Federal Highway Administration

National Long-Distance Passenger Model Documentation

User Guide

Exploratory Advanced Research Program

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16. Abstract This User Guide details the rJourney application software to apply the national tour-based microsimulation models of annual long-distance passenger travel demand. The models schedule travel across one full year to capture work-related travel (employer's business and commute) and nonwork travel (visiting friends and family, personal business and shopping, and leisure). The models are multimodal (auto, rail, bus, and air) and based on national networks for each mode. The User Guide also includes the new graphical user interface developed to assist the user in setting up and running the model, directions on how to run the model, the model input and output files, and instructions on how to use rJourney configuration files to customize the model.			
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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List of Abbreviations

F&R	friends and relatives
FHWA	Federal Highway Administration
FIPS	Federal Information Processing Standard
GUI	graphical user interface
HH	household
LOS	level-of-service
NAICS	North American Industrial Classification System
NUMA	National Use Microdata Area
VisitFR	visit friends and relatives trip purpose
VMT	vehicle miles traveled

CHAPTER 1. INTRODUCTION

Intercity travel is increasingly important in the United States because of the economic and mobility impacts that longer trips have on the national transportation system. The Federal government and many states are faced with improving mobility and reducing impacts for these travelers. In 2011, the Federal Highway Administration (FHWA) Exploratory Advanced Research program commissioned a study to develop new approaches for modeling long-distance traveler behavior. The purpose was to develop a national model of long-distance passenger travel for all United States households.

The study developed tour-based microsimulation models of annual long-distance passenger travel demand and developed software (rJourney) to apply these models. The models schedule travel across one full year to capture work-related travel (employer's business and commute) and nonwork travel (visiting friends and family, personal business and shopping, and leisure). The models are multimodal (auto, rail, bus, and air) and based on national networks for each mode. This provides opportunities for evaluation of intercity transportation investments or testing national economic, environmental, and pricing policies.

A detailed explanation of the modeling system and individual model components is provided in the Model Documentation. The research and development effort conducted for the earlier Exploratory Advanced Research program can be found in the Final and Implementation reports.[1] [2] The Final Report includes a detailed explanation of the data used in the model, including a thorough guide on how to generate the geographic and transportation system data used in the models. The Final Report also discusses possible applied research methods for each model component and a simplified approach to modeling household mode and destination choice as a demonstration. The Implementation Report describes model calibration of the demonstration model and provides information about running the rJourney software and the sensitivity tests used to evaluate the model readiness.

This User Guide details the rJourney application software, the new graphical user interface developed to assist the user in setting up and running the model, and directions on how to run the model. This User Guide also explains the model input and output files and how to use rJourney configuration files to customize the model.

[1] Maren Outwater et al., "Foundational Knowledge to Support a Long-Distance Passenger Travel Demand Modeling Framework: Part A: Final Report," (Federal Highway Administration, March 2015). Please visit the Foundational Knowledge to Support a Long-Distance Passenger Travel Demand Modeling Framework: Part A: Final Report: https://www.fhwa.dot.gov/policyinformation/analysisframework/docs/national_model.pdf.

[2] Maren Outwater et al., "Foundational Knowledge to Support a Long-Distance Passenger Travel Demand Modeling Framework: Implementation Report," (Federal Highway Administration, June 2015). Please visit the Foundational Knowledge to Support a Long-Distance Passenger Travel Demand Modeling Framework: Implementation Report: https://www.fhwa.dot.gov/policyinformation/analysisframework/docs/long-distance_model_implementation_report_final.pdf.

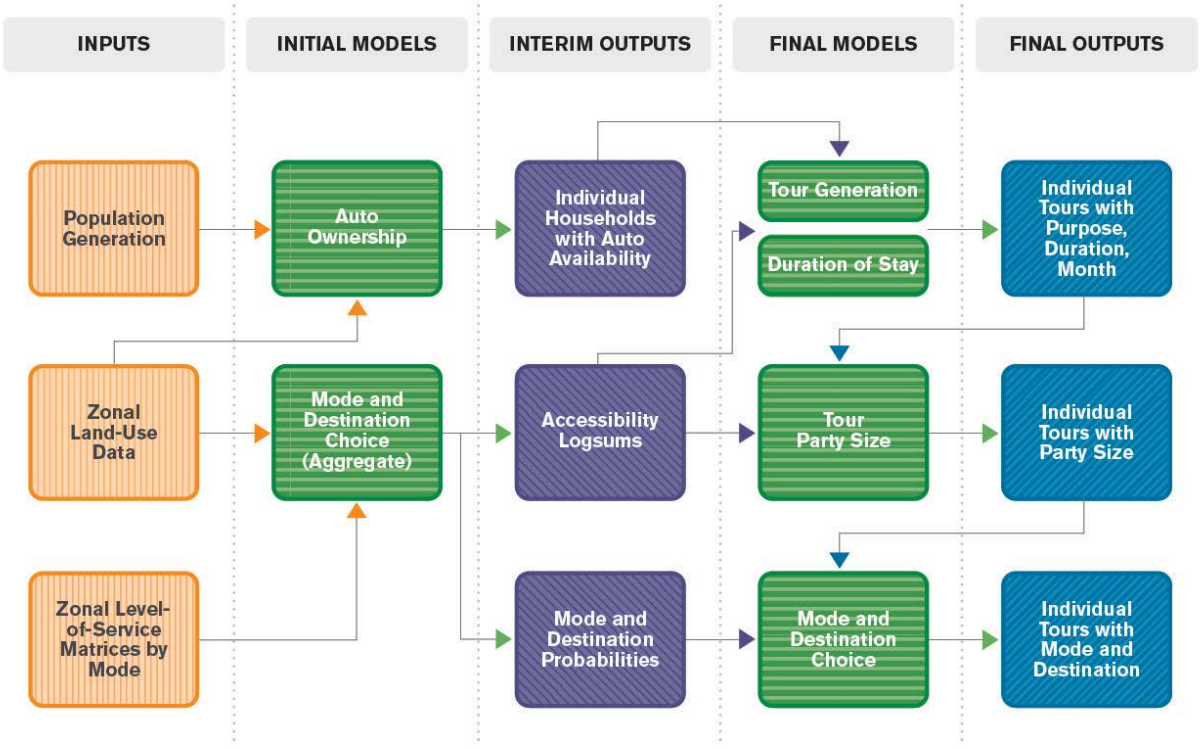
CHAPTER 2. APPLICATION SOFTWARE

2.1 Model Structure

Figure 1 depicts the structure of the long-distance passenger tour-based microsimulation model system used for the initial application. The three main inputs are the following:

1. Synthesized population representing every household in the United States and all members of those households.
2. Land-use file containing estimates of population, employment, and other key variables at the zone (NUMA) level.
3. Zone-to-zone matrices containing travel times, costs, and other origin-destination (O-D) variables for auto, bus, rail, and air.

Additional files with estimated/calibrated coefficients are input for each choice model, but these inputs only change with a major update to the models or new observed data sources to allow for re-estimation of the model components. Section 4.3 details documentation of these input files.



Source: FHWA

Figure 1. rJourney model process.

The choice models for the long-distance passenger models are presented in Table 1. The estimated models are documented in Appendix C. Estimated Model Coefficients. Output records are written at both the household level and the tour level. The output file contents and formats are documented in Section 4.4.

Table 1. Choice Model Components and Outputs

Model Component	Household Outputs	Tour Outputs
Auto Ownership	Number of Autos	N/A
Tour Generation	Number of Tours by Purpose	Tour Purpose
Scheduling	N/A	Tour Scheduling
Party Size	N/A	Tour Party Size
Destination Choice	N/A	Tour Origin and Destination
Mode Choice	N/A	Tour Mode

It is also possible to output trip matrices based on either mode/destination probabilities or stochastically simulated tours. A key aspect of the model structure is that the mode and destination probabilities and logsums are precalculated for all relevant combinations of income, auto availability, tour purpose, tour scheduling, and tour party size. The probabilities are stored in computer memory and used to predict the outcome for each simulated tour, which eliminates the need to apply the mode and destination-choice models separately for each tour. The application of the probabilities reduces the model run time by at least an order of magnitude and makes it practical to predict long-distance travel over the period of one year for the entire U.S. population. All other choice models in the modeling system are based on stochastically simulated outcomes. Further detail on the model components is provided in the Model Documentation Report.

2.2 Hardware and Software Requirements

The software program can run on a machine running a recent version of Windows with at least 4 GB of RAM and 10 GB of free disk space. The software runs on a single processor and does not require multiple cores. It is strongly recommended that users check their log file to verify the run completed prior to using the output files. Appendix A. Sample Log Print File includes an example log print file. The major requirement is free disk space (at least 10 GB) for the output file generated, particularly if the user wishes to output individual tour records for several different scenarios.

rJourney applies the long-distance model using the software Delphi (Pascal). This software exhibits fast run times. The Delphi language is like C++. The program code is compact and has only 1,750 lines of Delphi code.

2.3 Code Procedures

The main procedures (classes) in the code, and their order of execution and iteration, are as follows:

- ***GetConfigurationSettings***: Reads in the user configuration file.
- ***InitializeSummaryOutput***: Empties all counters for summary output tables.
- ***LoadZoneLandUseData***: Loads data from the zonal land-use file into memory.
- ***LoadRoadLOSMatrices***: Loads data from the auto and bus level-of-service (LOS) file into memory.
- ***LoadRailLOSMatrices***: Loads data from the rail LOS file into memory.
- ***LoadAirLOSMatrices***: Loads data from the auto and bus LOS file into memory.
- ***OpenHouseholdInputFile***: Opens the synthetic population file for sequential input.
- ***OpenHouseholdOutputFile***: If specified by user, opens a new household-level file for output.
- ***OpenTourOutputFile***: If specified by user, opens a new tour-level file for output.
- ***OpenTripMatrixOutputFile***: If specified by user, opens a new trip matrix file output.
- *Loop on households in synthetic population:*
    - ***LoadNextHouseholdRecord****:* Reads the next household record into memory.
    - *Check if current household is from a new residence zone, if so…*
        - ***CalculateModeDestinationProbabilities****:* Applies the tour mode and destination-choice models to calculate all probabilities and logsums from (and back to) the new residence zone.
    - *Check if current household is to be simulated, according to user settings. If so…*
        - ***ApplyAutoOwnershipModel****:* Applies the auto ownership model and simulates a single choice.
        - ***ApplyTourGenerationModel****:* Applies the tour-generation models and simulates how many tours are made for each tour purpose on each simulated month and day.
        - ***For each generated tour (if any)****…*
            - ***SimulateNewTour****:* Sets some variables and runs tour-level models.
            - ***ApplyTourNightsAwayModel****:* Applies the tour duration model and simulates a single choice.
            - ***ApplyTourPartySizeModel****:* Applies the tour-party-size model and simulates a single choice.

        - ***ApplyTourModeDestinationModel***: Uses the mode/destination-choice probabilities for the relevant income, car ownership, purpose, duration, and party size segments to simulate a single mode and destination or add the probabilities to the predicted trip matrices, depending on user settings.
        - ***WriteTourRecord***: If specified by user, writes a new tour record to output file.
    - ***WriteHouseholdRecord****:* If specified by user, writes a new household record to output file.
- *End of loop on households.*
- ***CloseHouseholdInputFile****:* Closes the connection to the household input file handler.
- ***CloseHouseholdOutputFile****:* Closes the connection to the household output file handler.
- ***CloseTourOutputFile****:* Closes the connection to the tour output file handler.
- ***WriteTripMatrixOutputFil***e: Writes the output trip matrix file, if specified by user.
- ***WriteSummaryOutput****:* Writes summary prediction tables to the log print file.

2.4 Installation Instructions

The rJourney software comes in a zipped file as a portable application. Please visit the rJourney zip files site: https://www.fhwa.dot.gov/policyinformation/analysisframework/02.cfm. The installation of the software is a simple one-step process:

Unzip *rJourney-X.X.X.zip* to a destination folder

where: X.X.X is the version number of the software, currently set at 1.3.1.

CHAPTER 3. GRAPHICAL USER INTERFACE

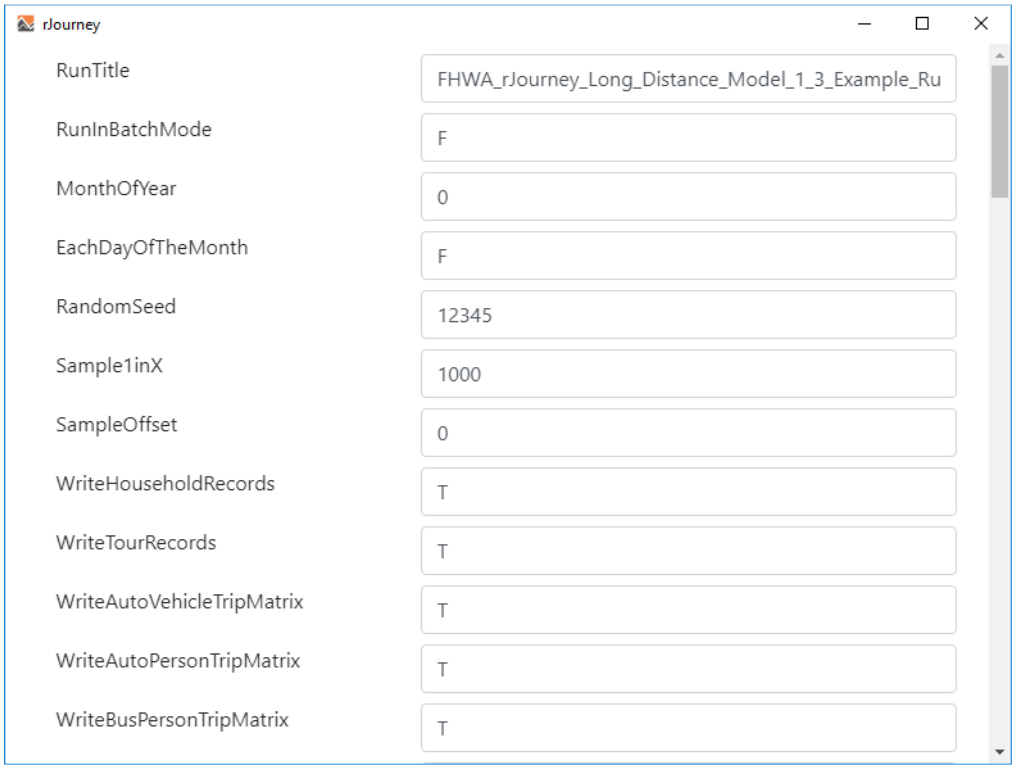
3.1 Options to Run rJourney

Using the Graphical User Interface

rJourney contains a simple graphical user interface (GUI). To run, double-click on the *rJourney.exe* file in the destination folder. Windows will open a GUI as shown in Figure 2. The software displays all the options available to the user to enter in the configuration file. Section 3.2 documents the configuration file details. Two options are available to the user at the end of the window (Figure 3).

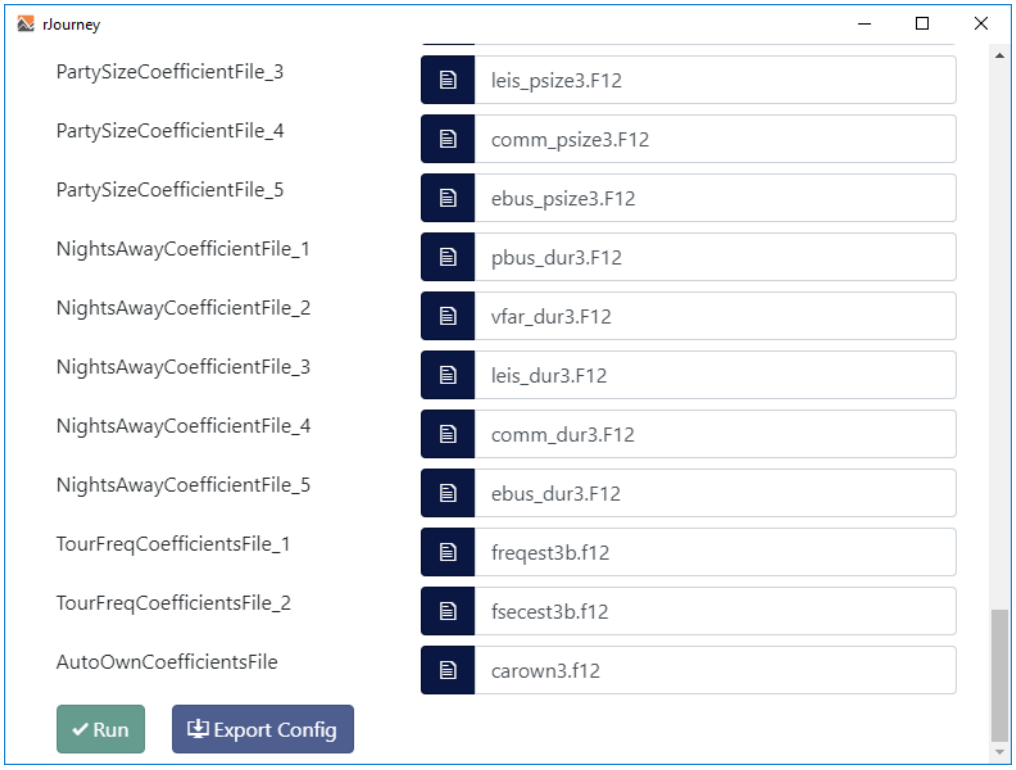
1. **Run**: This button, when clicked, opens a Windows command prompt and runs the long-distance passenger travel demand model with the configuration as shown in the GUI. Figure 4 displays a snapshot of a model run initiated by clicking the "Run" button.

2. **Export Config**: This button, when clicked, opens a Windows "Save As" dialog box to save the current configuration to a text file (Figure 5).



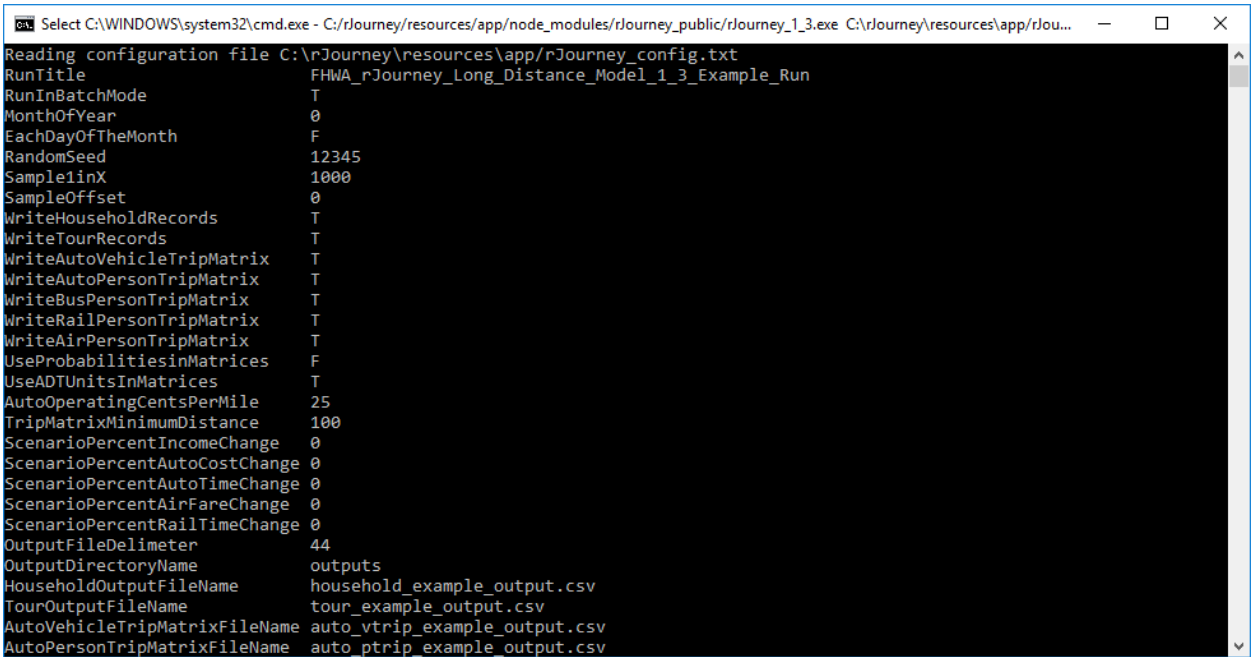
Source: FHWA

Figure 2. rJourney user interface.



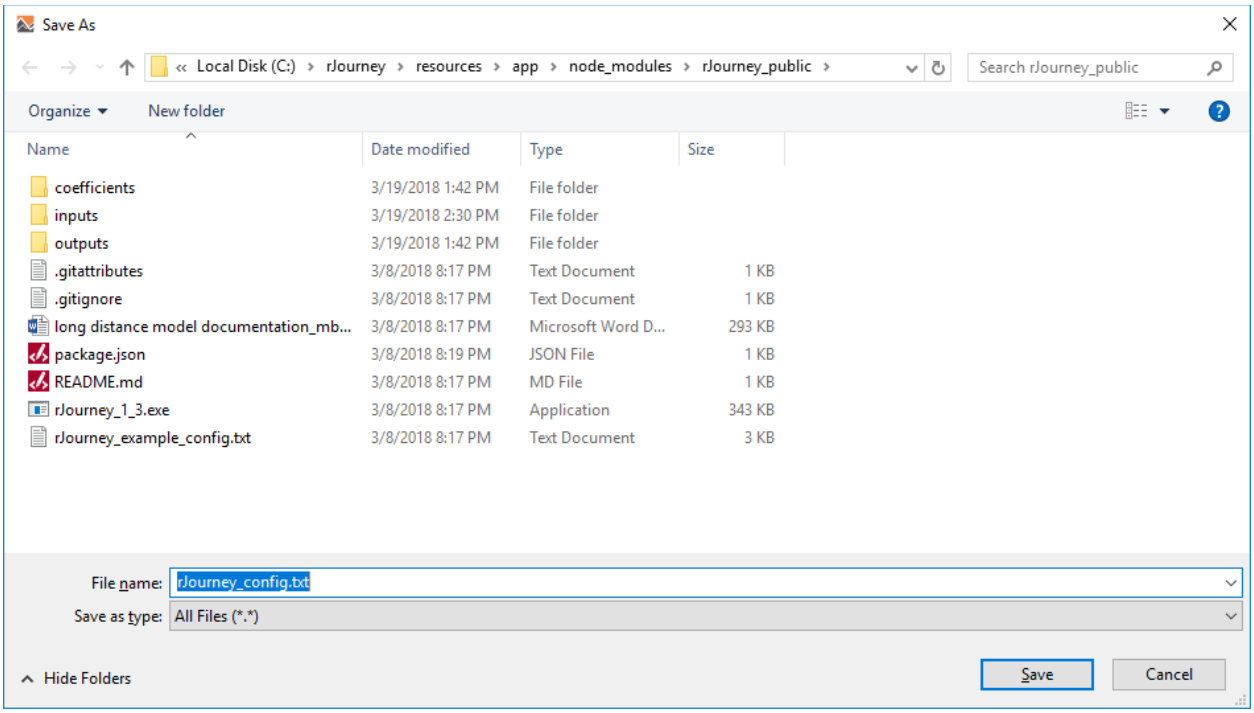
Source: FHWA

Figure 3. rJourney user interface with run and export configuration buttons.



Source: FHWA

Figure 4. Model run screen once rJourney is running.



Source: FHWA

Figure 5. Windows dialog box to export the configuration file.

Using the Command Window

The user can also run rJourney without using the rJourney user interface by double-clicking on *rJourney_1_3.exe* located at "..\rJourney\resources\app\node_modules\rJourney_public." Windows will then open a console command window and ask the user to input the name of the relevant user configuration file. The user can also set up a batch file giving the name of the configuration file as a command argument and double-click on that. For example, the user could create the batch file *rJourney.bat* with the following single line:

rJourney_1_3.exe rJourney_example_config.txt

Double-clicking on that batch file would run the program and use the specified configuration file as input. All files will be located in the "..\rJourney\resources\app\node_modules\rJourney_public" directory.

3.2 Configuration Options

The application window displays the configuration that the model will use to run. The configurations consist of options belonging to five categories. Figure 9 shows a snapshot of these options as displayed on the interface. Section 4.1 provides information on using these configuration options.

Three options exist for each configuration element:

- **Text Box**: A text box next to a configuration label allows the user to enter valid text. This will set those options to the value entered in the text box. For example, *F* entered in the text box next to the label *EachDayOfTheMonth* will set the value of that option to FALSE as seen in Figure 6.

Source: FHWA

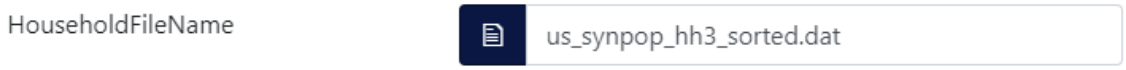
Figure 6. Text box used to set configuration option.

- **Select Folder**: A directory icon next to a configuration label allows a user to select a folder. For example, clicking on the directory icon next to *InputDirectoryName* label will open a Windows "Select Folder" dialog box that allows a user to create or select a folder. A snapshot of the icon is shown in Figure 7.

Source: FHWA

Figure 7. Snapshot of directory icon used to select folder.

- **Select File**: A file icon next to a configuration label allows a user to select a file. For example, clicking on the file icon next to *HouseholdFileName* label will open a Windows "Open" dialog box that allows a user to select/open a file containing household data. A snapshot of the icon is shown in Figure 8.



Source: FHWA

Figure 8. Snapshot of file icon used to select file.

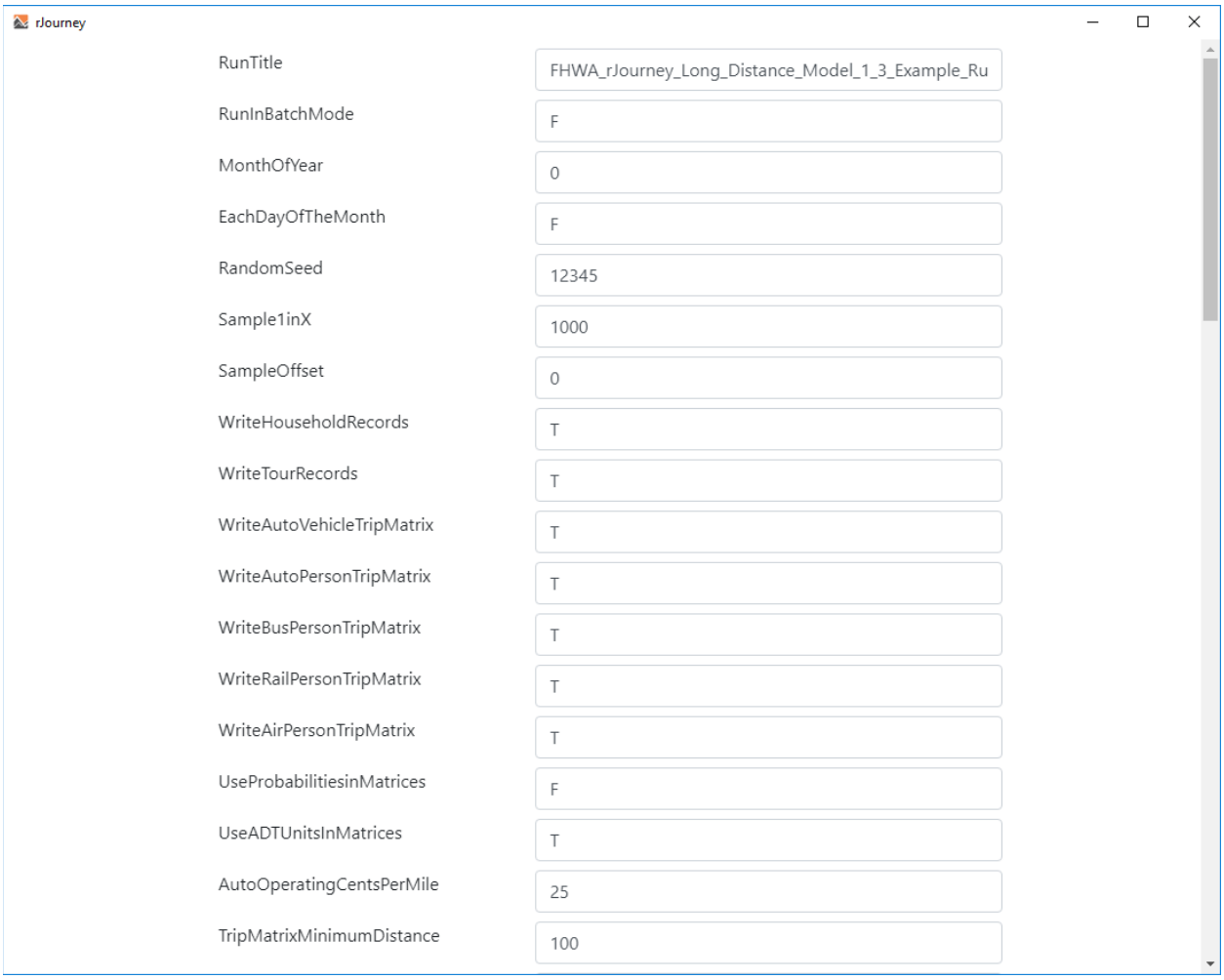
Software Options

The user controls how a model is run via the software options. Table 2 lists these options along with their default values and a brief description. These options provide an opportunity to shorten run times or expand the resolution of the output. For example, sampling more or fewer households provides a trade-off between model precision and model run times.

Table 2. Model run related configuration options.

Configuration Option	Default Value	Description
RunTitle	FHWA_rJourney_ Long_Distance_ Model_1_3_ Example_Run	A text label identifying the run in the log print file—contains no spaces
RunInBatchMode	F	T(rue)/F(alse) switch to run the model in batch mode
MonthOfYear	0	The month of the year to simulate (0=all months, 1=Jan, 2=Feb, … , 12=Dec)
EachDayOfTheMonth	F	T(rue)/F(alse) switch to simulate each day of each month separately
RandomSeed	12345	Initial seed value to use for random number generator
Sample1inX	100	Subsampling factor (e.g., 100 selects every 100th household for simulation)
SampleOffset	0	Subsampling offset (e.g., in above example, 3 selects the third out of every 100 households [HHs])
WriteHouseholdRecords	T	Whether or not to write out household-level records
WriteTourRecords	T	Whether or not to write out tour-level records
WriteAutoVehicleTripMatrix	T	Whether or not to write out zone-to-zone trip matrix for car trips with units as vehicle-trips
WriteAutoPersonTripMatrix	T	Whether or not to write out zone-to-zone trip matrix for car trips with units as person-trips
WriteBusPersonTripMatrix	T	Whether or not to write out zone-to-zone trip matrix for bus trips with units as person-trips
WriteRailPersonTripMatrix	T	Whether or not to write out zone-to-zone trip matrix for rail trips with units as person-trips
WriteAirPersonTripMatrix	T	Whether or not to write out zone-to-zone trip matrix for air trips with units as person-trips
UseProbabilitiesinMatrices	F	If true, uses mode/destination probabilities rather than single choices for matrices
UseADTUnitsInMatrices	T	If true, writes out trip matrices as daily trips rather than total trips
AutoOperatingCentsPerMile	25	The average auto operating cost per mile in cents
TripMatrixMinimumDistance	100	The minimum one-way trip distance to include in the trip matrices in miles (must be greater than 50 miles)

Figure 9 shows the user interface software options screenshot with default values.



Source: FHWA

Figure 9. rJourney software options.

Scenario Options

The user adjusts scenario options to fix scenario-specific parameters. Table 3 lists all the scenario-specific configuration options. These options were set to establish these five specific scenarios; users can develop other scenarios by adjusting model input files. Input files are described in Section 4.3.

Table 3. Scenario-specific configuration options.

Configuration Option	Default Value	Description
ScenarioPercentIncomeChange	0	For scenario tests—changes all household incomes by specified percentage
ScenarioPercentAutoCostChange	0	For scenario tests—changes auto toll and operating costs by specified percentage
ScenarioPercentAutoTimeChange	0	For scenario tests—changes all auto travel times by specified percentage
ScenarioPercentAirFareChange	0	For scenario tests—changes all air fares by specified percentage
ScenarioPercentRailTimeChange	0	For scenario tests—changes all rail travel times by specified percentage

Output Options

The user specifies output folder and output file names vis output options (Table 4). Full file names (with extension) are required. Output files are described in Section 4.4.

Table 4. Output-specific configuration options.

Configuration Option	Default Value	Description
OutputFileDelimeter	44	The delimiter character used in the output files (32=space, 9=tab, 44=comma)
OutputDirectoryName	outputs	Path to the directory where all the outputs will be saved
HouseholdOutputFileName	household_example_output.csv	The filename of the output household records
TourOutputFileName	tour_example_output.csv	The filename of the output tour records
AutoVehicleTripMatrixFileName	auto_vtrip_example_output.csv	The filename of the output party/vehicle trip matrix records
AutoPersonTripMatrixFileName	auto_ptrip_example_output.csv	The filename of the output car trip matrix records in person-trips
BusPersonTripMatrixFileName	bus_ptrip_example_output.csv	The filename of the output bus trip matrix records in person-trips
RailPersonTripMatrixFileName	rail_ptrip_example_output.csv	The filename of the output rail trip matrix records in person-trips
AirPersonTripMatrixFileName	air_ptrip_example_output.csv	The filename of the output air trip matrix records in person-trips

Input Options

The user specifies input folder and input file names via the input options (Table 5). Full file names (with extension) are required. Output files are described in Section 4.3.

Table 5. Input-specific configuration options.

Configuration Option	Default Value	Description
InputDirectoryName	inputs	Path to the directory where all the input files are located
RoadLOSFileName	zoneRoadLOS.dat	The filename of the input zonal road LOS data
RailLOSFileName	zoneRailLOS.dat	The filename of the input zonal rail LOS data
AirLOSFileName	zoneAirLOS.dat	The filename of the input zonal air LOS data
ZoneLandUseFileName	numa_2010_landuse.dat	The filename of the input zonal land use data
HouseholdFileName	us_synpop_hh3_sorted.dat	The filename of the input synthetic population household file

Coefficient Options

The user specifies a folder containing model coefficients and relevant file names via the coefficient options (Table 6). A sample of a coefficient file is provided in Appendix B. Sample Coefficient File.

Table 6. Model coefficient-related configuration options.

Configuration Option	Default Value	Description
CoefficientDirectoryName	coefficients	Path to the directory where the model coefficient files are stored
DestChoiceCoefficientFile_1	pbusdest6_bxc.F12	The filename of the personal business tour destination-choice coefficients
DestChoiceCoefficientFile_2	vfardest6_bxc.F12	The filename of the visit friends and relatives tour destination-choice coefficients
DestChoiceCoefficientFile_3	leisdest6_bxc.F12	The filename of the leisure tour destination-choice coefficients
DestChoiceCoefficientFile_4	commdest6_bxc.F12	The filename of the commute tour destination-choice coefficients
DestChoiceCoefficientFile_5	ebusdest6_bxc.F12	The filename of the employer's business tour destination-choice coefficients
ModeChoiceCoefficientFile_1	pbusmode13_est.F12	The filename of the personal business tour mode choice coefficients
ModeChoiceCoefficientFile_2	vfarmode13_est.F12	The filename of the visit friends & relatives tour mode choice coefficients
ModeChoiceCoefficientFile_3	leismode13_est.F12	The filename of the leisure tour mode choice coefficients
ModeChoiceCoefficientFile_4	commmode13_est.F12	The filename of the commute tour mode choice coefficients

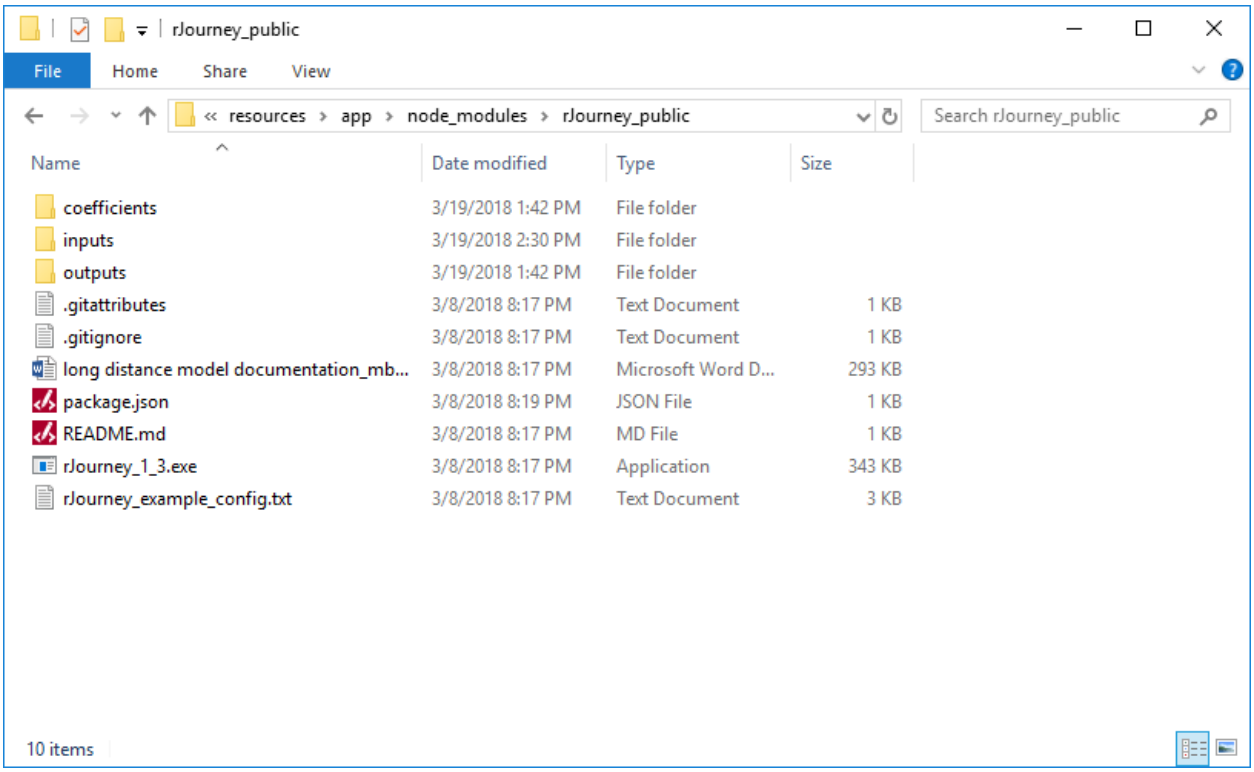
Configuration Option	Default Value	Description
ModeChoiceCoefficientFile_5	ebusmode13_est.F12	The filename of the employer's business tour mode choice coefficients
PartySizeCoefficientFile_1	pbus_psize3.F12	The filename of the personal business tour party size choice coefficients
PartySizeCoefficientFile_2	vfar_psize3.F12	The filename of the visit friends and relatives tour party size choice coefficients
PartySizeCoefficientFile_3	leis_psize3.F12	The filename of the leisure tour party size choice coefficients
PartySizeCoefficientFile_4	comm_psize3.F12	The filename of the commute tour party size choice coefficients
PartySizeCoefficientFile_5	ebus_psize3.F12	The filename of the employer's business tour party size choice coefficients
NightsAwayCoefficientFile_1	pbus_dur3.F12	The filename of the personal business tour scheduling choice coefficients
NightsAwayCoefficientFile_2	vfar_dur3.F12	The filename of the visit friends and relatives tour scheduling choice coefficients
NightsAwayCoefficientFile_3	leis_dur3.F12	The filename of the leisure tour scheduling choice coefficients
NightsAwayCoefficientFile_4	comm_dur3.F12	The filename of the commute tour scheduling choice coefficients
NightsAwayCoefficientFile_5	ebus_dur3.F12	The filename of the employer's business tour scheduling choice coefficients
TourFreqCoefficientsFile_1	freqest3a.f12	The filename of the primary tour-generation coefficients
TourFreqCoefficientsFile_2	fsecest3a.f12	The filename of the secondary tour-generation coefficients
AutoOwnCoefficientsFile	carown3.f12	The filename of the auto ownership coefficients

Table 3 through Table 6 list all the user configuration options currently recognized by the software. Each option is specified by a specific text label that is given in the first column of the table. (The labels are not case-sensitive—any upper- and lower-case combination works.) The user can also provide these configurations in a text file. If the user provides a configuration label that does not match one of these valid options in the table, the invalid input line is flagged for the user on the screen and written to the log print file. Each configuration variable also has a default value that is used if the specific configuration label is not found in the configuration file (i.e., the user does not need to include a line for a specific option if one wishes to use the default value). A sample configuration text file containing all the possible labels with the default values is provided along with the software, and the user can directly edit this file to create new configurations in place of using the GUI. This file is located at "rJourney\resources\app\node_modules\rJourney_public.".

CHAPTER 4. RUNNING THE MODEL

4.1 Getting Started

rJourney is opened by navigating to the rJourney_public directory and double-clicking on the rJouney_1_3.exe file. The directory for this example project is in "install_dir\rJourney\resources\app\node_modules\rJourney_public." The structure of this directory is shown in Figure 10. The software loads default values to the model configuration. Click the "Run" button to open a Windows command prompt window and run a base case of the long-distance passenger travel model as shown in Figure 4. Users can scroll down in case the green "Run" button is not visible.



Source: FHWA

Figure 10. Structure of example project directory.

The configuration options permit several methods for running the simulation, with the options described below.

Subsampling on Households

One way to limit run time in the simulation is to simulate travel for a random subsample and not every household in the synthetic population. The configuration settings ***Sample1inX*** and ***SampleOffSet*** facilitate subsampling. For example, if the values 20 and 7 are used, respectively, it would simulate only the seventh household out of every 20 households in the synthetic

population file. The fraction sampled would then be equal to ***1 / Sample1inX***, or a 5% sample in this example. The household expansion factor for output is set equal to ***Sample1inX***.

Subsampling on Months or Days

Another way to influence run time and target the forecast to a month or season is to use ***MonthOfYear*** and ***EachDayOfTheMonth.*** By default, an entire year of travel is simulated by setting ***MonthOfYear*** to 0 to simulate all 12 months for each household. Also by default, only one representative travel day is simulated for each month by setting ***EachDayOfTheMonth*** to False. This means that the tour-generation and subsequent models are only applied once for the month, and the expansion factor[1] for each generated tour in the month is multiplied by the number of days in the month (e.g., 31 for January and 28 for February).

If ***EachDayOfTheMonth*** is set to true, then every day of the month is simulated separately, which will increase the number of tours simulated and tour records written by a factor of 30 or so, but this will not increase the expanded number of tours. Simulating each day separately adds more variability (and thus less random simulation error) in the output. However, since each day of the month is simulated using identical probabilities (there is no conditionality from one day of the month to the next, so no intrahousehold-level consistency of travel scheduling), this does not add any true behavioral variability.

In general, it is advisable to save run time by setting ***EachDayOfTheMonth*** to False rather than by subsampling households, since each household record is different. As a result, using more households in the simulation *does* add some true behavioral variability. If monthly or annual forecasts are desired, then ***MonthOfYear*** should be used. If daily forecasts are the primary end product, then an average month (e.g. April or October) can be used to reduce run times or all 12 months can be run to determine a more precise average month.

Options for Generating Trip Matrices

The models, being a simplification of reality based on the limited data available, assume that all long-distance tours consist of exactly two trips: one trip from the residence zone to the destination zone and a second trip back to the residence zone. In reality, a small percentage of long-distance tours contain three or more long-distance trips connecting multiple destinations, other than simply stopping for gas or a meal. However, simulating these multi-stop tours is too complex and would take many times longer to run.

rJourney will accumulate and write out trip matrices for any specified mode. A model run saves five modal matrices: auto vehicle, auto person, bus person, rail person, and air person.

The software also includes several user options for accumulating the trip matrices:

- ***UseProbabilitiesinMatrices****:* This is the most important option because it changes the ways that the mode/destination probabilities are used for the trip matrices. Instead of stochastically choosing a single mode and a single destination for each tour—which is

[1] Expansion factors are calculated to represent all households, based on the subsampling of households.

done for the output tour records—this option adds the probability (times the expansion factor) to the matrix for every possible mode/destination alternative (four modes times approximately 4,500 zones, or 18,000 alternatives). This is analogous to how 4-step models work. Rather than resulting in integer numbers of trips in each cell of the matrix, there are fractions of trips—often tiny fractions. The advantage of this approach to generating matrices is that it adds variability—particularly spatial variability—and reduces random stochastic simulation error. The trade-off is that it increases model run times, and the trip outputs will not exactly match the tour outputs in terms of mode and spatial distribution.

- ***UseADTUnitsInMatrices****:* If this is true, the matrices are scaled to units of average daily trips instead of annual or monthly trips. If this is false, the matrices are not scaled and are either monthly or annual depending on the setting for ***MonthOfYear.***
- ***TripMatrixMinimumDistance****:* Although the models use a (somewhat arbitrary) threshold of 50 miles one way to define a long-distance trip, it may be desirable to generate outputs that are comparable to other data sources that use a different threshold. For example, if the user sets this to 100, only trips between zones that are 100 or more miles apart (based on network auto distance) are counted in the matrices.

Log Print File

The software generates a log print file that is named automatically each time it is run so as not to overwrite previous log files. For example, if ***inputs\test1_config.txt*** is the name of the configuration settings file, then the print file will be ***inputs\test1_config_01.log***. If the same configuration file is used again, then the print file will be ***inputs\test1_config_02.log***, and so on.

The contents of the log file are the same as what appears on the screen during the run. The screen displays the date and time the run starts and finishes along with a copy of all the configuration settings used for the run. In addition, the software provides a series of summary output tables as a quick check on the results. Appendix A. Sample Log Print File includes an example log print file.

Comparison of Run Times and Output Characteristics

Table 7 provides an idea of the model run times and file sizes using different combinations of configuration settings. The runs were done on an HP workstation with 16 GB of RAM and four processors. (The software itself uses only 2 GB of RAM and a single processor, since it is not yet written to use multithreading on multiple processors.)

Run 1 uses ***Sample1inX*** = 100 to run only a 1% sample of households, so the expansion factors are 100. It simulates every month of the year and each day of the month separately and uses stochastic choices rather than mode/destination probabilities for the trip matrices. The run time is approximately 55 minutes for Run 1. Out of a possible 20 million or so O-D pairs in the trip matrices, a positive number of auto trips exist for 3.64 million, or 18% of possible O-D pairs. A total of 1.1 million household records and 17.5 million tour records are in the output HH file, which is 60 MB. The total file size is just under 1 GB.

Run 2 uses ***Sample1inX*** = 1 to simulate every household, but it uses ***EachDayOfTheMonth***= False to simulate only a single representative day per month. In this case, the expansion factors range from 28 to 31 depending on the month. Compared to Run 1, the run time increases slightly to 65 minutes, but the spatial coverage in the auto trip matrix increases by a factor of nearly two, with positive trips for 31% of possible O-D zone pairs. Of course, the size of the output household file increases by a factor of 100 to 114.6 million records and almost 6 GB, while the size of the tour file increases by a factor of three or so, to 55.1 million tour records and 3.1 GB. (After expansion, the total numbers of households, tours, and trips are virtually identical in all runs as the runs represent different ways to achieve the same results.)

The settings for Run 2 are recommended for users who mainly want to analyze the output at the level of individual tour records, rather than using the trip matrix file generated by the software.

Table 7. Comparison of run times and output characteristics under different settings.

Metric	Run 1	Run 2	Run 3	Run 4
HH Sampling Rate	1%	100%	100%	100%
Months Simulated	All	All	All	All
Each Day of Month Separately?	Yes	No	No	Yes
Use Probabilities in Trip Matrix?	No	No	Yes	No
Expansion Factors	100	28-31 (days in month)	28-31 (days in month)	1
Run Time	55 min.	65 min.	240 min.	105 min.
O-Ds in Car Trip Matrix (Million)	3.64	6.31	19.65	16.27
% Of Possible O-Ds in Matrix	18%	31%	98%	81%
HH Records (Million)	1.1	114.6	--	--
HH File Size (MB)	60	5,780	--	--
Tour Records (Million)	17.5	55.1	--	--
Tour File Size (MB)	992	3,128	--	--

Run 3 is identical to Run 2, but the trip matrices use the mode/destination probabilities rather than stochastic trips. This extra computation of the matrices increases run time by a factor of nearly four—to 240 minutes—but the spatial coverage of the car trip matrices also increases by a factor of more than three, up to 98% of all O-D pairs. (The only zone pairs without car trips in this case are intrazonals and trips to or from Hawai'i and Alaska, which are not connected by car to the other 48 states in the networks). If household or tour files were written in this run, they would be identical to Run 2, since only the method of calculating trips matrices was changed.

Finally, Run 4 shows an alternative way of increasing spatial coverage of the trip matrices while reducing run time. Unlike Run 3, this method uses simulated integer trips instead of mode/destination probabilities to accumulate the trip matrices, but it also simulates each day of each month separately. This run is effectively the same as Run 1, but it uses a 100% household sample instead of a 1% sample. The resulting run time is about twice as long as Run 1, but less than half as long as Run 3. The car matrix O-D coverage is 81%, which is nearly as high as Run 3, and may be just as useful for assignment, considering the matrices for Run 4 have at least one trip in each cell (all integer numbers), while the matrices from Run 3 have many cells with small

fractions of trips. If a tour file had been generated from Run 4, it would be 100 times the size of the tour file from Run 1, with roughly 1.75 billion tour records and a file size of nearly 100 GB. Thus, the settings for Run 4 are good for generating trip matrices but are not practical for generating and analyzing detailed tour records.

The settings for Run 4 are recommended for users who mainly want to use the trip matrix file generated by the software (e.g., for highway assignment), but who do not wish to write out or analyze individual tour records.

Scenario Tests

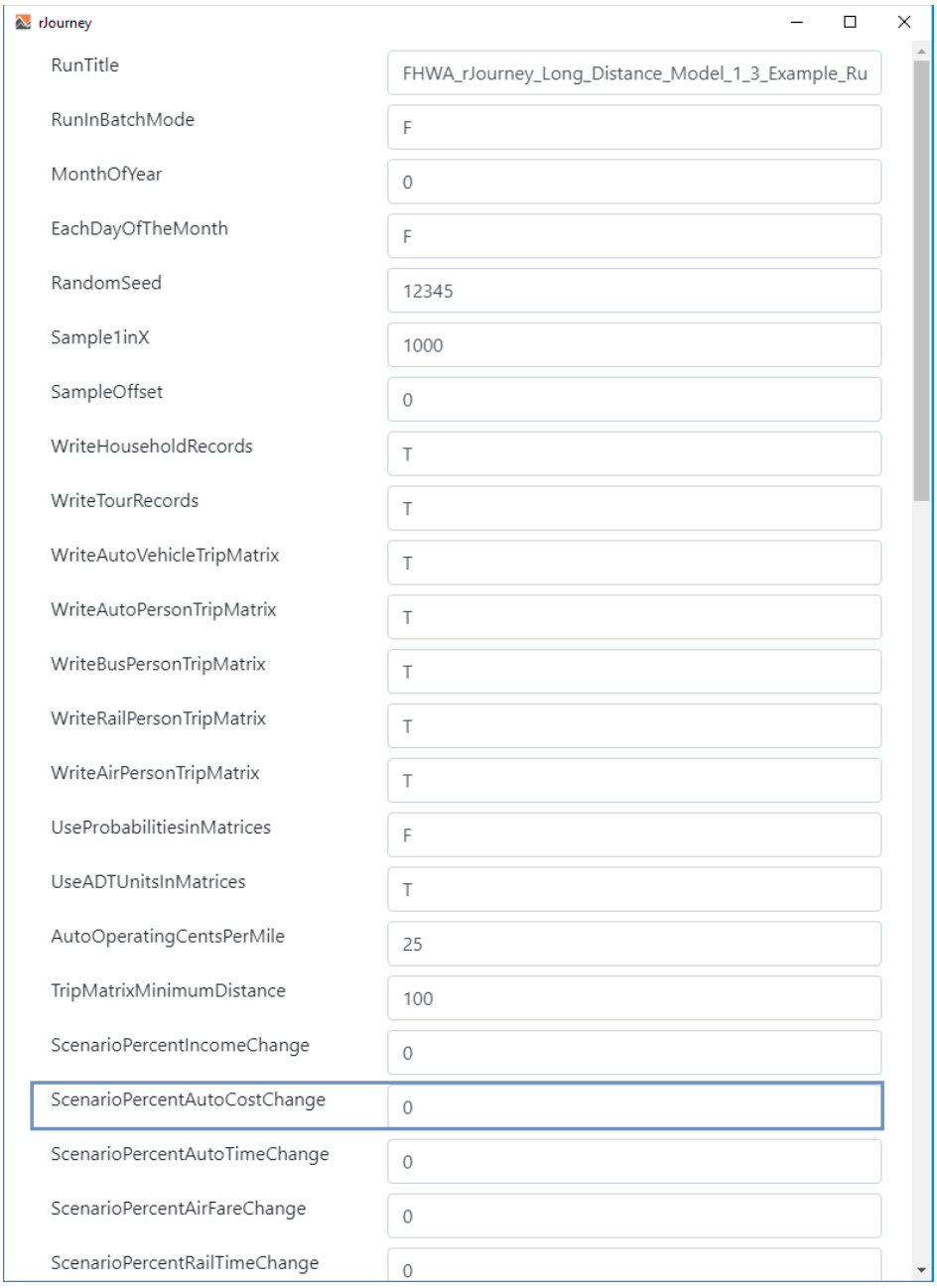
Each user has five options for making system-wide changes to some values. Negative values greater than -100 and all positive values are valid input fields. A positive value indicates percentage increase in the chosen variable and a negative value indicates percentage decrease.

- ***ScenarioPercentIncomeChange****:* This option allows users to test the impact of changes in household income. This test was developed to evaluate the impacts of changes in socioeconomic conditions on long-distance travel behavior. For example, increased income will likely encourage more long-distance travel, increase trip distances, and shift some trips to costlier modes, mainly air.
- ***ScenarioPercentAutoCostChange****:* This option allows users to test the impact of changes in auto toll and operating costs. This test was developed to evaluate the impacts of pricing for the auto mode. For example, increased auto costs will likely discourage long-distance travel for autos and encourage shorter trips.
- ***ScenarioPercentAutoTimeChange****:* This option allows users to test the impact of changes in auto travel time. This test was developed to evaluate the impacts of safety for the auto mode. For example, increased auto travel times will likely discourage travel for autos and increase the frequency of shorter trips as compared to increased auto costs.
- ***ScenarioPercentAirFareChange****:* This option allows users to test the impact of changes in air fare. This test was developed to evaluate the impacts of pricing for the air mode. For example, higher air fares will likely shift travel to other modes at a higher rate than higher auto costs.
- ***ScenarioPercentRailTimeChange****:* This option allows users to test the impact of changes in rail travel time. This test was developed to evaluate the impacts of travel time for the rail mode. For example, higher rail times will likely result in shifts to other modes and shorter trip distances.

Running Alternative Scenarios

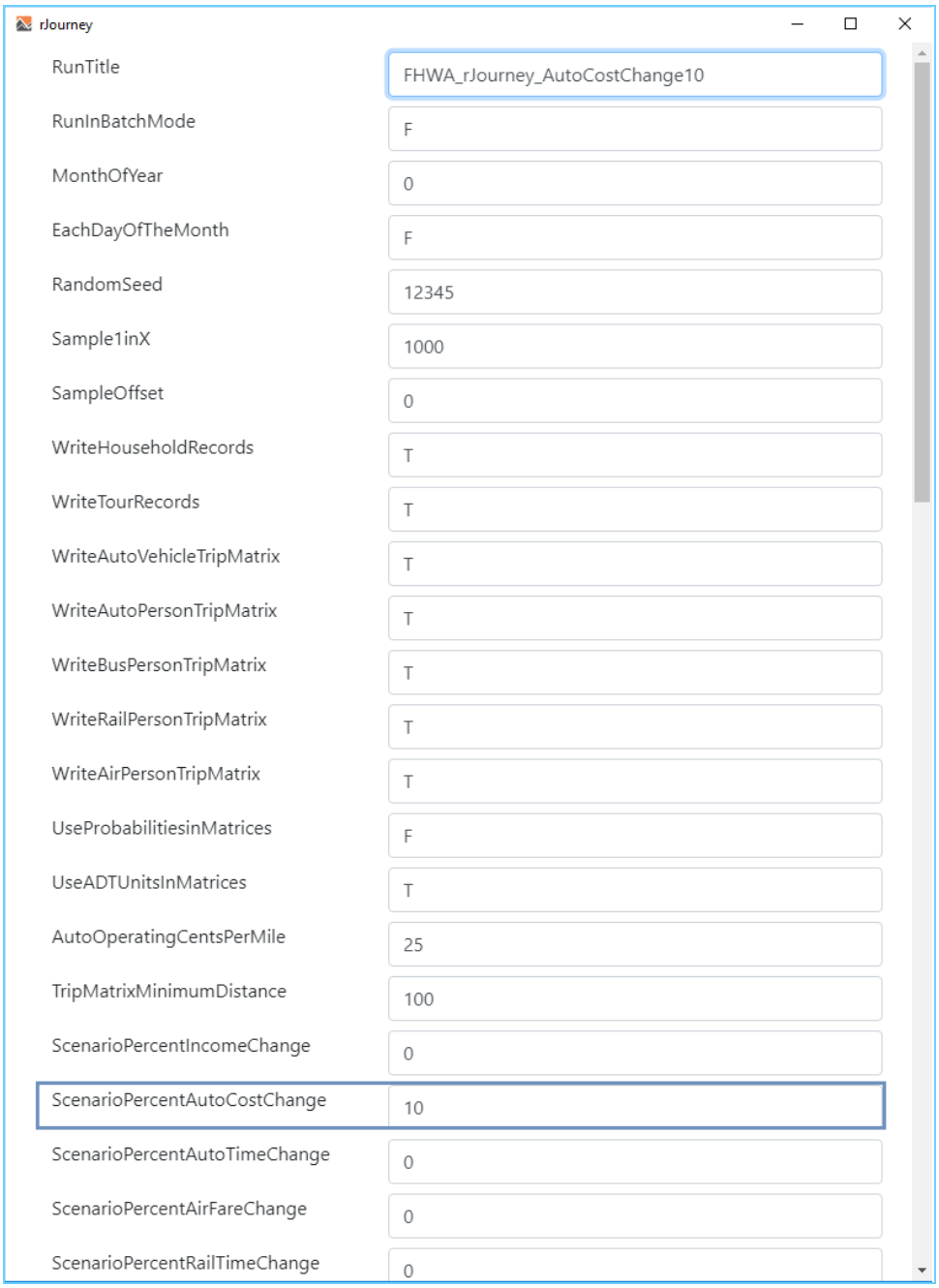
By editing one or more of the scenario settings, the user can investigate how a system-wide change to one of the selected variables would affect long-distance travel demand. For example, a user may want to analyze the impact of a 10% increase in national operating and toll costs for automobiles on vehicle miles traveled (VMT) by car. The user would perform the following operations to analyze this scenario:

1. Run the rJourney application with the base configuration options (per user's preference) as seen in Figure 11.
2. Change the *RunTitle* to an appropriate name and set the *ScenarioPercentAutoCostChange* to a value of 10 as shown in Figure 12.
3. Change the output folder by clicking on the folder icon next to the *OutputDirectoryName*. Windows will then display a "Select Folder" dialog box as seen in Figure 13. Create a new folder by clicking on "New Folder." Select the folder that was just created. Click the "Run" button to run rJourney with this new configuration.
4. Once the alternative scenario run is finished, load the tour output file into the preferred statistical software and calculate the total number of VMT for all auto trips (i.e., sum of *trAutoDistance* where *trMode==1*) separately for both scenarios.
5. Use this information to calculate various performance metrics to measure the impact of changes in operating expenses, if desired.
6. Explore other changes in the share of trips by mode by comparing the base and alternative scenario log files, if desired.



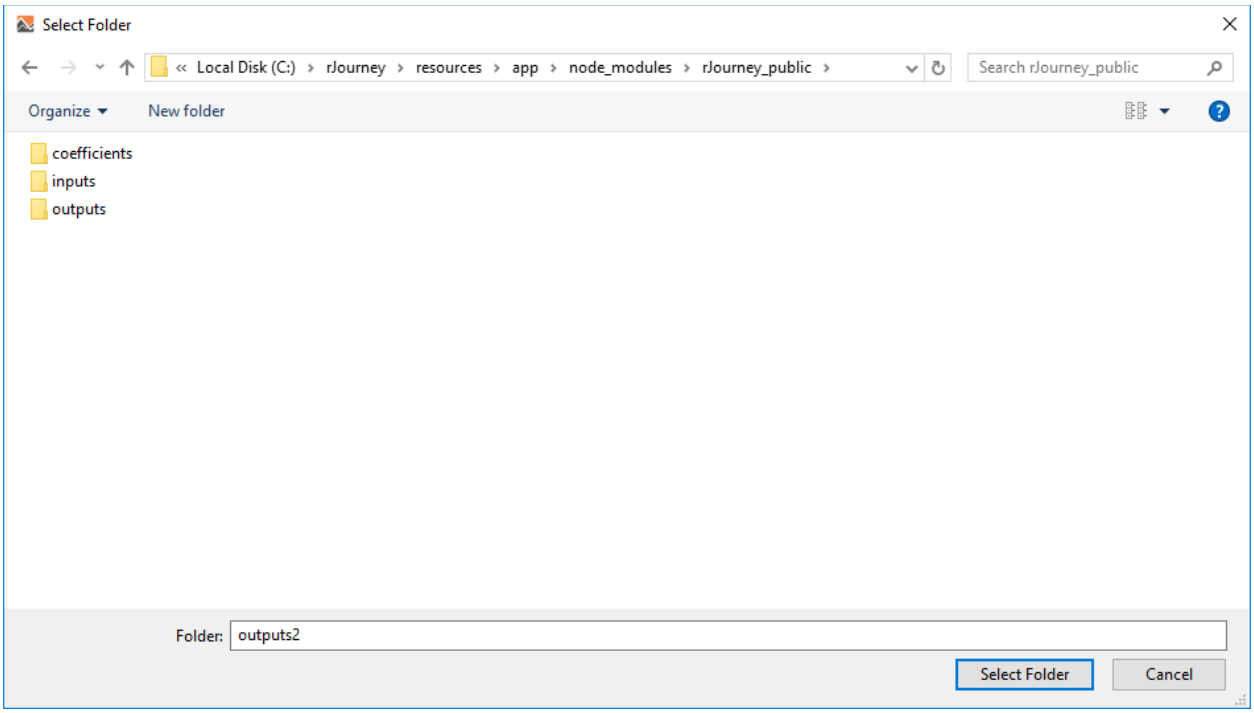
Source: FHWA

Figure 11. rJourney window displaying base scenario configuration.



Source: FHWA

Figure 12. rJourney window displaying alternative scenario configuration.



Source: FHWA

Figure 13. Window to select a folder as an output directory.

4.2 Adapting the Software for Different Zone Systems or Networks

The software could run on data for other synthetic populations, networks, or zone systems, provided that all data input files keep the same formats and variable order as the current input files. In practice, this would require generating new land use and network skim files matching the new zone system. If the zone system is an aggregation of Census tracts, then data preparation could be made easier in two ways:

1. The software includes a land-use file at the Census tract level, which could be aggregated up to a different zone system.

2. The synthetic population was controlled at the tract level, and the Census tract ID is included on each record; as a result, the zone ID field on the synthetic population records could be recoded to match a different tract-to-zone correspondence.

Note: Due to current Delphi memory limitations, the number of zones is limited to a maximum of 4,700. Future versions of the code may eliminate this limitation.

4.3 Input File Documentation

Inputs to the model are stored in the *inputs* folder within the project directory. Users can also choose an input folder by selecting *InputDirectoryName* from the rJourney user interface. The following sections document the list of input files and a brief description of the fields contained in the files.

Household File (us_synpop_hh3_sorted.dat)

The synthetic population household file includes approximately 115 million household records sampled using the PopGen software with 2010 Census tract-level controls; it is sorted by residence zone ID. The file is space-delimited text with a header record (Table 8).

Table 8. Household input variables.

Field Name	Description
HHId	Household identification number
HHTract	2010 residence Census tract Federal Information Processing Standard (FIPS) code
HHNUMA	Residence zone # (NUMA ID)
HHSize	The number of persons in the household
HHWorkers	The number of employed persons in the household (full or part time)
HHNonWkers	The number of nonemployed adults (age 18+) in the household
HHHasKids	Whether or not the household has kids under age 18 (1=yes, 2=no)
HHderAge	The age of the head of the household, in years
HHIncome	The previous year total gross income, in dollars
HHExpFac	The household expansion factor (always equals one on input)

Zonal Land-Use File (numa_2010_landuse.dat)

The zonal land-use file is based on 2010 to 2012 Census tract-level population and employment data and aggregated to NUMA zones. Employment categories are mutually exclusive and broken down by NAICS code. The file is space-delimited text with a header record (Table 9).

Table 9. NUMA 2010 land-use input variables.

Field Name	Description
ZoneID	NUMA ID
NTracts	The number of Census tracts in the zone
LandSqm	The land area in the zone (square miles)
NUMALat	The latitude of the NUMA centroid (degrees)
NUMALong	The longitude of the NUMA centroid (degrees)
StateFIPS	The state FIPS code
ParkSqm	The land area in public parks (square miles)
TotHH	The number of households living in the zone
UnivEnr	The number of university students enrolled in the zone
TotalEmp	The total number of jobs in the zone
AgricEmp	The number of agricultural jobs in the zone
MininEmp	The number of mining jobs in the zone
UtiliEmp	The number of utility jobs in the zone
ConstEmp	The number of construction jobs in the zone
ManufEmp	The number of manufacturing jobs in the zone
WholeEmp	The number of wholesale trade jobs in the zone

Field Name	Description
RetaiEmp	The number of retail trade jobs in the zone
TransEmp	The number of transportation services jobs in the zone
InforEmp	The number of information services jobs in the zone
FinanEmp	The number of financial services jobs in the zone
RealeEmp	The number of real estate service jobs in the zone
ProfeEmp	The number of professional services jobs in the zone
ManagEmp	The number of managerial jobs in the zone
AdminEmp	The number of administrative jobs in the zone
EducaEmp	The number of education jobs in the zone
MedicEmp	The number of medical jobs in the zone
EnterEmp	The number of entertainment jobs in the zone
AccomEmp	The number of accommodation jobs in the zone
OServEmp	The number of other service category jobs in the zone
PubAdEmp	The number of public administration jobs in the zone
StateEmp	The number of state government jobs in the zone
FederEmp	The number of Federal government jobs in the zone
BusStats	The number of bus stations within 40 miles of the zone centroid
RailStats	The number of rail stations within 50 miles of the zone centroid
MinStDist	Distance from the zone centroid to the nearest rail station (miles)
Airports	The number of airports within 100 miles of the zone centroid
MinAPDist	Distance from the zone centroid to the nearest airport (miles)

Road Level-of-Service File (zoneRoadLOS.dat)

The road LOS file is based on the National Highway Planning Network, with connectors added to NUMA zones, airports, and rail stations. The file is space-delimited text with a header record (Table 10).

Table 10. Road LOS input variables.

Field Name	Description
OZoneID	Origin zone (NUMA ID)
DZoneID	Destination zone (NUMA ID)
CarTime	Car time (minutes, 0 indicates no road connection)
CarDist	Car distance (miles)
CarToll	Car toll (cents)
BusTime	Bus time (minutes, based on factoring car time)
BusFare	Bus fare (dollars, from equation based on car distance)

Rail Level-of-Service File (zoneRailLOS.dat)

The rail LOS file is based on Amtrak schedules and fares and road access network; the least-generalized-cost station-pair is used for each zone pair. The file is space-delimited text with no header record (Table 11).

Table 11. Rail LOS input variables.

Field Name	Description
OZoneID	Origin zone (NUMA ID)
DZoneID	Destination zone (NUMA ID)
RailTime	Rail journey time, including stops (minutes, 0 indicates no rail connection)
RailXfers	Rail transfers * 100
RailFreq	Rail frequency (departures per week)
RailEconFare	Rail economy fare (dollars, from equation based on distance)
RailBusiFare	Rail business fare (dollars, from equation based on distance)
RailAccDist	Rail access distance (miles from NUMA to station, maximum is 50)
RailEgrDist	Rail egress distance (miles from station to NUMA, maximum is 50)
RailOStationID	Rail origin station ID #
RailDStationID	Rail destination station ID #
RailOStationCode	Rail origin station 3-letter code
RaiDStationCode	Rail destination station 3-letter code

Air Level-of-Service File (zoneAirLOS.dat)

The air LOS file is based on DB1B ticket database and on-time database; the least-generalized-cost airport pair is used for each zone pair. The file is space-delimited text with no header record (Table 12).

Table 12. Air LOS input variables.

Field Name	Description
OZoneID	Origin zone (NUMA ID)
OzoneID	Destination zone (NUMA ID)
AirTime	Airport pair in-flight time (minutes, 0 indicates no air connection)
AXfers	Airport pair average transfers * 100
AirFreqDirect	Airport pair frequency of direct flights (departures per week)
AirFreq1Stop	Airport pair frequency of routes with one stop (departures per week)
AirFreq2Stop	Airport pair frequency of routes with two stops (departures per week)
AirPctOnTime	Airport pair percent of flights within 30 minutes of scheduled arrival time
AirEconFare	Airport pair average economy fare paid (dollars)
AirBusiFare	Airport pair average business fare paid (dollars, from equation based on distance)
AirAccDist	Air access distance (miles from NUMA to airport, maximum is 100)
AirEgrDist	Air egress distance (miles from airport to NUMA, maximum is 50)
AirOAirportID	Air origin airport ID #
AirDAirportID	Air destination airport ID #
AirOAirportCode	Air origin airport 3-letter code
AirDAirportCode	Air destination airport 3-letter code

Various Model Coefficient Files

The various model coefficient files are kept in the .F12 text file format output by the ALogit model estimation software to minimize editing errors. For each variable, only the coefficient numbers and values are used by the model code (not the labels or standard errors). A sample of the ALogit F12 text file is in Appendix B. Sample Coefficient File. More information is online.[2]

The coefficients for each model component were estimated during the development of the national long-distance passenger travel demand framework. These files are input files; however, users should avoid modifying the coefficients unless new data allows for re-estimation. The model development process is described in further detail in the Final Report.[3] The final model coefficients are also provided in Appendix C. Estimated Model Coefficients.

4.4 Output File Documentation

Household File

The software writes a record for each simulated household in the household output file, if specified by the user. This file is written with a header record (Table 13).

Table 13. Household output variables.

Field Name	Description
HHId	Household identification number
HHZone	Residence zone # (NUMA ID)
HHState	Residence state (FIPS code)
HHSize	The number of persons in the household
HHWorkers	The number of employed persons in the household (full or part time)
HHNonWkers	The number of nonemployed adults (age 18+) in the household
HHHasKids	Whether or not the household has kids under age 18 (1=yes, 2=no)
HHHeadAge	The age of the head of the household, in years
HHIncome	The previous year total gross income, in dollars
HHVehicles	The number of vehicles predicted by the auto ownership model (4 = 4 or more)
HHPersBusTours	The number of personal business tours simulated for the household
HHVisitTours	The number of visit friends and relatives tours simulated for the household
HHLeisureTours	The number of leisure tours simulated for the household
HHCommuteTours	The number of commute tours simulated for the household
HHEmplBusTours	The number of employer's business tours simulated for the household
hhExpOut	The household expansion factor for output (depends on subsampling)

[2] Please visit Software for estimating and analysing generalised logit choice models: http://www.alogit.com/index.htm.

[3] Maren Outwater et al., "Foundational Knowledge to Support a Long-Distance Passenger Travel Demand Modeling Framework: Part A: Final Report," (Federal Highway Administration, March 2015). Please visit: Foundational Knowledge to Support a Long-Distance Passenger Travel Demand Modeling Framework: Part A: Final Report: https://www.fhwa.dot.gov/policyinformation/analysisframework/docs/national_model.pdf.

Tour File

The software writes a record for each simulated household in the tour file, if specified by the user. This file is written with a header record (Table 14).

Table 14. Tour output variables.

Field Name	Description
HHId	Household identification number
trNo	The tour sequence number for the household (1,2,3, etc.)
trMonth	The month the tour was generated (1=Jan, …., 12=Dec)
trPurpose	The main tour purpose (1=Pers.Bus, 2=Visit, 3=Leisure, 4=Commute, 5=Emp.Business)
trPartySize	The tour travel party size (1=1, 2=2, 3=3, 4=4 or more)
trNightsCategory	The tour duration (1=day trip, 2=1-2 nights, 3=3-6 nights, 4=7 or more nights)
trMode	The main tour mode (1=Car, 2=Bus, 3=Rail, 4=Air)
trOState	The tour origin state (FIPS code)
trDState	The tour destination state (FIPS code)
trOZone	The tour origin zone (NUMA ID)
trDZone	The tour destination zone (NUMA ID)
trAutoDistance	The tour round-trip distance if it were made on the auto network (miles)
trTravelTime	The tour round-trip travel time by the chosen main mode (minutes)
trTravelCost	The tour round-trip travel cost by the chosen mode (dollars, per person for nonauto)
trExpFactor	The tour expansion factor
trOrigStation	The tour origin rail station or airport ID #
trDestStation	The tour destination rail station or airport ID #

Trip Matrix File

The software writes a record for each zone pair with a nonzero number of trips in the trip matrix file, if specified by the user for a given mode. Each mode selected (auto vehicle, auto person, bus, rail, and air) is provided a separate trip matrix file. This file is written with a header record (Table 15).

Table 15. Trip matrix output variables.

Field Name	Description
OrigZone	The trip origin zone (NUMA ID)
DestZone	The trip destination zone (NUMA ID)
Trips	The number of trips predicted for the origin/destination/mode

APPENDIX A. SAMPLE LOG PRINT FILE

This is an example of a log print file generated after running rJourney.

```
Reading configuration file inputs\test3_config.txt
RunTitle FHWA_Long_Distance_Model_Test_Run
RoadLOSFileName inputs\zoneRoadLOS.dat
RailLOSFileName inputs\zoneRailLOS.dat
AirLOSFileName inputs\zoneAirLOS.dat
ZoneLandUseFileName inputs\numa_2010_landuse.dat
HouseholdFileName inputs\us_synpop_hh3_sorted.dat
DestChoiceCoefficientFile_1 inputs\pbusdest6_bxc.F12
DestChoiceCoefficientFile_2 inputs\vfardest6_bxc.F12
DestChoiceCoefficientFile_3 inputs\leisdest6_bxc.F12
DestChoiceCoefficientFile_4 inputs\commdest6_bxc.F12
DestChoiceCoefficientFile_5 inputs\ebusdest6_bxc.F12
ModeChoiceCoefficientFile_1 inputs\pbusmode13_est.F12
ModeChoiceCoefficientFile_2 inputs\vfarmode13_est.F12
ModeChoiceCoefficientFile_3 inputs\leismode13_est.F12
ModeChoiceCoefficientFile_4 inputs\commmode13_est.F12
ModeChoiceCoefficientFile_5 inputs\ebusmode13_est.F12
PartySizeCoefficientFile_1 inputs\pbus_psize3.F12
PartySizeCoefficientFile_2 inputs\vfar_psize3.F12
PartySizeCoefficientFile_3 inputs\leis_psize3.F12
PartySizeCoefficientFile_4 inputs\comm_psize3.F12
PartySizeCoefficientFile_5 inputs\ebus_psize3.F12
NightsAwayCoefficientFile_1 inputs\pbus_dur3.F12
NightsAwayCoefficientFile_2 inputs\vfar_dur3.F12
NightsAwayCoefficientFile_3 inputs\leis_dur3.F12
NightsAwayCoefficientFile_4 inputs\comm_dur3.F12
NightsAwayCoefficientFile_5 inputs\ebus_dur3.F12
TourFreqCoefficientsFile_1 inputs\freqest3a.f12
TourFreqCoefficientsFile_2 inputs\fsecest3a.f12
AutoOwnCoefficientsFile inputs\carown3.f12
HouseholdOutputFileName outputs\household_out_13.dat
TourOutputFileName outputs\tour_out_13.dat
TripMatrixOutputFileName outputs\trip_out_13.dat
OutputFileDelimeter 32
MonthOfYear 0
EachDayOfTheMonth T
RandomSeed 12345
Sample1inX 100
SampleOffset 0
WriteHouseholdRecords T
WriteTourRecords T
WriteCarTripMatrix T
WriteBusTripMatrix T
WriteRailTripMatrix T
WriteAirTripMatrix T
UseProbabilitiesinMatrices F
UseADTUnitsInMatrices F

Run started at 5/24/2015 1:25:00 PM
Loading Zone Land Use Data from inputs\numa_2010_landuse.dat
Loading Road LOS Matrices from inputs\zoneRoadLOS.dat
Loading Rail LOS Matrices from inputs\zoneRailLOS.dat
Loading Air LOS Matrices from inputs\zoneAirLOS.dat

Total expanded households simulated = 114736800

Household car ownership distribution by income group
Income> Total 0-35 $k 35-65$k 65-100k 100-150 Over150
0 cars 5.13% 11.67% 2.97% 1.43% 0.89% 0.56%
1 car 29.75% 51.44% 28.56% 16.28% 10.47% 7.51%
2 cars 40.92% 26.06% 44.37% 49.70% 51.21% 53.61%
3 cars 15.53% 7.71% 16.04% 20.45% 22.59% 23.09%
4+ cars 8.67% 3.12% 8.06% 12.13% 14.84% 15.23%
```

Household tour rates by purpose and income group (for simulated period)
Income> Total 0-35 $k 35-65$k 65-100k 100-150 Over150
PersBus 2.7827 2.5804 2.8464 2.9167 2.9035 2.9062
VisitFR 6.4060 5.2268 6.5070 6.9750 7.3120 8.0412
Leisure 4.6567 2.6680 4.3955 5.5243 6.5317 8.3446
Commute 1.0016 0.4280 0.9643 1.3101 1.5545 1.8222
EmplBus 2.6798 0.7904 2.2291 3.4815 4.6272 6.5755

Total expanded tours simulated = 2010968300

Tour nights away distribution by purpose
Purpose Total PersBus VisitFR Leisure Commute EmplBus
Daytrip 50.71% 68.49% 40.11% 46.43% 78.12% 54.76%
1-2 nts 28.34% 20.45% 35.87% 27.87% 11.53% 25.65%
3-6 nts 15.07% 8.01% 17.30% 17.35% 8.16% 15.68%
7+ nts 5.88% 3.04% 6.71% 8.36% 2.19% 3.92%

Tour party size distribution by purpose
Purpose Total PersBus VisitFR Leisure Commute EmplBus
1 pers 30.36% 21.87% 26.28% 12.55% 79.77% 61.40%
2 pers 35.91% 39.73% 38.43% 41.14% 13.96% 25.03%
3 pers 13.81% 17.58% 15.27% 15.96% 3.45% 6.55%
4+ pers 19.92% 20.81% 20.02% 30.35% 2.82% 7.02%

Tour distance band distribution by purpose
Purpose Total PersBus VisitFR Leisure Commute EmplBus
50-99 m 42.36% 47.40% 35.27% 43.38% 74.57% 40.30%
100-149 18.50% 20.35% 19.94% 18.83% 8.96% 16.15%
150-249 14.34% 12.95% 17.35% 14.51% 3.73% 12.27%
250-499 10.66% 8.34% 13.85% 9.35% 1.81% 11.05%
500-999 9.03% 8.16% 9.09% 8.27% 8.89% 11.16%
-1999 m 3.32% 2.03% 3.05% 3.74% 1.39% 5.32%
2000+ m 1.78% 0.78% 1.47% 1.91% 0.66% 3.75%

Tour mode choice distribution by purpose
Purpose Total PersBus VisitFR Leisure Commute EmplBus
Car 90.80% 95.03% 92.63% 90.83% 94.48% 80.62%
Bus 1.33% 1.53% 0.74% 2.44% 1.24% 0.64%
Rail 1.28% 0.88% 0.83% 1.16% 3.16% 2.24%
Air 6.59% 2.56% 5.80% 5.57% 1.13% 16.49%

Tour distance band distribution by mode and purpose
Mode = Car
Purpose Total PersBus VisitFR Leisure Commute EmplBus
50-99 m 45.24% 48.58% 37.33% 46.04% 75.29% 48.19%
100-149 19.90% 20.97% 21.19% 20.06% 9.20% 19.43%
150-249 14.84% 13.13% 18.09% 14.93% 3.64% 12.70%
250-499 10.93% 8.43% 14.35% 9.60% 1.79% 11.21%
500-999 7.29% 7.37% 7.43% 7.09% 8.75% 6.53%
-1999 m 1.64% 1.40% 1.48% 2.06% 1.28% 1.69%
2000+ m 0.17% 0.13% 0.14% 0.21% 0.06% 0.23%
Mode = Bus
Purpose Total PersBus VisitFR Leisure Commute EmplBus
50-99 m 37.37% 43.63% 34.37% 35.64% 48.81% 33.32%
100-149 15.24% 16.42% 17.52% 15.38% 5.07% 12.39%
150-249 15.47% 12.41% 14.02% 17.48% 13.54% 15.07%
250-499 9.82% 7.45% 9.98% 10.65% 5.70% 12.70%
500-999 18.20% 16.71% 19.91% 17.13% 23.41% 20.53%
-1999 m 3.57% 3.12% 3.85% 3.40% 3.24% 5.26%
2000+ m 0.34% 0.26% 0.34% 0.32% 0.22% 0.73%
Mode = Rail
Purpose Total PersBus VisitFR Leisure Commute EmplBus
50-99 m 55.65% 61.15% 47.67% 49.97% 89.50% 47.82%
100-149 15.12% 17.96% 18.91% 15.67% 6.57% 14.59%
150-249 14.65% 11.29% 14.61% 18.66% 2.01% 19.07%
250-499 5.44% 3.48% 6.64% 6.03% 0.47% 7.24%
500-999 7.18% 5.05% 9.79% 7.16% 1.25% 8.86%
-1999 m 1.65% 0.99% 2.01% 2.01% 0.18% 2.03%
2000+ m 0.32% 0.08% 0.36% 0.50% 0.02% 0.39%
Mode = Air
Purpose Total PersBus VisitFR Leisure Commute EmplBus

50-99 m 1.13% 1.09% 0.69% 2.02% 0.86% 0.99%
100-149 0.55% 0.50% 0.41% 0.97% 0.10% 0.43%
150-249 7.23% 7.38% 6.22% 5.52% 5.41% 9.12%
250-499 8.15% 7.09% 7.38% 5.40% 3.16% 10.70%
500-999 31.59% 33.44% 34.16% 23.99% 25.34% 33.75%
-1999 m 26.79% 25.03% 28.14% 31.59% 12.19% 23.49%
2000+ m 24.56% 25.47% 23.00% 30.51% 52.92% 21.52%

Daily tours by mode and O-D Census divisions (thousands)
Mode = Car
O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI
New Eng 160.6 83.4 4.2 0.8 8.9 1.1 0.6 0.3 0.3 0.0
Mid Atl 80.5 456.8 43.8 3.8 103.2 6.3 2.5 0.9 0.6 0.0
NE Cent 3.4 40.7 660.7 71.2 37.8 47.9 12.6 3.8 1.0 0.0
NW Cent 0.6 3.0 57.7 259.0 6.9 11.2 31.2 13.0 1.5 0.0
Sou Atl 7.8 86.1 38.3 7.4 797.7 72.8 14.1 1.7 1.0 0.0
SE Cent 1.0 5.4 46.8 12.2 70.9 182.7 32.6 1.5 0.5 0.0
SW Cent 0.4 1.7 9.2 26.8 12.3 28.7 440.6 15.0 1.8 0.0
Mountn 0.1 0.4 1.8 7.7 1.0 0.8 11.3 224.6 18.3 0.0
Pacific 0.2 0.4 0.8 1.3 1.0 0.4 2.5 46.3 539.8 0.0
AK & HI 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 5.4
Mode = Bus
O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI
New Eng 2.1 1.7 0.2 0.0 0.3 0.0 0.0 0.0 0.0 0.0
Mid Atl 1.5 7.7 1.3 0.2 2.0 0.2 0.1 0.0 0.0 0.0
NE Cent 0.1 1.1 9.0 1.2 1.1 0.8 0.4 0.1 0.0 0.0
NW Cent 0.0 0.1 0.9 2.1 0.2 0.2 0.5 0.2 0.0 0.0
Sou Atl 0.2 1.7 1.1 0.2 9.7 1.1 0.4 0.0 0.0 0.0
SE Cent 0.0 0.2 0.8 0.2 0.9 1.5 0.6 0.0 0.0 0.0
SW Cent 0.0 0.1 0.3 0.4 0.4 0.5 5.2 0.3 0.1 0.0
Mountn 0.0 0.0 0.1 0.1 0.0 0.0 0.2 2.0 0.3 0.0
Pacific 0.0 0.0 0.0 0.0 0.0 0.0 0.1 1.0 7.8 0.0
AK & HI 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Mode = Rail
O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI
New Eng 2.3 2.0 0.1 0.0 0.2 0.0 0.0 0.0 0.0 0.0
Mid Atl 7.2 21.7 1.3 0.2 5.1 0.1 0.1 0.0 0.1 0.0
NE Cent 0.1 0.5 5.4 0.5 0.2 0.1 0.1 0.1 0.0 0.0
NW Cent 0.0 0.0 0.2 0.3 0.0 0.0 0.0 0.0 0.0 0.0
Sou Atl 0.2 1.9 0.2 0.0 5.0 0.1 0.1 0.0 0.0 0.0
SE Cent 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
SW Cent 0.0 0.0 0.1 0.0 0.0 0.0 1.4 0.0 0.0 0.0
Mountn 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.3 0.1 0.0
Pacific 0.0 0.0 0.0 0.0 0.0 0.0 0.1 0.5 11.6 0.0
AK & HI 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
Mode = Air
O / D>> New Eng Mid Atl NE Cent NW Cent Sou Atl SE Cent SW Cent Mountn Pacific AK & HI
New Eng 0.4 2.7 2.3 0.9 3.9 0.6 1.5 1.8 5.3 0.1
Mid Atl 3.3 4.0 8.2 3.0 13.7 2.2 4.6 4.6 12.0 0.3
NE Cent 1.9 5.7 7.4 4.4 11.6 2.3 5.9 4.7 5.7 0.3
NW Cent 0.6 1.8 3.1 1.5 3.5 0.9 2.9 2.7 2.4 0.1
Sou Atl 3.0 8.8 10.6 4.2 16.9 3.3 7.5 5.0 11.1 0.3
SE Cent 0.5 1.5 2.1 1.1 3.5 0.7 2.1 1.0 1.4 0.1
SW Cent 1.0 2.7 4.3 2.8 6.3 1.7 8.8 4.6 4.6 0.2
Mountn 0.9 2.0 2.6 1.8 3.3 0.6 3.2 4.7 5.5 0.2
Pacific 4.7 8.9 6.0 3.0 12.4 1.4 6.0 11.3 13.5 1.1
AK & HI 0.2 0.4 0.5 0.2 0.6 0.2 0.4 0.4 0.4 0.0

Run finished at 5/24/2015 2:18:53 PM with 114736859 households processed

APPENDIX B. SAMPLE COEFFICIENT FILE

This is an example of a coefficient file generated by ALOGIT for commute party-size model.

```
commute party size choice
Created by ALOGIT version 4                                  10:40:00 on 19 May
15
END
   1  eq-hsize  F    .264279393988       .503885041558E-01
   2 eq-hadlts  F   -.255623101207       .445296191451E-01
 201  2p-const  F    .225982715379E-01   .252877567423
 202 2p-wratio  T    .000000000000       .000000000000
 203 2p-loginc  F   -.423746160543       .554542122321E-01
 204 2p-misinc  F   -1.69809603786       .267404060204
 205 2p-nocars  F   -.616168570911       .241813250389
 206 2p-carslta T    .000000000000       .000000000000
 207 2p-daytrip T    .000000000000       .000000000000
 208 2p-night12 T    .000000000000       .000000000000
 209 2p-weektrp T    .000000000000       .000000000000
 210 2p-misnigh T    .000000000000       .000000000000
 211 2p-junaug  T    .000000000000       .000000000000
 212 2p-janmar  F    .380265647090       .107977707224
 213 2p-novdec  T    .000000000000       .000000000000
 214 2p-misseas F   -.539678141153E-01   .797609951119E-01
 215 2p-ageu35  F    .329850292436       .689355145347E-01
 216 2p-age65p  F   -.456263229835       .157005730329
 301  3p-const  F   -.172083796414       .522376355079
 302 3p-wratio  T    .000000000000       .000000000000
 303 3p-loginc  F   -.547925316680       .114900766666
 304 3p-misinc  F   -3.52546496550       .699334967278
 305 3p-nocars  F    1.59823539078       .246678915813
 306 3p-carslta F    .674445348115       .172514119765
 307 3p-daytrip T    .000000000000       .000000000000
 308 3p-night12 T    .000000000000       .000000000000
 309 3p-weektrp T    .000000000000       .000000000000
 310 3p-misnigh T    .000000000000       .000000000000
 311 3p-junaug  F   -1.01622810716       .325681279336
 312 3p-janmar  F   -.980901298160       .254065218213
 313 3p-novdec  F   -1.42567374699       .437003026307
 314 3p-misseas F   -1.12713103919       .170448886574
 315 3p-ageu35  F   -.744528742076       .185827613628
 316 3p-age65p  F   -.986700608198       .375879941737
 401  4p-const  F    1.53796982027       .452157917442
 402 4p-wratio  F    .898166047825       .291112523031
 403 4p-loginc  F   -1.50342697065       .903716268055E-01
 404 4p-misinc  F   -6.22247627348       .487756155158
 405 4p-nocars  F    2.38712597493       .183948237541
 406 4p-carslta F    1.47604064070       .155029503019
 407 4p-daytrip T    .000000000000       .000000000000
 408 4p-night12 T    .000000000000       .000000000000
 409 4p-weektrp T    .000000000000       .000000000000
 410 4p-misnigh T    .000000000000       .000000000000
```

```
411 4p-junaug  T    .000000000000       .000000000000
412 4p-janmar  F   -1.43610037638       .368348233417
413 4p-novdec  F    .862873644150       .265552205648
414 4p-misseas F   -.491381592474       .181305194430
415 4p-ageu35  F    .575485759367       .136346782651
416 4p-age65p  F   -.755090038749       .351843646888
 -1
   9012  -.604203668958E+04  -.124932847824E+05  -.553355837865E+04
  6   010:40:00 on 19 May 15
-52285  -1047    651      0      0      0     -8  -4654 -95675      0
 -1819  -1034 -84897      0  86547    961   2423  -9528      0   9383
  8874      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0   4069  -7057
-21461      0   4403   3980  -1133      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0   1862  -4784 -34502      0  12020
 11562  -2856      0      0      0      0      0      0  55992      0
  2022  -7487 -25744      0  20057  20007  -2015      0      0      0
     0      0      0   1977      0  -6275 -11404  10590 -18185      0
 14151  10758  -1048      0      0      0      0      0      0   1029
     0   5354  15224   -903   1806   9605      0  -9208  -8247   -199
     0      0      0      0      0      0  -1952      0  -3093  -2551
 -1444      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
   480  -1454  -9240      0   9398   8297    125      0      0      0
     0      0      0    738      0   1505   2130   1219 -95807      0
  -759    216  -6566      0   6561   7364    199      0      0      0
     0      0      0    362      0   1005   1532    881 -67453      0
 68581   3658  -4907  -1849      0   1931   1699  10323      0      0
     0      0      0      0    356      0    -86    430   -567 -20156
     0  18826  15058   2626 -12046   -151      0    811    351   -410
     0      0      0      0      0      0    829      0    567   1067
 -1046  -8190      0   2283   2181  15980      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0      0      0
     0      0      0      0      0      0      0      0   -682    966
   165      0   -199   -120    -13      0      0      0      0      0
     0    -90      0    -92    -67     65 -11330      0   -568   -365
   452    391      0      0      0      0  -2574   2080  -1179      0
    96    102     52      0      0      0      0      0      0   7358
     0   3341   -268    324 -22649      0   7806   5378   -320  -4283
     0      0      0      0  24560  -1580    711     40      0    -26
     0     49      0      0      0      0      0      0    -33      0
```

11	-75	170	-8459	0	-322	584	-1532	-2972	0
0	0	0	14299	18579	-6482	2911	-2530	0	1065
1130	-411	0	0	0	0	0	0	3568	0
6712	-464	1226	-33499	0	11512	9494	-9955	-3182	0
0	0	0	36708	48882	27851	1167	2699	-1316	0
787	879	494	0	0	0	0	0	0	-272
0	-649	6226	870	-23049	0	19871	15052	-1277	1632
0	0	0	0	-2271	11	-1143	-5441	2447	441
-1345	0	905	717	69	0	0	0	0	0
0	226	0	561	884	4965	-19812	0	17536	10884
-3641	-4737	0	0	0	0	-1361	3717	1461	5361
11614	-5561	3736	14152	0	-13748	-12153	228	0	0
0	0	0	0	-2968	0	-4223	-2333	-1473	10023
0	-9798	-6834	683	-7	0	0	0	0	84
-1885	-380	-2654	-1234	-639	5687	302	308	0	-558
-490	-688	0	0	0	0	0	0	-94	0
-109	-123	-579	-693	0	638	360	-718	-554	0
0	0	0	335	232	-141	128	-173	861	-45170
-1015	-1348	-15572	0	16129	14180	-233	0	0	0
0	0	0	1311	0	2116	1919	2067	-10197	0
10590	7396	-73	245	0	0	0	0	-162	894
-107	1302	987	-756	-72747	-13863	-2303	318	-12227	0
12483	13317	138	0	0	0	0	0	0	873
0	1658	1664	1631	-7899	0	8085	6625	-217	-109
0	0	0	0	-115	886	-41	1334	816	-450
-56033	-8161	69609	5504	-1896	-4078	0	3996	3641	16792
0	0	0	0	0	0	276	0	-335	-660
-288	852	0	-997	-633	14602	570	0	0	0
0	-20	-652	129	-1339	874	139	-17666	10058	9472
10598	-7118	-760	-397	0	764	684	-406	0	0
0	0	0	0	63	0	156	345	502	-15
0	-137	-42	73	4865	0	0	0	0	-27
-265	282	293	113	-466	-21405	26002	-4978	-1268	29538
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

```
-1041    141   -890      0     -9    -34    417      0      0      0
    0      0      0   6114      0   2879    104    213  -1248      0
  679    483   -474   -512      0      0      0      0   -102   3790
  674   2100    -97    624 -15930  -2727   3342   3769  -5487  -4280
    0      0      0      0      0   2886  -1194     32      0   -162
 -228    125      0      0      0      0      0      0    291      0
  355   -176   -255  -1600      0    888    636  -1126   -582      0
    0      0      0   -152   1676   4682   2483    -69    853 -21014
 1562  -2181   1556  -5402   2226      0      0      0      0      0
26198  -1240     16  -2893      0   1126   1050   -393      0      0
    0      0      0      0   4459      0   7939   -508    701  -3041
    0   1910   1402  -1218   -770      0      0      0      0   -221
 2858   1348   5492   -396    903 -36113  -5652  10822  12523 -13104
-1706      0      0      0      0      0  39693  53823  -1505   1601
-1410      0    901   1049    645      0      0      0      0      0
    0   -265      0   -774   9038   1233  -3031      0   2778   2079
-1836   -447      0      0      0      0   -134    474      0    125
 6083    523 -26242  -7809  23279  19722  -4639  -2779      0      0
    0      0      0   -382    -40  -3314   3990   -338  -2533      0
 2090   1706    457      0      0      0      0      0      0    455
    0    723    929   5820    410      0   -866   -712   -446   -897
    0      0      0      0    -80    526     22    497   -215   8002
-30253 10186  22927  16623  -8840    -75      0      0      0      0
    0   2197   6058   6012  23506
    1
```

APPENDIX C. ESTIMATED MODEL COEFFICIENTS

Table 16 through Table 44 detail the estimated model coefficients for auto ownership, tour generation, tour party size, scheduling, destination choice, and mode choice, respectively. All models indicate the coefficient number (as shown in the F12 coefficient input files and used in the model code) and the alternative name, the variable description, the estimated coefficient value, and the computed t-statistic. Some variables indicated by * were used in model estimation to allow for missing data or to adjust for retrospective survey bias and are not needed for model application. F&R means “friends and relatives.”

Table 16. Auto ownership model.

Coeff. #	Altern.	Variable	Coefficient
10	0 cars	Constant	-2.98
11	0 cars	1 adult HH	2.45
12	0 cars	3 adult HH	0.813
13	0 cars	4+ adult HH	1.14
14	0 cars	HH workers/adults	-0.442
14	0 cars	HH has children	-0.877
16	0 cars	Head of HH age 65+	--
17	0 cars	Head of HH under 35	0.269
18	0 cars	Log of HH+job density	0.767
19	0 cars	Log of (HH income/1000)	-1.52
61	0 cars	Missing HH income data*	-6.22
20	1 car	Constant	0.726
21	1 car	1 adult HH	2.42
22	1 car	3 adult HH	-0.189
23	1 car	4+ adult HH	--
24	1 car	HH workers/adults	-0.224
25	1 car	HH has children	-1
26	1 car	Head of HH age 65+	0.184
27	1 car	Head of HH under 35	0.112
28	1 car	Log of HH+job density	0.243
29	1 car	Log of (HH income/1000)	-0.87
62	1 car	Missing HH income data*	-3.65
30	2 cars	Constant	0
40	3 cars	Constant	-1.4
41	3 cars	1 adult HH	--
42	3 cars	3 adult HH	1.61
43	3 cars	4+ adult HH	1.95
44	3 cars	HH workers/adults	0.464
45	3 cars	HH has children	--
46	3 cars	Head of HH age 65+	-0.218
47	3 cars	Head of HH under 35	-0.278
48	3 cars	Log of HH+job density	-0.103
49	3 cars	Log of (HH income/1000)	0.114
64	3 cars	Missing HH income data*	0.487
50	4+ cars	Constant	-2.8
51	4+ cars	1 adult HH	--
52	4+ cars	3 adult HH	1.89
53	4+ cars	4+ adult HH	3.68
54	4+ cars	HH workers/adults	1.09
55	4+ cars	HH has children	--

Coeff. #	Altern.	Variable	Coefficient
56	4+ cars	Head of HH age 65+	-0.229
57	4+ cars	Head of HH under 35	-0.144
58	4+ cars	Log of HH+job density	-0.234
59	4+ cars	Log of (HH income/1000)	0.276
60	4+ cars	Missing HH income data*	1.24

Table 17. Auto ownership model (fit statistics).

Statistic	Auto Ownership
Observations	114103
Final log-likelihood	-118875.8
Rho-squared vs. 0	0.353
Rho-squared vs. constants	0.197

Table 18. Tour-generation models.

Coefficient Number	Alternative	Variable	First Tour Coefficient	Second Tour Coefficient
0	No tour	Constant	0	0
100	Pers.Bus.	Constant	-4.18	-4.59
101	Pers.Bus.	January	-0.256	--
102	Pers.Bus.	February	--	--
103	Pers.Bus.	March	--	--
104	Pers.Bus.	April	--	--
105	Pers.Bus.	May	--	--
106	Pers.Bus.	June	--	--
107	Pers.Bus.	July	-0.134	--
108	Pers.Bus.	August	-0.152	--
109	Pers.Bus.	September	-0.176	--
110	Pers.Bus.	October	-0.265	--
111	Pers.Bus.	November	-0.15	--
112	Pers.Bus.	December	-0.317	--
113	Pers.Bus.	Access. logsum under 50 miles	-0.218	-0.136
114	Pers.Bus.	Access.logsum 50-150 miles	0.0329	0.0461
115	Pers.Bus.	Access logsum 150-500 miles	--	--
116	Pers.Bus.	Access logsum over 500 miles	--	--
117	Pers.Bus.	No logsum for under 50 miles	0.342	--
118	Pers.Bus.	Days before survey was taken*	-0.0141	--
119	Pers.Bus.	Log(days before survey taken)*	-0.131	-0.073
122	Pers.Bus.	Log of (HH income/1000)	0.0915	--
123	Pers.Bus.	Missing HH income data*	0.339	--
124	Pers.Bus.	HH has no cars	-0.757	--
125	Pers.Bus.	HH has car competition	-0.114	--
126	Pers.Bus.	HH has children	-0.0859	0.274
127	Pers.Bus.	HH workers/adults	-0.456	--
128	Pers.Bus.	HH has one person	-0.339	--
129	Pers.Bus.	Head of HH is under age 35	-0.478	-0.64
130	Pers.Bus.	Head of HH is age 65+	-0.111	--

Coefficient Number	Alternative	Variable	First Tour Coefficient	Second Tour Coefficient
131	Pers.Bus.	HH size	--	--
200	VisitFR	Constant	-5.73	-6.29
201	VisitFR	January	-0.456	--
202	VisitFR	February	-0.273	--
203	VisitFR	March	-0.18	--
204	VisitFR	April	--	--
205	VisitFR	May	--	--
206	VisitFR	June	0.0556	--
207	VisitFR	July	0.0306	--
208	VisitFR	August	-0.0823	--
209	VisitFR	September	-0.241	--
210	VisitFR	October	-0.288	--
211	VisitFR	November	--	--
212	VisitFR	December	--	--
213	VisitFR	Access. logsum under 50 miles	-0.0522	--
214	VisitFR	Access.logsum 50-150 miles	0.0467	0.207
215	VisitFR	Access logsum 150-500 miles	0.08	--
216	VisitFR	Access logsum over 500 miles	0.28	--
217	VisitFR	No logsum for under 50 miles	-0.267	--
218	VisitFR	Days before survey was taken*	-0.013	--
219	VisitFR	Log(days before survey taken)*	-0.097	--
222	VisitFR	Log of (HH income/1000)	0.128	0.104
223	VisitFR	Missing HH income data*	0.509	-0.0084
224	VisitFR	HH has no cars	-0.323	--
225	VisitFR	HH has car competition	-0.108	-0.427
226	VisitFR	HH has children	-0.245	-0.246
227	VisitFR	HH workers/adults	-0.111	--
228	VisitFR	HH has one person	-0.0991	-0.61
229	VisitFR	Head of HH is under age 35	0.0994	--
230	VisitFR	Head of HH is age 65+	--	--
231	VisitFR	HH size	-0.0425	
300	Leisure	Constant	-6.54	-6.94

Coefficient Number	Alternative	Variable	First Tour Coefficient	Second Tour Coefficient
301	Leisure	January	-0.494	--
302	Leisure	February	-0.316	--
303	Leisure	March	-0.107	--
304	Leisure	April	--	--
305	Leisure	May	--	--
306	Leisure	June	0.161	--
307	Leisure	July	0.365	--
308	Leisure	August	0.21	--
309	Leisure	September	--	--
310	Leisure	October	-0.152	--
311	Leisure	November	-0.308	--
312	Leisure	December	-0.509	--
313	Leisure	Access. logsum under 50 miles	-0.0682	-0.109
314	Leisure	Access.logsum 50-150 miles	0.01	0.0029
315	Leisure	Access logsum 150-500 miles	0.167	0.108
316	Leisure	Access logsum over 500 miles	0.402	0.58
317	Leisure	No logsum for under 50 miles	-0.159	--
318	Leisure	Days before survey was taken*	-0.0096	--
319	Leisure	Log(days before survey taken)*	-0.13	--
322	Leisure	Log of (HH income/1000)	0.266	0.106
323	Leisure	Missing HH income data*	1.12	0.328
324	Leisure	HH has no cars	--	--
325	Leisure	HH has car competition	-0.242	--
326	Leisure	HH has children	0.0613	0.28
327	Leisure	HH workers/adults	-0.134	--
328	Leisure	HH has one person	-0.301	--
329	Leisure	Head of HH is under age 35	--	--
330	Leisure	Head of HH is age 65+	-0.0698	-0.422
331	Leisure	HH size	-0.0281	--
400	Commute	Constant	-4.28	-7.17
401	Commute	January	0.599	--
402	Commute	February	0.598	--

Coefficient Number	Alternative	Variable	First Tour Coefficient	Second Tour Coefficient
403	Commute	March	0.629	--
404	Commute	April	--	--
405	Commute	May	0.523	--
406	Commute	June	--	--
407	Commute	July	--	--
408	Commute	August	0.386	--
409	Commute	September	--	--
410	Commute	October	--	--
411	Commute	November	0.288	--
412	Commute	December	0.277	--
413	Commute	Access. logsum under 50 miles	-0.157	--
414	Commute	Access. logsum 50-150 miles	0.449	--
415	Commute	Access logsum 150-500 miles	--	--
416	Commute	Access logsum over 500 miles	--	--
417	Commute	No logsum for under 50 miles	1.12	--
418	Commute	Days before survey was taken*	0	--
419	Commute	Log (days before survey taken)*	-0.412	-0.319
422	Commute	Log of (HH income/1000)	0.273	0.16
423	Commute	Missing HH income data*	1.46	-0.0557
424	Commute	HH has no cars	-1.6	--
425	Commute	HH has car competition	0.0812	--
426	Commute	HH has children	0.195	1.03
427	Commute	HH workers/adults	0.175	--
428	Commute	HH has one person	--	--
429	Commute	Head of HH is under age 35	-0.426	--
430	Commute	Head of HH is age 65+	-0.365	--
431	Commute	HH size	--	--
500	Empl.Bus.	Constant	-7.21	-8.21
501	Empl.Bus.	January	-0.125	--
502	Empl.Bus.	February	0.0945	--
503	Empl.Bus.	March	0.242	--
504	Empl.Bus.	April	--	--

Coefficient Number	Alternative	Variable	First Tour Coefficient	Second Tour Coefficient
505	Empl.Bus.	May	--	--
506	Empl.Bus.	June	--	--
507	Empl.Bus.	July	-0.086	--
508	Empl.Bus.	August	--	--
509	Empl.Bus.	September	--	--
510	Empl.Bus.	October	0.13	--
511	Empl.Bus.	November	-0.107	--
512	Empl.Bus.	December	-0.403	--
513	Empl.Bus.	Access. logsum under 50 miles	-0.0909	-0.0589
514	Empl.Bus.	Access. logsum 50-150 miles	0.0468	0.221
515	Empl.Bus.	Access logsum 150-500 miles	--	0.355
516	Empl.Bus.	Access logsum over 500 miles	0.134	--
517	Empl.Bus.	No logsum for under 50 miles	--	--
518	Empl.Bus.	Days before survey was taken*	-0.0076	--
519	Empl.Bus.	Log (days before survey taken)*	-0.176	-0.131
522	Empl.Bus.	Log of (HH income/1000)	0.521	0.288
523	Empl.Bus.	Missing HH income data*	2.5	0.74
524	Empl.Bus.	HH has no cars	-0.24	--
525	Empl.Bus.	HH has car competition	-0.106	--
526	Empl.Bus.	HH has children	-0.112	--
527	Empl.Bus.	HH workers/adults	0.584	0.758
528	Empl.Bus.	HH has one person	-0.134	-0.351
529	Empl.Bus.	Head of HH is under age 35	-0.251	--
530	Empl.Bus.	Head of HH is age 65+	-0.21	--
531	Empl.Bus.	HH size	--	--

Table 19. Tour-generation models (fit statistics).

Statistic	First Tour of the Day	Second Tour of the Day
Observations	1478748	33307
Final log-likelihood	-198879	-4705.9
Rho-squared vs. 0	0.921	0.918
Rho-squared vs. constants	0.025	0.011

Table 20. Tour-size-party models (personal business).

Coeff. #	Altern.	Variable	Coefficient
1	All	Party size=HH size	1.01
2	All	Party size=HH adults	-0.179
101	1 person	Constant	0
201	2 people	Constant	0.355
202	2 people	HH workers/Adults	-0.187
203	2 people	Log of (HH income/1000)	--
204	2 people	Missing HH income data*	--
205	2 people	HH has zero vehicles	-0.467
206	2 people	HH has car competition	0.428
207	2 people	0 nights away from home	0.259
208	2 people	1-2 nights away from home	0.284
209	2 people	7+ nights away from home	--
210	2 people	Missing nights away data*	-0.264
211	2 people	Month is June-August	0.118
212	2 people	Month is Jan-March	-0.122
213	2 people	Month is Nov-December	--
214	2 people	Missing month data*	-0.287
215	2 people	Head of HH under age 35	-0.237
216	2 people	Head of HH age 65+	0.107
301	3 people	Constant	-0.297
302	3 people	HH workers/Adults	-0.135
303	3 people	Log of (HH income/1000)	--
304	3 people	Missing HH income data*	--
305	3 people	HH has zero vehicles	--
306	3 people	HH has car competition	0.477
307	3 people	0 nights away from home	--
308	3 people	1-2 nights away from home	--
309	3 people	7+ nights away from home	-0.524
310	3 people	Missing nights away data*	-0.675
311	3 people	Month is June-August	0.303
312	3 people	Month is Jan-March	0.159
313	3 people	Month is Nov-December	0.229
314	3 people	Missing month data*	-0.181
315	3 people	Head of HH under age 35	--
316	3 people	Head of HH age 65+	-0.193
401	4+ people	Constant	-0.0688
402	4+ people	HH workers/Adults	--
403	4+ people	Log of (HH income/1000)	-0.0933
404	4+ people	Missing HH income data*	-0.623
405	4+ people	HH has zero vehicles	--

Coeff. #	Altern.	Variable	Coefficient
406	4+ people	HH has car competition	0.254
407	4+ people	0 nights away from home	--
408	4+ people	1-2 nights away from home	0.291
409	4+ people	7+ nights away from home	--
410	4+ people	Missing nights away data*	-0.776
411	4+ people	Month is June-August	0.557
412	4+ people	Month is Jan-March	--
413	4+ people	Month is Nov-December	0.113
414	4+ people	Missing month data*	-0.0725
415	4+ people	Head of HH under age 35	0.325
416	4+ people	Head of HH age 65+	-0.194

Table 21. Tour-size-party models (visit F&R).

Coeff. #	Altern.	Variable	Coefficient
1	All	Party size=HH size	1.75
2	All	Party size=HH adults	-0.591
101	1 person	Constant	0
201	2 people	Constant	-0.089
202	2 people	HH workers/Adults	-0.266
203	2 people	Log of (HH income/1000)	0.0502
204	2 people	Missing HH income data*	0.0759
205	2 people	HH has zero vehicles	0.216
206	2 people	HH has car competition	0.37
207	2 people	0 nights away from home	0.526
208	2 people	1-2 nights away from home	0.286
209	2 people	7+ nights away from home	--
210	2 people	Missing nights away data*	-0.24
211	2 people	Month is June-August	--
212	2 people	Month is Jan-March	-0.121
213	2 people	Month is Nov-December	0.129
214	2 people	Missing month data*	0.0125
215	2 people	Head of HH under age 35	--
216	2 people	Head of HH age 65+	0.115
301	3 people	Constant	-0.715
302	3 people	HH workers/Adults	-0.225
303	3 people	Log of (HH income/1000)	-0.074
304	3 people	Missing HH income data*	-0.401
305	3 people	HH has zero vehicles	0.612
306	3 people	HH has car competition	0.501
307	3 people	0 nights away from home	0.689

Coeff. #	Altern.	Variable	Coefficient
308	3 people	1-2 nights away from home	0.447
309	3 people	7+ nights away from home	--
310	3 people	Missing nights away data*	-0.17
311	3 people	Month is June-August	0.136
312	3 people	Month is Jan-March	-0.141
313	3 people	Month is Nov-December	0.422
314	3 people	Missing month data*	0.205
315	3 people	Head of HH under age 35	0.203
316	3 people	Head of HH age 65+	-0.109
401	4+ people	Constant	-0.845
402	4+ people	HH workers/Adults	-0.261
403	4+ people	Log of (HH income/1000)	--
404	4+ people	Missing HH income data*	--
405	4+ people	HH has zero vehicles	0.519
406	4+ people	HH has car competition	0.346
407	4+ people	0 nights away from home	0.746
408	4+ people	1-2 nights away from home	0.349
409	4+ people	7+ nights away from home	--
410	4+ people	Missing nights away data*	-0.292
411	4+ people	Month is June-August	0.261
412	4+ people	Month is Jan-March	-0.139
413	4+ people	Month is Nov-December	0.545
414	4+ people	Missing month data*	0.191
415	4+ people	Head of HH under age 35	0.36
416	4+ people	Head of HH age 65+	-0.425

Table 22. Tour-size-party models (leisure).

Coeff. #	Altern.	Variable	Coefficient
1	All	Party size=HH size	1.28
2	All	Party size=HH adults	-0.393
101	1 person	Constant	0
201	2 people	Constant	0.81
202	2 people	HH workers/Adults	-0.113
203	2 people	Log of (HH income/1000)	0.0818
204	2 people	Missing HH income data*	0.386
205	2 people	HH has zero vehicles	--
206	2 people	HH has car competition	0.29
207	2 people	0 nights away from home	--
208	2 people	1-2 nights away from home	0.132
209	2 people	7+ nights away from home	--

Coeff. #	Altern.	Variable	Coefficient
210	2 people	Missing nights away data*	-0.0538
211	2 people	Month is June-August	--
212	2 people	Month is Jan-March	--
213	2 people	Month is Nov-December	-0.121
214	2 people	Missing month data*	-0.136
215	2 people	Head of HH under age 35	--
216	2 people	Head of HH age 65+	--
301	3 people	Constant	0.0434
302	3 people	HH workers/Adults	--
303	3 people	Log of (HH income/1000)	--
304	3 people	Missing HH income data*	--
305	3 people	HH has zero vehicles	0.526
306	3 people	HH has car competition	0.67
307	3 people	0 nights away from home	--
308	3 people	1-2 nights away from home	--
309	3 people	7+ nights away from home	--
310	3 people	Missing nights away data*	--
311	3 people	Month is June-August	0.177
312	3 people	Month is Jan-March	--
313	3 people	Month is Nov-December	--
314	3 people	Missing month data*	-0.172
315	3 people	Head of HH under age 35	0.104
316	3 people	Head of HH age 65+	-0.232
401	4+ people	Constant	0.637
402	4+ people	HH workers/Adults	-0.179
403	4+ people	Log of (HH income/1000)	--
404	4+ people	Missing HH income data*	--
405	4+ people	HH has zero vehicles	--
406	4+ people	HH has car competition	0.361
407	4+ people	0 nights away from home	--
408	4+ people	1-2 nights away from home	--
409	4+ people	7+ nights away from home	--
410	4+ people	Missing nights away data*	--
411	4+ people	Month is June-August	0.44
412	4+ people	Month is Jan-March	0.0795
413	4+ people	Month is Nov-December	--
414	4+ people	Missing month data*	-0.597
415	4+ people	Head of HH under age 35	0.287
416	4+ people	Head of HH age 65+	-0.315

Table 23. Tour-size-party models (commute).

Coeff. #	Altern.	Variable	Coefficient
1	All	Party size=HH size	0.264
2	All	Party size=HH adults	-0.256
101	1 person	Constant	0
201	2 people	Constant	0.0226
202	2 people	HH workers/Adults	--
203	2 people	Log of (HH income/1000)	-0.424
204	2 people	Missing HH income data*	-1.7
205	2 people	HH has zero vehicles	-0.616
206	2 people	HH has car competition	--
207	2 people	0 nights away from home	--
208	2 people	1-2 nights away from home	--
209	2 people	7+ nights away from home	--
210	2 people	Missing nights away data*	--
211	2 people	Month is June-August	--
212	2 people	Month is Jan-March	0.38
213	2 people	Month is Nov-December	--
214	2 people	Missing month data*	-0.054
215	2 people	Head of HH under age 35	0.33
216	2 people	Head of HH age 65+	-0.456
301	3 people	Constant	-0.172
302	3 people	HH workers/Adults	--
303	3 people	Log of (HH income/1000)	-0.548
304	3 people	Missing HH income data*	-3.53
305	3 people	HH has zero vehicles	1.6
306	3 people	HH has car competition	0.674
307	3 people	0 nights away from home	--
308	3 people	1-2 nights away from home	--
309	3 people	7+ nights away from home	--
310	3 people	Missing nights away data*	--
311	3 people	Month is June-August	-1.02
312	3 people	Month is Jan-March	-0.981
313	3 people	Month is Nov-December	-1.43
314	3 people	Missing month data*	-1.13
315	3 people	Head of HH under age 35	-0.745
316	3 people	Head of HH age 65+	-0.987
401	4+ people	Constant	1.54
402	4+ people	HH workers/Adults	0.898
403	4+ people	Log of (HH income/1000)	-1.5
404	4+ people	Missing HH income data*	-6.22
405	4+ people	HH has zero vehicles	2.39

Coeff. #	Altern.	Variable	Coefficient
406	4+ people	HH has car competition	1.48
407	4+ people	0 nights away from home	--
408	4+ people	1-2 nights away from home	--
409	4+ people	7+ nights away from home	--
410	4+ people	Missing nights away data*	--
411	4+ people	Month is June-August	--
412	4+ people	Month is Jan-March	-1.44
413	4+ people	Month is Nov-December	0.863
414	4+ people	Missing month data*	-0.491
415	4+ people	Head of HH under age 35	0.575
416	4+ people	Head of HH age 65+	-0.755

Table 24. Tour-size-party models (employer business).

Coeff. #	Altern.	Variable	Coefficient
1	All	Party size=HH size	0.544
2	All	Party size=HH adults	
101	1 person	Constant	0
201	2 people	Constant	0.203
202	2 people	HH workers/Adults	-0.501
203	2 people	Log of (HH income/1000)	-0.151
204	2 people	Missing HH income data*	-0.739
205	2 people	HH has zero vehicles	0.78
206	2 people	HH has car competition	--
207	2 people	0 nights away from home	-0.419
208	2 people	1-2 nights away from home	--
209	2 people	7+ nights away from home	--
210	2 people	Missing nights away data*	-0.6
211	2 people	Month is June-August	--
212	2 people	Month is Jan-March	--
213	2 people	Month is Nov-December	--
214	2 people	Missing month data*	--
215	2 people	Head of HH under age 35	0.0619
216	2 people	Head of HH age 65+	0.411
301	3 people	Constant	-0.0635
302	3 people	HH workers/Adults	--
303	3 people	Log of (HH income/1000)	-0.439
304	3 people	Missing HH income data*	-2.14
305	3 people	HH has zero vehicles	0.948
306	3 people	HH has car competition	--
307	3 people	0 nights away from home	-0.496

Coeff. #	Altern.	Variable	Coefficient
308	3 people	1-2 nights away from home	--
309	3 people	7+ nights away from home	--
310	3 people	Missing nights away data*	-0.636
311	3 people	Month is June-August	--
312	3 people	Month is Jan-March	--
313	3 people	Month is Nov-December	-0.221
314	3 people	Missing month data*	-0.461
315	3 people	Head of HH under age 35	--
316	3 people	Head of HH age 65+	--
401	4+ people	Constant	0.894
402	4+ people	HH workers/Adults	-0.315
403	4+ people	Log of (HH income/1000)	-0.594
404	4+ people	Missing HH income data*	-3.04
405	4+ people	HH has zero vehicles	--
406	4+ people	HH has car competition	--
407	4+ people	0 nights away from home	-0.716
408	4+ people	1-2 nights away from home	--
409	4+ people	7+ nights away from home	--
410	4+ people	Missing nights away data*	-0.636
411	4+ people	Month is June-August	0.294
412	4+ people	Month is Jan-March	--
413	4+ people	Month is Nov-December	--
414	4+ people	Missing month data*	-0.941
415	4+ people	Head of HH under age 35	--
416	4+ people	Head of HH age 65+	--

Table 25. Tour-size-party models (fit statistics).

Statistic	Personal Business	VisitFR	Leisure	Commute	Employer Business
Observations	18833	31634	35998	9012	18626
Final log-likelihood	-22552	-33315.9	-39526.2	-5533.6	-16982.7
Rho-squared vs. 0	0.136	0.24	0.208	0.557	0.342
Rho-squared vs. constants	0.095	0.212	0.131	0.084	0.04

Table 26. Tour scheduling models (personal business).

Coeff. #	Altern.	Variable	Coefficient
0	0 nights	constant	0
20	1-2 nights	constant	-2.19
21	1-2 nights	HH size	0
22	1-2 nights	Missing HH income data*	0.631
23	1-2 nights	Log of (HH income/1000)	0.155
24	1-2 nights	Head of HH age 65+	-0.288
25	1-2 nights	Head of HH under age 35	0.419
26	1-2 nights	Log zone HH+job density	0.0963
27	1-2 nights	Month is June-August	-0.0917
28	1-2 nights	Month is Jan-March	-0.348
29	1-2 nights	Month is Nov-December	-0.263
30	3-6 nights	Constant	-3.48
31	3-6 nights	HH size	--
32	3-6 nights	Missing HH income data*	0.875
33	3-6 nights	Log of (HH income/1000)	0.167
34	3-6 nights	Head of HH age 65+	0.239
35	3-6 nights	Head of HH under age 35	0.217
36	3-6 nights	Log zone HH+job density	0.134
37	3-6 nights	Month is June-August	--
38	3-6 nights	Month is Jan-March	-0.458
39	3-6 nights	Month is Nov-December	-0.357
40	7+ nights	Constant	-4.7
41	7+ nights	HH size	--
42	7+ nights	Missing HH income data*	1.65
43	7+ nights	Log of (HH income/1000)	0.361
44	7+ nights	Head of HH age 65+	0.313
45	7+ nights	Head of HH under age 35	--
46	7+ nights	Log zone HH+job density	--
47	7+ nights	Month is June-August	0.173
48	7+ nights	Month is Jan-March	--
49	7+ nights	Month is Nov-December	--

Table 27. Tour scheduling models (visit F&R).

Coeff. #	Altern.	Variable	Coefficient
0	0 nights	constant	0
20	1-2 nights	constant	-0.127
21	1-2 nights	HH size	-0.0592
22	1-2 nights	Missing HH income data*	0.18
23	1-2 nights	Log of (HH income/1000)	0.0445
24	1-2 nights	Head of HH age 65+	-0.358
25	1-2 nights	Head of HH under age 35	0.361
26	1-2 nights	Log zone HH+job density	--
27	1-2 nights	Month is June-August	--
28	1-2 nights	Month is Jan-March	-0.102
29	1-2 nights	Month is Nov-December	--
30	3-6 nights	Constant	-1.51
31	3-6 nights	HH size	-0.142
32	3-6 nights	Missing HH income data*	0.383
33	3-6 nights	Log of (HH income/1000)	0.099
34	3-6 nights	Head of HH age 65+	0.141
35	3-6 nights	Head of HH under age 35	0.15
36	3-6 nights	Log zone HH+job density	0.0678
37	3-6 nights	Month is June-August	0.273
38	3-6 nights	Month is Jan-March	-0.152
39	3-6 nights	Month is Nov-December	0.389
40	7+ nights	Constant	-2.25
41	7+ nights	HH size	-0.218
42	7+ nights	Missing HH income data*	--
43	7+ nights	Log of (HH income/1000)	--
44	7+ nights	Head of HH age 65+	0.32
45	7+ nights	Head of HH under age 35	-0.275
46	7+ nights	Log zone HH+job density	0.111
47	7+ nights	Month is June-August	0.482
48	7+ nights	Month is Jan-March	--
49	7+ nights	Month is Nov-December	0.348

Table 28. Tour scheduling models (leisure).

Coeff. #	Altern.	Variable	Coefficient
0	0 nights	constant	0
20	1-2 nights	constant	-2.12
21	1-2 nights	HH size	--
22	1-2 nights	Missing HH income data*	1.09
23	1-2 nights	Log of (HH income/1000)	0.275
24	1-2 nights	Head of HH age 65+	-0.354
25	1-2 nights	Head of HH under age 35	0.141
26	1-2 nights	Log zone HH+job density	0.0873
27	1-2 nights	Month is June-August	--
28	1-2 nights	Month is Jan-March	-0.105
29	1-2 nights	Month is Nov-December	-0.224
30	3-6 nights	Constant	-3.93
31	3-6 nights	HH size	-0.0517
32	3-6 nights	Missing HH income data*	1.88
33	3-6 nights	Log of (HH income/1000)	0.433
34	3-6 nights	Head of HH age 65+	--
35	3-6 nights	Head of HH under age 35	--
36	3-6 nights	Log zone HH+job density	0.172
37	3-6 nights	Month is June-August	0.565
38	3-6 nights	Month is Jan-March	-0.151
39	3-6 nights	Month is Nov-December	-0.178
40	7+ nights	Constant	-5.13
41	7+ nights	HH size	--
42	7+ nights	Missing HH income data*	2.29
43	7+ nights	Log of (HH income/1000)	0.524
44	7+ nights	Head of HH age 65+	0.334
45	7+ nights	Head of HH under age 35	--
46	7+ nights	Log zone HH+job density	0.137
47	7+ nights	Month is June-August	0.629
48	7+ nights	Month is Jan-March	0.29
49	7+ nights	Month is Nov-December	-0.373

Table 29. Tour scheduling models (commute).

Coeff. #	Altern.	Variable	Coefficient
0	0 nights	constant	0
20	1-2 nights	constant	-1.26
21	1-2 nights	HH size	--
22	1-2 nights	Missing HH income data*	-3.19
23	1-2 nights	Log of (HH income/1000)	-0.152
24	1-2 nights	Head of HH age 65+	--
25	1-2 nights	Head of HH under age 35	--
26	1-2 nights	Log zone HH+job density	--
27	1-2 nights	Month is June-August	--
28	1-2 nights	Month is Jan-March	--
29	1-2 nights	Month is Nov-December	--
30	3-6 nights	Constant	-3.88
31	3-6 nights	HH size	--
32	3-6 nights	Missing HH income data*	2.31
33	3-6 nights	Log of (HH income/1000)	0.391
34	3-6 nights	Head of HH age 65+	--
35	3-6 nights	Head of HH under age 35	--
36	3-6 nights	Log zone HH+job density	--
37	3-6 nights	Month is June-August	--
38	3-6 nights	Month is Jan-March	-0.4
39	3-6 nights	Month is Nov-December	--
40	7+ nights	Constant	-3.5
41	7+ nights	HH size	-0.165
42	7+ nights	Missing HH income data*	--
43	7+ nights	Log of (HH income/1000)	--
44	7+ nights	Head of HH age 65+	--
45	7+ nights	Head of HH under age 35	--
46	7+ nights	Log zone HH+job density	--
47	7+ nights	Month is June-August	1.19
48	7+ nights	Month is Jan-March	--
49	7+ nights	Month is Nov-December	--

Table 30. Tour scheduling models (employer business).

Coeff. #	Altern.	Variable	Coefficient
0	0 nights	constant	0
20	1-2 nights	constant	-2.34
21	1-2 nights	HH size	-0.0275
22	1-2 nights	Missing HH income data*	1.74
23	1-2 nights	Log of (HH income/1000)	0.369
24	1-2 nights	Head of HH age 65+	--
25	1-2 nights	Head of HH under age 35	--
26	1-2 nights	Log zone HH+job density	--
27	1-2 nights	Month is June-August	--
28	1-2 nights	Month is Jan-March	--
29	1-2 nights	Month is Nov-December	--
30	3-6 nights	Constant	-3.37
31	3-6 nights	HH size	-0.0794
32	3-6 nights	Missing HH income data*	2.2
33	3-6 nights	Log of (HH income/1000)	0.437
34	3-6 nights	Head of HH age 65+	--
35	3-6 nights	Head of HH under age 35	--
36	3-6 nights	Log zone HH+job density	0.058
37	3-6 nights	Month is June-August	--
38	3-6 nights	Month is Jan-March	--
39	3-6 nights	Month is Nov-December	--
40	7+ nights	Constant	-4.85
41	7+ nights	HH size	--
42	7+ nights	Missing HH income data*	1.59
43	7+ nights	Log of (HH income/1000)	0.263
44	7+ nights	Head of HH age 65+	--
45	7+ nights	Head of HH under age 35	--
46	7+ nights	Log zone HH+job density	0.125
47	7+ nights	Month is June-August	0.504
48	7+ nights	Month is Jan-March	0.298
49	7+ nights	Month is Nov-December	--

Table 31. Tour scheduling models (fit statistics).

Statistic	Personal Business	VisitFR	Leisure	Commute	Employer Business
Observations	11932	21829	25706	1967	9689
Final log-likelihood	-10710.8	-25730.6	-30052.8	-1387.3	-10355
Rho-squared vs. 0	0.352	0.15	0.157	0.491	0.229
Rho-squared vs. constants	0.014	0.014	0.021	0.018	0.01

Table 32. Destination-choice models (personal business).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
1	All	Mode choice logsum	1	
2	All	Log (one-way distance)	-1.9	
3	All	One-way dist. sq.	0.006	
4	All	Day trip*1-way dist. sq.	-0.0192	
5	All	1-2 nights*1-way dist. sq.	-0.004	
6	All	Data missing*1-way dist. sq. *	-0.003	
7	All	One-way dist. 50-100 miles	--	
8	All	One-way dist. 100-150 miles	-0.151	-0.101
9	All	One-way dist. 150-250 miles	-0.704	-0.604
10	All	One-way dist. 250-500 miles	-1.07	
11	All	One-way dist. 500-1000 miles	0.808	0.408
12	All	One-way dist. 1000-1500 miles	0.959	
13	All	One-way dist. 1500-2000 miles	0.518	
14	All	One-way dist. over 2000 miles	-0.037	
15	All	Dest. zone has urban density	-0.162	
16	All	Dest. zone has rural density	0.486	
17	All	O and D zones have urban density	-0.261	
18	All	O and D zones have rural density	-0.569	
19	All	Log-size function multiplier	0.715	
20	All	Size variable 0	1	
20	All	Size variable 1 (log of coeff.)	0.273	
21	All	Size variable 2 (log of coeff.)	-11.6	
22	All	Size variable 3 (log of coeff.)	-4.36	
23	All	Size variable 4 (log of coeff.)	-0.908	

Table 33. Destination-choice models (visit F&R).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
1	All	Mode choice logsum	1	
2	All	Log (one-way distance)	-1.09	
3	All	One-way dist. sq.	0.0033	
4	All	Day trip*1-way dist. sq.	-0.023	
5	All	1-2 nights*1-way dist. sq.	-0.0104	
6	All	Data missing*1-way dist. sq. *	-0.0018	
7	All	One-way dist. 50-100 miles	--	
8	All	One-way dist. 100-150 miles	-0.185	

[6] Calibrated coefficients are only reported for those variables that required adjustment during calibration. All other coefficients remain the same.

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
9	All	One-way dist. 150-250 miles	-0.719	
10	All	One-way dist. 250-500 miles	-1.21	
11	All	One-way dist. 500-1000 miles	0.229	-0.109
12	All	One-way dist. 1000-1500 miles	0.389	
13	All	One-way dist. 1500-2000 miles	0.363	
14	All	One-way dist. over 2000 miles	0.184	
15	All	Dest. zone has urban density	-0.448	
16	All	Dest. zone has rural density	0.471	
17	All	O and D zones have urban density	0.0783	
18	All	O and D zones have rural density	-0.306	
19	All	Log-size function multiplier	0.688	
20	All	Size variable 0	1	
20	All	Size variable 1 (log of coeff.)	-1.35	
21	All	Size variable 2 (log of coeff.)	-0.615	
22	All	Size variable 3 (log of coeff.)	-20	
23	All	Size variable 4 (log of coeff.)	-5.25	

Table 34. Destination-choice models (leisure).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
1	All	Mode choice logsum	1	
2	All	Log (one-way distance)	-1.35	
3	All	One-way dist. sq.	0.0045	
4	All	Day trip*1-way dist. sq.	-0.0269	
5	All	1-2 nights*1-way dist. sq.	-0.012	
6	All	Data missing*1-way dist. sq. *	-0.0021	
7	All	One-way dist. 50-100 miles	--	
8	All	One-way dist. 100-150 miles	-0.31	
9	All	One-way dist. 150-250 miles	-0.862	-0.702
10	All	One-way dist. 250-500 miles	-1.41	-1.25
11	All	One-way dist. 500-1000 miles	0.101	-0.100
12	All	One-way dist. 1000-1500 miles	0.633	0.333
13	All	One-way dist. 1500-2000 miles	0.16	0.050
14	All	One-way dist. over 2000 miles	-0.254	-0.604
15	All	Dest. zone has urban density	-0.344	
16	All	Dest. zone has rural density	0.573	
17	All	O and D zones have urban density	-0.0675	
18	All	O and D zones have rural density	-0.555	
19	All	Log-size function multiplier	0.689	
20	All	Size variable 0	1	
20	All	Size variable 1 (log of coeff.)	-0.68	

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
21	All	Size variable 2 (log of coeff.)	-37.3	
22	All	Size variable 3 (log of coeff.)	-30	
23	All	Size variable 4 (log of coeff.)	1.31	

Table 35. Destination-choice models (commute).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
1	All	Mode choice logsum	0.211	
2	All	Log (one-way distance)	-3.58	
3	All	One-way dist. sq.	0.0238	
4	All	Day trip*1-way dist. sq.	-0.0032	
5	All	1-2 nights*1-way dist. sq.	-7.30E-04	
6	All	Data missing*1-way dist. sq. *	-0.0123	
7	All	One-way dist. 50-100 miles	--	
8	All	One-way dist. 100-150 miles	-0.464	-0.364
9	All	One-way dist. 150-250 miles	-0.784	-0.584
10	All	One-way dist. 250-500 miles	-0.803	-0.603
11	All	One-way dist. 500-1000 miles	1.61	-0.906
12	All	One-way dist. 1000-1500 miles	-0.581	-1.081
13	All	One-way dist. 1500-2000 miles	-2.44	-2.94
14	All	One-way dist. over 2000 miles	-12.4	-16.4
15	All	Dest. zone has urban density	-0.108	
16	All	Dest. zone has rural density	0.0175	
17	All	O and D zones have urban density	0.0618	
18	All	O and D zones have rural density	0.581	
19	All	Log-size function multiplier	0.611	
20	All	Size variable 0	1	
20	All	Size variable 1 (log of coeff.)	0.327	
21	All	Size variable 2 (log of coeff.)	-30	
22	All	Size variable 3 (log of coeff.)	-5.45	
23	All	Size variable 4 (log of coeff.)	-15.2	

Table 36. Destination-choice models (employer business).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
1	All	Mode choice logsum	1	
2	All	Log (one-way distance)	-1.64	
3	All	One-way dist. sq.	0.0035	
4	All	Day trip*1-way dist. sq.	-0.0084	
5	All	1-2 nights*1-way dist. sq.	-0.0022	
6	All	Data missing*1-way dist. sq. *	-0.0017	

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[6]
7	All	One-way dist. 50-100 miles	--	
8	All	One-way dist. 100-150 miles	-0.277	-0.207
9	All	One-way dist. 150-250 miles	-0.887	-0.807
10	All	One-way dist. 250-500 miles	-1.12	-1.103
11	All	One-way dist. 500-1000 miles	0.132	-0.232
12	All	One-way dist. 1000-1500 miles	0.151	0.051
13	All	One-way dist. 1500-2000 miles	0.235	0.041
14	All	One-way dist. over 2000 miles	0.376	-0.106
15	All	Dest. zone has urban density	-0.239	
16	All	Dest. zone has rural density	0.573	
17	All	O and D zones have urban density	0.31	
18	All	O and D zones have rural density	0.393	
19	All	Log-size function multiplier	0.79	
20	All	Size variable 0	1	
20	All	Size variable 1 (log of coeff.)	-1.2	
21	All	Size variable 2 (log of coeff.)	-30	
22	All	Size variable 3 (log of coeff.)	-2.93	
23	All	Size variable 4 (log of coeff.)	-2.2	

Table 37. Destination-choice models (fit statistics).

Statistic	Personal Business	VisitFR	Leisure	Commute	Employer Business
Observations	15130	27880	30865	6151	15987
Final log-likelihood	-79405.8	-164121.7	-174552.1	-27130.8	-91013.5
Rho-squared vs. 0	0.375	0.299	0.326	0.475	0.322
Rho-squared vs. constants	0.14	0.118	0.078	0.119	0.088

Table 38. Mode choice models (personal business).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
1	All	Mode generalized cost	0.281	
101	Car	HH has no cars	-2.03	
102	Car	HH has car competition	-0.571	
103	Car	Party size = 1	-0.821	
104	Car	Party size = 3 or more	--	
105	Car	0 nights away from home	0.332	
106	Car	7+ nights away from home	--	

[7] Calibrated coefficients are only reported for those variables that required adjustment during calibration. All other coefficients remain the same.

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
107	Car	Missing nights data *	0.401	
112	Car	One-way dist. over 500 miles	-1.07	
200	Bus	Constant	-7.27	-6.96
207	Bus	Missing HH income data *	-0.0729	
208	Bus	Log of (HH income/1000)	0.101	
209	Bus	Log of origin zone density	0.135	
210	Bus	Log of dest. zone density	0.284	
215	Bus	One-way dist. 50-150 miles	-0.236	
300	Rail	Constant	-12.9	-12.95
307	Rail	Missing HH income data *	-0.13	
308	Rail	Log of (HH income/1000)	0.12	
309	Rail	Log of origin zone density	0.274	
310	Rail	Log of dest. zone density	0.802	
315	Rail	One-way dist. 50-150 miles	--	
400	Air	Constant	-5.6	-5.12
407	Air	Missing HH income data *	0.901	
408	Air	Log of (HH income/1000)	0.197	
409	Air	Log of origin zone density	0.153	
410	Air	Log of dest. zone density	0.178	
411	Air	0 nights away from home	-2.26	
412	Air	1-2 nights away from home	-1.01	
413	Air	Missing nights data *	-0.946	
414	Air	Party size = 1	--	
415	Air	One-way dist. 50-150 miles	-3	

Table 39. Mode choice models (visit F&R).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
1	All	Mode generalized cost	0.344	
101	Car	HH has no cars	-2.2	
102	Car	HH has car competition	-0.269	
103	Car	Party size = 1	-0.894	
104	Car	Party size = 3 or more	0.539	
105	Car	0 nights away from home	0.412	
106	Car	7+ nights away from home	--	
107	Car	Missing nights data *	0.164	
112	Car	One-way dist. over 500 miles	-1.47	
200	Bus	Constant	-5.86	-5.17
207	Bus	Missing HH income data *	-2.57	
208	Bus	Log of (HH income/1000)	-0.524	
209	Bus	Log of origin zone density	0.274	

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
210	Bus	Log of dest. zone density	0.14	
215	Bus	One-way dist. 50-150 miles	0	
300	Rail	Constant	-7.78	-7.35
307	Rail	Missing HH income data *	-0.92	
308	Rail	Log of (HH income/1000)	-0.213	
309	Rail	Log of origin zone density	0.256	
310	Rail	Log of dest. zone density	0.371	
315	Rail	One-way dist. 50-150 miles	--	
400	Air	Constant	-6.18	
407	Air	Missing HH income data *	1.17	
408	Air	Log of (HH income/1000)	0.0917	
409	Air	Log of origin zone density	0.151	
410	Air	Log of dest. zone density	0.15	
411	Air	0 nights away from home	-1.8	
412	Air	1-2 nights away from home	-1.03	
413	Air	Missing nights data *	-0.546	
414	Air	Party size = 1	--	
415	Air	One-way dist. 50-150 miles	-2.52	

Table 40. Mode choice models (leisure).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
1	All	Mode generalized cost	0.344	
101	Car	HH has no cars	-1.22	
102	Car	HH has car competition	-0.313	
103	Car	Party size = 1	-0.467	
104	Car	Party size = 3 or more	--	
105	Car	0 nights away from home	-0.856	
106	Car	7+ nights away from home	--	
107	Car	Missing nights data *	-0.112	
112	Car	One-way dist. over 500 miles	-0.993	
200	Bus	Constant	-0.847	
207	Bus	Missing HH income data *	-3.06	
208	Bus	Log of (HH income/1000)	-0.95	
209	Bus	Log of origin zone density	0.0425	
210	Bus	Log of dest. zone density	0.0416	
215	Bus	One-way dist. 50-150 miles	-0.41	
300	Rail	Constant	-11.6	-12.0
307	Rail	Missing HH income data *	-1.84	
308	Rail	Log of (HH income/1000)	0.0498	
309	Rail	Log of origin zone density	0.179	

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
310	Rail	Log of dest. zone density	0.757	
315	Rail	One-way dist. 50-150 miles	-0.348	
400	Air	Constant	-4.17	-3.93
407	Air	Missing HH income data *	0.264	
408	Air	Log of (HH income/1000)	-0.0442	
409	Air	Log of origin zone density	0.0676	
410	Air	Log of dest. zone density	0.188	
411	Air	0 nights away from home	-3.04	
412	Air	1-2 nights away from home	-1.57	
413	Air	Missing nights data *	-1.12	
414	Air	Party size = 1	--	
415	Air	One-way dist. 50-150 miles	-1.7	

Table 41. Mode choice models (commute).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
1	All	Mode generalized cost	0.298	
101	Car	HH has no cars	-0.538	
102	Car	HH has car competition	-0.182	
103	Car	Party size = 1	--	
104	Car	Party size = 3 or more	--	
105	Car	0 nights away from home	-0.678	
106	Car	7+ nights away from home	--	
107	Car	Missing nights data *	-0.786	
112	Car	One-way dist. over 500 miles	--	
200	Bus	Constant	-5.58	-4.51
207	Bus	Missing HH income data *	-1.24	
208	Bus	Log of (HH income/1000)	-0.14	
209	Bus	Log of origin zone density	0.129	
210	Bus	Log of dest. zone density	0.336	
215	Bus	One-way dist. 50-150 miles	-2.08	
300	Rail	Constant	-19.5	-17.7
307	Rail	Missing HH income data *	6.56	
308	Rail	Log of (HH income/1000)	1.28	
309	Rail	Log of origin zone density	0.24	
310	Rail	Log of dest. zone density	1.08	
315	Rail	One-way dist. 50-150 miles	--	
400	Air	Constant	-8.51	-7.61
407	Air	Missing HH income data *	4.01	
408	Air	Log of (HH income/1000)	0.745	
409	Air	Log of origin zone density	0.116	

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
410	Air	Log of dest. zone density	0.305	
411	Air	0 nights away from home	-4.06	
412	Air	1-2 nights away from home	-1.57	
413	Air	Missing nights data *	-1.91	
414	Air	Party size = 1	--	
415	Air	One-way dist. 50-150 miles	-5.01	

Table 42. Mode choice models (employer business).

Coeff. #	Altern.	Variable	Estimated Coefficient	Calibrated Coefficient[7]
1	All	Mode generalized cost	0.265	
101	Car	HH has no cars	-1.59	
102	Car	HH has car competition	-0.161	
103	Car	Party size = 1	--	
104	Car	Party size = 3 or more	-0.515	
105	Car	0 nights away from home	0.366	
106	Car	7+ nights away from home	0.502	
107	Car	Missing nights data *	0.115	
112	Car	One-way dist. over 500 miles	-1.21	
200	Bus	Constant	-6.01	-5.65
207	Bus	Missing HH income data *	-0.905	
208	Bus	Log of (HH income/1000)	-0.274	
209	Bus	Log of origin zone density	0.175	
210	Bus	Log of dest. zone density	0.239	
215	Bus	One-way dist. 50-150 miles	-0.682	
300	Rail	Constant	-12.6	-12.7
307	Rail	Missing HH income data *	-0.416	
308	Rail	Log of (HH income/1000)	-0.132	
309	Rail	Log of origin zone density	0.186	
310	Rail	Log of dest. zone density	1.05	
315	Rail	One-way dist. 50-150 miles	-0.449	
400	Air	Constant	-8.04	-8.94
407	Air	Missing HH income data *	3.42	
408	Air	Log of (HH income/1000)	0.65	
409	Air	Log of origin zone density	0.156	
410	Air	Log of dest. zone density	0.221	
411	Air	0 nights away from home	-1.19	
412	Air	1-2 nights away from home	-0.219	
413	Air	Missing nights data *	-0.795	
414	Air	Party size = 1	0.626	
415	Air	One-way dist. 50-150 miles	-3.19	

Table 43. Mode choice models (fit statistics).

Statistic	Personal Business	VisitFR	Leisure	Commute	Employer Business
Observations	14743	27602	30077	6076	15824
Final log-likelihood	-2620.7	-4614.8	-6478.3	-1604.3	-3940.5
Rho-squared vs. 0	0.852	0.863	0.816	0.783	0.797
Rho-squared vs. constants	0.354	0.525	0.385	0.4	0.542

Table 44. Mode choice models (generalized cost coefficients).

Coeff. #	Altern.	Variable	Personal Business Coeff.	VisitFR Coeff.	Leisure Coeff.	Commute Coeff.	Employer Business Coeff.
10	All	Cost	-0.006	-0.006	-0.006	-0.006	-0.0025
11	Car	Time	-0.002	-0.002	-0.002	-0.002	-0.002
21	Bus	Time	-0.0015	-0.0015	-0.0012	-0.0015	-0.0015
31	Rail	Time	-0.002	-0.0015	-0.0012	-0.0015	-0.0015
32	Rail	Transfers	-0.3	-0.3	-0.3	-0.3	-0.5
33	Rail	Frequency/week	0.06	0.06	0.06	0.06	0.06
34	Rail	Access+egress distance	-0.025	-0.015	-0.02	-0.025	-0.015
35	Rail	Access+egress distance/car distance	-1.16	-3.04	-2.36	-1.16	-1.69
41	Air	Time	-0.0015	-0.0015	-0.0015	-0.0015	-0.0015
42	Air	Transfers	-0.3	-0.3	-0.15	-0.3	-0.5
43	Air	Frequency/week	0.06	0.06	0.06	0.06	0.12
44	Air	Access+egress distance	-0.005	-0.005	-0.009	-0.005	-0.006
45	Air	Access+egress distance/car distance	-1.86	-3.3	-0.46	-1.86	-4.93
46	Air	On-time percentage	0.015	0.03	0.015	0.03	0.03