California Statewide Travel Demand Model, Version 2.0

Long Distance Personal Travel Model

final

report

prepared for

California Department of Transportation

prepared by

Cambridge Systematics, Inc.

and

HBA Specto, Inc.

June 2014

www.camsys.com

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

date

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1.0 Model Overview

The Long Distance Personal Travel Demand Model consists of a series of models that produce long distance tours (those over 100 miles straight line distance from the home location) on a typical spring or fall weekday. The models consist of:

- **Travel Choice Model** – a model that runs "in-line" with the Short Distance Personal Travel Demand Model (SDPTM) that determines whether households produce short distance travel, long distance travel or out-of-state travel (LD/OOS); effectively functioning as tour generation and purpose choice for long distance travel.
- **Party Formation Models** – a series of models that run on households who choose to perform long distance or out-of-state travel, forming a party of LD/OOS travelers from the household and identifying the individual household members in the party.
- **Tour Property Models** – a series of models assigning temporal and directional characteristics for long distance travel groups, including the duration of the tour (in nights away); the travel status – i.e. which day in the tour is observed and which trip(s) result from this day – and the time of any long distance trips.
- **Destination Choice Models** – a model (varying by purpose) assigning a destination for the long distance tour.
- **Mode Choice Models** – a model assigning a primary mode of travel (car/rail/air), and if a non-car mode is chosen, models assigning travel modes to the access and from the egress station.

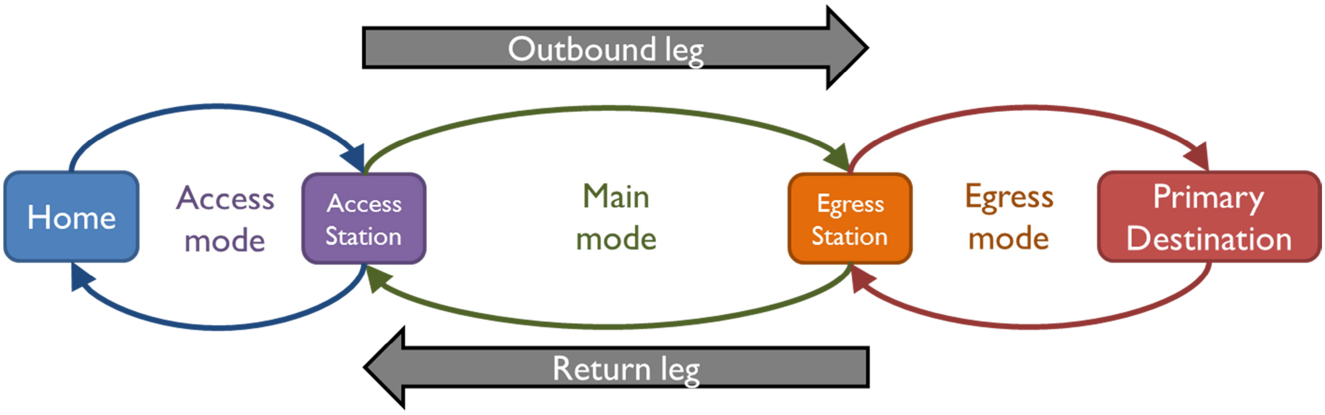
Out Of State (OOS) travel is travel outside of California, by any mode and to any destination from the walk between San Ysidro to Tijuana to a flight to the other side of the world. Households engaged in out of state travel are not transferred over to the External Travel Model (ETM); to do this would not only require a massive expansion in terms of networks and zones, it would only explain a portion of external travel, as most external travel is from people living outside of California. The simpler but complete ETM is the preferred solution to represent the network component of this travel. The role of OOS travel in the Travel Choice / Party Formation models is to provide the complete set of alternatives to households and to account for this travel in the households.

1.1 TOUR STRUCTURE AND TERMINOLOGY

The LDPTM is a tour-based model; the basic unit of travel is a tour from home to a primary destination and back. Secondary stops on the tour are not considered within the LDPTM, nor is travel based at the primary destination (visitor travel).

The tour structure of the LDPTM consists of an outbound leg from the home to the primary destination and a return leg from the primary destination back to home. Tours have a main mode, either car, air, conventional rail or high speed rail. For all modes except car, access and egress travel to and from the airport or rail station is also considered; stations are selected using a shortest-cost skimming process, and access and egress mode models assign modes to the access and egress tours. Figure 1-1 below shows the basic tour structure of the LDPTM (a car tour involves only the main mode travel directly from home to the primary destination and back).

Figure 1-1 LDPTM Conceptual Tour Structure



1.2 TRAVEL PURPOSES

The LDPTM is highly stratified by purpose; all models involve at least some consideration of travel purpose, due to the very different nature and demands of their travel. The purposes are:

- **Commuting;**
- **Business** travel, including conferences and trips combining business and pleasure;
- **Recreation**, including vacations, entertainment and outdoor recreation;
- Visiting Friends and/or Relatives (**VFR**) and;
- **Other**, including medical, school, shopping and personal business.

These purposes are often aggregated with Business and Commute in one group and Recreation, VFR, and Other in the second group.

1.3 TREATMENT OF INCOME

The LDPTM is highly sensitive to household income; incomes have been defined in a roughly "normalized" fashion, where the number of workers has been partially taken into account; income bands are defined for households with one worker or fewer, and for households with two or more workers. Not considering the number of workers means that two fast food workers (with $25K incomes) that move in together are treated in the same way as a single schoolteacher (with $50K income), or that two schoolteachers moving in together are treated in the same way as a single lawyer or executive. In test estimations, this structure outperformed the more "traditional" structure where only household level income is considered.

A large number of income categories are considered: at the low end of income, changes in income produce a strong response in the decision to perform long distance travel at all, but actual long distance trips are more common amongst high-income households, so a finer graduation helps capture differences in preferences for this group. A set of income bands has been developed, denoted with letters from A at the lowest end to F at the highest end. These are shown in Table 1-1 below, along with the proportion of all households and the proportion of long distance tours in each band:

Table 1-1 Household Income Group Definitions in LDPTM

<table>
<tr><th rowspan="2">Income Range</th><th rowspan="2">0-1 worker HH</th><th rowspan="2">2+ worker HH</th><th colspan="2">Proportion of HH</th><th colspan="2">Proportion of LD tours</th></tr>
<tr><th>0-1 worker</th><th>2+ worker</th><th>0-1 worker</th><th>2+ worker</th></tr>
<tr><td><$10K</td><td>A</td><td>A</td><td>4.8%</td><td rowspan="2">2.4%</td><td>1.0%</td><td rowspan="2">1.2%</td></tr>
<tr><td>$10K-$25K</td><td>B</td><td>A</td><td>12.6%</td><td>5.1%</td></tr>
<tr><td>$25K-$50K</td><td>C</td><td>B</td><td>16.7%</td><td>5.1%</td><td>11.0%</td><td>2.7%</td></tr>
<tr><td>$50K-$100K</td><td>D</td><td>C</td><td>17.8%</td><td>12.7%</td><td>21.8%</td><td>13.1%</td></tr>
<tr><td>$100K-$150K</td><td>E</td><td>D</td><td>6.5%</td><td rowspan="2">12.8%</td><td>9.3%</td><td rowspan="2">18.9%</td></tr>
<tr><td>$150K-$200K</td><td>F</td><td>D</td><td rowspan="3">4.8%</td><td rowspan="3">7.7%</td></tr>
<tr><td>$200K-$250K</td><td>F</td><td>E</td><td>1.6%</td><td>2.5%</td></tr>
<tr><td>$250K+</td><td>F</td><td>F</td><td>2.3%</td><td>5.7%</td></tr>
</table>

It can be seen that the lowest two income bands comprise 24.9% of households, but only 9.9% of long distance tours, while the highest two income bands comprise 15.2% of households, but 25.3% of long distance tours. The median household has an income at the high end of group C.

2.0 Travel Choice Model

The Travel Choice Model determines whether a household is involved in long distance or out of state travel. It is a logit model, with seven alternatives. One alternative is named Short, representing all households who do not make long distance or out of state travel (including households who do not travel at all; everyone in these households is represented in the Short Distance Personal Travel Model (SDPTM). A second alternative is Out of State (OOS), representing travel to destinations outside of California. The remaining five alternatives represent the five long distance travel purposes; Business, Commute, Recreation, Visiting Friends and Relatives (VFR) and Other. The Travel Choice Model is a multinomial logit model; various nesting structures were tested and found to be inappropriate. The coefficients are provided in Table 2-1.

Table 2-1 Travel Choice Model Parameters

<table>
<tr><th>Parameter</th><th>Short</th><th>OOS</th><th>Bus</th><th>Com</th><th>Rec</th><th>VFR</th><th>Other</th></tr>
<tr><td>Alternative specific constant</td><td>0.7998</td><td>0</td><td>-6.1782</td><td>-1.9167</td><td>-14.6964</td><td>-12.2293</td><td>-8.9030</td></tr>
<tr><td>0 workers, oldest person <65</td><td>0</td><td>0.1941</td><td colspan="2">-3.4717</td><td colspan="3">0.5037</td></tr>
<tr><td>0 workers, oldest person 65-74</td><td>0</td><td>0.4574</td><td colspan="2" rowspan="2">-2.1602</td><td colspan="3" rowspan="2">0.3767</td></tr>
<tr><td>0 workers, oldest person 75+</td><td>0</td><td>-0.5732</td></tr>
<tr><td>1 worker</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>2+ workers</td><td>0</td><td>0</td><td>0.3544</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>HH has children (0-14 years old)</td><td>0</td><td>-0.2644</td><td>-0.4582</td><td>-1.0127</td><td>0</td><td>-0.2103</td><td>-1.3526</td></tr>
<tr><td>HH Income A</td><td>0</td><td>-1.4184</td><td colspan="2">-3.7737</td><td>-3.2541</td><td>-2.0721</td><td>-2.1242</td></tr>
<tr><td>HH Income B</td><td>0</td><td>-0.8895</td><td colspan="2">-1.7751</td><td>-1.6200</td><td>-1.1962</td><td>-1.3568</td></tr>
<tr><td>HH Income C</td><td>0</td><td>-0.4772</td><td>-1.2275</td><td>-0.6363</td><td>-0.8275</td><td>0</td><td>0</td></tr>
<tr><td>HH Income D</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>HH Income E</td><td>0</td><td rowspan="2">0.3543</td><td>0.2130</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>HH Income F</td><td>0</td><td>0.7777</td><td>0.5728</td><td>0.3360</td><td>0</td><td>0</td></tr>
<tr><td>HH with insufficient autos</td><td>0</td><td>0</td><td colspan="4">-0.5043</td><td>-1.5227</td></tr>
<tr><td>HH with no autos</td><td>0</td><td>-0.5138</td><td colspan="4">-1.2728</td><td>-2.2778</td></tr>
<tr><td>Short distance accessibility</td><td>0.1818</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Network distance to nearest major airport[1], miles (max 50)</td><td>0</td><td>-0.0135</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Business accessibility</td><td>0</td><td>0</td><td>0.2742</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Recreation accessibility</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0.9642</td><td>0</td><td>0</td></tr>
<tr><td>VFR accessibility</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0.6794</td><td>0.4252</td></tr>
</table>

[1] Major airports are those with substantial out-of-state air traffic; SFO (San Francisco), LAX (Los Angeles), SAN (San Diego), SMF (Sacramento), OAK (Oakland), SJC (San Jose) and SNA (Santa Ana). These airports have at least 20,000 annual domestic out-of-state flights each, and comprise 86% of all domestic flights, 97% of domestic flights east of the Mississippi and virtually 100% of international flights from California.

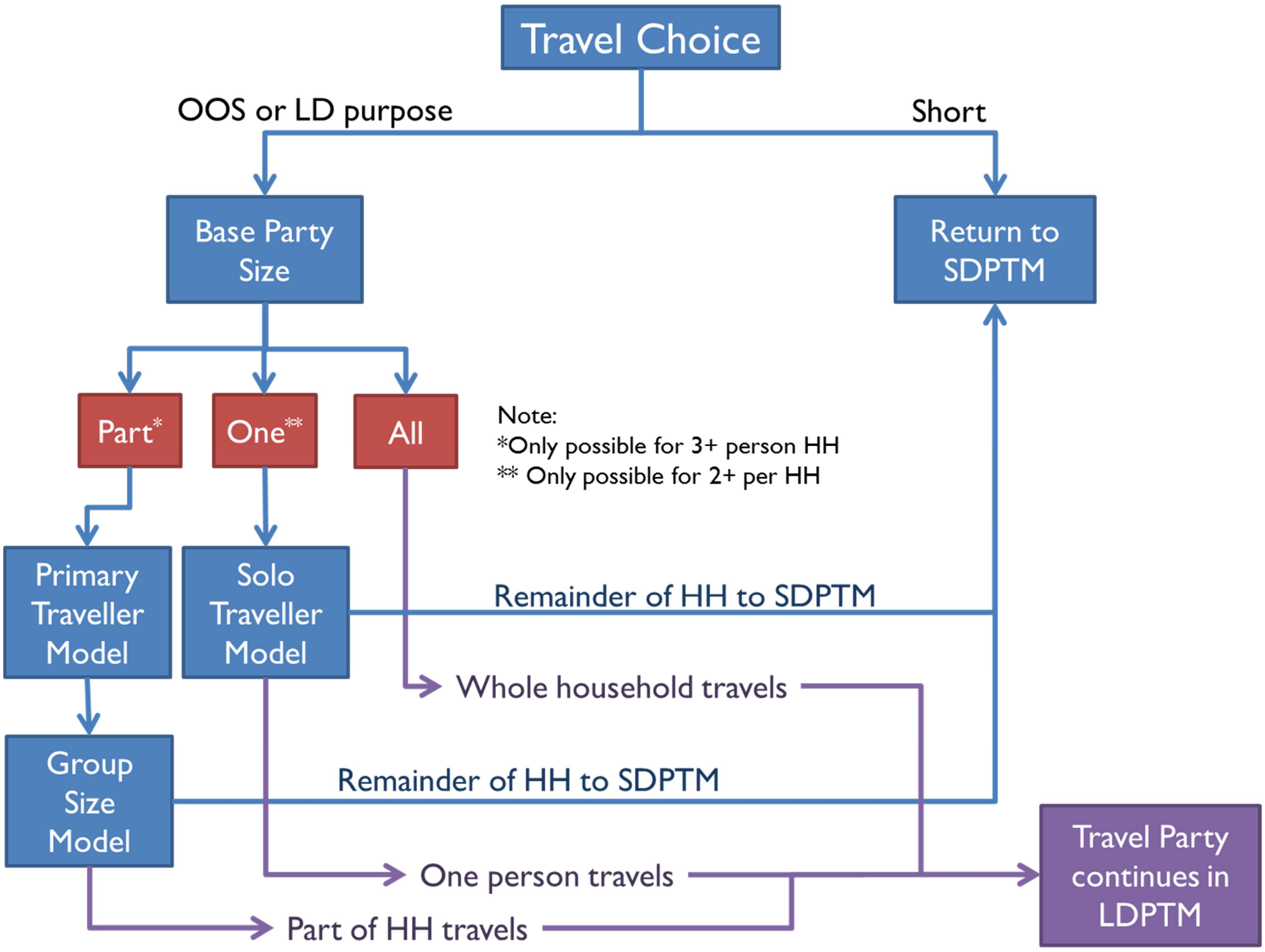
3.0 Party Formation Models

For households who choose long distance or out of state travel, a travel party must be formed, with individual household members assigned to it. Any remaining household members are then "returned" to the SPDTM and continue the day pattern choice the same as households where the travel choice is Short. For the sake of length, a household member who chooses to "travel" here means travelling as part of the long distance or out of state travel party; the remaining household members are certainly able to travel within the SDPTM context. A series of conditional party formation models assigns party members to the long distance tour, as follows:

- One person households (and noninstitutional group quarters residents) making long distance travel must by definition have a one-person party containing the entire household; no further party formation is needed.
- For all other (2+ person) households, a **Base Party Size Model** is run, selecting the basic description of the long distance party from three choices: All, where the entire household travel; One, where a single person travels; Part, where more than one household member travels and one or more household member remains. Each Base Party Size alternative has a resulting series of steps, consistent with the Base Party Size.
- If the Base Party Size is for All the household to travel, no further party formation is needed; the entire household is considered the party group.
- If the Base Party Size is for One household member to travel, then the **Solo Traveller Model** assigns each household member a utility for being the traveller, and a single traveller is chosen using Monte Carlo techniques and forms the party group, with the remaining household members returning to the SDPTM.
- If the Base Party Size is for Part of the household to travel, then the **Primary Traveller Model** selects a single person to be part of the travelling party in the same way as the Solo Traveller Model described above. Then, the **Group Size Model** determines the overall size of the travel party; household members are then randomly allocated to the party to meet the chosen party size, with the remaining household members returning to the SDPTM.

These steps are shown visually in Figure 3-1 below.

Figure 3-1 Flow of Party Formation Models



The four models comprising the Party Formation component of the LDPTM are described in the following sections.

It should be noted that the Party Formation models produce a specific party size, rather than a range such as 3+ persons. The output trip file will contain one trip for every person on the tour.

3.1 BASE PARTY SIZE MODEL

The Base Party Size model selects one of three alternatives:

- **One**; where a single member of the household forms the travel party
- **All**; where the entire household travels as a single party, or
- **Part**; where two or more household members travel, but at least one household member remains at home.

It can be seen that this decision is irrelevant for one person households, and that the Part option is only available for households with at least three members – two person households must either have one traveler or the entire household travelling. The coefficients of this model are summarized in Table 3-1 below.

Table 3-1 Base Party Size Model Parameters

	One	All	Part
Out of State purpose	0.1479	0.0905	0
Business purpose	1.1539	-0.4490	0
Commute purpose	1.4681	-0.1023	0
Recreation purpose	-0.7480	0.3155	0
VFR purpose	-0.0796	0.3105	0
Other purpose	0	0	0
Number of workers	0.0787	-0.6578	0
Number of nonworkers	-0.1759	-0.5898	0
Presence of children 0-5 years old	0.3803	1.5993	0
Presence of children 6-15 years old		1.2196	0
Income level E or F	0.2356	0.1678	0
Household has no car	0.9499	0	0
Short dist. accessibility (SDPTM Suff-Med work logsum)	0.1070	0	0
Alternative specific constant, 2 person HH	-1.4672	1.6028	-88
ASC, 3 person HH	-1.5784	1.0796	0
ASC, 4 person HH	-1.8373	1.4452	0
ASC, 5 person HH	-2.1590	1.9924	0
ASC, 6+ person HH	-2.5750	1.5450	0

3.2 SOLO TRAVELER MODEL

If the Base Party Size Model selects the One alternative, then the long distance / out of state travel party will involve a single person from the household. In this case, a person needs to be selected from the roster of household members. To do this, the Solo Traveler Model is applied to all persons in the household; each person is assigned a utility based on their characteristics, and the probability of person i in a household of n persons being selected as the solo traveler is the standard logit probability formula:

$$P_i = \frac{e^{U_i}}{\sum_n e^{U_n}}$$

In this way, a reasonable person will be selected to travel. The model parameters are described in Table 3-2 below:

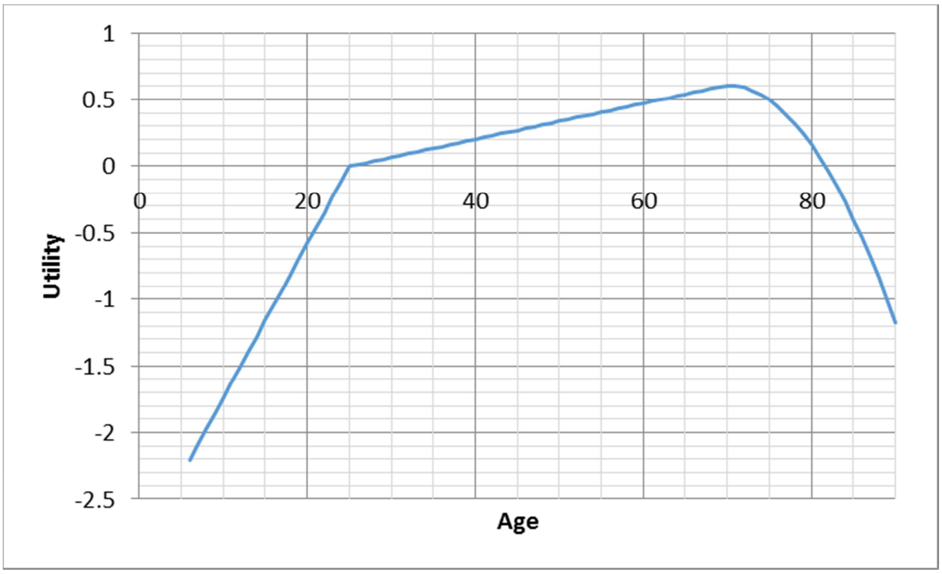
Table 3-2 Solo Traveler Model Parameters

Parameter	Utility
Age: Aged 0-5 years old	-88
Age: Years younger than 25	-0.1160
Age: Years older than 25 – capped at 45	0.0135
Age: Years older than 70, squared	-0.004454
Person has driver's license	1.4131
Full time worker	0.1571
Worker, Business tour	0.6635
Worker, Commute tour	2.2392
Person is only worker in household, Business / Commute tour	88
Management/Business or Professional worker	0.1905
Management/Business or Professional worker, Business / Commute tour	0.7264
Female, Business / Commute tour	-0.7730
Female, household has children 15 or under	-0.4401
Nonworking adult, household has children 15 or under	-0.2589
Post secondary student	0.2927

Two hard limitations based on observed data are seen; firstly, if the purpose of the tour is Business or Commute and the household has only one worker, then that worker must be the traveler – this was always the case in the observed data. The second is that young children cannot travel alone; 0-5 year olds are not permitted to travel; this is a reasonableness measure. (It should be noted that because multi-household parties are not represented in either survey or model, a child could apparently travel "alone", i.e. with no other person from their household, but in reality accompanied by someone else, for instance the case of a child of divorced parents being picked up by their non-custodial parent.)

The age parameters describe a function where the probability of someone being the chosen traveler begins at a very low level, increases sharply to the age of 25 (representing the onset of full adulthood), then increases slowly until the age of 70, dropping sharply again. The age utility parameters are shown in Figure 3-2 below.

Figure 3-2 Solo Traveler Model; Age Utility Component



The parameters of the model are reasonable; a driver's license is almost a prerequisite for long distance travel; for business and especially for commute travel, workers have a much higher utility. Management / Business, and Professional occupation workers (who are more likely to be doing the sort of high-value service that justifies travel expenses) are more likely to travel – even slightly more for nonbusiness purposes. The model also includes aspects of the current patriarchal nature of society; women are less likely to travel for business, and less likely to travel if the household has children. If children are present, any nonworking adult (who is more likely to have a child care role) is less likely to be the traveler. Finally, postsecondary students are slightly more likely to engage in long distance travel versus their peers.

3.3 PRIMARY TRAVELER MODEL

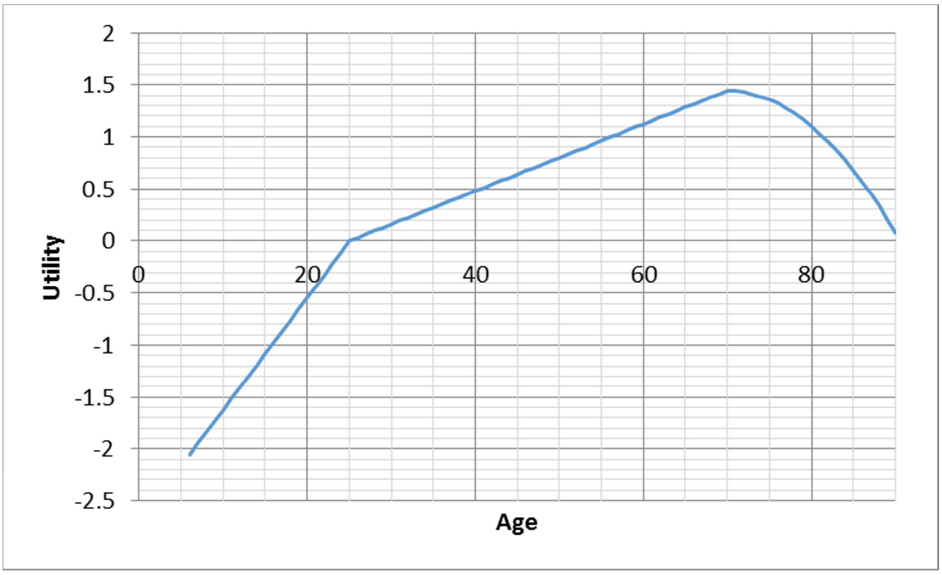
If the Base Party Size model selects that Part of the household will travel, then two models are applied; the first selects a "primary traveler", who is the person responsible for the travel party. This replicates the California Household Travel Survey (CHTS) structure, where the travel party data was limited to a number of household members and the indicator of a single person who traveled; the remainder of the fields in the database that would indicate the exact travelers were left blank. To include at least the known traveler, the Primary Traveler Model was estimated, with a very similar structure to the Solo Traveler Model. The parameters for this model are shown in Table 3-3 below.

Table 3-3 Primary Traveler Model Parameters

Parameter	Utility
Age: Aged 0-5 years old	-88
Age: Years younger than 25	-0.1082
Age: Years older than 25 – capped at 45	0.03210
Age: Years older than 70, squared	0.003422
Person has driver's license	0.3964
Full time worker	-0.1823
Management/Business or Professional worker	0.2036
Female, household has children 15 or under	0.3232
Post secondary student	-0.2734

This model has a similar age structure to the Solo Traveler Model, although the age distribution has a stronger effect for the ages between 25-70. The utility distribution is shown in Figure 3-3 below. The primary traveler is more likely to be a driver, and less likely to be a worker – although this effect is canceled out for Management/Business and Professional workers. Women in households with children are more likely to be the primary traveler, which is the opposite of the Solo Traveler model; that is, women with children are more likely to travel in groups (which presumably includes these children). Post secondary students are also different from the Solo Traveler model, less likely to travel in a partial household party – this may reflect their different schedule from other household members, as well as their independence, for instance if parents take their younger siblings out of town.

Figure 3-3 Primary Traveler Model; Age Utility Component



3.4 GROUP SIZE MODEL

The Group Size Model is the second model applied if the Base Party Size model selects that Part of the household will travel. One person has been selected as the primary traveler, but the remaining household members must be selected. Because the One person and Full household travel alternatives were not selected in the Base Party Size model, the group size alternatives for a household of n persons ranges from 2 to n-1 persons. It should be noted that this model is only applied to households of 4 or more persons; for 3 person households, the only option is a 2 person group, and a partial household party is not possible for 1 or 2 person households.

The alternative set here is each possible party size from 2 to n-1; the 2 person alternative is notably more likely than the other alternatives (if the group size was chosen at random from the available alternatives, 38% of the groups would be 2 person; the observed data has 52% of the groups having two people). The parameters for the Group Size Model are shown in Table 3-4 below.

Table 3-4 Group Size Model Parameters

Alternative	Parameter	Utility
2 persons	Alternative specific constant	0.2103
2 persons	Household size	0.1082
Prop. of HH	Base parameter	-0.5889
Prop. of HH	Income A, B, C	-0.7269
Prop. of HH	Income E, F	0.6298
Prop. of HH	Proportion of students in HH	-4.8544

The model structure may not be immediately apparent from the table. A concern in estimation was the possibility of "runaway" utility equations that perform oddly when applied outside of the estimation data: the CHTS only contains households of up to 8 persons; the Census PUMS data that is used for model operation contains a small number of households that are much larger – up to 20+ persons. To avoid problems with applying a model outside of its bounds, the alternatives were scaled to represent the proportion of the household that is travelling; for instance, a 5 person household has three alternatives: 2, 3 and 4 persons. These represent 0.4, 0.6 and 0.8 of the household members traveling. The "proportion of household" parameters are multiplied by the proportion of the household for each alternative. To help clarify this model structure, table 3-5 below shows a worked example with the components of the utility for each alternative in a 6 person household with a low income and 4 students (i.e. a student proportion of 0.6667 persons).

Table 3-4 Group Size Model – Worked Example

	2 persons	3 persons	4 persons	5 persons
Proportion of household	0.3333	0.5	0.6667	0.8333
Utility component				
Prop of HH base parameter	0.333*-0.5889 = -0.196	0.5*-0.5889 = -0.294	0.667*-0.5889 = -0.393	0.833*-0.5889 = -0.491
Prop of HH low income parameter	0.333*-0.7269 = -0.242	0.5*-0.7269 = -0.363	0.667*-0.7269 = -0.485	0.833*-0.7269 = -0.606
Prop of HH prop student parameter -4.8544 * 0.6667 = -3.2363	0.333*-3.2363 = -1.079	0.5*-3.2363 = -1.618	0.667*-3.2363 = -2.158	0.833*-3.2363 = -2.697
2 person alternative specific constant	0.2103	0	0	0
2 person household size param.	6 * 0.1082 = 0.649	0	0	0
Total utility	-0.6577	-2.275	-3.036	-3.794
Probability of alternative	74.9%	14.9%	7.0%	3.3%

The model has a strong tendency to produce two person travel groups. The household size parameter for the two person alternative mostly serves to help offset the shifting of 2 to a smaller proportion of the household as the household size increases; for a four person household the 2 person alternative is at 0.5, for a six person household, it is at 0.3333, for a ten person household, it is at 0.2 and so on.

The proportion parameters show that in general, the larger the group size alternative, the less likely it is. This effect is much more pronounced in lower income households, and less pronounced in higher income households; as household income rises, travel parties can encompass more of the household members. The number of students in the household leads to a strong reduction in group size; as the number of students increases, the larger proportion alternatives have strongly reduced utility. This implies that students, who have a restrictive schedule with limited holidays and may not be able to stay at home alone, have an inhibiting effect on travel. (It should be noted that the CSTDM represents travel during a "typical" fall or spring weekday in California, that is, the days when school is generally in session.)

Once a group size has been selected for the party, the primary traveler already selected is assigned to the party, and remaining household members are randomly selected until the party is full. The household members not assigned to the travel party return to the SDPTM pool.

4.0 Tour Property Models

To simulate long distance travel in a coherent fashion, once a party has been assigned to travel, a series of models provides additional tour properties, which are assigned before the destination and mode choice components of the LDPTM. These models consist of:

- **Tour Duration Model**, which assigns a duration to each long distance tour in terms of number of nights;
- **Travel Day Status Model**, which determines if the model day includes one or more travel episode, and;
- **Time of Travel Model**, which assigns any trips to a time period.

These models are heavily conditioned on the tour purpose, as represented in the Travel Choice model, and use observed frequencies to produce a realistic heterogeneous population of long distance travelers.

It should be noted that for households who choose Out Of State travel in the Travel Choice model, the model logic flow ends after the party membership models; the out of state travel itself is represented by the External Travel Model (ETM) if appropriate, and any household members not a part of the tour party are returned to the SDPTM pool. The Tour Property and all subsequent models, therefore, apply only to "true" (i.e. in-state) long distance travel.

4.1 Tour Duration Model

The long distance tours generated by the LDPTM need a travel duration assigned to them, which is taken into account in further models (main mode choice in particular). The duration of a tour is the number of nights away from home; the range of alternatives is 0-14 nights away from home.

A duration is assigned based on the observed frequency from the CHTS long distance travel data, by purpose. The probabilities of each alternative are shown in Table 4-1 below.

Table 4-1 Tour Duration Model Probabilities

Duration	Commute	Business	VFR	Recreation	Other
0 nights	20.0%	26.7%	12.1%	7.0%	26.5%
1 night	7.1%	24.2%	17.8%	23.4%	24.2%
2 nights	28.8%	17.8%	30.1%	23.0%	19.2%
3 nights	17.6%	13.0%	15.6%	14.8%	11.7%
4 nights	13.3%	5.2%	7.2%	14.7%	7.3%
5 nights	4.3%	2.5%	3.9%	4.6%	3.3%
6 nights	0.3%	1.4%	2.0%	2.0%	2.0%
7 nights	0.1%	0.7%	1.7%	2.1%	0.7%
8 nights	0.2%	1.9%	1.0%	2.1%	0.0%
9 nights	0.0%	4.1%	4.1%	2.2%	0.1%
10 nights	6.8%	0.3%	2.0%	0.6%	2.6%
11 nights	1.5%	0.4%	0.9%	0.8%	1.9%
12 nights	0.0%	1.1%	0.7%	1.2%	0.2%
13 nights	0.0%	0.2%	0.8%	0.7%	0.2%

The observed frequencies produce primarily shorter long distance tours; this is reasonable given the nature of intrastate travel. The durations of commute travel were longer than an a priori expectation may have indicated; this is partially due to the small sample size of commute combined with the scaling factors to increase commute travel produced by the California High Speed Rail Authority (CAHSRA) high speed rail modeling team, which may have led to "lumpy" scaling. It should be noted that corporate executives and other high-skill workers may maintain a pied-a-terre apartment in the city they work in and live in it Monday to Thursday nights, returning home at weekends.

4.2 Travel Day Status Model

The travel day status refers to the direction of travel that is observed, if any. Consider, for instance, a three night long distance tour where the tour party leaves home on Monday and returns home on Thursday. In this case, there is one day with outbound travel from home (Monday), one day with travel returning to home (Thursday), and two days at the destination (Tuesday and Wednesday) when only visitor travel is generated – visitor travel is out of scope of the CSTDM system as of Version 2.0. In this case, if a "survey day" is selected when the household is involved in this long distance tour, then there is a 25% chance that the outbound trip is observed, a 25% chance that the return trip is observed, and a 50% chance of no long distance travel being observed.

Tours of 0 night duration are a special case; in this case, there must be travel in both directions observed, and there is no need for the travel day status model. More generally, for a tour of n days duration, the probability that a given day involves travel is:

$$P_t = \frac{2}{n+1}$$

This equation produces a probability of an observed travel day, which is used in a Monte Carlo process. If a travel day is chosen, the second step is the determination of the direction of travel. This uses the observed probability distribution from the CHTS, conditional on tour duration. The probabilities are given in Table 4-2 below.

Table 4-2 Travel Day Status Model Direction Probabilities

Duration	Outbound	Return
0 nights	100%	100%
1 night	51.5%	48.5%
2 nights	69.9%	30.1%
3 nights	59.4%	40.6%
4 nights	52.8%	47.2%
5 nights	48.3%	51.7%
6 nights	44.9%	55.1%
7 nights	42.7%	57.3%
8 nights	33.7%	66.3%
9 nights	21.4%	78.6%
10 nights	51.1%	48.9%
11 nights	54.1%	45.9%
12 nights	57.2%	42.8%
13 nights	61.4%	38.6%

In general, the probability of outbound and return travel are a roughly 50/50 split, although some durations in particular have an imbalanced flow; the most significant one is 2 night tours; many of these involve outbound travel on a Friday (which is a weekday, and thus represented in the CSTDM) and return travel on a Sunday (which is not represented in the CSTDM). Therefore, an apparent imbalance in travel is created with more outbound trips on the observed days than return trips; a weekend travel model would produce the inverse.

Note that many tours will involve the tour party being at their destination during the modeled day of travel. For these parties, no trips will be created and written into the trip lists. The LDPTM_Tours output file will contain the tour level decisions of these tours, for further analytical purposes.

4.3 TIME OF TRAVEL MODEL

Once the direction of travel (if any) is chosen, the time period for travel needs to be assigned. Long distance travel is somewhat inconsistent with the idea of a day divided into time periods; the CSTDM AM and PM peak periods are four hours each; a car trip from Los Angeles to San Francisco takes on the order of 6 hours. Midday period skims are used in all destination and mode choice components of the model; this is consistent with the bulk of long distance travel and reflects a moderately congested network with no strong directional bias.

However, for assignment purposes, a specific time period needs to be assigned to each trip in the LDPTM. To do this, observed frequencies from the CHTS diary survey were used. (The long distance survey component did not ask about the time of return trips to home.) The purposes of the diary survey and the LDPTM do not match exactly, so the purposes were aggregated into Business/Commute (using work tours from the diary survey) and Rec/VFR/Other (using all other tours from the diary survey). Probabilities were developed for four possible trip directions:

- Outbound – not returning to home same day
- Return – day not beginning at home
- Outbound – returning to home same day
- Return – departed home same day

The first two correspond to the Outbound and Return directions for tours of 1 or more night's duration. The latter two correspond to the Outbound and Return directions for tours with 0 night duration, i.e. tours with same-day return to home. The probabilities of time periods are shown in Table 4-3 below.

Table 4-3 Time Of Travel Model Probabilities

Direction / Duration	Purpose	Early Offpeak	AM Peak	Midday	PM Peak	Late Offpeak
Outbound 1+ nights	Business/Commute	5.5%	60.5%	34.0%	0.0%	0.0%
	Rec/VFR/Other	1.2%	40.5%	27.6%	30.7%	0.0%
Return 1+ nights	Business/Commute	0%	0%	0.4%	32.4%	67.3%
	Rec/VFR/Other	0%	0%	66.9%	11.2%	22.0%
Outbound 0 night	Business/Commute	61.8%	31.8%	6.4%	0%	0%
	Rec/VFR/Other	16.0%	32.2%	51.8%	0%	0%
Return 0 night	Business/Commute	0%	0%	22.1%	53.2%	24.8%
	Rec/VFR/Other	0%	0%	41.6%	16.1%	42.3%

As expected, outbound travel occurs primarily in the earlier parts of the day and return travel in the later parts. Overall, work (Bus/Com) travel is somewhat more focused in peaks, and in the overnight offpeak, while nonwork travel (Rec/VFR/Oth) is more heavily focused in the midday time period.

5.0 Destination Choice Models

The LDPTM has five destination choice models, segmented by purpose. The model structures are common; a logit choice structure with a "size term" describing the attractiveness of each zone, and a simplified mode choice logsum component representing the travel cost to the zone across all modes.

Because of the complexity of the main mode choice model, a series of simplified mode choice models were estimated to provide "typical" logsums for travel conditions. The detailed parameters of these simplified mode choice models are described in section 6-1. There are five simplified mode choice logsums. A single business/commute logsum is used for those two purposes. For the other three purposes, there are a set of four "nonbusiness" logsums, divided into dimensions representing solo and group travel, and low (Incomes A-D) and high (incomes E-F) incomes; e.g. Nonbusiness Solo Low (NSL).

The size term structure, generically, is:

$$V_{ij} = U_{ij} + \mu \, ln \sum_{k=1}^{K^s} \beta_k x_{jk}$$

where:

V_{in} is the utility of destination TAZ alternative *i* for tour *n*.

U_{ij} is the utility of travel (using the logsums) and any other utility components

K^v is the number of utility parameters.

K^s is the number of size parameters.

β_k are the size term parameters (k=1 to Ks includes explanatory SIZE variables).

x_{jk} is the size attribute value for the TAZ alternative *j*.

μ is the size term scale parameter, which is held at 1 in all models.

The destination choice model is described in Table 5-1, with the size terms described in Table 5-2.

Table 5-1 Destination Choice Model Parameters

Model Parameter	Bus	Com	Rec	VFR	Oth
Bus / Com SMC logsum	0.4397	0.7350			
Nonbus Group High SMC logsum			0.9407	0.9663	0.2742
Nonbus Group Low SMC logsum			1.0547	0.7158	0.5976
Nonbus Solo High SMC logsum			0.7539	0.8125	0.0526
Nonbus Solo Low SMC logsum			0.6302	0.3370	0.5674
Total employment within 2 miles				0.0148	
(Office + Service emp. within 2 miles) ^ 0.3333	0.0296	0.0183			
Proportion of employment within 5 miles in Leisure/Hospitality industry			3.9752	2.6171	
Zone is on coast			0.9703		

Table 5-2 Destination Choice Size Term Parameters

Size Term Parameter	Bus	Com	Rec	VFR	Oth
Total employment	1	1	0.002		1
Total households			0.07	1	
Retail employment		14.65			
Office employment		21.31			2.41
Education/Medical employment					6.16
Leisure/Hospitality employment	2.67	43.75	1	1.87	27.95
Other Service employment	1.38	148.75			
Major Convention Centre employment	9.68				
Disneyland employment			13.71		
Major ski resort employment			6.38		
National park area			2.66		

Major Convention Centre employment refers to employment in zones with major convention facilities (over 500,000 square feet): there are currently four of these – Anaheim, Los Angeles, Moscone (San Francisco), San Diego. Disneyland employment is the employment in the happiest zone on earth. Major ski resort employment is employment in zones containing principal ski resorts; with over 2500 acres / 75 trails / 20 lifts (Squaw Valley USA, Heavenly Mountain Resort, Mammoth Mountain). National Park area is the area inside National Parks, in square miles.

During the calibration process, some region-specific destination attractiveness constants were added. These increase the attractiveness of the scenic areas in the North, Sierras and Coastal regions as well as in the capital region (SACOG). The San Joaquin Valley and SCAG had reductions in attractiveness. During validation, a small set (12 out of a possible 64) of interregional interchange constants had to be added to better reflect the otherwise unobservable patterns between regions, in a way that was consistent with other external travel information – particularly air travel. The calibration parameters are all relatively small. These calibration parameters are shown in Table 5-3 below.

Table 5-3 Destination Choice Calibration Parameters

Parameter	North	SACOG	MTC	SJV	Sierras	Coast	SCAG	SANDAG
Region constant	0.7189	0.3682	0	-0.3935	0.2577	0.7574	-0.3977	0
From North	0	0	0	0	0	0	0	0
From SACOG	0	0	0	0.7030	0	0	0	0
From MTC	0	0	0	0	0	0	-0.1141	0.4138
From SJV	0	0	0	0.6785	0	0	-0.2885	0
From Sierras	0	0	0	0	0	0	0	0
From Coast	0	0	0	0	0	0	0	0
From SCAG	0	-0.7741	-0.2146	-0.3911	0	0	0.5197	-0.1265
From SANDAG	0	0.6944	0	0	0	0	-0.2229	0

6.0 Main Mode Choice Models

6.1 MAIN MODE CHOICE MODELS

The main mode choice model selects between four alternatives; car, air, conventional rail (CVR) and high speed rail (HSR) – if available in the scenario. The models were estimated using the first three modes, with the HSR constant developed using the technique described in section 6.3 below. All model parameters other than the level of service and mode choice parameters pertain only to the car mode alternative.

Two models were developed; one representing business (and commute) travel, and one representing "nonbusiness" (recreation, VFR and other) travel. Their parameters are described in Tables 6-1 through 6-3 below.

Table 6-1 Main Mode Choice Models – Level of Service Parameters

Parameter	Business	Nonbusiness
In-vehicle time	-0.006607	-0.004005
Base money cost parameter	-0.008422	-0.01265
Additional money cost; 2 person group		0.005838
Additional money cost; 3 person group		0.007895
Additional money cost; Income AB		-0.002073
Additional money cost; Income D		0.000509
Additional money cost; Income EF		0.002870
Ln (1 + headway)	-0.5936	-0.5129
Access mode choice logsum	0.6750	0.2072
Egress mode choice logsum	0.3527	0.5698

Table 6-2 Main Mode Choice Models – Additional Car Mode Parameters

Parameter (car alternative)	Business	Nonbusiness
Tour is in a group	1.9221	
Household has persons remaining at home		-0.6303
Household has no car	-2.3286	
Ln (1 + employment density at destination)	-0.3821	
Man/Bus or Prof/Tech occupation	-0.3977	
Tour 3+ nights	-0.5237	
Income ABC	0.8417	
Income F	-0.5881	

Table 6-3 Main Mode Choice Models – Mode Specific Constants

Mode specific constants	Bus	Com	Rec	VFR	Oth
Car mode specific constant	0	0	0.5526	0	0
Air mode specific constant	-1.3448	-7.4036	0.6055	-0.3303	0.0127
Conventional rail mode specific constant	-5.0613	-6.9749	-2.4122	-2.5426	-2.1079
High-speed rail mode specific constant	-1.1	-5.0	-0.6	-0.5	0.0

In the business/commute model, the relationship between in vehicle time and money was fixed with a value of time of $47.07, the value of time from the CAHSRA business/commute mode choice model. For the nonbusiness model, the value of time varies by both household income and by group size. The value of time increases as the group size increases; this is because the time does not increase as the group size increases, but the cost of air and rail travel scales by the group size.

The headway, access mode logsum and egress mode logsum parameters only apply to the shared modes, i.e. air, CVR and HSR. The access/egress mode models are described in section 7 below. For simplicity, a "typical" traveler was used for the access/egress mode choice models to develop "typical" business and nonbusiness access/egress mode choice logsums. The "typical" properties are: solo traveler, not a commute tour, household with 2+ persons, sufficient auto ownership and a high income.

It should be noted that the party formation models described in section 3 fix a specific party size. This is used in mode choice; if airfare for a given OD pair is $150, a party of two people have a cost of $300, a party of three have a cost of $450 and so on. If the car mode is chosen, then the specific auto mode (SOV/HOV2/HOV3+) is determined using the party size.

During validation, it was noticed that certain airport pairs had much higher or lower travel than expected; a small set of interaction coefficients were introduced. The major role was to reflect the low usage of very short flights (SCAG-SANDAG and SACOG-MTC) as well as the small market to and from minor regional airports. The airport interaction constants developed are shown in Table 6-4 below. Note that these are all symmetrical in effect; that is, the same parameter applies to both travel from SCAG to SACOG or MTC and from SACOG or MTC to SCAG.

Table 6-4 Airport Interaction Constants

<table>
<tr><th>Region 1</th><th>Region 2</th><th>Constant</th></tr>
<tr><td>SCAG</td><td>SACOG/MTC</td><td>0.5806</td></tr>
<tr><td>SANDAG</td><td>SACOG/MTC</td><td>0.5040</td></tr>
<tr><td>SCAG</td><td>SANDAG</td><td rowspan="2">-2.8660</td></tr>
<tr><td>SACOG</td><td>MTC</td></tr>
<tr><td>Other</td><td>Any</td><td>-2.7867</td></tr>
</table>

Other refers to the areas outside the four major MPOs.

6.2 SIMPLIFIED MODE CHOICE MODELS

As described above, simplified mode choice models were developed to produce approximate logsums for typical travel conditions. These logsums are calculated and used to "feed" the destination choice models. They are structurally similar to the main mode choice models. As in the main mode choice models, money costs, such as fares, are scaled by party size; the party size used for group nonbusiness travel was 2.9, the average. For solo nonbusiness and business/commute travel, a party size of 1 was used. For business/commute travel, the $47.07 value of time used in the main mode choice model was retained. The simplified mode choice models are described below in Table 6-5.

Table 6-5 Simplified Mode Choice Parameters

Parameter	Business	Nonbusiness
In-vehicle time	-0.00606	-0.00415
Base money cost parameter	-0.00773	-0.0113
Additional money cost; group		0.0060
Additional money cost; Income EF		0.0019
Ln (1 + headway)	-0.8914	-0.5253
Access mode choice logsum	0.6430	0.1654
Egress mode choice logsum	0.5920	0.5104
Car alternative: Ln (1 + emp. dens. at dest.)	-0.2228	
Mode-specific constant: Car	0	0
Mode-specific constant: Air	-3.1968	-1.6826
Mode-specific constant: Conventional rail	-3.6966	-1.8157
Mode-specific constant: High-speed rail	-2.0	-1.0

6.3 High Speed Rail Parameters

The above described models have high speed rail alternative specific constants specified. The CHTS does not contain any high speed rail travel, as the mode is not currently available in California. To develop these constants, an "offset" method was used, based on the September 10 2013 memorandum from the CAHSRA model development team to the CAHSRA peer review panel.

The offset method, which was recommended by the peer review panel and adopted in the CAHSRA model, uses a joint estimation using both stated preference data and revealed preference data to develop mode specific constants for the four possible modes. Offsets are calculated for the HSR alternative specific constant relative to both the air and CVR alternatives from the stated preference estimations, indicating the relative attractiveness of HSR to these two similar modes.

These utility offsets are then applied to the calibrated Air and CVR mode constants; the average of these two offset constants is taken as the HSR mode specific constant.

The process used in the CSTDMv2.0 was consistent with this; however, rather than using utility offsets directly from the CAHSRA model, the effective equivalent minutes of in-vehicle time for the offsets were used – this ensures maximum consistency. These were then multiplied by the in-vehicle time parameter for all mode choice models to produce HSR constants offset from both air and CVR modes, with the average (rounded to one decimal place to highlight the approximate nature) used.

7.0 Access / Egress Mode Choice Models

The access/egress mode choice models select access and egress modes for shared mode tours (by air or by rail); these represent the mode choice for travel to and from the station. The LDPTM is a tour-based model, so there are actually two access and two egress trips per tour; the convention used to describe the models is that the "access" model pertains to the outbound access (home to station) and return egress (station to home) mode choice, and the "egress" model pertains to the outbound egress (station to destination) and the return access (destination to station) mode choice. This is illustrated in Figure 1-1.

The access /egress data in the CHTS provided a number of challenges. The possible number of observations was greatly reduced by the collection of access/egress mode data on only the most recent tour, if applicable – if the most recent tour was by car, then no access/egress data was collected, even if there was a previous air or rail tour in the dataset. Further, there was no standardized coding of access/egress locations, the mode alternatives were not consistent with the existing (previous iteration) HSR model, and half of the egress data was not usable as it discussed travel out of state (the egress mode from Heathrow airport to a hotel in London, for instance).

Due to these challenges, and the resource limitations of the project, the access / egress mode choice model from the new version of the CAHSRA high speed rail model was adopted. This model has six mode alternatives. Four of them: taxi, transit, walk, and "serve passenger" (get dropped off / get picked up) were common to both access and egress alternatives. The drive and park alternative is only available for access, and the rental car alternative is only available for egress.

The logit model parameters are described in Tables 7-1 and 7-2 below.

Table 7-1 Access/Egress Mode Choice Model – Business and Commute

Modes	Variable	Units for Variable	Coefficient
All	IVT – All	Minutes	-0.0101
All	Cost – All	Dollars (in 2005$)	-0.0152
All	Cost - Low Income (Additive to Cost-All)	Dollars (in 2005$)	-0.0050
All	Cost - High Income (Additive to Cost-All)	Dollars (in 2005$)	0.00014
All	Cost - Commute (Additive to Cost-All)	Dollars (in 2005$)	-0.0067
Taxi	Taxi Cost per Mile	Miles	1.665
All	OVT to IVT Ratio	–	2.50
All	Access Egress Time to Main Mode Time Ratio	–	1.50
Drive-Park	ASC - Access		1.047
Drive-Park	Commute		0.832
Drive-Park	Cars Less Than Workers (Access Mode Choice Only)		-0.476
Drive-Park	Low Income		-1.463
Drive-Park	Log (1 + Employment Density at Airport or Station - 2 mi buffer)**		-0.020
Rental Car	ASC - Egress		0.547
Rental Car	Commute		-0.714
Serve Pass.	One person Household (Access Mode Choice Only)		-0.417
Taxi	ASC - Access		-0.466
Taxi	ASC - Egress		0.312
Taxi	Commute		0.312
Taxi	Log (1 + Employment Density at Airport or Station - 2 mi buffer)**		0.055
Transit	ASC - Access		0.338
Transit	ASC - Egress		1.326
Transit	Commute		1.016
Transit	Cars Less Than Workers (Access Mode Choice Only)		0.872
Transit	Log (1 + Employment Density at Airport or Station - 2 mi buffer)**		0.068
Transit	Bus Used in Transit Path		-0.482
Walk	ASC - Access & Egress		1.065

** Total employees per square mile within 2 miles of the main mode airport or station.

Table 7-2 Access/Egress Mode Choice Model – Recreation, VFR, Other

Modes	Variable	Units for Variable	Coefficient
All	IVT – All	Minutes	-0.0068
All	Cost – All	Dollars (in 2005$)	-0.0188
All	Cost - High Income (Additive to Cost-All)	Dollars (in 2005$)	0.00022
Taxi	Taxi Cost per Mile	Miles	1.83
All	OVT to IVT Ratio	–	2.00
All	Access Egress Time to Main Mode Time Ratio	–	1.20
Drive-Park	ASC - Access		-0.0889
Drive-Park	Cars Less Than Workers (Access only)		-0.905
Drive-Park	Traveling in Group		0.768
Rental Car	ASC - Egress		-0.610
Rental Car	Low Income		-0.443
Rental Car	Traveling in Group		0.539
Serve Pass.	One Person Household (Access only)		-0.211
Serve Pass.	Low Income		0.154
Taxi	ASC - Access		-0.478
Taxi	ASC - Egress		-0.527
Taxi	Traveling in Group		0.771
Taxi	Log (1 + Employment Density at Airport or Station - 2 mi buffer)**		0.025
Transit	ASC - Access		0.316
Transit	ASC - Egress		0.500
Transit	Cars Less Than Workers (Access only)		0.413
Transit	Log (1 + Employment Density at Airport or Station - 2 mi buffer)**		0.0381
Transit	Bus Used in Transit Path		-0.343
Walk	ASC - Access		0.501
Walk	ASC - Egress		0.733

** Total employees per square mile within 2 miles of the main mode airport or station.

8.0 Calibration

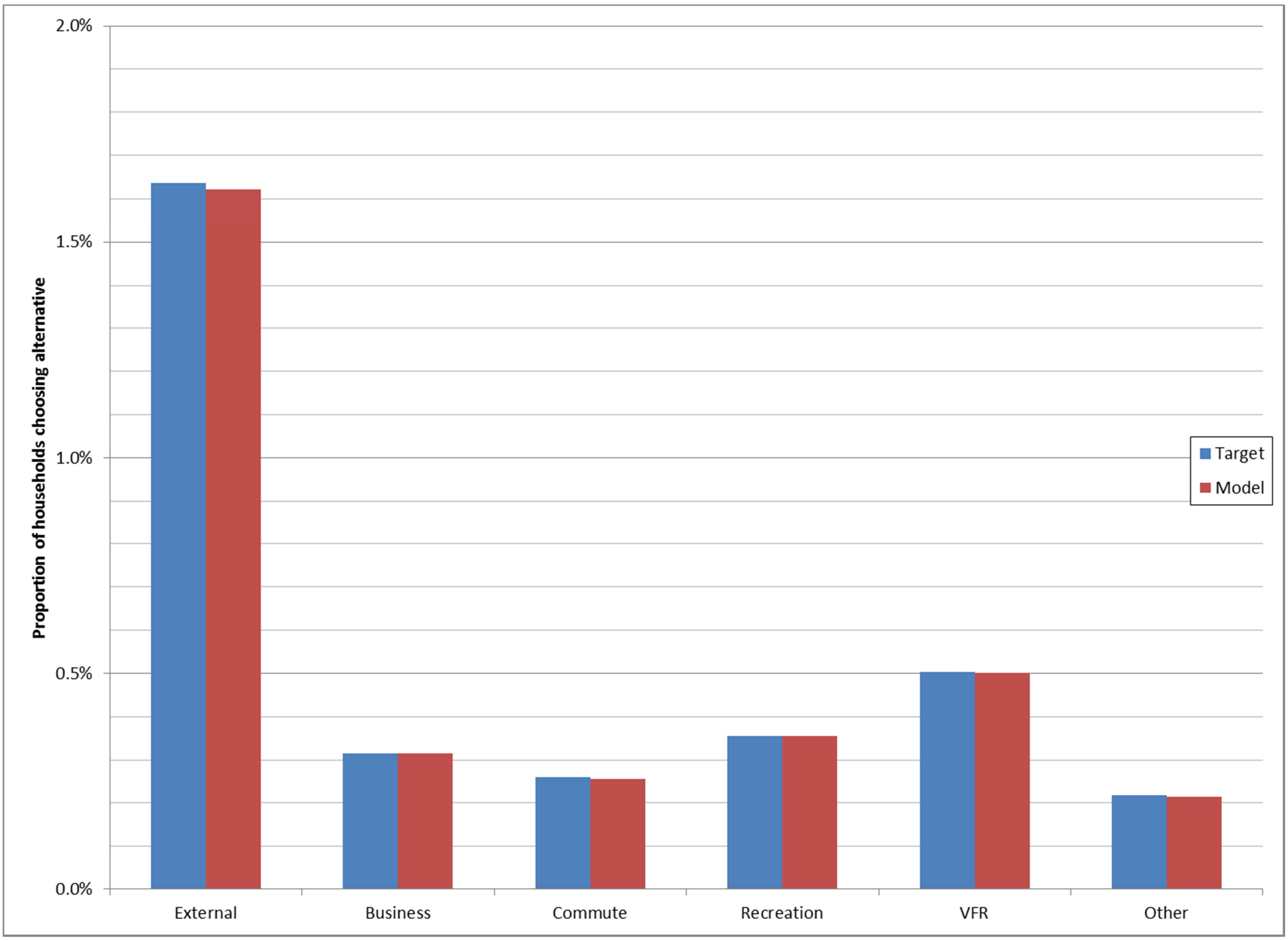
The LDPTM was calibrated to match observed travel under base conditions (in most cases from the CHTS long distance survey). The parameters presented in sections 2 to 7 of this report include all calibration adjustments.

8.1 TRAVEL CHOICE MODEL

The Travel Choice Model was calibrated to match the share of households choosing each alternative. The calibration targets were originally developed from the expanded CHTS long distance survey, using the CAHSRA model team tour scale factors (the primary purpose of which is to increase commute travel). During validation, this produced too few long distance tours.

The calibration targets were then adjusted to match the higher frequencies seen in the CHTS diary survey; this is potentially a more accurate dataset because it is less prone to trips being forgotten. Because the diary travel purposes did not match the model purposes exactly, three scale factors were developed; based on work travel from the diary (applied to business and commute), based on other travel from the diary (applied to recreation, VFR and other), and based on out of state travel from the diary. The resulting model fit is shown in Figure 8-1; it is excellent.

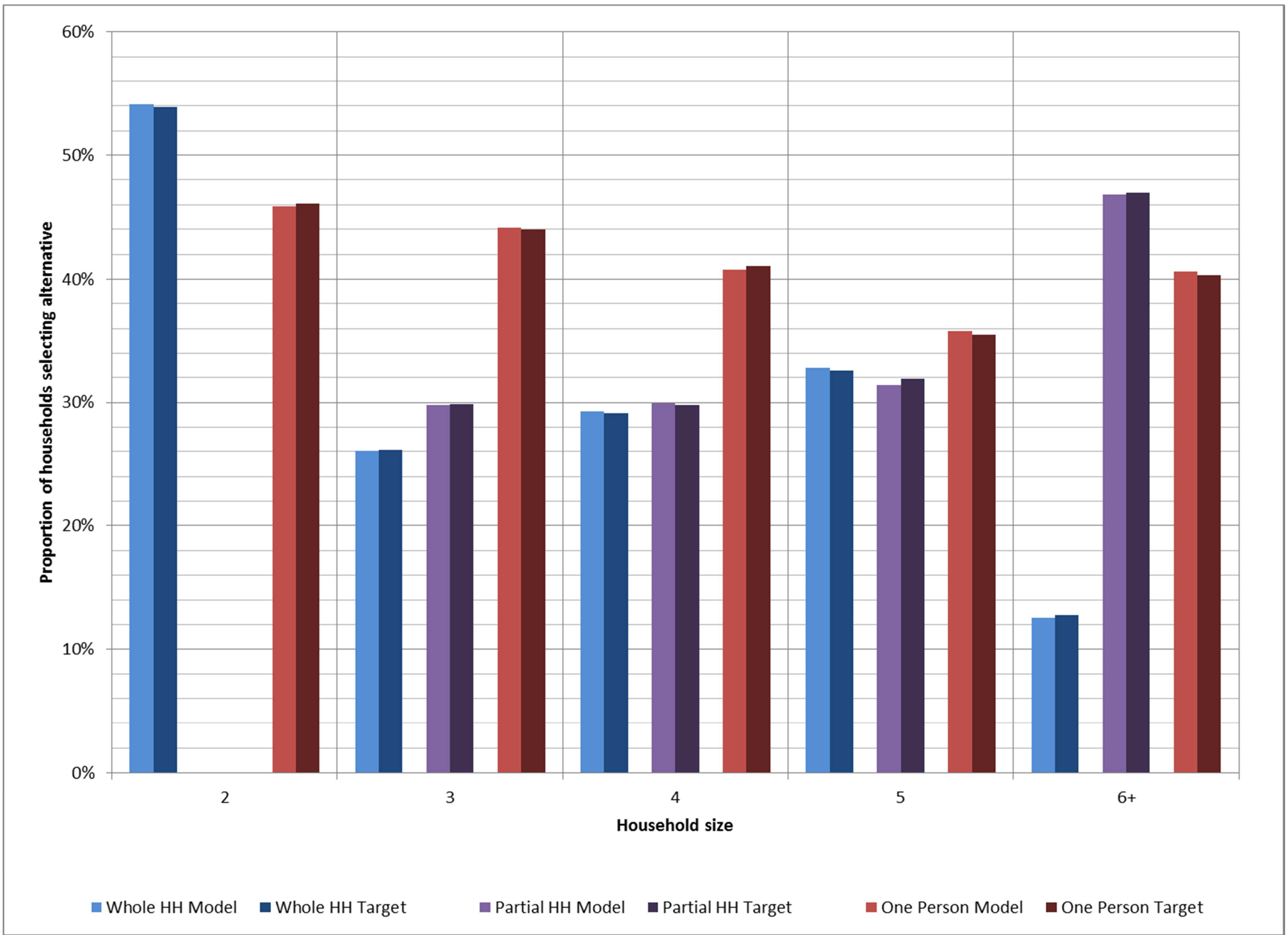
Figure 8-1 Travel Choice Model Calibration



8.2 Party Formation Models

The Base Party Size model was calibrated to match the proportion of households selecting each alternative by household size. It should be noted that one-person households are by definition travelling with their entire household and do not need to be calibrated; further, the partial household alternative is not available for two person households. The calibration fit is shown in Figure 8-2 below. This was felt to be the "key" to the party formation model series, as it is the primary determiner of travel party size, which is the most important property in the LDPTM from these models. The remaining party formation models were, therefore, not calibrated after application.

Figure 8-2 Base Party Size Model Calibration



The Tour Property models use applied proportions and do not have specific sensitivities; they were not felt to warrant additional calibration after application.

8.3 DESTINATION CHOICE

The Destination Choice models were calibrated in two ways; first for trip length distribution and secondly for origin-destination flow match. To calibrate trip length distributions, the mode choice logsum parameters for each purpose were scaled up or down; the scaled parameters are the ones reported in section 5 above. The tour proportion rate used for the y axis in Figures 8-3 and 8-4 is the proportion of tours that would be at a certain distance from home, normalized to consistent 50-mile bands to avoid the discontinuities where bands change size.

Figure 8-3 Destination Choice Model Calibration: Business and Commute Tour Lengths

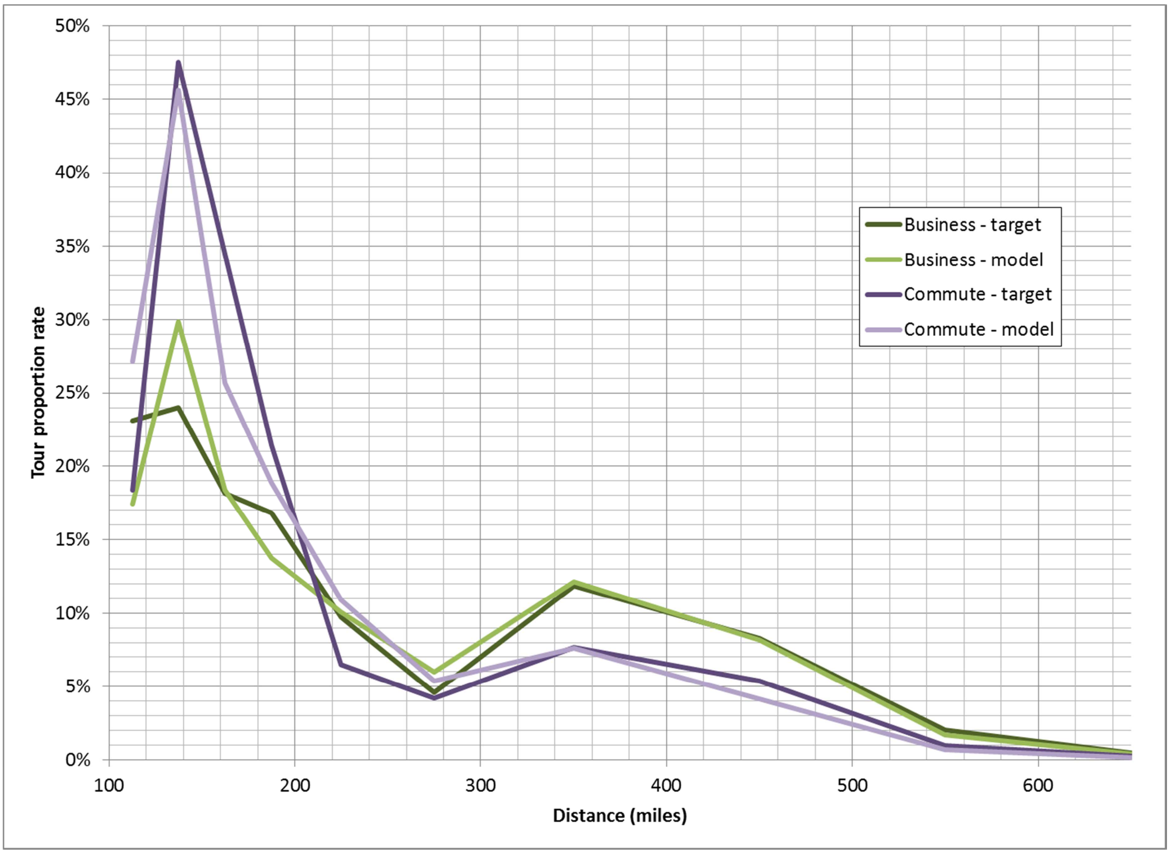
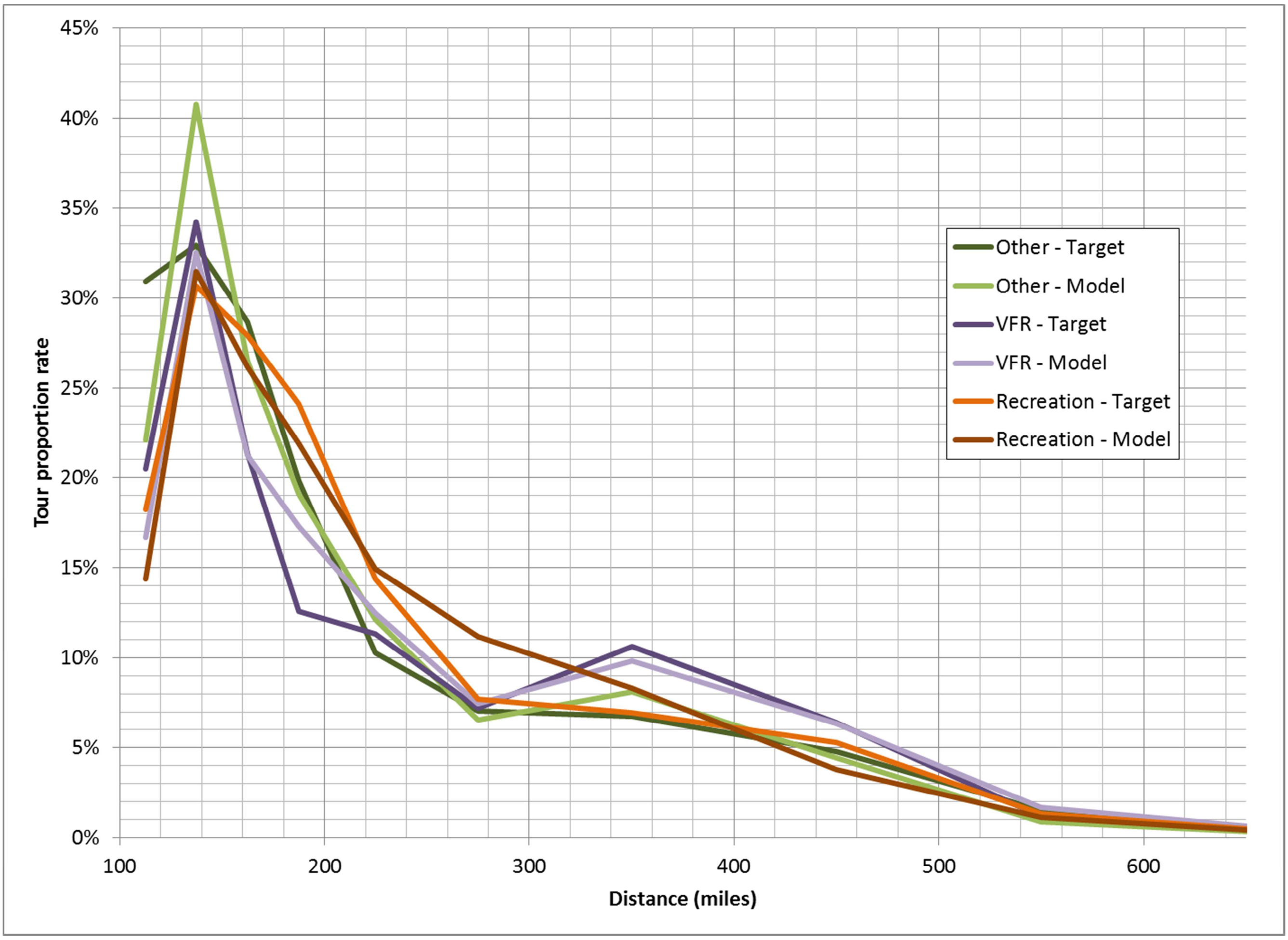


Figure 8-4 Destination Choice Model Calibration: Recreation, VFR and Other Tour Lengths



The average trip lengths and coincidence indices are well within the 2010 TMIP Model Validation report recommendation, as shown in table 8-1 below.

Table 8-1 Destination Choice Model Calibration: Key Statistics

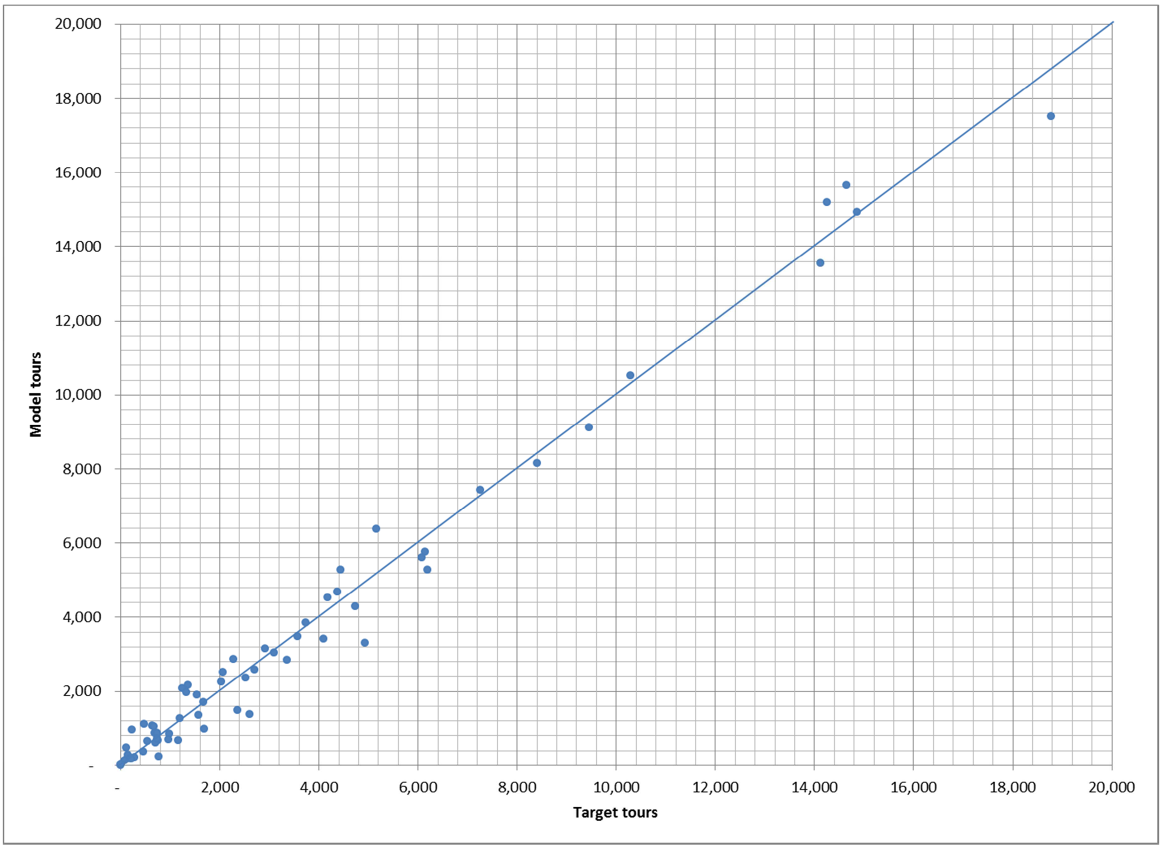
	Average Trip Length (miles)		Trip Length Error	Coincidence Index
	Model	Target		
Business	276.4	275.9	-0.2%	0.90
Commute	232.4	223.6	-3.8%	0.82
Recreation	243.2	243.4	0.1%	0.84
VFR	259.6	261.6	0.7%	0.86
Other	234.3	233.1	-0.5%	0.91
2010 TMIP Model Validation Report Recommendation			<5%	>0.70

The second dimension of calibration is in terms of origin-destination pairs. A system of eight areas was used for calibration; the four major MPOs (MTC, SACOG, SCAG and SANDAG); the eight-county San Joaquin Valley, and the remaining areas north of MTC/SACOG ("North"), east of the SJV ("Sierras") and west of the SJV ("Coast"). The match to flows between these regions is shown in Table 8-2, as well as visually in Figure 8-5 below; the fits are excellent.

Table 8-2 Destination Choice Model Calibration: O-D Performance

Model	North	SACOG	MTC	SJV	Sierras	Coast	SCAG	SANDAG
North	841	1,497	4,683	704	469	880	1,050	181
SACOG	1,383	13	2,584	3,053	962	2,866	3,860	671
MTC	8,162	5,271	247	5,270	3,297	6,377	15,189	4,527
SJV	1,971	2,842	5,611	3,485	1,109	3,422	9,122	2,163
Sierras	215	192	865	170	49	371	716	118
Coast	603	1,904	2,257	978	654	1,270	5,761	1,074
SCAG	2,069	3,148	15,648	7,425	4,292	17,514	13,546	14,929
SANDAG	284	1,698	2,514	1,361	680	2,371	10,522	0
Target	**North**	**SACOG**	**MTC**	**SJV**	**Sierras**	**Coast**	**SCAG**	**SANDAG**
North	982	2,368	4,376	966	122	693	666	132
SACOG	2,598	0	2,697	3,105	227	2,277	3,736	752
MTC	8,404	6,200	771	4,438	4,929	5,162	14,259	4,177
SJV	1,329	3,362	6,084	3,573	477	4,093	9,452	1,355
Sierras	275	192	730	219	10	464	731	76
Coast	711	1,541	2,026	1,696	544	1,194	6,153	637
SCAG	1,241	2,917	14,654	7,259	4,733	18,778	14,126	14,864
SANDAG	146	1,680	2,058	1,574	1,156	2,526	10,291	0
Difference	**North**	**SACOG**	**MTC**	**SJV**	**Sierras**	**Coast**	**SCAG**	**SANDAG**
North	-141	-871	307	-262	347	187	384	49
SACOG	-1,215	13	-113	-52	735	589	124	-81
MTC	-242	-929	-524	832	-1,632	1,215	930	350
SJV	642	-520	-473	-88	632	-671	-330	808
Sierras	-60	0	135	-49	39	-93	-15	42
Coast	-108	363	231	-718	110	76	-392	437
SCAG	828	231	994	166	-441	-1,264	-580	65
SANDAG	138	18	456	-213	-476	-155	231	0

Figure 8-5 Destination Choice Model Calibration: O-D Performance



8.4 MODE CHOICE MODELS

The Main Mode Choice model was calibrated primarily by adjusting the mode specific constants; the adjusted parameters are in Table 6-3 above. During validation, an external data source of air market trips was available, using the 10% sample of air tickets from the Airline Origin and Destination Survey conducted by the Bureau of Transportation Statistics. These market trips reflect travel between the trip origin and the "trip break", the destination. A traveler going from Arcata/Eureka airport (ACV) to SFO and deplaning would be included in this dataset, but a traveler going from ACV to SFO and connecting onwards, for example to JFK, would be listed as an ACV-JFK market trip; they could then be excluded for the purposes of the LDPTM.

It should be noted that the origin and destination survey is a modest overestimate of LDPTM travel; because the data is only identified by quarter, it is not possible to identify "typical" weekdays versus weekends, and especially holidays – which have greater travel than usual. The travel also has no information on the purchaser of the ticket; for instance, a consultant from Canada who visits a client in San Diego, then the next day visits a client in Sacramento, would be likely to fly for this SAN-SMF trip – they are a visitor to California and out of scope of the LDPTM.

In any case, the CHTS survey showed a substantial underreporting of air travel, and the survey values were scaled up by 50% to better match the observed air travel. Additionally during validation, it was noticed that certain airport pairs had much higher or lower travel than expected; a small set of interaction coefficients were introduced, and are shown in table 6-4 above.

The rail mode was not adjusted; Amtrak values were mostly corridor-level, and there are many legitimate short distance OD pairs on each of the Amtrak corridors in California. An estimate was that the Capitol Corridor is almost entirely short distance, the Pacific Surfliner is 25% short distance, and the San Joaquin is 50% short distance; this is consistent with the CHTS data.

The Main Mode Choice model calibration is shown in Figure 8-6 below. The fit is generally good; there was a challenge in matching the air share for business travel, as the major airport pairs had a mode share in excess of 80% air. The Access and Egress mode choice models were not calibrated; there was no data for a comparison.

Figure 8-6 Main Mode Choice Calibration