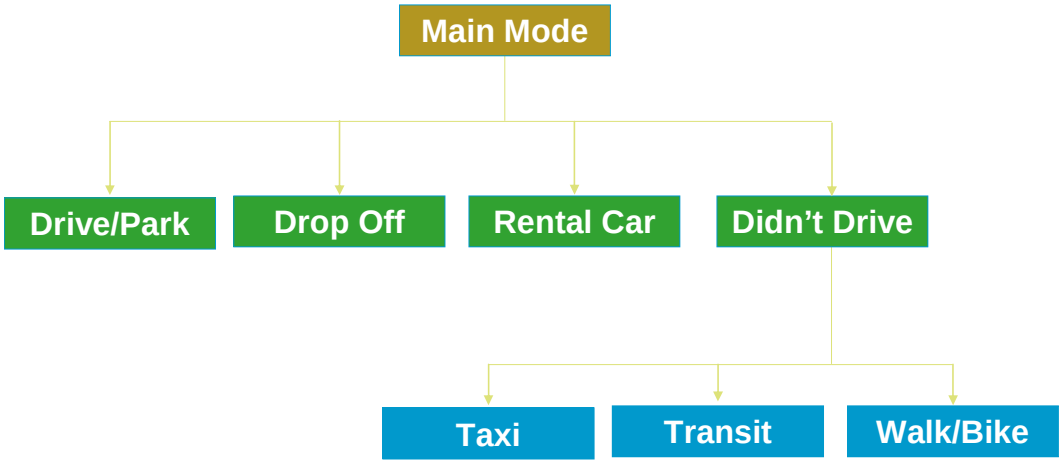
[3]Not used in application.

3.4 ACCESS/EGRESS MODE CHOICE MODELS

Model Structure

The access and egress models produce probabilities that each access and egress mode will be chosen, for each origin-destination pair, given the specific transportation and demographic characteristics of that traveler and trip. Several nesting structures were tested in model estimation to derive the nesting structure that provided the most logical and statistically sound nests. This nesting structure is displayed in Figure 3.7 and demonstrates that all driving modes are estimated at the upper nest, while non-driving modes are estimated at the lower nest.

Figure 3.7 Access/Egress Nested Model Structure



Model Specification

Table 3.11 below shows the distribution of the survey data used in model estimation. These access and egress choices reflect the survey data, but are not used directly in producing access and egress choices for each trip. For access, the majority or trips are drive and park or drop off. For egress, the shares vary more by purpose and distance, with transit more popular for short trips, and rental car and taxi more popular for long trips and business trips. The shares for short commute trips are unusually high for unpark and drive (indicating that someone keeps a car at the destination station) and taxi but these will be modified by observed values in the Census during model calibration.

Table 3.11 Access and Egress Mode Choice Shares

	Long		Short		
Choice Shares	**Business**	**Other**	**Business**	**Commute**	**Other**
Access					
Get dropped off	21.8%	41.9%	10.0%	10.1%	26.6%
Drive and park	58.5%	44.3%	76.8%	82.9%	60.4%
Rental car	3.7%	0.6%			
Taxi	10.7%	6.0%	1.9%	1.1%	4.3%
Transit	4.5%	6.5%	10.0%	5.0%	7.6%
Walk	0.8%	0.6%	1.4%	0.8%	1.2%
Egress					
Get picked up	16.0%	44.4%	14.2%	6.7%	36.8%
Unpark and drive	9.4%	1.7%	13.7%	22.2%	1.2%
Rental car	34.5%	26.6%	10.9%	0.6%	8.7%
Taxi	31.7%	18.0%	36.6%	26.7%	27.6%
Transit	5.2%	7.7%	18.0%	40.0%	17.5%
Walk	3.2%	1.5%	6.6%	3.8%	8.2%

The access and egress mode choice models were based on actual reported and hypothetical stated data. For people who were intercepted making actual air or rail journeys, the access and egress mode choices are the actual reported ones. For people whose actual journey was by car, the air and conventional rail access/egress mode choices are hypothetical. Obviously, the HSR access and egress mode choices are hypothetical for all respondents. So, each respondent provided up to 3 access choices and 3 egress choices, although most respondents only provided 2 of each, because conventional rail and air were only included together in the mode choice set for the LA-SD surveys.

For model estimation, the data were combined with network level of service measures for auto and transit, and nested mode choice models were estimated. The models also included a scale factor on the hypothetical choices relative to the actual ones, to test the hypothesis that the residual error is less in the actual choices.

Estimation Results

The access mode choice estimation results are shown in Table 3.12, and the egress mode choice estimation results are in Table 3.13. Some important results to note include the following:

Table 3.12 Access Mode Choice Models

	Long Trip				Short Trip					
	Business		Other		Business		Commute		Other	
Observations	1,500		2,724		206		341		497	
Final log-likelihood	-1,662.3		-2,519.4		-132.6		-148.4		-403.7	
Rho-squared(0)	0.276		0.365		0.486		0.639		0.316	
Rho-squared(cons)	0.003		0.068		0.012		0.022		0.079	
	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat
Access Mode Characteristics										
Constants (Dropped Off is the base)										
Drive and Park	4.503	4.6	1.319	2.6	3.705	3.8	6.947	1.9	1.618	5.2
Rental Car	-7.010	-4.3	-8.801	-3.2						
Taxi	0.927	1.4	-2.207	-2.7	-1.520	-1.5	-2.526	-1.7	-1.243	-3.3
Transit	0.912	1.0	-1.705	-2.1	1.904	1.7	0.375	0.2	0.318	0.4
Walk	3.142	2.9	0.901	0.8	3.778	2.1	1.983	0.9	2.497	2.3
Level of Service										
Cost ($)	-0.075	Constr	-0.120	constr	-0.050	constr	-0.100	constr	-0.100	constr
In-vehicle time (min)	-0.060	Constr	-0.030	constr	-0.040	constr	-0.030	constr	-0.025	constr
Out of vehicle time (min)	-0.147	-6.4	-0.083	-2.5	-0.100	-2.9	-0.060	constr	-0.061	-2.5
Implied Value of Time IVT ($/hour)	48		15		48		18		15	
Ratio OVT/IVT	2.45		2.76		2.51		2.00		2.43	
Mode-Specific LOS Variables										
Dropped Off – In-vehicle time (minutes)	-0.014	-2.5	-0.031	-3.1					-0.003	-0.7
Taxi – Distance (miles)	-0.084	-4.8	-0.071	-3.8	-0.041	-0.8			-0.014	-2.4
Transit – No walk egress	-4.836	-4.6	-1.807	-1.9	-1.469	-1.1			-3.345	-3.6
Transit – Rail used in path	3.689	5.2	1.727	2.4	3.313	2.7			3.271	4.2
Main Mode Characteristics										
Accessing Conventional Rail										
Rental Car	-5.0	Constr	-5.0	constr						
Taxi	-2.827	-2.6	-2.265	-2.4						
Accessing High Speed Rail										
Taxi			-1.092	-2.1						
Accessing Airport										
Walk	-5.000	Constr	-2.634	-1.0						
Specific Airport Access										
Drive and Park – LAX	-3.128	-3.8	-1.275	-1.7						
Drive and Park – SFO	-4.082	-4.4	-3.036	-2.6						
Drive and Park – SJC			-1.479	-2.1						
Drive and Park – SAN	-1.410	-2.3	-1.370	-2.3						
Trip/Household Characteristics										
Traveling Alone										
Drive and Park			-1.925	-3.0						
Taxi			-0.877	-1.8						
Transit			1.569	2.3						
Household Size										
Dropped Off	0.606	2.9	0.478	2.8			0.672	1.4	0.273	2.6
No Cars in Household										
Rental Car	5.110	3.2								
Transit			1.439	1.7						
Trip/Household Characteristics (continued)										
Car Competition (fewer cars than workers)										
Drive and Park	-1.547	-2.2	-1.903	-2.8			-3.775	-1.9	-1.166	-3.2
Transit	1.480	2.1							1.985	2.6
Income										
Low – Drive and Park	-2.741	-1.8	-1.960	-2.8	-2.017	-1.2			-0.494	-1.6
Low – Taxi	-3.010	-1.9								
Low – Transit			0.846	1.0						
High – Drive and Park	0.709	1.6	0.339	1.4						
High – Rental Car	2.953	2.4								
High – Taxi			0.849	1.9						
Nesting and scaling										
Nest – transit, walk, taxi*	0.387	5.9	0.451	3.3	0.570*	4.3	0.458*	2.0	1.000	constr

Scale on hypothetical choices	0.682	15.9	1.000	Constr	1.000	constr	1.000	constr	1.000	constr

*Taxi not in the nest.

Table 3.13 Egress Mode Choice Models

	Business Long		Other Long		Business Short		Commute Short		Other Short	
Observations	1,466		2,668		171		300		444	
Final log-likelihood	-2,121		-3,067		-268		-391		-515	
Rho-squared(0)	0.075		0.231		0.015		0.197		0.241	
Rho-squared(cons)	-0.023		0.053		-0.109		-0.049		0.054	
	Coeff.	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**
Egress Mode Characteristics										
Constants (Dropped Off is the base)										
Unpark and Drive	1.58	1.5	-7.241	-5.2	0.6449	0.8	5.098	2.3	-7.113	-3.3
Rental Car	6.345	4.8	-0.28	-1.3	-1.282	-1.2	-14.52	-2.1	-3.074	-3.3
Taxi	7.705	5.5	-0.7485	-3.3	4.962	3.0	6.179	2.1	0.04838	0.1
Transit	4.441	2.7	-3.715	-3.6	4.342	2.5	8.170	2.7	-0.525	-0.9
Walk	10.33	5.7	-0.815	-1.3	5.607	2.8	4.825	1.6	1.942	3.7
Level of Service										
Cost ($)	-0.075	constrained	-0.120	constrained	-0.050	constrained	-0.100	constrained	-0.100	constrained
In-vehicle time (min)	-0.060	constrained	-0.030	constrained	-0.040	constrained	-0.030	constrained	-0.025	constrained
Out of vehicle time (min)	-0.147	-6.4	-0.083	-2.5	-0.100	-2.9	-0.060	constrained	-0.061	-2.5
VOT IVT ($/hour)	$ 48.00		$ 15.00		$ 48.00		$ 18.00		$ 15.00	
Ratio OVT/IVT	2.45		2.76		2.51		2.00		2.43	
Drive and park										
Constant	4.503	4.6	1.319	2.6	3.705	3.8	6.947	1.9	1.618	5.2
Travel alone			-1.925	-3.0						
Fewer cars than persons	-1.547	-2.2	-1.903	-2.8			-3.775	-1.9	-1.166	-3.2
Low income	-2.741	-1.8	-1.960	-2.8	-2.017	-1.2			-0.494	-1.6
High income	0.709	1.6	0.339	1.4						
Airport is LAX	-3.128	-3.8	-1.275	-1.7						
Airport is SFO	-4.082	-4.4	-3.036	-2.6						
Airport is SJC			-1.479	-2.1						
Airport is SAN	-1.410	-2.3	-1.370	-2.3						
Rental car										
Constant	-7.010	-4.3	-8.801	-3.2						
To conventional rail	-5.000	constrained	-5.000	constrained						
No cars in HH	5.110	3.2								
High income	2.953	2.4								
Get dropped off										
In-vehicle time (min)	-0.014	-2.5	-0.031	-3.1					-0.003	-0.7
Household size	0.606	2.9	0.478	2.8			0.672	1.4	0.273	2.6
Taxi										
Auto distance	-0.084	-4.8	-0.071	-3.8	-0.041	-0.8			-0.014	-2.4
Constant	0.927	1.4	-2.207	-2.7	-1.520	-1.5	-2.526	-1.7	-1.243	-3.3
To conventional rail	-2.827	-2.6	-2.265	-2.4						
To high-speed rail			-1.092	-2.1						
Travel alone			-0.877	-1.8						
Low income	-3.010	-1.9								
High income			0.849	1.9						
Transit										
No walk egress	-4.836	-4.6	-1.807	-1.9	-1.469	-1.1			-3.345	-3.6
Rail used in path	3.689	5.2	1.727	2.4	3.313	2.7			3.271	4.2
Constant	0.912	1.0	-1.705	-2.1	1.904	1.7	0.375	0.2	0.318	0.4
Travel alone			1.569	2.3						
No cars in HH			1.439	1.7						
Fewer cars than persons	1.480	2.1							1.985	2.6
Low income			0.846	1.0						
Walk										

Constant	3.142	2.9	0.901	0.8	3.778	2.1	1.983	0.9	2.497	2.3
To airport	-5.000	constrai ned	-2.634	-1.0						
Nesting and scaling										
Nest- transit, walk, taxi	0.387	5.9	0.451	3.3	0.570	4.3	0.458	2.0	1.000	constrai ned
Scale on hypothetical choices	0.682	15.9	1.000	constrai ned	1.000	constrai ned	1.000	constrai ned	1.000	constrai ned

*Taxi not in the nest.

- The in-vehicle time and cost parameters had to be constrained at reasonable values for all segments, as the initial results were insignificant or the incorrect sign in all cases. A reasonable value of time was asserted for each segment based upon a review of other research. As the survey was not designed primarily to estimate access and egress choice models, and the zone size is in a statewide model is quite large for this type of local choice, the result is perhaps not surprising. Also note that the costs of options such as taxi and rental car and airport/station parking are not readily obtained from network data.
- The out-of-vehicle time coefficients were estimated for most segments, and result in ratios of out-of-vehicle time to in-vehicle time that are in the range of 2.0 to 2.9.
- For the Long Segments, the Drop Off and Pick Up alternatives have an additional negative in-vehicle time effect, capturing the disutility of the driver that has to make the round trip to the airport.
- We did not include taxi cost explicitly, but did include an additional distance coefficient for taxi, which is significant and negative for most segments, typically with an equivalent value of over $1.00 per mile.
- For most segments, transit is less likely to be chosen if there is no reasonable walk access to transit at the trip end, meaning that a drive to transit path was included instead.
- For most segments, transit, which can include rail and/or bus, is more likely to be chosen if rail is included in the best transit path.
- Due to much smaller sample sizes for the short trip segments, we were not able to estimate many other segmentation effects for those segments.
- For the long segments, taxi, parking, and rental cars are generally less desirable to rail stations than to airports, while transit is more desirable from rail stations. Walking is very rare to or from airports, capturing accessibility affects that are not captured well in the zone system.
- Drive and park access is less likely at the busiest airports – SFO, LAX, and SAN – and somewhat at SJC as well. This may capture both cost and inconvenience effects at those airports.
- Those traveling alone in the Other Long segment are more likely to use transit and less likely to use taxi and auto, relative to those traveling with others.
- For most segments, those in larger households are more likely to be dropped off.
- In general, high income favors rental car, taxi and drive and park, and low income slightly favors transit in some segments.

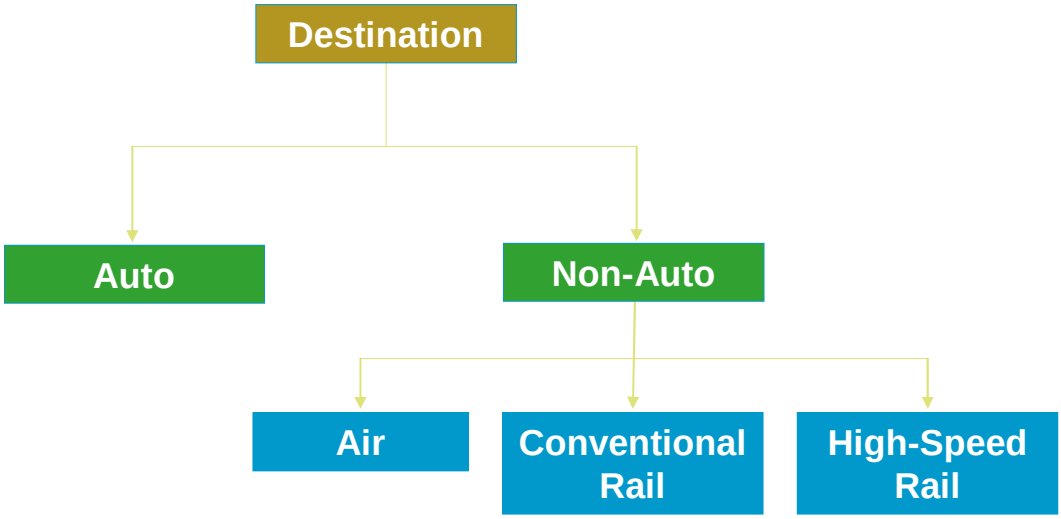
- In 7 of the 10 models, there is a logsum coefficient less than 1.0 on a nest that includes transit, walk, and taxi. Each of the other three alternatives is in its own "nest," and scaled by the same logsum parameter to preserve equal scaling at the elemental level. The logsum coefficient is typically near 0.5. In 2 of the models (Business Short Access and Commute Short Access), the taxi alternative is not included in the nest.
- For most of the Access mode segments, the scale (the inverse of the residual error variance) for the hypothetical choices was not significantly lower than 1.0. It was only so for the Business Long segment, which is mainly air travelers. This result suggest that most people are fairly familiar with the travel options near their home, but that business travelers may be more familiar with the airport access situation than with possible access to rail stations.
- In contrast, for most of the Egress model segments, the scale factor on hypothetical choices is significantly less than 1.0. This result indicates that many respondents have difficulty making accurate tradeoffs for mode choice in less familiar surroundings at the non-home end of their trip, so that hypothetical choices should be weighted less in estimation than actual ones.

3.5 Main Mode Choice Models

Model Structure

The main mode choice models produce probabilities that each trip will choose one of the main modes (auto, air, conventional rail, and high-speed rail). Several nesting structures were tested for the main mode choice models and the final nesting structure chosen is presented in Figure 3.8. This structure provided the most logical and statistically sound nesting structure for the mode choice models.

Figure 3.8 Main Mode Choice Nested Model Structure



We tested a few model variables that did not impact the final model specification, as follows:

- We tested "inertia" effects related to the actual mode that people used relative to their SP choices. This variable was significant in the models, but produces illogical results for most of the other variables, so was left out of the final models.
- We segmented the cost coefficients by income group, but these were not significant in the models. The high income coefficients used by mode were a more effective means to include income in the models.

We separated reliability and frequency variables for high-speed rail, but these were not significant so were not included in the final models.

Model Specification

The main mode choice models are based on stated-preference choice data, with each respondent making a choice for four separate scenarios. Three different types of choice sets were used in the SP surveys:

- Within Southern California (between the SCAG and SANDAG regions): All four modes – car, air, conventional rail, and HSR.
- Within Northern/Central California (both trip ends north of the SCAG region): Three modes – car, conventional rail, and HSR. Air not included.
- Between Southern and Northern/Central California: Three modes – car, air, and HSR. Conventional rail not included.

In general, most of the respondents in the Short trip segments less than 100 miles were in the first two groups, while most of those in the Long trip segments were in the third group.

The overall choice shares in the SP data are shown in Table 3.14 below by segment. Conventional rail was rarely made available for Long trips, and Air was very rarely made available for Short trips, which partly explain the low shares for those modes in particular segments. In general, the share for HSR is quite high, and is highest for business trips and long trips, giving a first indication that HSR substitutes more closely with air than with car.

Table 3.14 Overall Choice Shares in SP Data

	Long Trip		Short Trip		
	Business	Other	Business	Commute	Other
Car	9.2%	34.7%	27.9%	11.2%	50.4%
Air	20.9%	6.2%	0.0%	0.0%	0.0%
Conventional rail	1.3%	3.0%	21.8%	33.5%	14.1%
High-speed rail	68.6%	56.2%	50.3%	55.3%	35.6%

To prepare the data for estimation, the access and egress mode choice models were first applied to calculate access and egress mode logsums for each alternative. Then, a nested logit model was estimated across the four main modes for each of the segments (only three alternatives for the Short segments, as air was not available for those segments).

Estimation Results

The estimation results are shown in Table 3.15. Some results of note include the following:

- As in the access/egress models, there are fewer cases for the Short segments, and fewer significant coefficients as a result.
- The residual mode-specific constants for HSR are generally not very much higher than for the other modes. This result indicates that the high choice shares found for HSR are mainly due to the attractiveness of the time and cost, by the mode, rather than to SP-related survey effects or biases.
- For the three largest segments, the cost and in-vehicle time parameters were estimated non-constrained and give very reasonable values of time. For the Short Business and Commute segments, the original in-vehicle time coefficients were quite low, and so were constrained to give values of time that seem more in line with other models. In general, VOT for the longer, more expensive trips is higher than for the shorter, more frequent trips. This is a typical result.
- The value of frequency (headway) is significant for all segments, but is only about 20 percent as large as the in-vehicle time coefficient. If wait time were half the headway and valued twice as highly as in-vehicle time, then we would expect the same coefficient on headway and in-vehicle time. For these modes, and particularly air, headway is less related to wait time than it is to scheduling convenience. Because none of the levels used in the SP had headways higher than a few hours, the implications for scheduling may not have been large enough to greatly influence mode choice.
- The value of reliability is fairly low for all segments, although with the correct sign. It is very difficult to measure the effect of reliability in a large-scale mailout SP survey, so we decided to use a somewhat higher effect of reliability in application, based on any evidence from elsewhere. In addition, we are redefining reliability based on percent within 60 minutes of schedule time rather than the 15 minutes used in the survey to identify more significant reliability problems.
- For the Long segments, those traveling with others are more likely to use car and less likely to use air. This effect was also tested on the cost coefficients and not found to be significant, so this relative mode preference appears to be related to more than just cost – such as the fact that people can share driving for long trips.

Table 3.15 Main Mode Choice Models

	Long Trip				Short Trip					
	Business		Other		Business		Commute		Other	
Observations	2,918		8,075		326		564		852	
Final log-likelihood	-1,969		-3,933		-295		-445		-744	
Rho-squared(0)	0.389		0.31		0.175		0.281		0.205	
Rho-squared(cons)	0.163		0.155		0.123		0.159		0.117	
	Coeff.	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**	**Coeff.**	**T-stat**
Main Mode Characteristics										
Constants										
Car (base)										
Air	-1.645	-4.7	0.6898	2.8						
Conventional rail	-0.387	-0.9	0.6149	2.6	-0.268	-0.5	4.232	2.6	-0.3847	-1.4
High-speed rail	-0.3503	-1.1	1.434	7	-1.557	-2.8	4.048	2.5	0.5041	1.7
Level of Service										
Cost ($)	-0.01626	-12.8	-0.035	-18.5	-0.109	-5.4	-0.148	-11.3	-0.109	-8.2
In-vehicle time (min)	-0.016	-11.1	-0.011	-14.2	-0.5	constrained	-0.025	constrained	-0.014	-5.2
Service headway (min)	-0.003	-3.7	-0.003	-3.5	-0.006	-2.5	-0.0023	-2.4	-0.009	-5.5
Reliability (% on time)	0.001	0.3	0.005	1.9	0.023	1.8	0.006	0.6	0.004	0.6
Implied Value of Time IVT ($/hour)	$57.71		$18.33		$27.60		$10.12		$7.93	
Ratio Frequency/IVT	0.21		0.24		0.12		0.1		0.66	
Trip Characteristics										
Travel in a Group										
Car	0.8492	4.2	1.417	9.1						
Air	-0.3375	-2.7	-0.5061	-3.7						
Household Characteristics										
Household Size										
Car	0.0704	0.9	0.225	4.9			0.655	2		
Income										
High – car					-1.211	-2.3	-1.247	-1.8		
High – air	1.018	4.5								
High – conventional rail	0.5237	1.2								
High – high-speed rail	0.9807	4.8								
Fewer Cars than Workers										
Car	-0.7696	-2.4	-0.4354	-2.8	-0.7873	-0.8	-2	-1.5		
Nesting and scaling										
Nest – air, rail, high-speed rail	0.8514	8.8	0.7426	13	0.5159	2.7	0.5892	3.4	0.6855	6.1
Access mode choice logsum	0.115	3.1	0.2134	3.8	0.4628	1.9	0.33	1.5	0.3148	3.5
Egress mode choice logsum	0.1561	3.8	0.3974	7.1	0.4628	constrained	0.33	constrained	0.3148	3.5

- People in larger households are more likely to use car. Even though we already have the group/alone segmentation, people in larger households are likely to be in larger groups.
- Higher income generally favors air and high-speed rail versus auto.
- Low auto availability within the household is somewhat related to less chance of choosing the auto.
- A nest with air, rail, and HSR, (with car in its own "nest") produced a logsum coefficient below 1.0 for all segments, indicating that this was a reasonable nesting structure for interregional trips.
- The access mode choice logsums were estimated with positive coefficients in the range of 0.11 to 0.46 for all segments. The egress mode choice logsums gave negative values (which are illogical) for the business and commute short trips, so these were constrained to be the same as the access logsum.
- The access and egress logsums are somewhat lower for the long trips than for the short trips, which may reflect the fact that the access and egress legs are a smaller percentage of the total travel time for the long trips.
- For the long trips, the egress mode accessibility seems to have somewhat more influence on mode choice than does the access mode. Travelers may be less concerned about the home end, where they know the options and can use their own auto, and then they are about the destination end.

The main mode choice models are likely to be the key determinants of the sensitivity of the model system as a whole – particularly the models for the Long trip segments where HSR is likely to be most attractive.

3.6 MODEL APPLICATION

The interregional models will be applied with customized software within the Cube software framework. This application is described in concept in Figure 3.9. A full documentation of the model application will be developed in the report on model validation.

Figure 3.9 Model Application Structure Outline

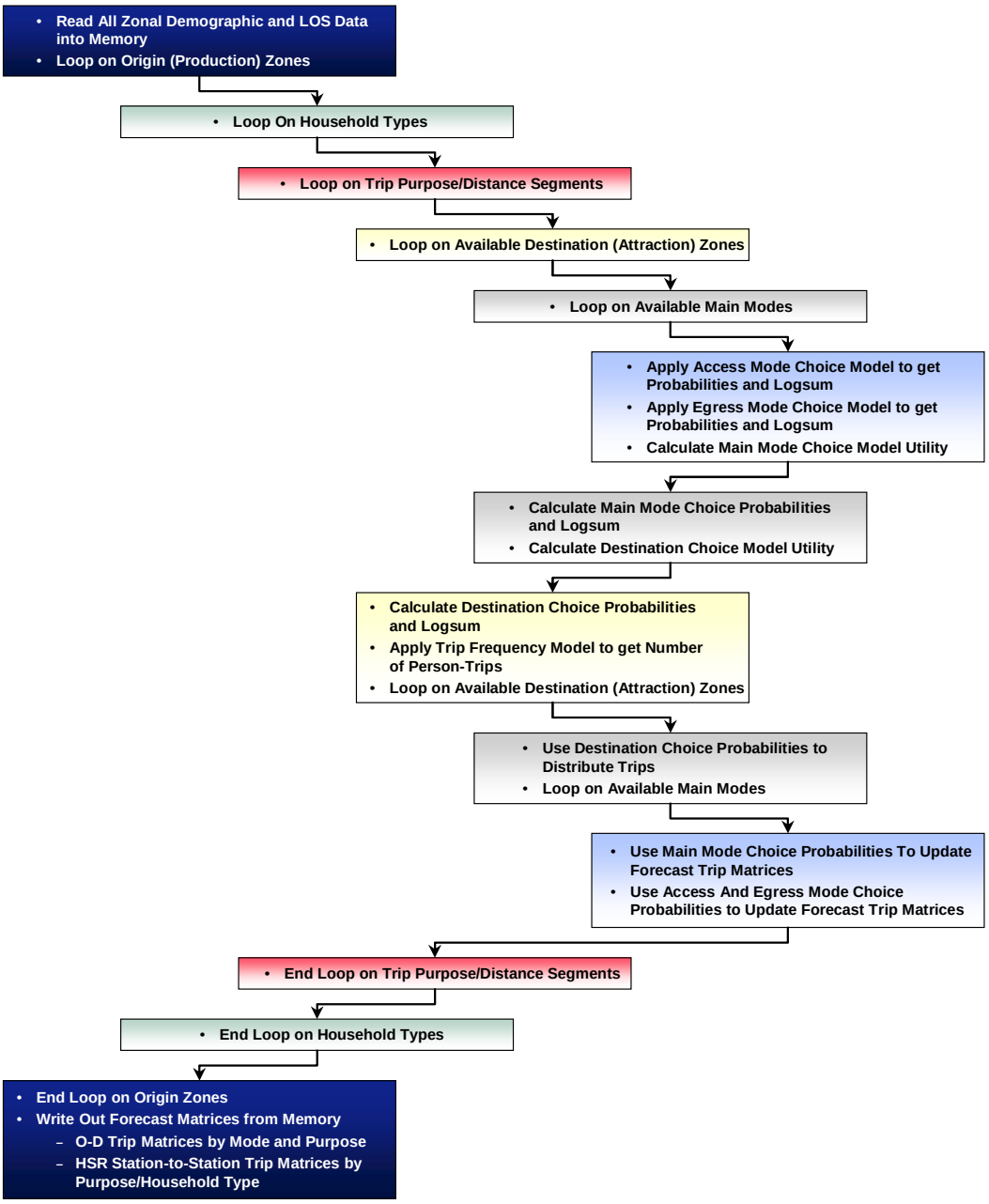
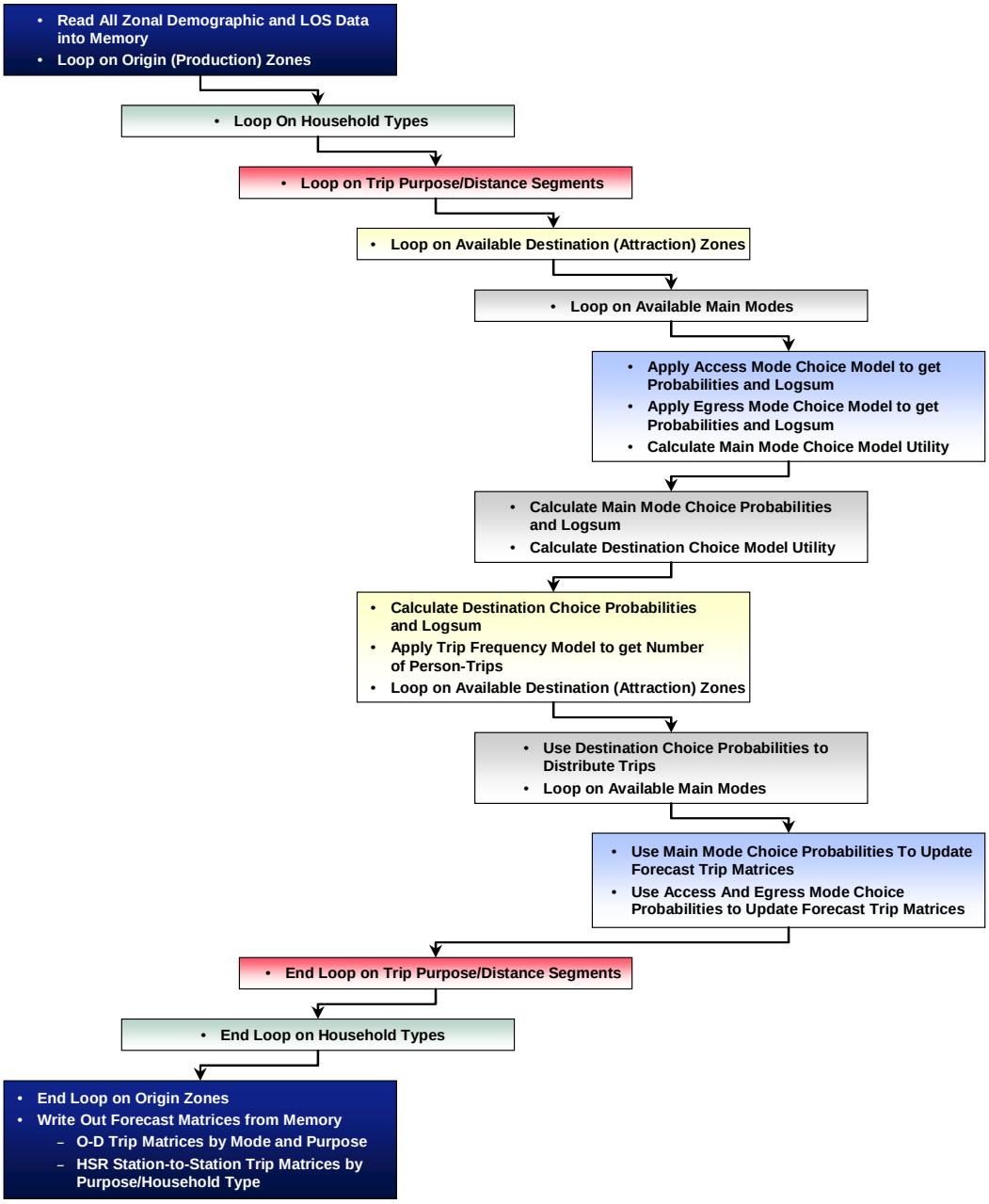



Figure 3.10 Interregional Model Purpose/Distance Segmentation