Model Specification Report

Atlanta Activity-Based Travel Model

Coordinated Travel – Regional Activity Based Modeling Platform

October 2009

Last Revised December 2015

Atlanta Regional Commission
40 Courtland Street, NE
Atlanta, GA 30303

PARSONS BRINCKERHOFF

3340 Peachtree Road
Suite 2400, Tower Place
Atlanta, GA 30326

Table of Contents

List of Tables

List of Figures

Model Framework

Introduction

The Activity-Based Model (ABM) of the Atlanta Regional Commission (ARC) forecasts typical weekday travel undertaken by residents of the ARC region. It is one of the components of the ARC regional travel demand model, along with the truck, airport, external-external and external-internal models. This model has been developed to ensure that the regional transportation planning process can rely on forecasting tools that are adequate for new socioeconomic environments and emerging planning challenges. It is equally suitable for conventional highway projects, transit projects, and various policy studies such as highway pricing and HOV analysis.

The ARC model is based on the CT-RAMP (Coordinated Travel Regional Activity-Based Modeling Platform) family of Activity-Based Models. The CT-RAMP framework, which is fully described in the following section, adheres to the following basic principles:

- The CT-RAMP design follows advanced principles of modeling individual travel choices with maximum behavioral realism. In particular, it addresses both household-level and person-level travel choices including intra-household interactions between household members.
- The ARC ABM operates at a detailed temporal (half-hourly) level, and considers congestion and pricing effects on time-of-day choice, thus allowing for peak spreading.
- The ARC ABM reflects and responds to detailed demographic information, including household structure, aging, changes in wealth, and other key attributes.
- The ARC ABM is implemented in the Common Modeling Framework, an open-source library created by Parsons Brinckerhoff specifically for implementing advanced travel demand forecasting models.
- The ARC ABM offers sensitivity to demographic and socio-economic changes observed or expected in the dynamic Atlanta region. This is ensured by the enhanced and flexible population synthesis procedures as well as by the fine level of model segmentation. In particular, the ARC ABM incorporates different household, family, and housing types as well as the relationships between different household compositions and person activity-travel patterns.
- The ARC ABM accounts for the full set of travel modes. Our experience with previously developed ABMs has shown that mode choice is one of the least transferable model components, because each region has a specific mix of modes developed in the context of the regional urban conditions.
- The ARC ABM integrates with other model components. The CT-RAMP model is one component (person travel) that is integrated with other components such as truck trip, airport trip and external trip models.
- The ARC ABM provides detailed inputs to traffic micro-simulation software. The ARC ABM time resolution eases the preparation of detailed trip inputs to traffic micro-simulation software for engineering-level analysis of corridor and intersection design.

Model Features and ARC Planning Needs

The ARC CT-RAMP model has been tailored specifically to meet ARC planning needs, considering current and future projects and policies and also taking into account the special markets that exist in the Atlanta region. The model system addresses requirements of the metropolitan planning process and relevant federal requirements, and provides support to ARC member agencies and other stakeholders. The ABM structure fully complies with the following major planning applications:

- RTP, TIP, and air quality conformity analysis. The ABM has been carefully validated and calibrated to replicate observed traffic counts and speeds with the necessary level of accuracy. The output of traffic assignment can be processed in a format required by the emission calculation software used by ARC, including MOVES.
- FTA New Starts analysis. The ABM application software package includes an option that produces the model output in a format required by FTA for the New Starts process. This output can be used as a direct input to the FTA software Summit used for calculation and analysis of the User Benefits. In order to meet the FTA "fixed total demand" requirement for comparison across the Baseline and Build alternatives, the ABM includes a run option for the Build alternative with certain travel dimensions fixed from the Baseline run.
- Highway pricing and managed lanes studies. One of the advantages of an ABM over a 4-step model is a significantly improved sensitivity to highway pricing. This includes various forms of congestion pricing, dynamic real-time pricing, daily area pricing, license plate rationing and other innovative policies that cannot be effectively modeled with a simplified 4-step model. The explicit modeling of joint travel was specifically introduced to enhance modeling of HOV/HOT facilities.
- Other transportation demand management measures. There are many new policies aimed at reducing highway congestion in major metropolitan areas, including telecommuting and teleshopping, compressed work weeks, and flexible work hours. ABMs are specifically effective for modeling these types of policies since these models are based on an individual micro-simulation of daily activity-travel patterns.

General Model Design

The ARC ABM has its roots in a wide array of analytical developments. They include discrete choice forms (multinomial and nested logit), activity duration models, time-use models, models of individual micro-simulation with constraints, and entropy-maximization models, among others. These advanced modeling tools are combined in the ABM design to ensure maximum behavioral realism, replication of the observed activity-travel patterns, and model sensitivity to level of service and transportation policies.

The model is implemented in a micro-simulation framework. Micro-simulation methods capture aggregate behavior through the representation of the behavior of individual decision-makers. In travel demand modeling these decision-makers are typically households and persons. The following section describes the basic conceptual framework at which the model operates.

Treatment of space

Activity-based and tour-based models can exploit more explicit geographic and locational information, but the advantages of additional spatial detail must be balanced against the additional efforts required to develop zone and associated network information at this level of detail, as well as against the increases in model runtime associated primarily with path-building and assignment to more zones.

Using a more spatially disaggregate zone system helps ensure appropriate model sensitivity. Use of large zones may produce aggregation biases, especially in destination choice, where the use of aggregate data can lead to illogical parameter estimates due to reduced variation in estimation data. In can also misrepresent access to transit modes, both in terms of opportunities and walk distances.

Smaller zones help to reduce these effects, and can also support more detailed representation of the highway network and highway loadings.

The current version of the ARC ABM utilizes the new 5,873 zone system used in the current set of regional travel models, shown in Figure 1. The new detailed zone system replaced the 2,027 zone system and transit accessibility sub-zones.

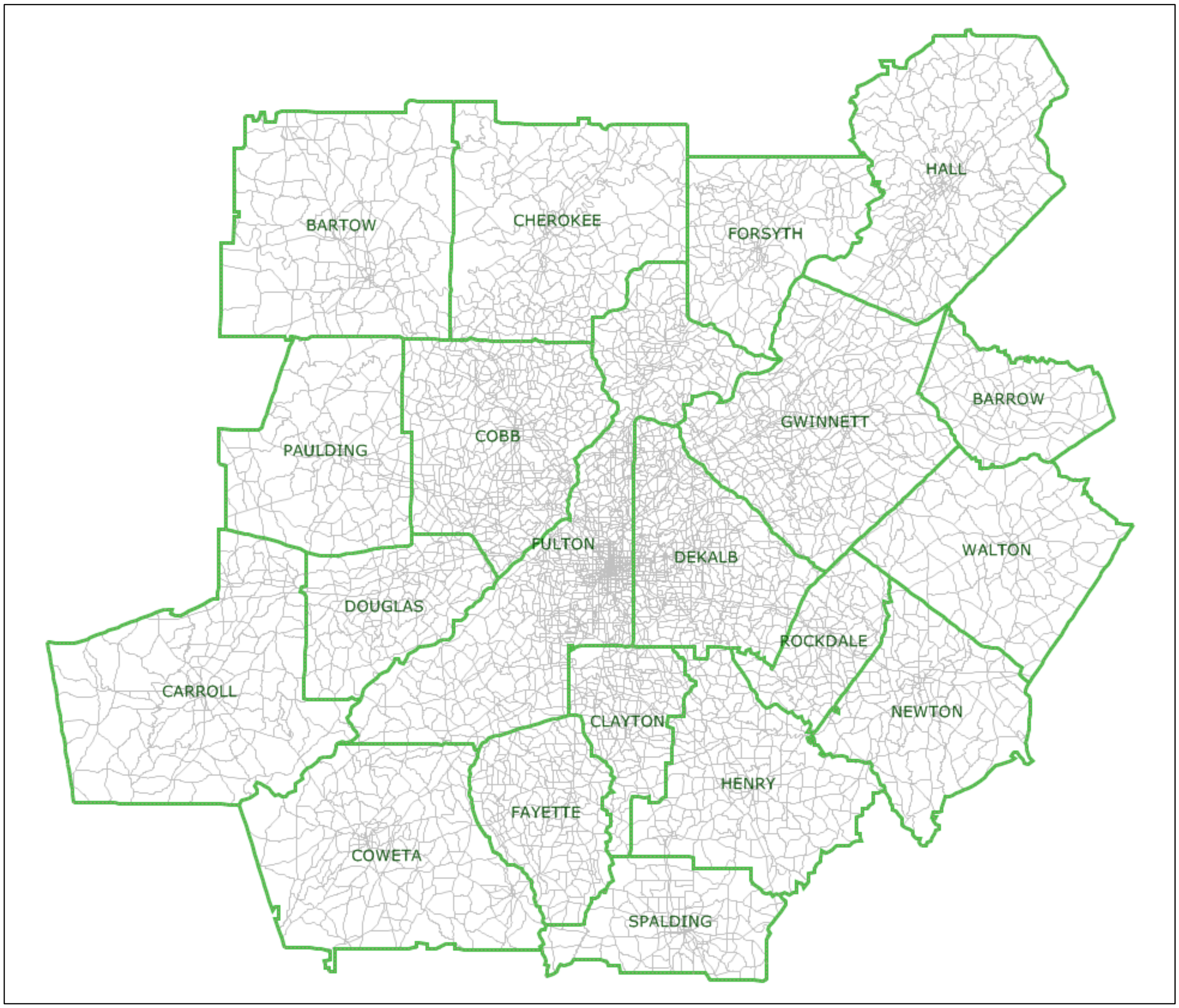

Figure 1: Atlanta Regional Traffic Analysis Zone System

The demographic forecasting department of ARC developed the socioeconomic inputs used by the model. The current ARC zonal inputs include the total households in each of four income quartiles, as well as the average income within each quartile. Total population in each of five age categories is also input. Age is used as a dimension in developing the synthesized population, but at the level of the age of the householder so as to capture important household life cycle tendencies.

As part of recent updates, the ARC ABM was revised to utilize the detailed NAICS-based employment categories shown in the right-most column in Table 1**Error! Reference source not found.**. Previously, the model utilized only the six aggregate categories shown on the left.

Table 1: NAICS-Based Employment Categories in ARC Data Inputs

Label	Category	NAICS	Descriptions
AGREMPN	Agricultural & Natural Resources	11	Agriculture/Forestry/Fishing/Hunting
		21	Mining
MWTEMPN	Manufacturing, Wholesale Trade & Transportation	22	Utilities
		31-33	Manufacturing
		42	Wholesale Trade
		48-49	Transportation & Warehousing
RETEMPN	Retail Trade	44-45	Retail Trade (excluding Eating & Drinking places)
FPSEMPN	Financial & Professional Services	52	Finance, Insurance
		53	Real Estate Rental & Leasing
		54	Professional, Scientific & Technical Services
		55	Management of Companies & Enterprises
		56	Administrative, Support, Waste Management
HEREMPN	Health, Educational and Recreational Services	61	Educational Services
		62	Health Care, Social Assistance
		71	Arts, Entertainment, Recreation
		72	Accommodation, Food Services
		81	Other Services
OTHEMPN	Other	23	Construction
		51	Information
		92	Public Administration

Decision-making units

Decision-makers in the model system include both persons and households. These decision-makers are created (synthesized) for each simulation year based on tables of households and persons from 2010 census data and forecasted TAZ-level distributions of households and persons by key socio-economic categories. These decision-makers are used in the subsequent discrete-choice models to select a single alternative from a list of available alternatives according to a probability distribution. The probability distribution is generated from a logit model which takes into account the attributes of the decision-maker and the attributes of the various alternatives. The decision-making unit is an important element of model estimation and implementation, and is explicitly identified for each model specified in the following sections.

Person-type segmentation

The ARC ABM system is implemented in a micro-simulation framework. A key advantage of using the micro-simulation approach is that there are essentially no computational constraints on the number of explanatory variables that can be included in a model specification. However, even with this flexibility, the model system will include some segmentation of decision-makers. Segmentation is a useful tool to structure models (for example, each person type segment could have their own model for certain choices) and also as a way to characterize person roles within a household. Segments can be created for persons as well as households.

A total of eight segments of person-types, shown in Table 2, are used for the ARC model system. The person-types are mutually exclusive with respect to age, work status, and school status, and are based on tabulations of the relevant data items from the 2001 HTS.

Table 2: Person Types

Number	Person-Type	Age	Work Status	School Status
1	Full-time worker	18+	Full-time	None
2	Part-time worker	18+	Part-time	None
3	College student	18+	Any	College +
4	Non-working adult	18 – 64	Unemployed	None
5	Non-working senior	65+	Unemployed	None
6	Driving age student	16 – 17	Any	Pre-college
7	Non-driving student	6 – 16	None	Pre-college
8	Pre-school	0 – 5	None	None

Activity type segmentation

The 2001 HTS used 16 different codes to identify activity purposes. Modeling all 16 activity types would add significant complexity to estimating and implementing the model system, so these detailed activity types are grouped into more aggregate activity types, based on the similarity of the activities. The activity types are used in most model system components, from developing daily activity patterns and to predicting tour and trip destinations and modes by purpose.

The proposed set of activity types is shown in Table 3. The activity types are also grouped according to whether the activity is mandatory, maintenance, or discretionary, and eligibility requirements are assigned to determine which person-types generate each activity type. The classification scheme of each activity type reflects the relative importance or natural hierarchy of the activity, where work and school activities are typically the most inflexible in terms of generation, scheduling and location, whereas discretionary activities are typically the most flexible on each of these dimensions. However, when generating and scheduling activities, this hierarchy is not rigid, so that scheduling is informed by both activity type and activity duration.

Each out-of-home location that a person travels to in the simulation is assigned one of these activity types.

Table 3: Activity Types

Type	Purpose	Description	Classification	Eligibility
1	Work	Working at regular workplace or work-related activities outside the home.	Mandatory	Workers and students
2	University	College +	Mandatory	Age 18+
3	High School	Grades 9-12	Mandatory	Age 14-17
4	Grade School	Grades K-8	Mandatory	Age 5-13
5	Escorting	Pick-up/drop-off passengers (auto trips only).	Maintenance	Age 16+
6	Shopping	Shopping away from home.	Maintenance	5+ (if joint travel, all persons)
7	Other Maintenance	Personal business and services, and medical appointments.	Maintenance	5+ (if joint travel, all persons)
8	Social/Recreational	Recreation, visiting friends and family.	Discretionary	5+ (if joint travel, all persons)
9	Eat Out	Eating outside of home.	Discretionary	5+ (if joint travel, all persons)
10	Other Discretionary	Volunteer work, religious activities.	Discretionary	5+ (if joint travel, all persons)

Treatment of time

The ARC ABM functions at a temporal resolution of 30 minutes. These half-hour increments begin with 3:00 A.M. and end with 3:00 A.M. the next day – that is, 3:00-3:30 is Period 1. To ensure temporal integrity no activities are scheduled with conflicting time windows, with the exception of short activities/tours that are completed within a half-hour period. For example, a person may have a short tour that begins and ends in the 8:00 A.M. - 8:30 A.M. period, as well as a second longer tour that begins in this time period and ends later in the day.

A critical aspect of the model system is the relationship between the temporal resolution used for scheduling activities, and the temporal resolution of the network simulation periods. Although activities are scheduled with 30 minute resolution, level-of-service matrices are only created for five aggregate time periods – early A.M., A.M., Midday, P.M., and evening. The trips occurring in each time period reference the appropriate transport network depending on their trip mode and the mid-point trip time. The definition of time periods for level-of-service matrices is given in Table 4.

Table 4: Time periods for level-of-service skims and trip assignment

Number	Description	Begin Time	End Time
1	Early A.M.	3:00 A.M.	5:59 A.M.
2	A.M. Peak	6:00 A.M.	9:59 A.M.
3	Midday	10:00 A.M.	2:59 P.M.
4	P.M. Peak	3:00 P.M.	6:59 P.M.
5	Evening	7:00 P.M.	2:59 A.M.

Trip modes

Table 5 lists the trip modes identified in the ARC models. There are 15 modes, including auto by occupancy and toll/non-toll choice, walk and bike non-motorized modes, and walk and drive access to different transit line-haul modes.

Table 5: Trip Modes for Assignment

Number	Mode Description
1	Auto Drive Alone (Free)
2	Auto Drive Alone (Pay)
3	Auto 2 Person Carpool (Free)
4	Auto 2 Person Carpool (Pay)
5	Auto 3+ Person Carpool (Free)
6	Auto 3+ Person Carpool (Pay)
7	Walk
8	Bike
9	Walk-All-Transit
10	Walk-Premium Transit-Only
11	PNR-All-Transit
12	PNR-Premium Transit-Only
13	KNR-All-Transit
14	KNR-Premium Transit-Only
15	School Bus

Basic design of the ARC CT-RAMP implementation

The general design of the ARC CT-RAMP model is presented in Figure 2 below. The following outline describes the basic sequence of sub-models and associated travel choices:

1. Synthetic population:
   - 1.1. Zonal distributions of population by controlled variables
   - 1.2. Household residential location choice (allocation to zones)
2. Long term level:
   - 2.1. Usual location for each mandatory activity for each relevant household member (workplace/university/school)
   - 2.2. Household car ownership
3. Daily pattern/schedule level:
   - 3.1. Daily pattern type for each household member (main activity combination, at home versus on tour) with a linkage of choices across various person categories
   - 3.2. Individual mandatory activities/tours for each household member (note that locations of mandatory tours have already been determined in long-term choice model)
     - 3.2.1. Frequency of mandatory tours
     - 3.2.2. Mandatory tour time of day (departure/arrival time combination)
   - 3.3. Joint travel tours (conditional upon the available time window left for each person after the scheduling of mandatory activities)
     - 3.3.1. Joint tour frequency
     - 3.3.2. Travel party composition (adults, children, mixed)
     - 3.3.3. Person participation in each joint tour
     - 3.3.4. Primary destination for each joint tour
     - 3.3.5. Joint tour time of day (departure/arrival time combination)
   - 3.4. Individual non-mandatory activities/tours (conditional upon the available time window left for each person after the scheduling of mandatory and joint non-mandatory activities)
     - 3.4.1. Person frequency of maintenance/discretionary tours
     - 3.4.2. Primary destination for each individual maintenance/discretionary tour
     - 3.4.3. Individual maintenance/discretionary tour departure/arrival time
   - 3.5. Individual at-work subtours (conditional upon the available time window within the work tour duration)
     - 3.5.1. Person frequency of at-work sub-tours
     - 3.5.2. Primary destination for each at-work sub-tour
   - 3.5.3. At-work sub-tour departure/arrival time
4. Tour level:
   - 4.1. Tour mode
   - 4.2. Frequency of secondary stops
   - 4.3. Location of secondary stops
5. Trip level:
   - 5.1. Trip depart time model
   - 5.2. Trip mode choice conditional upon the tour mode
   - 5.3. Auto trip parking location choice
   - 5.4. Trip assignment

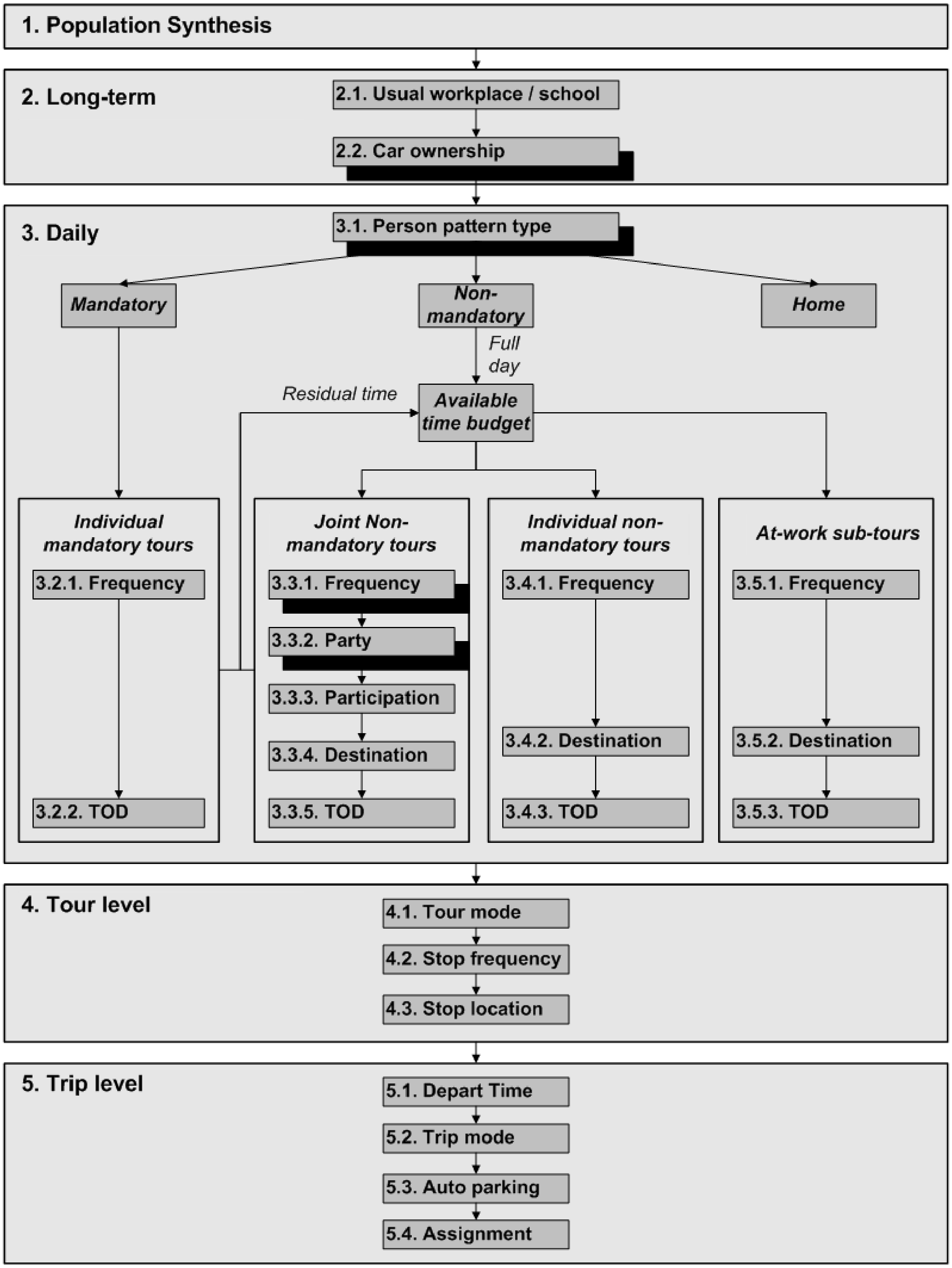

Figure 2: Basic Model Design and Linkages between Sub-models

Choices that relate to the entire household or a group of household members and assume explicit modeling of intra-household interactions (sub-models 2.2, 3.1, 3.3.1, 3.3.2) are shadowed in Figure 2. The other models are assumed to be individual-based for the basic design.

The model system uses synthetic household population as a base input (sub-model 1). It is followed by long-term choices that relate to the usual workplace/university/school for each worker and student (sub-model 2.1) and household car ownership (sub-model 2.2). The daily activity pattern type of each household member (model 3.1) is the first travel-related sub-model in the modeling hierarchy. This model classifies daily patterns by three types: 1) mandatory (that includes at least one out-of-home mandatory activity), 2) non-mandatory (that includes at least one out-of-home non-mandatory activity, but does not include out-of-home mandatory activities), and 3) home (that does not include any out-of-home activity and travel). However, the pattern type sub-model leaves open the frequency of tours for mandatory and non-mandatory purposes (maintenance, discretionary) since these sub-models are applied later in the model sequence. The pattern choice set contains a non-travel option in which the person can be engaged in in-home activity only (purposely or because of being sick) or can be out of town. In the model system application, a person who chooses a non- travel pattern is not considered further in the modeling stream. Daily pattern-type choices of the household members are linked in such a way that decisions made by some members are reflected in the decisions made by the other members.

The next set of sub-models (3.2.1-3.2.3) defines the frequency and time-of-day for each mandatory tour. The scheduling of mandatory activities is generally considered a higher priority decision than any decision regarding non-mandatory activities for either the same person or for the other household members. As the result of the mandatory activity scheduling, “residual time windows” are calculated for each person and their overlaps across household members are estimated. Time window overlaps, which are left in the daily schedule after the mandatory commitment of the household members has been made, constitute the potential for joint activity and travel.

The next major model component relates to joint household travel. This component produces a number of joint tours by travel purpose for the entire household (3.3.1), travel party composition in terms of adults and children (3.3.2), and then defines the participation of each household member in each joint household tour. It is followed by choice of destination (3.3.4) and time-of-day (3.3.5).

The next stage relates to maintenance and discretionary tours that are modeled at the individual person level. The models include tour frequency (3.4.1), choice of destination (3.4.2) and time of day (3.4.3). The next set of sub-models relate to the tour-level details on mode (4.1), exact number of intermediate stops on each half-tour (4.2) and stop location (4.3). It is followed by the last set of sub-models that add details for each trip including trip depart time (5.1), trip mode (5.2) and parking location for auto trips (5.3). The trips are then assigned to highway and transit networks depending on trip mode (5.4).

The next sections describe each model component in greater detail, including the general algorithm for each model, the decision-making unit, the choices considered, the market segmentation utilized (if any), and the explanatory variables used. Estimated model parameters, before calibration, are given in Appendix A.

Population Synthesizer

Population synthesis is a method for creating a fully-enumerated population of the ARC region (persons and households) based on a population sample. The ARC population synthesizer was developed to be a flexible tool for creating synthetic populations for AB modeling. It takes as an input Census data – specifically the Public Use Microdata Sample (PUMS) -- and zonal-level and regional marginal distributions of households by various characteristics. These distributions are used as controls or targets which the synthetic population attempts to match.

The person and household controls may be specified at three main levels of spatial aggregation – microzones (MAZ), traffic analysis zones (TAZ), and district. For ARC, these aggregations correspond to TAZs, PECAS zones, and County groups, respectively. Controls at the district level are also known as meta-controls. Some counties were grouped together to form the districts so that each meta-geography unit is at least as big as a PUMA.

The basic steps of the population synthesizer are described below. For a more detailed description of the procedure refer to the MAG ABM Model Design[1]. The algorithm is illustrated in Figure 3 below.

1) MAZ level control data is aggregated to the Census PUMA level
2) PUMS household record weights are list balanced to match PUMA controls
3) Weighted households are aggregated by PUMA to META level control categories
4) PUMA level totals are factored to match META level control totals
5) Factored PUMA level META controls are appended to the original PUMA controls
6) Final PUMA household record weights are determined by list balancing to match expanded set of PUMA controls
7) After list balancing for the PUMA, a linear programming solver is used to discretize the fractional weights
8) By PUMA, households are allocated to TAZs within the PUMA
9) The allocation procedure involves list balancing of the PUMA household records to match TAZ control totals (aggregated from MAZ controls)
10) TAZs are processed in order of number of households in TAZ, from smallest to largest
11) Initial weights for the household records are the integer weights determined from final PUMA level balancing
12) Only the household records with non-zero initial weights are used for balancing
13) After list balancing for the TAZ, a linear programming solver is used to discretize the fractional weights. The integer weights for all household records that were determined match TAZ controls
14) The PUMA level initial weights are reduced by the final TAZ integer weights
15) After all TAZs are allocated households, MAZs are allocated households using an identical procedure to TAZ allocation except the set of PUMS records are the non-zero weight records for each TAZ
16) The final output Table is a Table for each MAZ of household records with final integer weights that sum to the number of households in the MAZ

[1] Design and Development Plan for the MAG CT-RAMP Activity-Based Model. Parsons Brinckerhoff, July 2010.

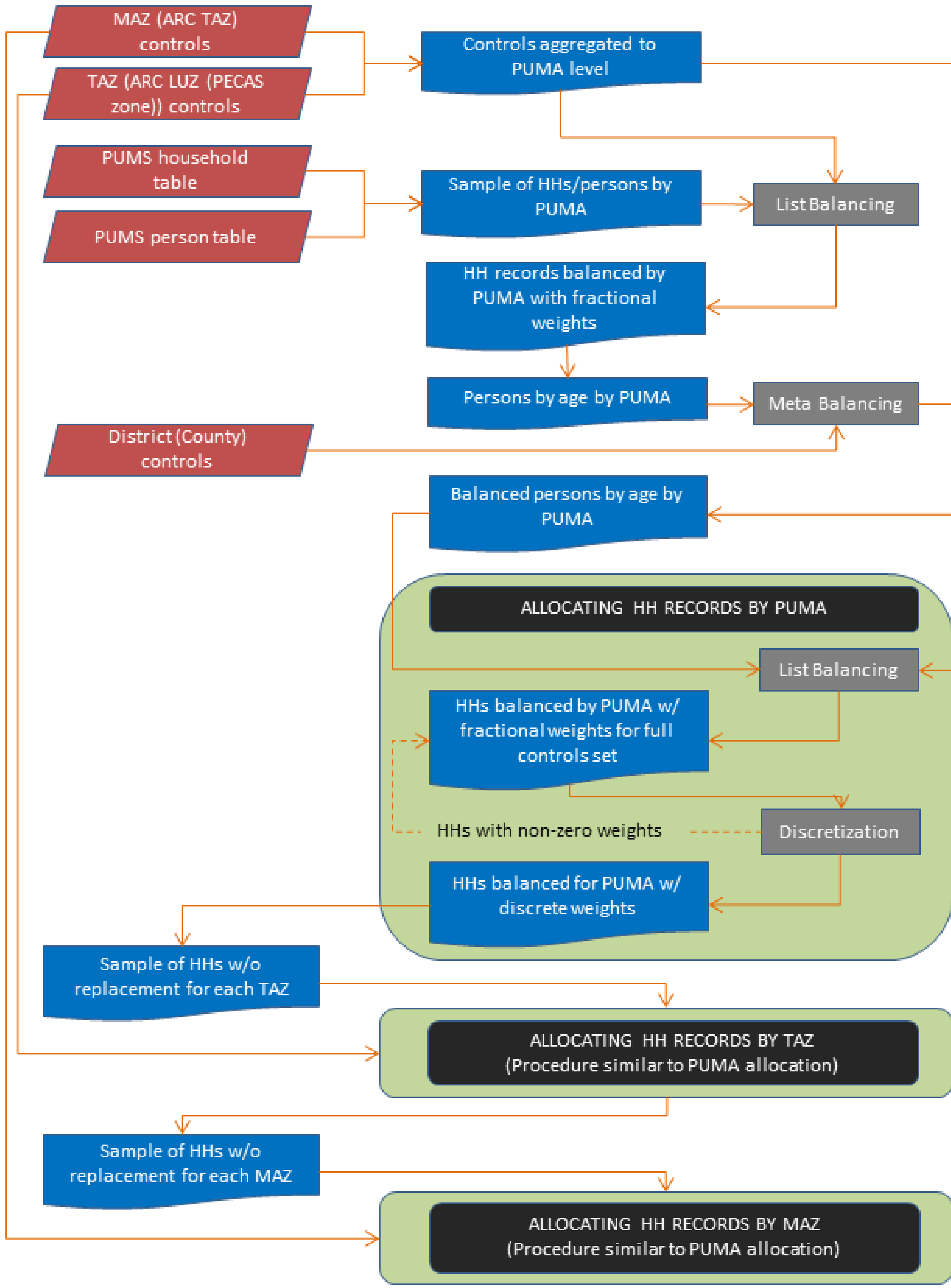

Figure 3: PopSyn III Flowchart

The ARC population synthesis uses the controls summarized in Table 6 below. The seed household and person population were obtained from the 2007-2011 5-Year PUMS datasets. The outputs from the population synthesis process are lists of synthetic households and persons that reside in the 20-county ARC region, as shown in Table 7 and Table 8.

Table 6: ARC Population Synthesis Controls

Control	Categories	Geography	Data Source
Number of HHs	N/A	Region	ARC socio-economic forecast
Number of HH by income[1]	0-25k, 25k-60k, 60k-120k, 120k+	MAZ (ARC TAZ)	ARC socio-economic forecast
Number of HH by HH size	1,2,3,4,5,6+	MAZ (ARC TAZ)	ARC socio-economic forecast
Number of HH by workers	0,1,2,3+	MAZ (ARC TAZ)	ARC workers per household shares from trip-based model
Number of persons by age	0-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75-84, 85+	District (ARC County group)	ARC socio-economic forecast
Number of persons by occupation	CL23WhiteCollar, CL24Services, CL25Health, CL26Retail, CL27BlueCollar	TAZ (ARC PECAS zone)	PECAS model

1 Income values expressed in $2011

Table 7: Synthetic Population Household Table in Expanded Form

FIELD	Description
HHID	Unique household ID
TEMPID	Unexpanded household ID
DISTRICT	District code (ARC County) in which HH is located
PUMA	PUMA code for HH record
TAZ	TAZ (ARC PECAS zone) code in which HH is located
MAZ	MAZ (ARC TAZ) code in which HH is located
WGTP	Housing Weight
FINALPUMSID	HH ID generated during population synthesis
FINALWEIGHT	HH weight generated during population synthesis
SERIALNO	Unique housing PUMS record identifier
NWRKRS_ESR	Number of workers in the household
*	Other PUMS HH fields

Table 8: Synthetic Population Person Table in Expanded Form

FIELD	Description
HHID	Unique household ID
PERID	Unique person ID
TEMPID	Unexpanded household ID
DISTRICT	District code (ARC County) in which HH is located
PUMA	PUMA code for HH record
TAZ	TAZ (ARC PECAS zone) code in which HH is located
MAZ	MAZ (ARC TAZ) code in which HH is located
WGTP	Housing Weight
FINALPUMSID	Person ID generated during population synthesis
FINALWEIGHT	Person weight generated during population synthesis
SPORDER	Person number in HH
EMPLOYED	Is person employed
PECAS_OCC	PECAS Occupation code for this person
*	Other PUMS Person fields

Long Term Choice Models

Mandatory Activity Location Choice

Number of Models:	3 (Work, K-12, University)
Decision-Making Unit:	Workers for Work Location Choice
	Persons age 5-12 for K-Grade School
	University students for University Model
Model Form:	Multinomial Logit
Alternatives:	Traffic Analysis Zones

The workplace location choice model assigns a workplace TAZ for every employed person in the synthetic population. Every worker is assigned a regular work location TAZ according to a multinomial logit destination choice model. The model parameters were estimated using the 2001 HTS; they are given in Appendix A. The following explanatory variables were found to be significant and are included in the final model specification:

- Mode choice logsum, which can be understood as a generalized cost of travel averaged over multiple modes
- Distance
- Distance interactions
    - Household income
    - Work status (full vs. part-time)
    - Area type
- Retail accessibility at the workplace location
- CBD and High density urban area types
- Size term

The size terms vary according to worker occupations, to reflect the different types of jobs that are likely to attract different (white collar versus blue-collar) workers. Accessibility is measured by a 'representative' mode choice logsum based on peak period travel (A.M. departure and P.M. return), as well as distance to the workplace. The mode choice logsum represents the total ease of travel between two zones across all available modes.

Since mode choice logsums are required for each destination, a two-stage procedure is used for all destination choice models in CT-RAMP to reduce computational time (it would be computationally prohibitive to compute a mode choice logsum for each of 5,873 zones and every worker in the synthetic population). In the first stage, a simplified destination choice model is applied in which all zones are alternatives. The only variables in this model are the size term and distance. This model creates a probability distribution for all possible alternatives (zones with no employment are not sampled). A set of alternatives are sampled from the probability distribution and these alternatives constitute the choice set in the full destination choice model. Mode choice logsums are computed for these alternatives and the destination choice model is applied. A workplace TAZ is chosen for each worker from this more limited set of alternatives. In the case of the work location choice model, a set of 30 alternatives is sampled.

Figure 4 illustrates the zonal total accessibilities used in the model.

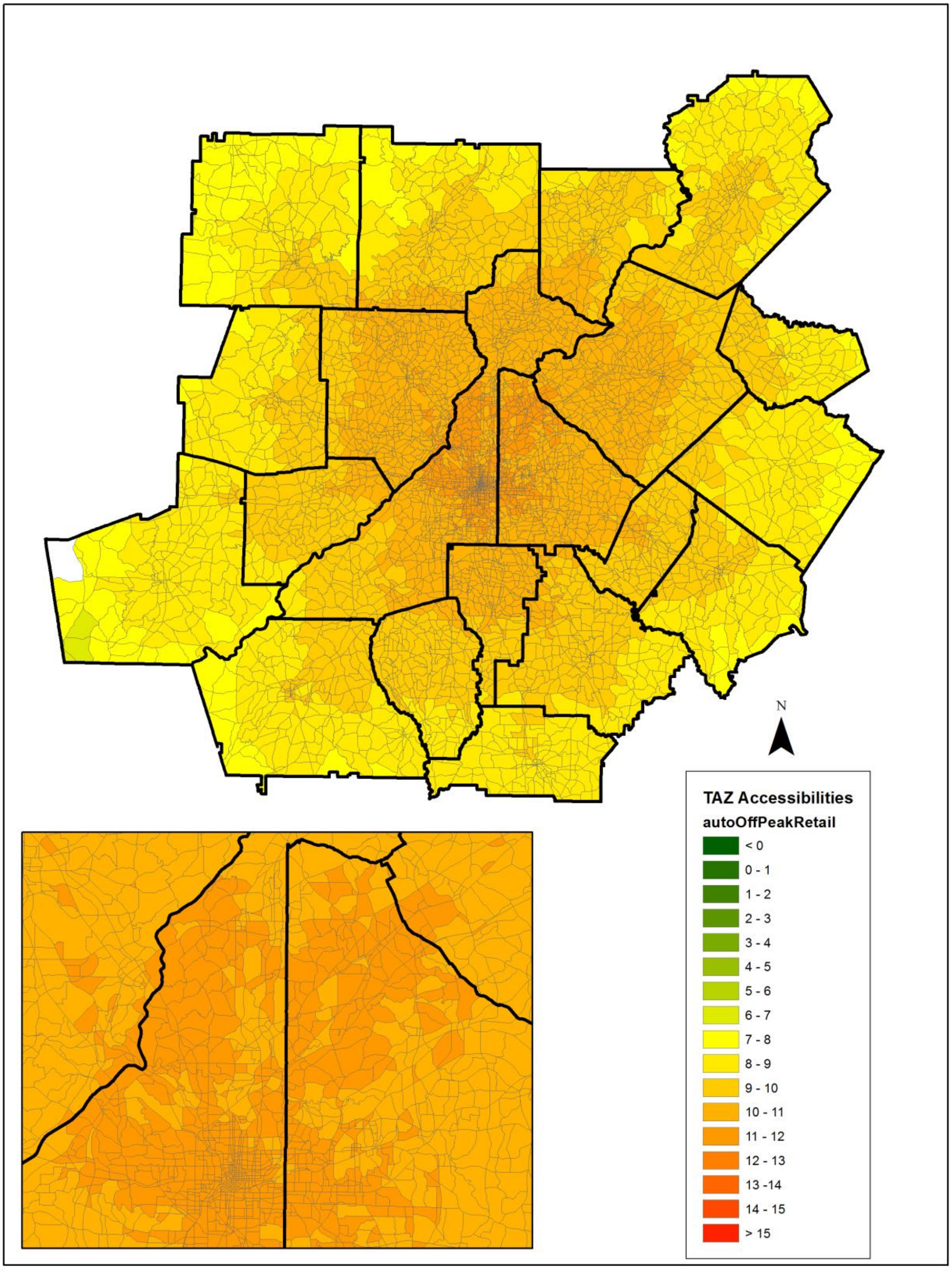

Figure 4: Auto Off-Peak Retail Accessibilities

Figure 5 illustrates the mode choice logsums for modeled trips from all zones to a representative zone in downtown Atlanta. This calculation is based on model outputs, and therefore is constrained by the trips that are modeled.

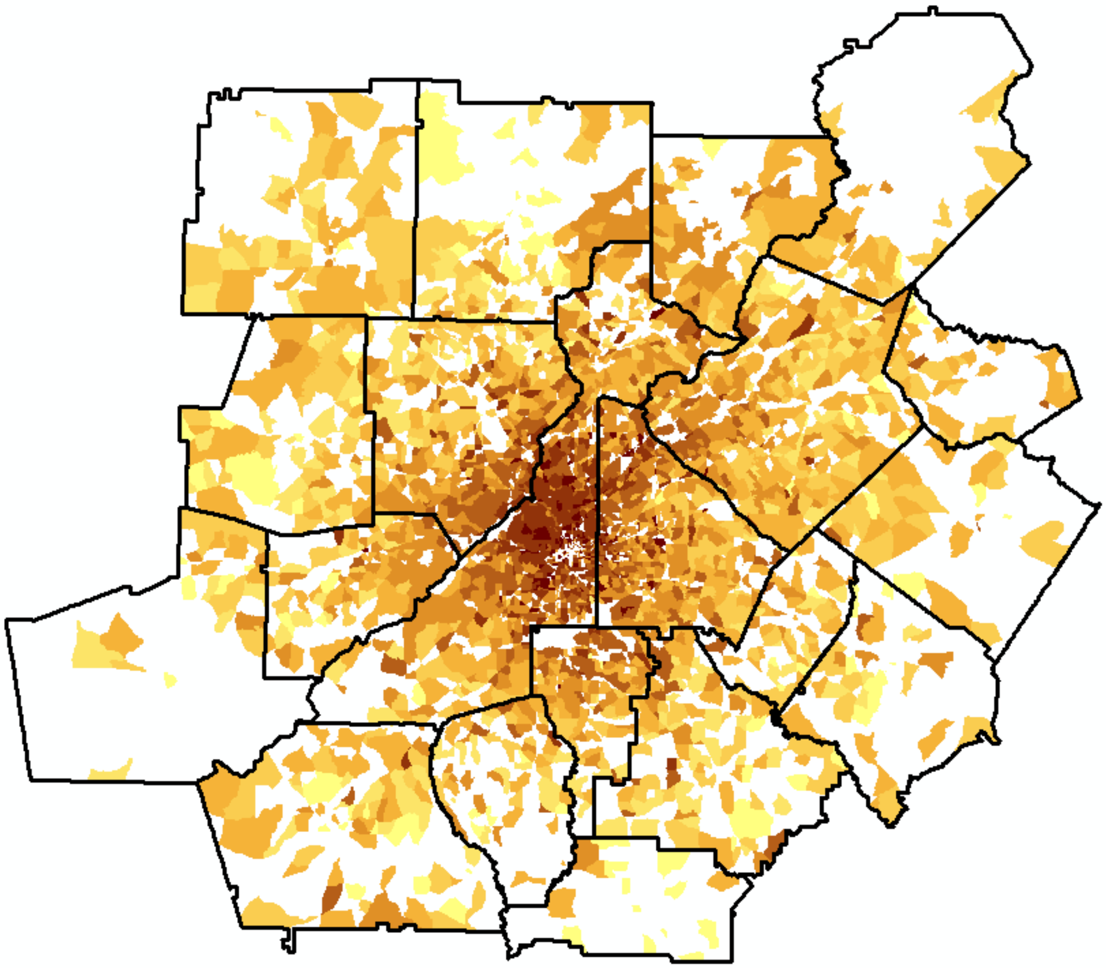

Figure 5: Sample Mode Choice Logsum to Downtown Atlanta

The application procedure utilizes an iterative shadow pricing mechanism in order to match workers to input employment totals by TAZ. The shadow prices are written to a file and can be used in subsequent model runs to cut down computational time. The destination-based accessibility type and area type variables are not included in the model in application, since they get replaced by the shadow prices.

The grade school location choice model assigns a school location to every school aged person (5-12 years old) in the synthetic population. The size term in this model is population aged 5-12, based on the assumption that grade schools generally follow population. If more accurate grade school enrollment data becomes available, the size terms will be replaced with that data. However, it will be necessary to include both public and private grade school locations and enrollment. Another useful dataset would be school district boundaries, to the extent that they are relevant in restricting or affecting school location choices based on residential location. District boundaries can be used in application to calibrate alternative-specific constant terms.

The grade school location choice model parameters are given in Appendix A. They include person/household characteristics, representative school mode choice logsums, distance, and size terms. School activities are located at the zone level, through explicitly choosing zones as alternatives in the destination choice model.

The university location choice model assigns a university location for every university student in the synthetic population. The size term in this model is university enrollment. The University grade school location choice model parameters are given in Appendix A. They include person/household characteristics, representative university mode choice logsums, distance, and size terms. University activities are located at the zone level.

Car Ownership Model

Number of Models:	1
Decision-Making Unit:	Households
Model Form:	Nested Logit
Alternatives:	0, 1, 2, and 3+ autos

The car ownership model predicts the number of vehicles owned by each household. It is formulated as a nested logit choice model with four elemental alternatives, including “no cars”, “one car”, “two cars”, and “three or more cars”. The model includes the following explanatory variables:

- Household size and composition
- Number of drivers in the household
- Household Income
- Auto accessibility
- Transit accessibility
- Accessibility via rail for workers and students
- Auto dependency for workers

Auto and transit accessibility take the form of destination choice logsum variables. These variables represent the total ease of travel from the residence zone to all possible destinations, respectively using auto modes and transit modes. This type of accessibility measure is preferred over measures based solely on travel time or distance because they incorporate multiple indicators of level of service, including cost, and are consistent with modal preferences.

Worker auto dependency is a measure of auto accessibility relative to transit accessibility, specifically for the workplace destinations of workers in the household. It is computed as the sum, across all workers in the household, of the difference between auto and transit mode choice logsums. Increasing values indicate worsening transit accessibility (in relative terms) and therefore higher likelihood of owning multiple cars.

Accessibility via rail for workers and students is the ratio of premium transit in-vehicle time to total transit in-vehicle time between home and work (or school, in case of students). Households that have good access to rail transit are more likely to choose to be transit dependent and forego high levels of auto ownership.

The auto ownership model parameters were estimated using the ARC 2011 HTS; they are given in Appendix A.

Free Parking Eligibility

Number of Models: 1
Decision-Making Unit: Persons
Model Form: Multinomial Logit
Alternatives: 2 (free on-site parking, pay parking)

This model predicts whether drivers traveling to areas where parking is not free have access to free parking. Respondents were asked about parking costs at their primary tour destination. The model assumes that people who park for free downtown are aware of the availability of this free space before they begin any travel tours. This is likely to be the case for workers who are guaranteed free parking downtown by their employer, but less true for drivers undertaking non-mandatory tours. The parking eligibility model is placed upstream of the destination and mode choice models so that these choices can be informed by the availability of free parking. Due to its placement in the model stream, the parking eligibility model is largely dependent on household characteristics. The model parameters are given in Appendix A.

Activity Pattern and Tour-Level Models

Coordinated Daily Activity Pattern (DAP) Model

Number of Models:	1
Decision-Making Unit:	Households
Model Form:	Multinomial Logit
Alternatives:	3 (one-person households)
	9 (two-person households)
	27 (three-person households)
	81 (four-person households)
	243 (five-person households)
	363 total alternatives

The next set of sub-models relates to personal DAPs and the generation of individual tours by purpose for all persons in the synthetic population.

The DAP is classified by three main pattern types:

- Mandatory pattern (M) that includes at least one of the three mandatory activities – work, university or school. This constitutes either a workday or a university/school day, and may include additional non-mandatory activities such as separate home-based tours or intermediate stops on the mandatory tours.
- Non-mandatory pattern (NM) that includes only individual and/or joint maintenance and discretionary tours. By virtue of the tour primary purpose definition, maintenance and discretionary tours cannot include travel for mandatory activities.
- At-home pattern (H) that includes only in-home activities. At-home patterns are not distinguished by any specific activity (e.g., work at home, take care of child, being sick, etc.). Cases with complete absence from town (e.g., business travel) are included in this category.

Statistical analyses conducted with data from Columbus, Atlanta and the San Francisco Bay Area have shown that there is an extremely strong correlation between DAP types of different household members, especially for joint NM and H types. For this reason, the DAP for different household members cannot be modeled independently. Therefore, alternative DAP types are broken into two groups. Mandatory activities form the first group; these activities are assumed to be undertaken individually. The second group contains two patterns – NM and H – that have the potential to be jointly utilized if several household members choose the same pattern.

The total number of possible DAP type combinations is significant for large households. However, there are several important considerations that significantly reduce the dimensionality of the simultaneous model. First of all, mandatory DAP types are only available for appropriate person types (workers and students). Even more importantly, intra-household coordination of DAP types is relevant only for the NM and H patterns. Thus, simultaneous modeling of DAP types for all household members is essential only for the trinary choice (M, NM, H), while the sub-choice of the mandatory pattern can be modeled for each person separately.

The CDAP model features simultaneous modeling of trinary pattern alternatives for all household members with the subsequent modeling of individual alternatives, as shown in **Error! Reference source not found.**. Tour frequency choice is a separate choice model conditional upon the choice of alternatives in the trinary choice. This structure is much more powerful for capturing intra-household interactions than sequential processing.

Simultaneous modeling of potentially joint alternatives for all household members assumes that for each person only a trinary choice (M, NM, H) is considered. Even for a household of five persons the simultaneous combination of trinary models results in a total of 243 alternatives that is a manageable number in estimation and application. For the limited number of households of size greater than five, the model is applied to the first five household members by priority while the rest of the household members are processed sequentially, conditional upon the choices made by the first five members.

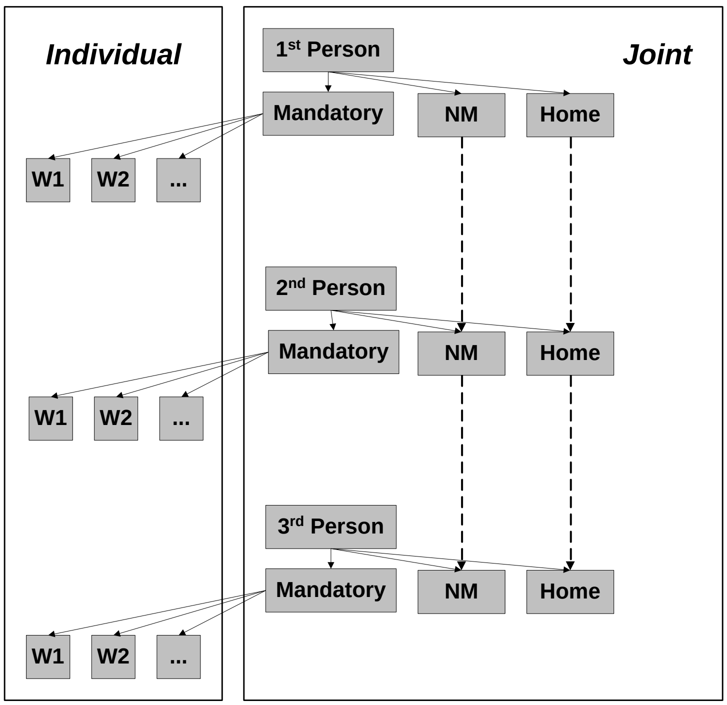

Figure 6: Day Activity Pattern Type Choice Structure

The CDAP model contains a number of explanatory variables including person and household attributes, accessibility measures, and density/urban form variables. Since the model features intra-household interactions, a number of the parameters in the model are specified as interaction terms. These terms are based on the contribution to the total utility of an alternative from either a two-person interaction, a three-person interaction, or an entire-household interaction. For example, the contribution of a two-worker interaction to the utility for each worker to stay home on the simulation day is positive, indicating that it is more likely that both workers will attempt to coordinate their days off. Similarly, the contribution of a pre-school child to a worker mandatory pattern is negative, indicating the likelihood that if a pre-school child stays at home, a worker also is more likely to stay at home with the child. The CDAP model parameters were estimated using the 2001 HTS and are given in Appendix A. Individual daily activity pattern model parameters for non-included persons are also given in the appendix.

Individual Mandatory Tour Frequency

Number of Models:	1
Decision-Making Unit:	Persons
Model Form:	Multinomial Logit
Alternatives:	5 (1 Work Tour, 2 Work Tours, 1 School Tour, 2 School Tours, 1 Work/1 School Tour)

Based on the DAP chosen for each person, individual mandatory tours, such as work, school and university tours are generated at person level. The model is designed to predict the exact number and purpose of mandatory tours (e.g., work and school/ university) for each person who chose the mandatory DAP type at the previous decision-making stage. Since the DAP type model at the household level determines which household members engage in mandatory tours, all persons subjected to the individual mandatory tour model implement at least one mandatory tour. The model has the following five alternatives:

- One work tour,
- One school tour,
- Two or more work tours,
- Two or more school tours,
- One work tour plus one school tour.

DAPs and subsequent behavioral models of travel generation include various explanatory variables that relate to household composition, income, car ownership, location of work and school activities, land-use development, residential and employment density, and accessibility factors. The individual mandatory tour frequency model parameters are given in Appendix A.

Individual Mandatory Tour Time of Day Choice

Number of Models:	1
Decision-Making Unit:	Persons
Model Form:	Multinomial Logit
Alternatives:	1,176 (combinations of tour departure and arrival half-hour periods)

After individual mandatory tours have been generated, the tour departure time from home and arrival time back at home is chosen simultaneously. Note that it is not necessary to select the destination of the tour, as this has already been determined in Model 2.1. The model is a discrete-choice construct that operates with tour departure-from-home and arrival-back-home time combinations as alternatives. The proposed utility structure is based on "continuous shift" variables, and represents an analytical hybrid that combines the advantages of a discrete-choice structure (flexible in specification and easy to estimate and apply) with the advantages of a duration model (a simple structure with few parameters, and which supports continuous time). The model has a temporal resolution of a half-hour that is expressed in 1,176 30-minute departure/arrival time alternatives. The model utilizes direct availability rules for each subsequently scheduled tour, to be placed in the residual time window left after scheduling tours of higher priority. This conditionality ensures a full consistency for the individual entire-day activity and travel schedule as an outcome of the model.

The model utilizes household, person, and zonal characteristics, most of which are generic across time alternatives. However, network LOS variables vary by time of day, and are specified as alternative-specific based on each alternative's departure and arrival time. By using generic coefficients and variables associated with the departure period, arrival period, or duration, a compact structure of the choice model is created, where the number of alternatives can be arbitrarily large depending on the chosen time unit scale, but the number of coefficients to estimate is limited to a reasonable number. Duration variables can be interpreted as "continuous shift" factors that parameterize the termination rate in such a way that if the coefficient multiplied by the variable is positive, this means the termination rate is getting lower and the whole distribution is shifted to the longer durations. Negative values work in the opposite direction, collapsing the distribution toward shorter durations.

In the CT-RAMP model structure, the tour-scheduling model is placed after destination choice and before mode choice. Thus, the destination of the tour and all related destination and origin-destination attributes are known and can be used as variables in the model estimation.

The choice alternatives are formulated as tour departure from home/arrival at home half-hour combinations (g,h), and the mode choice logsums and bias constants are related to departure/arrival periods (s,t). Tour duration is calculated as the difference between the arrival and departure half-hours ($h-g$) and incorporates both the activity duration and travel time to and from the main tour activity, including intermediate stops.

The tour TOD choice utility has the following general form:

$$V_{gh} = V_g + V_h + D_{h-g} + \mu \ln\left(\sum_m V_{stm}\right)$$ **Equation 1**

where:

V_g, V_h	=	departure and arrival time-specific components
D_{h-g}	=	duration-specific components
m	=	entire-tour modes (SOV, HOV, walk to transit, drive to transit, non-motorized)
V_{stm}	=	mode utility for the tour by mode *m*, leaving home in period *s* (containing half hour *h*) and returning home in period *t* (containing *g*)
μ	=	mode choice logsum coefficient

For model estimation, the following practical rules can be used to set the alternative departure/arrival time combinations:

- Each reported/modeled departure/arrival time is rounded to the nearest half-hour.
- Every possible combination of the 48 departure half-hours with the 48 arrival half-hours (where the arrival half-hour is the same or later than the departure hour) is an alternative. This gives 48 × (48-1)/2 + 48= 1,176 choice alternatives.

The network simulations to obtain travel time and cost skims are implemented for five broad periods:

- Early A.M. (3:00 AM to 5:59 AM)
- A.M. peak (6:00 AM to 9:59 AM)
- Midday (10:00 AM to 2:59 PM)
- P.M. peak (3:00 PM to 6:59 PM)
- Evening (7:00 PM to 2:59 AM)

Mode-choice logsums are used for all relevant combinations of the five time periods above. The model could include more TOD periods for network simulation, ultimately approaching a resolution of dynamic traffic assignment. For example, the 7:00-8:00 A.M. and 4:00-5:00 P.M. hours could be singled out of the peak periods to distinguish the morning and evening peak hours from the shoulders of the peaks. This would lead to a network simulation system with eight time-of-day periods, which is still manageable yet provides better resolution during the periods where congestion is more likely to occur.

The individual mandatory tour time-of-day choice model was estimated using the 2011 HTS and the explanatory variables are given in Appendix A.

Generation of Joint Household Tours

Joint travel for non-mandatory activities is modeled explicitly in the form of fully joint tours. In a fully joint tour all members of the travel party travel together from the very beginning to the end and participate in the same activities along the way. Fully joint travel accounts for more than 50% of joint travel. Partially joint travel like carpooling of workers and escorting children are not explicitly considered in the ARC ABM, though they are handled implicitly through shared-ride alternatives in mode choice.

An explicit model of joint travel constitutes one of the primary advantages of the CT-RAMP modeling paradigm. Each fully joint tour is considered a unit of modeling with a group-wise decision-making for the primary destination, mode, frequency and location of stops, etc. Formally, modeling joint activities involves two linked stages – see Figure 7:

- A tour generation stage that generates the number of joint tours by purpose/activity type made by the entire household. This is the joint tour frequency model.
- A tour participation stage at which the decision whether to participate or not in each joint tour is made for each household member and tour. This is the joint tour participation model. For analytical convenience this model is broken into two sub-models. The first addresses travel party composition, and the second focuses on person participation choice.

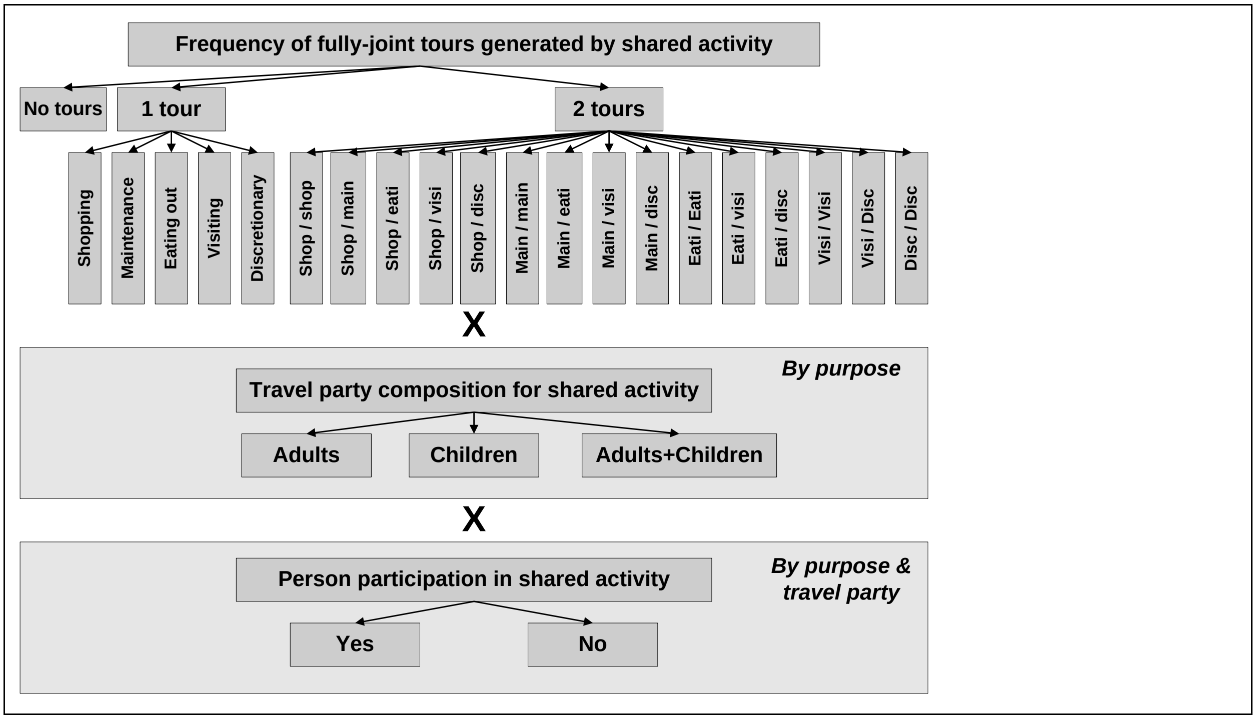

Figure 7: Model Structure for Joint Non-Mandatory Tours

Joint tour party composition is modeled for each tour. Travel party composition is defined in terms of person categories (e.g., adults and children) participating in each tour. Statistical analysis and model estimation has shown a strong linkage between trip purpose and typical party compositions. The essence of the joint party composition model is to narrow down the set of possible person participation choices modeled by the subsequent sub-model. Frequency choice and travel party composition models discussed above generally fall quite readily into the standard discrete choice structure. Regarding the person participation model, two alternative ways to formulate the choice model have been found (as shown in Figure 8). The first approach (shown on the left of the figure) constitutes entire-party choice. This approach is based on explicitly listing all possible person combinations for the travel party formation. The disadvantage of this approach is its complexity; in large households, it is not clear how to structure the alternatives, form a choice set, and estimate a model that is relatively easy to interpret. The second approach (shown on the right) is based on participation choice being modeled for each person sequentially. In this alternative approach, only a binary choice model is calibrated for each activity, party composition and person type. The model iterates through household members, and applies a binary choice to each to determine if the member participates. The model is constrained to only consider members with available time-windows overlapping with the generated joint tour. This method is used for modeling joint tour participation in CT-RAMP. The approach offers simplicity, but at the cost of overlooking potential non-independent participation probabilities across household members. The joint tour frequency, composition, and participation models are described below.

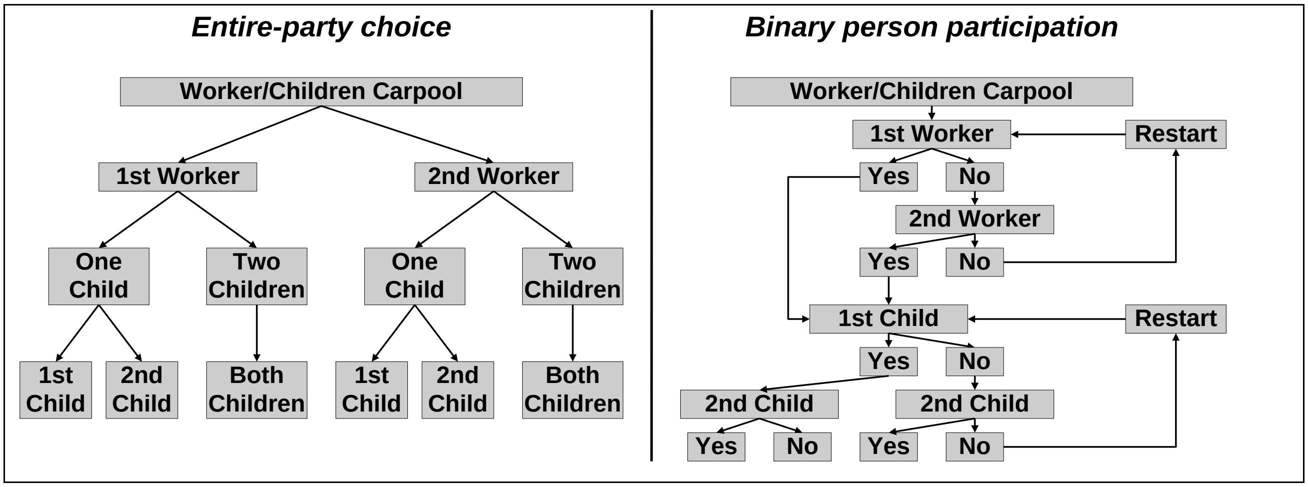

Figure 8: Travel Party Formation

Joint Tour Frequency

Number of Models: 1
Decision-Making Unit: Households
Model Form: Multinomial Logit
Alternatives: 21 (No Tours, 1 Tour segmented by purpose, 2 tours segmented by purpose combination)

Joint tour frequencies are generated by households, and include the number and purposes of the joint tours. Later models determine who in the household participates in the joint tour. The explanatory variables in the joint tour frequency model include household variables, accessibilities, and other urban form type variables. One of the most significant variables in the joint tour frequency model is the presence and size of overlapping time-windows, which represent the availability of household members to travel together after mandatory tours have been generated and scheduled. This formulation provides 'induced demand' effects on the generation and scheduling of joint tours; the frequency and duration of mandatory tours affects whether or not joint tours are generated. The joint tour frequency model parameters are given in Appendix A.

Joint Tour Composition

Number of Models: 1
Decision-Making Unit: Joint Tour
Model Form: Multinomial Logit
Alternatives: 3 (Adults-only, Children-only, Adults + Children)

Joint tour party composition is modeled for each tour, and determines the person types that participate in the tour. The model is multinomial logit, and explanatory variables include the maximum time window overlaps across adults, children and adults or children after mandatory tours have been scheduled. Other variables include household structure, area type, and the purpose of the joint tour. The joint tour composition model parameters are given in Appendix A.

Joint Tour Participation

Number of Models: 1
Decision-Making Unit: Persons
Model Form: Multinomial Logit
Alternatives: 2 (Yes or No)

Joint tour participation is modeled for each person and each joint tour. If the person is does not correspond to the composition of the tour determined in the joint tour composition model, they are ineligible to participate in the tour. Similarly, persons whose daily activity pattern type is home are excluded from participating. The model relies on heuristic process to assure that the appropriate persons participate in the tour as per the composition model. The model follows the logic depicted in Figure 9. Explanatory variables include the person type of the decision-maker, the maximum pair-wise overlaps between the decision-maker and other household members of the same person type (adults or children), household and person variables, and urban form variables. The joint tour participation model parameters are given in Appendix A.

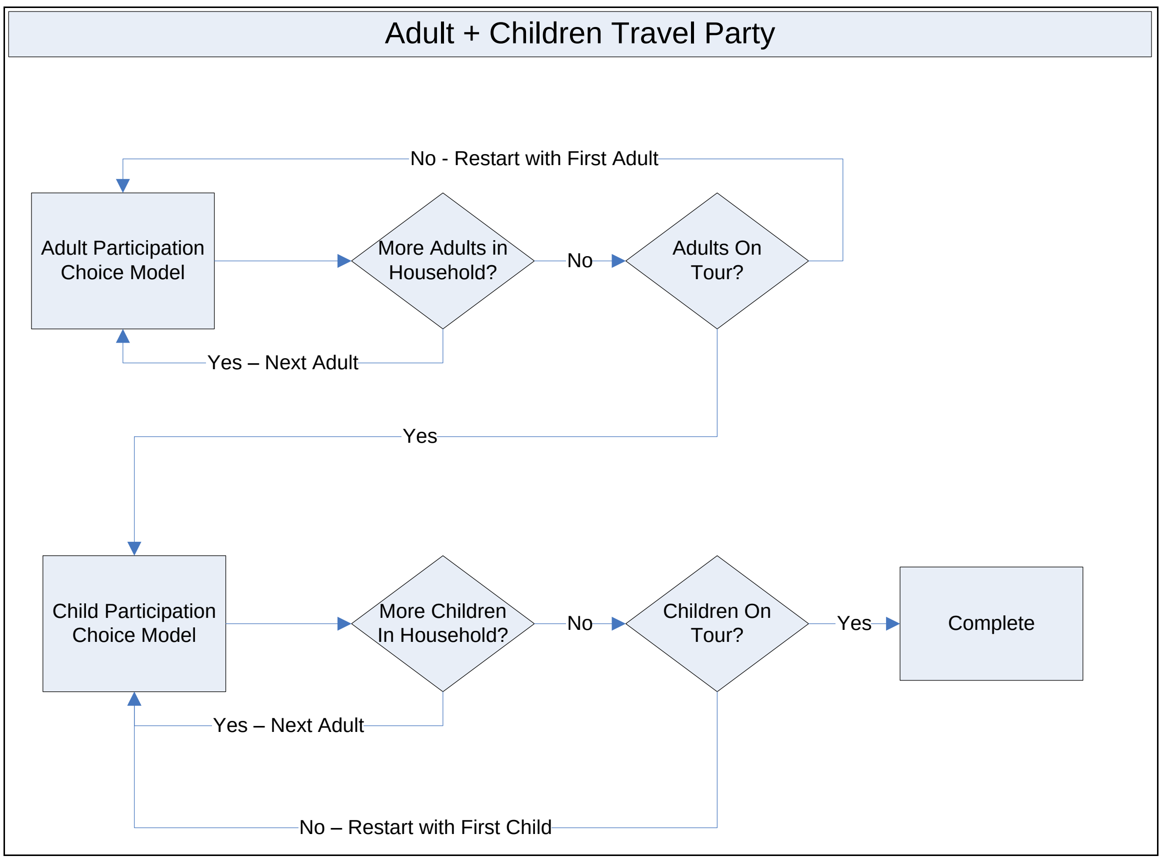

Figure 9: Application of the Person Participation Model

Joint Tour Primary Destination Choice

Number of Models: 1
Decision-Making Unit: Tour
Model Form: Multinomial Logit
Alternatives: Zones

The joint tour primary destination choice model determines the location of the tour primary destination. The destination is chosen for the tour and assigned to all tour participants. The model works at a zone level, and sampling of destination alternatives is implemented in order to reduce computation time. Explanatory variables include household and person characteristics, the tour purpose, logged size (i.e. attraction) variables, round-trip mode choice logsum, distance, and other variables. Note that the mode choice logsum used is based a 'representative' time period for joint tours, which is currently off-peak, since the actual time period has not been chosen at this stage of the simulation. Explanatory variables for the joint tour primary destination choice model are given in Appendix A.

Joint Tour Time of Day Choice

Number of Models: 1
Decision-Making Unit: Persons
Model Form: Multinomial Logit
Alternatives: 1,176 (combinations of tour departure half-hour and arrival half-hour back at home)

After joint tours have been generated and assigned a primary location, the tour departure time from home and arrival time back at home is chosen simultaneously. The model is conceptually similar to the one applied for individual mandatory tours. However, a unique condition applies when applying the time-of-day choice model to joint tours. That is, the tour departure and arrival period combinations are restricted to only those available for each participant on the tour, after scheduling mandatory activities. Once the tour departure/arrival time combination is chosen, it is applied to all participants on the tour. Explanatory variables for the joint tour time-of-day choice model are given in Appendix A. This model was estimated using the 2011 HTS.

Individual Non-Mandatory Tour Frequency

Number of Models: 8 (segmented by 8 person types)
Decision-Making Unit: Persons
Model Form: Multinomial Logit
Alternatives: 89 (Corresponding to most frequently observed combinations of number of individual maintenance and discretionary tours by purpose)

This model generates all non-mandatory, non-fully-joint tours at the individual person level. The model determines the number of both maintenance and discretionary tours simultaneously, at the person level, by purpose. There are six different kinds of maintenance and discretionary activities (escort, shop, other maintenance, eat out, visit, other discretionary), and a large number of possible combinations of each (assuming a maximum of 4 individual maintenance/discretionary tours per day, the number of possible combinations is 6^4 = 1,296 alternatives, many of which are not observed in the data). Table 9 shows a tabulation of person days by number of individual maintenance/discretionary tours by purpose and person-type from the ARC 2001 HTS. It reveals that there are a number of potential choices with few observations, indicating where appropriate collapsing of alternatives can occur.

Table 9: Distribution of Person Days by Number of Individual Non-Mandatory Tours

Person Type	Escorting				Shopping				Maintenance				Eating out				Visiting				Discretionary			
	0	1	2	3+	0	1	2	3+	0	1	2	3+	0	1	2	3+	0	1	2	3+	0	1	2	3+
1=Full-time worker	2050	195	73	15	1895	391	43	4	1929	378	25	1	2090	224	18	1	2161	168	4	0	1976	335	18	4
	327	42	10	3	244	116	21	1	276	96	10	0	271	100	11	0	327	54	1	0	283	88	11	0
	10595	350	59	7	10528	469	14	0	10775	231	5	0	10633	377	1	0	10869	140	2	0	10408	583	19	1
	803	22	6	2	668	160	5	0	749	78	6	0	493	337	3	0	786	47	0	0	557	260	16	0
2=Part-time worker	516	73	48	9	469	154	22	1	514	119	12	1	595	47	3	1	603	43	0	0	529	103	14	0
	113	19	10	4	86	52	8	0	102	38	6	0	102	42	2	0	132	14	0	0	92	50	4	0
	814	63	22	5	835	67	2	0	866	36	2	0	865	39	0	0	881	23	0	0	842	60	2	0
	80	12	3	1	67	27	2	0	73	21	2	0	74	21	1	0	88	7	1	0	64	29	3	0
3=University student	337	31	15	4	300	77	10	0	312	67	7	1	353	32	1	1	347	40	0	0	316	61	10	0
	66	8	3	2	46	24	9	0	63	16	0	0	52	25	2	0	70	9	0	0	46	27	5	1
	635	33	8	0	641	34	1	0	655	21	0	0	644	32	0	0	648	27	1	0	631	45	0	0
	47	4	2	0	42	11	0	0	46	6	1	0	37	14	2	0	49	4	0	0	32	20	1	0
4=Non-worker	2703	270	204	43	2499	646	70	5	2660	513	45	2	2972	227	21	0	3010	207	3	0	2748	415	56	1
	521	75	36	7	369	239	31	0	451	161	24	3	467	163	8	1	556	79	4	0	442	170	24	3
	126	7	3	2	129	9	0	0	128	10	0	0	135	2	1	0	136	2	0	0	128	9	1	0
	17	2	1	0	16	4	0	0	17	3	0	0	13	7	0	0	18	2	0	0	15	5	0	0
5=Retiree	2208	79	16	3	1850	415	38	3	1948	328	27	3	2144	150	10	2	2197	101	8	0	2015	270	20	1
	491	16	8	0	290	198	27	0	344	156	12	3	380	122	13	0	464	48	3	0	387	110	17	1
	65	2	0	0	62	4	1	0	62	5	0	0	64	3	0	0	67	0	0	0	61	6	0	0
	6	0	0	0	5	1	0	0	5	1	0	0	1	5	0	0	6	0	0	0	6	0	0	0
6=Driving school child	107	13	0	0	105	15	0	0	104	16	0	0	113	7	0	0	106	14	0	0	95	23	2	0
	27	4	0	0	16	15	0	0	19	10	2	0	25	6	0	0	26	5	0	0	20	11	0	0
	616	11	0	0	602	25	0	0	601	25	1	0	609	18	0	0	602	25	0	0	564	57	6	0
	46	0	1	0	38	9	0	0	40	7	0	0	34	13	0	0	45	2	0	0	24	23	0	0
7=Predriving school child	442	137	6	0	533	52	0	0	493	90	1	1	567	18	0	0	534	51	0	0	527	57	1	0
	204	33	0	0	166	71	0	0	164	71	2	0	192	41	4	0	204	33	0	0	154	77	5	1
	2388	51	4	0	2416	27	0	0	2399	44	0	0	2405	38	0	0	2406	36	1	0	2267	173	3	0
	389	2	0	0	346	45	0	0	338	53	0	0	311	80	0	0	362	29	0	0	179	199	13	0
8=Preschool child*	1313	40	14	4	1212	159	0	0	1135	235	1	0	1296	75	0	0	1307	64	0	0	1248	123	0	0
	158	18	0	0	119	55	2	0	125	47	3	1	149	26	1	0	146	28	2	0	128	45	3	0
	698	13	1	0	668	44	0	0	564	148	0	0	685	27	0	0	698	14	0	0	660	52	0	0
	44	2	0	0	37	8	1	0	39	7	0	0	35	11	0	0	41	5	0	0	28	18	0	0

The choice set was therefore simplified to include only the most frequently observed combinations of tours by purpose and number, resulting in a total of 89 alternatives, as shown in Table 10. Certain alternatives are defined as "one or more tours" of a certain purpose. If such alternatives are chosen, a subsequent frequency model determines the exact number of tours for those cases (either 1 or 2), based on the person type and the number of mandatory and fully joint tours already generated for the decision-maker. Table 11 shows the individual non-mandatory tour extension probabilities; these are expressed as cumulative probabilities for each potential choice of 0, 1, or 2 additional tours. Only rows with probabilities for at least one additional tour are shown in the table. Individual non-mandatory tour frequency model parameters are given in Appendix A.

Individual Non-Mandatory Tour Primary Destination Choice

Number of Models: 1
Decision-Making Unit: Person
Model Form: Multinomial Logit
Alternatives: Zones

The individual non-mandatory tour primary destination choice model determines the location of the tour primary destination. The model works at a zone level, and sampling of destination alternatives is implemented in order to reduce computation time. Explanatory variables include household and person characteristics, the tour purpose, logged size (i.e. attraction) variables, round-trip mode choice logsum, and distance, among others. The mode choice logsum is based on a 'representative' time period for individual non-mandatory tours, which is currently off-peak, since at this stage of the simulation the actual time period has not been chosen. The model parameters are given in Appendix A.

Individual Non-Mandatory Tour Time of Day Choice

Number of Models: 1
Decision-Making Unit: Person
Model Form: Multinomial Logit
Alternatives: 1,176 (combinations of tour departure half-hour and arrival half-hour back at home)

After individual non-mandatory tours have been generated and assigned a primary location, the tour departure time from home and arrival time back at home is chosen simultaneously. The model structured in the same way as the mandatory tour time-of-day choice model, described above. The tour departure and arrival period combinations are restricted to only those available for each participant on the tour, after scheduling individual mandatory tours and joint tours. This model was estimated using the 2011 HTS, and the parameters are given in Appendix A.

Table 10: Individual Non-Mandatory Tour Frequency Model Alternatives

	Number of tours by purpose					
Alternative	Escorting	Shopping	Maintenance	Eating	Visiting	Discretionary
1	0	0	0	0	0	0
2	0	0	0	0	0	1+
3	0	0	0	0	1+	0
4	0	0	0	0	1+	1+
5	0	0	0	1+	0	0
6	0	0	0	1+	0	1+
7	0	0	0	1+	1+	0
8	0	0	0	1+	1+	1+
9	0	0	1+	0	0	0
10	0	0	1+	0	0	1+
11	0	0	1+	0	1+	0
12	0	0	1+	0	1+	1+
13	0	0	1+	1+	0	0
14	0	0	1+	1+	0	1+
15	0	0	1+	1+	1+	0
16	0	0	1+	1+	1+	1+
17	0	1+	0	0	0	0
18	0	1+	0	0	0	1+
19	0	1+	0	0	1+	0
20	0	1+	0	0	1+	1+
21	0	1+	0	1+	0	0
22	0	1+	0	1+	0	1+
23	0	1+	0	1+	1+	0
24	0	1+	0	1+	1+	1+
25	0	1+	1+	0	0	0
26	0	1+	1+	0	0	1+
27	0	1+	1+	0	1+	0
28	0	1+	1+	0	1+	1+
29	0	1+	1+	1+	0	0
30	0	1+	1+	1+	0	1+
31	0	1+	1+	1+	1+	0
32	0	1+	1+	1+	1+	1+
33	1	0	0	0	0	0
34	1	0	0	0	0	1+
35	1	0	0	0	1+	0
36	1	0	0	0	1+	1+
37	1	0	0	1+	0	0
38	1	0	0	1+	0	1+
39	1	0	0	1+	1+	0
40	1	0	0	1+	1+	1+
41	1	0	1+	0	0	0
42	1	0	1+	0	0	1+
43	1	0	1+	0	1+	0
44	1	0	1+	0	1+	1+
45	1	0	1+	1+	0	0
46	1	0	1+	1+	0	1+

	Number of tours by purpose					
Alternative	Escorting	Shopping	Maintenance	Eating	Visiting	Discretionary
47	1	0	1+	1+	1+	0
48	1	0	1+	1+	1+	1+
49	1	1+	0	0	0	0
50	1	1+	0	0	0	1+
51	1	1+	0	0	1+	0
52	1	1+	0	0	1+	1+
53	1	1+	0	1+	0	0
54	1	1+	0	1+	0	1+
55	1	1+	0	1+	1+	0
56	1	1+	0	1+	1+	1+
57	1	1+	1+	0	0	0
58	1	1+	1+	0	0	1+
59	1	1+	1+	0	1+	0
60	1	1+	1+	0	1+	1+
61	1	1+	1+	1+	0	0
62	1	1+	1+	1+	0	1+
63	1	1+	1+	1+	1+	0
64	0	0	0	0	0	0
65	0	0	0	0	0	1+
66	0	0	0	0	1+	0
67	0	0	0	0	1+	1+
68	0	0	0	1+	0	0
69	0	0	0	1+	0	1+
70	0	0	0	1+	1+	0
71	0	0	0	1+	1+	1+
72	0	0	1+	0	0	0
73	0	0	1+	0	0	1+
74	0	0	1+	0	1+	0
75	0	0	1+	0	1+	1+
76	0	0	1+	1+	0	0
77	0	0	1+	1+	0	1+
78	0	0	1+	1+	1+	0
79	0	1+	0	0	0	0
80	0	1+	0	0	0	1+
81	0	1+	0	0	1+	0
82	0	1+	0	0	1+	1+
83	0	1+	0	1+	0	0
84	0	1+	0	1+	0	1+
85	0	1+	0	1+	1+	0
86	0	1+	1+	0	0	0
87	0	1+	1+	0	0	1+
88	0	1+	1+	0	1+	0
89	0	1+	1+	1+	0	0

Table 11: Individual Non-Mandatory Tour Extension Cumulative Probabilities

Person Type	Number of Mandatory Tours	Number of Joint Tours	Individual Discretionary Tour Purpose	Additional Tours		
				0	1	2
1	0	0	1	83.0%	100.0%	100.0%
2	0	0	1	76.9%	100.0%	100.0%
3	0	0	1	89.4%	100.0%	100.0%
4	0	0	1	75.0%	100.0%	100.0%
5	0	0	1	84.2%	100.0%	100.0%
6	0	0	1	71.4%	100.0%	100.0%
7	0	0	1	81.5%	100.0%	100.0%
8	0	0	1	75.0%	100.0%	100.0%
1	1	0	1	78.9%	100.0%	100.0%
2	1	0	1	60.0%	100.0%	100.0%
5	1	0	1	82.6%	100.0%	100.0%
6	1	0	1	83.7%	100.0%	100.0%
7	1	0	1	60.0%	100.0%	100.0%
1	0	1	1	84.2%	100.0%	100.0%
5	1	1	1	77.8%	100.0%	100.0%
1	0	0	2	89.3%	99.1%	100.0%
2	0	0	2	84.1%	99.3%	100.0%
3	0	0	2	97.1%	100.0%	100.0%
4	0	0	2	97.0%	100.0%	100.0%
5	0	0	2	87.0%	99.4%	100.0%
6	0	0	2	86.7%	100.0%	100.0%
7	0	0	2	97.1%	100.0%	100.0%
8	0	0	2	93.1%	100.0%	100.0%
1	1	0	2	88.5%	100.0%	100.0%
2	1	0	2	72.7%	100.0%	100.0%
3	1	0	2	97.1%	100.0%	100.0%
5	1	0	2	89.6%	99.3%	100.0%
6	1	0	2	88.5%	100.0%	100.0%
1	0	1	2	91.0%	99.3%	100.0%
2	0	1	2	88.0%	100.0%	100.0%
3	0	1	2	80.0%	100.0%	100.0%
6	1	1	2	96.5%	100.0%	100.0%
8	1	1	2	88.9%	100.0%	100.0%
1	0	0	3	93.6%	99.8%	100.0%
2	0	0	3	90.6%	100.0%	100.0%
3	0	0	3	97.9%	100.0%	100.0%
4	0	0	3	92.9%	100.0%	100.0%
5	0	0	3	90.2%	99.2%	100.0%
6	0	0	3	86.4%	100.0%	100.0%
7	0	0	3	94.7%	100.0%	100.0%
8	0	0	3	91.3%	100.0%	100.0%

Person Type	Number of Mandatory Tours	Number of Joint Tours	Individual Discretionary Tour Purpose	Additional Tours		
				0	1	2
1	1	0	3	89.3%	98.7%	100.0%
4	1	0	3	85.7%	100.0%	100.0%
5	1	0	3	91.6%	99.6%	100.0%
6	1	0	3	85.6%	98.4%	100.0%
7	1	0	3	100.0%	100.0%	100.0%
8	1	0	3	100.0%	100.0%	100.0%
1	0	1	3	91.6%	99.2%	100.0%
2	0	1	3	91.2%	98.2%	100.0%
6	0	1	3	83.3%	100.0%	100.0%
7	0	1	3	96.2%	100.0%	100.0%
1	1	1	3	97.8%	98.9%	100.0%
2	1	1	3	97.3%	100.0%	100.0%
5	1	1	3	99.6%	100.0%	100.0%
6	1	1	3	92.2%	98.0%	100.0%
1	0	0	4	92.2%	99.6%	100.0%
2	0	0	4	90.1%	100.0%	100.0%
3	0	0	4	99.7%	100.0%	100.0%
4	0	0	4	99.1%	100.0%	100.0%
5	0	0	4	92.2%	98.0%	100.0%
6	0	0	4	95.5%	100.0%	100.0%
8	0	0	4	95.5%	100.0%	100.0%
1	1	0	4	94.1%	97.1%	100.0%
2	1	0	4	92.6%	100.0%	100.0%
4	1	0	4	87.5%	100.0%	100.0%
5	1	0	4	91.5%	100.0%	100.0%
6	1	0	4	94.8%	99.4%	100.0%
7	1	0	4	66.7%	100.0%	100.0%
1	0	1	4	92.6%	98.8%	100.0%
2	0	1	4	90.4%	100.0%	100.0%
2	1	1	4	91.1%	100.0%	100.0%
6	1	1	4	96.3%	100.0%	100.0%
1	0	0	5	97.7%	100.0%	100.0%
2	0	0	5	98.2%	100.0%	100.0%
3	0	0	5	98.6%	100.0%	100.0%
8	0	0	5	87.5%	100.0%	100.0%
3	1	0	5	96.4%	100.0%	100.0%
5	1	0	5	98.6%	100.0%	100.0%
6	1	0	5	95.2%	100.0%	100.0%
1	0	1	5	92.7%	100.0%	100.0%
2	0	1	5	94.1%	100.0%	100.0%
3	1	1	5	97.3%	100.0%	100.0%
6	1	1	5	93.3%	100.0%	100.0%

Person Type	Number of Mandatory Tours	Number of Joint Tours	Individual Discretionary Tour Purpose	Additional Tours		
				0	1	2
1	0	0	6	93.8%	98.9%	100.0%
2	0	0	6	88.9%	100.0%	100.0%
3	0	0	6	96.7%	99.8%	100.0%
4	0	0	6	94.2%	100.0%	100.0%
5	0	0	6	88.0%	100.0%	100.0%
6	0	0	6	92.6%	100.0%	100.0%
7	0	0	6	96.8%	100.0%	100.0%
8	0	0	6	90.6%	100.0%	100.0%
1	1	0	6	85.9%	100.0%	100.0%
2	1	0	6	81.8%	97.0%	100.0%
4	1	0	6	95.2%	100.0%	100.0%
5	1	0	6	87.9%	99.8%	100.0%
6	1	0	6	86.3%	98.5%	100.0%
7	1	0	6	90.0%	100.0%	100.0%
1	0	1	6	92.8%	99.7%	100.0%
2	0	1	6	85.9%	99.2%	100.0%
5	0	1	6	92.0%	100.0%	100.0%
7	0	1	6	90.5%	100.0%	100.0%
1	1	1	6	98.3%	100.0%	100.0%
2	1	1	6	92.8%	98.8%	100.0%
3	1	1	6	98.3%	100.0%	100.0%
4	1	1	6	93.9%	100.0%	100.0%
6	1	1	6	93.8%	100.0%	100.0%

At-Work Sub-Tour Frequency

Number of Models: 1
Decision-Making Unit: Persons
Model Form: Multinomial Logit
Alternatives: 6 (None, 1 eating out tour, 1 business tour, 1 maintenance tour, 2 business tours, 1 eating out tour + 1 business tour)

Work-based sub-tours are modeled last, and are relevant only for those persons who implement at least one work tour. The underlying activities are mostly individual (e.g., business-related and dining-out purposes), but may include some household maintenance functions as well as person and household maintenance tasks. There are six alternatives in the model, corresponding to the most frequently observed patterns of at-work sub-tours. The alternatives define both the number of at-work sub-tours and their purpose. Explanatory variables include household and person attributes, duration of the parent work tour, the number of joint and individual non-mandatory tours already generated in the day, and accessibility and urban form variables. At-work sub-tour frequency model parameters are given in Appendix A.

At-Work Sub-Tour Primary Destination Choice

Number of Models: 1
Decision-Making Unit: Person
Model Form: Multinomial Logit
Alternatives: Zones

The at-work sub-tour primary destination choice model determines the location of the tour primary destination. The model works at a zone level, and sampling of destination alternatives is implemented in order to reduce computation time. Explanatory variables include household and person characteristics, the tour purpose, logged size (i.e. attraction) variables, round-trip mode choice logsum, distance, and other variables. The mode choice logsum is based on a 'representative' time period for individual non-mandatory tours, which is currently off-peak, since at this stage of the simulation the actual time period has not been chosen. The model is constrained such that only destinations within a reasonable time horizon from the workplace are chosen, so that the tour can be completed within the available time window. Explanatory variables for the at-work sub-tour primary destination choice model are given in Appendix A.

At-Work Sub-Tour Time of Day Choice

Number of Models: 1
Decision-Making Unit: Person
Model Form: Multinomial Logit
Alternatives: 1,176 (combinations of tour departure half-hour and arrival half-hour back at home)

After at-work sub-tours have been generated and assigned a primary location, the tour departure time from workplace and arrival time back at the workplace is chosen simultaneously. The model structured in the same way as the mandatory tour time-of-day choice model, described above. The tour departure and arrival period combinations are restricted to only those available based on the time window of the parent work tour. Explanatory variables for the at-work sub-tour tour time-of-day choice model are given in Appendix A. This model was estimated using the 2011 HTS.

Tour Mode Choice Model

Number of Models:	5 (Work, University, K-12, Non-Mandatory, At-work)
Decision-Making Unit:	Person
Model Form:	Nested Logit
Alternatives:	15 (See Figure 10)

The tour-based modeling approach requires a certain reconsideration of the conventional mode choice structure. Instead of a single mode choice model pertinent to a four-step structure, there are two different levels where the mode choice decision is modeled:

- The tour mode level (upper-level choice),
- The trip mode level (lower-level choice conditional upon the upper-level choice).

The tour mode level reflects the most important decisions that a traveler makes in terms of using a private car versus using public transit, non-motorized, or any other mode. Trip-level decisions correspond to details of the exact mode used for each trip. The modes identified by the tour mode choice model are listed in Table 12.

The model is distinguished by the following characteristics:

- Segmentation of the HOV mode by occupancy categories, which is essential for modeling HOV/HOT lanes and policies
- Explicit modeling of toll vs. non-toll choices as highway sub-modes, which is essential for modeling highway pricing projects and policies
- Distinguishing between certain transit sub-modes that are characterized by their attractiveness, reliability, comfort, convenience, and other characteristics beyond travel time and cost (such as local and premium)
- Distinguishing between walk and bike modes if the share of bicycle trips is significant

Note that free and pay alternatives for each auto mode provide an opportunity for toll choice as a path choice within the nesting structure. This requires separate free and pay skims to be provided as inputs to the model (where free paths basically "turn off" all toll and HOT lanes). Transit skims are segmented by line-haul mode in two major groups, local bus and premium transit. When building the premium transit skims, local bus routes are allowed to operate as feeder service to MARTA and other premium services.

The tour mode choice model is based on the round-trip level-of-service (LOS) between the tour anchor location (home for home-based tours and work for at-work sub-tours) and the tour primary destination. The tour mode is chosen based on LOS variables for both directions according to the time periods for the tour departure from the anchor and the arrival back at the anchor. This is one of the fundamental advantages of the tour-based approach. For example a commuter can have very attractive transit service in the a.m. peak period in the outbound direction, but if the return home time is in the midday or later at night, the commuter may prefer private auto due to lower off-peak transit service.

The appropriate skim values for the tour mode choice are a function of the TAZ of the tour origin and TAZ of the tour primary destination. The tour mode choice model contains a number of household and person attributes, including income, auto sufficiency, age, etc. Urban form variables are also important, particularly related to the choice of non-motorized modes. Explanatory variables and parameters used in tour mode choice are given in Appendix A.

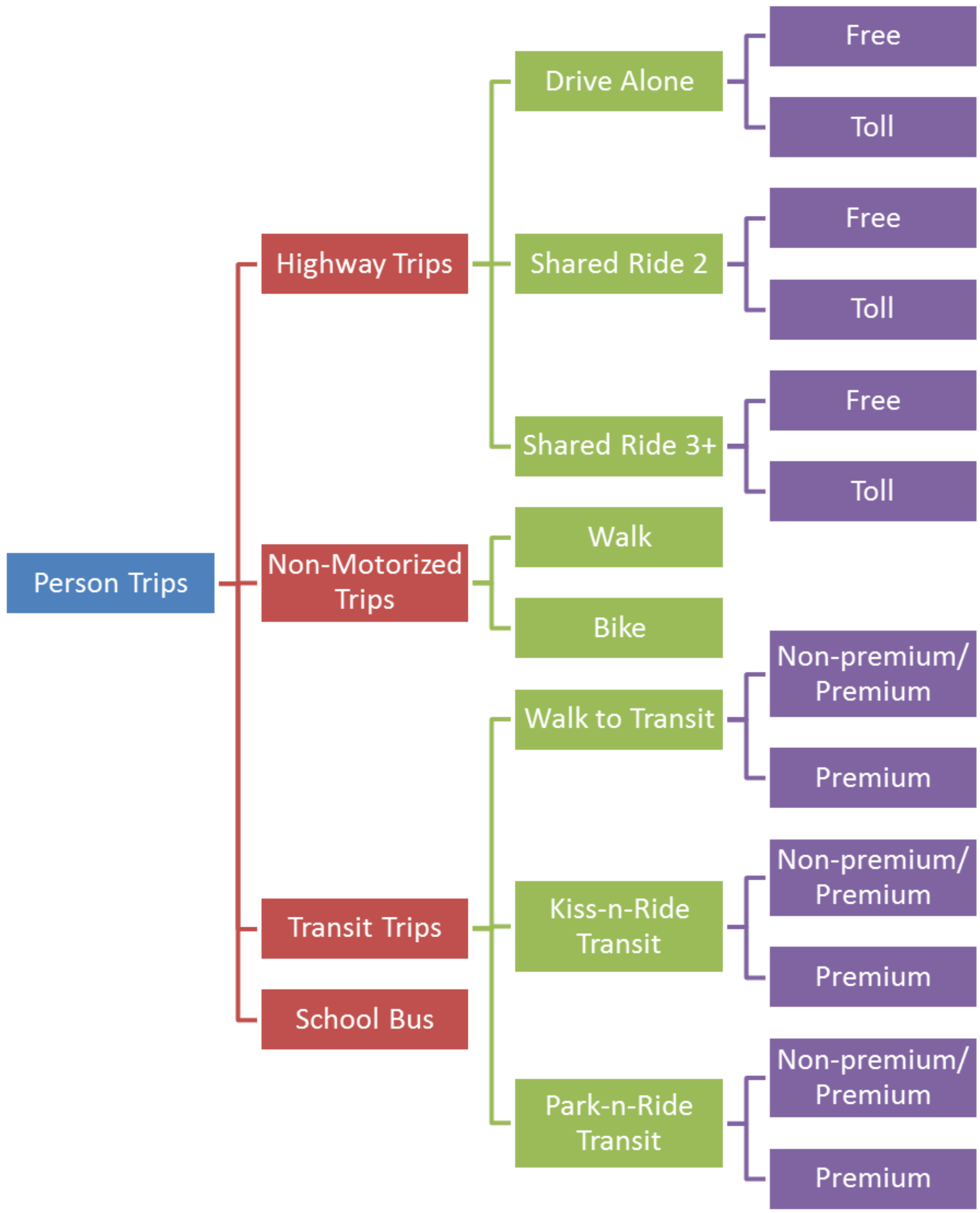

Figure 10: Tour Mode Choice Model Structure

Table 12: Level-of-Service Matrices Used in Tour Mode Choice

Mode	Level of Service (Skim) Matrices
Drive-alone free	All general purpose lanes available. HOV lanes, HOT lanes, and toll lanes unavailable.
Drive-alone pay	All general purpose lanes and toll lanes are available. HOV lanes and unavailable. HOT lanes are available for the SOV toll rate.
Shared-2 free	All general purpose lanes available. 2+ occupancy HOV lanes available. Toll lanes unavailable. HOT lanes where 2+ occupant vehicles go free are available.
Shared-2 pay	All general purpose lanes available. 2+ occupancy HOV lanes and HOT lanes where 2+ occupant vehicles go free are available for free. Toll lanes and HOT lanes where 2-occupant vehicles are tolled at the 2-occupant toll rate.
Shared-3+ free	All general purpose lanes available. 2+ and 3+ occupancy HOV lanes available. Toll lanes unavailable. HOT lanes where 2+ or 3+ occupant vehicles go free are available.
Shared-3+ pay	All general purpose lanes available. 2+ and 3+ occupancy HOV lanes and HOT lanes where 2 or 3+ occupant vehicles go free are available for free. Toll lanes and HOT lanes where 3+ occupant vehicles are tolled at the 3+ occupant toll rate.
Walk	Highway distance, excluding freeways
Bike	Highway distance, excluding freeways
Walk-Non-premium/Premium	Non-premium/Premium transit by walk access/egress
Walk-Premium	Premium only transit by walk access/egress.
PNR-Non-premium/Premium	Non-premium/Premium transit by park-and-ride access/egress
PNR-Premium	Premium only transit by park-and-ride access/egress.
KNR-Non-premium/Premium	Non-premium/Premium transit by kiss-and-ride access/egress
KNR-Premium	Premium only transit by kiss-and-ride access/egress.
School bus	Highway distance

Trip-Level ModelsIntermediate Stop Frequency

Number of Models: 9 (By purpose plus one model for at-work subtours)
Decision-Making Unit: Person
Model Form: Multinomial Logit
Alternatives: Maximum of 3 per tour direction, 6 total (see Table 13)

The stop frequency choice model determines the number of intermediate stops on the way to and from the primary destination. The ARC ABM recognizes up to three stops in each direction, for a maximum of 8 trips per tour (four on each tour leg). However, for many tour purposes, the number of intermediate stops observed in the data is significantly less than 3 per direction. Therefore the alternatives in the intermediate stop models were capped to only the most frequently observed cases, shown in Table 13. In addition, no stops are allowed on drive-transit tours, to ensure that drivers who drive to transit pick up their cars at the end of the tour.

Stop frequency is based on a number of explanatory variables, including household and person attributes, the duration of the tour (with longer durations indicating the potential for more stop-making) the distance from the tour anchor to the primary destination (with intermediate stop-making positively correlated to tour distance), and accessibility and urban form variables. The stop frequency choice model parameters are shown in Appendix A.

Table 13: Maximum Intermediate Stops by Purpose

Purpose	Maximum Stops Per Direction	Maximum Stops on Tour
Work	3	6
University	1	2
K-12	1	2
Escort	2	2
Shop	3	3
Maintenance	2	2
Eat/Visit	1	2
Other Discretionary	1	2
At-Work Sub-tour	1	2

Once the number of intermediate stops is determined, each intermediate stop is assigned a purpose based on a frequency distribution created from observed data. The distribution is segmented by tour purpose, tour direction (outbound versus return) and person type. Work tours are also segmented by departure or arrival time period. The stop purpose frequency distributions are presented in Appendix A.

Intermediate Stop Location Choice

Number of Models:	8 (By purpose plus one model for at-work subtours)
Decision-Making Unit:	Person
Model Form:	Multinomial Logit
Alternatives:	Zones

The stop location choice model predicts the location of stops along the tour other than the primary destination. The stop-location model is structured as a multinomial logit model using a zone attraction size variable and route deviation measure as impedance. The alternatives are sampled from the full set of zones, subject to availability of a zonal attraction size term. The sampling mechanism is also based on accessibility between tour origin and primary destination, and is subject to certain rules based on tour mode. All destinations are available for auto tour modes, so long as there is a positive size term for the zone. Intermediate stops on walk tours must be within 4 miles of both the tour origin and primary destination zones. Intermediate stops on bike tours must be within 8 miles of both the tour origin and primary destination zones. Intermediate stops on walk-transit tours must either be within 4 miles walking distance of both the tour origin and primary destination, or have transit access to both the tour origin and primary destination. Additionally, only short and long walk zones are available destinations on walk-transit tours.

The intermediate stop location choice model works by cycling through stops on tours. The level-of-service (LOS) variables (including mode choice logsums) are calculated as the additional utility between the last location and the next known location on the tour. For example, the LOS variable for the first stop on the outbound direction of the tour is based on additional impedance between the tour origin and the tour primary destination. The LOS variable for the next outbound stop is based on the additional impedance between the previous stop and the tour primary destination. Stops on return tour legs work similarly, except that the location of the first stop is a function of the additional impedance between the tour primary destination and the tour origin. The next stop location is based on the additional impedance between the first stop on the return leg and the tour origin, and so on. Intermediate stop location choice model parameters are given in Appendix A.

Intermediate Stop Duration

Number of Models:	1
Decision-Making Unit:	Person
Model Form:	Multinomial logit
Alternatives:	30-minute periods

The stop duration model allocates the total time on a tour, as predicted by the time-of-day choice model, into duration for each stop on the tour. The model operates in two stages. The first stage (Stage 1) splits total tour duration into three tour legs defined as inbound leg (the portion of the tour starting from home till the stop before the primary destination), main leg (the portion of the tour starting from the stop before the primary destination and the stop after the primary destination), and outbound leg (the portion of the tour comprising of first stop after the primary destination to home). This model is applied only to those tours that have at least one stop in either direction. The second stage (Stage 2) operates on the inbound and the outbound legs allocating the leg time into the different stops on that leg. This model is applied only if there is more than one stop on the leg. The parameters of the Stage 1 and Stage 2 models are given in Appendix A.

Trip Mode Choice

Number of Models:	8 (By purpose plus one model for at-work subtours)
Decision-Making Unit:	Person
Model Form:	Rule-based
Alternatives:	15

The trip mode choice model determines the mode for each trip along the tour. Trip modes are constrained by the main tour mode. The linkage between tour and trip levels is implemented through correspondence rules (which trip modes are allowed for which tour modes). The model can incorporate asymmetric mode combinations, but in reality, there is a great deal of symmetry between outbound and inbound modes used for the same tour. In particular, symmetry is enforced for drive-transit tours, by excluding intermediate stops from drive-transit tours.

The tour and trip mode correspondence rules are shown in Table 14. Note that in the ARC trip mode choice model, the trip modes are exactly the same as the modes in the tour mode choice model. However, every trip mode is not necessarily available for every tour mode. The correspondence rules depend on a kind of hierarchy, which is similar to that used for the definition of transit modes. The hierarchy is based on the following principles:

1) Pay trip modes are only available for pay tour modes (for example, drive-alone pay is only available at the trip mode level if drive-alone pay is selected as a tour mode).
2) The auto occupancy of the tour mode is determined by the maximum occupancy across all auto trips that make up the tour. Therefore, the auto occupancy for the tour mode is the maximum auto occupancy for any trip on the tour.
3) Transit tours can include auto shared-ride trips for particular legs. Therefore, 'casual carpool', wherein travelers share a ride to work and take transit back to the tour origin, is explicitly allowed in the tour/trip mode choice model structure.
4) The walk mode is allowed for any trip on a tour except for drive-alone, wherein the driver must use the vehicle for all trips on the tour.
5) The transit mode of the tour is determined by the highest transit mode used for any trip in the tour according to the transit mode hierarchy as described in Table 16.
6) As previously mentioned, free shared-ride modes are also available in transit tours, albeit with a low probability.

The trip mode choice models explanatory variables include household and person variables, level-of-service between the trip origin and destination according to the time period for the tour leg, urban form variables, and alternative-specific constants segmented by tour mode. The parameters of the trip mode choice models are given in Appendix A.

Table 14: Tour and Trip Mode Correspondence Rules

	Trip mode														
Tour mode	Drive alone free	Drive alone pay	Carpool 2P free	Carpool 2P pay	Carpool 3P+ free	Carpool 3P+ pay	Walk	Bike	Walk all transit	Walk premium transit	PNR all transit	PNR premium transit	KNR all transit	KNR premium transit	School bus
Drive alone free	●														
Drive alone pay	●	●													
Carpool 2P free	●		●				●								
Carpool 2P pay	●	●	●	●			●								
Carpool 3P+ free	●		●		●		●								
Carpool 3P+ pay	●	●	●	●	●	●	●								
Walk							●								
Bike							●	●							
Walk all transit			●		●		●		●						
Walk premium transit			●		●		●		●	●					
PNR all transit											●				
PNR premium transit												●			
KNR all transit													●		
KNR premium transit													●	●	
School bus			●		●		●		●						●

● Indicates allowed trip modes, given the tour mode

Parking Location Choice

Number of Models: 2 (work trips, non-work trips)
Decision-Making Unit: Trip
Model Form: Nested logit
Alternatives: Zones

The parking location choice model is applied to tours with a destination in the urban /city center areas where parking charges apply. The ARC ABM incorporates three of the following interrelated sub-models to capture parking conditions in the CBD, and allows for testing various policies:

- Parking cost model: determines the average cost of parking in each CBD zone.
- Person-free parking eligibility model: determines for each worker whether he/she has to pay for parking in the CBD.
- Parking location choice model: determines for each tour the primary destination parking location zone. The nested logit structure consists of an upper level binary choice between parking inside versus outside the modeled destination zone. At the lower level, the choice of parking zone is modeled for those who did not park in the destination zone.

The parking cost model was designed to produce a forecast of average long-term and short term parking costs for each zone. Percent free parking available by zone can be utilized in future forecasts and its effects on travel demand forecasts by mode can be tested. There is also the potential for testing the effects of allocating more or less of the total parking supply in each zone to short-term versus long-term use. ARC staff delivered parking supply information in terms of free short term, free long term, paid short term and paid long-term parking spaces, which was subsequently geocoded for the new zone system.

The methodology for calculating long and short term parking rates is as follows. The 2006 Downtown Parking Demand Management Action Plan parking survey has information on the rates by lot by type of parking. The long-term rate was calculated as the minimum of the monthly rate (divided by 100), the early bird rate (divided by 8) and the maximum daily rate (divided by 8). The non-zero rates were weighted by the number of spaces in each category and aggregated to the zonal level. The short-term rates are calculated as 1.7 times the long-term rates.

The free parking eligibility model is described above, under Long term choices.

The parking location choice model works in conjunction with the assignment to improve the realism of the auto component of assigned vehicle traffic. It is applied after the trip destination and mode choices have been simulated. The destination end of auto-vehicle trips destined for the CBD are reallocated to parking location TAZs in accordance with model results for input to the assignment process. Two separate models are implemented -- one for work trips and one for non-work trips. The model is a two-step model where the first “choice” is whether the destination zone is the same as the parking zone and, if false, then the second choice is a location choice from 10 randomly selected CBD zones. The parking location choice model was asserted based on the Columbus, Ohio, parking location model since no parking location survey was undertaken in Atlanta. Appendix A contains the model parameters.

The parking location model takes advantage of the individual processing of records in micro-simulation. All records where a SOV trips is made to a CBD zone are individually re-processed. If the primary tour destination zone is not chosen for parking, then the record will be updated to indicate that the SOV trip had a different destination. Since the actual parking supply is used to regulate the allocation of parking locations, at least a rough balance between parking supply and demand is required.

Appendix A: Model Parameters

Table 15: Workplace Location Choice Model

Observations		7938
Final log Likelihood		-47775.1
Rho-squared		0.190
Explanatory variables	**Coeff.**	**t-Stat**
Mode choice logsum	0.65	constr
Retail activity accessibility logsum (destination)	0.3412	10.4
CBD area type	0.7587	16.8
Urban high area type	0.1878	4.3
Intrazonal constant	0.9833	12.1
Distance	0.01446	2.0
Distance squared	-2.25E-04	-2.3
Distance cubed	1.47E-06	3.2
Log of distance	-0.7505	-12.3
Distance - sub/exurban resident	-0.00547	-3.5
Distance - rural resident	-0.01748	-9.3
Distance – HH income less than $20K	-0.01817	-4.4
Distance - HH income more than $100K	0.008615	5.1
Distance – part-time worker	-0.02001	-9.6
Size term[1]		
Retail employment (base)	1.0	n/a
Service employment- part-time	0.582	-2.7
Service employment- FT income 1	0.280	-2.9
Service employment- FT income 2	1.290	1.1
Service employment- FT income 3	2.443	4.6
Service employment- FT income 4	6.104	3.6
Other employment – part-time	0.313	-6.2
Other employment - FT income 1	0.275	-4.1
Other employment - FT income 2	1.369	1.5
Other employment - FT income 3	2.263	4.5
Other employment - FT income 4	3.622	2.6
Households – part-time	0.363	-6.1
Households - FT income 1	0.203	-5.0
Households - FT income 2	0.510	-2.8
Households - FT income 3	0.589	-2.5
Households - FT income 4	0.852	-0.3

1 The values shown for the size term variables are the exponentiated coefficients.

Table 16: 2.1 - K-12 and University School Location Choice Model Parameters

	Usual School Location K-12		Usual School Location University	
Observations		2552		912
Final log Likelihood		-1724		-4529
Rho-squared		0.434		0.331
Explanatory variables	**Coeff.**	**t-Stat**	**Coeff.**	**t-Stat**
Mode choice logsum	1.0	constr	1.0	constr
CBD area type	-0.6092	-3.9	0.5678	6.8
Urban high area type	-1.759	-6.9		
Intrazonal	-0.5708	-6.7	-0.1518	-0.5
Distance	-0.1509	-10.9	0.00726	0.3
Distance squared	0.001388	6.7	-1.90E-04	-0.6
Distance cubed	-3.45E-06	-3.8	1.16E-06	0.8
Log of distance	-0.922	-10.1	-0.9622	-5.7
Distance- driving age student	0.01476	3.7		
Distance – HH income less than $20K	-0.01406	-1.5	-0.02285	-2.9
Distance - HH income more than $100K	0.01152	2.7		
Size term[1]				
Households (base)	0.05	n/a		
University enrollment (base)			1.0	n/a
Service employment - age 16+	1.0	n/a	0.288	-17.1
Service employment - age <16	1.0	n/a		

1 The values shown for the size term variables are the exponentiated coefficients.

Table 17: Auto Ownership Model Parameters

Observations	10278
Final log likelihood	-8539
Rho-squared(0)	0.397
Rho-squared(constants)	0.305

	0 cars		1 car		2 cars		3+ cars	
Explanatory variables	**Coeff.**	**t-Stat**	**Coeff.**	**t-Stat**	**Coeff.**	**t-Stat**	**Coeff.**	**t-Stat**
Constant								
1 driver in HH	-4.860	-9.42			-0.959	-7.16	-3.900	-10.86
2 drivers in HH	-4.470	-8.71	-2.010	-11.42			-1.540	-7.48
3+ drivers in HH	-4.050	-7.60	-2.610	-11.49	-1.880	-6.71		
Ratio of workers to drivers in HH								
Zero cars	-1.000	-4.41						
2 drivers in HH	-1.000	-4.41	-0.495	-2.56				
3+ drivers in HH	-1.000	-4.41	-0.495	-2.56	-0.495	-2.56		
Ratio of people age 18-24 to drivers in HH								
1 driver in HH					-0.946	-1.54	-0.946	-1.54
2 drivers in HH			-0.504	-1.87			-0.946	-1.54
3+ drivers in HH			-0.504	-1.87	-0.504	-1.87		
Ratio of people age 6-15 to drivers in HH								
1 driver in HH					-0.122	-1.25	-0.122	-1.25
2 drivers in HH							-0.122	-1.25
3+ drivers in HH								
Ratio of people 80 or older to drivers in HH								
1 driver in HH	0.739	3.02						
2 drivers in HH	0.739	3.02	1.230	4.35				
3+ drivers in HH	0.739	3.02	1.230	4.35	1.230	4.35		
HH income under $10K								
1 driver in HH	5.300	10.45			-1.450	-5.49	-1.450	-5.49
2 drivers in HH	5.300	10.45	3.310	13.51			-1.450	-5.49
3+ drivers in HH	5.300	10.45	3.310	13.51	3.310	13.51		
HH income $10K-$30K								
1 driver in HH	4.310	8.69			-0.890	-5.93	-0.890	-5.93
2 drivers in HH	4.310	8.69	2.860	17.33			-0.890	-5.93
3+ drivers in HH	4.310	8.69	2.860	17.33	2.860	17.33		
HH income $30K- $60K								
1 driver in HH	2.390	4.83			-0.532	-4.26	-0.532	-4.26
2 drivers in HH	2.390	4.83	1.840	12.35			-0.532	-4.26
3+ drivers in HH	2.390	4.83	1.840	12.35	1.840	12.35		
HH income $60K-$100K								
1 driver in HH	0.858	1.56			-0.399	-3.33	-0.399	-3.33
2 drivers in HH	0.858	1.56	0.824	5.57			-0.399	-3.33
3+ drivers in HH	0.858	1.56	0.824	5.57	0.824	5.57		
Auto – Transit zonal accessibility								

	0 cars		1 car		2 cars		3+ cars	
Explanatory variables	**Coeff.**	**t-Stat**	**Coeff.**	**t-Stat**	**Coeff.**	**t-Stat**	**Coeff.**	**t-Stat**
1 driver in HH	-0.634	-5.24			0.132	1.65	0.132	1.65
2 drivers in HH	-0.634	-5.24	-0.278	-2.91			0.132	1.65
3+ drivers in HH	-0.634	-5.24	-0.278	-2.91	-0.278	-2.91		
Retail employment accessible within 30 minutes of premium transit time (per 10,000 jobs)								
1 driver in HH	0.983	6.64			-0.593	-2.95	-0.593	-2.95
2 drivers in HH	0.983	6.64	0.543	3.23			-0.593	-2.95
3+ drivers in HH	0.983	6.64	0.543	3.23	0.543	3.23		
Household work activity rail index								
1 driver in HH	0.636	2.44			-0.892	-4.93	-0.892	-4.93
2 drivers in HH	0.636	2.44	0.467	2.64			-0.892	-4.93
3+ drivers in HH	0.636	2.44	0.467	2.64	0.467	2.64		
Household school activity rail index								
1 driver in HH	0.466	1.60						
2 drivers in HH	0.466	1.60	0.465	2.35				
3+ drivers in HH	0.466	1.60	0.465	2.35	0.465	2.35		
Household workers auto dependency								
1 driver in HH	-0.663	-3.90			0.101	1.43	0.101	1.43
2 drivers in HH	-0.663	-3.90	-0.476	-5.07			0.101	1.43
3+ drivers in HH	-0.663	-3.90	-0.476	-5.07	-0.476	-5.07		

Table 18: Free Parking Eligibility Model Parameters

Explanatory variable	Free parking choice	
	Coefficient	t-Stat
Constant	-0.4700	-3.6
HH income greater than $100,000	0.2300	1.3
HH income between $50,000 and $100,000	0.2010	1.3
More than 3 persons in HH	0.2530	1.5
Car sufficient HH (autos > workers)	0.2310	1.5
Car insufficient HH (autos < workers)	-1.4790	-4.5

Table 19: Coordinated Daily Activity Pattern Model Parameters

Explanatory variables	Mandatory (M)		Non mandatory (NM)		Home all day (H)	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Constants						
FW (Full time worker)	1.809	6.8	0.9652	17.2		
PW (Part time worker)	-0.2456	-0.4	0.9854	6.6		
US (University student)	1.683	13.0	0.3354	1.0		
NW (Non-working adult)	-4.352	-3.8	-0.6639	-2.0		
RT (Retired)	-7.499	-3.7	-0.5391	-1.5		
SD (Driving age schoolchild)	2.689	7.8	-0.03897	-0.1		
SP (Pre-driving age schoolchild)	3.105	20.5	0.5628	1.4		
PS (Pre-school child)	-0.2948	-1.8	-1.646	-4.1		
Age						
PS – Age 0 to 1	-0.4515	-3.3				
PS – Age 4 to 5	0.6107	4.9				
SP – Age 6 to 9	-0.2943	-2.7				
SP - Age 13 to 15	-0.7141	-4.1	-0.672	-3.7		
FW – Age under 40	0.2091	4.9				
RT – Age over 80					0.7666	8.1
Gender						
FW – Female	-0.1259	-2.9				
NW – Female	-0.743	-4.5				
RT – Female					0.4769	5.0
Car ownership						
More cars than workers						
NW	0.6515	2.7	0.8168	8.4		
RT	2.992	3.0	1.056	8.2		
PS			0.2991	2.8		
Fewer cars than workers						
FW					0.5039	4.5
NW					0.8965	3.1
RT					0.5496	1.3
SD					0.6475	1.2
SP					0.5862	2.8
PS					0.5061	3.0
Household Income						
Less than $20,000						
FW					0.5313	4.3
RT					0.533	5.7
PW					0.3232	1.3
SD					1.307	3.0
$50,000 to $100,000						
PW					-0.4032	-2.1
NW					-0.5602	-6.8
SD					-0.5031	-1.2

Explanatory variables	Mandatory (M)		Non mandatory (NM)		Home all day (H)	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
PS					-0.5708	-5.9
More than $100,000						
PW			0.4207	3.0	-0.3534	-1.3
NW					-0.7188	-5.6
SD					-2.046	-2.0
PS					-0.6186	-4.3
Accessibility						
Peak accessibility to employment						
FW	0.1212	4.9				
PW	0.2004	3.4				
NW	0.2314	2.3				
RT	0.2792	1.8				
Off-peak accessibility to retail						
NW/RT/US			0.07207	2.4		
SD/SP/PS			0.08233	2.3		
FW/PW- Usual work location is home	-1.758	-23.1			0.1813	1.9
FW/PW - No usual work location	-0.5935	-11.5				
SD/SP - No usual school location	-0.866	-10.2				
2 way interactions						
Full time x Full time	0.141	2.5	1.123	12.3	1.626	11.2
Full time x Part time	0.08845	1.0	0.4947	3.7	0.7407	2.4
Full time x University	0.4273	4.9	0.5523	3.4	1.183	3.9
Full time x Non-worker			0.02186	0.2	0.9436	6.7
Full time x Retired			0.3115	2.2	1.298	8.0
Full time x Driving child	0.3842	3.9	0.4095	1.8	2.064	7.3
Full time x Pre-driving child	0.2623	4.1	0.6008	5.1	1.501	9.7
Full time x Pre-school child	0.5118	5.9	0.751	6.6	0.9912	7.7
Part time x Part time	1.135	5.0	1.032	3.0	0.8911	1.3
Part time x University	0.173	0.8	0.3355	1.0	1.642	2.8
Part time x Non-worker			0.7477	3.8	0.7057	2.2
Part time x Retired			0.09831	0.5	0.463	1.3
Part time x Driving child	1.103	5.1	0.495	0.9	3.057	6.0
Part time x Pre-driving child	0.3079	3.4	0.8984	6.8	0.7685	2.3
Part time x Pre-school child	0.5074	3.5	1.452	9.9	1.07	5.2
University x University	0.8726	6.0	1.054	5.3	1.018	1.4
University x Non-worker			0.193	0.9	1.781	6.3
University x Retired			0.4065	1.6	0.4835	0.8
University x Driving child	-0.0021	-0.1	1.62	4.0	1.546	1.5
University x Pre-driving child	0.2975	2.1	0.5165	1.8	1.552	3.4
University x Pre-school child	0.2254	1.1	0.8973	4.1	1.34	5.2
Non-worker x Non-worker			0.6984	5.1	1.352	7.9
Non-worker x Retired			0.1864	1.4	1.209	8.2
Non-worker x Driving child			0.6801	3.2	0.5243	1.2

Explanatory variables	Mandatory (M)		Non mandatory (NM)		Home all day (H)	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Non-worker x Pre-driving child			0.5646	5.1	0.8112	4.1
Non-worker x Pre-school child			1.164	10.5	1.167	8.8
Retired x Retired			0.7291	7.0	1.407	11.7
Retired x Child (all ages)			0.2919	1.2	0.8632	3.2
Driving child x Driving child	0.4794	1.4	1.512	2.2	2.198	2.5
Driving child x Pre-driving child	0.5151	3.8	1.422	5.9	0.977	1.4
Driving child x Pre-school child	0.5516	1.4	1.273	2.4	1.467	2.7
Pre-driving child x Pre-driving child	0.9731	8.8	1.553	11.3	2.8	15.8
Pre-driving child x Pre-school child	0.5961	5.0	0.6184	4.3	1.434	8.2
Pre-school child x Pre-school child	1.651	11.1	0.8771	5.7	1.378	9.5
3 way interactions***						
FW x FW x FW	0.3133	3.4				
FW x FW x PW/NW	0.3495	2.4	0.4637	1.8		
FW x FW x SP/PS						
FW x PW/NW x PW/NW			0.3491	1.0	0.9573	2.8
FW x PW/NW x SP/PS					0.2939	1.4
FW x SP/PS x SP/PS			0.3553	2.3		
PW/NW x PW/NW x PW/NW			-1.386	-1.7	0.9881	2.9
PW/NW x PW/NW x SP/PS			-0.8571	-3.8	0.4374	1.9
PW/NW x SP/PS x SP/PS					0.4747	2.4
SP/PS x SP/PS x SP/PS	-0.3906	-2.1				
Interaction across all household members						
All same patterns						
3 person household	-0.0671	-0.7	-0.3653	-2.5	-1.181	-6.0
4 person household	-0.6104	-2.6	-1.346	-4.0	-3.733	-7.5
5 person household	-1.528	-3.4	-3.453	-5.0	-8.621	-7.0
Estimation statistics						
Observations					13677	
Final log likelihood					-19404	
Rho^2 (0)					0.422	
Rho^2 (c)					0.264	

Table 20: Individual Mandatory Tour Frequency Model Parameters

Explanatory variables Person type	1 Work Tour	2+ Work Tours	1 School Tour	2+ School Tours	1 Work & 1 School Tours
	Coefficient & t-Stat by Choice Alternative				
Constant					
FW	0 (base)	-2.545 (-27.6)	-6.34 (-22.4)	n/a	-6.419 (-14.5)
PW	0 (base)	-2.379 (-14.7)	-6.035 (-9.8)	n/a	-4.747 (-6.6)
US	-2.408 (-8.0)	-8.695 (-13.8)	0 (base)	-3.226 (-5.6)	-4.773 (-9.5)
NW	0 (base)	-1.953 (-4.9)	-2.463 (-7.5)	n/a	n/a
RT	0 (base)	-1.379 (-3.4)	-2.022 (-5.3)	n/a	n/a
DC	-5.215 (-15.6)	n/a	0 (base)	-3.768 (-10.2)	-3.823 (-10.0)
SC	-5.557 (-16.8)	n/a	0 (base)	-4.934 (-14.7)	n/a
Person is female					
FW	0 (base)	-0.2255 (-2.8)	0.1592 (0.8)	n/a	-0.3442 (-1.7)
PW	0 (base)	-0.2255 (-2.8)	0.1592 (0.8)	n/a	-0.3442 (-1.7)
US	0.1737 (1.0)	-0.2255 (-2.8)	0 (base)	0.1140 (0.5)	-0.3442 (-1.7)
NW	0 (base)	-0.2255 (-2.8)	0.1592 (0.8)	n/a	n/a
RT	0 (base)	-0.2255 (-2.8)	0.1592 (0.8)	n/a	n/a
DC	0.1737 (1.0)	n/a	0 (base)	0.1140 (0.5)	-0.3442 (-1.7)
SC	0.1737 (1.0)	n/a	0 (base)	0.1140 (0.5)	n/a
Person is 35 year old or younger					
FW	0 (base)	-0.1375 (-1.6)	0.7218 (3.5)	n/a	0.9761 (3.2)
PW	0 (base)	-0.1375 (-1.6)	0.7218 (3.5)	n/a	0.9761 (3.2)
US	-0.4629 (-1.9)	-0.1375 (-1.6)	0 (base)	1.275 (2.4)	0.9761 (3.2)
NW	0 (base)	-0.1375 (-1.6)	0.7218 (3.5)	n/a	n/a
Workplace within walking distance of 3 miles					
FW		0.5268 (5.1)			
PW		0.5268 (5.1)			
US		0.5268 (5.1)			
NW		0.5268 (5.1)			
RT		0.5268 (5.1)			
School within walking distance					
US				0.7114 (2.6)	
DC				0.7114 (2.6)	
SC				0.7114 (2.6)	
Workplace or school within walking distance					
FW					0.1391 (0.6)
PW					0.1391 (0.6)
US					0.1391 (0.6)
DC					0.1391 (0.6)
Round trip auto time to & from workplace, min					
FW		-0.0035 (-4.9)			-0.0031 (-3.0)
PW		-0.0035 (-4.9)			-0.0031 (-3.0)

Explanatory variables Person type	1 Work Tour	2+ Work Tours	1 School Tour	2+ School Tours	1 Work & 1 School Tours
US		-0.0035 (-4.9)			-0.0031 (-3.0)
NW		-0.0035 (-4.9)			n/a
RT		-0.0035 (-4.9)			n/a
Round trip auto time to & from school, min					
US				-0.0034 (-1.5)	-0.0031 (-3.0)
DC				-0.0034 (-1.5)	-0.0031 (-3.0)
SC				-0.0034 (-1.5)	n/a
Person is employed					
US	3.014 (13.8)	3.014 (13.8)			3.014 (13.8)
DC	3.014 (13.8)	3.014 (13.8)			3.014 (13.8)
Person is student					
FW			3.883 (18.3)	3.883 (18.3)	3.883 (18.3)
PW			3.883 (18.3)	3.883 (18.3)	3.883 (18.3)
NW			3.883 (18.3)	3.883 (18.3)	3.883 (18.3)
RT			3.883 (18.3)	3.883 (18.3)	3.883 (18.3)
No cars in household					
FW		-1.306 (-2.9)		n/a	-1.302 (-1.3)
PW		-1.306 (-2.9)		n/a	-1.302 (-1.3)
US		-1.306 (-2.9)		-1.413 (-1.9)	-1.302 (-1.3)
NW		-1.306 (-2.9)		n/a	n/a
RT		-1.306 (-2.9)		n/a	n/a
DC		n/a		-1.413 (-1.9)	-1.302 (-1.3)
SC		n/a		-1.413 (-1.9)	n/a
Cars fewer than drivers in household					
US				-0.5759 (-2.1)	
DC				-0.5759 (-2.1)	
SC				-0.5759 (-2.1)	
Number of preschool children in household					
FW	0 (base)	-0.1478 (-1.6)	-0.134 (-0.7)	n/a	-0.1251 (-0.5)
PW	0 (base)	-0.1478 (-1.6)	-0.134 (-0.7)	n/a	-0.1251 (-0.5)
US	0.2191 (1.1)	-0.1478 (-1.6)	0 (base)	-0.5577 (-1.5)	-0.1251 (-0.5)
NW	0 (base)	-0.1478 (-1.6)	-0.134 (-0.7)	n/a	n/a
RT	0 (base)	-0.1478 (-1.6)	-0.134 (-0.7)	n/a	n/a
DC	0.2191 (1.1)	n/a	0 (base)	-0.5577 (-1.5)	-0.1251 (-0.5)
SC	0.2191 (1.1)	n/a	0 (base)	-0.5577 (-1.5)	n/a
Number of non-workers in household					
FW			0.2574 (1.2)	n/a	
PW			0.2574 (1.2)	n/a	
Household income of $50K or higher					
FW	0 (base)		0.03470 (0.2)	n/a	0.03470 (0.2)
PW	0 (base)		0.0347 (0.2)	n/a	0.03470 (0.2)

Explanatory variables Person type	**Coefficient & t-Stat by Choice Alternative**				
	1 Work Tour	**2+ Work Tours**	**1 School Tour**	**2+ School Tours**	**1 Work & 1 School Tours**
US	-0.0528 (-0.3)	-0.0528 (-0.3)	0 (base)		-0.0528 (-0.3)
NW	0 (base)		0.0347 (0.2)	n/a	n/a
RT	0 (base)		0.0347 (0.2)	n/a	n/a
DC	-0.0528 (-0.3)	n/a	0 (base)		-0.0528 (-0.3)
SC	-0.0528 (-0.3)	n/a	0 (base)		n/a
Non-family household					
FW	0 (base)		-0.250 (-1.1)	n/a	-0.2500 (-1.1)
PW	0 (base)		-0.250 (-1.1)	n/a	-0.2500 (-1.1)
US	-0.1792 (-0.8)	-0.1792 (-0.8)	0 (base)		-0.1792 (-0.8)
NW	0 (base)		-0.250 (-1.1)	n/a	n/a
RT	0 (base)		-0.250 (-1.1)	n/a	n/a
DC	-0.1792 (-0.8)	n/a	0 (base)		-0.1792 (-0.8)
SC	-0.1792 (-0.8)	n/a	0 (base)		n/a
Number of children younger than 16 at home or with non-mandatory DAP					
FW		0.1804 (1.2)		n/a	-0.1955 (-0.5)
PW		0.1804 (1.2)		n/a	-0.1955 (-0.5)
US		0.1804 (1.2)		0.08664 (0.2)	-0.1955 (-0.5)
NW		0.1804 (1.2)		n/a	n/a
RT		0.1804 (1.2)		n/a	n/a
DC		n/a		0.08664 (0.2)	-0.1955 (-0.5)
SC		n/a		0.08664 (0.2)	n/a
Residence in urban area					
FW	0 (base)	0.2308 (2.5)	-0.136 (-0.5)	n/a	-0.3509 (-1.2)
PW	0 (base)	0.2308 (2.5)	-0.136 (-0.5)	n/a	-0.3509 (-1.2)
US	-0.2831 (-1.3)	0.2308 (2.5)	0 (base)	0.3170 (1.2)	-0.3509 (-1.2)
NW	0 (base)	0.2308 (2.5)	-0.136 (-0.5)	n/a	n/a
RT	0 (base)	0.2308 (2.5)	-0.136 (-0.5)	n/a	n/a
DC	-0.2831 (-1.3)	n/a	0 (base)	0.3170 (1.2)	-0.3509 (-1.2)
SC	-0.2831 (-1.3)	n/a	0 (base)	0.3170 (1.2)	n/a

Estimation Statistics	
Initial likelihood (zero coefficients)	-23277
Likelihood with constants only	-13041
Final likelihood	-4487
Rho-squared w.r.t. Zero	0.807
Rho-squared w.r.t. Constants	0.656

Table 21: Work Tour Time-of-Day Choice Model Parameters

Explanatory variable	Coefficient	t-Stat
Mode choice logsum	0.2279	1.61
Departure time constants		
Linear shift for every 30 minutes before 6:00 am	-1.152	-22.30
Before 06:00 AM	-2.198	-20.17
06:00 AM - 06:30 AM (7)	-1.314	-16.77
06:30 AM - 07:00 AM (8)	-0.559	-11.03
07:00 AM - 07:30 AM (9)	0.000	
07:30 AM - 08:00 AM (10)	-0.037	-0.93
08:00 AM - 08:30 AM (11)	-0.286	-5.85
08:30 AM - 09:00 AM (12)	-0.555	-9.22
After 09:00 AM	-0.865	-14.82
Square root shift for every 30 minutes after 9:30 am	-0.436	-10.11
Arrival time constants		
Linear shift for every 30 minutes before 3:00 pm	-0.192	-10.10
Before 03:30 PM	-0.289	-2.97
03:30 PM - 04:00 PM (26)	-0.274	-3.03
04:00 PM - 04:30 PM (27)	-0.143	-1.94
04:30 PM - 05:00 PM (28)	-0.125	-2.08
05:00 PM - 05:30 PM (29)	0.004	0.09
05:30 PM - 06:00 PM (30)	0.000	
06:00 PM - 06:30 PM (31)	-0.061	-1.32
06:30 PM - 7:00 PM (32)	-0.237	-4.34
7:00 PM - 7:30 PM (33)	-0.578	-8.45
7:30 PM - 8:00 PM (34)	-0.816	-9.95
After 08:00 PM	-0.854	-10.35
Square root shift for every 30 minutes after 6:30 pm	-0.470	-10.12
Duration constants		
Linear shift for every 30 minutes less than 8.5 hrs	-0.074	-5.52
Shorter than 8.5 hrs	-0.749	-8.98
8.5 hours	-0.655	-8.16
9 hours	-0.372	-5.60
9.5 hours	-0.144	-2.61
10 hours	0.013	0.28
10.5 hours	0.000	
11 hours	-0.116	-2.36
11.5 hours	-0.289	-5.01
12 hours	-0.524	-7.50
Longer than 12 hrs	-0.599	-7.99
Linear shift for every 30 minutes more than 10 hrs	-0.294	-15.37
Female		
Departure before 7:00 am - Linear	-0.129	-6.00

Explanatory variable	Coefficient	t-Stat
Arrival after 6:00 pm - Linear	-0.041	-5.96
Female & presence of pre-school child in the HH		
Departure before 7:00 am - Linear	-0.129	-2.18
Departure after 7:30 am – Linear	-0.032	-2.16
Arrival after 6:00 pm – Linear	-0.049	-2.52
Low income (<=$25,000)		
Departure before 7:00 am - Linear	0.233	6.17
Departure after 7:30 am - Linear	0.015	1.71
Arrival after 6:00 pm - Linear	0.039	3.10
Medium income ($25,001 to $60,000)		
Departure before 7:00 am - Linear	0.124	4.90
Arrival after 6:00 pm - Linear	0.021	2.80
Medium-high income ($60,001 to $120,00)		
Departure before 7:00 am - Linear	0.099	4.19
Age group		
Age 16 to 18 yrs - Departure Before 7:00 am	-0.460	-1.36
Age 16 to 18 yrs - Departure After 7:30 am	0.061	3.33
Age 19 to 24 yrs - Departure After 7:30 am	0.031	2.68
Age 25 to 40 yrs - Departure Before 7:00 am	-0.117	-5.00
Age 65+ yrs - Departure After 7:30 am	0.052	4.56
Age 19 to 24 yrs - Arrival after 6:00 pm	0.033	2.02
Age 25 to 40 yrs - Arrival before 5:30 pm	-0.028	-2.98
Age 56 to 64 yrs - Arrival after 6:00 pm	-0.049	-4.90
Age 65+ yrs - Arrival before 5:30 pm	0.057	3.84
Age 65+ yrs - Arrival after 6:00 pm	-0.078	-3.70
Zero auto ownership		
Departure before 7:00 am - Linear	0.397	5.16
Arrival after 6:00 pm - Linear	0.051	1.79
Part-time worker		
Departure before 7:00 am - Linear	-0.265	-7.10
Departure after 7:30 am - Linear	0.127	17.10
Arrival before 5:30 pm - Linear	0.175	18.66
Arrival after 6:00 pm - Linear	-0.054	-4.65
University student		
Departure after 7:30 am - Linear	0.025	2.06
Arrival before 5:30 pm - Linear	0.035	1.97
Arrival after 6:00 pm - Linear	0.062	4.43
Blue collar worker		
Departure before 7:00 am - Linear	0.327	12.26
Departure after 7:30 am - Linear	0.047	4.42
Arrival before 5:30 pm - Linear	0.042	3.26
Service		

Explanatory variable	Coefficient	t-Stat
Departure before 7:00 am - Linear	0.118	2.96
Departure after 7:30 am - Linear	0.082	9.00
Arrival before 5:30 pm - Linear	0.051	3.54
Health		
Departure before 7:00 am - Linear	0.135	3.77
Arrival after 6:00 pm - Linear	0.062	5.30
Retail and food		
Departure after 7:30 am - Linear	0.076	9.50
Arrival before 5:30 pm - Linear	0.053	4.56
Arrival after 6:00 pm - Linear	0.027	2.59
Travel time		
Departure before 7:00 am - Linear	0.012	18.22
Departure after 7:30 am - Linear	-0.004	-14.39
Arrival before 5:30 pm - Linear	-0.005	-15.53
Arrival after 6:00 pm - Linear	0.002	8.74
Presence of non-working adult in the HH		
Departure before 7:00 am - Linear	0.070	3.06
Arrival before 5:30 pm - Linear	-0.020	-1.93
Presence of pre-driving age children in the HH		
Departure before 7:30 am - Linear	-0.085	-3.83
Departure after 8 am - Linear	-0.024	-3.31
Arrival before 5:30 pm - Linear	0.019	2.24
Arrival after 6:00 pm - Linear	-0.032	-3.65
First of 2+ mandatory tour		
Departure before 7:00 am	0.146	2.86
Departure after 7:30 am	-0.215	-12.67
Duration < 9.5 hours	0.307	26.05
Duration > 9.5 hours	-0.526	-3.99
2nd or later of 2+ mandatory tour		
Departure before 1:30 pm	-0.221	-9.16
Departure after 2:00 pm	-0.176	-9.26
Duration < 9.5 hours	0.065	5.93
Duration > 9.5 hours	-0.657	-2.77

Estimation statistics	
Observations	9317
Final log likelihood	-49912
$Rho^2(0)$	0.237
$Rho^2(c)$	0.039

Table 22: University Tour Time-of-Day Choice Model Parameters

Explanatory variables	Coefficient	t-Stat
Mode Choice Logsum	0.384	0.84
Departure Time Constants		
Linear shift for every 30 minutes before 06:30 am	-0.948	-6.42
Before 07:30 AM	-0.296	-1.18
07:30 AM - 08:00 AM	-0.651	-2.47
08:00 AM - 08:30 AM	0.000	
08:30 AM - 09:00 AM	-0.526	-2.12
After 09:00 AM	-0.536	-2.49
Square root shift for every 30 minutes after 10:00 am	-0.500	-3.32
Arrival Time Constants		
Linear shift for every 30 minutes before 02:30 pm	-0.209	-3.68
Before 03:00 PM	-0.963	-3.72
03:00 PM - 03:30 PM	-0.628	-2.17
03:30 PM - 04:00 PM	0.000	
04:00 PM - 04:30 PM	-0.191	-0.73
After 04:30 PM	-0.665	-2.32
Linear shift for every 30 minutes after 05:00 pm	-0.210	-3.92
Square root shift for every 30 minutes after 05:00 pm	0.503	2.38
Duration Constants		
Square root shift for every 30 minutes less than 4.5 hrs	0.226	1.16
4.5 hours or less	0.031	0.10
5 hours	0.000	
5.5 hours or more	0.343	1.27
Linear shift for every 30 minutes more than 5.5 hrs	-0.115	-2.88
Low Income (<=$24,999)		
Departure before 8:00 am - Linear	0.246	2.52
Duration< 4 hrs -Linear	-0.262	-1.68
Medium High Income ($60,000 to $120,000)		
Departure after 8:30 am - Linear	-0.039	-1.65
Duration> 4 hrs- Linear	-0.042	-1.72
High Income (>= $120,000)		
Departure after 8:30 am - Linear	-0.039	-1.58
Age group 41+		
Departure after 8:30 am - Linear	0.055	2.31
Duration< 4 hrs -Linear	-0.152	-1.25
Auto Distance		
Departure before 8:00 am - Linear	0.007	1.83
Departure after 8:30 am - Linear	0.004	3.75
Duration< 4 hrs -Linear	-0.040	-3.00
Duration> 4 hrs- Linear	0.004	4.09
Duration< 4 hrs - Square Root	0.041	1.69

Explanatory variables	**Coefficient**	**t-Stat**
Subsequent tour is work tour		
Departure after 8:30 am	-0.292	-3.47
Duration < 4 hours	-0.482	-1.58
Duration > 4 hours	-0.365	-4.77
Departure after 8:30 am	-0.286	-2.88
Duration < 4 hours	0.303	1.95
Duration > 4 hours	-0.247	-2.38
Duration < 4 hours	-0.211	-1.63
Duration > 4 hours	-0.353	-3.61

Estimation statistics	
Observations	370
Final log likelihood	-2231
$Rho^2(0)$	0.143
$Rho^2(c)$	-0.147

Table 23: School Tour Time-of-Day Choice Model Parameters

Explanatory variables	Coefficient	t-Stat
Mode Choice Logsum	0.524	3.69
Departure Time		
Before 06:00 AM	-10.044	-19.09
06:00 AM to 06:30 AM (7)	-3.792	-21.60
06:30 AM to 07:00 AM (8)	-1.942	-17.53
07:00 AM to 07:30 AM (9)	-0.558	-9.00
07:30 AM to 08:00 AM (10)	0.000	
After 08:00 AM	-0.280	-4.53
Linear shift for every 30 minutes after 8:30 am	0.294	7.48
Square root shift for every 30 minutes after 8:30 am	-1.220	-14.48
Arrival Time		
Before 02:30 PM	0.721	3.95
02:30 PM - 03:00 PM (24)	1.605	13.39
03:00 PM - 03:30 PM (25)	0.464	5.00
03:30 PM - 04:00 PM (26)	0.196	3.04
04:00 PM - 04:30 PM (27)	0.000	
04:30 PM - 05:00 PM (28)	-0.389	-5.57
05:00 PM - 05:30 PM (29)	-1.413	-12.74
05:30 PM - 06:00 PM (30)	-1.939	-13.46
After 06:00 PM	-2.246	-12.75
Linear shift for every 30 minutes after 6:30 pm	-0.552	-12.56
Duration Constants		
Linear shift for every 30 minutes less than 6.5 hrs	-0.250	-8.08
Shorter than 7 hrs	-2.791	-18.75
7 hours	-1.679	-15.93
7.5 hours	-0.555	-8.70
8 hours	0.000	
8.5 hours	-0.139	-2.25
9 hours	-0.510	-5.30
Longer than 9 hrs	-0.561	-4.30
Linear shift for every 30 minutes more than 9.5 hrs	0.379	7.41
Squared shift for every 30 minutes more than 9.5 hrs	-0.029	-5.55
Low Income (<=$25,000)		
Departure before 7:30 am - Linear	0.135	2.48
Departure after 8:00 am - Linear	-0.076	-1.75
Duration < 8hrs - Linear	-0.150	-3.56
Duration > 8hrs - Linear	-0.044	-2.21
Medium Income ($25,001 to $60,000)		
Departure before 7:30 am - Linear	0.103	2.46
Age Group		
Age 0 to 5 yrs - Departure Before 7:30 am	-0.179	-3.28

Explanatory variables	Coefficient	t-Stat
Age 0 to 5 yrs - Departure After 8:00 am	0.000	
Age 13 to 15 yrs - Departure Before 7:30 am	-0.165	-3.54
Age 13 to 15 yrs - Departure After 8:00 am	0.170	5.68
Age 16 to 17 yrs - Departure Before 7:30 am	0.000	
Age 16 to 17 yrs - Departure After 8:00 am	0.078	2.49
Age 0 to 5 yrs - Duration < 8hrs	0.254	11.88
Age 0 to 5 yrs - Duration > 8hrs	0.144	9.18
Age 13 to 15 yrs - Duration < 8hrs	-0.211	-5.61
Age 13 to 15 yrs - Duration > 8hrs	0.102	6.94
Age 16 to 17 yrs - Duration < 8hrs	0.000	
Age 16 to 17 yrs - Duration > 8hrs	0.118	7.26
Travel Time		
Departure before 7:30 am - Linear	0.012	5.93
Departure after 8:00 am - Linear	-0.009	-5.11
Arrival before 4:00 pm - Linear	-0.012	-7.99
Arrival after 4:30 pm - Linear	0.001	1.81
If all adults are full-time workers		
Departure before 7:30 am - Linear	0.163	4.21
Departure after 8 am - Linear	-0.162	-5.66
Arrival before 4:00 pm - Linear	-0.233	-9.17
Arrival after 4:00 pm - Linear	0.085	6.40
Subsequent tour is work tour		
Duration < 8 hours	0.154	2.44
Duration > 8 hours	-0.629	-2.15
Subsequent tour is school tour		
Departure after 8:00 am	-0.416	-3.01
Duration < 8 hours	0.261	5.94
Duration > 8 hours	-0.264	-3.48
Second tour of two mandatory tours		
Duration < 4 hours	-0.538	-8.04
Duration > 4 hours	-0.545	-7.62

Estimation statistics	
Observations	4698
Final log likelihood	-19159
$Rho^2(0)$	0.421
$Rho^2(c)$	0.001

Table 24: Joint Tour Frequency Model Parameters

Observations	8367
Final log-likelihood	-6836
Rho-squared (0)	0.732
Rho-squared (constants)	0.103

Explanatory variables	Tour purpose					
	Stay Home		Shopping		Maintenance	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Stay at home patterns in HH by person type*	1.1750	5.5				
Full time workers	1.4470	2.7				
Part time workers	1.5140	6.5				
Homemakers	0.6053	2.6				
Retirees	0.5685	1.5				
University/driving students	0.5308	4.4				
Pre-driving and pre-school children	1.1750	5.5				
Non-mandatory patterns in HH by person type*						
Full time workers			0.2052	1.6	0.3173	2.2
Part time workers			0.1866	1.0	0.2452	1.2
Homemakers			0.7078	5.7	0.4643	3.4
Retirees			0.9410	7.5	0.9050	6.8
University/driving students			0.7648	5.0	0.2643	1.2
Pre-driving and pre-school children			0.5474	5.7	0.6482	5.3
Mandatory patterns in HH by person type*						
Full time workers			-0.2424	-2.7	-0.3009	-3.0
Driving students					-0.3237	-1.7
Pre-driving and pre-school children					0.2299	2.3
Log of time window **						
Maximum overlap across adults			0.5945	6.8	0.3714	4.3
Maximum overlap children w/adults			0.1416	2.5	0.1760	2.2
Maximum overlap across children			0.1086	1.6	0.2443	3.3
Household car sufficiency						
HH has no cars						
HH has fewer cars than drivers			0.2523	2.0	0.4611	3.3
HH has more cars than workers			-0.3027	-2.2		
Constants ***						
1 joint tour			-4.424	-27.1	-4.461	-27.2
2+ joint tours for same purpose			-10.20	-24.9	-10.14	-23.0
2+ joint tours for different purposes			-9.792	-41.4	-9.792	-41.4

Explanatory variables	Tour purpose					
	Visit		Discretionary		Eating out	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Non-mandatory patterns in HH by person type*						
Full time workers	0.6445	3.3	0.1275	1.1	0.2275	2.0
Part time workers	0.1332	0.4	0.4979	3.1	0.3765	2.2
Homemakers	0.5475	2.7	0.2871	2.7	0.1820	1.6
Retirees	0.5579	2.7	0.6136	5.3	0.4264	3.9
University/driving students	0.2809	0.9	0.7546	4.8	0.4097	2.5
Pre-driving and pre-school children	0.6008	3.4	0.5331	4.8	0.3851	4.4
Mandatory patterns in HH by person type*						
Full time workers						
Driving students			0.1932	1.6		
Pre-driving and pre-school children			0.3862	4.6		
Log of time window **						
Maximum overlap across adults			0.3428	4.6	0.4856	5.8
Maximum overlap children w/adults			0.1162	1.7		
Maximum overlap across children			0.2212	3.4	0.0921	1.4
Time window						
Maximum overlap across adults	0.0596	2.6				
Maximum overlap children w/adults	0.0092	0.5				
Maximum overlap across children	0.02563	1.1				
Household income						
HH income $50-100K			0.3167	2.6	0.2977	2.5
HH income over $100K			0.486	3.4	0.4492	3.1
HH income missing			0.3723	1.9	0.2780	1.4
Household car sufficiency						
HH has no cars	-0.9802	-1.0	-0.9094	-1.5		
HH has fewer cars than drivers						
HH has more cars than workers					0.3825	3.2
Zonal walk accessibility to retail employment					0.0623	2.6
Constants ***						
1 joint tour	-5.088	-33.7	-4.445	-31.6	-4.739	-29.3
2+ joint tours for same purpose	-11.61	-11.0	-10.18	-25.0	-10.92	-23.4
2+ joint tours for different purposes	-9.792	-41.4	-9.792	-41.4	-9.792	-41.4

Notes:
* The number of people in the household with an out of home (non-)mandatory pattern, capped at 3
** 1.0 is added to the windows before taking the natural log. 16 hours of the day are used to calculate time windows (630 to 2230)
*** A single constant was used for each alternative. Constant for purpose combinations applies to all columns.
All variables except constants are multiplied by 2 in the 2+ tour alternatives

Table 25: Joint Tour Party Composition Model Parameters

Explanatory variables	Party size composition		
	Adult	Children	Mixed
	Coefficient	Coefficient	Coefficient
Constant		2.7377	3.6259
Tour purpose			
Eating-out tours		-0.9678	-0.8027
Discretionary tours		0.7648	0.5101
Day-patterns in HH by person type			
Number of full-time workers	1.0240		0.3624
Number of part-time workers	0.5412		0.3164
Number of university students	0.8245		
Number of non-workers	0.6263		-0.3724
Number of preschool children		0.7306	0.7906
Number of pre-driving school children		0.7306	0.3532
Number of driving school children		-0.2667	-0.9399
Household variables			
Low HH income	1.2480		0.5755
Medium HH income	0.8369		
No of cars greater than number of workers	1.3860		0.7510
Residential urban area	0.5741		
Residential suburban area	0.5105		0.1283
Time windows			
Log of max window overlaps between adults	1.1920		
Log of max window overlaps between children		1.8410	
Log of max window overlaps between adult & child			1.9580
Party composition availability			
Not more than 1 travel active adult in HH	-999		
Not more than 1 travel active child in HH		-999	
No travel-active pair adult-child in HH			-999

Table 26: Joint Tour Participation Model Parameters

	True	False
Explanatory variables	Coefficient	Coefficient
Party composition / person type variables		
Full-time worker in mixed party	-3.5660	0.5000
Part-time worker in adult party	-0.3655	
Part-time worker in mixed party	-3.0410	
University student in mixed party	-3.1640	
Non-worker in adult party	0.7152	
Non-worker in mixed party	-2.7860	
Preschool child in children party	-1.8930	
Preschool child in mixed party	-0.7217	
Pre-driving school child in children party	-1.7520	
Pre-driving school child in mixed party	-1.8220	
Driving school child in children party	-1.3530	
Driving school child in mixed party	-2.0410	
Tour purpose / person type variables		
Full-time worker on eating-out joint tour	0.7157	0.5000
Full-time worker on discretionary joint tour	0.4392	0.5000
Part-time worker on eating-out joint tour	2.1880	
Part-time worker on discretionary joint tour	0.2850	
University student on eating-out joint tour	-0.8200	
Non-worker on eating-out joint tour	0.1617	
Non-worker on discretionary joint tour	-0.1835	
Preschool child on eating-out joint tour	0.6589	
Preschool child on discretionary joint tour	0.1284	
Pre-driving school child on eating-out joint tour	1.3910	
Pre-driving school child on discretionary joint tour	0.6626	
Driving school child on eating-out joint tour	2.3440	
Driving school child on discretionary joint tour	-0.6675	
Home located in urban area		
Adult in adult party	0.0000	
Adult in mixed party	-0.1370	
Child in children party	1.2100	
Child in mixed party	0.6265	
Home located in suburban area		
Adult in adult party	0.0000	
Adult in mixed party	-0.0601	
Child in children party	0.0000	
Child in mixed party	0.0000	
Car sufficient household (more cars than workers)		
Adult in adult party	-0.2133	
Adult in mixed party	-0.6031	
Child in children party	-0.4214	

	True	False
Explanatory variables	Coefficient	Coefficient
Child in mixed party	-0.3776	
Household income (equal to or greater than $50,000)		
Adult in adult party	-0.1682	
Adult in mixed party	-0.0261	
Child in children party	-0.5619	
Child in mixed party	-0.1528	
Number of household joint tours		
Adult in adult party	-0.3242	
Adult in mixed party	-0.3584	
Child in children party	0.1047	
Child in mixed party	-0.5089	
Number of other household adults		
Adult in adult party	-0.4244	
Adult in mixed party	-0.4058	
Number of other household children		
Child in children party	-0.2891	
Child in mixed party	-0.4392	
Time window (log of max window overlap)		
Between the adult and other adults for adult party	0.8436	
Between the adult and children for mixed party	2.1890	
Between the child and adults for mixed party	1.5380	
Between the child and other children for children party	1.2960	
Exclusions		
Adults cannot participate in children party	-999	
Children cannot participate in adult party	-999	
Person stays at home	-999	
One of the two available adults must participate in adult party		-999
The only available adult must participate in mixed party		-999
One of the two available children must participate in children party		-999
The only available child must participate in mixed party		-999

Table 27: Maintenance Tour Destination Choice Model Parameters

Explanatory variables	Escort		Shopping		Other Maintenance	
	Coeff.	t-Stat	Coeff.	t-Stat	Coeff.	t-Stat
Mode choice logsum	1.0	constr	0.6529	5.9	0.7423	6.1
CBD area type			-0.5719	-6.9	-0.3807	-4.3
Urban high area type			0.06509	1.2	-0.6179	-7.4
Intrazonal dummy	-0.06336	-0.6	-0.228	-2.9	-0.1244	-1.2
Distance	-0.1258	-7.4	-0.1246	-9.9	-0.07082	-5.4
Distance squared	0.001834	6.3	0.001368	7.2	6.54E-04	3.6
Distance cubed	-7.32E-06	-4.5	-4.57E-06	-4.6	-1.65E-06	-1.9
Log of distance	-0.7693	-7.3	-0.7858	-10.7	-0.7517	-8.3
Distance – income over $50K						
Distance - child under 16	-0.0155	-2.8	-0.02022	-3.3		
Distance - secondary tour	-0.01106	-3.5	-0.004078	-1.6	-0.00983	-3.6
Distance - work-based subtour	-0.00763	-1.3	-0.01263	-2.1	-0.0135	-2.2
Size variables[1]						
Retail employment (base)	1.0	n/a	1.0	n/a	1.0	n/a
Service employment - no kids in HH	1.457	0.9				
Service employment - kids in HH	0.440	-2.1				
Service employment			0.005	-9	0.942	-0.5
Other employment - no kids in HH	0.761	-0.6				
Other employment - kids in HH	0.403	-2.9				
Other employment			0.011	-13.7	0.099	-10.3
Households - no kids in HH	1.112	0.3				
Households - kids in HH	2.370	3.9				
Households			0.119	-35.1	0.350	-9.6

1 The values of the size variable coefficients are given in exponentiated form, exp(coef.)

Estimation statistics	Escort Tours	Shopping Tours	Other Maintenance
Observations	2332	4576	3075
Final log L	-11386	-21575	-16522
Rho-squared	0.343	0.365	0.277

Table 28: Discretionary Tour Destination Choice Model Parameters

Explanatory variables	**Eating out**		**Social/visit**		**Other Discretionary**	
	Coeff.	t-Stat	Coeff.	t-Stat	Coeff.	t-Stat
Mode choice logsum	0.3771	1.8	1.0	constr	1.0	constr
CBD area type	-0.8162	-5.6	-0.8913	-3.6	0.1541	1.8
Urban high area type	-0.6056	-5.3	-0.432	-2.2		
Intrazonal dummy	-0.1792	-1.1	0.714	3.4	-0.1284	-1.3
Distance	-0.1497	-4.9	-0.08396	-2.9	-0.05786	-3.7
Distance squared	0.001999	3.4	0.001479	3.0	7.75E-04	2.9
Distance cubed	-1.06E-05	-2.7	-7.50E-06	-2.7	-3.15E-06	-2.1
Log of distance	-0.6527	-4.0	-0.3851	-1.9	-0.8402	-8.5
Distance – income over $50K	0.008183	1.6				
Distance - child under 16			-0.02203	-2.5	-0.00959	-2.3
Distance - secondary tour	-0.00797	-1.8	-0.0114	-2.8	-0.01154	-4.0
Distance - work-based subtour			-0.00995	-1.4	-0.00779	-1.3
Size variables[1]						
Retail employment (base)	1.0	n/a	1.0	n/a	1.0	n/a
Service employment	0.018	-7.5	1.114	0.3	0.574	-3.6
Other employment	0.000	-0.1	0.000	-0.1	0.089	-7.2
Households	0.137	-17.5	1.749	1.9	0.939	-0.6

1 The values of the size variable coefficients are given in exponentiated form, exp(coef.)

Estimation statistics	Escort Tours	Shopping Tours	Other Maintenance
Observations	1317	779	2737
Final log L	-6626	-4507	-14667
Rho-squared	0.323	0.221	0.279

Table 29: Escort Tour Time-of-Day Choice Model Parameters

Explanatory variables	Coefficient	t-Stat
Mode Choice Logsum	1.173	4.93
Departure Time Constants		
Linear shift for every 30 minutes before 06:30 am	-1.469	-12.10
Before 07:00 AM	-2.070	-14.21
07:00 AM - 07:30 AM	-0.643	-7.08
07:30 AM - 08:00 AM	0.000	
08:00 AM - 08:30 AM	-0.215	-2.14
08:30 AM - 09:00 AM	-0.147	-1.10
After 09:00 AM	-1.357	-8.41
01:30 PM - 02:00 PM	0.368	2.00
02:00 PM - 02:30 PM	1.167	6.10
02:30 PM - 03:00 PM	1.285	5.79
03:00 PM - 03:30 PM	0.582	2.18
After 03:30 PM	0.835	2.89
Linear shift for every 30 minutes after 9:30 am	0.175	5.29
Linear shift for every 30 minutes after 4:00 pm	-0.019	-0.56
Arrival Time Constants		
Linear shift for every 30 minutes before 6:30 am	0.450	1.98
Before 07:00 AM	0.550	2.20
07:00 AM - 07:30 AM	0.488	3.10
07:30 AM - 08:00 AM	0.236	2.31
08:00 AM - 08:30 AM	0.000	
08:30 AM - 09:00 AM	-0.684	-6.52
After 09:00 AM	-1.429	-10.81
02:30 PM - 03:00 PM	1.311	7.96
03:00 PM - 03:30 PM	1.317	6.75
03:30 PM - 04:00 PM	1.397	6.66
04:00 PM - 04:30 PM	1.031	4.46
After 04:30 PM	0.907	3.66
Linear shift for every 30 minutes after 9:30 am	-0.148	-5.31
Linear shift for every 30 minutes after 5:00 pm	-0.389	-13.57
Duration Constants		
0 hrs	-0.174	-1.52
0.5 hrs	0.000	
1 hrs	-0.431	-7.48
1.5hrs	-0.700	-8.52
2 hrs	-1.072	-9.43
Longer than 2 hrs	-1.691	-11.82
Distance		
Duration Constant 0 hrs [Dep. & Arr. in the same period]	-0.335	-12.36
Duration > 0.5 hrs - Linear	0.005	8.67

Explanatory variables	Coefficient	t-Stat
Full-time worker		
Departure after 08:00 AM - Linear	-0.038	-3.96
Departure after 03:00 PM - Linear	0.163	5.89
Duration Constant 0 hrs [Dep. & Arr. in the same period]	-0.275	-2.19
Duration > 0.5 hrs - Linear	0.052	2.80
University Student		
Duration Constant 0 hrs [Dep. & Arr. in the same period]	-0.427	-1.60
Non-driving age student		
Duration > 0.5 hrs - Linear	0.241	6.50
Driving-age student		
Duration Constant 0 hrs [Dep. & Arr. in the same period]	-0.554	-1.90
Duration > 0.5 hrs - Linear	0.299	13.72
Pre-school kid		
Duration > 0.5 hrs - Linear	0.195	9.11
Medium-High Income ($60,001 to $120,00)		
Duration > 0.5 hrs - Linear	-0.029	-1.85
Households with no kids		
Departure before 07:30 AM - Linear	0.589	6.00
Departure after 08:00 AM - Linear	0.087	2.73
Departure before 2:30 PM - Linear	0.478	4.26
Departure after 03:00 PM - Linear	-0.204	-3.76
Arrival before 08:00 AM - Linear	-0.360	-3.08
Arrival after 08:30 AM - Linear	0.092	3.01
Arrival before 3:00 PM - Linear	0.433	3.92
Arrival after 03:30 PM - Linear	0.131	2.57
Pre-School Child in HH with Mandatory tour (Dummy- 1,0)		
Departure after 08:00 AM - Linear	0.110	6.04
Departure after 03:00 PM - Linear	-0.225	-6.22
Arrival before 08:00 AM - Linear	-0.357	-3.74
Arrival before 3:00 PM - Linear	0.629	7.93
Driving age School Child in HH with Mandatory tour		
Departure after 08:00 AM – Linear	0.039	1.63
Arrival after 08:30 AM – Linear	-0.066	-2.57
Arrival after 03:30 PM – Linear	0.118	3.51
Number of Auto > Number of adults		
Duration > 0.5 hrs - Linear	-0.057	-2.87
First Tour of multiple escort tours		
Departure after 08:00 AM - Linear	-0.215	-16.91
Departure after 03:00 PM - Linear	0.278	5.97
Duration Constant 0 hrs [Dep. & Arr. in the same period]	0.358	2.83
Duration > 0.5 hrs - Linear	-0.211	-7.65
Number of Individual Tours (excluding escorting)		

Explanatory variables	Coefficient	t-Stat
Duration > 0.5 hrs - Linear	-0.063	-5.18
Number of joint tours		
Duration > 0.5 hrs - Linear	-0.049	-3.65

Estimation statistics	
Observations	2978
Final log likelihood	-12914
$Rho^2(0)$	0.327
$Rho^2(c)$	0.048

Table 30: Shopping and Maintenance Tour Time-of-Day Choice Model Parameters

Explanatory variables	Coefficient	t-Stat
Shopping Tour Departure Time Constants		
Linear Shift for every 30 minutes before 08:30 am	-0.960	-8.97
Square Root Shift for every 30 minutes before 08:30 am	1.113	5.04
Before 09:00 AM	-0.446	-3.01
09:00 AM - 09:30 AM	-0.022	-0.18
09:30 AM - 10:00 AM	-0.283	-2.46
10:00 AM - 10:30 AM	0.000	
10:30 AM - 11:00 AM	-0.309	-2.87
After 11:00 AM	-0.541	-5.40
Linear Shift for every 30 minutes after 11:30 am	-0.072	-2.80
Squared Shift for every 30 minutes after 11:30 am	-0.001	-0.72
Shopping Tour Arrival Time Constants		
Linear Shift for every 30 minutes before 12:00 pm	-0.184	-6.23
Before 12:30 PM	-0.716	-3.83
12:30 PM - 03:00 PM	-0.503	-3.75
03:00 PM - 03:30 PM	-0.168	-1.42
03:30 PM - 04:00 PM	-0.157	-1.37
04:00 PM - 04:30 PM	0.000	
04:30 PM - 05:00 PM	-0.057	-0.51
05:00 PM - 05:30 PM	-0.580	-4.25
05:30 PM - 07:00 PM	-0.322	-2.63
07:00 PM - 09:30 PM	-0.348	-1.95
After 09:30 PM	-1.124	-4.33
Linear Shift for every 30 minutes after 10:00 pm	-0.500	-8.32
Shopping Tour Duration Constants		
0 hrs	-0.132	-0.75
0.5 hrs	0.889	9.38
1 hrs	0.000	
1.5hrs	-0.333	-5.37
2 hrs	-0.851	-10.51
Longer than 2 hrs	-1.204	-12.00
Shift for every 30 minutes after 5:00 pm		
Duration > 2.5 hrs - Linear	-0.294	-8.43
Duration > 2.5 hrs - Square Root	-0.216	-2.66
Maintenance Tour Departure Time Constants		
Linear shift for every 30 minutes before 07:30 am	-0.864	-6.18
Square root shift for every 30 minutes before 07:30 am	0.505	1.96
Before 08:00 AM	-0.384	-1.86
08:00 AM - 08:30 AM	-0.077	-0.44
08:30 AM - 09:00 AM	-0.169	-1.11
09:00 AM - 09:30 AM	-0.052	-0.40

Explanatory variables	Coefficient	t-Stat
09:30 AM - 10:00 AM	-0.215	-1.80
10:00 AM - 10:30 AM	0.000	
10:30 AM - 11:00 AM	-0.428	-3.39
After 11:00 AM	-0.521	-4.50
Linear shift for every 30 minutes after 11:30 am	0.043	1.21
Squared shift for every 30 minutes after 11:30 am	-0.003	-3.21
Maintenance Tour Arrival Time Constants		
Linear shift for every 30 minutes before 10:00 am	-0.227	-4.42
Before 10:30 AM	-0.223	-1.58
10:30 AM - 11:00 AM	0.000	
11:00 AM - 11:30 AM	-0.128	-0.86
11:30 AM - 01:30 PM	0.168	1.08
01:30 PM - 02:30 PM	-0.149	-0.63
02:30 PM - 04:00 PM	0.088	0.29
04:00 PM - 04:30 PM	0.122	0.33
After 04:30 PM	0.107	0.28
Linear shift for every 30 minutes after 5:00 pm	-0.233	-6.88
Maintenance Tour Duration Constants		
0 hrs	-0.484	-3.74
0.5 hrs	0.000	
Longer than 0.5 hrs	-1.451	-12.81
Shift for every 30 minutes after 5:00 pm		
Duration > 2.5 hrs - Linear	-0.275	-7.21
Duration > 1 hrs - Square Root	0.208	3.39
Joint Shopping tours		
Departure before 10:00 AM - Linear	-0.191	-3.79
Departure after 10:30 AM - Linear	-0.030	-2.87
Joint Maintanance tours		
Departure before 10:00 AM - Linear	-0.139	-3.67
Departure after 10:30 AM - Linear	-0.066	-4.58
Joint Tours Party Size > 2		
Duration < 1.5 hrs	-0.292	-1.22
Duration > 1.5 hr	0.046	1.37
Joint adults only tour		
Duration < 1.5 hrs	-0.571	-4.49
Kids in Joint Tour		
Duration < 1.5 hrs	-0.469	-3.12
Duration > 1.5 hr	-0.047	-1.74
Driving age student		
Duration > 1.5 hr	0.122	3.12
Full-time worker		
Duration > 1.5 hr	-0.038	-3.02

Explanatory variables	Coefficient	t-Stat
Non-driving Student		
Duration > 1.5 hr	0.102	3.30
Pre-school Child		
Duration < 1.5 hrs	-1.883	-2.64
Part Time Worker		
Duration < 1.5 hrs	-0.197	-2.07
Duration > 1.5 hr	-0.045	-3.25
Retired		
Duration < 1.5 hrs	-0.265	-2.45
Duration > 1.5 hr	-0.043	-3.15
University Student		
Duration > 1.5 hr	0.046	2.59
Female		
Duration < 1.5 hrs	-0.417	-5.98
Duration > 1.5 hr	0.046	4.69
Low Income (<=$25,000)		
Duration > 1.5 hr	0.041	4.14
Medium Income ($25,001 to $60,000)		
Duration < 1.5 hrs	0.108	1.56
Medium-High Income ($60,001 to $120,00)		
Duration > 1.5 hr	-0.038	-3.54
Distance		
Duration < 1.5 hrs	-0.215	-16.84
Duration > 1.5 hr	0.008	20.04
Time pressure		
Duration > 1.5 hr	0.014	2.64
Number of Additional Individual Tours of Same Purpose *		
Duration < 1.5 hrs	0.079	1.49
Duration > 1.5 hr	-0.115	-9.10

Estimation statistics	
Observations	5460
Final log likelihood	-28438
$Rho^2(0)$	0.210
$Rho^2(c)$	0.043

Table 31: Eat-Out Tour Time-of-Day Choice Model Parameters

Explanatory variables	Coefficient	t-Stat
Individual tours departure time constants		
07:30 AM - 09:00 AM	1.222	4.85
10:00 AM - 10:30 AM		
10:30 AM - 11:00 AM	0.520	1.35
11:00 AM - 11:30 AM	1.192	4.22
11:30 AM - 12:00 PM	1.669	7.12
12:00 PM - 12:30 PM	1.164	4.40
12:30 PM - 01:00 PM	1.057	3.93
Linear shift for every 30 minutes before 04:30 pm	-0.477	-3.49
Squared	-0.033	-0.28
Before 05:00 PM	-1.216	-3.72
05:00 PM - 05:30 PM	-0.426	-1.67
05:30 PM - 06:00 PM	0.000	
06:00 PM - 06:30 PM	-0.228	-0.95
06:30 PM - 07:00 PM	-0.294	-1.09
Linear shift for every 30 minutes after 07:30 pm	-0.554	-4.21
Individual tours arrival time constants		
9:30 AM to 11:00 AM	0.486	1.68
12:30 PM to 01:00 PM	0.629	2.13
01:00 PM to 01:30 PM	0.939	3.70
01:30 PM to 02:00 PM	0.584	2.12
02:00 PM to 02:30 PM	0.843	3.36
02:30 PM to 03:00 PM	0.298	0.96
Linear shift for every 30 minutes before 06:00 pm	0.125	1.67
Before 6:30 PM	-0.029	-0.08
6:30 PM to 7:00 PM	-0.509	-1.28
7:00 PM to 7:30 PM	-0.125	-0.42
7:30 PM to 8:00 PM	-0.605	-2.17
8:00 PM to 8:30 PM	0.000	
8:30 PM to 9:00 PM	-0.657	-2.61
After 9:00 PM	-0.814	-3.20
Linear shift for every 30 minutes after 09:30 pm	-0.205	-2.50
Individual tour duration constants		
0 hours	-11.727	-2.90
0.5 hous	-5.089	-2.55
1 hour	-0.126	-0.69
1.5 hours	0.000	
2 hours	-0.125	-0.68
2.5 hours or more	-0.156	-0.77
Linear shift for every 30 minutes more than 3 hrs	-0.336	-3.80
Joint tours departure time constants		

Explanatory variables	Coefficient	t-Stat
11:00 AM - 12:00 PM	0.532	1.23
12:00 PM - 12:30 PM	0.674	1.43
12:30 PM to 01:00 PM	0.422	0.84
Linear shift for every 30 minutes before 05:00 pm	-0.033	-0.28
Before 05:30 PM	-0.561	-1.54
05:30 PM - 06:00 PM	-0.179	-0.66
06:00 PM - 06:30 PM	0.000	
06:30 PM - 07:00 PM	-0.282	-1.11
07:00 PM - 07:30 PM	-0.300	-0.88
After 07:30 PM	-0.845	-1.84
Linear shift for every 30 minutes after 08:00 pm	-0.668	-3.54
Joint tours arrival time constants		
12:30 PM to 01:00 PM	2.002	3.77
01:00 PM to 01:30 PM	2.115	4.39
01:30 PM to 02:00 PM	1.648	3.26
02:00 PM to 02:30 PM	1.525	3.24
Linear shift for every 30 minutes before 06:30 pm	-0.153	-1.32
Before 7:00 PM	-0.412	-0.88
7:00 PM to 7:30 PM	-0.385	-1.05
7:30 PM to 8:00 PM	-0.044	-0.17
8:00 PM to 8:30 PM	0.000	
8:30 PM to 9:00 PM	-0.240	-0.92
After 09:00 PM	-0.249	-0.72
Linear	-0.205	-1.45
Joint tours duration constants		
0 hours	-4.269	-3.87
0.5 hous	-1.323	-3.35
1 hour	0.000	
1.5 hours	-0.196	-0.96
2 hours or more	-0.524	-1.84
Linear shift for every 30 minutes more than 2.5 hrs	-0.649	-4.67
Auto Distance		
Duration < 1 hrs – Linear	-0.135	-3.34
Duration > 1 hrs - Linear	0.018	9.24
Low Income (<=$24,999)		
Duration < 1 hrs - Linear	1.002	2.99
Medium Income ($25,000 to $60,000)		
Duration < 1 hrs - Linear	0.500	2.05
Zero auto households		
Duration > 1 hrs - Linear	0.259	3.14
Kids in Joint Tour		
Duration < 1.5 hrs	1.785	3.38

Explanatory variables	Coefficient	t-Stat
Joint Tours Party Size > 2		
Duration < 1.5 hrs	-1.626	-2.49
University student		
Departure after 7:00 pm - Linear	0.294	2.58
Female [Individual tours]		
Duration < 1 hrs - Linear	-0.399	-1.51
Duration > 1 hrs - Linear	0.065	1.84
Time Pressure [Individual Tours]		
Departure before 6:30 pm - Linear	0.084	2.23
Duration < 1 hrs - Linear	1.696	2.52

Estimation statistics	
Observations	775
Final log likelihood	-3660
$Rho^2(0)$	0.234
$Rho^2(c)$	-0.014

Table 32: Social and Discretionary Tour Time-of-Day Choice Model Parameters

Explanatory variables	Coefficient	t-Stat
Discretionary tours departure time constants		
Shift for every 30 minutes after 07:30 pm		
Linear	-0.742	-12.54
Before 7:30 AM	-1.324	-3.30
7:30 AM to 8:00 AM	-0.695	-1.91
8:00 AM to 8:30 AM	-0.270	-0.84
8:30 AM to 9:00 AM	-0.094	-0.33
9:00 AM to 9:30 AM	0.266	1.09
9:30 AM to 10:00 AM	0.288	1.35
10:00 AM to 10:30 AM	0.397	2.16
Linear shift for every 30 minutes before 04:30 pm	-0.246	-4.52
Before 05:00 PM	-1.344	-7.28
05:00 PM - 05:30 PM	-0.623	-3.85
05:30 PM - 06:00 PM	-0.457	-3.60
06:00 PM - 06:30 PM	-0.207	-2.11
06:30 PM - 07:00 PM	0.000	
After 07:00 PM	-0.464	-4.32
Linear shift for every 30 minutes after 07:30 pm	-0.292	-4.41
Discretionary tour arrival time constants		
Shift for every 30 minutes before 06:00 pm		
Linear shift for every 30 minutes before 06:00 pm	0.149	3.61
Before 6:30 PM	0.669	3.33
6:30 PM to 7:00 PM	-0.054	-0.29
7:00 PM to 7:30 PM	0.100	0.72
7:30 PM to 8:00 PM	0.063	0.60
8:00 PM to 8:30 PM	0.000	
8:30 PM to 9:00 PM	-0.186	-1.84
After 9:00 PM	-0.423	-3.47
Linear shift for every 30 minutes after 09:30 pm	-0.526	-11.10
Discretionary tour duration constants – joint tours		
0 hours	-0.944	-1.67
0.5 hous	-0.118	-0.32
1 hour	0.438	1.91
1.5 hours	-0.003	-0.02
2 hours	0.000	
2.5 hours or more	0.239	1.68
Linear shift for every 30 minutes more than 3 hrs	-0.108	-2.17
Discretionary tour duration constants – individual tours		
0 hours	0.437	0.60
0.5 hous	1.360	2.58
1 hour	1.693	4.60

1.5 hours	1.119	4.66
2 hours	0.771	5.51
2.5 hours or more	0.000	
2.5 hours or more	-0.631	-4.78
Linear shift for every 30 minutes more than 3 hrs	-0.701	-5.82
Social tour departure time constants		
Linear shift for every 30 minutes before 08:30 am	-0.530	-9.56
Before 09:00 AM	-0.198	-0.88
09:00 AM to 09:30 AM	0.138	0.61
Linear shift for every 30 minutes before 05:00 pm	-0.142	-3.05
Before 05:30 PM	-0.391	-2.23
05:30 PM - 06:00 PM	-0.454	-2.12
06:00 PM - 06:30 PM	0.000	
06:30 PM - 07:00 PM	-0.089	-0.44
07:00 PM - 07:30 PM	0.053	0.25
After 07:30 PM	-0.650	-2.70
Linear shift for every 30 minutes after 08:00 pm	-0.096	-1.30
Social tour arrival time constants		
03:00 PM to 03:30 PM	0.377	1.67
03:30 PM to 04:00 PM	0.583	2.88
04:00 PM to 04:30 PM	0.728	3.98
05:00 PM to 06:00 PM	0.250	1.70
Linear shift for every 30 minutes before 08:00 pm	0.054	1.90
Before 8:30 PM	0.309	1.63
8:30 PM to 9:00 PM	-0.209	-0.91
9:00 PM to 9:30 PM	-0.336	-1.52
9:30 PM to10:00 PM	0.000	
10:00 PM to 10:30 PM	-0.056	-0.29
After 10:30 PM	-0.612	-3.06
Linear shift for every 30 minutes after 11:00 pm	-0.348	-6.68
Social tour duration constants – joint tours		
Linear shift for every 30 minutes less than 1.5 hrs	0.619	3.02
Less than 2 hours	-0.584	-1.42
2 hours	-0.272	-0.66
2.5 hours	0.000	
3 hours	0.042	0.13
Linear shift for every 30 minutes more than 3.5 hrs	-0.130	-2.97
Social tour duration constants – individual tours		
Linear shift for every 30 minutes less than 2.5 hrs	0.614	4.58
Less than 3 hrs	0.354	1.70
3 hours	0.000	
3.5 hours	-0.691	-3.29
4 hours	-1.344	-5.15
Linear shift for every 30 minutes more than 4.5 hrs	-0.787	-6.71

Person< 18 years old [Individual tours]		
Duration < 1.5 hrs – Linear	-0.263	-2.21
Duration > 1.5 hrs – Linear	0.087	6.83
Non-working senior/ retiree [Individual tours]		
Duration < 1.5 hrs – Linear	0.468	3.16
Retiree/ Non-working senior only HH [Individual tours]		
Duration < 1.5 hrs – Linear	-0.312	-1.51
Zero auto households		
Duration < 1.5 hrs - Linear	-0.508	-1.40
Duration > 1.5 hrs - Linear	0.074	3.14
Number of autos more that number of adults		
Duration < 1.5 hrs - Linear	0.127	1.22
Duration > 1.5 hrs - Linear	0.049	3.52
Kids in Joint Tour		
Duration < 1.5 hrs	-0.560	-3.58
Duration > 1.5 hr	-0.115	-3.18
Joint Tours Party Size > 2		
Duration > 1.5 hr	0.104	2.87
Auto Distance		
Duration < 1 hrs - Linear	-0.163	-10.79
Duration > 1 hrs - Linear	0.007	14.14
Time Pressure		
Duration < 1 hrs - Linear	-0.229	-3.78
Duration > 1 hrs - Linear	0.219	6.11
Number of Additional Individual Tours of Same Purpose *		
Duration < 1 hrs - Linear	0.156	2.02

Estimation statistics	
Observations	3408
Final log likelihood	-17352
$Rho^2(0)$	0.181
$Rho^2(c)$	0.030

Table 33: At-Work Sub-tour Frequency Choice Model Parameters

Explanatory variables	No Subtour	1 Eat	1 Business	1 Maint.	2 Business	2 Eat & Bus
Constant		-0.1237	-0.6149	-1.1528	-1.9766	-1.7178
Person type						
Full-time worker	-0.6000	-7.2800	-7.3750	-8.0930	-14.2800	-14.7900
Non full-time worker	-0.6000	-8.6040	-8.3190	-8.2140	-14.2800	-14.7900
Non-worker person types		0.0000	-5.0000	-5.0000	-5.0000	-5.0000
Household income						
$25,000 – $59,999		0.6100	0.5555	0.1527	1.1110	1.1655
$60,000 or more		0.8693	1.0660	0.1651	2.1320	1.9353
Zero car household		-0.3391		0.1762	0.0000	-0.3391
Non-mandatory tour participation						
Individual discretionary tour & full-time worker		0.2334	0.7045	0.5061	1.4090	0.9379
Individual discretionary tour & part-time worker		0.6776	0.7045	0.5061	1.4090	1.3821
Individual eating-out tour		0.5491	0.5434	0.9166	1.0868	1.0925
Maintenance tour & full-time worker		-0.0520	-0.1903	0.1446	-0.3806	-0.2423
Maintenance tour & part-time worker		-0.3099	-0.1903	-0.2723	-0.3806	-0.5002
Participation in at least one joint maintenance tour		0.2458	0.0830	0.0803	0.1660	0.3288
Participation in at least one joint discretionary tour		0.3588	-0.2637	0.5822	-0.5274	0.0951
Log of the work tour duration		1.5500	1.1420	1.6590	2.2840	2.6920
Dummy for drive-alone mode for the work tour		0.4804	0.9901	1.1530	1.9802	1.4705
Two work tours implemented by the person		-0.9862	0.3753	-0.2312	0.7506	-0.6109
Workplace area type[1]						
Urban area		-0.4182	-0.2235	-0.1479	-0.4470	-0.6417
Suburban area		-0.2916	-0.1102		-0.2204	-0.4018
Workplace accessibility to retail						
Auto accessibility	z	0.0150	0.0534	0.0265	0.1067	0.0683
Walk accessibility	z	0.0600		0.0400	0.0000	0.0600
Dummy for worker or student with non-mandatory tour(s)				-0.3573	0.0000	0.0000

1 Area types are as follows: cbd=1, urban=2,3, suburban=4,5,6, rural=7

Table 34: At-Work Subtour Destination Choice Model Parameters

Explanatory variable	Coefficient
Distance	0.1357
Distance squared	-0.012361
Distance cubed	1.337E-04
Log of distance	-2.0842
Full-time worker, distance	
Business subtour	-0.0345
Eatout subtour	-0.2266
Other subtour	-0.1468
Non full-time worker, distance	
Business subtour	-0.1864
Eatout subtour	-0.3905
Other subtour	-0.3176
Off-peak mode choice logsum	
Business subtour	1.0000
Eatout subtour	1.0000
Other subtour	1.0000
Drive alone not chosen for mandatory tour	2.4850
Size variable	
Business subtour	0.4610
Eatout subtour	0.6904
Other subtour	0.6166

Table 35: At-Work Subtour Time-of-Day Choice Model Parameters

Explanatory variables	Coefficient	t-Stat
Departure Time Constants		
Linear shift for every 30 minutes before 10:30 am	-0.732	-8.81
Before 11:00 AM	-2.177	-8.94
11:00 AM - 11:30 AM	-1.190	-6.48
11:30 AM - 12:00 PM	-0.198	-1.70
12:00 AM - 12:30 PM	0.000	
12:30 PM - 01:00 PM	-0.085	-0.68
After 01:00 PM	-0.206	-1.20
Square Root shift for every 30 minutes after 1:30 pm	0.539	3.46
Arrival Time		
Linear shift for every 30 minutes before 11:30 am	0.415	5.32
Before 12:00 PM	0.279	1.19
12:00 AM - 12:30 PM	-0.045	-0.25
12:30 PM - 01:00 PM	0.214	1.88
01:00 PM - 01:30 PM	0.000	
01:30 PM - 02:00 PM	-0.697	-5.63
02:00 PM - 02:30 PM	-1.284	-7.18
After 02:30 PM	-2.120	-8.81
Linear shift for every 30 minutes after 3:00 pm	-0.508	-8.83
Duration Constants		
0 hrs	-0.970	-4.17
0.5 hrs	0.000	
1 hrs	0.177	1.83
1.5hrs	-0.171	-1.13
2 hrs	-0.468	-2.21
Longer than 2 hrs	-0.524	-2.16
Square root shift for every 30 minutes more than 2.5 hrs	-0.424	-2.71
Female		
Departure after 12:30 pm - Linear	0.056	1.89
Part-time Worker		
Departure after 12:30 pm - Linear	0.129	2.26
Duration > 0.5 hrs - Linear	0.162	3.31
Business tour purpose		
Departure before12:00 pm - Linear	0.269	6.85
Departure after 12:30 pm - Linear	0.176	4.90
Duration > 0.5 hrs - Linear	0.362	9.89
Eatout tour purpose		
Departure before12:00 pm - Linear	-0.251	-4.71
Departure after 12:30 pm - Linear	-0.170	-3.98
Duration < 0.5 hrs - Linear	-0.679	-2.75
Low Income (<=$25,000)		

Explanatory variables	**Coefficient**	**t-Stat**
Duration < 0.5 hrs - Linear	0.885	1.86
Medium Income ($25,001 to $60,000)		
Duration < 0.5 hrs - Linear	0.527	2.12
Duration > 0.5 hrs - Linear	-0.082	-2.28
Medium-High Income ($60,001 to $120,00)		
Duration > 0.5 hrs - Linear	-0.068	-2.06
Health		
Duration < 0.5 hrs - Linear	0.791	1.96
Blue Collar Worker		
Duration < 0.5 hrs - Linear	1.191	2.95
Duration > 0.5 hrs - Linear	0.123	3.05
Distance		
Duration < 0.5 hrs - Linear	-0.292	-4.68
Duration > 0.5 hrs - Linear	0.007	6.12

Estimation statistics	
Observations	1212
Final log likelihood	-4919
$Rho^2(0)$	0.263
$Rho^2(c)$	0.016

Table 36: Work Tour Mode Choice Model Parameters

Explanatory variables	Estimated Parameters		Application Parameters[1]
	Coefficient	t-Stat	Coefficient
Level of service			
Car in-vehicle time (min)	-0.02472	-4.4	-0.02472
Transit in-vehicle (min)	-0.0172	-2.7	-0.02472
Cost (parking, toll, operating, fare) (cents)	-0.001584	-3.7	
Low income (Less than $20,000)			-0.0103
Medium income ($20,000 - $49,999)			-0.0023
High income ($50,000 or more)			-0.0014
Transit walk access/egress time (short walk) (min)	-0.06438	-5.2	-0.0494
Transit walk access/egress time (long walk) (min)	-0.06438	-5.2	-0.0618
Transit first wait time (min)	-0.0579	-2.9	-0.0494
Transit transfer time (min)	-0.0172	-2.7	-0.0494
Transit transfers (#)	-0.2599	-2.3	
Walk time (short walk) (min)	-0.07992	-3.1	-0.0494
Walk time (short walk) (min)	-0.05697	-6.5	-0.0618
Bike time (short ride) (min)	-0.07992	-3.1	-0.1112
Bike time (long ride) (min)	-0.05697	-6.5	-0.1112
Transit PNR drive access time (min)			-0.0494
Transit KNR drive access time (min)			-0.0618
Drive alone			
Outbound escort stop on tour	-3.657	-19.1	
Inbound escort stop on tour	-3.429	-15.9	
Outbound shopping stop on tour	0.7024	3.5	
Inbound shopping stop on tour	0.691	6.0	
Age 16-22	-0.4227	-2.6	-0.4227
Homemaker	-0.6893	-4.5	-0.6893
Shared ride			
Constant	-2.484	-37.4	
No cars in HH	*-3.141*	*-6.6*	
Cars in HH>0 but <workers	*1.773*	*14.4*	
Cars in HH>workers	*-0.2974*	*-4.3*	
HH income <20K	*0.4231*	*2.7*	
HH income 20-50K	*0.2447*	*3.2*	
HH income missing	*0.05974*	*0.5*	
Outbound 1+ stops on tour	*0.7632*	*9.0*	
Inbound 1+ stops on tour	*0.901*	*12.0*	
Single person HH	-0.7019	-6.6	-0.7019
Male with children under 16	0.2215	2.6	0.2215
Female with children under 16	0.9644	11.2	0.9644

Explanatory variables	Estimated Parameters		Application Parameters[1]
	Coefficient	t-Stat	Coefficient
Male with children age 16+	0.1003	0.6	0.1003
Female with children age 16+	0.3513	2.4	0.3513
Depart from home before 6 AM	-0.3082	-2.4	-0.3082
Depart from home after 4 PM	0.5427	3.6	0.5427
Drive to transit			
Constant	-3.87	-14.3	
Cars in HH>0 but <workers	1.779	5.7	
HH income <20K	0.7054	1.8	
HH income 20-50K	0.6269	3.2	
HH income missing	0.6211	2.0	
Outbound 1+ stops on tour	0.979	5.3	
Inbound 1+ stops on tour	0.8509	4.8	
Walk to transit			
Constant	-5.526	-6.7	
No cars in HH	4.374	4.6	
Cars in HH>0 but <workers	4.371	7.1	
Cars in HH>workers	-2.011	-2.8	
HH income <20K	1.089	1.9	
HH income 20-50K	0.7161	1.7	
HH income missing	0.7136	1.0	
Walk and bike			
Constant	-5.105	-5.7	
Cars in HH>0 but <workers	3.276	4.7	
Outbound 1+ stops on tour	-3.223	-3.4	
Inbound 1+ stops on tour	-1.727	-2.7	
Percent of roads with sidewalks (O+D)	2.414	5.2	
Age under 40	0.7449	1.8	0.7449
Male	0.9845	2.3	0.9845
Nesting parameters			
Car nest (Drive alone + Shared ride + Drive to transit)	0.5275	8.3	
Primary mode nest (Auto | Non-motorized | Transit)			0.6000
Submode nest			0.4000

1 Refer to the Model Calibration report for the value of the mode and market-specific constants

Estimation statistics	
Observations	11067
Final log likelihood	-4765
$Rho^2(0)$	0.570
$Rho^2(c)$	0.363

Table 37: School and University Tour Mode Choice Model Parameters

Explanatory variables	Estimated Parameters		Application Parameters School[1]	Application Parameters University[1]
	Coefficient	t-stat	Coefficient	Coefficient
Level of service				
In-vehicle time				
University tours	-0.01587	-1.8		-0.02470
School tours	-0.00636	-1.2	-0.00636	
Out of vehicle time				
University tours	-0.04573	-3.8		
School tours	-0.0474	-5.5		
Transit first wait time (min)			-0.0494	-0.0127
Transit transfer wait time (min)			-0.0494	-0.0127
Walk time (min)			-0.0457	-0.0127
Bike time (min)			-0.0457	-0.0127
Transit PNR drive access time (min)			-0.0494	-0.0127
Transit KNR drive access time (min)			-0.0618	-0.0159
Cost (parking, toll, operating, fare) (cents)	-0.003477	-2.5		
Low income (Less than $20,000)			-0.0103	-0.0040
Medium income ($20,000 - $49,999)			-0.0023	-0.0009
High income ($50,000 or more)			-0.0014	-0.0005
Drive alone				
Escort stop on tour	-10.31	-3.6		
Age 16 or 17	-2.241	-3.4	-2.241	-2.241
Worker	1.92	2.3	1.92	1.92
University student	2.505	3.5		2.505
Shared ride				
Constant	-3.054	-4.2		
No cars in HH	-7.988	-4.9		
Cars in HH>0 but <drivers	4.666	5.3		
HH income <20K	-0.5635	-1.5		
HH income 20-50K	-0.2276	-1.0		
HH income >100K	0.654	2.5		
HH income missing	0.2964	0.8		
Outbound 1+ stops on tour	1.276	3.1		
Inbound 1+ stops on tour	1.705	4.6		
Single person HH	-2.993	-1.7	-2.993	-2.993
Walk to transit				
Constant	-4.796	-4.6		
Cars in HH>0 but <drivers	6.468	5.3		

Explanatory variables	Estimated Parameters		Application Parameters School[1]	Application Parameters University[1]
	Coefficient	t-stat	Coefficient	Coefficient
HH income<50 K	1.507	2.8	1.507	1.507
University student	2.297	3.3		2.297
School bus				
Constant	-8.015	-5.5		
No cars in HH	-1.403	-2.9		
Cars in HH>0 but <drivers	6.218	5.6		
Grade school pre-driver	2.962	4.4	2.962	
Grade school driver	0.1473	0.3	0.1473	
Destination in rural/exurban area	1.34	4.8	1.34	
OD distance over 10 miles	-2.372	-4.7	-2.372	
Depart from home before 8 AM	0.596	2.7	0.596	
Arrive back home before 5 PM	2.573	5.5	2.573	
Walk and bike				
Constant	-7.476	-4.7		
Cars in HH>0 but <drivers	5.343	5.1		
HH income<50 K	2.524	3.8	2.524	2.524
HH income missing	1.087	1.1		
Outbound 1+ stops on tour	-2.153	-1.4		
Inbound 1+ stops on tour	-5.051	-3.6		
University student	4.087	3.4		4.087
Percent of roads with sidewalks (O+D)	2.393	4.1		
Male	1.094	2.3	1.094	1.094
Nesting parameter				
Bus nest (Walk to transit + School bus)	0.4421	6.1		
Primary mode nest (Auto | Non-motorized | Transit)			0.6000	0.6000
Submode nest			0.4000	0.4000

1 Refer to the Model Calibration report for the value of the mode and market-specific constants

Estimation statistics	
Observations	3792
Final log likelihood	-2690
$Rho^2(0)$	0.353
$Rho^2(c)$	0.285

Table 38: Non-Mandatory Tour and At-Work Subtour Mode Choice Model Parameters

Explanatory variables	Estimated parameters		Application parameters[1]
	Coefficient	t-Stat	Coefficient
Level of service			
In-vehicle time (min)	-0.02142	-2.8	-0.02142
Transit first wait time (min)	-0.03714	-1.5	-0.04284
Transfer wait time (min)	-0.02142	-2.8	-0.04284
Transit walk access/egress time (min)	-0.05432	-2.7	
Short walk (less than 2/3 mile)			-0.05871
Long walk (excess over 2/3 mile)			-0.04058
Walk time (min)			
Short walk	-0.05871	-5.3	-0.05871
Long walk	-0.04058	-9.0	-0.04058
Bike time (min)			
Short ride (min)	-0.05871	-5.3	-0.04058
Long ride (min)	-0.04058	-9.0	-0.04058
Transit PNR drive access time (min)			-0.0428
Transit KNR drive access time (min)			-0.0536
Cost (parking, toll, operating, fare) ($)	-0.2429	-3.1	
Low income (Less than $20,000)			-0.0103
Medium income ($20,000 - $49,999)			-0.0023
High income ($50,000 or more)			-0.0014
Drive alone			
HH income <20K	-0.3872	-3.3	
HH income 20-50K	-0.1754	-2.6	
HH income missing	0.1147	1.1	
Main tour purpose is escort	-1.692	-6.0	
Main tour purpose is shopping	0.1724	2.7	
Joint household tour	-5.21	-14.3	-999
Outbound escort stop on tour	-3.545	-12.6	
Inbound escort stop on tour	-3.111	-9.9	
Working adult			1.9200
Age 16-17			-2.2410
Age 40 to 59	0.3017	5.0	0.3017
Age 60 to 79	0.4468	5.6	0.4468
Non-working adult	-0.1479	-2.5	-0.1479
OD distance under 5 miles	0.3875	7.1	0.3875
Shared ride			
Constant	-1.601	-17.6	
No cars in HH	-3.226	-8.3	
Cars in HH>0 but <drivers	0.5172	6.5	
Main tour purpose is escort	2.068	7.7	2.068
Joint household tour, 2-person party size	1.068	5.2	1.068
Main tour purpose is eating out	0.9919	12.8	0.9919
Outbound 1+ eat/visit/discr stops on tour	0.8041	7.2	

Inbound 1+ eat/visit/discr stops on tour	0.7307	7.4	
Outbound 1+ shop/maint stops on tour	0.09117	1.1	
Inbound 1+ shop/maint stops on tour	0.1924	2.6	
Single person HH	-0.7493	-9.2	-0.7493
Male adult with children under 16	0.7186	7.3	0.7186
Female adult with children under 16	1.144	14.2	1.144
Other female adults	0.4521	7.1	0.4521
Child under age 16	1.275	4.1	1.275
Depart from home after 4 PM	0.4036	4.8	0.4036
Arrive back home after 7 PM	0.4206	4.9	0.4206
Drive to transit			
Constant	-4.772	-10.4	
Cars in HH>0 but <drivers	1.911	3.8	
Non-working adult	0.7251	1.6	0.7251
At-work subtour			-999
Walk to transit			
Constant	-7.666	-7.0	
No cars in HH	4.116	4.5	
Cars in HH>0 but <drivers	3.22	3.7	
Non-working adult	1.322	2.4	1.322
Age is 60+	-1.087	-1.6	-1.087
Walk and bike			
Constant	-3.153	-6.4	
HH income > 100K	-0.945	-3.5	-0.945
HH income missing or less than zero	0.6629	2.3	0.6629
Cars in HH>0 but <drivers	1.031	4.5	
Main tour purpose is eat out/visit/discr.	0.8532	4.4	0.8532
Outbound 1+ stops on tour	-2.297	-5.1	
Inbound 1+ stops on tour	-1.677	-4.7	
Percent of roads with sidewalks (O+D)	1.944	8.3	
Age under 40	0.5114	2.5	0.5114
Age is 60+	-1.044	-3.8	-1.044
Intrazonal tour	1.004	4.0	1.004
Nesting parameter			
Car nest (Drive alone + Shared ride + Drive to transit)	0.6068	10.7	
Primary mode nest (Auto | Non-motorized | Transit)			0.6000
Submode nest			0.4000

1 Refer to the Model Calibration report for the value of the mode and market-specific constants

Estimation statistics	
Observations	14437
Final log likelihood	-6057
$Rho^2(0)$	0.607
$Rho^2(c)$	0.473

Table 39: Work Tour Stop Frequency Model Parameters

Explanatory variable	Coeff.	t-Stat
Constants		
1 outbound stop	-2.4850	-13.8
2 outbound stops	-5.3557	-15.1
3 outbound stops	-7.3163	-13.7
1 return stop	-1.9514	-11.1
2 return stops	-4.4591	-12.6
3 return stops	-6.3672	-12.0
2 total stops	1.3089	7.2
3 total stops	2.6479	7.4
4 total stops	4.0625	7.6
5 total stops	5.8090	8.1
6 total stops	7.3705	8.1
Household variables		
Income between $20,000 and $50,000	0.1649	1.6
Income between $50,000 and $100,000	0.2330	2.3
Income greater than $100,000	0.2469	2.2
Number of HH Persons	-0.3120	-10.3
Number of Students in HH	0.2102	5.5
Presence of children between 0 and 5 old	0.7398	6.3
Number of children between 5 and 16 years old	0.0838	3.9
Presence of children between 5 and 16 years old	0.2614	2.9
Number of Adults (persons older than 16 years old)	0.0331	3.6
Car sufficiency (cars > workers)	0.1782	1.7
Person variables		
Female	0.2586	6.4
Mode variables		
Walk tour	-1.5309	-6.0
Activity variables		
Number of work tours minus 1	-0.1516	-2.3
Number of university tours	-0.4658	-1.6
Number of school tours	-1.5642	-3.2
Number of escort tours	0.1986	2.7
Number of subtours	0.1972	3.9
Number of household shopping tours - number of person shopping tours	-0.0480	-2.6
Number of participants in the tour – 1, tours with outbound stops	0.1586	1.6
Number of participants in the tour – 1, tours with return stops	0.3022	3.9
Departure time between 7:00 and 8:59, tours with outbound stops	-1.9192	-3.3
Arrival time between 19:00 and 23:59, tours with return stops	0.3132	6.0
Duration of the tour is equal or greater than 11 hours, tours with return stops	0.6096	11.7

Accessibility and area type variables		
Area type = 4, 5, 6, 7, outbound tours	0.2024	3.1
Primary tour destination is in the CBD	0.2255	4.1
Trip distance is less than 20 miles	-0.2166	-2.7
Distance (miles)	0.0055	1.8

Estimation statistics	
Final likelihood	-16160
$Rho^2(0)$	0.4489

Table 40: University and School Tour Stop Frequency Model Parameters

Explanatory variable	Coeff.	t-Stat	Coeff.	t-Stat
Constants				
1 outbound stop	-6.2664	-5.6	-2.6711	-5.0
1 return stop	-5.3718	-4.8	-2.1399	-4.1
2 total stops	5.0407	4.4	1.0397	1.8
Household Variables				
Number of HH Persons	-0.2827	-2.6	-0.5060	-4.1
Presence of children between 5 and 16 years old	0.6823	2.0	0.3299	1.5
Number of vehicles	0.1703	1.5	0.5331	2.4
Person variables				
Female	0.7349	3.6	0.4099	2.4
Mode variables				
Walk tour			-1.8163	-1.7
Activity variables				
Number of escort tours	0.9018	3.2	1.2365	2.1
Arrival time between 17:00 and 23:59, tours with return stops	0.3890	1.6	1.8377	7.2
Duration of the tour is equal or greater to 11 hours, tours with return stops	0.8434	3.3	0.9549	4.0
Accessibility and area type variables				
Area type = 4, 5, 6, 7, outbound tours	0.5310	2.2		
HH accessibility, inbound tours	0.2481	2.7		
Trip distance			0.0438	1.8

Estimation statistics		
Final log likelihood	-444	-503
$Rho^2(0)$	0.4032	0.5452

Table 41: Escort, Shop and Maintenance Tour Stop Frequency Model Parameters

Explanatory variable	Escort		Shopping		Other Maintenance	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Constants						
1 outbound stop	-1.7865	-8.2			-3.2322	-14.5
2 outbound stop			-1.8054	-18.0	-3.3410	-11.7
3 outbound stop			-2.3751	-19.8		
1 return stop	-1.3263	-6.3	-0.9764	-13.6	-2.2817	-10.6
2 return stops	-0.4773	-1.6	-2.2117	-20.2	-2.3787	-9.0
3 return stops			-2.6800	-20.6		
2 total stops	-1.6012	-7.8			-0.6295	-4.1
3 total stops	-2.3364	-4.3			1.6094	4.8
Household Variables						
Income $50,000 to $100,000			0.1382	1.6		
Number of HH persons	-0.2373	-3.5	-0.1493	-3.4		
Number of students in HH	0.1895	2.5				
Number of children between 5 and 16 years old			0.0475	3.1		
Person variables						
Female			0.1624	2.6	0.3798	3.7
Mode variables						
Walk tour	-1.9140	-3.2	-1.4917	-5.4	-1.4323	-3.9
Activity variables						
Number of work tours	-0.2916	-2.7	-0.5504	-6.0	-0.3640	-3.0
Number of university tours			-0.6733	-1.8	-0.6378	-1.3
Number of school tours					-1.3781	-2.6
Number of maintenance tours			-0.1978	-1.8		
Number of escort tours	-0.1505	-2.5				
Number of shopping tours					-0.1424	-1.3
Number of household shopping tours			-0.0715	-3.3		
Number of household maintenance tours					-0.0482	-2.2
One or more adults participate in joint tour			0.3906	2.4	0.3584	1.2
One or more children accompany adult in joint tour					0.0926	0.3
Number of joint tour participants, inbound stops					0.3020	1.5
Arrival Time between 17:00 and 23:59, tours with return stops	0.2160	2.0				
Duration of the tour is equal to or greater than 11 hrs.	0.5921	1.8	0.9062	2.6	0.5219	2.0
Accessibility and area type variables						
Trip distance less than 5 miles	0.3216	2.7				
Trip distance less than 20 miles					0.0273	3.3
Trip distance (miles)	0.0148	2.4	0.0287	5.5		
Trip destination in exurban-type area			-0.3517	-3.0		
Trip destination in rural-type area			-0.2299	-1.9		

Estimation statistics	Escort	Shopping	Other Maintenance
Final likelihood	-2119	-6222	-2579
$Rho^2(0)$	0.475	0.190	0.319

Table 42: Eat out, Visit and Other Discretionary Tour Stop Frequency Model Parameters

Explanatory variable	Eat out & Visit		Other Discretionary	
	Coef.	t-Stat	Coef.	t-Stat
Constants				
1 outbound stop	-1.4163	-8.7	-1.6688	-19.6
1 return stop	-1.5645	-11.2	-0.5120	-5.7
2 total stops	1.4546	9.3		
Household Variables				
Number of cars in HH	-0.1946	-3.2		
Mode variables				
Walk tour	-1.7267	-5.0	-2.4626	-5.8
Activity variables				
Number of work tours	-0.2784	-2.8	-0.6123	-6.1
Number of school tours			-0.8294	
Number of maintenance tours			-0.3693	-2.7
Number of shopping tours	-0.2432	-2.0	-0.6285	-4.8
One or more adults participate in joint tour			-0.0181	-0.1
One or more children accompany adult in joint tour	0.3669	1.6	-0.1302	-0.7
Number of joint tour participants, outbound stops	-0.4641	-3.7		
Arrival Time between 17:00 and 23:59, tours with return stops	-0.4469	-3.9	-0.6291	-5.7
Duration of the tour is equal to or greater than 11 hrs.			0.8281	2.7
Accessibility and area type variables				
Trip distance less than 20 miles			0.3778	3.2
Trip distance (miles)	-0.0088	-1.6	-0.0223	-3.0
Trip destination in exurban-type area	-0.2238	-1.4		
Trip origin in rural-type area	0.2065	1.6		

Estimation statistics	Eat out & Visit	Other Discretionary
Final likelihood	-2032	-1963
Rho²(0)	0.306	0.379

Table 43: Stop Purpose Frequency Distribution, Outbound Tour Leg

Tour purpose	Time of day	Person type	Stop purpose									Total
			Work	Univ.	School	Escort	Shop	Maint.	Eat out	Visit	Discr.	
Work	Before 9 AM	FT worker	19.8%	0.4%	0.0%	46.6%	8.3%	8.6%	9.3%	0.4%	6.6%	100.0%
Work	Before 9 AM	PT worker	9.4%	0.0%	0.0%	65.7%	7.6%	7.0%	6.7%	0.9%	2.7%	100.0%
Work	Before 9 AM	University student	6.7%	8.1%	0.0%	43.3%	0.5%	3.8%	15.3%	10.8%	11.5%	100.0%
Work	9 AM and later	FT worker	27.8%	0.8%	0.0%	17.2%	18.0%	19.3%	10.7%	1.6%	4.6%	100.0%
Work	9 AM and later	PT worker	44.2%	0.0%	0.0%	8.9%	10.5%	17.5%	10.2%	3.0%	5.7%	100.0%
Work	9 AM and later	University student	4.9%	8.6%	0.0%	39.2%	15.9%	15.7%	6.9%	7.3%	1.5%	100.0%
University	Any	FT Worker	52.6%	17.8%	0.0%	1.6%	16.0%	3.5%	2.8%	5.7%	0.0%	100.0%
University	Any	PT Worker	5.9%	94.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%
University	Any	University student	10.9%	3.4%	0.0%	38.2%	13.6%	14.7%	9.4%	4.8%	5.0%	100.0%
School	Any	Driving Age Child	0.0%	0.0%	0.0%	54.8%	1.5%	10.0%	20.6%	7.3%	5.8%	100.0%
School	Any	Pre-Driving Child	0.0%	0.0%	0.0%	53.0%	2.5%	8.4%	11.2%	4.8%	20.1%	100.0%
School	Any	Preschool Child	0.0%	0.0%	0.0%	77.2%	0.7%	8.6%	2.3%	7.1%	4.1%	100.0%
Escort	Any	FT Worker	0.0%	0.0%	0.0%	55.0%	15.3%	8.4%	10.4%	4.9%	6.0%	100.0%
Escort	Any	PT Worker	0.0%	0.0%	0.0%	44.9%	19.4%	7.0%	16.7%	5.9%	6.1%	100.0%
Escort	Any	University student	0.0%	0.0%	0.0%	50.9%	19.3%	15.8%	4.8%	5.8%	3.4%	100.0%
Escort	Any	Homemaker	0.0%	0.0%	0.0%	44.4%	21.6%	8.4%	10.8%	11.8%	3.0%	100.0%
Escort	Any	Retired	0.0%	0.0%	0.0%	37.0%	20.4%	19.2%	3.0%	6.8%	13.6%	100.0%
Escort	Any	Driving-age child	0.0%	0.0%	0.0%	58.6%	22.7%	0.0%	7.2%	11.5%	0.0%	100.0%
Escort	Any	Pre-driving child	0.0%	0.0%	0.0%	37.0%	18.3%	29.0%	6.4%	1.3%	8.0%	100.0%
Escort	Any	Preschool	0.0%	0.0%	0.0%	53.1%	6.4%	0.0%	13.1%	19.6%	7.8%	100.0%
Shop	Any	FT worker	0.0%	0.0%	0.0%	10.2%	45.6%	22.6%	11.0%	6.0%	4.6%	100.0%
Shop	Any	PT worker	0.0%	0.0%	0.0%	18.2%	29.1%	31.1%	10.8%	3.1%	7.7%	100.0%
Shop	Any	University student	0.0%	0.0%	0.0%	13.0%	26.2%	36.0%	12.4%	6.0%	6.4%	100.0%
Shop	Any	Homemaker	0.0%	0.0%	0.0%	14.4%	33.6%	27.4%	12.2%	6.8%	5.6%	100.0%
Shop	Any	Retired	0.0%	0.0%	0.0%	5.8%	35.7%	41.8%	5.0%	4.7%	7.0%	100.0%
Shop	Any	Driving-age child	0.0%	0.0%	0.0%	7.6%	19.3%	29.8%	4.7%	13.0%	25.6%	100.0%
Shop	Any	Pre-driving child	0.0%	0.0%	0.0%	12.1%	14.2%	23.2%	29.1%	3.0%	18.4%	100.0%
Shop	Any	Preschool	0.0%	0.0%	0.0%	13.8%	29.2%	30.1%	18.7%	6.4%	1.8%	100.0%
Maintenance	Any	FT worker	0.0%	0.0%	0.0%	20.1%	25.2%	36.6%	11.7%	3.2%	3.2%	100.0%
Maintenance	Any	PT worker	0.0%	0.0%	0.0%	27.0%	25.9%	32.5%	10.9%	0.0%	3.7%	100.0%
Maintenance	Any	University student	0.0%	0.0%	0.0%	48.9%	13.0%	16.7%	2.5%	15.0%	3.9%	100.0%

Tour purpose	Time of day	Person type	Stop purpose									Total
			Work	Univ.	School	Escort	Shop	Maint.	Eat out	Visit	Discr.	
Maintenance	Any	Homemaker	0.0%	0.0%	0.0%	27.9%	22.9%	34.4%	7.8%	3.9%	3.1%	100.0%
Maintenance	Any	Retired	0.0%	0.0%	0.0%	22.4%	13.9%	32.1%	9.8%	6.4%	15.4%	100.0%
Maintenance	Any	Driving-age child	0.0%	0.0%	0.0%	13.5%	0.0%	25.9%	8.3%	52.3%	0.0%	100.0%
Maintenance	Any	Pre-driving child	0.0%	0.0%	0.0%	19.1%	40.8%	34.4%	4.1%	0.8%	0.8%	100.0%
Maintenance	Any	Preschool	0.0%	0.0%	0.0%	14.3%	30.1%	46.4%	1.7%	2.9%	4.6%	100.0%
Eating Out	Any	FT worker	0.0%	0.0%	0.0%	14.4%	28.3%	20.2%	3.6%	12.9%	20.6%	100.0%
Eating Out	Any	PT worker	0.0%	0.0%	0.0%	16.9%	37.4%	17.9%	1.3%	13.5%	13.0%	100.0%
Eating Out	Any	University student	0.0%	0.0%	0.0%	32.0%	8.5%	11.1%	0.0%	15.3%	33.1%	100.0%
Eating Out	Any	Homemaker	0.0%	0.0%	0.0%	20.1%	22.4%	26.9%	6.3%	8.2%	16.1%	100.0%
Eating Out	Any	Retired	0.0%	0.0%	0.0%	14.2%	23.7%	23.7%	3.4%	12.3%	22.7%	100.0%
Eating Out	Any	Driving-age child	0.0%	0.0%	0.0%	17.5%	28.9%	34.6%	0.0%	10.5%	8.5%	100.0%
Eating Out	Any	Pre-driving child	0.0%	0.0%	0.0%	12.4%	13.5%	13.5%	4.0%	4.8%	51.8%	100.0%
Eating Out	Any	Preschool	0.0%	0.0%	0.0%	5.5%	32.9%	16.5%	6.1%	0.0%	39.0%	100.0%
Visiting	Any	FT worker	0.0%	0.0%	0.0%	18.6%	38.2%	14.4%	12.2%	12.6%	4.0%	100.0%
Visiting	Any	PT worker	0.0%	0.0%	0.0%	17.5%	15.3%	16.7%	14.7%	18.3%	17.5%	100.0%
Visiting	Any	University student	0.0%	0.0%	0.0%	0.0%	21.2%	9.1%	43.2%	23.4%	3.1%	100.0%
Visiting	Any	Homemaker	0.0%	0.0%	0.0%	31.1%	39.2%	14.9%	7.1%	5.8%	1.9%	100.0%
Visiting	Any	Retired	0.0%	0.0%	0.0%	12.0%	40.7%	20.3%	15.1%	10.2%	1.7%	100.0%
Visiting	Any	Driving-age child	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	41.5%	58.5%	100.0%
Visiting	Any	Pre-driving child	0.0%	0.0%	0.0%	32.2%	11.0%	5.0%	0.0%	37.8%	14.0%	100.0%
Visiting	Any	Preschool	0.0%	0.0%	0.0%	29.4%	0.0%	15.9%	0.0%	54.7%	0.0%	100.0%
Discretionary	Any	FT worker	0.0%	0.0%	0.0%	23.6%	16.9%	14.3%	19.0%	9.3%	16.9%	100.0%
Discretionary	Any	PT worker	0.0%	0.0%	0.0%	22.3%	20.8%	18.1%	19.3%	12.9%	6.6%	100.0%
Discretionary	Any	University student	0.0%	0.0%	0.0%	13.5%	12.3%	6.1%	34.2%	12.3%	21.6%	100.0%
Discretionary	Any	Homemaker	0.0%	0.0%	0.0%	26.3%	29.5%	14.8%	8.8%	8.2%	12.4%	100.0%
Discretionary	Any	Retired	0.0%	0.0%	0.0%	22.5%	5.6%	38.9%	16.0%	9.1%	7.9%	100.0%
Discretionary	Any	Driving-age child	0.0%	0.0%	0.0%	31.1%	12.6%	5.1%	1.8%	14.2%	35.2%	100.0%
Discretionary	Any	Pre-driving child	0.0%	0.0%	0.0%	22.2%	11.2%	17.2%	17.3%	14.1%	18.0%	100.0%
Discretionary	Any	Preschool	0.0%	0.0%	0.0%	27.1%	10.8%	39.3%	14.6%	4.3%	3.9%	100.0%
Work-Based	All	All	20.6%	0.0%	0.0%	12.2%	16.6%	24.7%	24.1%	0.4%	1.4%	100.0%

Table 44: Stop Purpose Frequency Distribution, Inbound Tour Leg

Tour purpose	Time of day	Person type	Stop purpose									Total
			Work	Univ.	School	Escort	Shop	Maint.	Eat out	Visit	Discr.	
Work	Before 3 PM	PT Worker	9.7%	0.0%	0.0%	25.2%	21.1%	19.2%	15.9%	8.9%	0.0%	100.0%
Work	Before 3 PM	University Student	13.4%	0.0%	0.0%	32.9%	11.4%	21.2%	16.9%	4.2%	0.0%	100.0%
Work	3 PM and later	FT Worker	15.1%	1.1%	0.0%	20.1%	28.0%	12.7%	10.3%	3.5%	9.2%	100.0%
Work	3 PM and later	PT Worker	11.0%	0.0%	0.0%	24.3%	28.1%	13.0%	11.9%	3.6%	8.1%	100.0%
Work	3 PM and later	University Student	5.8%	12.7%	0.0%	22.4%	26.9%	7.9%	7.2%	10.8%	6.3%	100.0%
University	Any	FT Worker	35.2%	3.2%	0.0%	3.2%	14.6%	11.4%	17.7%	2.8%	11.9%	100.0%
University	Any	PT Worker	0.0%	0.0%	0.0%	82.2%	17.8%	0.0%	0.0%	0.0%	0.0%	100.0%
University	Any	University Student	5.4%	2.5%	0.0%	19.4%	20.9%	17.9%	15.9%	6.7%	11.3%	100.0%
School	Any	Driving Age Child	0.0%	0.0%	0.0%	30.1%	11.7%	9.8%	16.9%	18.6%	12.9%	100.0%
School	Any	Pre-Driving Child	0.0%	0.0%	0.0%	16.6%	15.8%	14.7%	12.2%	13.3%	27.4%	100.0%
School	Any	Preschool Child	0.0%	0.0%	0.0%	38.0%	14.8%	8.9%	14.6%	10.2%	13.5%	100.0%
Escort	Any	FT Worker	0.0%	0.0%	0.0%	34.3%	23.5%	11.4%	22.2%	3.9%	4.7%	100.0%
Escort	Any	PT Worker	0.0%	0.0%	0.0%	24.0%	29.8%	12.8%	15.7%	4.5%	13.2%	100.0%
Escort	Any	University Student	0.0%	0.0%	0.0%	19.5%	31.9%	28.7%	2.0%	2.7%	15.2%	100.0%
Escort	Any	Homemaker	0.0%	0.0%	0.0%	28.0%	32.5%	16.9%	10.3%	5.0%	7.3%	100.0%
Escort	Any	Retired	0.0%	0.0%	0.0%	31.0%	31.7%	7.3%	11.1%	11.2%	7.7%	100.0%
Escort	Any	Driving-age child	0.0%	0.0%	0.0%	0.0%	48.9%	0.0%	14.8%	36.3%	0.0%	100.0%
Escort	Any	Pre-driving child	0.0%	0.0%	0.0%	18.8%	25.9%	12.9%	20.2%	6.0%	16.2%	100.0%
Escort	Any	Preschool	0.0%	0.0%	0.0%	41.3%	21.5%	11.8%	21.1%	1.9%	2.4%	100.0%
Shop	Any	FT Worker	0.0%	0.0%	0.0%	9.1%	52.6%	15.9%	15.2%	4.7%	2.5%	100.0%
Shop	Any	PT Worker	0.0%	0.0%	0.0%	10.4%	55.3%	15.6%	10.5%	3.7%	4.5%	100.0%
Shop	Any	University Student	0.0%	0.0%	0.0%	10.0%	43.0%	6.4%	34.4%	0.3%	5.9%	100.0%
Shop	Any	Homemaker	0.0%	0.0%	0.0%	11.0%	52.8%	15.8%	12.2%	5.9%	2.3%	100.0%
Shop	Any	Retired	0.0%	0.0%	0.0%	5.2%	54.9%	15.9%	12.3%	6.0%	5.7%	100.0%
Shop	Any	Driving-age child	0.0%	0.0%	0.0%	11.8%	70.7%	0.0%	4.1%	13.4%	0.0%	100.0%
Shop	Any	Pre-driving child	0.0%	0.0%	0.0%	1.5%	19.0%	25.6%	15.7%	17.9%	20.3%	100.0%
Shop	Any	Preschool	0.0%	0.0%	0.0%	20.6%	17.2%	22.0%	20.2%	15.8%	4.2%	100.0%
Maintenance	Any	FT Worker	0.0%	0.0%	0.0%	17.1%	36.4%	21.5%	15.9%	2.9%	6.2%	100.0%
Maintenance	Any	PT Worker	0.0%	0.0%	0.0%	22.8%	36.5%	17.0%	13.0%	4.1%	6.6%	100.0%
Maintenance	Any	University Student	0.0%	0.0%	0.0%	4.6%	34.5%	19.2%	29.8%	6.0%	5.9%	100.0%
Maintenance	Any	Homemaker	0.0%	0.0%	0.0%	17.0%	42.3%	15.8%	17.1%	6.4%	1.4%	100.0%

Tour purpose	Time of day	Person type	Stop purpose									Total
			Work	Univ.	School	Escort	Shop	Maint.	Eat out	Visit	Discr.	
Maintenance	Any	Retired	0.0%	0.0%	0.0%	9.9%	39.1%	21.3%	24.1%	3.6%	2.0%	100.0%
Maintenance	Any	Driving-age child	0.0%	0.0%	0.0%	3.1%	35.6%	7.5%	45.8%	3.1%	4.9%	100.0%
Maintenance	Any	Pre-driving child	0.0%	0.0%	0.0%	18.1%	25.5%	14.2%	31.3%	0.0%	10.9%	100.0%
Maintenance	Any	Preschool	0.0%	0.0%	0.0%	16.4%	24.9%	33.8%	5.3%	0.6%	19.0%	100.0%
Eating Out	Any	FT Worker	0.0%	0.0%	0.0%	10.6%	44.0%	11.2%	4.1%	12.8%	17.3%	100.0%
Eating Out	Any	PT Worker	0.0%	0.0%	0.0%	16.8%	33.1%	22.5%	2.3%	6.3%	19.0%	100.0%
Eating Out	Any	University Student	0.0%	0.0%	0.0%	16.5%	33.4%	10.4%	8.8%	13.5%	17.4%	100.0%
Eating Out	Any	Homemaker	0.0%	0.0%	0.0%	14.8%	54.7%	9.2%	5.6%	5.5%	10.2%	100.0%
Eating Out	Any	Retired	0.0%	0.0%	0.0%	16.6%	41.4%	16.9%	2.0%	16.6%	6.5%	100.0%
Eating Out	Any	Driving-age child	0.0%	0.0%	0.0%	19.5%	33.2%	11.4%	11.4%	0.0%	24.5%	100.0%
Eating Out	Any	Pre-driving child	0.0%	0.0%	0.0%	7.2%	35.6%	5.3%	1.9%	16.9%	33.1%	100.0%
Eating Out	Any	Preschool	0.0%	0.0%	0.0%	1.0%	28.6%	4.5%	11.7%	6.4%	47.8%	100.0%
Visiting	Any	FT Worker	0.0%	0.0%	0.0%	12.0%	28.6%	12.3%	19.0%	25.5%	2.6%	100.0%
Visiting	Any	PT Worker	0.0%	0.0%	0.0%	10.6%	12.2%	3.9%	55.3%	4.7%	13.3%	100.0%
Visiting	Any	University Student	0.0%	0.0%	0.0%	10.5%	27.4%	17.6%	0.0%	20.6%	23.9%	100.0%
Visiting	Any	Homemaker	0.0%	0.0%	0.0%	31.3%	32.6%	13.0%	6.2%	7.5%	9.4%	100.0%
Visiting	Any	Retired	0.0%	0.0%	0.0%	9.7%	33.8%	6.7%	15.6%	32.8%	1.4%	100.0%
Visiting	Any	Driving-age child	0.0%	0.0%	0.0%	0.0%	0.0%	36.8%	15.0%	48.2%	0.0%	100.0%
Visiting	Any	Pre-driving child	0.0%	0.0%	0.0%	5.8%	16.2%	8.5%	28.1%	12.5%	28.9%	100.0%
Visiting	Any	Preschool	0.0%	0.0%	0.0%	23.0%	2.8%	7.2%	23.0%	44.0%	0.0%	100.0%
Discretionary	Any	FT Worker	0.0%	0.0%	0.0%	10.8%	31.9%	13.2%	27.0%	11.2%	5.9%	100.0%
Discretionary	Any	PT Worker	0.0%	0.0%	0.0%	10.2%	34.6%	15.4%	18.1%	8.7%	13.0%	100.0%
Discretionary	Any	University Student	0.0%	0.0%	0.0%	11.6%	37.4%	12.4%	16.2%	3.3%	19.1%	100.0%
Discretionary	Any	Homemaker	0.0%	0.0%	0.0%	11.0%	38.9%	19.0%	19.0%	6.7%	5.4%	100.0%
Discretionary	Any	Retired	0.0%	0.0%	0.0%	11.1%	28.4%	18.6%	19.7%	11.1%	11.1%	100.0%
Discretionary	Any	Driving-age child	0.0%	0.0%	0.0%	27.7%	30.4%	5.7%	20.5%	15.7%	0.0%	100.0%
Discretionary	Any	Pre-driving child	0.0%	0.0%	0.0%	11.4%	20.4%	14.8%	29.1%	8.9%	15.4%	100.0%
Discretionary	Any	Preschool	0.0%	0.0%	0.0%	33.5%	13.3%	11.1%	28.2%	5.2%	8.7%	100.0%

Table 45: Intermediate Stop Destination Choice Models (Impedance Variables)

Explanatory variables	Coefficient	t-Stat
Mode choice logsum	1.821	28.0
Stop is tour origin zone	0.7112	22.6
Stop is tour destination zone	1.037	38.3
CBD area type	-0.285	-8.8
Distance	-0.2188	-26.4
Distance squared	0.002887	22.1
Distance cubed	-1.09E-05	-14.6
Log of distance	-0.3218	-6.3
Distance interactions		
Return half tour	0.00873	5.1
2nd stop of half tour	-0.00269	-1.4
3rd+ stop on half tour	-0.01045	-4.0
Shared ride tour	0.002442	1.4
Transit tour	-0.01308	-2.9
Walk/bike tour	0.2731	3.0
Work tour	-0.00885	-3.7
Work-based tour	-0.00119	-0.2
Work stop	0.0127	5.3
Escort stop	-0.0117	-4.9
Eat out stop	-0.01969	-7.3
Shopping stop	-0.02404	-10.2

Table 46: Intermediate Stop Destination Choice Models (Size Variables)

	Retail		Service		Other		Households	
Tour purpose	exp(c)	t-stat	exp(c)	t-stat	exp(c)	t-stat	exp(c)	t-stat
Work	1.0	n/a	0.482	3.7	0.568	3.7	0.588	3.8
Escort								
Children in HH	1.0	n/a	0.367	2.7	0.524	2.4	3.677	6.3
No children in HH	1.0	n/a	0.767	0.8	0.687	1.2	1.834	2.2
Shopping	1.0	n/a	0.006	8.2	0.023	16.7	0.183	34.5
Other maintenance	1.0	n/a	0.232	11.2	0.083	12.7	0.359	12.8
Eating out	1.0	n/a	0.038	11.5	0.026	13.3	0.138	-28.0
Social & visit	1.0	n/a	1.226	0.6	0.000	0.1	3.353	4.2
Other discretionary	1.0	n/a	0.590	3.4	0.015	2.6	0.506	5.6

Estimation statistics	
Observations	22049
Final log L	-104049
Rho-squared	0.363

Table 47: Work, University and At-Work Trip Mode Choice Model Parameters

Explanatory variables	Work and University Tours[1]		At-Work Tours[1]	
	Coef.	Ratio	Coef.	Ratio
In vehicle time	-0.0371		-0.0321	
In vehicle time factor, express bus	0.95		0.95	
In vehicle time factor, BRT	0.85		0.85	
In vehicle time factor, light rail	0.80		0.80	
In vehicle time factor, MARTA	0.75		0.75	
In vehicle time factor, commuter rail	0.75		0.75	
First wait time (< 7 min)	-0.0741	2.0	-0.0643	2.0
First wait time (> 7 min)	-0.0741	2.0	-0.0643	2.0
Transfer wait time	-0.0741	2.0	-0.0643	2.0
Transit walk time (short walk)	-0.0741	2.0	-0.0867	2.7
Transit walk time (long walk)	-0.0926	2.5	-0.0610	1.9
Transit PNR drive access time	-0.0741	2.0		
Transit KNR drive access time	-0.0926	2.0		
Walk mode time (short walk)	-0.0741	2.0	-0.0867	2.7
Walk mode time (long walk)	-0.0926	2.5	-0.0610	1.9
Bike mode time	-0.1667	4.5	-0.0610	1.9
Cost				
Low HH income (less than $20k)	-0.0154		-0.0200	
Medium HH income ($20k-$50k)	-0.0034		-0.0045	
High HH income (more than $50k)	-0.0021		-0.0027	

1 Please refer to the Model Calibration report for the value of the mode and market-specific constants

Table 48: School and Non-Mandatory Tour Trip Mode Choice Model Parameters

Explanatory variables	School Tours[1]		Non-Mandatory Tours[1]	
	Coef.	Ratio	Coef.	Ratio
In vehicle time	-0.0127		-0.0321	
In vehicle time factor, express bus	0.95		0.95	
In vehicle time factor, BRT	0.85		0.85	
In vehicle time factor, light rail	0.80		0.80	
In vehicle time factor, MARTA	0.75		0.75	
In vehicle time factor, commuter rail	0.75		0.75	
First wait time (< 7 min)	-0.0254	2.0	-0.0643	2.0
First wait time (> 7 min)	-0.0254	2.0	-0.0643	2.0
Transfer wait time	-0.0254	2.0	-0.0643	2.0
Transit walk time (short walk)	-0.0254	2.0	-0.0867	2.7
Transit walk time (long walk)	-0.0254	2.0	-0.0610	1.9
Transit PNR drive access time	-0.0254	2.0	-0.0643	1.9
Transit KNR drive access time	-0.0926	2.0	-0.0804	2.5
Walk mode time (short walk)	-0.0254	2.0	-0.0867	2.7
Walk mode time (long walk)	-0.0254	2.0	-0.0610	1.9
Bike mode time	-0.0318	2.5	-0.0610	1.9
Cost				
Low HH income (less than $20k)	-0.0079		-0.0200	
Medium HH income ($20k-$50k)	-0.0018		-0.0045	
High HH income (more than $50k)	-0.0011		-0.0027	

1 Please refer to the Model Calibration report for the value of the mode and market-specific constants

Table 49: Parking Location Choice Model Parameters

Explanatory variable	Paid parkers				Free parkers			
	Mandatory trips		Non-mandatory trips		Mandatory trips		Non-mandatory trips	
	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat	Coef.	t-Stat
Constant	-0.2487	-2.7	0.5673	3.9	0.2096	1.4		
Percent free parking	-0.6498	-4.2	-1.025	-4.4			0.597	1.6
Percent free parking > 75%					0.4225	1.5		
Total parking in zone (log)			0.1441	2.0			0.3538	2.1
Long term parking (log)	0.164	4.2			0.1246	1.5		
Long term parking rate	-1.232	-2.8	-2.291	-4.0				
Distance origin to parking zone			-0.2572	-1.6	0.4048	2.1		
Distance parking zone to destination	-4.366	-24.1	-3.181	-11.8	-4.12	-12.5	-4.716	-9.4
Parking zone is CBD area type	0.1673	1.8	0.4377	2.9	0.6619	3.6	0.7646	2.4
CBD Area type 1 (binary)	-0.6398	-5.8			-1.57	-6.9	-0.5618	-1.7

Estimation statistics	Paid parkers: Mandatory trips	Paid parkers: Non-mandatory trips	Free parkers: Mandatory trips	Free parkers: Non-mandatory trips
Initial log likelihood	-2896	-1199	-1170	-1170
Log likelihood with constants	-822	-343	-327	-93
Final log likelihood	-1906	-717	-569	-154
$Rho^2(0)$	0.34	0.40	0.51	0.55
$Rho^2(c)$	-1.32	-1.09	-0.74	-0.66