Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
SWUTC/07/167862-1		

4. Title and Subtitle	5. Report Date
Comparing Microscopic Activity-Based and Traditional Models of Travel Demand: An Austin Area Case Study	September 2007
	6. Performing Organization Code
7. Author(s)	**8. Performing Organization Report No.**
Laura B. McWethy and Kara M. Kockelman	Final Report
9. Performing Organization Name and Address	**10. Work Unit No. (TRAIS)**
Center for Transportation Research University of Texas at Austin 3208 Red River, Suite 200 Austin, Texas 78705-2650	11. Contract or Grant No. 10727
12. Sponsoring Agency Name and Address	**13. Type of Report and Period Covered**
Southwest Region University Transportation Center Texas Transportation Institute Texas A&M University System College Station, Texas 77843-3135	14. Sponsoring Agency Code

15. Supplementary Notes

Supported by general revenues from the State of Texas.

16. Abstract

Two competing approaches to travel demand modeling exist today. The more traditional "4-step" travel demand models rely on aggregate demographic data at a traffic analysis zone (TAZ) level. Activity-based microsimulation methods employ more robust behavioral theory while focusing on individuals and households. While currently not widely used in practice, many modelers believe that activity-based approaches promise greater predictive capability, more accurate forecasts, and more realistic sensitivity to policy changes.

Little work has examined in detail the benefits of activity-based models, relative to more traditional approaches. In order to better understand the tradeoffs between these two methodologies, this paper examines model results produced by both, in an Austin, Texas application. Results of the analysis reveal several differences in model performance and accuracy. In general, activity-based models are more sensitive to changes in model inputs, supporting the notion that aggregate models ignore important behavioral distinctions across the population. However, they generally involve much more calibration and application effort, in order to ensure that synthetic populations match key criteria and that activity schedules match surveyed behaviors, while being realistic and consistent across household members.

17. Key Words	18. Distribution Statement
Travel Demand Modeling, Activity-Based Models, Austin, Texas	No restrictions. This document is available to the public through NTIS: National Technical Information Service 5285 Port Royal Road Springfield, Virginia 22161

19. Security Classif.(of this report)	20. Security Classif.(of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	134	

Form DOT F 1700.7 (8-72) **Reproduction of completed page authorized**

Comparing Microscopic Activity-Based and Traditional Models of Travel Demand: An Austin Area Case Study

By

Laura B. McWethy
and
Kara M. Kockelman

Research Report SWUTC/07/167862-1

Southwest Region University Transportation Center
Center for Transportation Research
The University of Texas at Austin
Austin, Texas 78712

September 2007

Abstract

Two competing approaches to travel demand modeling exist today. The more traditional "4-step" travel demand models rely on aggregate demographic data at a traffic analysis zone (TAZ) level. Activity-based microsimulation methods employ more robust behavioral theory while focusing on individuals and households. While currently not widely used in practice, many modelers believe that activity-based approaches promise greater predictive capability, more accurate forecasts, and more realistic sensitivity to policy changes.

Little work has examined in detail the benefits of activity-based models, relative to more traditional approaches. In order to better understand the tradeoffs between these two methodologies, this paper examines model results produced by both, in an Austin, Texas application. Results of the analysis reveal several differences in model performance and accuracy. In general, activity-based models are more sensitive to changes in model inputs, supporting the notion that aggregate models ignore important behavioral distinctions across the population. However, they involve more calibration and application effort, in order to ensure that synthetic populations match key criteria and that activity schedules match surveyed behaviors, while being realistic and consistent across household members.

Executive Summary

While substantial effort has been devoted to developing activity-based models and application of microsimulation methods, little research has focused on comparing these to more traditional model specifications. This work undertakes such a comparison for the region of Austin, Texas. Instrumental to this was a study of the aggregate model application, as well as applying the destination choice and mode choice models and traffic assignment in TransCAD.

Traditional travel demand models (TDMs) use a four-step process based on demographically and spatially aggregate data. While widely used for many years, this method has many drawbacks, including limited behavioral theory, disregard of intra-household constraints, and neglect of tour-based dependencies in mode, departure time, and destination choice. Continuity in activity participation and recognition of the various interdependencies in activity timing and other travel attributes allow greater realism in models of travel demand. Methods that allow for this continuity, such as activity-based modeling and microsimulation, are heralded as offering a considerable advantage over traditional methods. Moreover, activity-based modeling is better suited to current transportation planning interests, as emphasis has switched from long-term capital improvement projects to shorter-term congestion management strategies, such as alternative work schedules and congestion pricing (Bhat and Koppelman 1999).

The question of how much "better" activity-based microsimulation models perform relative to traditional aggregate approaches is controversial – and to date largely overlooked. The widespread endorsement by the academic community of activity-based, microscopic models has had little empirical foundation. This work addresses this issue by calibrating and then applying two such models, using identical data sets with application to the same study area for the base case, expanded-capacity and centralized employment scenarios.

Due to time constraints, the microsimulation sub-models were not fully explored (and validated) before moving on in the overall model estimation process. Such accuracy evaluations along the way may be vital to a successful implementation process, since the models may quickly diverge from population tendencies. Opportunities for mis-prediction are no doubt in part due to the inter-dependence of so many model predictions in sequence. Here (and in MORPC), the forecasting moves from primary activity pattern choice (in hierarchy, across all household members), to mode choice to destination choice to secondary activity pattern choice. Errors can emerge and propagate across these complex, intertwined, and cross-constrained behavioral models.

The results indicate that activity-based models do indeed perform rather differently than traditional aggregate approaches. The microscopic model proved much more sensitive to capacity expansion and employment location tests. Unfortunately, appraising the accuracy of the models under changes to model inputs (relative to actual traffic patterns) is not possible (without actually undertaking such a policy and collecting new traffic and travel data). Moreover, the microscopic model was far trickier to estimate in such a way that reasonable behaviors emerged. Nonetheless, it seems that the more exhaustive behavioral theory incorporated in the microscopic, activity-based models may offer significant benefits for scenario analysis, an important component of the planning process. Far more investigation is needed, to ascertain the true benefits of such modeling methods, and the extent to which they warrant the expertise and effort that they require, but this research attempts to provide a basis for future comparisons.

Table of Contents

List of Figures

List of Tables

Disclaimer

Acknowledgements

The author wishes to thank the Southwest University Transportation Center for support provided from the U.S. Department of Transportation, University Transportation Centers Program. The author is also grateful to CAMPO's Daniel Yang and SmartMobility's Norm Marshall who provided valuable data sets and GISDK code, Oregon DOT's Brian Gregor for helpful suggestions on R programming, research supervisor Dr. Kara Kockelman, thesis reader Dr. Randy Machemehl, and Annette Perrone for editing assistance.

Chapter One: Introduction

Traditional travel demand models (TDMs) use a four-step process based on demographically and spatially aggregate data. While widely used for many years, this method has many drawbacks, including limited behavioral theory, disregard of intra-household constraints, and neglect of tour-based dependencies in mode, departure time, and destination choice. Continuity in activity participation and recognition of the various interdependencies in activity timing and other travel attributes allow greater realism in models of travel demand. Methods that allow for this continuity, such as activity-based modeling and microsimulation, are heralded as offering a considerable advantage over traditional methods. Moreover, activity-based modeling is better suited to current transportation planning interests, as emphasis has switched from long-term capital improvement projects to shorter-term congestion management strategies, such as alternative work schedules and congestion pricing (Bhat and Koppelman 1999). While substantial effort has been devoted to developing activity-based models and application of microsimulation methods, little research has focused on comparing these to more traditional model specifications. This work undertakes such a comparison for the region of Austin, Texas and is a collaborative effort with Jason Lemp and Dr. Kara Kockelman. Jason Lemp was instrumental in undertaking the aggregate model application, as well as applying the destination choice and mode choice models and traffic assignment in TransCAD. Both Jason Lemp and Dr. Kockelman are co-authors on this topic. The paper by McWethy et al. (2007) is a condensed version of this thesis.

This research seeks to compare trip-based to tour-/activity-based models, as well as traditional aggregate methods to microsimulation. The results of applying a microsimulation activity-based TDM to a synthetic Austin population are compared to those of a relatively traditional model, offering insights into the tradeoffs between such approaches, in terms of accuracy and modeling effort, both in development and application. Other differences examined here include modeling sensitivities to policies and investments that affect the timing and cost of travel. Comparisons include estimates and observations of traffic flows during peak hours and off-peak hours, total vehicle hours traveled during peak and off-peak hours, and mode shares. Such relationships are important when considering a variety of potential strategies for managing traffic congestion, improving quality of life, and forecasting a region's future.

One way in which the models differ is their required inputs. The aggregate model uses zonal averages for household information. Households were assigned to different types based on three household characteristics: household size, the presence of children and household income. A total of 27 household types were considered (or 81 types, once vehicle ownership levels are added, in the first stage of the aggregate modeling sequence). The activity-based model relies on disaggregate socioeconomic information (such as household size, income, and employment status of household members). Both rely, to some extent, on aggregate zonal land use data for trip generation models; and, for their sub-models' estimation, both rely on the same network and system level-of-service (LOS) characteristics (of interzonal costs and times across two times of day [peak and off-peak]).

The following sections discuss the data and model specifications used here, the scenarios evaluated for results comparison across both TDM approaches, and the results of the comparisons. The final section offers some conclusions as well as recommendations regarding modeling directions. Appendices A-C contain additional model specifications and Appendices D-F contain model code.

Chapter Two: Literature Review

MOTIVATION

A key feature of the newest TDMs is their use of disaggregate data, synthesis of micro-population features, and simulation of individual behaviors. This enhancement allows for greater precision in results and a greater reliance on behavioral theory, as well as allowing for much greater stratification of the model results. Jovicic (2001, pp. 3-4) lists the following as motivation for activity-based travel demand modeling:

- "Travel is a derived demand from the activity participation.
- Focus is on sequence of activities (rather than on trips).
- Activities are both planned and executed in the household context (recognizing intra-household constraints).
- Activities are spread along a 24-hour period in a continuous manner, rather than using a simple categorization of 'peak' and off-peak' events.
- Travel choices are limited in time and space, and by personal constraints."

The switch to activity-based modeling involves a focus on individuals and their households, allowing for various forms of microsimulation, greater precision in results, and potentially better use of behavioral theory.

The primary aspect examined in this work is microsimulation of individuals and their regional travels, which involves the sampling of individual households and persons using multivariate distributions for base demographic data. This population of travelers typically is assigned both home and job locations as well as a series of simulated daily activities. Detailed travel itineraries, including mode and route assignments, strive to mimic realistic activity patterns while recognizing the travel choices of other household members.

MODEL METHODOLOGY

There several options when estimating activity-based microsimulation travel demand models. This section is a brief overview of some of the methods currently in practice and their applications.

Probabilistic Models - Random Utility, Logit and Nested Logit

Discrete choices such as mode choice and residential location can be modeled using models such as Random Utility, Logit and Nested Logit models. For the Random Utility model, the probability of choosing option *i* is equal to a function of the attributes of choice *i* divided by the sum of the attribute functions of all of the choices. This result comes from the distribution of the error term of the utility function, which is distributed iid Gumbel (Kockelman, 2005).

Logit Models are based on choice attribute functions that have a constant marginal utility with respect to money. This means that the expected value of the error term is zero and the probability of choice *i* is given by Bierlaire (1997) below, where μV_i is a scaled function of the attributes of choice *i*:

$$\mathbf{P}_C(i) = \frac{e^{\mu V_i}}{\sum_{k \in C} e^{\mu V_k}}.$$

Nested Logit models allow for correlation between choices (Bierlaire, 1997). Bierlaire (1997) describes the probability function for a nested logit model as below, with the same variable definitions from above:

$$\mathrm{P}_C(i) = \frac{e^{\sigma_k V_i}}{\sum_{j \in C_k} e^{\sigma_k V_j}} \cdot \frac{e^{\mu V'_{C_k}}}{\sum_{l=1}^{m} e^{\mu V'_{C_l}}},$$

Autonomous Agent Simulation or Multi-Agent Simulation

A criticism of many microsimulation models is a lack of dependence on behavioral theory, leading to a model which is a statistical black box and the results may not be trusted (Waddell and Ulfarsson, 2004). Autonomous agent simulation is one way to address this issue and bring in behavioral theory to travel demand modeling. This is developed from the field of complex systems, which is "…any system featuring a large number of interacting components (agents, processes, etc.) whose aggregate activity is nonlinear (not derivable from the summations of the activity of individual components) and typically exhibits hierarchical self-organization under selective pressures." (Rocha, 1999a) To improve the social network modeling, simulation has moved from autonomous agent simulation, in which agents only respond to inputs and their present state, to "Socio-Technical Organizations", as named by Rocha (1999b). In these systems, "Semiotic Agents" have a variety of possible outcomes and choose one outcome based on their interactions with their environment and other agents (Rocha, 1999b). Much programming in the multi-agent simulation field is based on the programming libraries of SWARM.

Gilbert and Terna (1999) offer practical advice for programming a multi-agent simulation model. "…every agent design has to include mechanisms for receiving input from the environment, for storing a history of previous inputs and actions, for devising what to do next, for carrying out actions and for distributing outputs." (Gilbert and Terna, 1999) Two methods of multi-agent simulation include a production system, which contains a set of rules, a working memory, and a rule interpreter, and learning methods. The production system is undesirable because knowledge can be changed, but rules must stay the same (Gilbert and Terna, 1999). Learning methods can be either neural networks, which use the back propagation of error method to modify responses based on inputs, and evolutionary algorithms, such as the genetic algorithm. The genetic algorithm works on the principle of a level of "fitness" assigned to each agent. The fittest agents reproduce and the average fitness of the population increases as the population adapts to the environment (Gilbert and Terna, 1999). This technique can be used at the agent or population level.

It is most useful to use an object-oriented language, such as Swarm, when programming a multi-agent simulation model, as it reduces the code to a set of agents, which can be represented as objects, and a set of events that are coded as steps activated by containing loops (Gilbert and Terna, 1999). Rule-based microsimulation is simply a type of autonomous agent simulation that allows for learning mechanisms to be coded into the rules of the system.

Monte Carlo Markov Chain Simulation

Monte Carlo simulation is a method that randomly selects values from a mathematical or physical system's probability density function to find a solution to a problem, as opposed to deterministic methods that will always generate the same response to the same inputs. This is done by taking the average of the random samples from the population to determine a statistic about the population (Coddington, 1996). A difficulty in simulation is the generation of truly random numbers, which must be done a large number of times for an accurate Monte Carlo simulation (Coddington, 1996).

A Markov Chain is a collection of random variables in which the future is conditional independent of the past, given the present, as shown in the equation below (http://mathworld.wolfram.com).

$$P(X_t = j \mid X_0 = i_0, X_1 = i_1, \ldots, X_{t-1} = i_{t-1}) = P(X_t = j \mid X_{t-1} = i_{t-1}).$$

This is a helpful simplification from considering that the future is dependent on all previous choices, such as in an activity diary. This process determines an activity transition matrix for all possible transitions between activities (Janssens, *et al.,* 2005). This can be highly intensive computationally, and so an improvement was developed by Janssens, *et. al* (2005) which involves "codebooks". The idea behind the codebooks is that "transition probabilities are no longer immediately estimated by ignoring the independence between sequences, but are first stored in codebooks per sequence" (Janssens, *et al*., 2005). This method only takes into account the most frequently occurring combination and has the added advantage of weighting the frequencies for each combination (Janssens, *et al*., 2005).

Kitamura, *et al.* (2000) devised another Monte Carlo Markov Chain activity pattern simulator. Their practical application of the Monte Carlo Markov Chain simulation includes several variables which play an important role and are not necessarily included in the traditional four-step evaluation until later on in the process. The model and the variables included are enumerated below:

"If $L_{i,j-1}$ = home base:

$$\Pr[X_{ij}, T_{ij}, L_{ij}, M_{ij} \mid \mathbf{H}_{ij-1}]$$
$$= \Pr[X_{ij} \mid \mathbf{H}_{ij-1}] \text{ x } \Pr[T_{ij} \mid X_{ij}, \mathbf{H}_{ij-1}] \text{ x } \Pr[L_{ij} \mid X_{ij}, T_{ij}, \mathbf{H}_{ij-1}] \text{ x } \Pr[M_{ij} \mid X_{ij}, T_{ij}, L_{ij}, \mathbf{H}_{ij-1}] \quad (7a)$$

If $L_{i,j-1} \neq$ home base:

$$= \Pr[X_{ij} \mid \mathbf{H}_{ij-1}] \text{ x } \Pr[T_{ij} \mid X_{ij}, \mathbf{H}_{ij-1}] \text{ x } \Pr[M_{ij} \mid X_{ij}, T_{ij}, \mathbf{H}_{ij-1}] \text{ x } \Pr[L_{ij} \mid X_{ij}, T_{ij}, M_{ij}, \mathbf{H}_{ij-1}]. \quad (7b)$$

X_{ij} = the type of the *j*-th activity (or a bundle of activities) pursued by individual *i* (excluding travel),
T_{ij} = the duration of the *j*-th activity pursued by individual *i*,
L_{ij} = the location of the *j*-th activity pursued by individual *i*,
M_{ij} = the mode of travel used to reach the *j*-th activity location, and
n = the number of activities involved in individual *i*'s daily activity-travel pattern,

$t_{i,j}$ = the time of the day when the j-th activity of individual i is completed,

$\mathbf{Z}_i$ = a vector of variables representing attributes of individual i and those of the household to which individual i belongs,

h_i = the residence location of individual i,

w_i = the work or school location of individual i,

SD = a vector of variables representing demographic and socio-economic characteristics of the study area,

LU = a vector of variables representing land use characteristics of the study area, and

TR = a vector of variables representing transportation network and travel time characteristics of the study area." (Kitamura, *et al.*, 2000)

CURRENT ACTIVITY-BASED, MICROSIMULATION MODELS

Existing models include MORPC (PB Consult, 2005), TRANSIMS (http://tmip.fhwa.dot.gov/transims/), ILUTE (Miller and Salvini, 2001), CEMDAP (Bhat, et al., 2001), and ALBATROSS (Arentze and Timmermans, 2000), among others. Activity-based models in practice today include Columbus, Ohio's MORPC, the San Francisco Bay Area's SFCTA, New York City's NYMTC, Atlanta's ARC, and Portland's METRO (Vovsha, et. al, 2004). While all these models share certain characteristics, their details differ. Additionally, none offers a clear, applications-based comparison to a traditional TDM, as sought here. Overviews of a few relevant models are provided here, as a starting point for our investigations.

In present practice, Columbus's recently applied Mid-Ohio Region Planning Commission (MORPC) model has generated a lot of interest. It relies on a nested logit framework for all its main modules. These include household synthesis, auto ownership, activity pattern selection, and tour production, as well as secondary stop decisions, mode, time of day, and destination choices (Anderson, 2005). This model incorporates a wide range of modeling techniques being used in research currently, such as activity-based tours and household interactions. The MORPC model forms the basis for the microscopic model developed and applied here.

MORPC's household synthesis module simulates household counts (for each TAZ) on the basis of household size, income category, age category, and employment status for each household member, using iterative proportional fitting (IPF), which is the standard procedure for most population synthesizers. Auto availability is a function of household size and composition, income, neighborhood density, transit access, and relative counts of workers to vehicles (Anderson, 2005). The activity generator determines whether individuals will have a mandatory activity (e.g., work or school), non-mandatory activity, or no travel in their day, and the number of such tours (Anderson, 2005).

The tour production module recognizes the interdependence of household members, unlike many current models (which determine trip and tour attributes independently across household members) (Vovsha, et al., 2003). This is done in a very structured fashion, however, and assumes that children are the most "independent" members in their household, so their activity patterns are determined first. This raises a question about causality, with the case-in-point of unavoidable activities in a child's life (e.g., daycare and school, or special needs while sick) that determine a parent's activity pattern. This issue is not currently addressed in the MORPC model (Vovsha, et. al, 2004), nor here. Recognition of such interdependencies is important, since joint travel comprises 40 to 50% of total trip-making, and members of the same household make up approximately 75% of joint person-trips (Vovsha, et al., 2003). The MORPC model further recognizes such interdependence by using overlapping time windows of household member availability in tour production, as opposed to later (e.g., the mode choice stage, as several other models do (Vovsha, et al., 2003)). MORPC's gravity-based destination choice model determines the primary destination TAZ for each tour, based on the type and duration of tour (Anderson, 2005). And the MORPC model of mode choice relies on a nested logit.

TRANSIMS (http://tmip.fhwa.dot.gov/transims/ 2006) was (and remains) a highly ambitious microsimulation model of travel demand, developed by a large team of scientists and modelers at the Los Alamos National Laboratory (Arentze and Timmermans, 2001). It includes a population synthesizer, activity generator, route planner, and traffic microsimulator. The population simulator uses iterative proportion fitting of multivariate probabilities to specify a population based on Census and PUMS data. Its outputs serve as inputs to the activity generator, which also relies directly on household activity survey data, as well as network data. A classification and regression tree (CART) algorithm classifies surveyed households by demographic attributes and activity patterns. One limitation of this method is that the sampled schedules are independent of network performance, so feedback of travel times and costs, as well as changing land use conditions, has no bearing. The TRANSIMS route planner uses deterministic (shortest-path) algorithms, rather than allowing for some random variation. Finally, the traffic microsimulator relies on a rule-based cellular automata principle, which ensures the absence of accidents (FHWA 2006).

As opposed to the purely logistical models described above, there are also rule-based models of travel demand in practice today. One of these is ILUTE, which is largely based on autonomous agent theory. The population is simulated (as persons, households and decision making units), which then has processes simulated based on the current attributes of the agent, using "probabilistic state ‘transition’ models”. (Miller and Salvini, 2001) ILUTE uses several different types of models for “triggering processes”, or “sudden transitions from a passive to an active state at an arbitrary point in time”. These include hazard models of duration, random utility models, and rule-based models. (Miller and Salvini, 2001).

Due to issues with the Canadian Census data, ILUTE’s population synthesizer is a sequential process of conditional probabilities to define the simulated joint probabilities of all person and household types, as opposed to a completely multivariate process.

ILUTE’s pattern-based approach to scheduling activities uses random utility models that take into account the probabilities of activities based on such factors as age, gender, household income, work and school status, and transport accessibility to activity locations. After the activity patterns are chosen, hazard duration functions determine the length of all activities (Miller et al., 2004). The number and location of any intermediate stops on each tour are determined via Monte Carlo simulation of logit functions with utility that control for tour type, tour mode, home accessibility, and the tour’s primary activity (Miller et al., 2004). The ILUTE model eventually aims to develop activity schedules based on a set of “projects” that individual’s need to accomplish, rather than picking a pattern from a predetermined list. “Each project has an ‘agenda’ of specific activity ‘episodes’ which are candidates to be actually scheduled and executed within a person’s activity/travel pattern for the day. Activity episodes are randomly generated for each project for each person based on episode frequencies derived from large sample surveys.” (Miller, et al., 2004, p.36) These episodes are scheduled into a person’s activity pattern based on priority, and durations and start times can be modified to fit the person’s activity pattern. Mode choice is also included in this activity pattern selection (Miller et al., 2004).

A well-established rule-based model is the ALBATROSS model. ALBATROSS uses three microsimulation components: a “scheduling engine, inference system, and a rule-based system representing the choice heuristics of individuals.” (Arentze and Timmermans, 2000, p. 81) (Figure 1) The model uses a learning process to determine the activity sequence, much like autonomous agent theory, based on constraints and conditional preferences.

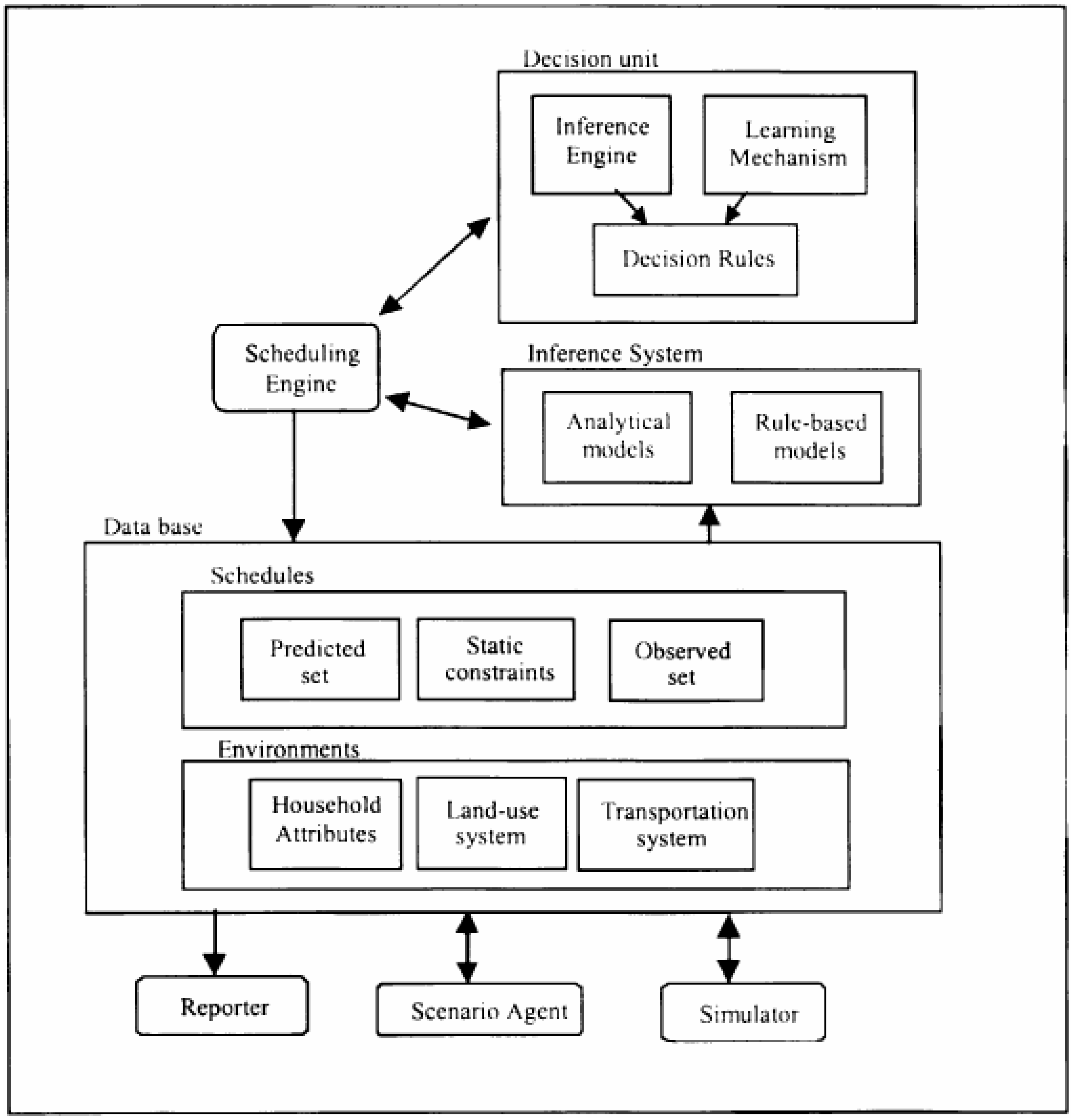

Figure 1: Architecture of the ALBATROSS System (From Arentze and Timmermans, 2000, p. 83, titled "Figure 3.2: Architecture of the system")

While all the above models incorporate various emerging aspects of microsimulation and activity-based modeling, there is very little research directly comparing traditional, aggregate methods and microscopic modeling techniques. One such study was undertaken for Las Vegas, Nevada (Walker, 2005). While this work offered a direct comparison, its microsimulation model is trip-based, not allowing for mode, scheduling or intra-household consistency of activity choices. Walker (2005) capably illustrated how her two approaches' computation time, and calibration efforts were quite similar. Her microsimulation model offered the additional benefits of preserving demographic distinctions across the population, thus allowing for analysis of sub-group impacts (of transportation policies and investments, for example). In addition, the microsimulation approach eliminated aggregation errors, while allowing for calculations of the associated simulation error or variance (Walker, 2005). The current paper seeks to expand this comparison to a microscopic model with tours, rather than trips, as the basic unit of analysis, and utilizing more sophisticated methods to incorporate intra-household constraints and activity scheduling.

Chapter Three: Microscopic Model Description

DATA SOURCES AND PREPARATION

The data set used for the population synthesis was the Census 2000 5-percent Public Use Microdata Sample (PUMS) data for Travis, Williamson, and Hayes Counties, as well as block-group level average data for the same region. Each PUMA is a geographic area (containing at least 100,000 individuals in each PUMA, and these can be seen in Figures 2 through 4. Since it is a 5-percent sample, these data contain approximately 5000 individuals from each PUMA. The PUMS data was not reformatted and no data entries were removed before the population synthesis. The block-group level data was spatially reformatted into traffic analysis zones (TAZs) in order to be comparable to the other spatial data used in the model process.

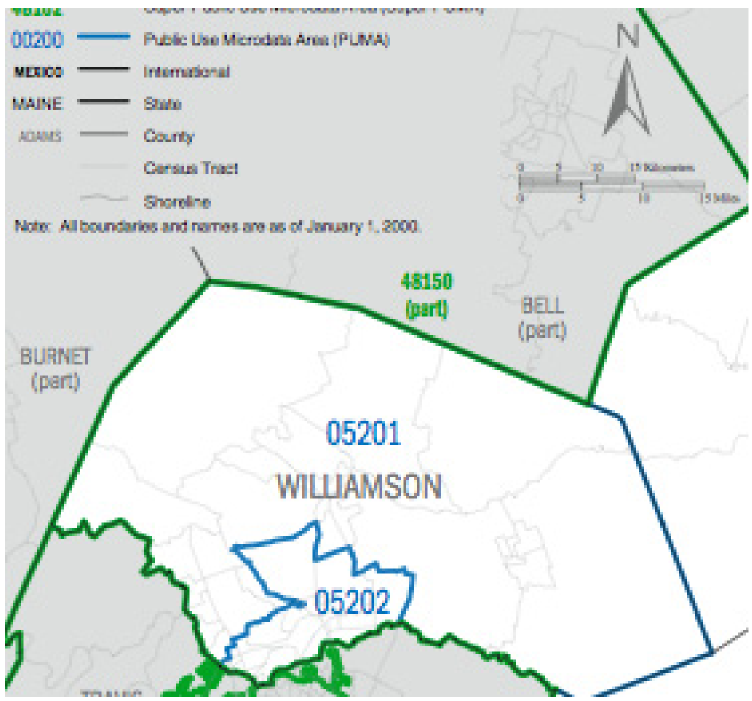

Figure 2: PUMA Divisions of Williamson County (from www.Census.gov)

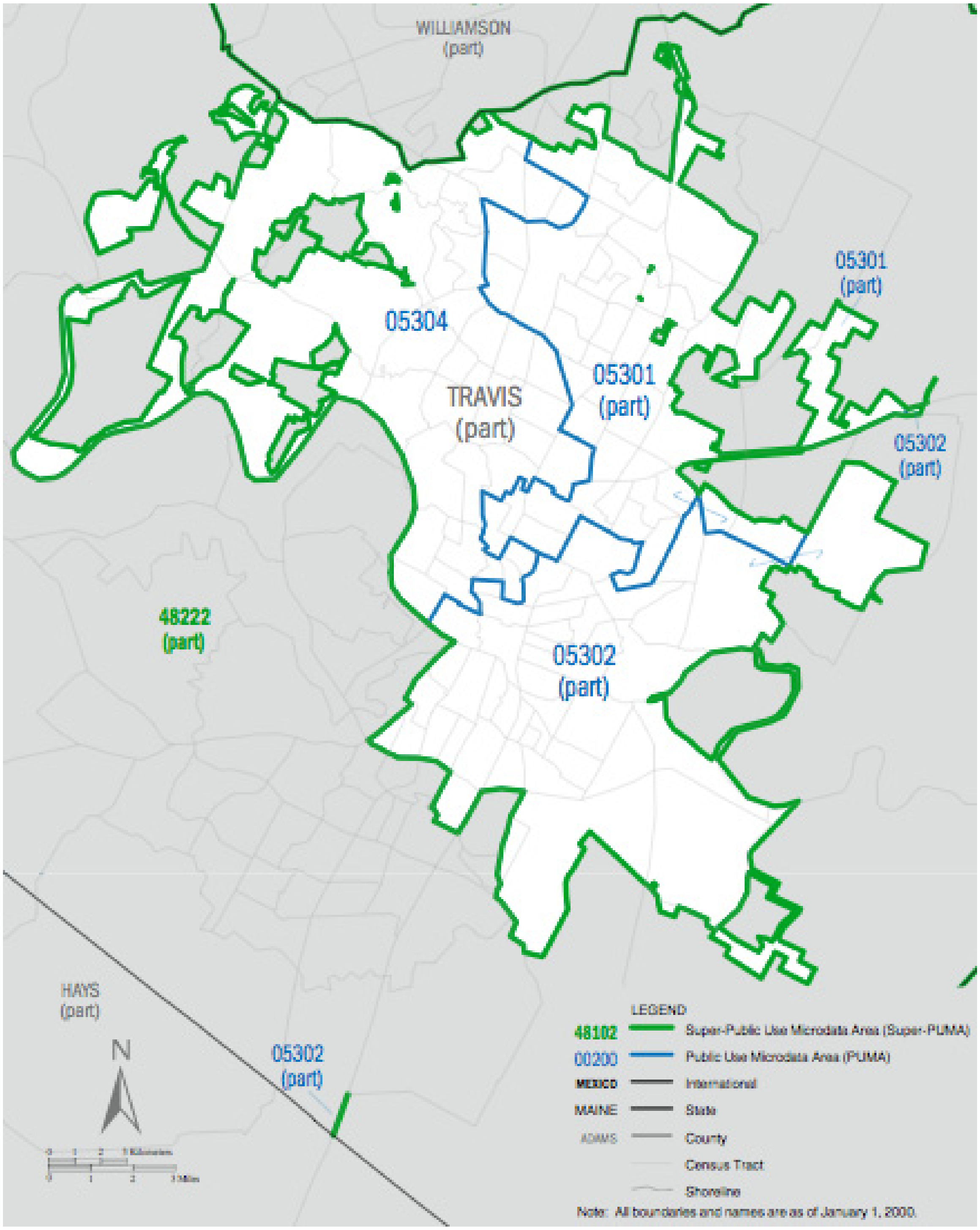

Figure 3: PUMA Divisions of Travis County (from www.Census.gov)

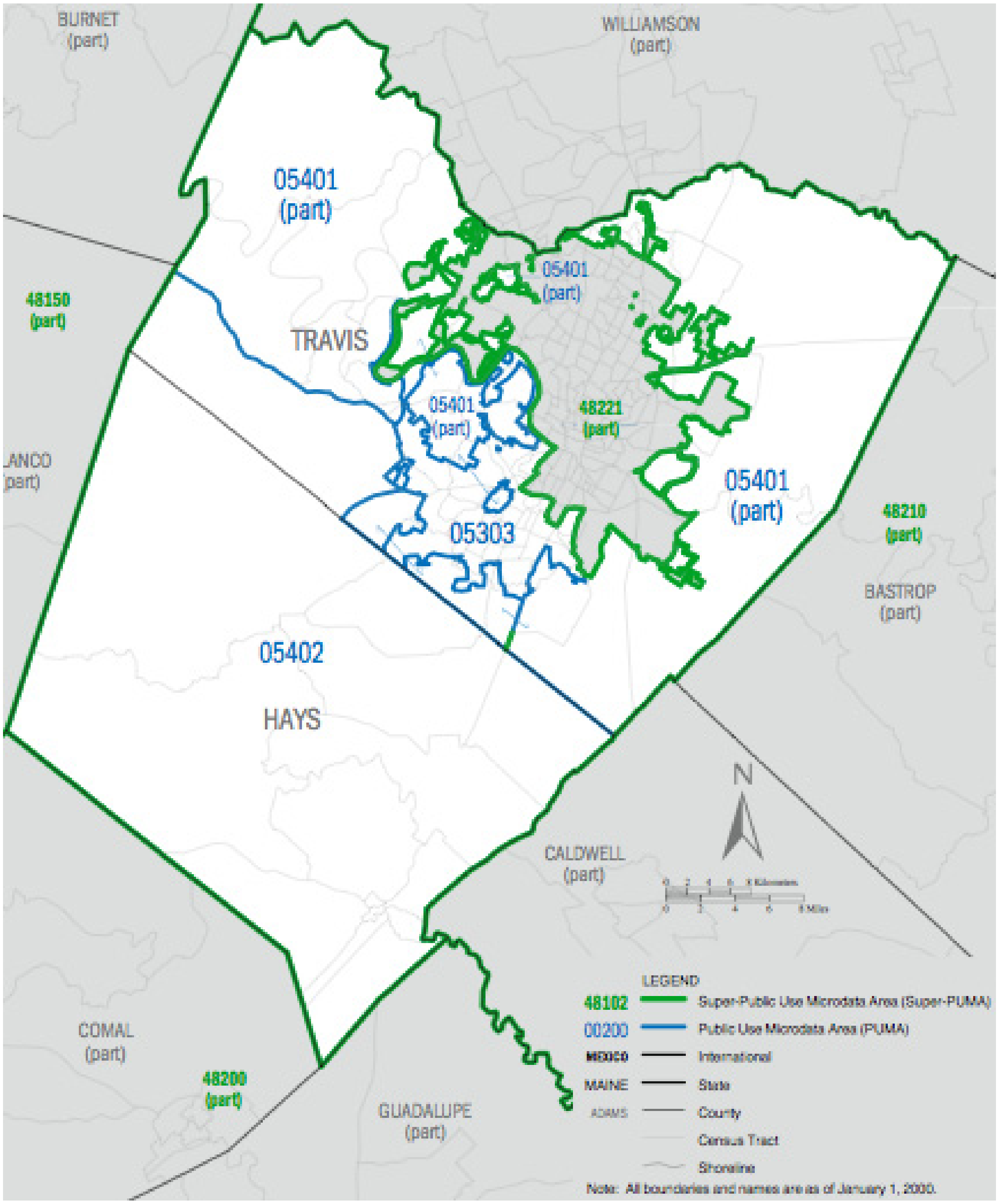

Figure 4: PUMA Divisions of Travis and Hays Counties (from www.Census.gov)

The primary data source used to estimate the microscopic travel demand model system was the Austin Travel Survey (ATS 1997). This data set contains 3154 complete travel diaries. 164 (5.2%) of these were excluded from the data analysis due to tours that started and/or ended away from home, along with another 203 (6.4%) exclusions for other reasons (such as incomplete entries). This leaves a total of 2787 travel diaries for model calibration[1] and activity pattern sampling.

The ATS was reformatted from the trip-based survey to tours (chains of activities starting and ending at home) in order to analyze travel behavior on the tour and activity levels. These tours were comprised of one primary activity and possibly multiple secondary activities, which start and end at home. The primary activity of the tour is defined as being the first mandatory activity in the tour, or if none of the mandatory activities are present in the tour, preference is given to the first maintenance activity and then to the first discretionary activity if the tour is comprised solely of discretionary activities. The activities are broken down into seven categories for this model system. These include mandatory activities (work, school, and university), maintenance activities (escorting, shopping, and other maintenance), and discretionary activities.

Seven person types were defined, including preschool children (ages 0 through 4), pre-driving school-age children (ages 5 through 15), driving school-age children (ages 16 and 17), non-working adults, student adults (full-time students only), part-time working adults (1-39 work hours per week), and full-time working adults (40+ hours of work per week). The next personal attribute defined for the data set was the primary activity pattern (PAP) for the individual. A PAP determines the skeletal pattern for the day by assigning the primary activity that the person needs to undertake that day, e.g. work, school or staying at home. There are a total of seven different PAPs, the assignment availability of which varies based on person type, including one work tour, two or more work tours, university day, work and college day, school day, non-mandatory day and at-home day. The estimation data splits are located in Table 1.

[1] The ATS data set provides population weights. However, these were not used in model estimation here. As long as the model specifications are appropriate, weighting should not have great effect on parameter estimates.

Table 1: Primary Activity Pattern (PAP) Counts in ATS Data Set

	Work (1 Tour)	Work (2 Tours)	College	Work & College	School	Non-Mandatory	At Home	Total
Preschool Child	---	---	---	---	3	---	351	354
Pre-Driving Child	9	---	---	---	516	40	350	915
Driving Child	16	---	---	---	53	7	65	141
Non-Working Adult	9	---	7	---	---	401	372	789
Student Adult	---	---	87	---	---	51	79	217
Part-Time Working Adult	195	16	50	8	---	107	210	586
Full-Time Working Adult	1248	138	16	11	---	179	575	2167
Total	1477	154	160	19	572	785	2002	5169

The TAZ-level land area type data was obtained from the 1997 Capital Area Metropolitan Planning Organization (CAMPO) zone data. This data set includes land use indicator variables (rural, suburban, urban and CBD) and employment totals by category (retail, service, and all others). Transit/bus availability is also included in the TAZ-level data, and is computed as two separate variables: the percentage of area within each TAZ that lies within ¼ and ½ mile, respectively, of a transit stop.

MICROSCOPIC MODEL SPECIFICATIONS

The microscopic travel demand model system is comprised of several components, as shown in Figure 5. The microsimulation model was structured in a manner very similar to MORPC's activity-based and tour-based model framework (PB Consult, Inc, 2005). This model synthesizes the Austin population and uses a series of multinomial logit (MNL) model results to simulate the daily activity patterns and travel decisions made by each individual in the synthesized population. The model consists of a population synthesizer, primary activity pattern (PAP) models for all person types, maintenance and discretionary tour allocation models, activity scheduler, primary and secondary destination choice models, and mode choice models, as well as aggregate network assignment. The model application procedure and the SPSS code used to run the model can be found in the appendices.

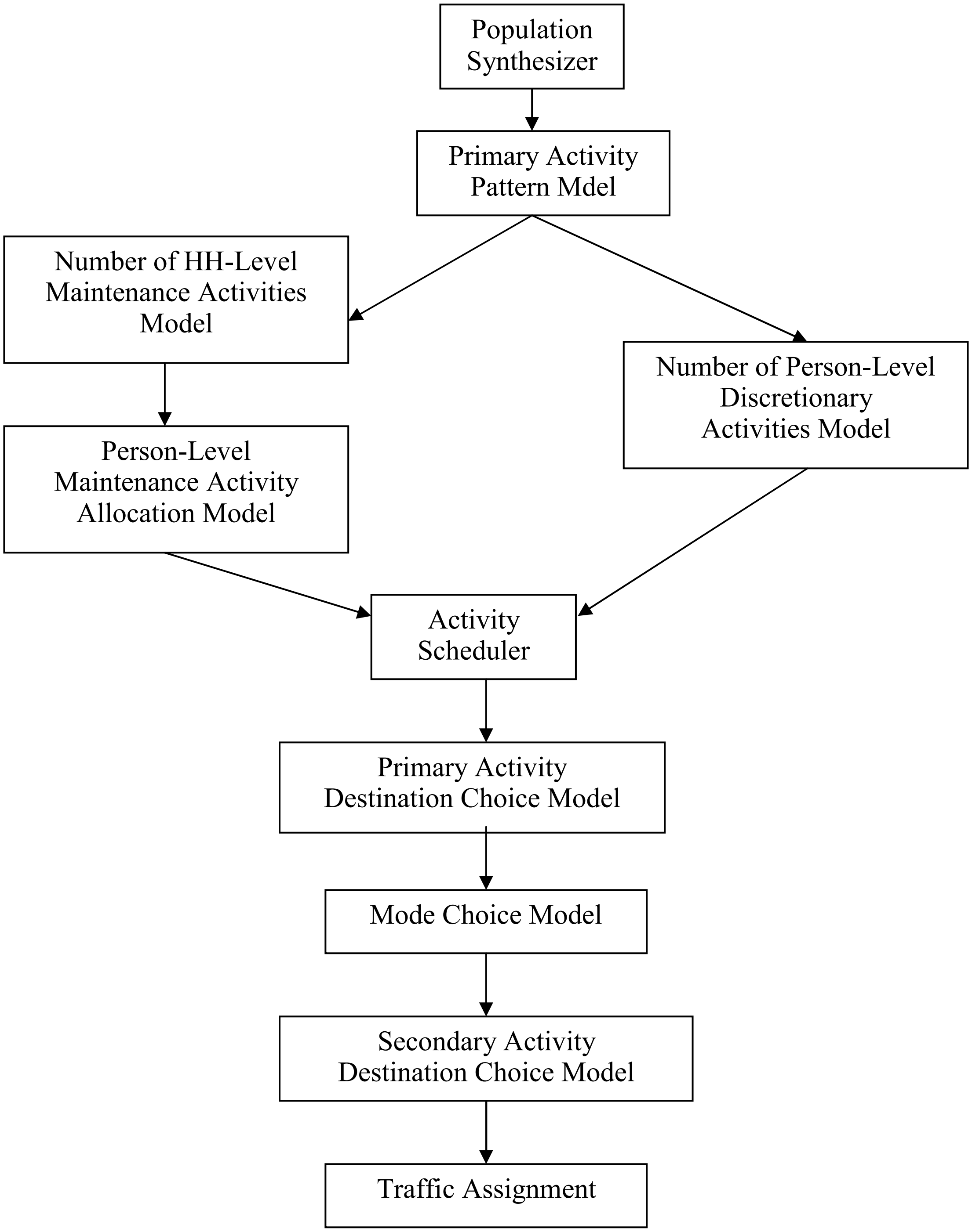

Figure 5: Microscopic Activity Based Model Structure

POPULATION SYNTHESIS

The first step in the microscopic model process is thepopulation synthesis. The population synthesizer builds zonal populations based on local and regional Census data. The inputs to this synthesis process, for each zone, are (zonal) population, household population, labor force population, and average annual household income. Only average values for household size are available at the

Census tract level, so the shifted Poisson distribution was used to generate marginal distributions for household size. PUMS data at the larger PUMA level were then used as seeds for an iterative proportional fitting (IPF) process, in order to reconcile zonal information with the multi-dimensional nature of these distributions. Most synthetic population generators use some form of the IPF procedure in conjunction with the available Census data (Beckman, et al., 1996). The procedure is done by balancing the row and column total values of the multivariate seed table (household income and household size) against the marginal zonal values. This procedure was done using the programming language R, and 40 iterations of IPF were run to obtain the final proportions table, which is a fairly typical number. The code used in synthesizing the population used for this research can be found in Appendix D. A more efficient method of population synthesis can be found in the code in Appendix E. For the microscopic model, random draws[2] of actual values from the closest-matching PUMA household then provided demographic information on individual household members, household auto ownership, and a continuous value of household income (rather than a categorical income). The outputs are a list of specific households in each zone, characterized by size and composition (i.e., worker/student status, age and gender for each household member), income, and auto ownership.

The actual IPF procedure is done on the basis of household size (1-8+) and income category (low, moderate, and high) and is performed using the programming language R. The result of the IPF procedure is a multivariate table for each zone with the proportion of households in each household size/income category. This proportion is then multiplied by the total number of households in the zone and then rounded to the nearest integer to obtain the household populations by the multivariate distribution. A PUMS household in the corresponding PUMA is then drawn by taking the first household that matches the multivariate distribution to provide demographic information for the households and individuals. Uncontrolled variables assigned include household composition and employment status, gender, age, continuous income values, and auto ownership.

This method does not allow for randomness in household synthesization, as the same number of households will appear in each household size/income category for every population synthesis. The rounding procedure introduces a source of error into the population synthesis as well, as the population marginal zonal distributions will not necessarily match the Census marginal distributions perfectly.

The resulting two output files from the population synthesizer include a detailed list of households and persons in each zone. These output files were then fed through the rest of the model. The microscopic model uses the complete set of individual and household characteristics throughout

[2] Random (or, more correctly, pseudo-random) drawing is typically done using Monte Carlo simulation, which is a method that randomly selects values from a mathematical or physical system's probability density function, as opposed to deterministic methods that will always generate the same response to the same inputs. (Coddington, 1996)

the model system (e.g., household size, worker/student status, age category, income, and auto sufficiency). The data set is aggregated for different household types at the zonal level for the aggregate model and uses only the household size, income, and presence of children variables from the synthesis.

PRIMARY ACTIVITY PATTERN MODEL SYSTEM

Model Structure

The primary activity pattern model system determines the skeletal pattern for the day by assigning the primary activity that the person needs to undertake that day, e.g. work, school or staying at home. There are a total of seven different PAPs, the assignment availability of which varies based on person type, including one work tour, two or more work tours, university day, work and university day, school day, non-mandatory day and at-home day. It is comprised of MNL models specific to seven person types: preschool children (ages four and under), pre-driving school-age children (ages 5 through 15), driving-age children (ages 16 and 17), non-working adults, adult students, part-time working adults, and full-time working adults. This system incorporates household member dependencies via a sequential modeling format, which models the person types in order of their assumed dependence on other household members, thus accounting for other members' PAPs. This ordering is adapted from the MORPC TDM model (PB Consult, 2005) and is as follows: preschool children are assigned PAPs first, then pre-driving children, driving children, adult students, full-time working adults, part-time working adults and, finally, non-working adults. This ordering can be seen graphically in Figure 6. Tables 2-8 contain the estimation results for the model specifications.

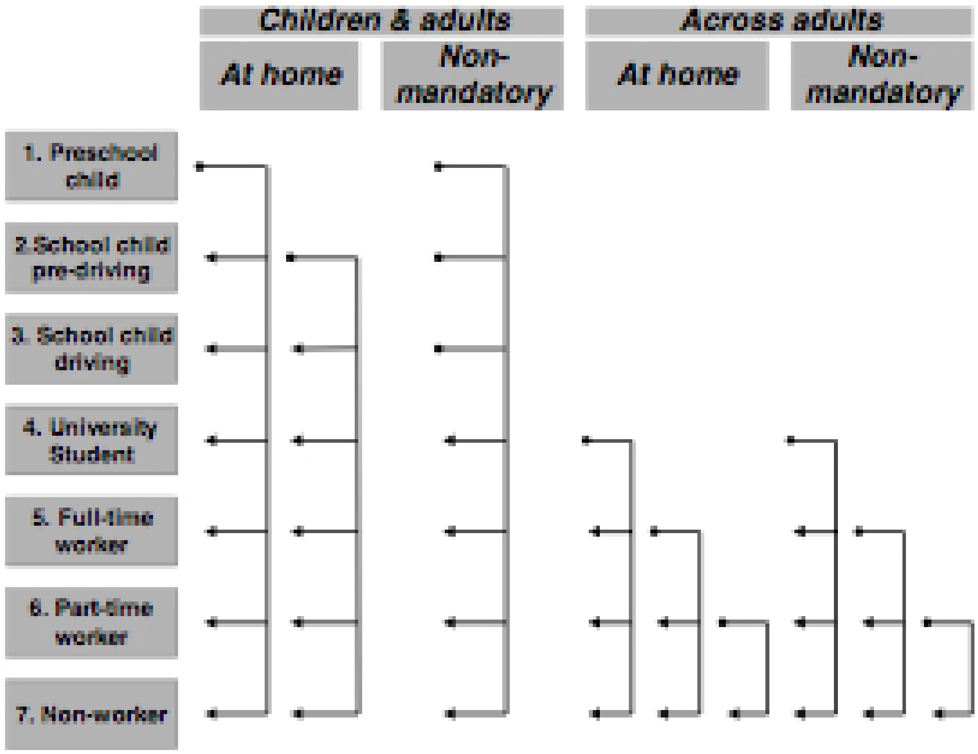

Figure 6: MORPC DAP Model Order (From Vovsha et al.'s (2004, p. 28) Figure 3, titled "Intra-household linkage of daily activity-travel patterns (DAPs)")

The choice alternatives vary from two to seven depending on the person type and are enumerated below.

Choice Alternatives

Mandatory workday with 1 tour (not available for preschool children)

Mandatory workday with 2 tours (only available for part- and full-time working adults)

Mandatory university day (not available for children)

Mandatory work/university (only available for part- and full-time working adults)

Mandatory school day (not available for adults)

Non-mandatory

At home

The explanatory variables used in this model are listed below and include household size and composition, auto sufficiency (The number of household vehicles minus the number of household adults), household income, population density, transit availability at the home zone, and indicator variables for PAPs chosen by household members already modeled.

Explanatory Variables

Auto sufficiency

Household income

Household size

Presence & number of preschool children

Presence & number of pre-driving children

Presence & number of driving children

Presence & number of non-working adults

Presence & number of student adults

Presence & number of part-time working adults

Presence & number of full-time working adults

Residential area type

Zonal transit accessibility

Age

Gender

Indicators for activity patterns chosen by other HH members

Preschool child at home/non-mandatory

Pre-driving school child at home/non-mandatory

School driving child at home/non-mandatory

Adult at home/non-mandatory

Table 2: Preschool Child PAP Model Specification

Alternative Patterns (Mand. School day as base)		
	At Home	
	Coeff.	t-ratio
Alternative-specific constant	7.317	2.00
Household size	-1.716	-1.53
Number of children	2.499	1.93
Statistics:		
Likelihood for Constants Model	-440.842	
Likelihood for Final Model	-230.866	

Table 3: Pre-driving School Child PAP Model Specification

	Alternative Patterns (Mand. School day as base)					
	Mand. 1 Work		Non-Mandatory		At Home	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Alternative-specific constant	-4.047	-12.04	-3.133	-3.92	0.176	0.49
Person Characteristics:						
Age			-0.173	-2.94		
Household Characteristics:						
Household Size			0.409	3.02		
No. of preschool children					1.201	2.54
No. of pre-driving children					0.513	5.09
No. of driving children					3.163	2.85
Pres. of preschool children					-1.376	-2.34
Pres. of driving children					-3.562	-2.97
No. of part-time working adults			0.810	2.97		
Pres. of full-time working adults					-0.776	-3.15
Income					-0.000021	-5.79
Auto surplus					0.477	2.30
Auto shortage					-0.658	-3.67
Zonal Characteristics:						
Suburban area					-0.821	-3.29
Urban area					-0.770	-3.68
Statistics:						
Likelihood for Constants Model	-701.311					
Likelihood for Final Model	-582.004					

Table 4: Driving Child PAP Model Specification

	Alternative Patterns (Mand. School day as base)					
	Mand. 1 Work		**Non-Mandatory**		**At Home**	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Alternative-specific constant	-0.704	-1.22	-3.827	-4.19	0.887	1.84
Household Characteristics:						
No. of children			0.689	2.66		
No. of non-working adults					0.825	1.94
Income	-0.000019	-2.02			-0.000036	-3.79
Auto surplus	0.813	2.08				
Auto shortage					-1.008	-2.27
Zonal Characteristics:						
Suburban area						
Urban area						
Statistics:						
Likelihood for Constants Model	-145.3621					
Likelihood for Final Model	-115.6537					

Table 5: Non-working Adult PAP Model Specification

	Alternative Patterns (Mand. Workday as base)					
	Mand. University		**Non-Mandatory**		**At Home**	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Alternative-specific constant	-4.043	-2.51	3.148	5.95	3.105	6.05
Person Characteristics:						
Age						
Household Characteristics:						
Pres. of pre-school children			-1.650	-3.06	-1.577	-2.81
Pres. of pre-driving school children					-1.398	-4.59
No. of full-time working adults			-0.602	-3.98		
Pres. of part-time working adults			-0.896	-3.28		
Income	0.000026	3.00	0.000016	5.06		
Auto shortage						
Zonal Characteristics:						
Transit within 0.5 miles	3.648	2.13	1.489	1.90	1.643	2.08
HH DAP Indicators:						
Pre-school child at home					-0.935	-2.11
Driving child at home					3.405	5.61
Part-time working adult at home						
Full-time working adult at home						
Statistics:						
Likelihood for Constants Model	-558.2984					
Likelihood for Final Model	-491.252					

Table 6: Student Adult PAP Model Specification

	Alternative Patterns (Mand. University as base)			
	Non-Mandatory		**At Home**	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**
Alternative-specific constant	-1.180	-1.80	-0.646	-0.90
Person Characteristics:				
Age	0.049	3.04		
Household Characteristics:				
Household size	-0.414	-2.22		
Income	0.000013	2.22		
No. of children			-0.994	-2.04
Zonal Characteristics:				
Transit within 0.25 miles			-2.143	-2.18
Transit within 0.50 miles			2.205	1.75
Household DAP Indicators:				
Pre-driving child at home			4.346	2.76
Statistics:				
Likelihood for Constants Model	-208.724			
Likelihood for Final Model	-190.018			

Table 7: Part-time Working Adult PAP Model Specification

	Alternative Patterns (Mand. Workday as base)									
	Mand. 2 Work		**Mand. College**		**Mand. Work / College**		**Non-Mandatory**		**At Home**	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Alternative-specific constant	-1.849	-5.50	1.665	1.82	-5.969	-4.97	-1.950	-4.27	0.010	0.02
Person Characteristics:										
Age			-0.131	-4.50			0.046	4.90		
Household characteristics:										
Household size										
No. of preschool children							1.062	3.60	0.903	2.60
Pres. of pre-driving children									-1.733	-3.52
No. of adults			0.689	2.86						
No. of part-time working adults					1.569	2.71			0.625	2.63
No. of student adults			1.762	2.92			1.113	3.19		
Pres. of non-working adults							-1.945	-3.35		
Pres. of full-time working adults	-1.237	-2.19	-1.392	-3.19					-1.446	-4.08
Income							-0.0000089	-2.17	-0.000015	-2.77
Zonal characteristics:										
Suburban area							-0.544	-1.95	-0.881	-3.16
Urban area			-0.934	-2.10						
HH DAP Indicators:										
Predriving child at home									4.079	5.20
Student adult at home									2.480	3.26
Full-time working adult at home									3.822	8.48
Statistics:										
Likelihood for Constants Model	-731.774									
Likelihood for Final Model	-513.8093									

Table 8: Full-time Working Adult PAP Model Specification

	Mand. 2 Work		Mand. College		Mand. Work / College		Non-Mandatory		At Home	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Alternative-specific constant	-2.313	-5.49	-0.463	-0.33	1.648	1.16	-2.576	-8.51	0.029	0.10
Person Characteristics:										
Male									0.351	2.72
Age			-0.107	-3.01	-0.154	-3.36	0.014	2.01	-0.016	-2.83
Household characteristics:										
Household size	-0.335	-2.76	-0.991	-3.35	-0.991	-3.35				
Pres. of preschool children	0.656	2.93								
Pres. of pre-driving children	0.656	2.93	2.511	3.62	2.511	3.62				
No. of student adults			1.863	2.75						
No. of part-time working adults							-0.501	-2.07		
Income									-0.000011	-4.74
Auto shortage			-1.429	-3.39	-1.280	-2.84	-0.383	-2.24	-0.738	-6.52
Zonal characteristics:										
Suburban area	0.905	2.55	1.347	1.97						
Urban area	0.744	2.12								
Transit within 0.50 miles									-0.966	-6.46
HH DAP Indicators:										
Preschool child at home									0.424	2.57
Pre-driving child with non-mandatory pattern							1.652	4.19		
Pre-driving child at home									3.094	13.66
Driving child at home									1.811	4.43
Student adult at home									1.640	3.91
Statistics:										
Likelihood for Constants Model	-2167.3031									
Likelihood for Final Model	-1791.459									

NON-MANDATORY ACTIVITY ALLOCATION MODEL SYSTEM

Model Structure

The non-mandatory activity model system is comprised of three MNL sub-models, which run at the household level, and two individual-level sub-models. The household level models determine the number of escort activities (parents chauffeuring children, typically), shopping activities and other maintenance activities (0 through 3+ for each type of activity) for the entire household. The first individual-level model allocates the household maintenance activities to household members and the second individual-level model determines the number of discretionary activities undertaken by each household member.

The model structures for the household number of activities models and the individual maintenance activity allocation and number of discretionary activities models are listed below, with the estimation results for each separate model located in Tables 9-12.

Household Number of Maintenance Activities Models:

Choice Alternatives

- 0 tours
- 1 tour
- 2 tours
- 3+ tours

Explanatory Variables

- Auto sufficiency
- Household income
- Household size
- Indicator variable for household size
- Presence & number of preschool children
- Presence & number of pre-driving children
- Presence & number of driving children
- Presence & number of non-working adults

Presence & number of student adults

Presence & number of part-time working adults

Presence & number of full-time working adults

Residential area type

Zonal transit accessibility

Indicators for at home / non-mandatory activity patterns chosen by HH members

Number of escort activities undertaken by household (shopping activities and other maintenance activities models only)

Number of shopping activities undertaken by household (other maintenance activities model only)

Table 9: Household Number of Escort Activities Model Specification

	Alternative Patterns (0 Tours as base)					
	1 Tour		2 Tours		3+ Tours	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Alternative-specific constant	-3.658	-10.45	-6.212	-5.76	-7.283	-7.28
Household Characteristics:						
Auto surplus	0.556	2.21				
No. of preschool children	0.800	3.55				
No. of non-working adults			0.662	1.95		
No. of part-time working adults			0.749	1.92		
Zonal Characteristics						
Urban area			1.835	1.71		
Suburban area			1.835	1.71		
Transit within 0.25 miles	2.391	2.31	-1.748	-2.38		
Transit withing 0.50 miles	-2.383	-2.39				
HH DAP Indicators:						
Child with non-mandatory pattern	1.075	2.14				
Adult with non-mandatory pattern	0.519	2.43	0.519	2.43		
Statistics:						
Likelihood for Constants Model	-323.295					
Likelihood for Final Model	-299.475					

Table 10: Household Number of Shopping Activities Model Specification

	Alternative Patterns (0 Tours as base)					
	1 Tour		2 Tours		3+ Tours	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Alternative-specific constant	-0.971	-6.61	-2.539	-13.46	-2.585	-12.19
Household Characteristics:						
Household size of 1 dummy					-0.735	-2.89
No. of pre-driving children	-0.277	-3.04				
No. of non-working adults			0.987	7.24		
Pres. of non-working adults	0.886	5.39			1.777	9.08
Pres. of student adults			0.877	3.11		
Household income	0.0000053	2.75	0.0000089	3.70	0.0000086	3.50
Number of escort tours for household			0.234	2.06	0.322	3.13
Zonal Characteristics:						
Transit within 0.25 miles						
Transit within 0.50 miles						
Suburban area	-0.293	-2.25				
Urban area			0.246	1.84	0.246	1.84
HH DAP Indicators:						
Student adult with non-mandatory pattern	0.767	2.06			1.985	5.20
Part-time working adult with non-mandatory pattern	0.924	3.19	1.616	5.11	1.859	6.03
Full-time working adult with non-mandatory pattern	0.529	2.46	0.579	2.01	1.100	4.44
Non-working adult at home	-1.140	-4.08	-2.080	-4.37	-2.803	-5.16
Full-time working adult at home	-0.535	-2.00	-0.535	-2.00	-0.976	-2.11
Statistics:						
Likelihood for Constants Model	-1837.991					
Likelihood for Final Model	-1695.515					

Table 11: Household Number of Other Maintenance Activities Model Specification

	Alternative Patterns (0 Tours as base)					
	1 Tour		2 Tours		3+ Tours	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Alternative-specific constant	-1.941	-14.06	-3.753	-11.58	-3.351	-13.61
Household Characteristics:						
Household size of 1 dummy					-0.666	-2.19
Pres. of non-working adults						
No. of non-working adults	0.326	3.04	0.880	5.77		
Household income	0.000006	3.10	0.000026	2.85	0.000005	1.97
Number of household escort tours	0.263	2.77			0.265	2.23
Number of household shopping tours	0.315	4.78	0.370	4.04	0.657	7.48
HH DAP Indicators:						
Pre-driving child with non-mandatory pattern	-1.599	-2.14				
Non-working adult with non-mandatory pattern					1.030	4.84
Student adult with non-mandatory pattern			0.959	3.38		
Part-time working adult with non-mandatory pattern	0.869	3.42	0.959	3.38	0.975	2.94
Full-time working adult with non-mandatory pattern	0.487	2.18	1.278	4.86	0.918	3.34
Full-time working adult at home					-1.460	-1.97
Non-working adult at home			-1.450	-2.63		
Student adult at home	1.314	2.10	1.314	2.10		
Statistics:						
Likelihood for Constants Model	-1589.552					
Likelihood for Final Model	-1450.588					

Individual Maintenance Activity Allocation Model

Choice Alternatives

The choice alternatives for the individual maintenance activity allocation model include each household member, up to the eighth member. For households greater than eight people, the eight most senior members are included as the alternatives.

Explanatory Variables

Age

Gender

Person type indicators

PAP indicators

Auto availability

Household income

Residential area type

Zonal transit accessibility

Indicators for at home / non-mandatory activity patterns chosen by HH members

Table 12: Maintenance Activity Allocation Model Specification

Generic Parameters (Most Senior Household Member as base):	**Coeff.**	**t-ratio**
Preschool child	0.483	2.29
Pre-driving child	0.607	5.26
Non-working adult	-0.234	-2.19
Student adult	-0.325	-1.96
University DAP	0.368	1.81
Non-mandatory DAP	0.297	3.76
Person 2 Parameters:		
Alternative-specific constant	0.427	4.3
Household Income	-0.0000034	-2.29
Preschool child at home	2.942	6.28
Student adult at home	1.879	3.35
Escort Activity	0.278	2.1
Person 3 Parameters:		
Alternative-specific constant	0.692	4.38
Household Income	-0.0000046	-2.44
Student adult with non-mandatory pattern	0.502	1.88
Preschool child at home	2.539	5.31
Person 4 Parameters:		
Alternative-specific constant	0.939	4.63
Household Income	-0.0000071	-3.14
Preschool child at home	3.19	6.45
Person 5 Parameters:		
Alternative-specific constant	1.344	4.44
Household Income	-0.0000084	-2.35
Auto surplus	-0.882	-1.88
Preschool child at home	3.502	6.18
Pre-driving child with non-mandatory pattern	-0.745	-2.46
Person 6 Parameters:		
Alternative-specific constant	1.375	3.56
Person 7 Parameters:		
Alternative-specific constant	4.303	6.43
Person 8 Parameters:		
Alternative-specific constant	3.521	2.88
Statistics:		
Likelihood for Constants Model	-2600.464	
Likelihood for Final Model	-2493.381	

Individual Number of Discretionary Activities Model

Choice Alternatives

0 tours

1 tour

2 tours

3+ tours

Explanatory Variables

Age

Gender

Person type indicators

DAP indicators

Number of maintenance activities undertaken

Auto Availability

Household Income

Household size

Presence & number of preschool children

Presence & number of pre-driving children

Presence & number of driving children

Presence & number of non-working adults

Presence & number of student adults

Presence & number of part-time working adults

Residential area type

Zonal transit accessibility

Tour type indicators

Indicators for at home / non-mandatory activity patterns chosen by HH members

Table 13: Individual Number of Discretionary Activities Model Specification

	Alternative Patterns (0 Tours as base)					
	1 Tour		2 Tours		3+ Tours	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Alternative-specific constant	-0.240	-2.43	-1.634	-22.16	-1.993	-17.38
Household Characteristics:						
No. of preschool children	-1.828	-3.47	-1.253	-2.00	-2.716	-3.84
Pres. of driving children			-1.193	-2.59		
Pres. of student adults			-1.035	-2.61		
Pres. of part-time working adults					-0.486	-1.83
Pres. of full-time working adults	-0.343	-3.78				
Zonal Characteristcs:						
Suburb area					-0.554	-2.95
CBD area			0.812	2.13		
Transit within 0.25 miles	-0.317	-2.72				
HH DAP Indicators:						
Preschool or pre-driving child at home	-2.670	-3.20	-2.132	-2.34		
Non-working adult at home	-1.566	-5.41	-2.392	-3.33	-2.447	-2.42
Full-time working adult at home	-0.945	-3.67	-1.312	-2.83	-2.374	-2.35
Statistics:						
Likelihood for Constants Model	-2974.909					
Likelihood for Final Model	-2733.911					

ACTIVITY SCHEDULER

Model Structure

The activity scheduler is a rule-based model, which draws from the ATS activity diaries, in order to fit the individual's person type, PAP, the number of maintenance activities, and the number of discretionary activities for the individual. If no ATS activity diaries match the modeled individual perfectly, the matches are made on the basis of person type, PAP, and the number of non-mandatory activities (sum of maintenance and discretionary activities). If there are still no matches, which is typically not the case and was not required for the model runs in this comparison, the person type and PAP are the matching variables. The details that comprise the activity diary include the number of tours and the number of activities in each tour, the daily start time and the type and duration of all activities.

Explanatory Variables

Person type

Daily activity pattern chosen

Number of maintenance activities

Number of discretionary activities

PRIMARY DESTINATION CHOICE MODEL

Model Structure

The primary destination choice model is comprised of two MNL models (for mandatory and non-mandatory activities) and determines the location of the primary activity of each tour (typically a mandatory activity). These models use a random sampling procedure in the estimation stage to generate 31 different choice alternatives from the 1074 zones in the three-county Austin area to choose each tour's primary destination zone, and all zones for the application stage. This sampling procedure was done due to software estimation limitations, but it may be possible to increase the number of sampled alternatives. Tables 14 and 15 show the estimation results for the models.

Choice Alternatives

The choice alternatives for the primary destination choice model are all of the 1074 zones in the 3-county Austin area.

Explanatory Variables

Zonal area

Employment by type

Destination zone land use type

Origin/destination pairs land use types

Mode choice log sum by time-of-day (peak or off-peak)

Table 14: Primary Mandatory Activity Destination Choice Model Specification

Parameters:	Coeff.	t-ratio
Mode logsum	-0.453	-6.39
Zonal area	0.023	4.11
Basic employment	0.00029	16.77
Retail employment	0.00064	12.01
CBD destination indicator	3.296	36.43
Rural origin and suburb destination indicator	0.940	6.80
Rural origin and urban destination indicator	0.684	4.29
Suburb origin and destination indicator	2.167	21.58
Suburb origin and urban destination indicator	2.277	21.49
Urban origin and suburb destination indicator	1.235	11.46
Urban origin and destination indicator	2.357	23.55
No Coefficients Model		-8952.405
Final Model		-7428.484

Table 15: Primary Non-Mandatory Activity Destination Choice Model Specification

Parameters:	Coeff.	t-ratio
Mode logsum	-3.408	-20.16
Basic employment	0.00016	6.32
Suburb destination indicator	-1.518	-2.85
Rural origin and suburb destination indicator	1.746	3.20
Suburb origin and destination indicator	3.407	6.29
Suburb origin and urban destination indicator	2.395	22.79
Urban origin and suburb destination indicator	2.766	5.06
Urban origin and destination indicator	3.079	26.77
No Coefficients Model		-7905.039
Final Model		-6763.660

MODE CHOICE MODEL

Once the destination is chosen for the primary stop of the tour, the mode is chosen for the entire tour, ensuring consistency of mode use across all tour segments. Mode choice relies on an MNL model with both time and cost parameters by time-of-day (peak or off-peak), as well as travel-purpose and mode-specific constants, person-type constants indicating age and employment status, household income, auto sufficiency and household composition. (For example, the presence of children increases the likelihood of carpooling/shared ride.) The four alternatives considered are drive alone, shared ride, transit, and non-motorized modes. Logsums across these mode alternatives, specific to both times of day, are used in the destination choice model.

In the initial specification, the parameter on cost had a positive coefficient, which causes the value of travel time (VOTT) to be highly negative (-$20/hr). While this result reflects an insensitivity to travel cost in the ATS population, it is not a reasonable result, and it causes the model application results to be off. This was corrected by fixing VOTT to equal $10/person-hour (as done in the traditional model) and utilizing a generalized cost term instead of having the travel times and costs interact with separate parameters in the model. Due to time constraints, the model results discussed here were obtained using the initial mode choice model specification, but any further application with this model should use the final specification.

Model Structure

The mode choice model is an MNL model which uses both time and cost parameters based on the time-of-day chosen (peak or off-peak) to determine the mode for each entire tour. Tables 16 and 17 show the estimation results for the model specifications for the initial and final models, respectively.

Choice Alternatives

SOV (not available for preschool and pre-driving children, or escorting tours)
HOV
Transit (not available for origin or destination zones without transit)
Non-motorized

Explanatory Variables

In-vehicle travel time
Wait time (transit wait only)
Cost ($0.10/mile for auto and fare for transit)
Travel-purpose and mode specific constants
Person type indicator variables
Auto sufficiency
Presence of a preschool or school pre-driving-age child in the household

Table 16: Initial Mode Choice Model Specification

	Mode Choice (Drive Alone as Base)							
	Drive Alone		**Shared Ride**		**Transit**		**Non-Motorized**	
	Coeff.	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**	**Coeff.**	**t-ratio**
Alt-spec. constant			0.349	2.04	-1.885	-6.33	-0.556	-1.81
Level of Service characteristics:								
In-vehicle time	-0.005	-10.08	-0.005	-10.08	-0.005	-10.08	-0.005	-10.08
Wait time					-0.011	-3.02		
Operating cost	0.015	4.41	0.015	4.41	0.015	4.41	0.015	4.41
Tour Char.:								
Work tour			-1.825	-9.58			-1.857	-6.27
School tour			1.174	5.80	5.000	15.55	1.589	5.41
University tour			-0.938	-3.81				
Shopping tour			-0.522	-4.47			-0.761	-2.72
Other maint. tour			-0.448	-3.70				
No. of work act.			-0.296	-2.51			0.579	4.40
No. of univ. act.					1.958	7.12	1.299	5.74
No. of shop act.					-0.720	-2.31		
No. of discr. act.			0.241	4.63	-0.398	-2.02		
Household Char.:								
Income					-0.00002	-5.98		
Auto surplus			-0.224	-2.67	-0.273	-1.36		
Auto shortage			-1.117	-12.03	-1.534	-10.83	-1.507	-11.54
Presence of preschool child			0.705	5.25			1.208	4.85
Presence of pre-driving child			1.317	12.24	0.774	3.12	0.890	3.84
Individual Char.:								
Male							0.445	2.87
Age			-0.011	-4.11			-0.027	-4.56
Pre-school child			-0.563	-2.58			-2.404	-4.49
Pre-driving child			-0.520	-2.79			-1.646	-5.22
Part-time working adult			-0.249	-2.10				
Full-time working adult			-0.379	-4.21	-1.229	-4.29	-0.408	-2.02
Schoolday DAP			-0.520	-3.21				
University day DAP					0.640	1.93		
Statistics:								
Likelihood for Constants Model	-4886.25							
Likelihood for Final Model	-3276.292							

Table 17: Final Mode Choice Model Specification

	Mode Choice (Drive Alone as Base)					
	Shared Ride		Transit		Non-Motorized	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Alt-spec. constant	-0.369	-3.42	-2.394	-8.89	-2.129	-9.20
Level of Service Characteristics:						
Generalized cost (also applies to Drive Alone)	-0.00016	-2.71	-0.00016	-2.71	-0.00016	-2.71
Tour Characteristics:						
Work tour	-1.565	-9.18			-1.826	-7.90
School tour	1.473	7.49	4.808	14.73	2.295	8.56
University tour			1.162	2.37		
Shopping tour	-0.227	-2.12				
Escort tour	0.408	2.34			-2.078	-2.04
No. of work activities	-0.290	-2.76	-0.290	-2.76		
No. of university activities			1.471	3.71	1.356	7.28
No. of shopping activities			-1.036	-3.43	-0.714	-3.84
No. of discretionary activities	0.353	7.09	-0.589	-3.24		
Household Characteristics:						
Income			-0.00002	-6.59	-0.000007	-2.69
Auto surplus	-0.174	-2.19				
Auto shortage	-1.147	-12.40	-1.546	-11.14	-1.540	-12.08
Presence of preschool child	0.676	6.71			0.886	4.33
Presence of pre-driving child	1.200	11.83	0.634	2.62		
Individual Characteristics:						
Male					0.439	2.88
Age						
Pre-driving child	-0.550	-4.96				
Non-working adult	-0.350	-3.06			-0.822	-2.89
Student adult	-0.258	-2.29				
Part-time working adult	-0.258	-2.29			0.436	2.18
Full-time working adult	-0.385	-4.09	-1.187	-4.12	-0.500	-2.44
Statistics:						
Likelihood for Constants Model						
Likelihood for Final Model						

SECONDARY DESTINATION CHOICE MODEL

Model Structure

Once the mode for each tour is chosen, the secondary destination choice model is applied, which is structured very similarly to the primary destination choice models. Like the primary model, it is comprised of two MNL models (for mandatory and non-mandatory activities), which use a random sampling procedure in the estimation stage to choose each tour's primary destination zone, and all zones for the application stage. This model differs from the primary-destination-choice model by controlling for the location of the primary activity (via distances to both home and primary activity zones) and the chosen mode. This is done by incorporating explanatory variables of distance (to both the home zone and the primary activity destination), as well as travel time and cost variables specific to the mode chosen. Tables 18 and 19 show the estimation results for this model.

Choice Alternatives

The choice alternatives for the destination choice model are all of the 1074 zones in the 3-county Austin area.

Explanatory Variables

Zonal area

Employment by type

Destination land use type

Origin/destination pairs land use types

Travel time to both primary activity location and home location (non-mandatory model only)

Travel cost to both primary activity location and home location (non-mandatory model only)

Table 18: Secondary Mandatory Activity Destination Choice Model Specification

Parameters	Coeff.	t-ratio
Zonal area	0.036	4.45
Basic employment	0.00028	8.74
Retail employment	0.00054	6.05
CBD destination indicator	1.343	6.45
Rural origin and suburb destination indicator	3.719	22.36
Rural origin and urban destination indicator	0.926	3.01
Suburb origin and destination indicator	2.895	11.88
Suburb origin and urban destination indicator	1.544	5.29
Urban origin and suburb destination indicator	1.980	10.26
Urban origin and destination indicator	2.010	8.73
No Coefficients Model		-2977.267
Final Model		-2345.880

Table 19: Secondary Non-Mandatory Activity Destination Choice Model Specification

Parameters	Coeff.	t-stat
Travel time to home zone	-0.197	-94.36
Travel time to primary destination	-0.0577	-13.83
Cost to home zone	-0.708	-8.26
Service employment	0.00070	19.26
Retail employment	0.00007	5.50
No Coefficients Model	-27155.971	
Final Model	-10958.700	

TRAFFIC ASSIGNMENT

Once all trips are determined through the model system, they are assigned to the Austin area network using standard origin-destination assignment methods at the TAZ level. This is done using TransCAD and they are aggregated by time of day. Trips with at least one external end zone and commercial vehicle trip matrices are loaded as well. Feedback of travel times and costs was not done for the destination choice and mode choice models, as the effort required is significant (requiring at least one person-day). Ideally, feedback would be performed until convergence, but this was not possible due to time constraints.

MICROSCOPIC MODEL LIMITATIONS

Due to the complexity of the model system as well as data limitations and time constraints, several simplifications were made to allow for the model estimation. As explained in the population synthesis section, the synthesis procedure is not random due to the method of multiplying the probabilities of each household type by the number of households in each zone. To allow for randomness in this procedure one can randomly draw from the probabilities of each household type in order to generate each household in the zone. The drawing procedure can be further enhanced by assigning probabilities to households that share the same control variables, based on other, non-control variables (like age and employment status of household head and household auto availability). Such added stratification can further enhance the sample's representativeness. Another limitation of the population synthesis is the use of just two dimensions for the IPF procedure and assigning all other variables in an uncontrolled manner, as most population synthesis procedures use 3 or 4 dimensions. This procedure can be done on more dimensions (e.g., 3 dimensions are used in the MORPC population synthesis procedure), which improve accuracy of the synthesized population. Another limitation of the population synthesis procedure is the inclusion of auto ownership as an uncontrolled variable. This does not allow for households to change the car ownership based on policy changes, which is an important affect to analyze.

The PAP model system also exhibits certain limitations. For example, they are all estimated as MNL models, which ignore any latent correlation between choice alternatives, which is not necessarily the case. There may well exist correlations between alternatives like work with one tour, work with two tours, and work/university day. This could be accounted for, to some extent, via the use of a nested logit model. Another limitation of the PAP model is found in the person-type sequence assumption. This restricts household interactions to a sequence of one-way dependencies, instead of simultaneously allowing all household members' PAPs to influence each other. Assuming the sequence ordering, by first modeling the children, places a further limitation on the model, since the PAPs chosen by the adults are not allowed to influence the children. It can be argued that this is an incorrect assumption, since full-time workers (and others) may have a more constrained schedule than a pre-school child.

The non-mandatory activities model system also has limitations. All four of the number of activities models (escorting, shopping, other maintenance, and discretionary activities) are modeled using MNL models, which assumes no ordering in the choice alternatives. The number of activities an individual undertakes during the day is an ordered situation, and an ordered probit model or some other ordered model structure may fit the data better. Another potential limitation of the maintenance activity models is their sequential process: escorting activities are generated first, then shopping activities and finally other maintenance activities. It is preferable to determine all maintenance activities at once, but due to limited estimation data, the models were estimated in this format. In the current model system there are no interactions present between the maintenance activity models and the discretionary activity model. This is a limitation to the model system, as these sorts of activities interact with each other in an individual's decision process for the daily activity pattern. A final limitation in the non-mandatory activity model system is in the maintenance activity allocation model. It only allows for allocation to the eight most senior members of the household, ignoring further members if the household size is greater than eight. As few households have greater than eight members, it is not as strong a limitation, and it was imposed in this manner due to the small number of households with greater than eight members in the model estimation data set.

The activity scheduler has the limitation of pulling from a small pool of activity diaries (2787 diaries) to be matched to the 768,320 individuals in the synthesized population not staying at home. This does not allow for very much flexibility in the activity scheduling, especially in the time-of-day decision choices as the activity times are fixed in the travel diaries. This is an especially important limitation when analyzing policies such as congestion pricing. One of the attractive features of microsimulation is the ease of examining trips by time-of-day without using artificial peak factors, which can still be done with this model, but the times will not necessarily change due to policy changes.

A limitation of both the primary and secondary activity destination choice models is the use of randomly sampled alternatives in the estimation stage. By not incorporating all possible alternatives, certain affects could be neglected, which could change the model parameters. Another limitation of the destination choice models is the exclusion of chaining the locations. Currently, the origin of primary activity trips is assumed to be the home TAZ, and only the primary activity location is taken into account in the secondary activity destination choice model. It would be useful to look at the location of the activity that directly precedes the activity in question, but this would make the model much more complicated and difficult to estimate.

The final model component with limitation is the mode choice model, which currently does not incorporate constraints on auto availability. This could potentially introduce errors into the results, by assigning the same vehicle to multiple members of the household.

The run time of the model system is another aspect that is a limitation of the microscopic model. The model code used in this application took approximately 28 hours to run one time, which did not include any travel times and costs feedback. With the improved population synthesis code, this is cut to about 18 hours, but there are still many areas which could be improved. The population synthesis procedure takes approximately 30 minutes to run in R and SPSS, the activity modeling sequence up to the activity scheduler take approximately 1 hour to run in SPSS, and the destination/mode choice modules take 16 hours to run in TransCAD.

MICROSCOPIC MODEL VALIDATION

No explicit calibration, such as setting aside 10% or so of the estimation data and then running that through the model and adjusting the model parameters so the model results match the actual results, was performed on the microscopic model due to time constraints. However, it is possible to see how accurately the models perform based on comparisons of model vehicle miles traveled (VMT) versus 1997 traffic-count-based VMT for different facility types. This measure is shown in Table 20, and is described in greater detail in the Accuracy and Model Sensitivities section of Chapter 4. One should expect a slight increase in VMT as our data is based on the year 2000, but there is a significant increase in VMT for both the microscopic and traditional models, implying that further calibration may be wise, by adjusting certain model parameters at each step in the system, to better match the desired results.

Table 20: Link-based Comparisons of Predicted VMTs to Actual Count-based VMTs

Functional Class	Count-based VMT	Traditional Model VMT Predictions	Traditional Model % Increase from Count	Microscopic Model VMT Predictions	Microscopic % Increase from Count-based VMT
IH 35	6,673,294	8,565,982	28.36	13,547,613	103.01
Other Freeway	2,573,492	3,209,617	24.72	3,989,389	55.02
Expressway	1,244,116	1,237,403	-0.54	1,408,235	13.19
Principal Arterial - divided	5,918,496	7,930,362	33.99	7,429,663	25.53
Principal Arterial - undivided	4,641,065	6,181,469	33.19	7,500,631	61.61
Minor Arterial - divided	0	0	0.00	0	0.00
Minor Arterial - undivided	3,161,542	4,550,970	43.95	5,883,360	86.09
Collector	172,686	176,604	2.27	573,127	231.89
Local	803	200	-75.10	604	-24.79
Express Lanes	155,752	191,885	23.20	256,441	64.65
Ramps	315,711	343,775	8.89	337,211	6.81
Frontage Roads	1,455,020	1,619,640	11.31	2,702,860	85.76
TOTAL	26,311,978	34,007,908	29.25	43,629,134	65.81

Chapter Four: Model Application for an Austin Area Case Study

CASE SCENARIOS

One of the proposed advantages of the microsimulation models over traditional, aggregate models is behavioral sensitivity to environmental and other system changes, for use in policy analysis. To fully examine the responsiveness of the models, three scenarios were analyzed which attempt to explore a range of possible policy changes. These include the base scenario, an expanded-capacity scenario, and centralized-employment scenario. The base case used the 2000 Census data, the 1996 ATS data, and the current network to run the complete model system. The expanded capacity scenario uses the base scenario population and reflects an added lane on the two most important N-S corridors in the region (I-35 [entire length] and Loop 1 [from Parmer Ln. to 290]), as shown in Figure 7.

A land use change that could potentially occur is the shifting of employment locations, so the third scenario analyzed is a centralized-employment scenario, which is comprised of a shift in employment locations to the central business district (CBD). This scenario is run using the base scenario population and using different land use schemes in the destination and mode choice models.

TRADITIONAL MODEL DESCRIPTION

The traditional model was applied by Jason Lemp, and the following description was taken directly from the McWethy et al. (2007) paper. The traditional TDM employed here relies on techniques used in several existing TDMs for the Austin region, all based on data in the 1996-1997 ATS (CAMPO 2000, Smart Mobility 2003, Gupta 2004, Kalmanje and Kockelman 2004, and Kalmanje 2005), as well as many standard techniques outlined by Martin and McGuckin (1998). All components were estimated to facilitate comparison with the activity-based model, while maintaining a rather traditional (though not highly simplistic) structure. The model uses rather standard and streamlined approaches: fixed rates of trip productions (as a function of household and employment counts [by type]), multinomial logit models for destination choice and mode choice, fixed time of day and vehicle occupancy trip apportionments, and static traffic assignment routines. For consistency, it also features a vehicle ownership model upstream of trip production. Due to space limitations, many of the details of the models were not included here.

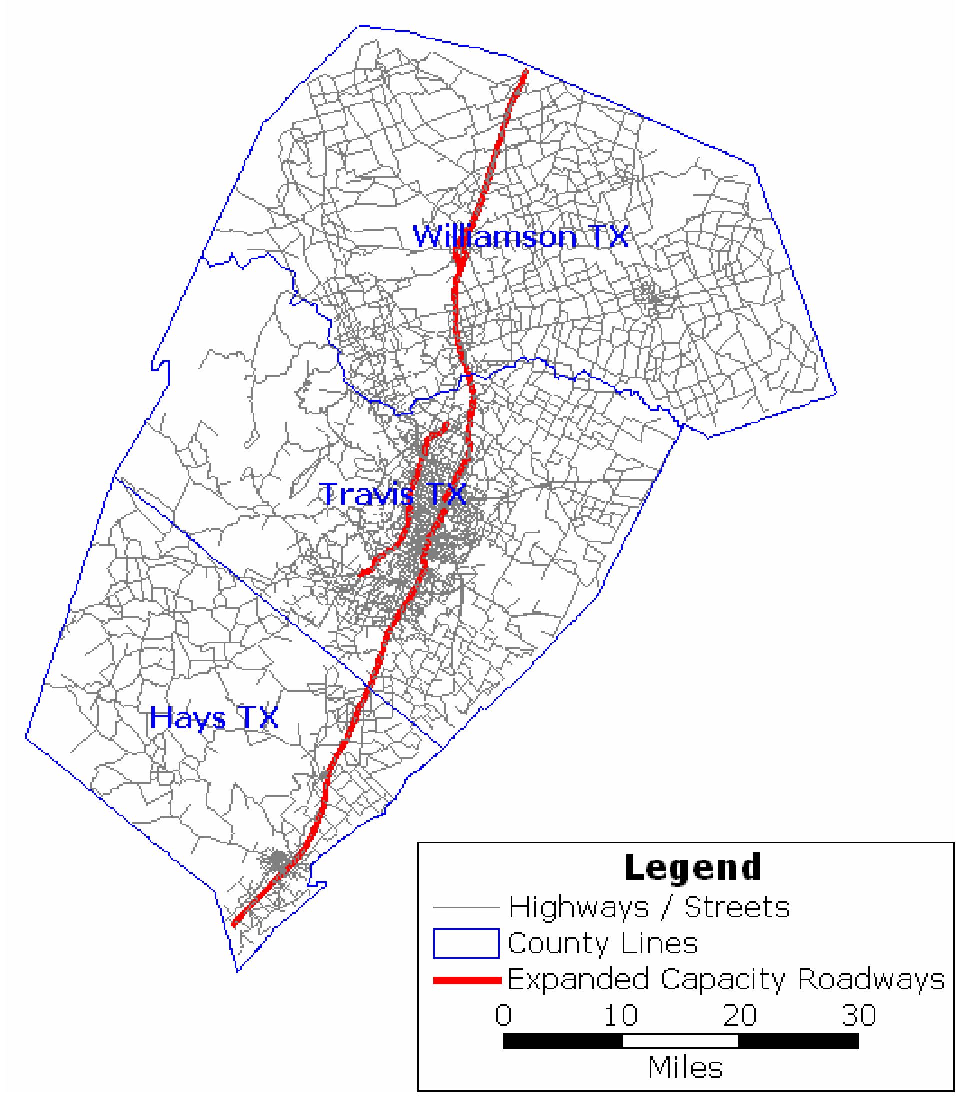

Figure 7: Areas Affected by Expanded Capacity Scenario

For a more detailed discussion of the model estimation results, please refer to Appendix A and Lemp and Kockelman (2006).

ACCURACY AND MODEL SENSITIVITIES

The performance of the two models was compared on the basis of predictive accuracy (both in model development and application), modeling sensitivities to policies and investments that affect the timing and cost of travel, using the direct observations of traffic flows during peak hours and off-peak hours, departure time patterns, and mode splits forecasted by each model.

The model application results presented in this paper are largely drawn from McWethy et al. (2007).

In order to examine the accuracy of the two models, actual link flow data were compared to those predicted by the models using the base scenario, as shown in Table 19. The actual data come from 1997 traffic counts performed by CAMPO on 6,606 of the total network's 7,203 coded non-centroid-connecting links (2,436 (or 25%) of the network's links are centroid connectors). Of course, the models were applied using 2000 CAMPO employment data and 2000 Census data rather than 1997 travel data, so one expects somewhat higher model-predicted counts, due to population, job and income growth during the 1997-2000 period – which was a time of significant economic expansion for the U.S. and Austin economies. Moreover, the TDMs assume a school day, while CAMPO's counts are for an average day (including weekends and summertime), over the course of a year. Despite expectations of higher counts, the results were substantially different: the traditional model predicts approximately 29% greater network VMT (7.7 million vehicle-miles per day) and the microscopic model is 66% greater (17.3 million miles). Part of this error is possibly due to the mis-specification of the mode choice model, which incorporated a negative VOTT. This model has been corrected, but due to time constraints, was not able to be included in this results section.

After recognizing the growth in population, employment and travel during the 1997-2000 period, and the emphasis of school days in the TDM, it seems that the traditional model is performing reasonably, in general, system-level performance terms. however, the microscopic model is not. Upon closer inspection, the microscopic model is suffering from very long travel distance predictions, though trip generation rates are 13.5% lower than the ATS would suggest (per person, per weekday). This issue appears to emerge from the mode choice components, where allowing the model to give unreasonable (and even negative) values of travel time (by estimating a positive utility parameter on the cost term) results in a generalized-cost-insensitive destination choice model, which muddles the forecasting exercise. Forcing a reasonable value of travel time, as done in the conventional model, should address this to a great extent, while allowing for much more reasonable responses to policies like roadway tolling and the like, which are emerging in Austin in the coming months.

Model-predicted mode shares also were compared to the (population-corrected) ATS shares, as shown in Table 21. In the aggregate model, transit and walk/bike mode shares are significantly less than that of the population weighted ATS (1.2% and 2.7%, rather than ATS shares of 2.0% and 4.3%). For walk/bike trips, this may be a result of the low (4 mph) speed assumption, made during model estimation, which may not apply for Austin. In contrast, the microscopic model over-estimates these shares. Of course, these are minor modes, so mis-predictions will not really affect most/many applications of the model. Fortunately, the mode shares for both shared ride and drive alone appear reasonable, under both model formulations.

Table 21: Daily Mode Split Comparisons to ATS Survey Data for Base Case

	Mode	ATS	Base	
			Share	% Change from ATS
Traditional TDM	Drive Alone	0.539	0.586	8.799
	Shared Ride	0.398	0.375	-5.852
	Transit	0.020	0.012	-40.611
	Walk / Bike	0.043	0.027	-37.243
Microscopic TDM	Drive Alone	0.539	0.537	-0.428
	Shared Ride	0.398	0.373	-6.245
	Transit	0.020	0.040	100.053
	Walk / Bike	0.043	0.050	16.631

SCENARIO EVALUATIONS VIA MODEL RESPONSES

To investigate model sensitivities to input changes, three measures were used for comparison to the base scenario's outputs: changes in VMT by roadway type, VMT and vehicle-hours traveled (VHT) by time of day, and mode split. Changes in these variables (from the base case outputs for both models) were used to assess scenario results, across the two modeling frameworks.

RESULTS OF EXPANDED-CAPACITY SCENARIO

Table 22 provides the VMT and VHT estimates by time of day for both models under expanded link capacities for I-35 and Loop 1. As expected, for the traditional model, total VHT estimates fell for each time period (except during the midday time of day, which exhibited barely any effect). Thanks to faster travel times, VMT is predicted to increase anywhere between 2.14% (off-peak) and 3.48% (in the PM peak period). Of course, the critical question is how these compare to the microscopic model estimates. The activity-based model shows similar results for the direction of change at each time of day, but the magnitudes generally are larger for VHT, ranging from -7.41% (off-peak) to -43.1% (AM peak). There is little change in VMT for the microscopic model, ranging from 0.14% (AM peak) to 1.55% (off-peak period), which is no doubt due to the odd signs on cost in the mode and destination choice models.

Table 22: Time of Day Comparisons for Expanded Capacity Scenario

Time of Day	Measure	Base Case Value	Traditional Model Value	Traditional Model % Increase from Base	Microscopic Model Value	Microscopic Model % Increase from Base
AM	VMT	7,392,041	7,642,963	3.39	14,570,144	0.14
	VHT	287,258	275,425	-4.12	7,072,147	-43.07
	Avg. Speed	25.73	27.75	7.85	2.06	76.07
MID	VMT	13,208,623	13,608,395	3.03	15,388,356	1.09
	VHT	304,927	305,190	0.09	372,826	-10.75
	Avg. Speed	43.32	44.59	2.93	41.27	13.25
OP	VMT	2,654,155	2,710,919	2.14	6,867,118	1.55
	VHT	57,337	58,268	1.62	143,929	-7.41
	Avg. Speed	46.29	46.53	0.52	47.71	9.68
PM	VMT	10,753,088	11,127,640	3.48	7,204,556	1.53
	VHT	307,976	299,862	-2.63	167,709	-9.69
	Avg. Speed	34.92	37.11	6.27	42.96	12.43
DAILY	VMT	34,007,908	35,089,917	3.18	44,030,174	0.92
	VHT	957,499	938,745	-1.96	7,756,611	-41.16
	Avg. Speed	35.52	37.38	5.24	5.68	71.60

It is expected that with increased capacity, people will shift to routes that offer higher speeds under free-flow and regular traffic conditions (in this case, I-35 or Loop 1). The traditional model's results suggest just that: people shift their travel behavior toward these higher speed freeways, as shown in Table 22. Other roadways still receive significant use, but people tend to drive longer distances, relying more on the additional capacity offered by I-35 and Loop 1. The microsimulation model forecasts indicate similar effects, but again with rather larger magnitudes. The microsimulation model also suggests a greater shift towards I-35 over Loop 1, as also shown in Table 23, while the traditional model suggests a higher shift toward Loop 1 The shift is also more evident from frontage roads to the freeways in the microscopic model than for the traditional model.

Table 23: VMT by Roadway Type for Expanded Capacity Scenario

Functional Class	Traditional TDM VMT	Traditional TDM % Increase from Trad. Base	Microscopic TDM VMT	Microscopic TDM % Increase from Micro. Base
IH 35	9,646,682	12.62	16,125,640	19.03
Other Freeway	3,617,275	12.70	4,313,112	8.11
Expressway	1,192,435	-3.63	1,262,323	-10.36
Principal Arterial - divided	7,846,180	-1.06	7,001,992	-5.76
Principal Arterial - undivided	6,092,186	-1.44	6,899,933	-8.01
Minor Arterial - undivided	4,437,734	-2.49	5,265,182	-10.51
Collector	176,583	-0.01	447,620	-21.90
Local	198	-1.25	608	0.70
Express Lanes	235,405	22.68	296,294	15.54
Ramps	364,426	6.01	344,575	2.18
Frontage Roads	1,480,811	-8.57	2,072,896	-23.31
TOTAL	35,089,917	3.18	44,030,174	0.92

The mode splits for the aggregate model are very close to those of the base scenario, as shown in Table 24. Similarly, the modal splits for the microscopic model show little change, with a slight increase in both drive alone and shared ride travel. This is due to the substantial alternative-specific constants in both model's mode choice settings, which generally are two or three times as high as the cost and time component contributions to systematic utility.

Table 24: Daily Mode Splits for Expanded Capacity Scenario

	Mode	ATS	Base Share	Expanded Capacity Share	Expanded Capacity % Change from Base
Traditional TDM	Drive Alone	0.539	0.586	0.586	-0.037
	Shared Ride	0.398	0.375	0.375	0.197
	Transit	0.020	0.012	0.012	-0.710
	Walk / Bike	0.043	0.027	0.027	-1.621
Microscopic TDM	Drive Alone	0.539	0.537	0.537	0.070
	Shared Ride	0.398	0.373	0.373	0.061
	Transit	0.020	0.040	0.040	-1.235
	Walk / Bike	0.043	0.050	0.050	-0.216

RESULTS OF CENTRALIZED EMPLOYMENT SCENARIO

Table 25 provides the VMT and VHT results by time of day for both models under the centralized employment location scenario. The results of the traditional model show little impact for this scenario, with a slight decrease in VMT and VHT over all time periods, except the AM peak period, which exhibits a VHT increase of 3.24%. This can be explained as more commuters are concentrated on the routes heading into the CBD. The microscopic model predicts a much larger impact, with increases in both VHT and VMT across all time periods. This is the expected result, as workers travel downtown in the AM and PM peak periods, as well as during the midday (for lunch, business meetings, and errands, for example). The overall increase of 13.13% in VMT for the microscopic model is also an expected result, as more people will be commuting to the CBD from suburban locations.

Table 25: Time of Day Comparisons for Centralized Employment Scenario

Time of Day	Measure	Base Case	Traditional Model		Microscopic Model	
		Value	Value	% Increase from Base	Value	% Increase from Base
AM	VMT	7,392,041	7,364,178	-0.38	16,626,382	14.28
	VHT	287,258	296,570	3.24	35,057,368	182.19
	Avg. Speed	25.73	24.83	-3.50	0.47	-59.83
MID	VMT	13,208,623	13,018,526	-1.44	17,302,740	13.67
	VHT	304,927	300,595	-1.42	519,270	24.31
	Avg. Speed	43.32	43.31	-0.02	33.32	-8.56
OP	VMT	2,654,155	2,647,513	-0.25	7,494,130	10.82
	VHT	57,337	57,181	-0.27	179,325	15.37
	Avg. Speed	46.29	46.3	0.02	41.79	-3.93
PM	VMT	10,753,088	10,670,152	-0.77	7,933,535	11.80
	VHT	307,976	306,088	-0.61	219,264	18.07
	Avg. Speed	34.92	34.86	-0.17	36.18	-5.31
DAILY	VMT	34,007,908	33,700,369	-0.90	49,356,788	13.13
	VHT	957,499	960,435	0.31	35,975,228	172.91
	Avg. Speed	35.52	35.09	-1.21	1.37	-58.61

With more centralized employment, we expected greater use of arterial-type routes and less of limited access routes, as Austin's downtown is not easily connected to most freeways in the region. This can be seen in both models, though with a much greater impact in the microscopic model, as shown in Table 26. The microscopic model has increases from 2.21% for the express lanes to 50.41% for the undivided minor arterials. The shift from limited access routes to arterial-type routes is logical, as activity locations are likely to be closer in the more concentrated CBD area, and so it is easier to use local routes.

Table 26: VMT by Roadway Type for Centralized Employment Scenario

	Traditional TDM		Microscopic TDM	
Functional Class	VMT	% Increase from Trad. Base	VMT	% Increase from Micro. Base
IH 35	8,525,707	-0.47	14,591,996	7.71
Other Freeway	3,211,544	0.06	4,175,542	4.67
Expressway	1,213,486	-1.93	1,544,098	9.65
Principal Arterial - divided	7,815,131	-1.45	8,197,128	10.33
Principal Arterial - undivided	6,133,647	-0.77	8,826,555	17.68
Minor Arterial - undivided	4,502,355	-1.07	7,359,821	25.10
Collector	172,527	-2.31	862,061	50.41
Local	204	2.20	800	32.33
Express Lanes	185,037	-3.57	262,115	2.21
Ramps	342,736	-0.30	358,134	6.20
Frontage Roads	1,597,996	-1.34	3,178,538	17.60
TOTAL	33,700,369	-0.90	49,356,788	13.13

As in the expanded capacity scenario, the mode splits for the aggregate model are very close to those of the base scenario, as shown in Table 27, again indicating an insensitivity and heavy weight of alternative-specific constant terms. One would expect a shift away from the non-auto modes as commute (and linked) distances increase, due to job concentration (without a parallel shift in residential concentrations). The microscopic model predicts much larger impacts, with 9.0% and 13.3% predicted decreases in transit and walk/bike mode shares.. In any case, it seems the microscopic model is more sensitive to the impacts of policy changes on travel, as expected – thanks to the explicit chaining of linked trips, mode consistency requirements within a tour, and so forth (see, e.g., Bowman and Ben-Akiva, 1997).

Table 27: Daily Mode Splits for Centralized Employment Scenario

	Mode	Base	Centralized Employment	
		Share	Share	% Change from Base
Traditional TDM	Drive Alone	0.586	0.586	-0.035
	Shared Ride	0.375	0.374	-0.205
	Transit	0.012	0.012	2.383
	Walk / Bike	0.027	0.028	2.549
Microscopic TDM	Drive Alone	0.638	0.573	-10.172
	Shared Ride	0.261	0.347	32.933
	Transit	0.047	0.036	-22.536
	Walk / Bike	0.054	0.044	-19.437

Chapter Five: Further Research Directions

While activity-based, microsimulation models are hoped to perform better than traditional, aggregate methods, there are many areas for improvement in the microscopic model described here. Many of the limitations described above in Chapter 3 can be removed and more accurate results potentially can be obtained as a result of this. Perhaps the most important extension of this research is a rigorous validation process to improve the overall performance of the microscopic model.

The population synthesis offers a few options for improvement, including making the R code more efficient and able to incorporate randomness. The current R code takes approximately seven hours to run for 1074 TAZs, which each have a proportional table of 24 elements (8 household size categories and 3 household income categories) due to inefficient code loops. This can be shortened to minutes using matrix functions. Drawing a random number for each household in the population and matching it with the probabilities of each household type in the respective TAZ can build in the randomness, which will allow calculation of the synthesis error. Currently, policy changes do not affect auto ownership in the model system, which would be helpful in policy analysis. This could be changed by incorporating an auto ownership model instead of allowing number of household vehicles to be an uncontrolled variable added in the population synthesis process. To more fully ensure that this is a microsimulation model, an important addition to the population synthesis procedure is the assignment of home and job locations to parcels within the TAZ. This also is likely to ensure more accurate work trip assignments, as the destination choice model currently does not ensure that work trips end at the same location. Currently, the model system does not have a procedure for evolving the population for future year forecasting. This can be built into the model in two ways: applying rule-based models for allowing the population to "grow up", or regenerating the population, using the base-year probability tables as a seed and changing the marginal values for each TAZ based on forecasted data.

An item that can be implemented to hopefully improve all models in the system would be to incorporate the ATS population weights in model estimation. Another item to further investigate is the model structure for the PAP models. It may be that greater accuracy and sensitivity can be achieved through a nested logit structure instead of a standard multinomial logit structure, due to correlation between choice alternatives, as discussed in Chapter 3's model limitations section. In addition to this, the sequencing used in modeling person types could be investigated, to determine the most accurate ordering. This could be done by estimating the models multiple times, utilizing a different model sequence each time and determining which sequence fits the data best. A final item for PAP model improvement is the addition of constraints, to ensure, for example, that one parent stays at home with a sick child or that if one preschool child has a school day all other preschool children do as well.

As mentioned in the limitations section, the number of maintenance activities models could potentially be thought of as ordered as opposed to categorical models, which would best be modeled with an ordered probit model. An extension of this research is to test which model structure best fits the maintenance activities data. Another improvement would be to introduce interactions between the discretionary activity and maintenance activity models. The maintenance activity allocation model is currently very limited in its assignment capabilities, and it would be beneficial to see if there is another model structure that would produce better results, and allow for more constraints and interactions.

In order to more accurately reflect behavioral theory and also to incorporate sensitivity to policy changes, it would be beneficial to change the activity scheduler from a deterministic, code-based assignment to a behavioral, logistic model. This allows for much more flexibility in scheduling, as well as time-of-day changes. Through this change, sensitivities to travel times and cost could be better incorporated. Rule-based constraints will still play an important role in a logistic activity-scheduling model, since this is an important area to incorporate household scheduling constraints. This allows for behavioral realism, since most households coordinate their trip-making with other household members, and so time-of-day choices should reflect this.

To improve the accuracy of the destination choice models, the number of sampled alternatives in the estimation stage could be increased to fifty or more to determine if the parameter estimates are stabilizing.

The addition of constraints in the mode choice model would ensure incorrect assignment of vehicle use within a household, which could perhaps cause over-predicting drive alone and shared ride modes.

Chapter Six: Conclusions

The question of how much "better" activity-based microsimulation models perform relative to traditional aggregate approaches is controversial – and to date largely overlooked. The widespread endorsement by the academic community of activity-based, microscopic models has had little empirical foundation. This paper addresses this issue by calibrating and then applying two such models, using identical data sets with application to the same study area for the base case, expanded-capacity and centralized employment scenarios.

The calibration of the microscopic model is necessarily more time-consuming for multiple reasons. Traditional travel surveys are coded as trip data, as opposed to tour data, and so the data needs to be converted before the models can be calibrated. The model is also more complex, requiring that 18 separate sub-models be estimated and applied (rather than the 13 used under the conventional modeling approach). Complexity of such models is a key cost that may be over-ridden by the detailed results that can be acquired and policy issues that can be analyzed through these models. However, the analysts must first be confident that their simulation methods and activity-pattern, trip timing and other specifications are error-free and appropriately reflect actual travel patterns. If the experience of this research team is any indication, the added effort (and skill requirements) of activity-based models may not be feasible for most MPOs, particularly in the near term. This particular microscopic model has been under development for almost a year and still exhibits many "bugs". Its predictions suggest many areas for model improvement and validation.

Due to time constraints, the microsimulation sub-models were not fully explored (and validated) before moving on in the overall model estimation process. Such accuracy evaluations along the way may be vital to a successful implementation process, since the models may quickly diverge from population tendencies. Opportunities for mis-prediction are no doubt in part due to the inter-dependence of so many model predictions in sequence. Here (and in MORPC), the forecasting moves from primary activity pattern choice (in hierarchy, across all household members), to mode choice to destination choice to secondary activity pattern choice. Errors can emerge and propagate across these complex, intertwined, and cross-constrained behavioral models.

The results indicate that activity-based models do indeed perform rather differently than traditional aggregate approaches. The microscopic model proved much more sensitive to capacity expansion and employment location tests. Unfortunately, appraising the accuracy of the models under changes to model inputs (relative to actual traffic patterns) is not possible (without actually undertaking such a policy and collecting new traffic and travel data). Moreover, the microscopic model was far trickier to estimate in such a way that reasonable behaviors emerged. Nonetheless, it seems that the more exhaustive behavioral theory incorporated in the microscopic, activity-based models may offer significant benefits for scenario analysis, an important component of the planning process. Far more investigation is needed, to ascertain the true benefits of such modeling methods, and the extent to which they warrant the expertise and effort that they require, but this research attempts to provide a basis for future comparisons.

References

Anderson, R. (2005) Implementation of a Tour-based Microsimulation Regional Travel Demand Model: Mid-Ohio Region. Proceedings of the 9th Transportation Research Board Conference on the Application of Transportation Planning Methods, Baton Rouge, LA

Arentze, T. and Timmermans, H. (2001). *ALBATROSS: A Learning Based Transportation Oriented Simulation System*. Technische Universiteit Eindhoven, Netherlands.

ATS (1997). *Austin Travel Study*. Capital Area Metropolitan Planning Organization (CAMPO). Austin, TX.

Beckman, R., Baggerly, K. and McKay, M. (1996) Creating Synthetic Baseline Populations. *Transportation Research A*. Vol. 30. No. 6. pg. 415-429.

Bhat, C. and F. Koppelman (1999) Activity-Based Modeling for Travel Demand. *Handbook of Transportation Science*, R.W. Hall (ed.), Kluwer Academic Publisher.

Bhat, C., S. Srinivasan, and J. Guo (2001) Activity-Based Travel-Demand Modeling for Metropolitan Areas in Texas: Model Components and Mathematical Formulations. Report 4080-2. Prepared for the Texas Department of Transportation.

Bierlaire, M. (1997) "Discrete Choice Models" NATO Advanced Studies Institute on "Operations research and decision aid methodologies in traffic and transportation management", March 10-22, 1997, Hotel UNI, Balatonfured, Hungary. (http://scholar.google.com/url?sa=U&q=http://rosowww.epfl.ch/mbi/papers/discreteChoice.ps.gz)

Bowman, J. and M. Ben-Akiva (1997) Activity-Based Travel Forecasting. Working Paper. Travel Model Improvement Program (TMIP).

CAMPO (2000). *1997 Base Year Travel Demand Model Calibration Summary for Updating the 2025 Long Range Plan*. Transportation Planning and Programming Division, TXDOT.

Coddington, P. (1996) University of Syracuse. Lecture Notes. Monte Carlo Simulation for Statistical Physics.

FHWA (2006) TRANSIMS Home Page. URL: http://tmip.fhwa.dot.gov/transims/ (Accessed July 2006)

Gilbert, N. and P. Terna (1999), How to Build and Use Agent-Based Models in Social Science. Discussion Paper, May 18, 1999.

Gupta, S. (2004). Road Pricing Simulations: Traffic, Welfare, Home Value and Land Use Impacts for Austin, Texas. Master's Thesis. Department of Civil Engineering. The University of Texas at Austin.

Janssens, D., G. Wets, T. Brijs, K. Vanhoof (2005) "The development of an adapted Markov chain modeling heuristic and simulation framework in the context of transportation research." *Expert Systems with Applications*. Vol. 28. p. 105-117.

Jovicic, G. (2001) Activity Based Travel Demand Modelling – A Literature Study. Danmarks TransportForskning.

Kalmanje, S. U. and Kockelman, K. M. (2004). Credit-Based Congestion Pricing: Travel, Land Value and Welfare Impacts. Proceedings of the 83rd Annual Meeting of the Transportation Research Board, Washington DC.

Kalmanje, S. U. (2005). Toll Roads in Texas: Traffic and Welfare Impacts. Master's Thesis. Department of Civil Engineering. University of Texas at Austin.

Kitamura, R., C. Chen, R. M. Pendyala, and R. Narayanan (2000) Microsimulation of Daily Activity-Travel Patterns for Travel Demand Forecasting. In Transportation, Vol. 27. p. 25-51.

Kockelman, K. M. (2005) University of Texas at Austin. Lecture Notes. Transport Economics.

Lemp, J. and K. M. Kockelman (2006) Documentation of Traditional Travel Demand Modeling Assumptions for Austin Model Comparison. Working Paper, Department of Civil, Architectural, and Environmental Engineering. University of Texas at Austin.

Martin, W. A. and McGuckin, N. A. (1998). *Travel Estimation Techniques for Urban Planning*. NCHRP Report 365. National Research Council, Washington, D.C.

McFadden, D. (1978) Modeling the Choice of Residential Location. In Spatial Interaction Theory and Planning Models (A. Karlquist, L. Lundquist, F. Snickbars, and J.W. Weibull, eds.). North-Holland, Amsterdan, p. 75-96.

McWethy, Laura, Jason Lemp, and Kara Kockelman (2007) From Aggregate Methods to Microsimulation: Assessing the Benefits of Microscopic Activity-Based Models of Travel Demand. Proceedings of the 86th Annual Meeting of the Transportation Research Board, Washington, D.C.

Miller, E.J., J.D. Hunt, J.E. Abraham, and P.A. Salvini (2004) Microsimulating Urban System. *Computers, Environment and Urban Systems*. Vol. 28. p.. 9-44.

Miller, Eric and Paul Salvini (2001) The Integrated Land Use, Transportation, Environment (ILUTE) Microsimulation Modelling System: Description and Current Status. *Travel Behavior Research.* Ed. David Hensher, p. 711-723. Oxford: Elsevier Science Ltd.

PB Consult (2005) *The MORPC Travel Demand Model Validation and Final Report*. Prepared for the Mid-Ohio Region Planning Commission. (https://ftp.pbworld.com/GetFile.aspx?fn=1941597264.zip Accessed November 2005).

Rocha, L. M. (1999a) BITS: Computer and Communications News. Computing, Information and Communications Division. Los Alamos National Library.

Rocha, L. M. and C. Joslyn (1999b) Decision Structures of Socio-Technical Organizations. Position Paper. Background and Approach: Semiotic Modeling of Socio-Technical Organizations. Accessed at http://wwwc3.lanl.gov/~joslyn/nmsu/position.html on 10/2005.

Smart Mobility (2003). *Envision Central Texas Transportation Model: Technical Documentation*. Prepared for Envision Central Texas. Smart Mobility, Inc, Norwich, VT.

Waddell, P. (2001) Towards a Behavioural Integration of Land Use and Transportation Modelling. In *Travel Behavior Research: The Leading Edge,*, D. Hensher eds, Pergamon Press, 711-723.

Waddell, P.and G. F. Ulfarsson (2004) Introduction to Urban Simulation: Design and Development of Operational Models. In *Handbook in Transport, Volume 5: Transport Geography and Spatial Systems*, Stopher, Button, Kingsley, Hensher eds. Pergamon Press, p. 203-236.

Walker, J. L. (2005) Making Household Microsimulation of Travel and Activities Accessible to Planners. In *Transportation Research Record*, 1931, p. 38-48.

Vovsha, P., M. Bradley, and J.L. Bowman (2004) Activity-based Travel Forecasting Models in the United States: Progress since 1995 and Prospects for the Future. Presented at the EIRASS Conference on Progress in Activity-Based Analysis, May 28-31, 2004, Masstricht, The Netherlands.

Vovsha, P., E. Petersen, and R. Donnelly (2003) Explicit Modeling of Joint Travel by Household Members: Statistical Evidence and Applied Approach. *Transportation Research Record* 1831, Washington, D.C., 1-10.

Vovsha, P., E. Petersen, and R. Donnelly (2004) Impact of Intra-Household Interaction on Individual Daily Activity-Travel Patterns. *Transportation Research Record* 1898, Washington, D.C., 87-97.

Appendix A: Aggregate Model Specification

The aggregate model specification was written by Jason Lemp.

Traditional, Aggregate Model Specification
The traditional TDM employed here relies on techniques used in several existing TDMs for the Austin region, all based on data in the 1996-1997 ATS (CAMPO 2000, Smart Mobility 2003, Gupta 2004, Kalmanje and Kockelman 2004, and Kalmanje 2005), as well as many standard techniques outlined by Martin and McGuckin (1998). All components were estimated to facilitate comparison with the activity-based model, while maintaining a rather traditional (though not highly simplistic) structure. The model uses rather standard and streamlined approaches: regression models for trip generation, fixed rates of trip productions (as a function of household and employment counts [by type]), multinomial logit models for destination and mode choice, fixed time of day and vehicle occupancy trip apportionments, and static traffic assignment routines. For consistency, it also features a vehicle ownership model upstream of trip production.

Auto Availability

While auto availability does not comprise one of the four steps in the basic four-step modeling procedure (as outlined by Martin and McGuckin (1998)), auto availability plays a key role in travel behavior (Smart Mobility 2003). For this reason, an auto ownership model was estimated and placed upstream of more traditional steps offering consistency with many of the better TDMs in practice today.

Since there is distinct ordering in the alternatives (i.e. 0, 1, 2, etc.), an ordered-probit model type was chosen. In addition, the ordered model requires fewer parameter estimates than an unordered model. The model specification includes five explanatory variables representing household characteristics and two other variables representing the density of households for the TAZ in which the household is located. Household types are designated by three variables: presence of children (either yes or no), household income group ($0-29,999, $30,000-74,999, and $75,000 or greater), and household size group (1, 2, 3, 4, or 5 or more). Three choice alternatives were used: 0, 1, and 2 or more autos. The parameter estimates for the auto availability sub-model are shown in Table E1.

Table E1: Ordered Probit Model Estimation for Auto Availability

	Ordered Probit Model	
	Coefficient	p-value
Threshold 1	5.087	0.000
Threshold 2	6.990	0.000
Presence of Children under 18	-0.857	0.000
Dummy for Middle Income Group	0.967	0.000
Dummy for High Income Group	1.588	0.000
Household Size (Over 5 is assigned to 5)	-2.026	0.000
Square Root of Household Size	8.180	0.000
Household Density of Home Zone	0.000120	0.008
Square Root Household Density of Home Zone	-0.01679	0.000
Log Likelihood of Model	-1058.96	
Log Likelihood of Constants only Model	-1513.69	

Trip Generation

Using linear regression models, home-based trip productions were modeled at the household level based on four characteristics: the presence of children under 18 years of age, annual household income categories ($0-29,999, $30,000-74,999, and over $74,999), household size, and auto availability. The first three of these characteristics come directly from the synthesized household types, and auto availability comes from the three choice probabilities of the auto availability model. Work and non-work trips were modeled separately. Model estimation results for home-based work (HBW) and home-based non-work (HBNW) trips are shown in Tables E2 and E3.

Non-home based (NHB) trips were modeled at the zonal level (rather than at the household level) using zonal housing and employment characteristics. Like home-based trips, models for work and non-work trips were estimated separately. The model parameter estimates are relevant only for the sample. For model application, parameter estimates were inflated to represent the total population. Expansion factors were not used for model estimation for two reasons. First, the expansion factors represent the CAMPO 1997 population, not the population estimates used in this study. If the expansion factors were used, inaccurate estimates for non-home based trips may have resulted. Second, the model fit is better without the expansion factors. This could be a result that the zonal housing and employment characteristics came from a different year than did the survey data. It was assumed that zones with no households and no employment will not produce any trips; hence, constants were not used in the two NHB trip-generation regression equations. Scatter plots of NHB trips (work and non-work in nature) versus each of the explanatory variables support this notion. Model estimation results for non-home-based work (NHBW) and non-home-based non-work (NHBNW) trips are shown in Table E4.

Table E2: Home-Based Work (HBW) Trip Production Regression Model Estimation

	Coefficient	t-stat
Constant	0.060	0.336
Number of Autos	0.551	5.549
Presence of Children Less than 18	-0.591	-4.414
Dummy for Middle Income Group	0.346	3.587
Dummy for High Income Group	0.296	2.308
Household Size (Greater than 5 set to 5)	0.325	2.633
Spline for HH Size Greater than 2	0.805	4.185
Spline for HH Size Greater than 3	-1.120	-6.486
R	0.413	
R Square	0.170	
Adjusted R Square	0.167	
Std. Error of the Estimate	1.599	

Table E3: Home-Based Non-Work (HBNW) Trip Production Regression Model Estimation

	Coefficient	t-stat
Constant	-0.629	-0.940
Number of Autos	0.823	1.460
Dummy for 2+ Auto HHs	-1.557	-2.354
Presence of Children Less than 18	0.971	3.263
Dummy for High Income Group	0.318	1.340
Household Size (Greater than 5 set to 5)	1.923	6.848
Spline for HH Size Greater than 2	-0.712	-1.665
Spline for HH Size Greater than 3	1.393	3.642
R	0.596	
R Square	0.355	
Adjusted R Square	0.353	
Std. Error of the Estimate	3.538	

Table E4: Non-Home Based (NHB) Trip Production Regression Model Estimation for Work and Non-Work Trip Types

	NHBW		NHBNW	
	Coefficient	t-stat	Coefficient	t-stat
Households	0.00107	5.109	0.00281	8.342
NSG_BAS_00	0.00068	3.141	N/A	N/A
NSG_RET_00	0.00514	7.833	0.01418	13.516
NSG_SER_00	0.00274	13.052	0.00067	2.069
SG_SER_00	0.00335	3.977	0.00286	2.111
SG_ED2_00	0.00259	5.823	0.00459	6.401
R	0.770		0.733	
R Square	0.594		0.538	
Adjusted R Square	0.590		0.534	
Std. Error of the Estimate	3.832		6.178	
Number of Observations	639		639	

Mode Choice

Multinomial logit models of mode choice were estimated for each of the four trip types using the ATS supplied expansion factors. Because of the unreasonably low value of travel time implied by the models (VOTTs were estimated to be very low [less than $2/hour] and sometimes negative. This is perhaps due to travelers having a poor perception of actual travel costs and times, across modes, for their intended trips, and/or CAMPO's cost and time assumptions not matching travelers' realities.), and the desire for time-sensitive travel patterns (in mode, route, and destination choices) value of travel time was assumed to be $9 per hour per person for work trips and $4.50 per hour per person for non-work trips. A generalized cost term was then formulated based on total travel time and cost using CAMPO's peak and off-peak travel cost and time matrices (by mode type). Indicator variables for whether the individual lives in a household with one or more vehicles per household member were devised. This was done using the categorical values for household size (1, 2, 3, 4, and 5+) and number of autos (0, 1, and 2+). Therefore, there are some households that in actuality have one or more vehicles per person, but have a value of 0 assigned for the indicator variable (e.g., 3 autos and 3 persons), but these were relatively few. The standard utility for a trip *n*, taken by an individual from a household type *h*, produced in zone *i* and attracted to zone *j* using mode *m* during time period *t*, is given be equation (E1).

$$U_{hnijmt} = \beta_{1nm} + \beta_{GC}\left(\frac{Cost_{ijmt}}{VOTT_n} + TT_{ijmt}\right) + \beta_{2nm}(AutSurp_h) \qquad \text{(E1)}$$

where U is the utility, β_1 is the alternative specific constant, β_{GC} is the generalized cost parameter, β_2 is the parameter estimate for the alternative specific variable, *AutSurp* (which takes a value of 1 if there is 1 or more autos per household member or 0 otherwise), $Cost_{ijmt}$ is the total monetary cost from zone *i* to zone *j* using mode *m* during time period *t*, TT_{ijmt} is the total travel time from zone *i* to zone *j* using mode *m* during time period *t*, and *VOTT* is the value of travel time.

Several assumptions were made in the formulation of these models. First, unlicensed individuals were not allowed to make drive alone trips. This was implemented by forcing the drive alone LOS variables to 999. In the ATS dataset, there were some cases where unlicensed individuals made drive alone trips. These cases were not used in model estimation. Second, transit fare for certain individuals was set to zero. These individuals include children 5 years of age and under, elderly 65 years of age and older, students, and those with mobility impairments. Third, as transit skims were not available for them, external trips were not used in model estimation. Fourth, walk and bike trips were assumed to be free of cost, and the walk and bike speed was assumed to be 4 mph. While this speed may be low for bicycle trips, bicycle trips were not well represented in the sample making it difficult to easily distinguish between the two in the model. Furthermore, walk and bike trips were assumed to use the same path as the auto mode. Last, it was assumed that marginally relevant vehicle operating costs (for purposes of mode choice) were $0.10 per mile, which approximate gasoline costs. This was divided by vehicle occupancy. For shared ride when shared ride was not the chosen mode, average shared ride vehicle occupancy was used in the cost calculation.

Model estimation results for the four mode choice models are shown in Table E5.

Table E5: Multinomial Logit Mode Choice Model Estimation Results by Trip Type

	HBW		HBNW		NHBW		NHBNW	
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Shared Ride Specific Constant	-1.728	-25.480	0.083	2.240	-1.215	-15.296	0.352	5.751
Transit Specific Constant	-2.510	-13.687	-1.494	-14.529	-4.106	-12.620	-1.926	-9.761
Walk/Bike Specific Constant	-2.650	-12.755	-1.216	-16.054	-2.126	-13.755	-1.553	-10.565
Generalized Cost	-0.021	-6.197	-0.022	-13.497	-0.015	-4.764	-0.018	-6.513
Indicator for Autos >= HH Size (Shared Ride)	-1.241	-9.003	-1.082	-18.239	-0.283	-2.442	-0.795	-9.181
Indicator for Autos >= HH Size (Transit)	-0.442	-1.738	-1.012	-5.699	N/A	N/A	-1.135	-3.310
Indicator for Autos >= HH Size (Walk/Bike)	N/A	N/A	-0.600	-4.888	N/A	N/A	-0.311	-1.573
Log Likelihood at Convergence	-1522.06		-5523.63		-1282.95		-2162.19	
Log Likelihood (constants only)	-4380.69		-9966.07		-2595.14		-3935.69	
Number of Observations	3160		7189		1872		2839	

Destination Choice

While destination choice precedes mode choice in the standard four-step model, here a nested formulation is used, since a logsum (expected minimum cost) formulation across modes and times of day was used to estimate (and then apply) the multinomial model of destination choice. For time of day purposes, two travel time skims were performed for peak and off-peak periods. The logsum from origin i to destination j for trip purpose p is computed as shown in equation (E2) across all modes m and time periods t.

$$LOGSUM_{ijp} = \ln\left(\sum_{m,t\in C}\exp\left[U_{ijmpt}\right]\right) \tag{E2}$$

where U_{ijmpt} is the utility associated with mode *m* during time period *t* from zone *i* to zone *j* for trip purpose *p*.

For purposes of estimation, not all choice alternatives could be used since the total choice set includes over 1,000 possibilities. Instead, 30 choice alternatives were generated at random, plus the chosen alternative, for a total of 31 choice alternatives used in model estimation (as per McFadden's [1978] finding that such sampling results in consistent estimators). These models were estimated using a multinomial logit framework. The standard utility for a trip with purpose *p*, produced in zone *i* and attracted to zone *j*, is given be equation (E3).

$$U_{ijp} = \beta_{LS}\left(LS_{ijp}\right) + \beta_{Area}\left(\sqrt{Area_j}\right) + \beta_{HHs}\left(\sqrt{HHs_j}\right) + \beta_{TotEmp}\left(\sqrt{TotEmp_j}\right) \tag{E3}$$

where U_{ijp} is the utility from zone *i* to zone *j* for trip purpose *p*, *LS* is the logsum as calculated in equation (E2), $Area_j$ is the total land area of attraction zone *j*, HHs_j is the total households located in attraction zone *j*, and $TotEmp_j$ is the total employment located in attraction zone *j*.

Model estimation results for the 4 destination choice models are shown in Table E6.

Table E6: Destination Choice Model Estimation Results by Trip Purpose

	HBW		HBNW		NHBW		NHBNW	
Variables	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Logsum	-2.1195	-36.820	-3.6368	-85.628	-5.5807	-38.764	-4.7915	-51.499
Square Root Total Destination Area	0.0899	2.959	0.2740	11.933	0.2056	3.871	0.1857	4.181
Square Root Total Destination Households	0.0307	22.063	0.0410	37.750	0.0154	7.833	0.0284	17.096
Square Root Total Desintation Employment	0.0251	28.626	0.0063	8.445	0.0291	24.906	0.0201	19.188
Log Likelihood at Convergence	-8218.44		-14765.78		-3924.06		-5769.22	
Log Likelihood with Constants Only	-10851.40		-24686.93		-6428.42		-9749.09	

Time of Day and Vehicle Occupancy

For time of day analysis, four time periods were used: AM peak (6 am – 8:59 am), PM peak (3 pm – 6:59 pm), midday/evening (9 am – 2:59 pm and 7 pm – 8:59 pm), and overnight (9 pm – 5:59 am). Fixed proportions (specific to each of the four trip types) were obtained from the (population-weighted) ATS to use in application. Home-based trips were split by departure trips and return trips. Similarly, vehicle occupancy rates were derived from the travel survey for application to shared ride trips. These rates were also derived specific to trip type. Table E7 shows time of day trip rates and vehicle occupancy factors.

Table E7: Time of Day Proportions and Vehicle Occupancy Factors by Trip Type

Trip Type	AM	MID	OP	PM	Vehicle Occupancy
HBW Departure	0.6975	0.1749	0.0784	0.0492	2.441
HBW Return	0.0142	0.2589	0.0622	0.6648	2.441
HBNW Departure	0.3388	0.3481	0.0377	0.2755	2.711
HBNW Return	0.0518	0.4628	0.1108	0.3746	2.711
NHBW	0.0868	0.6449	0.0081	0.2601	2.465
NHBNW	0.0862	0.5487	0.0477	0.3174	2.690

Appendix B: Microscopic Model Application Procedure

Instructions for Running Activity-Based Microscopic Model

1. Population Synthesis (~ 8 hours)
    a. IPF procedure in R (~ 7 hours using code in appendix D with for loops, or ~10 minumtes using code in Appendix E)
        i. Inputs
            1. PUMA-level MV seeds
            2. TAZ-level household size marginals
            3. TAZ-level household income marginals
            4. No. of HHs in each TAZ
            5. List of TAZs in each PUMA
        ii. Use code file to run IPF
        iii. Output
            1. List of all households and their income and size characteristics (HH.csv)
    b. SPSS formatting (~ 1 hour)
        i. Load file into SPSS
        ii. Label HHs from 1-N (enter in Excel and paste into SPSS)
        iii. Sort cases by PUMA and then HHMV
        iv. Copy Serial Numbers from PUMSdata.xls into HH.sav based on PUMA and HHMV
        v. Merge with HHPUMS based on matching method
        vi. Create Sen1-Sen24 variables
        vii. Restructure HH file into Persons file
        viii. Create HHPerNo variable (HHNo*100+Ser)
        ix. Create SerPerNo variable (SerialNo*100+Sen)
        x. Merge with PerPUMS based on SerPerNo variable
        xi. Save file as Persons1.sav

2. PAP Model System (all done from code file SPSScode10-25.doc) (~30 min)
    a. Open Persons1.sav
    b. Run Preschool, Pre-driving Child and Driving Child PAP models
    c. Save file
    d. Restructure into HH file and calculate indicator variables for children
    e. Save file as HH1.sav
    f. Restructure back into Persons file and run Student PAP
    g. Save as Persons2.sav
    h. Restructure into HH file and calculate indicator variables for student adults.
    i. Save as HH2.sav
    j. Restructure back into Persons file and run full-time worker PAP model.
    k. Save as Persons3.sav
    l. Restructure into HH file and calculate indicator variables for full-time workers.
    m. Save as HH3.sav
    n. Restructure back into Persons file and run part-time worker PAP model.
    o. Save as Persons4.sav
    p. Restructure into HH file and calculate indicator variables for part-time workers.

q. Save as HH4.sav
r. Restructure back into Persons file and run non-working adult PAP model.
s. Save as Persons5.sav
t. Restructure into HH file and calculate indicator variables for non-workers.
u. Save as HH-PAP.sav

3. Maintenance and Discretionary Activity Model System (all done from code file SPSScode10-25.doc) (~ 30 min)
    a. Run escort model.
    b. Run shopping model
    c. Run other maintenance model
    d. Save as HH-NMaint.sav
    e. Assign all Persons=1 maintenance activities
    f. Run escort act#1 allocation model
    g. Run escort act#2 allocation model
    h. Run escort act#3 allocation model
    i. Run shopping act#1 allocation model
    j. Run shopping act#2 allocation model
    k. Run shopping act#3 allocation model
    l. Run other maint. act#1 allocation model
    m. Run other maint. act#2 allocation model
    n. Run other maint. act#3 allocation model
    o. Calculate number of maintenance activities for each individual
    p. Save as HH-maint.sav
    q. Restructure into Person file
    r. Run number of discretionary activities model
    s. Save as HH-act.sav

4. Activity Scheduler (~ 3 hours)
    a. Calculate PerIndex=Category*1000+PAP*100+NMaint+NDisc
    b. Find frequencies of PerIndex in HH-act.sav
    c. Find frequencies of PerIndex in ATSdiaries.sav
    d. Substitute HH-act PerIndex with values that exist in ATSdiaries
    e. Use previous matching procedure to assign ActIndex variable
    f. Merge with ATSdiaries.sav based on ActIndex variable
    g. Calculate Tour ID=HHPerNo*10+TourNo
    h. Calculate number of work, school, etc activities
    i. Restructure into Activities file

5. Primary Destination Choice Model, Mode Choice Model, Secondary Destination Choice Model and Traffic Assignment
   Run in TransCAD

Appendix C: Variable Definitions for Microscopic Model

Household Variables	
Variable Name	**Description**
HHNo	Synthesized Household ID Number
SerialNo	PUMS Household ID Number
TAZ	Traffic Analysis Zone
PUMA	Census Public Use Micro-data Area (Geographic Unit)
HHMV	Household Multivariate Category
Persons	Number of Persons in Household (uncondensed)
CondPer	Condensed Number of Persons in Household (max = 8)
HH1	Household Size of One Indicator
Autos	Number of Vehicles in Household
AutoSur	Auto Surplus (Autos - Number of HH Adults > 0)
AutoSh	Auto Shortage (Autos - Number of HH Adults < 0)
lowinc	Low Income Category Indicator (Income < 30k)
medinc	Medium Income Category Indicator (29k < Income < 75k)
hiinc	High Income Category Indicator (Income > 74k)
Income	Continuous Household Income
NPresch	Number of Preschool Children in Household (age < 5)
NPredri	Number of Pre-driving Children in Household (4 < age < 16)
NDriving	Number of Driving Children in Household (Age = 16 or 17)
NNonwk	Number of Non-working Adults in Household
NStud	Number of Student Adults in Household
NPart	Number of Part-time Working Adults in Household (< 40 hrs/wk)
NFull	Number of Full-time Working Adults in Household (> 39 hrs/wk)
PPresch	Presence of Preschool Children in Household (age < 5)
PPredri	Presence of Pre-driving Children in Household (4 < age < 16)
PDriving	Presence of Driving Children in Household (age = 16 or 17)
PNonwk	Presence of Non-working Adults in Household
PStud	Presence of Student Adults in Household
PPart	Presence of Part-time Working Adults in Household (< 40 hrs/wk)
PFull	Presence of Full-time Working Adults in Household (> 39 hrs/wk)
Rural	Rural Area Indicator (TAZ level)
Suburb	Suburban Area Indicator (TAZ level)
Urban	Urban Area Indicator (TAZ level)
CBD	Central Business District Indcator (TAZ level)
Tran25	Percentage of TAZ with Transit within 0.25 Miles
Tran50	Percentage of TAZ with Transit within 0.50 Miles

Household Variables, Con't	
Variable Name	**Description**
iPredri6	Household Pre-driving Child with Non-Mandatory DAP Indicator
iDriv6	Household Driving Child with Non-Mandatory DAP Indicator
iNonwk6	Household Non-working Adult with Non-Mandatory DAP Indicator
iStud6	Household Student Adult with Non-Mandatory DAP Indicator
iPart6	Household Part-time Working Adult with Non-Mandatory DAP Indicator
iFull6	Household Full-time Working Adult with Non-Mandatory DAP Indicator
iPresch7	Household Preschool Child with At Home DAP Indicator
iPredri7	Household Pre-driving Child with At Home DAP Indicator
iDriv7	Household Driving Child with At Home DAP Indicator
iNonwk7	Household Non-Working Adult with At Home DAP Indicator
iStud7	Household Student Adult with At Home DAP Indicator
iPart7	Household Part-time Adult with At Home DAP Indicator
iFull7	Household Full-time Working Adult with At Home DAP Indicator

Individual Variables	
Variable Name	**Description**
PUMS PerNo	Person Number in PUMS record
PerNo	Person Number (Starts with most senior HH member)
Male	Male Indicator
Age	Continuous Age
Presch	Preschool Child Indicator (age < 5)
Predri	Pre-driving Child Indicator (4 < age < 16)
Driv	Driving Child Indicator (age = 16 or 17)
Nonwk	Non-working Adult Indicator
Stud	Student Adult Indicator
Part	Part-time Working Adult Indicator (< 40 hrs/wk)
Full	Full-time Working Adult Indicator (> 39 hrs/wk)
Category	1= Presch, 2 = Predri, 3 = Driv, 4 = Nonwk, 5 = Stud, 6 = Part, 7 = Full
Work1	Workday with 1 Work Tour Daily Activity Pattern
Work2	Workday with 2 Work Tours Daily Activity Pattern
Uni	University Day Daily Activity Pattern
WorkUni	Work and University Day Daily Activity Pattern
School	Schoolday Daily Activity Pattern
NonMand	Non-mandatory Daily Actiivty Pattern
AtHome	At Home Daily Activity Pattern

Appendix D: R Code for IPF Procedure Using For Loops

8/28/06 Synthesis Code – Base Case
Microsimulation Population Synthesis for Austin Area

#Summary of Important Model Variables and Indices:

# R Directory Files (input files)	
# SeedXXXX	Multivariate Seeds for each PUMA
# TAZlistXXXX	TAZs in each PUMA
# PerPXXXX	TAZ-level Household Size Marginal Distributions for each PUMA
# IncPXXXX	TAZ-level Income Level Marginal Distributions for each PUMA
# NoHHsXXXX	Number of HHs in each TAZ for each PUMA
#1. Model Inputs	
# K = 3	Number of Income Categories (k)
# L = 8	Number of Person Categories (i)
# D	Number of TAZs in each PUMA – Varies by PUMA (d)
# E = 8	Number of PUMAs in Synthesization area (e)
# F = 24	Number of MV Categories
# N = 20	Number of IPF Iterations
#TAZs [[e]]	Number of TAZs in each PUMA
# PUMAs [[e]]	PUMA labels
# Seed [[e]] [k,i]	Multivariate Seeds for each PUMA
# TAZlist [[e]] [d]	TAZs in each PUMA
# PerP [[n]] [[e]] [[d]] [[k]]	Percentage of HHs in each Persons Category for each TAZ
# IncP [[n]] [[e]] [[d]] [[i]]	Percentage of HHs in each Income Category for each TAZ
# NoHHs [[n]] [[e]] [[d]]	Number of HHs in each TAZ
#2. Multivariate Distribution of Persons and Income (IPF Procedure)	
# colsum [[n]] [[e]] [[d]] [k]	Column Sums for each TAZ IPF iteration
# rowsum [[n]] [[e]] [d]] [i]	Row Sums for each TAZ IPF Iteration
# CSeed [[n]] [[e]] [[d]] [k,i]	Column Balancing on PUMS Seed for each TAZ in Area
# RSeed [[n]] [[e]] [[d]] [k,i]	Row Balancing on PUMS Seed for each TAZ in Area
# Diff [[e]] [[d]] [k,i]	Difference between Row and Column Balancing for each TAZ
# TAZP [[e]] [[d]] [k,i]	Final Seed of Percentages for each TAZ after IPF
# TAZ [[e]] [[d]] [k,i]	Number of HHs in each Income/HH Size Category for each TAZ
#3. Create Output Frame	
# Length1 [[e]] [[d]] [f]	Number of simulated HHs in each TAZ
# HHMVfinal [[e]][[d]]	MV Distribution Category of Simulated Household
# frameHH [[e]] [[d]]	
# TAZno [[e]] [[d]]	TAZ Number of Simulated Household
# PUMAno [[e]] [[d]]	PUMA Number of Simulated Household
#4. Addition of Uncontrolled Variables	
# HH [[e]]	Characteristics of Simulated HHs in each PUMA
# HHs	Characteristics of Simulated HHs in Entire Population

```
##################################################################
#1. Model Inputs – Read all input files from R Directory

K<-3
L<-8
N<-20
E<-8
TAZs<-c(229,75,63,118,92,91,172,234)
PUMAs<-c(5201,5202,5301,5302,5303,5304,5401,5402)

CSeed<-
list(read.csv("Seed5201.csv"),read.csv("Seed5202.csv"),read.csv("Seed5301.csv"),read.csv("Seed5302.csv"),read.csv("Seed5303.csv"),read.csv(
"Seed5304.csv"),read.csv("Seed5401.csv"),read.csv("Seed5402.csv"))
Seed<-CSeed
TAZlist<-
list(read.csv("TAZ5201.csv"),read.csv("TAZ5202.csv"),read.csv("TAZ5301.csv"),read.csv("TAZ5302.csv"),read.csv("TAZ5303.csv"),read.csv(
"TAZ5304.csv"),read.csv("TAZ5401.csv"),read.csv("TAZ5402.csv"))
rows<-c("Per1","Per2","Per3","Per4","Per5","Per6","Per7","Per8")

for(e in 1:E) {
```

```
rownames(CSeed[[e]])<-rows }

PerPFrame<-
list(read.csv("PerP5201.csv"),read.csv("PerP5202.csv"),read.csv("PerP5301.csv"),read.csv("PerP5302.csv"),read.csv("PerP5303.csv"),read.csv(
"PerP5304.csv"),read.csv("PerP5401.csv"),read.csv("PerP5402.csv"))
PerP<-
list(PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,P
erPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame,PerPFrame)

IncPFrame<-
list(read.csv("IncMarg5201.csv"),read.csv("IncMarg5202.csv"),read.csv("IncMarg5301.csv"),read.csv("IncMarg5302.csv"),read.csv("IncMarg5
303.csv"),read.csv("IncMarg5304.csv"),read.csv("IncMarg5401.csv"),read.csv("IncMarg5402.csv"))
IncP<-
list(IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,Inc
PFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame,IncPFrame)

NoHHs<-
list(read.csv("HH5201.csv"),read.csv("HH5202.csv"),read.csv("HH5301.csv"),read.csv("HH5302.csv"),read.csv("HH5303.csv"),read.csv("HH5
304.csv"),read.csv("HH5401.csv"),read.csv("HH5402.csv"))

##################################################################
#2. Multivariate Distribution of Persons and Income from PUMS Data

# Create frameworks for IPF procedure
{
colsum1<-list(rep(0,K))
rowsum1<-list(rep(0,L))

colsum5201<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1c
olsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,c
olsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,c
olsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,c
olsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1)

colsum5202<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1)

colsum5301<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1)

colsum5302<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1)

colsum5303<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
```

```
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1)

colsum5304<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1)

colsum5401<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1)

colsum5402<-list(
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,
colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1,colsum1)

rowsum5201<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1)

rowsum5202<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1)

rowsum5301<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1)
```

```
rowsum5302<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1)

rowsum5303<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1)

rowsum5304<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1)

rowsum5401<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1)

rowsum5402<-list(
rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsu
m1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,ro
wsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1
,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1,rowsum1)

colframe<-list(colsum5201,colsum5202,colsum5301,colsum5302,colsum5303,colsum5304,colsum5401,colsum5402)
rowframe<-list(rowsum5201,rowsum5202,rowsum5301,rowsum5302,rowsum5303,rowsum5304,rowsum5401,rowsum5402)
colsum<-
list(colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe,colframe
,colframe,colframe,colframe,colframe,colframe)
rowsum<-
list(rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe,rowfra
me,rowframe,rowframe,rowframe,rowframe,rowframe,rowframe)

Seed1<-list(
```

```
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed
[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]],
Seed[[1]],Seed[[1]],Seed[[1]],Seed[[1]])

Seed2<-list(
Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed
[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],
Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed
[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],
Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed[[2]],Seed
[[2]],Seed[[2]],Seed[[2]])

Seed3<-list(
Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed
[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],
Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed
[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],
Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]],Seed[[3]])

Seed4<-list(
Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed
[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],
Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed
[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],
Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed
[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],
Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed
[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],Seed[[4]],
Seed[[4]],Seed[[4]])

Seed5<-list(
Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed
[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],
Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed
[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],
Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed
[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],
Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]],Seed[[5]])

Seed6<-list(
Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed
[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],
Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed
[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],
Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed
[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]],
Seed[[6]],Seed[[6]],Seed[[6]],Seed[[6]])

Seed7<-list(
Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed
[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],
Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed
[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],
Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed
[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],
Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed
[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],
Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed
[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],
```

```
Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed
[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]],Seed[[7]])

Seed8<-list(
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]]Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed
[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],Seed[[8]],
Seed[[8]],Seed[[8]])

CSeedFrame<-list(Seed1,Seed2,Seed3,Seed4,Seed5,Seed6,Seed7,Seed8)

CSeed<-
list(CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeed
Frame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame,CSeedFrame)

RSeed<-CSeed
Diff<-CSeed[[1]]
TAZ<-CSeed[[1]]
TAZP<-CSeed[[1]]

# IPF Procedure – 20 iterations repeated twice
# Row and column balancing to match TAZ marginal distributions to PUMA multivariate distributions.

for(n in 2:N) {
for(e in 1:E) {
        for(d in 1:TAZs[e]) {
        for(k in 1:K) {
        for(i in 1:L) {
                colsum[[n]][[e]][[d]][k]<-sum(RSeed[[n-1]][[e]][[d]][,k])
                CSeed[[n]][[e]][[d]][i,k]<-RSeed[[n-1]][[e]][[d]][i,k]*IncP[[n-1]][[e]][d,][k]/
                colsum[[n]][[e]][[d]][k]
                rowsum[[n]][[e]][[d]][i]<-sum(CSeed[[n]][[e]][[d]][i,])
                RSeed[[n]][[e]][[d]][i,k]<-CSeed[[n]][[e]][[d]][i,k]*PerP[[n]][[e]][d,][i]/
                rowsum[[n]][[e]][[d]][i]}}
                Diff[[e]][[d]]<-RSeed[[n]][[e]][[d]]-CSeed[[n]][[e]][[d]]
                }}}
colsum2<-colsum
rowsum2<-rowsum
RSeed2<-RSeed
CSeed2<-CSeed
Diff2<-Diff

for(n in 2:N) {
for(e in 1:E) {
        for(d in 1:TAZs[e]) {
        for(k in 1:K) {
        for(i in 1:L) {
                RSeed2[[1]][[e]][[d]]<-RSeed[[20]][[e]][[d]]
                colsum2[[n]][[e]][[d]][k]<-sum(RSeed2[[n-1]][[e]][[d]][,k])
                CSeed2[[n]][[e]][[d]][i,k]<-RSeed2[[n-1]][[e]][[d]][i,k]*IncP[[n-1]][[e]][d,][k]/
                colsum2[[n]][[e]][[d]][k]
                rowsum2[[n]][[e]][[d]][i]<-sum(CSeed2[[n]][[e]][[d]][i,])
                RSeed2[[n]][[e]][[d]][i,k]<-CSeed2[[n]][[e]][[d]][i,k]*PerP[[n]][[e]][d,][i]/
                rowsum2[[n]][[e]][[d]][i]}}
                Diff2[[e]][[d]]<-RSeed2[[n]][[e]][[d]]-CSeed2[[n]][[e]][[d]]
                }}}

# Correct for row or column sums = 0. This is not automatic and must be coded specifically for each problematic TAZ.

for(n in 2:3) {
```

```
		for(d in 29:30) {
		for(k in 1:K) {
		for(i in 1:L) {
				colsum[[n]][[4]][[d]][k]<-sum(RSeed[[n-1]][[4]][[d]][,k])
				CSeed[[n]][[4]][[d]][i,k]<-RSeed[[n-1]][[4]][[d]][i,k]*IncP[[n-1]][[4]][d,][k]/
				colsum[[n]][[4]][[d]][k]
				rowsum[[n]][[4]][[d]][i]<-sum(CSeed[[n]][[4]][[d]][i,])
				RSeed[[n]][[4]][[d]][i,k]<-CSeed[[n]][[4]][[d]][i,k]*PerP[[n]][[4]][d,][i]/
				rowsum[[n]][[4]][[d]][i]}}
				Diff[[4]][[d]]<-RSeed[[n]][[4]][[d]]-CSeed[[n]][[4]][[d]]
				}}
for(e in 1:E) {
for(d in 1:TAZs[e]) {
for(f in 1:24) {
		TAZP[[e]][[d]]<-RSeed2[[20]][[e]][[d]]
		TAZP[[4]][[29]]<-RSeed[[2]][[4]][[29]]
		TAZP[[4]][[30]]<-RSeed[[2]][[4]][[30]]
		TAZHHnew[[e]][d]<-NoHHs[[e]][d,]
		TAZ[[e]][[d]]<-round(TAZP[[e]][[d]]*TAZHHnew[[e]][d])}}}
```

#3. Create Output Frame

```
length5201<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,
24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(
0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),re
p(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,
24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24))

length5202<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24))

length5301<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24))

length5302<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,
24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(
0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24))

length5303<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
```

```
),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,
24),rep(0,24),rep(0,24),rep(0,24))

length5304<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,
24),rep(0,24),rep(0,24))

length5401<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,
24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(
0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),re
p(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24))

length5402<-list(
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,
24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(
0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),re
p(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0
,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep
(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),r
ep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24
),rep(0,24),rep(0,24),rep(0,24),
rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,2
4),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24),rep(0,24))

Length1<-list(length5201,length5202,length5301,length5302,length5303,length5304,length5401,length5402)
HHMV<- list(length5201,length5202,length5301,length5302,length5303,length5304,length5401,length5402)


for(e in 1:E) {
for(d in 1:TAZs[e]) {
Length1[[e]][[d]]<-rbind(TAZ[[e]][[d]][1,1],TAZ[[e]][[d]][1,2],TAZ[[e]][[d]][1,3],
TAZ[[e]][[d]][2,1],TAZ[[e]][[d]][2,2],TAZ[[e]][[d]][2,3],TAZ[[e]][[d]][3,1],TAZ[[e]][[d]][3,2],TAZ[[e]][[d]][3,3],
TAZ[[e]][[d]][4,1],TAZ[[e]][[d]][4,2],TAZ[[e]][[d]][4,3],TAZ[[e]][[d]][5,1],TAZ[[e]][[d]][5,2],TAZ[[e]][[d]][5,3],
TAZ[[e]][[d]][6,1],TAZ[[e]][[d]][6,2],TAZ[[e]][[d]][6,3],TAZ[[e]][[d]][7,1],TAZ[[e]][[d]][7,2],TAZ[[e]][[d]][7,3],
TAZ[[e]][[d]][8,1],TAZ[[e]][[d]][8,2],TAZ[[e]][[d]][8,3])}}

HHMVfinal<-HHMV
frameHH<-list(rep(0,229),rep(0,75),rep(0,63),rep(0,118),rep(0,92),rep(0,91),rep(0,172),rep(0,234))
HH<-frameHH
TAZno<-frameHH
PUMAno<-frameHH

for(e in 1:E) {
for(d in 1:TAZs[e]) {
for(f in 1:24) {
		HHMV [[e]] [[d]] [[f]]<-data.frame(rep(f,Length1[[e]] [[d]][f,] ))
		colnames(HHMV[[e]][[d]][[f]])<-“HHMV”
HHMVfinal[[e]][[d]]<-
rbind(HHMV[[e]][[d]][[1]],HHMV[[e]][[d]][[2]],HHMV[[e]][[d]][[3]],HHMV[[e]][[d]][[4]],HHMV[[e]][[d]][[5]],HHMV[[e]][[d]][[6]],
HHMV[[e]][[d]][[7]],HHMV[[e]][[d]][[8]],HHMV[[e]][[d]][[9]],HHMV[[e]][[d]][[10]],HHMV[[e]][[d]][[11]],HHMV[[e]][[d]][[12]],HHMV[[e]
][[d]][[13]],HHMV[[e]][[d]][[14]],HHMV[[e]][[d]][[15]],HHMV[[e]][[d]][[16]],HHMV[[e]][[d]][[17]],HHMV[[e]][[d]][[18]],HHMV[[e]][[d]][[
19]],HHMV[[e]][[d]][[20]],HHMV[[e]][[d]][[21]],HHMV[[e]][[d]][[22]],HHMV[[e]][[d]][[23]],HHMV[[e]][[d]][[24]])
```

```
frameHH[[e]] [[d]] <-data.frame(rep(0,sum(Length1[[e]][[d]])))
TAZno[[e]] [[d]] <-data.frame(rep(TAZlist[[e]] [d,],sum(Length1[[e]][[d]])))
PUMAno[[e]] [[d]]<-data.frame(rep(PUMAs[[e]],sum(Length1[[e]][[d]])))
colnames(frameHH[[e]][[d]]<-"frame"
colnames(TAZno[[e]][[d]])<-"TAZ"
colnames(PUMAno[[e]][[d]])<-"PUMA" }}}

for(e in 1:E) {
for(d in 1:TAZs[e]) {
HH[[e]][[d]]<-cbind(frameHH [[e]][[d]], TAZno[[e]][[d]],PUMAno[[e]][[d]], HHMVfinal[[e]][[d]]) }}

HHlist<-c("HHNo","SerialNo","TAZ","PUMA","HHMV")

for(e in 1:E) {
for(d in 1:TAZs[e]) {
colnames(HH[[e]][[d]])<-HHlist }}

HH1<-rbind(
HH[[1]][[1]],HH[[1]][[2]],HH[[1]][[3]],HH[[1]][[4]],HH[[1]][[5]],HH[[1]][[6]],HH[[1]][[7]],HH[[1]][[8]],HH[[1]][[9]],HH[[1]][[10]],
HH[[1]][[11]],HH[[1]][[12]],HH[[1]][[13]],HH[[1]][[14]],HH[[1]][[15]],HH[[1]][[16]],HH[[1]][[17]],HH[[1]][[18]],HH[[1]][[19]],HH[[1]][[20]]
,HH[[1]][[21]],HH[[1]][[22]],HH[[1]][[23]],HH[[1]][[24]],HH[[1]][[25]],HH[[1]][[26]],HH[[1]][[27]],HH[[1]][[28]],HH[[1]][[29]],HH[[1]][[30]
],HH[[1]][[31]],HH[[1]][[32]],HH[[1]][[33]],HH[[1]][[34]],HH[[1]][[35]],HH[[1]][[36]],HH[[1]][[37]],HH[[1]][[38]],HH[[1]][[39]],HH[[1]][[40
]],HH[[1]][[41]],HH[[1]][[42]],HH[[1]][[43]],HH[[1]][[44]],HH[[1]][[45]],HH[[1]][[46]],HH[[1]][[47]],HH[[1]][[48]],HH[[1]][[49]],HH[[1]][[5
0]],HH[[1]][[51]],HH[[1]][[52]],HH[[1]][[53]],HH[[1]][[54]],HH[[1]][[55]],HH[[1]][[56]],HH[[1]][[57]],HH[[1]][[58]],HH[[1]][[59]],HH[[1]][[
60]],HH[[1]][[61]],HH[[1]][[62]],HH[[1]][[63]],HH[[1]][[64]],HH[[1]][[65]],HH[[1]][[66]],HH[[1]][[67]],HH[[1]][[68]],HH[[1]][[69]],HH[[1]][
[70]],HH[[1]][[71]],HH[[1]][[72]],HH[[1]][[73]],HH[[1]][[74]],HH[[1]][[75]],HH[[1]][[76]],HH[[1]][[77]],HH[[1]][[78]],HH[[1]][[79]],HH[[1]]
[[80]],HH[[1]][[81]],HH[[1]][[82]],HH[[1]][[83]],HH[[1]][[84]],HH[[1]][[85]],HH[[1]][[86]],HH[[1]][[87]],HH[[1]][[88]],HH[[1]][[89]],HH[[1]
][[90]],HH[[1]][[91]],HH[[1]][[92]],HH[[1]][[93]],HH[[1]][[94]],HH[[1]][[95]],HH[[1]][[96]],HH[[1]][[97]],HH[[1]][[98]],HH[[1]][[99]],HH[[1
]][[100]],HH[[1]][[101]],HH[[1]][[102]],HH[[1]][[103]],HH[[1]][[104]],HH[[1]][[105]],HH[[1]][[106]],HH[[1]][[107]],HH[[1]][[108]],HH[[1]][
[109]],HH[[1]][[110]],HH[[1]][[111]],HH[[1]][[112]],HH[[1]][[113]],HH[[1]][[114]],HH[[1]][[115]],HH[[1]][[116]],HH[[1]][[117]],HH[[1]][[1
18]],HH[[1]][[119]],HH[[1]][[120]],HH[[1]][[121]],HH[[1]][[122]],HH[[1]][[123]],HH[[1]][[124]],HH[[1]][[125]],HH[[1]][[126]],HH[[1]][[127
]],HH[[1]][[128]],HH[[1]][[129]],HH[[1]][[130]],HH[[1]][[131]],HH[[1]][[132]],HH[[1]][[133]],HH[[1]][[134]],HH[[1]][[135]],HH[[1]][[136]],
HH[[1]][[137]],HH[[1]][[138]],HH[[1]][[139]],HH[[1]][[140]],
HH[[1]][[141]],HH[[1]][[142]],HH[[1]][[143]],HH[[1]][[144]],HH[[1]][[145]],HH[[1]][[146]],HH[[1]][[147]],HH[[1]][[148]],HH[[1]][[149]],H
H[[1]][[150]],HH[[1]][[151]],HH[[1]][[152]],HH[[1]][[153]],HH[[1]][[154]],HH[[1]][[155]],HH[[1]][[156]],HH[[1]][[157]],HH[[1]][[158]],HH[
[1]][[159]],HH[[1]][[160]],HH[[1]][[161]],HH[[1]][[162]],HH[[1]][[163]],HH[[1]][[164]],HH[[1]][[165]],HH[[1]][[166]],HH[[1]][[167]],HH[[1]
][[168]],HH[[1]][[169]],HH[[1]][[170]],HH[[1]][[171]],HH[[1]][[172]],HH[[1]][[173]],HH[[1]][[174]],HH[[1]][[175]],HH[[1]][[176]],HH[[1]][[
177]],HH[[1]][[178]],HH[[1]][[179]],HH[[1]][[180]],HH[[1]][[181]],HH[[1]][[182]],HH[[1]][[183]],HH[[1]][[184]],HH[[1]][[185]],HH[[1]][[18
6]],HH[[1]][[187]],HH[[1]][[188]],HH[[1]][[189]],HH[[1]][[190]],HH[[1]][[191]],HH[[1]][[192]],HH[[1]][[193]],HH[[1]][[194]],HH[[1]][[195]]
,HH[[1]][[196]],HH[[1]][[197]],HH[[1]][[198]],HH[[1]][[199]],HH[[1]][[200]],HH[[1]][[201]],HH[[1]][[202]],HH[[1]][[203]],HH[[1]][[204]],H
H[[1]][[205]],HH[[1]][[206]],HH[[1]][[207]],HH[[1]][[208]],HH[[1]][[209]],HH[[1]][[210]],HH[[1]][[211]],HH[[1]][[212]],HH[[1]][[213]],HH[
[1]][[214]],HH[[1]][[215]],HH[[1]][[216]],HH[[1]][[217]],HH[[1]][[218]],HH[[1]][[219]],HH[[1]][[220]],HH[[1]][[221]],HH[[1]][[222]],HH[[1]
][[223]],HH[[1]][[224]],HH[[1]][[225]],HH[[1]][[226]],HH[[1]][[227]],HH[[1]][[228]],HH[[1]][[229]])

HH2<-rbind(
HH[[2]][[1]],HH[[2]][[2]],HH[[2]][[3]],HH[[2]][[4]],HH[[2]][[5]],HH[[2]][[6]],HH[[2]][[7]],HH[[2]][[8]],HH[[2]][[9]],HH[[2]][[10]],
HH[[2]][[11]],HH[[2]][[12]],HH[[2]][[13]],HH[[2]][[14]],HH[[2]][[15]],HH[[2]][[16]],HH[[2]][[17]],HH[[2]][[18]],HH[[2]][[19]],HH[[2]][[20]]
,HH[[2]][[21]],HH[[2]][[22]],HH[[2]][[23]],HH[[2]][[24]],HH[[2]][[25]],HH[[2]][[26]],HH[[2]][[27]],HH[[2]][[28]],HH[[2]][[29]],HH[[2]][[30]
],HH[[2]][[31]],HH[[2]][[32]],HH[[2]][[33]],HH[[2]][[34]],HH[[2]][[35]],HH[[2]][[36]],HH[[2]][[37]],HH[[2]][[38]],HH[[2]][[39]],HH[[2]][[40
]],HH[[2]][[41]],HH[[2]][[42]],HH[[2]][[43]],HH[[2]][[44]],HH[[2]][[45]],HH[[2]][[46]],HH[[2]][[47]],HH[[2]][[48]],HH[[2]][[49]],HH[[2]][[5
0]],HH[[2]][[51]],HH[[2]][[52]],HH[[2]][[53]],HH[[2]][[54]],HH[[2]][[55]],HH[[2]][[56]],HH[[2]][[57]],HH[[2]][[58]],HH[[2]][[59]],HH[[2]][[
60]],HH[[2]][[61]],HH[[2]][[62]],HH[[2]][[63]],HH[[2]][[64]],HH[[2]][[65]],HH[[2]][[66]],HH[[2]][[67]],HH[[2]][[68]],HH[[2]][[69]],HH[[2]][
[70]],HH[[2]][[71]],HH[[2]][[72]],HH[[2]][[73]],HH[[2]][[74]],HH[[2]][[75]])

HH3<-rbind(
HH[[3]][[1]],HH[[3]][[2]],HH[[3]][[3]],HH[[3]][[4]],HH[[3]][[5]],HH[[3]][[6]],HH[[3]][[7]],HH[[3]][[8]],HH[[1]][[9]],HH[[3]][[10]],
HH[[3]][[11]],HH[[3]][[12]],HH[[3]][[13]],HH[[3]][[14]],HH[[3]][[15]],HH[[3]][[16]],HH[[3]][[17]],HH[[3]][[18]],HH[[3]][[19]],HH[[3]][[20]]
,HH[[3]][[21]],HH[[3]][[22]],HH[[3]][[23]],HH[[3]][[24]],HH[[3]][[25]],HH[[3]][[26]],HH[[3]][[27]],HH[[3]][[28]],HH[[3]][[29]],HH[[3]][[30]
],HH[[3]][[31]],HH[[3]][[32]],HH[[3]][[33]],HH[[3]][[34]],HH[[3]][[35]],HH[[3]][[36]],HH[[3]][[37]],HH[[3]][[38]],HH[[3]][[39]],HH[[3]][[40
]],HH[[3]][[41]],HH[[3]][[42]],HH[[3]][[43]],HH[[3]][[44]],HH[[3]][[45]],HH[[3]][[46]],HH[[3]][[47]],HH[[3]][[48]],HH[[3]][[49]],HH[[3]][[5
0]],HH[[3]][[51]],HH[[3]][[52]],HH[[3]][[53]],HH[[3]][[54]],HH[[3]][[55]],HH[[3]][[56]],HH[[3]][[57]],HH[[3]][[58]],HH[[3]][[59]],HH[[3]][[
60]],HH[[3]][[61]],HH[[3]][[62]],HH[[3]][[63]])

HH4<-rbind(
HH[[4]][[1]],HH[[4]][[2]],HH[[4]][[3]],HH[[4]][[4]],HH[[4]][[5]],HH[[4]][[6]],HH[[4]][[7]],HH[[4]][[8]],HH[[4]][[9]],HH[[4]][[10]],
HH[[4]][[11]],HH[[4]][[12]],HH[[4]][[13]],HH[[4]][[14]],HH[[4]][[15]],HH[[4]][[16]],HH[[4]][[17]],HH[[4]][[18]],HH[[4]][[19]],HH[[4]][[20]]
,HH[[4]][[21]],HH[[4]][[22]],HH[[4]][[23]],HH[[4]][[24]],HH[[4]][[25]],HH[[4]][[26]],HH[[4]][[27]],HH[[4]][[28]],HH[[4]][[29]],HH[[4]][[30]
],HH[[4]][[31]],HH[[4]][[32]],HH[[4]][[33]],HH[[4]][[34]],HH[[4]][[35]],HH[[4]][[36]],HH[[4]][[37]],HH[[4]][[38]],HH[[4]][[39]],HH[[4]][[40
]],HH[[4]][[41]],HH[[4]][[42]],HH[[4]][[43]],HH[[4]][[44]],HH[[4]][[45]],HH[[4]][[46]],HH[[4]][[47]],HH[[4]][[48]],HH[[4]][[49]],HH[[4]][[5
0]],HH[[4]][[51]],HH[[4]][[52]],HH[[4]][[53]],HH[[4]][[54]],HH[[4]][[55]],HH[[4]][[56]],HH[[4]][[57]],HH[[4]][[58]],HH[[4]][[59]],HH[[4]][[
60]],HH[[4]][[61]],HH[[4]][[62]],HH[[4]][[63]],HH[[4]][[64]],HH[[4]][[65]],HH[[4]][[66]],HH[[4]][[67]],HH[[4]][[68]],HH[[4]][[69]],HH[[4]][
[70]],HH[[4]][[71]],HH[[4]][[72]],HH[[4]][[73]],HH[[4]][[74]],HH[[4]][[75]],HH[[4]][[76]],HH[[4]][[77]],HH[[4]][[78]],HH[[4]][[79]],HH[[4]]
```

```
[[80]],HH[[4]][[81]],HH[[4]][[82]],HH[[4]][[83]],HH[[4]][[84]],HH[[4]][[85]],HH[[4]][[86]],HH[[4]][[87]],HH[[4]][[88]],HH[[4]][[89]],HH[[4]
][[90]],HH[[4]][[91]],HH[[4]][[92]],HH[[4]][[93]],HH[[4]][[94]],HH[[4]][[95]],HH[[4]][[96]],HH[[4]][[97]],HH[[4]][[98]],HH[[4]][[99]],HH[[4
]][[100]],HH[[4]][[101]],HH[[4]][[102]],HH[[4]][[103]],HH[[4]][[104]],HH[[4]][[105]],HH[[4]][[106]],HH[[4]][[107]],HH[[4]][[108]],HH[[4]][
[109]],HH[[4]][[110]],HH[[4]][[111]],HH[[4]][[112]],HH[[4]][[113]],HH[[4]][[114]],HH[[4]][[115]],HH[[4]][[116]],HH[[4]][[117]],HH[[4]][[1
18]])

HH5<-rbind(
HH[[5]][[1]],HH[[5]][[2]],HH[[5]][[3]],HH[[5]][[4]],HH[[5]][[5]],HH[[5]][[6]],HH[[5]][[7]],HH[[5]][[8]],HH[[5]][[9]],HH[[5]][[10]],
HH[[5]][[11]],HH[[5]][[12]],HH[[5]][[13]],HH[[5]][[14]],HH[[5]][[15]],HH[[5]][[16]],HH[[5]][[17]],HH[[5]][[18]],HH[[5]][[19]],HH[[5]][[20]]
,HH[[5]][[21]],HH[[5]][[22]],HH[[5]][[23]],HH[[5]][[24]],HH[[5]][[25]],HH[[5]][[26]],HH[[5]][[27]],HH[[5]][[28]],HH[[5]][[29]],HH[[5]][[30]
],HH[[5]][[31]],HH[[5]][[32]],HH[[5]][[33]],HH[[5]][[34]],HH[[5]][[35]],HH[[5]][[36]],HH[[5]][[37]],HH[[5]][[38]],HH[[5]][[39]],HH[[5]][[40
]],HH[[5]][[41]],HH[[5]][[42]],HH[[5]][[43]],HH[[5]][[44]],HH[[5]][[45]],HH[[5]][[46]],HH[[5]][[47]],HH[[5]][[48]],HH[[5]][[49]],HH[[5]][[5
0]],HH[[5]][[51]],HH[[5]][[52]],HH[[5]][[53]],HH[[5]][[54]],HH[[5]][[55]],HH[[5]][[56]],HH[[5]][[57]],HH[[5]][[58]],HH[[5]][[59]],HH[[5]][[
60]],HH[[5]][[61]],HH[[5]][[62]],HH[[5]][[63]],HH[[5]][[64]],HH[[5]][[65]],HH[[5]][[66]],HH[[5]][[67]],HH[[5]][[68]],HH[[5]][[69]],HH[[5]][
[70]],HH[[5]][[71]],HH[[5]][[72]],HH[[5]][[73]],HH[[5]][[74]],HH[[5]][[75]],HH[[5]][[76]],HH[[5]][[77]],HH[[5]][[78]],HH[[5]][[79]],HH[[5]]
[[80]],HH[[5]][[81]],HH[[5]][[82]],HH[[5]][[83]],HH[[5]][[84]],HH[[5]][[85]],HH[[5]][[86]],HH[[5]][[87]],HH[[5]][[88]],HH[[5]][[89]],HH[[5]
][[90]],HH[[5]][[91]],HH[[5]][[92]])

HH6<-rbind(
HH[[6]][[1]],HH[[6]][[2]],HH[[6]][[3]],HH[[6]][[4]],HH[[6]][[5]],HH[[6]][[6]],HH[[6]][[7]],HH[[6]][[8]],HH[[6]][[9]],HH[[6]][[10]],
HH[[6]][[11]],HH[[6]][[12]],HH[[6]][[13]],HH[[6]][[14]],HH[[6]][[15]],HH[[6]][[16]],HH[[6]][[17]],HH[[6]][[18]],HH[[6]][[19]],HH[[6]][[20]]
,HH[[6]][[21]],HH[[6]][[22]],HH[[6]][[23]],HH[[6]][[24]],HH[[6]][[25]],HH[[6]][[26]],HH[[6]][[27]],HH[[6]][[28]],HH[[6]][[29]],HH[[6]][[30]
],HH[[6]][[31]],HH[[6]][[32]],HH[[6]][[33]],HH[[6]][[34]],HH[[6]][[35]],HH[[6]][[36]],HH[[6]][[37]],HH[[6]][[38]],HH[[6]][[39]],HH[[6]][[40
]],HH[[6]][[41]],HH[[6]][[42]],HH[[6]][[43]],HH[[6]][[44]],HH[[6]][[45]],HH[[6]][[46]],HH[[6]][[47]],HH[[6]][[48]],HH[[6]][[49]],HH[[6]][[5
0]],HH[[6]][[51]],HH[[6]][[52]],HH[[6]][[53]],HH[[6]][[54]],HH[[6]][[55]],HH[[6]][[56]],HH[[6]][[57]],HH[[6]][[58]],HH[[6]][[59]],HH[[6]][[
60]],HH[[6]][[61]],HH[[6]][[62]],HH[[6]][[63]],HH[[6]][[64]],HH[[6]][[65]],HH[[6]][[66]],HH[[6]][[67]],HH[[6]][[68]],HH[[6]][[69]],HH[[6]][
[70]],HH[[6]][[71]],HH[[6]][[72]],HH[[6]][[73]],HH[[6]][[74]],HH[[6]][[75]],HH[[6]][[76]],HH[[6]][[77]],HH[[6]][[78]],HH[[6]][[79]],HH[[6]]
[[80]],HH[[6]][[81]],HH[[6]][[82]],HH[[6]][[83]],HH[[6]][[84]],HH[[6]][[85]],HH[[6]][[86]],HH[[6]][[87]],HH[[6]][[88]],HH[[6]][[89]],HH[[6]
][[90]],HH[[6]][[91]])

HH7<-rbind(
HH[[7]][[1]],HH[[7]][[2]],HH[[7]][[3]],HH[[7]][[4]],HH[[7]][[5]],HH[[7]][[6]],HH[[7]][[7]],HH[[7]][[8]],HH[[7]][[9]],HH[[7]][[10]],
HH[[7]][[11]],HH[[7]][[12]],HH[[7]][[13]],HH[[7]][[14]],HH[[7]][[15]],HH[[7]][[16]],HH[[7]][[17]],HH[[7]][[18]],HH[[7]][[19]],HH[[7]][[20]]
,HH[[7]][[21]],HH[[7]][[22]],HH[[7]][[23]],HH[[7]][[24]],HH[[7]][[25]],HH[[7]][[26]],HH[[7]][[27]],HH[[7]][[28]],HH[[7]][[29]],HH[[7]][[30]
],HH[[7]][[31]],HH[[7]][[32]],HH[[7]][[33]],HH[[7]][[34]],HH[[7]][[35]],HH[[7]][[36]],HH[[7]][[37]],HH[[7]][[38]],HH[[7]][[39]],HH[[7]][[40
]],HH[[7]][[41]],HH[[7]][[42]],HH[[7]][[43]],HH[[7]][[44]],HH[[7]][[45]],HH[[7]][[46]],HH[[7]][[47]],HH[[7]][[48]],HH[[7]][[49]],HH[[7]][[5
0]],HH[[7]][[51]],HH[[7]][[52]],HH[[7]][[53]],HH[[7]][[54]],HH[[7]][[55]],HH[[7]][[56]],HH[[7]][[57]],HH[[7]][[58]],HH[[7]][[59]],HH[[7]][[
60]],HH[[7]][[61]],HH[[7]][[62]],HH[[7]][[63]],HH[[7]][[64]],HH[[7]][[65]],HH[[7]][[66]],HH[[7]][[67]],HH[[7]][[68]],HH[[7]][[69]],HH[[7]][
[70]],HH[[7]][[71]],HH[[7]][[72]],HH[[7]][[73]],HH[[7]][[74]],HH[[7]][[75]],HH[[7]][[76]],HH[[7]][[77]],HH[[7]][[78]],HH[[7]][[79]],HH[[7]]
[[80]],HH[[7]][[81]],HH[[7]][[82]],HH[[7]][[83]],HH[[7]][[84]],HH[[7]][[85]],HH[[7]][[86]],HH[[7]][[87]],HH[[7]][[88]],HH[[7]][[89]],HH[[7]
][[90]],HH[[7]][[91]],HH[[7]][[92]],HH[[7]][[93]],HH[[7]][[94]],HH[[7]][[95]],HH[[7]][[96]],HH[[7]][[97]],HH[[7]][[98]],HH[[7]][[99]],HH[[7
]][[100]],HH[[7]][[101]],HH[[7]][[102]],HH[[7]][[103]],HH[[7]][[104]],HH[[7]][[105]],HH[[7]][[106]],HH[[7]][[107]],HH[[7]][[108]],HH[[7]][
[109]],HH[[7]][[110]],HH[[7]][[111]],HH[[7]][[112]],HH[[7]][[113]],HH[[7]][[114]],HH[[7]][[115]],HH[[7]][[116]],HH[[7]][[117]],HH[[7]][[1
18]],HH[[7]][[119]],HH[[7]][[120]],HH[[7]][[121]],HH[[7]][[122]],HH[[7]][[123]],HH[[7]][[124]],HH[[7]][[125]],HH[[7]][[126]],HH[[7]][[127
]],HH[[7]][[128]],HH[[7]][[129]],HH[[7]][[130]],HH[[7]][[131]],HH[[7]][[132]],HH[[7]][[133]],HH[[7]][[134]],HH[[7]][[135]],HH[[7]][[136]],
HH[[7]][[137]],HH[[7]][[138]],HH[[7]][[139]],HH[[7]][[140]],
HH[[7]][[141]],HH[[7]][[142]],HH[[7]][[143]],HH[[7]][[144]],HH[[7]][[145]],HH[[7]][[146]],HH[[7]][[147]],HH[[7]][[148]],HH[[7]][[149]],H
H[[7]][[150]],HH[[7]][[151]],HH[[7]][[152]],HH[[7]][[153]],HH[[7]][[154]],HH[[7]][[155]],HH[[7]][[156]],HH[[7]][[157]],HH[[7]][[158]],HH[
[7]][[159]],HH[[7]][[160]],HH[[7]][[161]],HH[[7]][[162]],HH[[7]][[163]],HH[[7]][[164]],HH[[7]][[165]],HH[[7]][[166]],HH[[7]][[167]],HH[[7]
][[168]],HH[[7]][[169]],HH[[7]][[170]],HH[[7]][[171]],HH[[7]][[172]])

HH8<-rbind(
HH[[8]][[1]],HH[[8]][[2]],HH[[8]][[3]],HH[[8]][[4]],HH[[8]][[5]],HH[[8]][[6]],HH[[8]][[7]],HH[[8]][[8]],HH[[8]][[9]],HH[[8]][[10]],
HH[[8]][[11]],HH[[8]][[12]],HH[[8]][[13]],HH[[8]][[14]],HH[[8]][[15]],HH[[8]][[16]],HH[[8]][[17]],HH[[8]][[18]],HH[[8]][[19]],HH[[8]][[20]]
,HH[[8]][[21]],HH[[8]][[22]],HH[[8]][[23]],HH[[8]][[24]],HH[[8]][[25]],HH[[8]][[26]],HH[[8]][[27]],HH[[8]][[28]],HH[[8]][[29]],HH[[8]][[30]
],HH[[8]][[31]],HH[[8]][[32]],HH[[8]][[33]],HH[[8]][[34]],HH[[8]][[35]],HH[[8]][[36]],HH[[8]][[37]],HH[[8]][[38]],HH[[8]][[39]],HH[[8]][[40
]],HH[[8]][[41]],HH[[8]][[42]],HH[[8]][[43]],HH[[8]][[44]],HH[[8]][[45]],HH[[8]][[46]],HH[[8]][[47]],HH[[8]][[48]],HH[[8]][[49]],HH[[8]][[5
0]],HH[[8]][[51]],HH[[8]][[52]],HH[[8]][[53]],HH[[8]][[54]],HH[[8]][[55]],HH[[8]][[56]],HH[[8]][[57]],HH[[8]][[58]],HH[[8]][[59]],HH[[8]][[
60]],HH[[8]][[61]],HH[[8]][[62]],HH[[8]][[63]],HH[[8]][[64]],HH[[8]][[65]],HH[[8]][[66]],HH[[8]][[67]],HH[[8]][[68]],HH[[8]][[69]],HH[[8]][
[70]],HH[[8]][[71]],HH[[8]][[72]],HH[[8]][[73]],HH[[8]][[74]],HH[[8]][[75]],HH[[8]][[76]],HH[[8]][[77]],HH[[8]][[78]],HH[[8]][[79]],HH[[8]]
[[80]],HH[[8]][[81]],HH[[8]][[82]],HH[[8]][[83]],HH[[8]][[84]],HH[[8]][[85]],HH[[8]][[86]],HH[[8]][[87]],HH[[8]][[88]],HH[[8]][[89]],HH[[8]
][[90]],HH[[8]][[91]],HH[[8]][[92]],HH[[8]][[93]],HH[[8]][[94]],HH[[8]][[95]],HH[[8]][[96]],HH[[8]][[97]],HH[[8]][[98]],HH[[8]][[99]],HH[[8
]][[100]],HH[[8]][[101]],HH[[8]][[102]],HH[[8]][[103]],HH[[8]][[104]],HH[[8]][[105]],HH[[8]][[106]],HH[[8]][[107]],HH[[8]][[108]],HH[[8]][
[109]],HH[[8]][[110]],HH[[8]][[111]],HH[[8]][[112]],HH[[8]][[113]],HH[[8]][[114]],HH[[8]][[115]],HH[[8]][[116]],HH[[8]][[117]],HH[[8]][[1
18]],HH[[8]][[119]],HH[[8]][[120]],HH[[8]][[121]],HH[[8]][[122]],HH[[8]][[123]],HH[[8]][[124]],HH[[8]][[125]],HH[[8]][[126]],HH[[8]][[127
]],HH[[8]][[128]],HH[[8]][[129]],HH[[8]][[130]],HH[[8]][[131]],HH[[8]][[132]],HH[[8]][[133]],HH[[8]][[134]],HH[[8]][[135]],HH[[8]][[136]],
HH[[8]][[137]],HH[[8]][[138]],HH[[8]][[139]],HH[[8]][[140]],
HH[[8]][[141]],HH[[8]][[142]],HH[[8]][[143]],HH[[8]][[144]],HH[[8]][[145]],HH[[8]][[146]],HH[[8]][[147]],HH[[8]][[148]],HH[[8]][[149]],H
H[[8]][[150]],HH[[8]][[151]],HH[[8]][[152]],HH[[8]][[153]],HH[[8]][[154]],HH[[8]][[155]],HH[[8]][[156]],HH[[8]][[157]],HH[[8]][[158]],HH[
[8]][[159]],HH[[8]][[160]],HH[[8]][[161]],HH[[8]][[162]],HH[[8]][[163]],HH[[8]][[164]],HH[[8]][[165]],HH[[8]][[166]],HH[[8]][[167]],HH[[8]
][[168]],HH[[8]][[169]],HH[[8]][[170]],HH[[8]][[171]],HH[[8]][[172]],HH[[8]][[173]],HH[[8]][[174]],HH[[8]][[175]],HH[[8]][[176]],HH[[8]][[
177]],HH[[8]][[178]],HH[[8]][[179]],HH[[8]][[180]],HH[[8]][[181]],HH[[8]][[182]],HH[[8]][[183]],HH[[8]][[184]],HH[[8]][[185]],HH[[8]][[18
6]],HH[[8]][[187]],HH[[8]][[188]],HH[[8]][[189]],HH[[8]][[190]],HH[[8]][[191]],HH[[8]][[192]],HH[[8]][[193]],HH[[8]][[194]],HH[[8]][[195]]
```

```
,HH[[8]][[196]],HH[[8]][[197]],HH[[8]][[198]],HH[[8]][[199]],HH[[8]][[200]],HH[[8]][[201]],HH[[8]][[202]],HH[[8]][[203]],HH[[8]][[204]],H
H[[8]][[205]],HH[[8]][[206]],HH[[8]][[207]],HH[[8]][[208]],HH[[8]][[209]],HH[[8]][[210]],HH[[8]][[211]],HH[[8]][[212]],HH[[8]][[213]],HH[
[8]][[214]],HH[[8]][[215]],HH[[8]][[216]],HH[[8]][[217]],HH[[8]][[218]],HH[[8]][[219]],HH[[8]][[220]],HH[[8]][[221]],HH[[8]][[222]],HH[[8]
][[223]],HH[[8]][[224]],HH[[8]][[225]],HH[[8]][[226]],HH[[8]][[227]],HH[[8]][[228]],HH[[8]][[229]],HH[[8]][[230]],HH[[8]][[231]],HH[[8]][[
232]],HH[[8]][[233]],HH[[8]][[234]])
```

Appendix E: R Code for IPF Procedure Using Matrix Operations

```
#1. Create iterative proportional fitting function

 ipf <- function(rowcontrol, colcontrol, seed, maxiter=50,closure=0.01){

 # input data checks: sum of marginal totals equal and no zeros in marginal totals
 #if(sum(rowcontrol) != sum(colcontrol)) stop("sum of rowcontrol must equal sum of colcontrol")


 if(any(rowcontrol==0)){
 numzero <- sum(rowcontrol==0)
 rowcontrol[rowcontrol==0] <- 0.001
 warning(paste(numzero, "zeros in rowcontrol argument replaced with 0.001", sep=" "))
 }
 if(any(colcontrol==0)){
 numzero <- sum(colcontrol==0)
 colcontrol[colcontrol==0] <- 0.001
 warning(paste(numzero, "zeros in colcontrol argument replaced with 0.001", sep=" "))
 }

 # set initial values
 result <- seed
 rowcheck <- 1
 colcheck <- 1
 iter <- 0

 # successively proportion rows and columns until closure or iteration criteria are met


 while((rowcheck > closure) & (colcheck > closure) & (iter < maxiter))
 {
 rowtotal <- rowSums(result)
 rowfactor <- rowcontrol/rowtotal
 result <- sweep(result, 1, rowfactor, "*")
 coltotal <- colSums(result)
 colfactor <- colcontrol/coltotal
 result <- sweep(result, 2, colfactor, "*")
 rowcheck <- sum(abs(1-rowfactor))
 colcheck <- sum(abs(1-colfactor))
 iter <- iter + 1
 }
 result
 }

#2. Input Data

E<-8 #Number of PUMAs
TAZs<-c(229,75,63,118,92,91,172,234)
PUMAs<-c(5201,5202,5301,5302,5303,5304,5401,5402)

SeedFrame<-
list(read.csv("Seed5201.csv"),read.csv("Seed5202.csv"),read.csv("Seed5301.csv"),read.csv("Seed5302.csv"),read.csv("Seed5303.csv"),read.csv("Seed5304.csv"),read.csv("Seed5401.csv"),read.csv("Seed5402.csv"))
rows<-c("Per1","Per2","Per3","Per4","Per5","Per6","Per7","Per8")
for(e in 1:E) {
rownames(SeedFrame[[e]])<-rows }

PerP<-
list(read.csv("PerP5201.csv"),read.csv("PerP5202.csv"),read.csv("PerP5301.csv"),read.csv("PerP5302.csv"),read.csv("PerP5303.csv"),read.csv("PerP5304.csv"),read.csv("PerP5401.csv"),read.csv("PerP5402.csv"))

IncP<-
list(read.csv("IncMarg5201.csv"),read.csv("IncMarg5202.csv"),read.csv("IncMarg5301.csv"),read.csv("IncMarg5302.csv"),read.csv("IncMarg5303.csv"),read.csv("IncMarg5304.csv"),read.csv("IncMarg5401.csv"),read.csv("IncMarg5402.csv"))

NoHHs<-
list(read.csv("HH5201.csv"),read.csv("HH5202.csv"),read.csv("HH5301.csv"),read.csv("HH5302.csv"),read.csv("HH5303.csv"),read.csv("HH5304.csv"),read.csv("HH5401.csv"),read.csv("HH5402.csv"))
```

```
TAZlist<-
list(read.csv("TAZ5201.csv"),read.csv("TAZ5202.csv"),read.csv("TAZ5301.csv"),read.csv("TAZ5302.csv"),read.csv("TAZ5303.csv"),read.csv("
TAZ5304.csv"),read.csv("TAZ5401.csv"),read.csv("TAZ5402.csv"))

RowMarg<-vector("list",E)
ColMarg<-vector("list",E)
Seed<-vector("list",E)

for(e in 1:E) {
RowMarg[[e]]<-vector("list",TAZs[[e]])
ColMarg[[e]]<-vector("list",TAZs[[e]])
Seed[[e]]<-vector("list",TAZs[[e]])

for(d in 1:TAZs[[e]]){
RowMarg[[e]][[d]]<-as.numeric(PerP[[e]][d,])
ColMarg[[e]][[d]]<-as.numeric(IncP[[e]][d,])
Seed[[e]][[d]]<-SeedFrame[[e]]}}

#3. Create iterative proportional fitting function for all PUMAs

PUMAipf<-function(TAZs,E,rowcontrol,colcontrol,seed) {
TAZProb<-vector("list",E)
for(e in 1:E) {
for(d in 1:TAZs[[e]]) {
TAZProb[[e]][[d]]<-ipf(RowMarg[[e]][[d]],ColMarg[[e]][[d]],Seed[[e]][[d]]) }}
TAZProb
}

#4. Run IPF for all PUMAs

TAZP<-PUMAipf(TAZs,E,RowMarg,ColMarg,Seed)
TAZ<-TAZP
TAZHHnew<-vector("list",E)

for(e in 1:E) {
for(d in 1:TAZs[[e]]) {
TAZHHnew[[e]]<-vector("list",d) }}

for(e in 1:E) {
for(d in 1:TAZs[[e]]) {
TAZHHnew[[e]][[d]]<-NoHHs[[e]][d,]
TAZ[[e]][[d]]<-round(sweep(TAZP[[e]][[d]],1,TAZHHnew[[e]][[d]], "*")) }}

#5. Create Output Files

Length<- vector("list",E)
Length[[1]]<-vector("list",TAZs[[1]])
Length[[2]]<-vector("list",TAZs[[2]])
Length[[3]]<-vector("list",TAZs[[3]])
Length[[4]]<-vector("list",TAZs[[4]])
Length[[5]]<-vector("list",TAZs[[5]])
Length[[6]]<-vector("list",TAZs[[6]])
Length[[7]]<-vector("list",TAZs[[7]])
Length[[8]]<-vector("list",TAZs[[8]])
HHMVfinal<-Length
HHMV<-Length


for(e in 1:E) {
for(d in 1:TAZs[[e]]) {
Length[[e]][[d]]<-
as.vector(c(TAZ[[e]][[d]][1,1],TAZ[[e]][[d]][1,2],TAZ[[e]][[d]][1,3],TAZ[[e]][[d]][2,1],TAZ[[e]][[d]][2,2],TAZ[[e]][[d]][2,3],TAZ[[e]][[d]][3,1]
,TAZ[[e]][[d]][3,2],TAZ[[e]][[d]][3,3],TAZ[[e]][[d]][4,1],TAZ[[e]][[d]][4,2],TAZ[[e]][[d]][4,3],TAZ[[e]][[d]][5,1],TAZ[[e]][[d]][5,2],TAZ[[e]][[
d]][5,3],TAZ[[e]][[d]][6,1],TAZ[[e]][[d]][6,2],TAZ[[e]][[d]][6,3],TAZ[[e]][[d]][7,1],TAZ[[e]][[d]][7,2],TAZ[[e]][[d]][7,3],TAZ[[e]][[d]][8,1],T
AZ[[e]][[d]][8,2],TAZ[[e]][[d]][8,3]))}}

for(e in 1:E) {
for(d in 1:TAZs[[e]]) {
HHMV[[e]][[d]]<- vector("list",24)}}

for(e in 1:E) {
for(d in 1:TAZs[e]) {
for(f in 1:24) {
```

```
HHMV [[e]] [[d]] [[f]]<-data.frame(rep(f,Length[[e]] [[d]][[f]] ))
colnames(HHMV[[e]][[d]][[f]])<- "HHMV"}}}

for(e in 1:E) {
for(d in 1:TAZs[e]) {
for(f in 1:24) {
HHMVfinal[[e]][[d]]<-
rbind(HHMV[[e]][[d]][[1]],HHMV[[e]][[d]][[2]],HHMV[[e]][[d]][[3]],HHMV[[e]][[d]][[4]],HHMV[[e]][[d]][[5]],HHMV[[e]][[d]][[6]],HHMV[
[e]][[d]][[7]],HHMV[[e]][[d]][[8]],HHMV[[e]][[d]][[9]],HHMV[[e]][[d]][[10]],HHMV[[e]][[d]][[11]],HHMV[[e]][[d]][[12]],HHMV[[e]][[d]][[1
3]],HHMV[[e]][[d]][[14]],HHMV[[e]][[d]][[15]],HHMV[[e]][[d]][[16]],HHMV[[e]][[d]][[17]],HHMV[[e]][[d]][[18]],HHMV[[e]][[d]][[19]],HH
MV[[e]][[d]][[20]],HHMV[[e]][[d]][[21]],HHMV[[e]][[d]][[22]],HHMV[[e]][[d]][[23]],HHMV[[e]][[d]][[24]]) }}}

TAZno<-HHMVfinal
PUMAno<-HHMVfinal
HH<-HHMVfinal

for(e in 1:E) {
for(d in 1:TAZs[[e]]) {
TAZno[[e]] [[d]] <-data.frame(rep(TAZlist[[e]] [d,],sum(Length[[e]][[d]])))
PUMAno[[e]] [[d]]<-data.frame(rep(PUMAs[[e]],sum(Length[[e]][[d]]))) }}


for(e in 1:E) {
for(d in 1:TAZs[e]) {
HH[[e]][[d]]<-cbind(TAZno[[e]][[d]],PUMAno[[e]][[d]], HHMVfinal[[e]][[d]]) }}

HHlist<-c("TAZ","PUMA","HHMV")

for(e in 1:E) {
for(d in 1:TAZs[e]) {
colnames(HH[[e]][[d]])<-HHlist }}

HH1<-rbind(
HH[[1]][[1]],HH[[1]][[2]],HH[[1]][[3]],HH[[1]][[4]],HH[[1]][[5]],HH[[1]][[6]],HH[[1]][[7]],HH[[1]][[8]],HH[[1]][[9]],HH[[1]][[10]],HH[[1]][[
11]],HH[[1]][[12]],HH[[1]][[13]],HH[[1]][[14]],HH[[1]][[15]],HH[[1]][[16]],HH[[1]][[17]],HH[[1]][[18]],HH[[1]][[19]],HH[[1]][[20]],HH[[1]][
[21]],HH[[1]][[22]],HH[[1]][[23]],HH[[1]][[24]],HH[[1]][[25]],HH[[1]][[26]],HH[[1]][[27]],HH[[1]][[28]],HH[[1]][[29]],HH[[1]][[30]],HH[[1]]
[[31]],HH[[1]][[32]],HH[[1]][[33]],HH[[1]][[34]],HH[[1]][[35]],HH[[1]][[36]],HH[[1]][[37]],HH[[1]][[38]],HH[[1]][[39]],HH[[1]][[40]],HH[[1]
][41]],HH[[1]][[42]],HH[[1]][[43]],HH[[1]][[44]],HH[[1]][[45]],HH[[1]][[46]],HH[[1]][[47]],HH[[1]][[48]],HH[[1]][[49]],HH[[1]][[50]],HH[[1
]][[51]],HH[[1]][[52]],HH[[1]][[53]],HH[[1]][[54]],HH[[1]][[55]],HH[[1]][[56]],HH[[1]][[57]],HH[[1]][[58]],HH[[1]][[59]],HH[[1]][[60]],HH[[
1]][[61]],HH[[1]][[62]],HH[[1]][[63]],HH[[1]][[64]],HH[[1]][[65]],HH[[1]][[66]],HH[[1]][[67]],HH[[1]][[68]],HH[[1]][[69]],HH[[1]][[70]],HH[
[1]][[71]],HH[[1]][[72]],HH[[1]][[73]],HH[[1]][[74]],HH[[1]][[75]],HH[[1]][[76]],HH[[1]][[77]],HH[[1]][[78]],HH[[1]][[79]],HH[[1]][[80]],HH
[[1]][[81]],HH[[1]][[82]],HH[[1]][[83]],HH[[1]][[84]],HH[[1]][[85]],HH[[1]][[86]],HH[[1]][[87]],HH[[1]][[88]],HH[[1]][[89]],HH[[1]][[90]],H
H[[1]][[91]],HH[[1]][[92]],HH[[1]][[93]],HH[[1]][[94]],HH[[1]][[95]],HH[[1]][[96]],HH[[1]][[97]],HH[[1]][[98]],HH[[1]][[99]],HH[[1]][[100]],
HH[[1]][[101]],HH[[1]][[102]],HH[[1]][[103]],HH[[1]][[104]],HH[[1]][[105]],HH[[1]][[106]],HH[[1]][[107]],HH[[1]][[108]],HH[[1]][[109]],H
H[[1]][[110]],HH[[1]][[111]],HH[[1]][[112]],HH[[1]][[113]],HH[[1]][[114]],HH[[1]][[115]],HH[[1]][[116]],HH[[1]][[117]],HH[[1]][[118]],HH[
[1]][[119]],HH[[1]][[120]],HH[[1]][[121]],HH[[1]][[122]],HH[[1]][[123]],HH[[1]][[124]],HH[[1]][[125]],HH[[1]][[126]],HH[[1]][[127]],HH[[1]
][[128]],HH[[1]][[129]],HH[[1]][[130]],HH[[1]][[131]],HH[[1]][[132]],HH[[1]][[133]],HH[[1]][[134]],HH[[1]][[135]],HH[[1]][[136]],HH[[1]][[
137]],HH[[1]][[138]],HH[[1]][[139]],HH[[1]][[140]],HH[[1]][[141]],HH[[1]][[142]],HH[[1]][[143]],HH[[1]][[144]],HH[[1]][[145]],HH[[1]][[14
6]],HH[[1]][[147]],HH[[1]][[148]],HH[[1]][[149]],HH[[1]][[150]],HH[[1]][[151]],HH[[1]][[152]],HH[[1]][[153]],HH[[1]][[154]],HH[[1]][[155]]
,HH[[1]][[156]],HH[[1]][[157]],HH[[1]][[158]],HH[[1]][[159]],HH[[1]][[160]],HH[[1]][[161]],HH[[1]][[162]],HH[[1]][[163]],HH[[1]][[164]],H
H[[1]][[165]],HH[[1]][[166]],HH[[1]][[167]],HH[[1]][[168]],HH[[1]][[169]],HH[[1]][[170]],HH[[1]][[171]],HH[[1]][[172]],HH[[1]][[173]],HH[
[1]][[174]],HH[[1]][[175]],HH[[1]][[176]],HH[[1]][[177]],HH[[1]][[178]],HH[[1]][[179]],HH[[1]][[180]],HH[[1]][[181]],HH[[1]][[182]],HH[[1]
][[183]],HH[[1]][[184]],HH[[1]][[185]],HH[[1]][[186]],HH[[1]][[187]],HH[[1]][[188]],HH[[1]][[189]],HH[[1]][[190]],HH[[1]][[191]],HH[[1]][[
192]],HH[[1]][[193]],HH[[1]][[194]],HH[[1]][[195]],HH[[1]][[196]],HH[[1]][[197]],HH[[1]][[198]],HH[[1]][[199]],HH[[1]][[200]],HH[[1]][[20
1]],HH[[1]][[202]],HH[[1]][[203]],HH[[1]][[204]],HH[[1]][[205]],HH[[1]][[206]],HH[[1]][[207]],HH[[1]][[208]],HH[[1]][[209]],HH[[1]][[210]]
,HH[[1]][[211]],HH[[1]][[212]],HH[[1]][[213]],HH[[1]][[214]],HH[[1]][[215]],HH[[1]][[216]],HH[[1]][[217]],HH[[1]][[218]],HH[[1]][[219]],H
H[[1]][[220]],HH[[1]][[221]],HH[[1]][[222]],HH[[1]][[223]],HH[[1]][[224]],HH[[1]][[225]],HH[[1]][[226]],HH[[1]][[227]],HH[[1]][[228]],HH[
[1]][[229]])

HH2<-rbind(
HH[[2]][[1]],HH[[2]][[2]],HH[[2]][[3]],HH[[2]][[4]],HH[[2]][[5]],HH[[2]][[6]],HH[[2]][[7]],HH[[2]][[8]],HH[[2]][[9]],HH[[2]][[10]],HH[[2]][[
11]],HH[[2]][[12]],HH[[2]][[13]],HH[[2]][[14]],HH[[2]][[15]],HH[[2]][[16]],HH[[2]][[17]],HH[[2]][[18]],HH[[2]][[19]],HH[[2]][[20]],HH[[2]][
[21]],HH[[2]][[22]],HH[[2]][[23]],HH[[2]][[24]],HH[[2]][[25]],HH[[2]][[26]],HH[[2]][[27]],HH[[2]][[28]],HH[[2]][[29]],HH[[2]][[30]],HH[[2]]
[[31]],HH[[2]][[32]],HH[[2]][[33]],HH[[2]][[34]],HH[[2]][[35]],HH[[2]][[36]],HH[[2]][[37]],HH[[2]][[38]],HH[[2]][[39]],HH[[2]][[40]],HH[[2]
][41]],HH[[2]][[42]],HH[[2]][[43]],HH[[2]][[44]],HH[[2]][[45]],HH[[2]][[46]],HH[[2]][[47]],HH[[2]][[48]],HH[[2]][[49]],HH[[2]][[50]],HH[[2
]][[51]],HH[[2]][[52]],HH[[2]][[53]],HH[[2]][[54]],HH[[2]][[55]],HH[[2]][[56]],HH[[2]][[57]],HH[[2]][[58]],HH[[2]][[59]],HH[[2]][[60]],HH[[
2]][[61]],HH[[2]][[62]],HH[[2]][[63]],HH[[2]][[64]],HH[[2]][[65]],HH[[2]][[66]],HH[[2]][[67]],HH[[2]][[68]],HH[[2]][[69]],HH[[2]][[70]],HH[
[2]][[71]],HH[[2]][[72]],HH[[2]][[73]],HH[[2]][[74]],HH[[2]][[75]])

HH3<-rbind(
HH[[3]][[1]],HH[[3]][[2]],HH[[3]][[3]],HH[[3]][[4]],HH[[3]][[5]],HH[[3]][[6]],HH[[3]][[7]],HH[[3]][[8]],HH[[1]][[9]],HH[[3]][[10]],HH[[3]][[
11]],HH[[3]][[12]],HH[[3]][[13]],HH[[3]][[14]],HH[[3]][[15]],HH[[3]][[16]],HH[[3]][[17]],HH[[3]][[18]],HH[[3]][[19]],HH[[3]][[20]],HH[[3]][
[21]],HH[[3]][[22]],HH[[3]][[23]],HH[[3]][[24]],HH[[3]][[25]],HH[[3]][[26]],HH[[3]][[27]],HH[[3]][[28]],HH[[3]][[29]],HH[[3]][[30]],HH[[3]]
```

```
[[31]],HH[[3]][[32]],HH[[3]][[33]],HH[[3]][[34]],HH[[3]][[35]],HH[[3]][[36]],HH[[3]][[37]],HH[[3]][[38]],HH[[3]][[39]],HH[[3]][[40]],HH[[3]
][[41]],HH[[3]][[42]],HH[[3]][[43]],HH[[3]][[44]],HH[[3]][[45]],HH[[3]][[46]],HH[[3]][[47]],HH[[3]][[48]],HH[[3]][[49]],HH[[3]][[50]],HH[[3
]][[51]],HH[[3]][[52]],HH[[3]][[53]],HH[[3]][[54]],HH[[3]][[55]],HH[[3]][[56]],HH[[3]][[57]],HH[[3]][[58]],HH[[3]][[59]],HH[[3]][[60]],HH[[
3]][[61]],HH[[3]][[62]],HH[[3]][[63]])

HH4<-rbind(
HH[[4]][[1]],HH[[4]][[2]],HH[[4]][[3]],HH[[4]][[4]],HH[[4]][[5]],HH[[4]][[6]],HH[[4]][[7]],HH[[4]][[8]],HH[[4]][[9]],HH[[4]][[10]],HH[[4]][[
11]],HH[[4]][[12]],HH[[4]][[13]],HH[[4]][[14]],HH[[4]][[15]],HH[[4]][[16]],HH[[4]][[17]],HH[[4]][[18]],HH[[4]][[19]],HH[[4]][[20]],HH[[4]][
[21]],HH[[4]][[22]],HH[[4]][[23]],HH[[4]][[24]],HH[[4]][[25]],HH[[4]][[26]],HH[[4]][[27]],HH[[4]][[28]],HH[[4]][[29]],HH[[4]][[30]],HH[[4]]
[[31]],HH[[4]][[32]],HH[[4]][[33]],HH[[4]][[34]],HH[[4]][[35]],HH[[4]][[36]],HH[[4]][[37]],HH[[4]][[38]],HH[[4]][[39]],HH[[4]][[40]],HH[[4]
][[41]],HH[[4]][[42]],HH[[4]][[43]],HH[[4]][[44]],HH[[4]][[45]],HH[[4]][[46]],HH[[4]][[47]],HH[[4]][[48]],HH[[4]][[49]],HH[[4]][[50]],HH[[4
]][[51]],HH[[4]][[52]],HH[[4]][[53]],HH[[4]][[54]],HH[[4]][[55]],HH[[4]][[56]],HH[[4]][[57]],HH[[4]][[58]],HH[[4]][[59]],HH[[4]][[60]],HH[[
4]][[61]],HH[[4]][[62]],HH[[4]][[63]],HH[[4]][[64]],HH[[4]][[65]],HH[[4]][[66]],HH[[4]][[67]],HH[[4]][[68]],HH[[4]][[69]],HH[[4]][[70]],HH[
[4]][[71]],HH[[4]][[72]],HH[[4]][[73]],HH[[4]][[74]],HH[[4]][[75]],HH[[4]][[76]],HH[[4]][[77]],HH[[4]][[78]],HH[[4]][[79]],HH[[4]][[80]],HH
[[4]][[81]],HH[[4]][[82]],HH[[4]][[83]],HH[[4]][[84]],HH[[4]][[85]],HH[[4]][[86]],HH[[4]][[87]],HH[[4]][[88]],HH[[4]][[89]],HH[[4]][[90]],H
H[[4]][[91]],HH[[4]][[92]],HH[[4]][[93]],HH[[4]][[94]],HH[[4]][[95]],HH[[4]][[96]],HH[[4]][[97]],HH[[4]][[98]],HH[[4]][[99]],HH[[4]][[100]],
HH[[4]][[101]],HH[[4]][[102]],HH[[4]][[103]],HH[[4]][[104]],HH[[4]][[105]],HH[[4]][[106]],HH[[4]][[107]],HH[[4]][[108]],HH[[4]][[109]],H
H[[4]][[110]],HH[[4]][[111]],HH[[4]][[112]],HH[[4]][[113]],HH[[4]][[114]],HH[[4]][[115]],HH[[4]][[116]],HH[[4]][[117]],HH[[4]][[118]])

HH5<-rbind(
HH[[5]][[1]],HH[[5]][[2]],HH[[5]][[3]],HH[[5]][[4]],HH[[5]][[5]],HH[[5]][[6]],HH[[5]][[7]],HH[[5]][[8]],HH[[5]][[9]],HH[[5]][[10]],HH[[5]][[
11]],HH[[5]][[12]],HH[[5]][[13]],HH[[5]][[14]],HH[[5]][[15]],HH[[5]][[16]],HH[[5]][[17]],HH[[5]][[18]],HH[[5]][[19]],HH[[5]][[20]],HH[[5]][
[21]],HH[[5]][[22]],HH[[5]][[23]],HH[[5]][[24]],HH[[5]][[25]],HH[[5]][[26]],HH[[5]][[27]],HH[[5]][[28]],HH[[5]][[29]],HH[[5]][[30]],HH[[5]]
[[31]],HH[[5]][[32]],HH[[5]][[33]],HH[[5]][[34]],HH[[5]][[35]],HH[[5]][[36]],HH[[5]][[37]],HH[[5]][[38]],HH[[5]][[39]],HH[[5]][[40]],HH[[5]
][[41]],HH[[5]][[42]],HH[[5]][[43]],HH[[5]][[44]],HH[[5]][[45]],HH[[5]][[46]],HH[[5]][[47]],HH[[5]][[48]],HH[[5]][[49]],HH[[5]][[50]],HH[[5
]][[51]],HH[[5]][[52]],HH[[5]][[53]],HH[[5]][[54]],HH[[5]][[55]],HH[[5]][[56]],HH[[5]][[57]],HH[[5]][[58]],HH[[5]][[59]],HH[[5]][[60]],HH[[
5]][[61]],HH[[5]][[62]],HH[[5]][[63]],HH[[5]][[64]],HH[[5]][[65]],HH[[5]][[66]],HH[[5]][[67]],HH[[5]][[68]],HH[[5]][[69]],HH[[5]][[70]],HH[
[5]][[71]],HH[[5]][[72]],HH[[5]][[73]],HH[[5]][[74]],HH[[5]][[75]],HH[[5]][[76]],HH[[5]][[77]],HH[[5]][[78]],HH[[5]][[79]],HH[[5]][[80]],HH
[[5]][[81]],HH[[5]][[82]],HH[[5]][[83]],HH[[5]][[84]],HH[[5]][[85]],HH[[5]][[86]],HH[[5]][[87]],HH[[5]][[88]],HH[[5]][[89]],HH[[5]][[90]],H
H[[5]][[91]],HH[[5]][[92]])

HH6<-rbind(
HH[[6]][[1]],HH[[6]][[2]],HH[[6]][[3]],HH[[6]][[4]],HH[[6]][[5]],HH[[6]][[6]],HH[[6]][[7]],HH[[6]][[8]],HH[[6]][[9]],HH[[6]][[10]],HH[[6]][[
11]],HH[[6]][[12]],HH[[6]][[13]],HH[[6]][[14]],HH[[6]][[15]],HH[[6]][[16]],HH[[6]][[17]],HH[[6]][[18]],HH[[6]][[19]],HH[[6]][[20]],HH[[6]][
[21]],HH[[6]][[22]],HH[[6]][[23]],HH[[6]][[24]],HH[[6]][[25]],HH[[6]][[26]],HH[[6]][[27]],HH[[6]][[28]],HH[[6]][[29]],HH[[6]][[30]],HH[[6]]
[[31]],HH[[6]][[32]],HH[[6]][[33]],HH[[6]][[34]],HH[[6]][[35]],HH[[6]][[36]],HH[[6]][[37]],HH[[6]][[38]],HH[[6]][[39]],HH[[6]][[40]],HH[[6]
][[41]],HH[[6]][[42]],HH[[6]][[43]],HH[[6]][[44]],HH[[6]][[45]],HH[[6]][[46]],HH[[6]][[47]],HH[[6]][[48]],HH[[6]][[49]],HH[[6]][[50]],HH[[6
]][[51]],HH[[6]][[52]],HH[[6]][[53]],HH[[6]][[54]],HH[[6]][[55]],HH[[6]][[56]],HH[[6]][[57]],HH[[6]][[58]],HH[[6]][[59]],HH[[6]][[60]],HH[[
6]][[61]],HH[[6]][[62]],HH[[6]][[63]],HH[[6]][[64]],HH[[6]][[65]],HH[[6]][[66]],HH[[6]][[67]],HH[[6]][[68]],HH[[6]][[69]],HH[[6]][[70]],HH[
[6]][[71]],HH[[6]][[72]],HH[[6]][[73]],HH[[6]][[74]],HH[[6]][[75]],HH[[6]][[76]],HH[[6]][[77]],HH[[6]][[78]],HH[[6]][[79]],HH[[6]][[80]],HH
[[6]][[81]],HH[[6]][[82]],HH[[6]][[83]],HH[[6]][[84]],HH[[6]][[85]],HH[[6]][[86]],HH[[6]][[87]],HH[[6]][[88]],HH[[6]][[89]],HH[[6]][[90]],H
H[[6]][[91]])

HH7<-rbind(
HH[[7]][[1]],HH[[7]][[2]],HH[[7]][[3]],HH[[7]][[4]],HH[[7]][[5]],HH[[7]][[6]],HH[[7]][[7]],HH[[7]][[8]],HH[[7]][[9]],HH[[7]][[10]],HH[[7]][[
11]],HH[[7]][[12]],HH[[7]][[13]],HH[[7]][[14]],HH[[7]][[15]],HH[[7]][[16]],HH[[7]][[17]],HH[[7]][[18]],HH[[7]][[19]],HH[[7]][[20]],HH[[7]][
[21]],HH[[7]][[22]],HH[[7]][[23]],HH[[7]][[24]],HH[[7]][[25]],HH[[7]][[26]],HH[[7]][[27]],HH[[7]][[28]],HH[[7]][[29]],HH[[7]][[30]],HH[[7]]
[[31]],HH[[7]][[32]],HH[[7]][[33]],HH[[7]][[34]],HH[[7]][[35]],HH[[7]][[36]],HH[[7]][[37]],HH[[7]][[38]],HH[[7]][[39]],HH[[7]][[40]],HH[[7]
][[41]],HH[[7]][[42]],HH[[7]][[43]],HH[[7]][[44]],HH[[7]][[45]],HH[[7]][[46]],HH[[7]][[47]],HH[[7]][[48]],HH[[7]][[49]],HH[[7]][[50]],HH[[7
]][[51]],HH[[7]][[52]],HH[[7]][[53]],HH[[7]][[54]],HH[[7]][[55]],HH[[7]][[56]],HH[[7]][[57]],HH[[7]][[58]],HH[[7]][[59]],HH[[7]][[60]],HH[[
7]][[61]],HH[[7]][[62]],HH[[7]][[63]],HH[[7]][[64]],HH[[7]][[65]],HH[[7]][[66]],HH[[7]][[67]],HH[[7]][[68]],HH[[7]][[69]],HH[[7]][[70]],HH[
[7]][[71]],HH[[7]][[72]],HH[[7]][[73]],HH[[7]][[74]],HH[[7]][[75]],HH[[7]][[76]],HH[[7]][[77]],HH[[7]][[78]],HH[[7]][[79]],HH[[7]][[80]],HH
[[7]][[81]],HH[[7]][[82]],HH[[7]][[83]],HH[[7]][[84]],HH[[7]][[85]],HH[[7]][[86]],HH[[7]][[87]],HH[[7]][[88]],HH[[7]][[89]],HH[[7]][[90]],H
H[[7]][[91]],HH[[7]][[92]],HH[[7]][[93]],HH[[7]][[94]],HH[[7]][[95]],HH[[7]][[96]],HH[[7]][[97]],HH[[7]][[98]],HH[[7]][[99]],HH[[7]][[100]],
HH[[7]][[101]],HH[[7]][[102]],HH[[7]][[103]],HH[[7]][[104]],HH[[7]][[105]],HH[[7]][[106]],HH[[7]][[107]],HH[[7]][[108]],HH[[7]][[109]],H
H[[7]][[110]],HH[[7]][[111]],HH[[7]][[112]],HH[[7]][[113]],HH[[7]][[114]],HH[[7]][[115]],HH[[7]][[116]],HH[[7]][[117]],HH[[7]][[118]],HH[
[7]][[119]],HH[[7]][[120]],HH[[7]][[121]],HH[[7]][[122]],HH[[7]][[123]],HH[[7]][[124]],HH[[7]][[125]],HH[[7]][[126]],HH[[7]][[127]],HH[[7]
][[128]],HH[[7]][[129]],HH[[7]][[130]],HH[[7]][[131]],HH[[7]][[132]],HH[[7]][[133]],HH[[7]][[134]],HH[[7]][[135]],HH[[7]][[136]],HH[[7]][[
137]],HH[[7]][[138]],HH[[7]][[139]],HH[[7]][[140]],HH[[7]][[141]],HH[[7]][[142]],HH[[7]][[143]],HH[[7]][[144]],HH[[7]][[145]],HH[[7]][[14
6]],HH[[7]][[147]],HH[[7]][[148]],HH[[7]][[149]],HH[[7]][[150]],HH[[7]][[151]],HH[[7]][[152]],HH[[7]][[153]],HH[[7]][[154]],HH[[7]][[155]]
,HH[[7]][[156]],HH[[7]][[157]],HH[[7]][[158]],HH[[7]][[159]],HH[[7]][[160]],HH[[7]][[161]],HH[[7]][[162]],HH[[7]][[163]],HH[[7]][[164]],H
H[[7]][[165]],HH[[7]][[166]],HH[[7]][[167]],HH[[7]][[168]],HH[[7]][[169]],HH[[7]][[170]],HH[[7]][[171]],HH[[7]][[172]])

HH8<-rbind(
HH[[8]][[1]],HH[[8]][[2]],HH[[8]][[3]],HH[[8]][[4]],HH[[8]][[5]],HH[[8]][[6]],HH[[8]][[7]],HH[[8]][[8]],HH[[8]][[9]],HH[[8]][[10]],HH[[8]][[
11]],HH[[8]][[12]],HH[[8]][[13]],HH[[8]][[14]],HH[[8]][[15]],HH[[8]][[16]],HH[[8]][[17]],HH[[8]][[18]],HH[[8]][[19]],HH[[8]][[20]],HH[[8]][
[21]],HH[[8]][[22]],HH[[8]][[23]],HH[[8]][[24]],HH[[8]][[25]],HH[[8]][[26]],HH[[8]][[27]],HH[[8]][[28]],HH[[8]][[29]],HH[[8]][[30]],HH[[8]]
[[31]],HH[[8]][[32]],HH[[8]][[33]],HH[[8]][[34]],HH[[8]][[35]],HH[[8]][[36]],HH[[8]][[37]],HH[[8]][[38]],HH[[8]][[39]],HH[[8]][[40]],HH[[8]
][[41]],HH[[8]][[42]],HH[[8]][[43]],HH[[8]][[44]],HH[[8]][[45]],HH[[8]][[46]],HH[[8]][[47]],HH[[8]][[48]],HH[[8]][[49]],HH[[8]][[50]],HH[[8
]][[51]],HH[[8]][[52]],HH[[8]][[53]],HH[[8]][[54]],HH[[8]][[55]],HH[[8]][[56]],HH[[8]][[57]],HH[[8]][[58]],HH[[8]][[59]],HH[[8]][[60]],HH[[
8]][[61]],HH[[8]][[62]],HH[[8]][[63]],HH[[8]][[64]],HH[[8]][[65]],HH[[8]][[66]],HH[[8]][[67]],HH[[8]][[68]],HH[[8]][[69]],HH[[8]][[70]],HH[
[8]][[71]],HH[[8]][[72]],HH[[8]][[73]],HH[[8]][[74]],HH[[8]][[75]],HH[[8]][[76]],HH[[8]][[77]],HH[[8]][[78]],HH[[8]][[79]],HH[[8]][[80]],HH
[[8]][[81]],HH[[8]][[82]],HH[[8]][[83]],HH[[8]][[84]],HH[[8]][[85]],HH[[8]][[86]],HH[[8]][[87]],HH[[8]][[88]],HH[[8]][[89]],HH[[8]][[90]],H
```

```
H[[8]][[91]],HH[[8]][[92]],HH[[8]][[93]],HH[[8]][[94]],HH[[8]][[95]],HH[[8]][[96]],HH[[8]][[97]],HH[[8]][[98]],HH[[8]][[99]],HH[[8]][[100]],
HH[[8]][[101]],HH[[8]][[102]],HH[[8]][[103]],HH[[8]][[104]],HH[[8]][[105]],HH[[8]][[106]],HH[[8]][[107]],HH[[8]][[108]],HH[[8]][[109]],H
H[[8]][[110]],HH[[8]][[111]],HH[[8]][[112]],HH[[8]][[113]],HH[[8]][[114]],HH[[8]][[115]],HH[[8]][[116]],HH[[8]][[117]],HH[[8]][[118]],HH[
[8]][[119]],HH[[8]][[120]],HH[[8]][[121]],HH[[8]][[122]],HH[[8]][[123]],HH[[8]][[124]],HH[[8]][[125]],HH[[8]][[126]],HH[[8]][[127]],HH[[8]
][[128]],HH[[8]][[129]],HH[[8]][[130]],HH[[8]][[131]],HH[[8]][[132]],HH[[8]][[133]],HH[[8]][[134]],HH[[8]][[135]],HH[[8]][[136]],HH[[8]][[
137]],HH[[8]][[138]],HH[[8]][[139]],HH[[8]][[140]],HH[[8]][[141]],HH[[8]][[142]],HH[[8]][[143]],HH[[8]][[144]],HH[[8]][[145]],HH[[8]][[14
6]],HH[[8]][[147]],HH[[8]][[148]],HH[[8]][[149]],HH[[8]][[150]],HH[[8]][[151]],HH[[8]][[152]],HH[[8]][[153]],HH[[8]][[154]],HH[[8]][[155]]
,HH[[8]][[156]],HH[[8]][[157]],HH[[8]][[158]],HH[[8]][[159]],HH[[8]][[160]],HH[[8]][[161]],HH[[8]][[162]],HH[[8]][[163]],HH[[8]][[164]],H
H[[8]][[165]],HH[[8]][[166]],HH[[8]][[167]],HH[[8]][[168]],HH[[8]][[169]],HH[[8]][[170]],HH[[8]][[171]],HH[[8]][[172]],HH[[8]][[173]],HH[
[8]][[174]],HH[[8]][[175]],HH[[8]][[176]],HH[[8]][[177]],HH[[8]][[178]],HH[[8]][[179]],HH[[8]][[180]],HH[[8]][[181]],HH[[8]][[182]],HH[[8]
][[183]],HH[[8]][[184]],HH[[8]][[185]],HH[[8]][[186]],HH[[8]][[187]],HH[[8]][[188]],HH[[8]][[189]],HH[[8]][[190]],HH[[8]][[191]],HH[[8]][[
192]],HH[[8]][[193]],HH[[8]][[194]],HH[[8]][[195]],HH[[8]][[196]],HH[[8]][[197]],HH[[8]][[198]],HH[[8]][[199]],HH[[8]][[200]],HH[[8]][[20
1]],HH[[8]][[202]],HH[[8]][[203]],HH[[8]][[204]],HH[[8]][[205]],HH[[8]][[206]],HH[[8]][[207]],HH[[8]][[208]],HH[[8]][[209]],HH[[8]][[210]]
,HH[[8]][[211]],HH[[8]][[212]],HH[[8]][[213]],HH[[8]][[214]],HH[[8]][[215]],HH[[8]][[216]],HH[[8]][[217]],HH[[8]][[218]],HH[[8]][[219]],H
H[[8]][[220]],HH[[8]][[221]],HH[[8]][[222]],HH[[8]][[223]],HH[[8]][[224]],HH[[8]][[225]],HH[[8]][[226]],HH[[8]][[227]],HH[[8]][[228]],HH[
[8]][[229]],HH[[8]][[230]],HH[[8]][[231]],HH[[8]][[232]],HH[[8]][[233]],HH[[8]][[234]])

write.csv(HH1,"HH1.csv")
write.csv(HH2,"HH2.csv")
write.csv(HH3,"HH3.csv")
write.csv(HH4,"HH4.csv")
write.csv(HH5,"HH5.csv")
write.csv(HH6,"HH6.csv")
write.csv(HH7,"HH7.csv")
write.csv(HH8,"HH8.csv")
```

Appendix F: Model Application Code for SPSS

```
/* Application of Microscopic TDM – 10/10/2006 */

/* SPSS Formatting of Population Synthesis */
/* Load file into SPSS
/* Label HHs from 1-N (enter in Excel and paste into SPSS)
/* Sort cases by PUMA and then HHMV
/* Document Jason's matching method
/* Merge with HHPUMS based on matching variable
/* Create Sen1-Sen24 (Seniority Variables)

Compute Sen1=1.
Compute HH1=0.
If(Persons=1) HH1=1.
If(persons>1) Sen2=2.
If(Persons>2) Sen3=3.
If(Persons>3) Sen4=4.
If(Persons>4) Sen5=5.
If(Persons>5) Sen6=6.
If(Persons>6) Sen7=7.
If(Persons>7) Sen8=8.
If(Persons>8) Sen9=9.
If(Persons>9) Sen10=10.
If(Persons>10) Sen11=11.
If(Persons>11) Sen12=12.
If(Persons>12) Sen13=13.
If(Persons>13) Sen14=14.
If(Persons>14) Sen15=15.
If(Persons>15) Sen16=16.
If(Persons>16) Sen17=17.
If(Persons>17) Sen18=18.
If(Persons>18) Sen19=19.
If(Persons>19) Sen20=20.
If(Persons>20) Sen21=21.
If(Persons>21) Sen22=22.
If(persons>22) Sen23=23.
If(Persons>23) Sen24=24.
Execute.

/* Restructure into Person File
/* Create SerPerNo and HHPerNo

Compute HHPerNo=HHNo*100+Sen.
Compute SerPerNo=Serial*100+Sen.
Execute.

/* Merge with PerPUMS file based on SerPerNo variable

/* 1. DAP Model System */
Compute iPresch7=0.
Compute iPredri6=0.
Compute iPredri7=0.
Compute iDriv6=0.
Compute iDriv7=0.
Compute iNonwk6=0.
Compute iNonwk7=0.
Compute iStud6=0.
Compute iStud7=0.
Compute iPart6=0.
Compute iPart7=0.
Compute iFull6=0.
```

```
Compute iFull7=0.
IF(Presch=1) Category=1.
if(Predri=1) Category=2.
If(Driv=1) Category=3.
If(Nonwk=1) Category=4.
If(Stud=1) Category=5.
If(Part=1) Category=6.
If(Full=1) Category=7.
Compute VDAP1=0.
Compute VDAP2=0.
Compute VDAP3=0.
Compute VDAP4=0.
Compute VDAP5=0.
Compute VDAP6=0.
Compute VDAP7=0.
Compute SumAlt=0.
Compute Pr1=0.
Compute Pr2=0.
Compute Pr3=0.
Compute Pr4=0.
Compute Pr5=0.
Compute Pr6=0.
Compute Pr7=0.
COMPUTE RandDAP = RV.UNIFORM(0,1) .
Compute Work1=0.
Compute Work2=0.
Compute Uni=0.
Compute WorkUni=0.
Compute School=0.
Compute NonMand=0.
Compute Home=0.
Execute.
```

/* 2. Preschool Child DAP Model */

```
If(Category=1) VDAP7=7.317-1.716* Persons+2.499*( NPresch+ NPredri+ NDriv).
If(Category=1) SumAlt=exp(VDAP5) +exp(VDAP7).
If(Category=1) Pr5=EXP(VDAP5)/SumAlt.
If(Category=1) Pr7=EXP(VDAP7)/SumAlt.
If(Category=1 & RandDAP<=Pr5) School=1.
If(Category=1 & RandDAP > Pr5) Home=1.
Execute.
```

/* 3. Pre-driving Child DAP Model */

```
If(Category=2) VDAP1=-4.047.
If(Category=2) VDAP6=-3.133-0.173*age+0.409*Persons+0.81*NPart.
If(Category=2) VDAP7=0.176+1.201*NPresch+0.513*NPredri+3.163*NDriv-1.376*PPresch-3.562*PDriv-0.776*PFull-
0.000021*Income+0.477*Autosur-0.658*Autosh-0.821*suburb-0.77*urban.
If(Category=2) SumAlt=exp(VDAP1)+exp(VDAP5)+exp(VDAP6)+exp(VDAP7).
If(Category=2) Pr1=exp(VDAP1)/SumAlt.
If(Category=2) Pr5=exp(VDAP5)/SumAlt.
If(Category=2) Pr6=exp(VDAP6)/SumAlt.
If(Category=2) Pr7=exp(VDAP7)/SumAlt.
If(Category=2 & RandDAP<=Pr1) Work1=1.
If(Category=2 & RandDAP>Pr1 & RandDAP<=Pr1+Pr5) School=1.
If(Category=2 & RandDAP>Pr1+Pr5 & RandDAP<=Pr1+Pr5+Pr6) NonMand=1.
If(Category=2 & RandDAP>Pr1+Pr5+Pr6) Home=1.
Execute.
```

/* 4. Driving Child DAP Model */

```
If(Category=3) VDAP1=-0.704-0.000019*Income+0.813*Autosur.
If(Category=3) VDAP6=-3.827+0.689*(NPresch+NPredri+NDriv).
If(Category=3) VDAP7=0.887+0.825*NNonwk-0.000036*Income-1.008*Autosh.
If(Category=3) SumAlt= exp(VDAP1)+exp(VDAP5)+exp(VDAP6)+exp(VDAP7).
If(Category=3) Pr1=exp(VDAP1)/SumAlt.
If(Category=3) Pr5=exp(VDAP5)/SumAlt.
If(Category=3) Pr6=exp(VDAP6)/SumAlt.
If(Category=3) Pr7=exp(VDAP7)/SumAlt.
If(Category=3 & RandDAP<=Pr1) Work1=1.
If(Category=3 & RandDAP>Pr1 & RandDAP<=Pr1+Pr5) School=1.
If(Category=3 & RandDAP>Pr1+Pr5 & RandDAP<=Pr1+Pr5+Pr6) NonMand=1.
If(Category=3 & RandDAP>Pr1+Pr5+Pr6) Home=1.
```

```
Execute.
```

/* 5. Restructure into Household file and calculated indicator variables for children */

```
SORT CASES BY HHNo .
CASESTOVARS
 /ID = HHNo
 /GROUPBY = VARIABLE .
Execute.

If(Category.1=1 & Home.1=1) iPresch7=1.
If(Category.2=1 & Home.2=1) iPresch7=1.
If(Category.3=1 & Home.3=1) iPresch7=1.
If(Category.4=1 & Home.4=1) iPresch7=1.
If(Category.5=1 & Home.5=1) iPresch7=1.
If(Category.6=1 & Home.6=1) iPresch7=1.
If(Category.7=1 & Home.7=1) iPresch7=1.
If(Category.8=1 & Home.8=1) iPresch7=1.
If(Category.9=1 & Home.9=1) iPresch7=1.
If(Category.10=1 & Home.10=1) iPresch7=1.
If(Category.11=1 & Home.11=1) iPresch7=1.
If(Category.12=1 & Home.12=1) iPresch7=1.
If(Category.13=1 & Home.13=1) iPresch7=1.
If(Category.14=1 & Home.14=1) iPresch7=1.
If(Category.15=1 & Home.15=1) iPresch7=1.
If(Category.16=1 & Home.16=1) iPresch7=1.
If(Category.17=1 & Home.17=1) iPresch7=1.
If(Category.18=1 & Home.18=1) iPresch7=1.
If(Category.19=1 & Home.19=1) iPresch7=1.
If(Category.20=1 & Home.20=1) iPresch7=1.
If(Category.21=1 & Home.21=1) iPresch7=1.
If(Category.22=1 & Home.22=1) iPresch7=1.
If(Category.23=1 & Home.23=1) iPresch7=1.
If(Category.24=1 & Home.24=1) iPresch7=1.

If(Category.1=2 & NonMand.1=1) iPredri6=1.
If(Category.2=2 & NonMand.2=1) iPredri6=1.
If(Category.3=2 & NonMand.3=1) iPredri6=1.
If(Category.4=2 & NonMand.4=1) iPredri6=1.
If(Category.5=2 & NonMand.5=1) iPredri6=1.
If(Category.6=2 & NonMand.6=1) iPredri6=1.
If(Category.7=2 & NonMand.7=1) iPredri6=1.
If(Category.8=2 & NonMand.8=1) iPredri6=1.
If(Category.9=2 & NonMand.9=1) iPredri6=1.
If(Category.10=2 & NonMand.10=1) iPredri6=1.
If(Category.11=2 & NonMand.11=1) iPredri6=1.
If(Category.12=2 & NonMand.12=1) iPredri6=1.
If(Category.13=2 & NonMand.13=1) iPredri6=1.
If(Category.14=2 & NonMand.14=1) iPredri6=1.
If(Category.15=2 & NonMand.15=1) iPredri6=1.
If(Category.16=2 & NonMand.16=1) iPredri6=1.
If(Category.17=2 & NonMand.17=1) iPredri6=1.
If(Category.18=2 & NonMand.18=1) iPredri6=1.
If(Category.19=2 & NonMand.19=1) iPredri6=1.
If(Category.20=2 & NonMand.20=1) iPredri6=1.
If(Category.21=2 & NonMand.21=1) iPredri6=1.
If(Category.22=2 & NonMand.22=1) iPredri6=1.
If(Category.23=2 & NonMand.23=1) iPredri6=1.
If(Category.24=2 & NonMand.24=1) iPredri6=1.

If(Category.1=2 & Home.1=1) iPredri7=1.
If(Category.2=2 & Home.2=1) iPredri7=1.
If(Category.3=2 & Home.3=1) iPredri7=1.
If(Category.4=2 & Home.4=1) iPredri7=1.
If(Category.5=2 & Home.5=1) iPredri7=1.
If(Category.6=2 & Home.6=1) iPredri7=1.
If(Category.7=2 & Home.7=1) iPredri7=1.
If(Category.8=2 & Home.8=1) iPredri7=1.
If(Category.9=2 & Home.9=1) iPredri7=1.
If(Category.10=2 & Home.10=1) iPredri7=1.
If(Category.11=2 & Home.11=1) iPredri7=1.
If(Category.12=2 & Home.12=1) iPredri7=1.
If(Category.13=2 & Home.13=1) iPredri7=1.
```

```
If(Category.14=2 & Home.14=1) iPredri7=1.
If(Category.15=2 & Home.15=1) iPredri7=1.
If(Category.16=2 & Home.16=1) iPredri7=1.
If(Category.17=2 & Home.17=1) iPredri7=1.
If(Category.18=2 & Home.18=1) iPredri7=1.
If(Category.19=2 & Home.19=1) iPredri7=1.
If(Category.20=2 & Home.20=1) iPredri7=1.
If(Category.21=2 & Home.21=1) iPredri7=1..
If(Category.22=2 & Home.22=1) iPredri7=1.
If(Category.23=2 & Home.23=1) iPredri7=1.
If(Category.24=2 & Home.24=1) iPredri7=1.

If(Category.1=3 & NonMand.1=1) iDriv6=1.
If(Category.2=3 & NonMand.2=1) iDriv6=1.
If(Category.3=3 & NonMand.3=1) iDriv6=1.
If(Category.4=3 & NonMand.4=1) iDriv6=1.
If(Category.5=3 & NonMand.5=1) iDriv6=1.
If(Category.6=3 & NonMand.6=1) iDriv6=1.
If(Category.7=3 & NonMand.7=1) iDriv6=1.
If(Category.8=3 & NonMand.8=1) iDriv6=1.
If(Category.9=3 & NonMand.9=1) iDriv6=1.
If(Category.10=3 & NonMand.10=1) iDriv6=1.
If(Category.11=3 & NonMand.11=1) iDriv6=1.
If(Category.12=3 & NonMand.12=1) iDriv6=1.
If(Category.13=3 & NonMand.13=1) iDriv6=1.
If(Category.14=3 & NonMand.14=1) iDriv6=1.
If(Category.15=3 & NonMand.15=1) iDriv6=1.
If(Category.16=3 & NonMand.16=1) iDriv6=1.
If(Category.17=3 & NonMand.17=1) iDriv6=1.
If(Category.18=3 & NonMand.18=1) iDriv6=1.
If(Category.19=3 & NonMand.19=1) iDriv6=1.
If(Category.20=3 & NonMand.20=1) iDriv6=1.
If(Category.21=3 & NonMand.21=1) iDriv6=1.
If(Category.22=3 & NonMand.22=1) iDriv6=1.
If(Category.23=3 & NonMand.23=1) iDriv6=1.
If(Category.24=3 & NonMand.24=1) iDriv6=1.

If(Category.1=3 & Home.1=1) iDriv7=1.
If(Category.2=3 & Home.2=1) iDriv7=1.
If(Category.3=3 & Home.3=1) iDriv7=1.
If(Category.4=3 & Home.4=1) iDriv7=1.
If(Category.5=3 & Home.5=1) iDriv7=1.
If(Category.6=3 & Home.6=1) iDriv7=1.
If(Category.7=3 & Home.7=1) iDriv7=1.
If(Category.8=3 & Home.8=1) iDriv7=1.
If(Category.9=3 & Home.9=1) iDriv7=1.
If(Category.10=3 & Home.10=1) iDriv7=1.
If(Category.11=3 & Home.11=1) iDriv7=1.
If(Category.12=3 & Home.12=1) iDriv7=1.
If(Category.13=3 & Home.13=1) iDriv7=1.
If(Category.14=3 & Home.14=1) iDriv7=1.
If(Category.15=3 & Home.15=1) iDriv7=1.
If(Category.16=3 & Home.16=1) iDriv7=1.
If(Category.17=3 & Home.17=1) iDriv7=1.
If(Category.18=3 & Home.18=1) iDriv7=1.
If(Category.19=3 & Home.19=1) iDriv7=1.
If(Category.20=3 & Home.20=1) iDriv7=1.
If(Category.21=3 & Home.21=1) iDriv7=1.
If(Category.22=3 & Home.22=1) iDriv7=1.
If(Category.23=3 & Home.23=1) iDriv7=1.
If(Category.24=3 & Home.24=1) iDriv7=1.
Execute.
```

/* 6. Restructure back into Person file*/

```
VARSTOCASES /MAKE Sen FROM Sen.1 Sen.2 Sen.3 Sen.4 Sen.5 Sen.6 Sen.7 Sen.8 Sen.9 Sen.10 Sen.11 Sen.12 Sen.13 Sen.14 Sen.15
 Sen.16 Sen.17 Sen.18 Sen.19 Sen.20 Sen.21 Sen.22 Sen.23 Sen.24
 /MAKE HHPerNo FROM HHPerNo.1 HHPerNo.2 HHPerNo.3 HHPerNo.4 HHPerNo.5 HHPerNo.6 HHPerNo.7 HHPerNo.8 HHPerNo.9
HHPerNo.10
 HHPerNo.11 HHPerNo.12 HHPerNo.13 HHPerNo.14 HHPerNo.15 HHPerNo.16 HHPerNo.17 HHPerNo.18 HHPerNo.19 HHPerNo.20
HHPerNo.21
 HHPerNo.22 HHPerNo.23 HHPerNo.24
 /MAKE SerPerNo FROM SerPerNo.1 SerPerNo.2 SerPerNo.3 SerPerNo.4 SerPerNo.5 SerPerNo.6 SerPerNo.7 SerPerNo.8 SerPerNo.9
```

```
 SerPerNo.10 SerPerNo.11 SerPerNo.12 SerPerNo.13 SerPerNo.14 SerPerNo.15 SerPerNo.16 SerPerNo.17 SerPerNo.18 SerPerNo.19
 SerPerNo.20 SerPerNo.21 SerPerNo.22 SerPerNo.23 SerPerNo.24
 /MAKE Male FROM Male.1 Male.2 Male.3 Male.4 Male.5 Male.6 Male.7 Male.8 Male.9 Male.10 Male.11 Male.12 Male.13 Male.14
 Male.15 Male.16 Male.17 Male.18 Male.19 Male.20 Male.21 Male.22 Male.23 Male.24
 /MAKE Age FROM Age.1 Age.2 Age.3 Age.4 Age.5 Age.6 Age.7 Age.8 Age.9 Age.10 Age.11 Age.12 Age.13 Age.14 Age.15 Age.16 Age.17
 Age.18 Age.19 Age.20 Age.21 Age.22 Age.23 Age.24
 /MAKE RandDAP FROM RandDAP.1 RandDAP.2 RandDAP.3 RandDAP.4 RandDAP.5 RandDAP.6 RandDAP.7 RandDAP.8 RandDAP.9
RandDAP.10
 RandDAP.11 RandDAP.12 RandDAP.13 RandDAP.14 RandDAP.15 RandDAP.16 RandDAP.17 RandDAP.18 RandDAP.19 RandDAP.20
RandDAP.21 RandDAP.22 RandDAP.23 RandDAP.24
 /MAKE Part FROM Part.1 Part.2 Part.3 Part.4 Part.5 Part.6 Part.7 Part.8 Part.9 Part.10 Part.11 Part.12 Part.13 Part.14 Part.15 Part.16 Part.17
Part.18 Part.19 Part.20 Part.21 Part.22 Part.23 Part.24
 /MAKE Full FROM Full.1 Full.2 Full.3 Full.4 Full.5 Full.6 Full.7 Full.8 Full.9 Full.10 Full.11 Full.12 Full.13 Full.14 Full.15 Full.16 Full.17
Full.18 Full.19 Full.20 Full.21 Full.22 Full.23 Full.24
 /MAKE Category FROM Category.1 Category.2 Category.3 Category.4 Category.5 Category.6 Category.7 Category.8 Category.9 Category.10
Category.11 Category.12 Category.13 Category.14 Category.15 Category.16 Category.17 Category.18 Category.19 Category.20 Category.21
Category.22 Category.23 Category.24
 /MAKE Predri FROM Predri.1 Predri.2 Predri.3 Predri.4 Predri.5 Predri.6 Predri.7 Predri.8 Predri.9 Predri.10 Predri.11 Predri.12 Predri.13
Predri.14 Predri.15 Predri.16 Predri.17 Predri.18 Predri.19 Predri.20 Predri.21 Predri.22 Predri.23 Predri.24
 /MAKE VDAP1 FROM VDAP1.1 VDAP1.2 VDAP1.3 VDAP1.4 VDAP1.5 VDAP1.6 VDAP1.7 VDAP1.8 VDAP1.9 VDAP1.10 VDAP1.11
VDAP1.12 VDAP1.13 VDAP1.14 VDAP1.15 VDAP1.16 VDAP1.17 VDAP1.18 VDAP1.19 VDAP1.20 VDAP1.21 VDAP1.22 VDAP1.23
VDAP1.24
 /MAKE VDAP6 FROM VDAP6.1 VDAP6.2 VDAP6.3 VDAP6.4 VDAP6.5 VDAP6.6 VDAP6.7 VDAP6.8 VDAP6.9 VDAP6.10 VDAP6.11
VDAP6.12 VDAP6.13 VDAP6.14 VDAP6.15 VDAP6.16 VDAP6.17 VDAP6.18 VDAP6.19 VDAP6.20 VDAP6.21 VDAP6.22 VDAP6.23
VDAP6.24
 /MAKE Stud FROM Stud.1 Stud.2 Stud.3 Stud.4 Stud.5 Stud.6 Stud.7 Stud.8 Stud.9 Stud.10 Stud.11 Stud.12 Stud.13 Stud.14 Stud.15 Stud.16
Stud.17 Stud.18 Stud.19 Stud.20 Stud.21 Stud.22 Stud.23 Stud.24
 /MAKE Driv FROM Driv.1 Driv.2 Driv.3 Driv.4 Driv.5 Driv.6 Driv.7 Driv.8 Driv.9 Driv.10 Driv.11 Driv.12 Driv.13 Driv.14 Driv.15 Driv.16
Driv.17 Driv.18 Driv.19 Driv.20 Driv.21 Driv.22 Driv.23 Driv.24
 /MAKE Presch FROM Presch.1 Presch.2 Presch.3 Presch.4 Presch.5 Presch.6 Presch.7 Presch.8 Presch.9 Presch.10 Presch.11 Presch.12
Presch.13 Presch.14 Presch.15 Presch.16 Presch.17 Presch.18 Presch.19 Presch.20 Presch.21 Presch.22 Presch.23 Presch.24
 /MAKE VDAP7 FROM VDAP7.1 VDAP7.2 VDAP7.3 VDAP7.4 VDAP7.5 VDAP7.6 VDAP7.7 VDAP7.8 VDAP7.9 VDAP7.10 VDAP7.11
VDAP7.12 VDAP7.13 VDAP7.14 VDAP7.15 VDAP7.16 VDAP7.17 VDAP7.18 VDAP7.19 VDAP7.20 VDAP7.21 VDAP7.22 VDAP7.23
VDAP7.24
 /MAKE SumAlt FROM SumAlt.1 SumAlt.2 SumAlt.3 SumAlt.4 SumAlt.5 SumAlt.6 SumAlt.7 SumAlt.8 SumAlt.9 SumAlt.10 SumAlt.11
SumAlt.12 SumAlt.13 SumAlt.14 SumAlt.15 SumAlt.16 SumAlt.17 SumAlt.18 SumAlt.19 SumAlt.20 SumAlt.21 SumAlt.22 SumAlt.23
SumAlt.24
 /MAKE Pr5 FROM Pr5.1 Pr5.2 Pr5.3 Pr5.4 Pr5.5 Pr5.6 Pr5.7 Pr5.8 Pr5.9 Pr5.10 Pr5.11 Pr5.12 Pr5.13 Pr5.14 Pr5.15 Pr5.16 Pr5.17 Pr5.18
Pr5.19 Pr5.20 Pr5.21 Pr5.22 Pr5.23 Pr5.24
 /MAKE Pr7 FROM Pr7.1 Pr7.2 Pr7.3 Pr7.4 Pr7.5 Pr7.6 Pr7.7 Pr7.8 Pr7.9 Pr7.10 Pr7.11 Pr7.12 Pr7.13 Pr7.14 Pr7.15 Pr7.16 Pr7.17 Pr7.18
Pr7.19 Pr7.20 Pr7.21 Pr7.22 Pr7.23 Pr7.24
 /MAKE Home FROM Home.1 Home.2 Home.3 Home.4 Home.5 Home.6 Home.7 Home.8 Home.9 Home.10 Home.11 Home.12 Home.13
Home.14
 Home.15 Home.16 Home.17 Home.18 Home.19 Home.20 Home.21 Home.22 Home.23 Home.24
 /MAKE School FROM School.1 School.2 School.3 School.4 School.5 School.6 School.7 School.8 School.9 School.10 School.11 School.12
School.13 School.14 School.15 School.16 School.17 School.18 School.19 School.20 School.21 School.22 School.23 School.24
 /MAKE Pr1 FROM Pr1.1 Pr1.2 Pr1.3 Pr1.4 Pr1.5 Pr1.6 Pr1.7 Pr1.8 Pr1.9 Pr1.10 Pr1.11 Pr1.12 Pr1.13 Pr1.14 Pr1.15 Pr1.16 Pr1.17 Pr1.18
Pr1.19 Pr1.20 Pr1.21 Pr1.22 Pr1.23 Pr1.24
 /MAKE Pr6 FROM Pr6.1 Pr6.2 Pr6.3 Pr6.4 Pr6.5 Pr6.6 Pr6.7 Pr6.8 Pr6.9 Pr6.10 Pr6.11 Pr6.12 Pr6.13 Pr6.14 Pr6.15 Pr6.16 Pr6.17 Pr6.18
Pr6.19 Pr6.20 Pr6.21 Pr6.22 Pr6.23 Pr6.24
 /MAKE NonMand FROM NonMand.1 NonMand.2 NonMand.3 NonMand.4 NonMand.5 NonMand.6 NonMand.7 NonMand.8 NonMand.9
NonMand.10
 NonMand.11 NonMand.12 NonMand.13 NonMand.14 NonMand.15 NonMand.16 NonMand.17 NonMand.18 NonMand.19 NonMand.20
NonMand.21
 NonMand.22 NonMand.23 NonMand.24
 /MAKE Work1 FROM Work1.1 Work1.2 Work1.3 Work1.4 Work1.5 Work1.6 Work1.7 Work1.8 Work1.9 Work1.10 Work1.11 Work1.12
Work1.13
 Work1.14 Work1.15 Work1.16 Work1.17 Work1.18 Work1.19 Work1.20 Work1.21 Work1.22 Work1.23 Work1.24
 /MAKE NonWk FROM Nonwk.1 Nonwk.2 Nonwk.3 Nonwk.4 Nonwk.5 Nonwk.6 Nonwk.7 Nonwk.8 Nonwk.9 Nonwk.10 Nonwk.11
Nonwk.12 Nonwk.13
 Nonwk.14 Nonwk.15 Nonwk.16 Nonwk.17 Nonwk.18 Nonwk.19 Nonwk.20 Nonwk.21 Nonwk.22 Nonwk.23 Nonwk.24
/KEEP = HHNo TAZ PUMA Persons HH1 Autos AutoSur AutoSh Income NPresch NPredri NDriv NNonwk NStud NPart NFull PPresch
PPredri PDriv PNonwk PStud PPart PFull Rural Suburb Urban CBD Tran25 Tran50 SerialNo iPresch7 iPredri6 iPredri7 iDriv6 iDriv7 iNonwk6
iNonwk7 iStud6 iStud7 iPart6 iPart7 iFull6 iFull7 VDAP2 VDAP3 VDAP4 VDAP5 Pr2 Pr3 Pr4 Work2 Uni WorkUni
 /NULL = DROP.
```

/* 7. University Student DAP Model

```
If(Category=5) VDAP6=-1.18+0.049*age-0.414*Persons+0.000013*Income.
If(Category=5) VDAP7=-0.646-0.994*(NPresch+NPredri+NDriv)-2.143*Tran25+2.205*Tran50+4.346*iPredri7.
If(Category=5) SumAlt=exp(VDAP3)+exp(VDAP6)+exp(VDAP7).
If(Category=5) Pr3=exp(VDAP3)/SumAlt.
If(Category=5) Pr6=exp(VDAP6)/SumAlt.
```

```
If(Category=5) Pr7=exp(VDAP7)/SumAlt.
If(Category=5 & RandDAP<=Pr3) Uni=1.
If(Category=5 & RandDAP>Pr3 & RandDAP<=Pr3+Pr6) NonMand=1.
If(Category=5 & RandDAP>Pr3+Pr6) Home=1.
Execute.
```

/* 8. Restructure into Household file and calculated indicator variables for Student adults */

```
SORT CASES BY HHNo .
CASESTOVARS
 /ID = HHNo
 /GROUPBY = VARIABLE .
Execute.

If(Category.1=5 & NonMand.1=1) iStud6=1.
If(Category.2=5 & NonMand.2=1) iStud6=1.
If(Category.3=5 & NonMand.3=1) iStud6=1.
If(Category.4=5 & NonMand.4=1) iStud6=1.
If(Category.5=5 & NonMand.5=1) iStud6=1.
If(Category.6=5 & NonMand.6=1) iStud6=1.
If(Category.7=5 & NonMand.7=1) iStud6=1.
If(Category.8=5 & NonMand.8=1) iStud6=1.
If(Category.9=5 & NonMand.9=1) iStud6=1.
If(Category.10=5 & NonMand.10=1) iStud6=1.
If(Category.11=5 & NonMand.11=1) iStud6=1.
If(Category.12=5 & NonMand.12=1) iStud6=1.
If(Category.13=5 & NonMand.13=1) iStud6=1.
If(Category.14=5 & NonMand.14=1) iStud6=1.
If(Category.15=5 & NonMand.15=1) iStud6=1.
If(Category.16=5 & NonMand.16=1) iStud6=1.
If(Category.17=5 & NonMand.17=1) iStud6=1.
If(Category.18=5 & NonMand.18=1) iStud6=1.
If(Category.19=5 & NonMand.19=1) iStud6=1.
If(Category.20=5 & NonMand.20=1) iStud6=1.
If(Category.21=5 & NonMand.21=1) iStud6=1.
If(Category.22=5 & NonMand.22=1) iStud6=1.
If(Category.23=5 & NonMand.23=1) iStud6=1.
If(Category.24=5 & NonMand.24=1) iStud6=1.

If(Category.1=5 & Home.1=1) iStud7=1.
If(Category.2=5 & Home.2=1) iStud7=1.
If(Category.3=5 & Home.3=1) iStud7=1.
If(Category.4=5 & Home.4=1) iStud7=1.
If(Category.5=5 & Home.5=1) iStud7=1.
If(Category.6=5 & Home.6=1) iStud7=1.
If(Category.7=5 & Home.7=1) iStud7=1.
If(Category.8=5 & Home.8=1) iStud7=1.
If(Category.9=5 & Home.9=1) iStud7=1.
If(Category.10=5 & Home.10=1) iStud7=1.
If(Category.11=5 & Home.11=1) iStud7=1.
If(Category.12=5 & Home.12=1) iStud7=1.
If(Category.13=5 & Home.13=1) iStud7=1.
If(Category.14=5 & Home.14=1) iStud7=1.
If(Category.15=5 & Home.15=1) iStud7=1.
If(Category.16=5 & Home.16=1) iStud7=1.
If(Category.17=5 & Home.17=1) iStud7=1.
If(Category.18=5 & Home.18=1) iStud7=1.
If(Category.19=5 & Home.19=1) iStud7=1.
If(Category.20=5 & Home.20=1) iStud7=1.
If(Category.21=5 & Home.21=1) iStud7=1.
If(Category.22=5 & Home.22=1) iStud7=1.
If(Category.23=5 & Home.23=1) iStud7=1.
If(Category.24=5 & Home.24=1) iStud7=1.
Execute.
```

/* 10. Restructure back into Person file and run Full-time Worker DAP model. */

```
VARSTOCASES /MAKE Sen FROM Sen.1 Sen.2 Sen.3 Sen.4 Sen.5 Sen.6 Sen.7 Sen.8 Sen.9 Sen.10 Sen.11 Sen.12 Sen.13 Sen.14 Sen.15
 Sen.16 Sen.17 Sen.18 Sen.19 Sen.20 Sen.21 Sen.22 Sen.23 Sen.24
 /MAKE HHPerNo FROM HHPerNo.1 HHPerNo.2 HHPerNo.3 HHPerNo.4 HHPerNo.5 HHPerNo.6 HHPerNo.7 HHPerNo.8 HHPerNo.9
HHPerNo.10
 HHPerNo.11 HHPerNo.12 HHPerNo.13 HHPerNo.14 HHPerNo.15 HHPerNo.16 HHPerNo.17 HHPerNo.18 HHPerNo.19 HHPerNo.20
HHPerNo.21
 HHPerNo.22 HHPerNo.23 HHPerNo.24
```

```
 /MAKE SerPerNo FROM SerPerNo.1 SerPerNo.2 SerPerNo.3 SerPerNo.4 SerPerNo.5 SerPerNo.6 SerPerNo.7 SerPerNo.8 SerPerNo.9
 SerPerNo.10 SerPerNo.11 SerPerNo.12 SerPerNo.13 SerPerNo.14 SerPerNo.15 SerPerNo.16 SerPerNo.17 SerPerNo.18 SerPerNo.19
 SerPerNo.20 SerPerNo.21 SerPerNo.22 SerPerNo.23 SerPerNo.24
 /MAKE Male FROM Male.1 Male.2 Male.3 Male.4 Male.5 Male.6 Male.7 Male.8 Male.9 Male.10 Male.11 Male.12 Male.13 Male.14
 Male.15 Male.16 Male.17 Male.18 Male.19 Male.20 Male.21 Male.22 Male.23 Male.24
 /MAKE Age FROM Age.1 Age.2 Age.3 Age.4 Age.5 Age.6 Age.7 Age.8 Age.9 Age.10 Age.11 Age.12 Age.13 Age.14 Age.15 Age.16 Age.17
 Age.18 Age.19 Age.20 Age.21 Age.22 Age.23 Age.24
 /MAKE RandDAP FROM RandDAP.1 RandDAP.2 RandDAP.3 RandDAP.4 RandDAP.5 RandDAP.6 RandDAP.7 RandDAP.8 RandDAP.9
RandDAP.10
 RandDAP.11 RandDAP.12 RandDAP.13 RandDAP.14 RandDAP.15 RandDAP.16 RandDAP.17 RandDAP.18 RandDAP.19 RandDAP.20
RandDAP.21 RandDAP.22 RandDAP.23 RandDAP.24
 /MAKE Part FROM Part.1 Part.2 Part.3 Part.4 Part.5 Part.6 Part.7 Part.8 Part.9 Part.10 Part.11 Part.12 Part.13 Part.14 Part.15 Part.16 Part.17
Part.18 Part.19 Part.20 Part.21 Part.22 Part.23 Part.24
 /MAKE Full FROM Full.1 Full.2 Full.3 Full.4 Full.5 Full.6 Full.7 Full.8 Full.9 Full.10 Full.11 Full.12 Full.13 Full.14 Full.15 Full.16 Full.17
Full.18 Full.19 Full.20 Full.21 Full.22 Full.23 Full.24
 /MAKE Category FROM Category.1 Category.2 Category.3 Category.4 Category.5 Category.6 Category.7 Category.8 Category.9 Category.10
Category.11 Category.12 Category.13 Category.14 Category.15 Category.16 Category.17 Category.18 Category.19 Category.20 Category.21
Category.22 Category.23 Category.24
 /MAKE Predri FROM Predri.1 Predri.2 Predri.3 Predri.4 Predri.5 Predri.6 Predri.7 Predri.8 Predri.9 Predri.10 Predri.11 Predri.12 Predri.13
Predri.14 Predri.15 Predri.16 Predri.17 Predri.18 Predri.19 Predri.20 Predri.21 Predri.22 Predri.23 Predri.24
 /MAKE VDAP1 FROM VDAP1.1 VDAP1.2 VDAP1.3 VDAP1.4 VDAP1.5 VDAP1.6 VDAP1.7 VDAP1.8 VDAP1.9 VDAP1.10 VDAP1.11
VDAP1.12 VDAP1.13 VDAP1.14 VDAP1.15 VDAP1.16 VDAP1.17 VDAP1.18 VDAP1.19 VDAP1.20 VDAP1.21 VDAP1.22 VDAP1.23
VDAP1.24
 /MAKE VDAP6 FROM VDAP6.1 VDAP6.2 VDAP6.3 VDAP6.4 VDAP6.5 VDAP6.6 VDAP6.7 VDAP6.8 VDAP6.9 VDAP6.10 VDAP6.11
VDAP6.12 VDAP6.13 VDAP6.14 VDAP6.15 VDAP6.16 VDAP6.17 VDAP6.18 VDAP6.19 VDAP6.20 VDAP6.21 VDAP6.22 VDAP6.23
VDAP6.24
 /MAKE VDAP7 FROM VDAP7.1 VDAP7.2 VDAP7.3 VDAP7.4 VDAP7.5 VDAP7.6 VDAP7.7 VDAP7.8 VDAP7.9 VDAP7.10 VDAP7.11
VDAP7.12 VDAP7.13 VDAP7.14 VDAP7.15 VDAP7.16 VDAP7.17 VDAP7.18 VDAP7.19 VDAP7.20 VDAP7.21 VDAP7.22 VDAP7.23
VDAP7.24
 /MAKE SumAlt FROM SumAlt.1 SumAlt.2 SumAlt.3 SumAlt.4 SumAlt.5 SumAlt.6 SumAlt.7 SumAlt.8 SumAlt.9 SumAlt.10 SumAlt.11
SumAlt.12 SumAlt.13 SumAlt.14 SumAlt.15 SumAlt.16 SumAlt.17 SumAlt.18 SumAlt.19 SumAlt.20 SumAlt.21 SumAlt.22 SumAlt.23
SumAlt.24
 /MAKE Pr5 FROM Pr5.1 Pr5.2 Pr5.3 Pr5.4 Pr5.5 Pr5.6 Pr5.7 Pr5.8 Pr5.9 Pr5.10 Pr5.11 Pr5.12 Pr5.13 Pr5.14 Pr5.15 Pr5.16 Pr5.17 Pr5.18
Pr5.19 Pr5.20 Pr5.21 Pr5.22 Pr5.23 Pr5.24
 /MAKE Pr7 FROM Pr7.1 Pr7.2 Pr7.3 Pr7.4 Pr7.5 Pr7.6 Pr7.7 Pr7.8 Pr7.9 Pr7.10 Pr7.11 Pr7.12 Pr7.13 Pr7.14 Pr7.15 Pr7.16 Pr7.17 Pr7.18
Pr7.19 Pr7.20 Pr7.21 Pr7.22 Pr7.23 Pr7.24
 /MAKE School FROM School.1 School.2 School.3 School.4 School.5 School.6 School.7 School.8 School.9 School.10 School.11 School.12
School.13 School.14 School.15 School.16 School.17 School.18 School.19 School.20 School.21 School.22 School.23 School.24
 /MAKE Pr1 FROM Pr1.1 Pr1.2 Pr1.3 Pr1.4 Pr1.5 Pr1.6 Pr1.7 Pr1.8 Pr1.9 Pr1.10 Pr1.11 Pr1.12 Pr1.13 Pr1.14 Pr1.15 Pr1.16 Pr1.17 Pr1.18
Pr1.19 Pr1.20 Pr1.21 Pr1.22 Pr1.23 Pr1.24
 /MAKE Pr6 FROM Pr6.1 Pr6.2 Pr6.3 Pr6.4 Pr6.5 Pr6.6 Pr6.7 Pr6.8 Pr6.9 Pr6.10 Pr6.11 Pr6.12 Pr6.13 Pr6.14 Pr6.15 Pr6.16 Pr6.17 Pr6.18
Pr6.19 Pr6.20 Pr6.21 Pr6.22 Pr6.23 Pr6.24
 /MAKE Pr3 FROM Pr3.1 Pr3.2 Pr3.3 Pr3.4 Pr3.5 Pr3.6 Pr3.7 Pr3.8 Pr3.9 Pr3.10 Pr3.11 Pr3.12 Pr3.13 Pr3.14 Pr3.15 Pr3.16 Pr3.17 Pr3.18
Pr3.19 Pr3.20 Pr3.21 Pr3.22 Pr3.23 Pr3.24
 /MAKE Stud FROM Stud.1 Stud.2 Stud.3 Stud.4 Stud.5 Stud.6 Stud.7 Stud.8 Stud.9 Stud.10 Stud.11 Stud.12 Stud.13 Stud.14 Stud.15 Stud.16
Stud.17 Stud.18 Stud.19 Stud.20 Stud.21 Stud.22 Stud.23 Stud.24
 /MAKE NonMand FROM NonMand.1 NonMand.2 NonMand.3 NonMand.4 NonMand.5 NonMand.6 NonMand.7 NonMand.8 NonMand.9
NonMand.10
 NonMand.11 NonMand.12 NonMand.13 NonMand.14 NonMand.15 NonMand.16 NonMand.17 NonMand.18 NonMand.19 NonMand.20
NonMand.21
 NonMand.22 NonMand.23 NonMand.24
 /MAKE Home FROM Home.1 Home.2 Home.3 Home.4 Home.5 Home.6 Home.7 Home.8 Home.9 Home.10 Home.11 Home.12 Home.13
Home.14
 Home.15 Home.16 Home.17 Home.18 Home.19 Home.20 Home.21 Home.22 Home.23 Home.24
 /MAKE Driv FROM Driv.1 Driv.2 Driv.3 Driv.4 Driv.5 Driv.6 Driv.7 Driv.8 Driv.9 Driv.10 Driv.11 Driv.12 Driv.13 Driv.14 Driv.15 Driv.16
Driv.17 Driv.18 Driv.19 Driv.20 Driv.21 Driv.22 Driv.23 Driv.24
 /MAKE Work1 FROM Work1.1 Work1.2 Work1.3 Work1.4 Work1.5 Work1.6 Work1.7 Work1.8 Work1.9 Work1.10 Work1.11 Work1.12
Work1.13
 Work1.14 Work1.15 Work1.16 Work1.17 Work1.18 Work1.19 Work1.20 Work1.21 Work1.22 Work1.23 Work1.24
 /MAKE Presch FROM Presch.1 Presch.2 Presch.3 Presch.4 Presch.5 Presch.6 Presch.7 Presch.8 Presch.9 Presch.10 Presch.11 Presch.12
Presch.13 Presch.14 Presch.15 Presch.16 Presch.17 Presch.18 Presch.19 Presch.20 Presch.21 Presch.22 Presch.23 Presch.24
 /MAKE Uni FROM Uni.1 Uni.2 Uni.3 Uni.4 Uni.5 Uni.6 Uni.7 Uni.8 Uni.9 Uni.10 Uni.11 Uni.12 Uni.13 Uni.14 Uni.15 Uni.16 Uni.17 Uni.18
Uni.19 Uni.20 Uni.21 Uni.22 Uni.23 Uni.24
 /MAKE NonWk FROM NonWk.1 NonWk.2 NonWk.3 NonWk.4 NonWk.5 NonWk.6 NonWk.7 NonWk.8 NonWk.9 NonWk.10 NonWk.11
NonWk.12 NonWk.13 NonWk.14 NonWk.15 NonWk.16 NonWk.17 NonWk.18 NonWk.19 NonWk.20 NonWk.21 NonWk.22 NonWk.23
NonWk.24
 /KEEP = HHNo TAZ PUMA Persons HH1 Autos AutoSur AutoSh Income NPresch NPredri NDriv NNonwk NStud NPart NFull PPresch
PPredri PDriv PNonwk PStud PPart PFull Rural Suburb Urban CBD Tran25 Tran50 SerialNo iPresch7 iPredri6 iPredri7 iDriv6 iDriv7 iNonwk6
iNonwk7 iStud6 iStud7 iPart6 iPart7 iFull6 iFull7 VDAP2 VDAP3 VDAP4 VDAP5 Pr2 Pr4 Work2 WorkUni
 /NULL = DROP.
```

/* 11. Full-Time Worker DAP Model */

```
If(Category=7) VDAP2=-2.313-0.335*Persons+0.656*(PPresch+PPredri)+0.905*Suburb+0.744*Urban.
If(Category=7) VDAP3=-0.463-0.107*age-0.991*Persons+2.511*PPredri+1.863*NStud-1.429*Autosh+1.347*Suburb.
If(Category=7) VDAP4=1.648-0.154*age-0.991*Persons+2.511*PPredri-1.28*Autosh.
If(Category=7) VDAP6=-2.576+0.014*age-0.501*NPart-0.383*Autosh+1.652*iPredri6.
If(Category=7) VDAP7=0.029+0.351*male-0.016*age-0.000011*Income-0.738*Autosh-
0.966*Tran50+0.424*iPresch7+3.094*iPredri7+1.811*iDriv7+1.64*iStud7.
If(Category=7) SumAlt=exp(VDAP1)+exp(VDAP2)+exp(VDAP3)+exp(VDAP4)+exp(VDAP6)+exp(VDAP7).
If(Category=7) Pr1=exp(VDAP1)/SumAlt.
If(Category=7) Pr2=exp(VDAP2)/SumAlt.
If(Category=7) Pr3=exp(VDAP3)/SumAlt.
If(Category=7) Pr4=exp(VDAP4)/SumAlt.
If(Category=7) Pr6=exp(VDAP6)/SumAlt.
If(Category=7) Pr7=exp(VDAP7)/SumAlt.
If(Category=7 & RandDAP<=Pr1) Work1=1.
If(Category=7 & RandDAP>Pr1 & RandDAP<=Pr1+Pr2) Work2=1.
If(Category=7 & RandDAP>Pr1+Pr2 & RandDAP<=Pr1+Pr2+Pr3) Uni=1.
If(Category=7 & RandDAP>Pr1+Pr2+Pr3 & RandDAP<=Pr1+Pr2+Pr3+Pr4) WorkUni=1.
If(Category=7 & RandDAP>Pr1+Pr2+Pr3+Pr4 & RandDAP<=Pr1+Pr2+Pr3+Pr4+Pr6) NonMand=1.
If(Category=7 & RandDAP>Pr1+Pr2+Pr3+Pr4+Pr6) Home=1.
Execute.
```

/* 12. Restructure into Household file and calculated indicator variables for Full-time Workers */

```
SORT CASES BY HHNo .
CASESTOVARS
 /ID = HHNo
 /GROUPBY = VARIABLE .
Execute.

If(Category.1=7 & NonMand.1=1) iFull6=1.
If(Category.2=7 & NonMand.2=1) iFull6=1.
If(Category.3=7 & NonMand.3=1) iFull6=1.
If(Category.4=7 & NonMand.4=1) iFull6=1.
If(Category.5=7 & NonMand.5=1) iFull6=1.
If(Category.6=7 & NonMand.6=1) iFull6=1.
If(Category.7=7 & NonMand.7=1) iFull6=1.
If(Category.8=7 & NonMand.8=1) iFull6=1.
If(Category.9=7 & NonMand.9=1) iFull6=1.
If(Category.10=7 & NonMand.10=1) iFull6=1.
If(Category.11=7 & NonMand.11=1) iFull6=1.
If(Category.12=7 & NonMand.12=1) iFull6=1.
If(Category.13=7 & NonMand.13=1) iFull6=1.
If(Category.14=7 & NonMand.14=1) iFull6=1.
If(Category.15=7 & NonMand.15=1) iFull6=1.
If(Category.16=7 & NonMand.16=1) iFull6=1.
If(Category.17=7 & NonMand.17=1) iFull6=1.
If(Category.18=7 & NonMand.18=1) iFull6=1.
If(Category.19=7 & NonMand.19=1) iFull6=1.
If(Category.20=7 & NonMand.20=1) iFull6=1.
If(Category.21=7 & NonMand.21=1) iFull6=1.
If(Category.22=7 & NonMand.22=1) iFull6=1.
If(Category.23=7 & NonMand.23=1) iFull6=1.
If(Category.24=7 & NonMand.24=1) iFull6=1.

If(Category.1=7 & Home.1=1) iFull7=1.
If(Category.2=7 & Home.2=1) iFull7=1.
If(Category.3=7 & Home.3=1) iFull7=1.
If(Category.4=7 & Home.4=1) iFull7=1.
If(Category.5=7 & Home.5=1) iFull7=1.
If(Category.6=7 & Home.6=1) iFull7=1.
If(Category.7=7 & Home.7=1) iFull7=1.
If(Category.8=7 & Home.8=1) iFull7=1.
If(Category.9=7 & Home.9=1) iFull7=1.
If(Category.10=7 & Home.10=1) iFull7=1.
If(Category.11=7 & Home.11=1) iFull7=1.
If(Category.12=7 & Home.12=1) iFull7=1.
If(Category.13=7 & Home.13=1) iFull7=1.
If(Category.14=7 & Home.14=1) iFull7=1.
If(Category.15=7 & Home.15=1) iFull7=1.
If(Category.16=7 & Home.16=1) iFull7=1.
If(Category.17=7 & Home.17=1) iFull7=1.
If(Category.18=7 & Home.18=1) iFull7=1.
If(Category.19=7 & Home.19=1) iFull7=1.
```

```
If(Category.20=7 & Home.20=1) iFull7=1.
If(Category.21=7 & Home.21=1) iFull7=1.
If(Category.22=7 & Home.22=1) iFull7=1.
If(Category.23=7 & Home.23=1) iFull7=1.
If(Category.24=7 & Home.24=1) iFull7=1.
Execute.
```

/* 13. Restructure back into Person file and run Part-time Worker DAP model. */

```
VARSTOCASES /MAKE Sen FROM Sen.1 Sen.2 Sen.3 Sen.4 Sen.5 Sen.6 Sen.7 Sen.8 Sen.9 Sen.10 Sen.11 Sen.12 Sen.13 Sen.14 Sen.15
 Sen.16 Sen.17 Sen.18 Sen.19 Sen.20 Sen.21 Sen.22 Sen.23 Sen.24
 /MAKE HHPerNo FROM HHPerNo.1 HHPerNo.2 HHPerNo.3 HHPerNo.4 HHPerNo.5 HHPerNo.6 HHPerNo.7 HHPerNo.8 HHPerNo.9
HHPerNo.10
 HHPerNo.11 HHPerNo.12 HHPerNo.13 HHPerNo.14 HHPerNo.15 HHPerNo.16 HHPerNo.17 HHPerNo.18 HHPerNo.19 HHPerNo.20
HHPerNo.21
 HHPerNo.22 HHPerNo.23 HHPerNo.24
 /MAKE SerPerNo FROM SerPerNo.1 SerPerNo.2 SerPerNo.3 SerPerNo.4 SerPerNo.5 SerPerNo.6 SerPerNo.7 SerPerNo.8 SerPerNo.9
SerPerNo.10 SerPerNo.11 SerPerNo.12 SerPerNo.13 SerPerNo.14 SerPerNo.15 SerPerNo.16 SerPerNo.17 SerPerNo.18 SerPerNo.19
SerPerNo.20 SerPerNo.21 SerPerNo.22 SerPerNo.23 SerPerNo.24
 /MAKE Male FROM Male.1 Male.2 Male.3 Male.4 Male.5 Male.6 Male.7 Male.8 Male.9 Male.10 Male.11 Male.12 Male.13 Male.14 Male.15
Male.16 Male.17 Male.18 Male.19 Male.20 Male.21 Male.22 Male.23 Male.24
 /MAKE Age FROM Age.1 Age.2 Age.3 Age.4 Age.5 Age.6 Age.7 Age.8 Age.9 Age.10 Age.11 Age.12 Age.13 Age.14 Age.15 Age.16 Age.17
Age.18 Age.19 Age.20 Age.21 Age.22 Age.23 Age.24
 /MAKE RandDAP FROM RandDAP.1 RandDAP.2 RandDAP.3 RandDAP.4 RandDAP.5 RandDAP.6 RandDAP.7 RandDAP.8 RandDAP.9
RandDAP.10
 RandDAP.11 RandDAP.12 RandDAP.13 RandDAP.14 RandDAP.15 RandDAP.16 RandDAP.17 RandDAP.18 RandDAP.19 RandDAP.20
RandDAP.21 RandDAP.22 RandDAP.23 RandDAP.24
 /MAKE Part FROM Part.1 Part.2 Part.3 Part.4 Part.5 Part.6 Part.7 Part.8 Part.9 Part.10 Part.11 Part.12 Part.13 Part.14 Part.15 Part.16 Part.17
Part.18 Part.19 Part.20 Part.21 Part.22 Part.23 Part.24
 /MAKE Full FROM Full.1 Full.2 Full.3 Full.4 Full.5 Full.6 Full.7 Full.8 Full.9 Full.10 Full.11 Full.12 Full.13 Full.14 Full.15 Full.16 Full.17
Full.18 Full.19 Full.20 Full.21 Full.22 Full.23 Full.24
 /MAKE Category FROM Category.1 Category.2 Category.3 Category.4 Category.5 Category.6 Category.7 Category.8 Category.9 Category.10
Category.11 Category.12 Category.13 Category.14 Category.15 Category.16 Category.17 Category.18 Category.19 Category.20 Category.21
Category.22 Category.23 Category.24
 /MAKE Predri FROM Predri.1 Predri.2 Predri.3 Predri.4 Predri.5 Predri.6 Predri.7 Predri.8 Predri.9 Predri.10 Predri.11 Predri.12 Predri.13
Predri.14 Predri.15 Predri.16 Predri.17 Predri.18 Predri.19 Predri.20 Predri.21 Predri.22 Predri.23 Predri.24
 /MAKE VDAP1 FROM VDAP1.1 VDAP1.2 VDAP1.3 VDAP1.4 VDAP1.5 VDAP1.6 VDAP1.7 VDAP1.8 VDAP1.9 VDAP1.10 VDAP1.11
VDAP1.12 VDAP1.13 VDAP1.14 VDAP1.15 VDAP1.16 VDAP1.17 VDAP1.18 VDAP1.19 VDAP1.20 VDAP1.21 VDAP1.22 VDAP1.23
VDAP1.24
/MAKE VDAP2 FROM VDAP2.1 VDAP2.2 VDAP2.3 VDAP2.4 VDAP2.5 VDAP2.6 VDAP2.7 VDAP2.8 VDAP2.9 VDAP2.10 VDAP2.11
VDAP2.12 VDAP2.13 VDAP2.14 VDAP2.15 VDAP2.16 VDAP2.17 VDAP2.18 VDAP2.19 VDAP2.20 VDAP2.21 VDAP2.22 VDAP2.23
VDAP2.24
/MAKE VDAP3 FROM VDAP3.1 VDAP3.2 VDAP3.3 VDAP3.4 VDAP3.5 VDAP3.6 VDAP3.7 VDAP3.8 VDAP3.9 VDAP3.10 VDAP3.11
VDAP3.12 VDAP3.13 VDAP3.14 VDAP3.15 VDAP3.16 VDAP3.17 VDAP3.18 VDAP3.19 VDAP3.20 VDAP3.21 VDAP3.22 VDAP3.23
VDAP3.24
/MAKE VDAP4 FROM VDAP4.1 VDAP4.2 VDAP4.3 VDAP4.4 VDAP4.5 VDAP4.6 VDAP4.7 VDAP4.8 VDAP4.9 VDAP4.10 VDAP4.11
VDAP4.12 VDAP4.13 VDAP4.14 VDAP4.15 VDAP4.16 VDAP4.17 VDAP4.18 VDAP4.19 VDAP4.20 VDAP4.21 VDAP4.22 VDAP4.23
VDAP4.24
 /MAKE VDAP6 FROM VDAP6.1 VDAP6.2 VDAP6.3 VDAP6.4 VDAP6.5 VDAP6.6 VDAP6.7 VDAP6.8 VDAP6.9 VDAP6.10 VDAP6.11
VDAP6.12 VDAP6.13 VDAP6.14 VDAP6.15 VDAP6.16 VDAP6.17 VDAP6.18 VDAP6.19 VDAP6.20 VDAP6.21 VDAP6.22 VDAP6.23
VDAP6.24
 /MAKE VDAP7 FROM VDAP7.1 VDAP7.2 VDAP7.3 VDAP7.4 VDAP7.5 VDAP7.6 VDAP7.7 VDAP7.8 VDAP7.9 VDAP7.10 VDAP7.11
VDAP7.12 VDAP7.13 VDAP7.14 VDAP7.15 VDAP7.16 VDAP7.17 VDAP7.18 VDAP7.19 VDAP7.20 VDAP7.21 VDAP7.22 VDAP7.23
VDAP7.24
 /MAKE SumAlt FROM SumAlt.1 SumAlt.2 SumAlt.3 SumAlt.4 SumAlt.5 SumAlt.6 SumAlt.7 SumAlt.8 SumAlt.9 SumAlt.10 SumAlt.11
SumAlt.12 SumAlt.13 SumAlt.14 SumAlt.15 SumAlt.16 SumAlt.17 SumAlt.18 SumAlt.19 SumAlt.20 SumAlt.21 SumAlt.22 SumAlt.23
SumAlt.24
 /MAKE Pr5 FROM Pr5.1 Pr5.2 Pr5.3 Pr5.4 Pr5.5 Pr5.6 Pr5.7 Pr5.8 Pr5.9 Pr5.10 Pr5.11 Pr5.12 Pr5.13 Pr5.14 Pr5.15 Pr5.16 Pr5.17 Pr5.18
Pr5.19 Pr5.20 Pr5.21 Pr5.22 Pr5.23 Pr5.24
 /MAKE Pr7 FROM Pr7.1 Pr7.2 Pr7.3 Pr7.4 Pr7.5 Pr7.6 Pr7.7 Pr7.8 Pr7.9 Pr7.10 Pr7.11 Pr7.12 Pr7.13 Pr7.14 Pr7.15 Pr7.16 Pr7.17 Pr7.18
Pr7.19 Pr7.20 Pr7.21 Pr7.22 Pr7.23 Pr7.24
 /MAKE School FROM School.1 School.2 School.3 School.4 School.5 School.6 School.7 School.8 School.9 School.10 School.11 School.12
School.13 School.14 School.15 School.16 School.17 School.18 School.19 School.20 School.21 School.22 School.23 School.24
 /MAKE Pr1 FROM Pr1.1 Pr1.2 Pr1.3 Pr1.4 Pr1.5 Pr1.6 Pr1.7 Pr1.8 Pr1.9 Pr1.10 Pr1.11 Pr1.12 Pr1.13 Pr1.14 Pr1.15 Pr1.16 Pr1.17 Pr1.18
Pr1.19 Pr1.20 Pr1.21 Pr1.22 Pr1.23 Pr1.24
 /MAKE Pr6 FROM Pr6.1 Pr6.2 Pr6.3 Pr6.4 Pr6.5 Pr6.6 Pr6.7 Pr6.8 Pr6.9 Pr6.10 Pr6.11 Pr6.12 Pr6.13 Pr6.14 Pr6.15 Pr6.16 Pr6.17 Pr6.18
Pr6.19 Pr6.20 Pr6.21 Pr6.22 Pr6.23 Pr6.24
/MAKE Pr2 FROM Pr2.1 Pr2.2 Pr2.3 Pr2.4 Pr2.5 Pr2.6 Pr2.7 Pr2.8 Pr2.9 Pr2.10 Pr2.11 Pr2.12 Pr2.13 Pr2.14 Pr2.15 Pr2.16 Pr2.17 Pr2.18 Pr2.19
Pr2.20 Pr2.21 Pr2.22 Pr2.23 Pr2.24
/MAKE Pr3 FROM Pr3.1 Pr3.2 Pr3.3 Pr3.4 Pr3.5 Pr3.6 Pr3.7 Pr3.8 Pr3.9 Pr3.10 Pr3.11 Pr3.12 Pr3.13 Pr3.14 Pr3.15 Pr3.16 Pr3.17 Pr3.18 Pr3.19
Pr3.20 Pr3.21 Pr3.22 Pr3.23 Pr3.24
/MAKE Pr4 FROM Pr4.1 Pr4.2 Pr4.3 Pr4.4 Pr4.5 Pr4.6 Pr4.7 Pr4.8 Pr4.9 Pr4.10 Pr4.11 Pr4.12 Pr4.13 Pr4.14 Pr4.15 Pr4.16 Pr4.17 Pr4.18 Pr4.19
Pr4.20 Pr4.21 Pr4.22 Pr4.23 Pr4.24
```

```
/MAKE Stud FROM Stud.1 Stud.2 Stud.3 Stud.4 Stud.5 Stud.6 Stud.7 Stud.8 Stud.9 Stud.10 Stud.11 Stud.12 Stud.13 Stud.14 Stud.15 Stud.16
Stud.17 Stud.18 Stud.19 Stud.20 Stud.21 Stud.22 Stud.23 Stud.24
 /MAKE NonMand FROM NonMand.1 NonMand.2 NonMand.3 NonMand.4 NonMand.5 NonMand.6 NonMand.7 NonMand.8 NonMand.9
NonMand.10
 NonMand.11 NonMand.12 NonMand.13 NonMand.14 NonMand.15 NonMand.16 NonMand.17 NonMand.18 NonMand.19 NonMand.20
NonMand.21
 NonMand.22 NonMand.23 NonMand.24
 /MAKE Home FROM Home.1 Home.2 Home.3 Home.4 Home.5 Home.6 Home.7 Home.8 Home.9 Home.10 Home.11 Home.12 Home.13
Home.14
 Home.15 Home.16 Home.17 Home.18 Home.19 Home.20 Home.21 Home.22 Home.23 Home.24
 /MAKE Driv FROM Driv.1 Driv.2 Driv.3 Driv.4 Driv.5 Driv.6 Driv.7 Driv.8 Driv.9 Driv.10 Driv.11 Driv.12 Driv.13 Driv.14 Driv.15 Driv.16
Driv.17 Driv.18 Driv.19 Driv.20 Driv.21 Driv.22 Driv.23 Driv.24
 /MAKE Work1 FROM Work1.1 Work1.2 Work1.3 Work1.4 Work1.5 Work1.6 Work1.7 Work1.8 Work1.9 Work1.10 Work1.11 Work1.12
Work1.13
 Work1.14 Work1.15 Work1.16 Work1.17 Work1.18 Work1.19 Work1.20 Work1.21 Work1.22 Work1.23 Work1.24
/MAKE Work2 FROM Work2.1 Work2.2 Work2.3 Work2.4 Work2.5 Work2.6 Work2.7 Work2.8 Work2.9 Work2.10 Work2.11 Work2.12
Work2.13
 Work2.14 Work2.15 Work2.16 Work2.17 Work2.18 Work2.19 Work2.20 Work2.21 Work2.22 Work2.23 Work2.24
/MAKE WorkUni FROM WorkUni.1 WorkUni.2 WorkUni.3 WorkUni.4 WorkUni.5 WorkUni.6 WorkUni.7 WorkUni.8 WorkUni.9
WorkUni.10 WorkUni.11 WorkUni.12 WorkUni.13 WorkUni.14 WorkUni.15 WorkUni.16 WorkUni.17 WorkUni.18 WorkUni.19 WorkUni.20
WorkUni.21 WorkUni.22 WorkUni.23 WorkUni.24
 /MAKE Presch FROM Presch.1 Presch.2 Presch.3 Presch.4 Presch.5 Presch.6 Presch.7 Presch.8 Presch.9 Presch.10 Presch.11 Presch.12
Presch.13 Presch.14 Presch.15 Presch.16 Presch.17 Presch.18 Presch.19 Presch.20 Presch.21 Presch.22 Presch.23 Presch.24
 /MAKE Uni FROM Uni.1 Uni.2 Uni.3 Uni.4 Uni.5 Uni.6 Uni.7 Uni.8 Uni.9 Uni.10 Uni.11 Uni.12 Uni.13 Uni.14 Uni.15 Uni.16 Uni.17 Uni.18
Uni.19 Uni.20 Uni.21 Uni.22 Uni.23 Uni.24
 /MAKE NonWk FROM NonWk.1 NonWk.2 NonWk.3 NonWk.4 NonWk.5 NonWk.6 NonWk.7 NonWk.8 NonWk.9 NonWk.10 NonWk.11
NonWk.12 NonWk.13 NonWk.14 NonWk.15 NonWk.16 NonWk.17 NonWk.18 NonWk.19 NonWk.20 NonWk.21 NonWk.22 NonWk.23
NonWk.24
 /KEEP = HHNo TAZ PUMA Persons HH1 Autos AutoSur AutoSh IncomeOld NPresch NPredri NDriv NNonwk NStud NPart NFull PPresch
PPredri PDriv PNonwk PStud PPart PFull Rural Suburb Urban CBD Tran25 Tran50 SerialNo iPresch7 iPredri6 iPredri7 iDriv6 iDriv7 iNonwk6
iNonwk7 iStud6 iStud7 iPart6 iPart7 iFull6 iFull7 VDAP5 Income
/NULL = DROP.
```

/* 14. Part-Time Worker DAP Model */

```
If(Category=6) VDAP2=-1.849-1.237*PFull.
If(Category=6) VDAP3=1.665-0.131*age+0.689*(NNonwk+NStud+NPart+NFull)+1.762*NStud-1.392*PFull-0.934*Urban.
If(Category=6) VDAP4=-5.969+1.569*NPart.
If(Category=6) VDAP6=-1.95+0.046*age+1.062*NPresch+1.113*NStud-1.945*PNonwk-0.0000089*Income-0.544*Suburb.
If(Category=6) VDAP7=0.01+0.903*NPresch-1.733*PPredri+0.625*NPart-1.446*PFull-0.000015*Income-
0.881*Suburb+4.079*iPredri7+2.48*iStud7+3.822*iFull7.
If(Category=6) SumAlt=exp(VDAP1)+exp(VDAP2)+exp(VDAP3)+exp(VDAP4)+exp(VDAP6)+exp(VDAP7).
If(Category=6) Pr1=exp(VDAP1)/SumAlt.
If(Category=6) Pr2=exp(VDAP2)/SumAlt.
If(Category=6) Pr3=exp(VDAP3)/SumAlt.
If(Category=6) Pr4=exp(VDAP4)/SumAlt.
If(Category=6) Pr6=exp(VDAP6)/SumAlt.
If(Category=6) Pr7=exp(VDAP7)/SumAlt.
If(Category=6 & RandDAP<=Pr1) Work1=1.
If(Category=6 & RandDAP>Pr1 & RandDAP<=Pr1+Pr2) Work2=1.
If(Category=6 & RandDAP>Pr1+Pr2 & RandDAP<=Pr1+Pr2+Pr3) Uni=1.
If(Category=6 & RandDAP>Pr1+Pr2+Pr3 & RandDAP<=Pr1+Pr2+Pr3+Pr4) WorkUni=1.
If(Category=6 & RandDAP>Pr1+Pr2+Pr3+Pr4 & RandDAP<=Pr1+Pr2+Pr3+Pr4+Pr6) NonMand=1.
If(Category=6 & RandDAP>Pr1+Pr2+Pr3+Pr4+Pr6) Home=1.
Execute.
```

/* 15. Restructure into Household file and calculated indicator variables for Part-time Workers */

```
SORT CASES BY HHNo .
CASESTOVARS
 /ID = HHNo
 /GROUPBY = INDEX .
Execute.

If(Category.1=6 & NonMand.1=1) iPart6=1.
If(Category.2=6 & NonMand.2=1) iPart6=1.
If(Category.3=6 & NonMand.3=1) iPart6=1.
If(Category.4=6 & NonMand.4=1) iPart6=1.
If(Category.5=6 & NonMand.5=1) iPart6=1.
If(Category.6=6 & NonMand.6=1) iPart6=1.
If(Category.7=6 & NonMand.7=1) iPart6=1.
If(Category.8=6 & NonMand.8=1) iPart6=1.
If(Category.9=6 & NonMand.9=1) iPart6=1.
If(Category.10=6 & NonMand.10=1) iPart6=1.
```

```
If(Category.11=6 & NonMand.11=1) iPart6=1.
If(Category.12=6 & NonMand.12=1) iPart6=1.
If(Category.13=6 & NonMand.13=1) iPart6=1.
If(Category.14=6 & NonMand.14=1) iPart6=1.
If(Category.15=6 & NonMand.15=1) iPart6=1.
If(Category.16=6 & NonMand.16=1) iPart6=1.
If(Category.17=6 & NonMand.17=1) iPart6=1.
If(Category.18=6 & NonMand.18=1) iPart6=1.
If(Category.19=6 & NonMand.19=1) iPart6=1.
If(Category.20=6 & NonMand.20=1) iPart6=1.
If(Category.21=6 & NonMand.21=1) iPart6=1.
If(Category.22=6 & NonMand.22=1) iPart6=1.
If(Category.23=6 & NonMand.23=1) iPart6=1.
If(Category.24=6 & NonMand.24=1) iPart6=1.

If(Category.1=6 & Home.1=1) iPart7=1.
If(Category.2=6 & Home.2=1) iPart7=1.
If(Category.3=6 & Home.3=1) iPart7=1.
If(Category.4=6 & Home.4=1) iPart7=1.
If(Category.5=6 & Home.5=1) iPart7=1.
If(Category.6=6 & Home.6=1) iPart7=1.
If(Category.7=6 & Home.7=1) iPart7=1.
If(Category.8=6 & Home.8=1) iPart7=1.
If(Category.9=6 & Home.9=1) iPart7=1.
If(Category.10=6 & Home.10=1) iPart7=1.
If(Category.11=6 & Home.11=1) iPart7=1.
If(Category.12=6 & Home.12=1) iPart7=1.
If(Category.13=6 & Home.13=1) iPart7=1.
If(Category.14=6 & Home.14=1) iPart7=1.
If(Category.15=6 & Home.15=1) iPart7=1.
If(Category.16=6 & Home.16=1) iPart7=1.
If(Category.17=6 & Home.17=1) iPart7=1.
If(Category.18=6 & Home.18=1) iPart7=1.
If(Category.19=6 & Home.19=1) iPart7=1.
If(Category.20=6 & Home.20=1) iPart7=1.
If(Category.21=6 & Home.21=1) iPart7=1.
If(Category.22=6 & Home.22=1) iPart7=1.
If(Category.23=6 & Home.23=1) iPart7=1.
If(Category.24=6 & Home.24=1) iPart7=1.
Execute.
```

/* 16. Restructure back into Person file and run Non-working Adult DAP model. */

```
VARSTOCASES /MAKE Sen FROM Sen.1 Sen.2 Sen.3 Sen.4 Sen.5 Sen.6 Sen.7 Sen.8 Sen.9 Sen.10 Sen.11 Sen.12 Sen.13 Sen.14 Sen.15
 Sen.16 Sen.17 Sen.18 Sen.19 Sen.20 Sen.21 Sen.22 Sen.23 Sen.24
 /MAKE HHPerNo FROM HHPerNo.1 HHPerNo.2 HHPerNo.3 HHPerNo.4 HHPerNo.5 HHPerNo.6 HHPerNo.7 HHPerNo.8 HHPerNo.9
HHPerNo.10
 HHPerNo.11 HHPerNo.12 HHPerNo.13 HHPerNo.14 HHPerNo.15 HHPerNo.16 HHPerNo.17 HHPerNo.18 HHPerNo.19 HHPerNo.20
HHPerNo.21
 HHPerNo.22 HHPerNo.23 HHPerNo.24
 /MAKE SerPerNo FROM SerPerNo.1 SerPerNo.2 SerPerNo.3 SerPerNo.4 SerPerNo.5 SerPerNo.6 SerPerNo.7 SerPerNo.8 SerPerNo.9
SerPerNo.10 SerPerNo.11 SerPerNo.12 SerPerNo.13 SerPerNo.14 SerPerNo.15 SerPerNo.16 SerPerNo.17 SerPerNo.18 SerPerNo.19
SerPerNo.20 SerPerNo.21 SerPerNo.22 SerPerNo.23 SerPerNo.24
 /MAKE Male FROM Male.1 Male.2 Male.3 Male.4 Male.5 Male.6 Male.7 Male.8 Male.9 Male.10 Male.11 Male.12 Male.13 Male.14 Male.15
Male.16 Male.17 Male.18 Male.19 Male.20 Male.21 Male.22 Male.23 Male.24
 /MAKE Age FROM Age.1 Age.2 Age.3 Age.4 Age.5 Age.6 Age.7 Age.8 Age.9 Age.10 Age.11 Age.12 Age.13 Age.14 Age.15 Age.16 Age.17
Age.18 Age.19 Age.20 Age.21 Age.22 Age.23 Age.24
 /MAKE RandDAP FROM RandDAP.1 RandDAP.2 RandDAP.3 RandDAP.4 RandDAP.5 RandDAP.6 RandDAP.7 RandDAP.8 RandDAP.9
RandDAP.10
 RandDAP.11 RandDAP.12 RandDAP.13 RandDAP.14 RandDAP.15 RandDAP.16 RandDAP.17 RandDAP.18 RandDAP.19 RandDAP.20
RandDAP.21 RandDAP.22 RandDAP.23 RandDAP.24
 /MAKE Part FROM Part.1 Part.2 Part.3 Part.4 Part.5 Part.6 Part.7 Part.8 Part.9 Part.10 Part.11 Part.12 Part.13 Part.14 Part.15 Part.16 Part.17
Part.18 Part.19 Part.20 Part.21 Part.22 Part.23 Part.24
 /MAKE Full FROM Full.1 Full.2 Full.3 Full.4 Full.5 Full.6 Full.7 Full.8 Full.9 Full.10 Full.11 Full.12 Full.13 Full.14 Full.15 Full.16 Full.17
Full.18 Full.19 Full.20 Full.21 Full.22 Full.23 Full.24
 /MAKE Category FROM Category.1 Category.2 Category.3 Category.4 Category.5 Category.6 Category.7 Category.8 Category.9 Category.10
Category.11 Category.12 Category.13 Category.14 Category.15 Category.16 Category.17 Category.18 Category.19 Category.20 Category.21
Category.22 Category.23 Category.24
 /MAKE Predri FROM Predri.1 Predri.2 Predri.3 Predri.4 Predri.5 Predri.6 Predri.7 Predri.8 Predri.9 Predri.10 Predri.11 Predri.12 Predri.13
Predri.14 Predri.15 Predri.16 Predri.17 Predri.18 Predri.19 Predri.20 Predri.21 Predri.22 Predri.23 Predri.24
 /MAKE VDAP1 FROM VDAP1.1 VDAP1.2 VDAP1.3 VDAP1.4 VDAP1.5 VDAP1.6 VDAP1.7 VDAP1.8 VDAP1.9 VDAP1.10 VDAP1.11
VDAP1.12 VDAP1.13 VDAP1.14 VDAP1.15 VDAP1.16 VDAP1.17 VDAP1.18 VDAP1.19 VDAP1.20 VDAP1.21 VDAP1.22 VDAP1.23
VDAP1.24
```

```
/MAKE VDAP2 FROM VDAP2.1 VDAP2.2 VDAP2.3 VDAP2.4 VDAP2.5 VDAP2.6 VDAP2.7 VDAP2.8 VDAP2.9 VDAP2.10 VDAP2.11
VDAP2.12 VDAP2.13 VDAP2.14 VDAP2.15 VDAP2.16 VDAP2.17 VDAP2.18 VDAP2.19 VDAP2.20 VDAP2.21 VDAP2.22 VDAP2.23
VDAP2.24
/MAKE VDAP3 FROM VDAP3.1 VDAP3.2 VDAP3.3 VDAP3.4 VDAP3.5 VDAP3.6 VDAP3.7 VDAP3.8 VDAP3.9 VDAP3.10 VDAP3.11
VDAP3.12 VDAP3.13 VDAP3.14 VDAP3.15 VDAP3.16 VDAP3.17 VDAP3.18 VDAP3.19 VDAP3.20 VDAP3.21 VDAP3.22 VDAP3.23
VDAP3.24
/MAKE VDAP4 FROM VDAP4.1 VDAP4.2 VDAP4.3 VDAP4.4 VDAP4.5 VDAP4.6 VDAP4.7 VDAP4.8 VDAP4.9 VDAP4.10 VDAP4.11
VDAP4.12 VDAP4.13 VDAP4.14 VDAP4.15 VDAP4.16 VDAP4.17 VDAP4.18 VDAP4.19 VDAP4.20 VDAP4.21 VDAP4.22 VDAP4.23
VDAP4.24
 /MAKE VDAP6 FROM VDAP6.1 VDAP6.2 VDAP6.3 VDAP6.4 VDAP6.5 VDAP6.6 VDAP6.7 VDAP6.8 VDAP6.9 VDAP6.10 VDAP6.11
VDAP6.12 VDAP6.13 VDAP6.14 VDAP6.15 VDAP6.16 VDAP6.17 VDAP6.18 VDAP6.19 VDAP6.20 VDAP6.21 VDAP6.22 VDAP6.23
VDAP6.24
 /MAKE VDAP7 FROM VDAP7.1 VDAP7.2 VDAP7.3 VDAP7.4 VDAP7.5 VDAP7.6 VDAP7.7 VDAP7.8 VDAP7.9 VDAP7.10 VDAP7.11
VDAP7.12 VDAP7.13 VDAP7.14 VDAP7.15 VDAP7.16 VDAP7.17 VDAP7.18 VDAP7.19 VDAP7.20 VDAP7.21 VDAP7.22 VDAP7.23
VDAP7.24
 /MAKE SumAlt FROM SumAlt.1 SumAlt.2 SumAlt.3 SumAlt.4 SumAlt.5 SumAlt.6 SumAlt.7 SumAlt.8 SumAlt.9 SumAlt.10 SumAlt.11
SumAlt.12 SumAlt.13 SumAlt.14 SumAlt.15 SumAlt.16 SumAlt.17 SumAlt.18 SumAlt.19 SumAlt.20 SumAlt.21 SumAlt.22 SumAlt.23
SumAlt.24
 /MAKE Pr5 FROM Pr5.1 Pr5.2 Pr5.3 Pr5.4 Pr5.5 Pr5.6 Pr5.7 Pr5.8 Pr5.9 Pr5.10 Pr5.11 Pr5.12 Pr5.13 Pr5.14 Pr5.15 Pr5.16 Pr5.17 Pr5.18
Pr5.19 Pr5.20 Pr5.21 Pr5.22 Pr5.23 Pr5.24
/MAKE Pr2 FROM Pr2.1 Pr2.2 Pr2.3 Pr2.4 Pr2.5 Pr2.6 Pr2.7 Pr2.8 Pr2.9 Pr2.10 Pr2.11 Pr2.12 Pr2.13 Pr2.14 Pr2.15 Pr2.16 Pr2.17 Pr2.18 Pr2.19
Pr2.20 Pr2.21 Pr2.22 Pr2.23 Pr2.24
/MAKE Pr4 FROM Pr4.1 Pr4.2 Pr4.3 Pr4.4 Pr4.5 Pr4.6 Pr4.7 Pr4.8 Pr4.9 Pr4.10 Pr4.11 Pr4.12 Pr4.13 Pr4.14 Pr4.15 Pr4.16 Pr4.17 Pr4.18 Pr4.19
Pr4.20 Pr4.21 Pr4.22 Pr4.23 Pr4.24
 /MAKE Pr7 FROM Pr7.1 Pr7.2 Pr7.3 Pr7.4 Pr7.5 Pr7.6 Pr7.7 Pr7.8 Pr7.9 Pr7.10 Pr7.11 Pr7.12 Pr7.13 Pr7.14 Pr7.15 Pr7.16 Pr7.17 Pr7.18
Pr7.19 Pr7.20 Pr7.21 Pr7.22 Pr7.23 Pr7.24
 /MAKE School FROM School.1 School.2 School.3 School.4 School.5 School.6 School.7 School.8 School.9 School.10 School.11 School.12
School.13 School.14 School.15 School.16 School.17 School.18 School.19 School.20 School.21 School.22 School.23 School.24
 /MAKE Pr1 FROM Pr1.1 Pr1.2 Pr1.3 Pr1.4 Pr1.5 Pr1.6 Pr1.7 Pr1.8 Pr1.9 Pr1.10 Pr1.11 Pr1.12 Pr1.13 Pr1.14 Pr1.15 Pr1.16 Pr1.17 Pr1.18
Pr1.19 Pr1.20 Pr1.21 Pr1.22 Pr1.23 Pr1.24
 /MAKE Pr6 FROM Pr6.1 Pr6.2 Pr6.3 Pr6.4 Pr6.5 Pr6.6 Pr6.7 Pr6.8 Pr6.9 Pr6.10 Pr6.11 Pr6.12 Pr6.13 Pr6.14 Pr6.15 Pr6.16 Pr6.17 Pr6.18
Pr6.19 Pr6.20 Pr6.21 Pr6.22 Pr6.23 Pr6.24
 /MAKE Pr3 FROM Pr3.1 Pr3.2 Pr3.3 Pr3.4 Pr3.5 Pr3.6 Pr3.7 Pr3.8 Pr3.9 Pr3.10 Pr3.11 Pr3.12 Pr3.13 Pr3.14 Pr3.15 Pr3.16 Pr3.17 Pr3.18
Pr3.19 Pr3.20 Pr3.21 Pr3.22 Pr3.23 Pr3.24
 /MAKE Stud FROM Stud.1 Stud.2 Stud.3 Stud.4 Stud.5 Stud.6 Stud.7 Stud.8 Stud.9 Stud.10 Stud.11 Stud.12 Stud.13 Stud.14 Stud.15 Stud.16
Stud.17 Stud.18 Stud.19 Stud.20 Stud.21 Stud.22 Stud.23 Stud.24
 /MAKE NonMand FROM NonMand.1 NonMand.2 NonMand.3 NonMand.4 NonMand.5 NonMand.6 NonMand.7 NonMand.8 NonMand.9
NonMand.10
 NonMand.11 NonMand.12 NonMand.13 NonMand.14 NonMand.15 NonMand.16 NonMand.17 NonMand.18 NonMand.19 NonMand.20
NonMand.21
 NonMand.22 NonMand.23 NonMand.24
 /MAKE Home FROM Home.1 Home.2 Home.3 Home.4 Home.5 Home.6 Home.7 Home.8 Home.9 Home.10 Home.11 Home.12 Home.13
Home.14
 Home.15 Home.16 Home.17 Home.18 Home.19 Home.20 Home.21 Home.22 Home.23 Home.24
 /MAKE Driv FROM Driv.1 Driv.2 Driv.3 Driv.4 Driv.5 Driv.6 Driv.7 Driv.8 Driv.9 Driv.10 Driv.11 Driv.12 Driv.13 Driv.14 Driv.15 Driv.16
Driv.17 Driv.18 Driv.19 Driv.20 Driv.21 Driv.22 Driv.23 Driv.24
 /MAKE Work1 FROM Work1.1 Work1.2 Work1.3 Work1.4 Work1.5 Work1.6 Work1.7 Work1.8 Work1.9 Work1.10 Work1.11 Work1.12
Work1.13
 Work1.14 Work1.15 Work1.16 Work1.17 Work1.18 Work1.19 Work1.20 Work1.21 Work1.22 Work1.23 Work1.24
/MAKE Work2 FROM Work2.1 Work2.2 Work2.3 Work2.4 Work2.5 Work2.6 Work2.7 Work2.8 Work2.9 Work2.10 Work2.11 Work2.12
Work2.13
 Work2.14 Work2.15 Work2.16 Work2.17 Work2.18 Work2.19 Work2.20 Work2.21 Work2.22 Work2.23 Work2.24
 /MAKE Presch FROM Presch.1 Presch.2 Presch.3 Presch.4 Presch.5 Presch.6 Presch.7 Presch.8 Presch.9 Presch.10 Presch.11 Presch.12
Presch.13 Presch.14 Presch.15 Presch.16 Presch.17 Presch.18 Presch.19 Presch.20 Presch.21 Presch.22 Presch.23 Presch.24
 /MAKE Uni FROM Uni.1 Uni.2 Uni.3 Uni.4 Uni.5 Uni.6 Uni.7 Uni.8 Uni.9 Uni.10 Uni.11 Uni.12 Uni.13 Uni.14 Uni.15 Uni.16 Uni.17 Uni.18
Uni.19 Uni.20 Uni.21 Uni.22 Uni.23 Uni.24
/MAKE WorkUni FROM WorkUni.1 WorkUni.2 WorkUni.3 WorkUni.4 WorkUni.5 WorkUni.6 WorkUni.7 WorkUni.8 WorkUni.9
WorkUni.10 WorkUni.11 WorkUni.12 WorkUni.13 WorkUni.14 WorkUni.15 WorkUni.16 WorkUni.17 WorkUni.18 WorkUni.19 WorkUni.20
WorkUni.21 WorkUni.22 WorkUni.23 WorkUni.24
 /MAKE NonWk FROM NonWk.1 NonWk.2 NonWk.3 NonWk.4 NonWk.5 NonWk.6 NonWk.7 NonWk.8 NonWk.9 NonWk.10 NonWk.11
NonWk.12 NonWk.13 NonWk.14 NonWk.15 NonWk.16 NonWk.17 NonWk.18 NonWk.19 NonWk.20 NonWk.21 NonWk.22 NonWk.23
NonWk.24
 /KEEP = HHNo TAZ PUMA Persons HH1 Autos AutoSur AutoSh NPresch NPredri NDriv NNonwk NStud NPart NFull PPresch PPredri PDriv
PNonwk PStud PPart PFull Rural Suburb Urban CBD Tran25 Tran50 SerialNo iPresch7 iPredri6 iPredri7 iDriv6 iDriv7 iNonwk6 iNonwk7
iStud6 iStud7 iPart6 iPart7 iFull6 iFull7 VDAP5 Income
/NULL = DROP.
```

/* 17. Non-Working Adult DAP Model */

```
If(Category=4) VDAP3=-4.043+0.000026*Income+3.648*Tran50.
If(Category=4) VDAP6=3.148-1.65*PPresch-0.602*NFull-0.896*PPart+0.000016*Income+1.489*Tran50.
If(Category=4) VDAP7=3.105-1.577*PPresch-1.398*PPredri+1.643*Tran50-0.935*iPresch7+3.405*iDriv7.
If(Category=4) SumAlt=exp(VDAP1)+exp(VDAP3)+exp(VDAP6)+exp(VDAP7).
```

```
If(Category=4) Pr1=exp(VDAP1)/SumAlt.
If(Category=4) Pr3=exp(VDAP3)/SumAlt.
If(Category=4) Pr6=exp(VDAP6)/SumAlt.
If(Category=4) Pr7=exp(VDAP7)/SumAlt.
If(Category=4 & RandDAP<=Pr1) Work1=1.
If(Category=4 & RandDAP>Pr1 & RandDAP<=Pr1+Pr3) Uni=1.
If(Category=4 & RandDAP>Pr1+Pr3 & RandDAP<=Pr1+Pr3+Pr6) NonMand=1.
If(Category=4 & RandDAP>Pr1+Pr3+Pr6) Home=1.
Execute.
```

/* 18. Restructure into Household file and calculated indicator variables for Non-workers */

```
SORT CASES BY HHNo .
CASESTOVARS
 /ID = HHNo
 /GROUPBY = INDEX .
Execute.

If(Category.1=4 & NonMand.1=1) iNonWk6=1.
If(Category.2=4 & NonMand.2=1) iNonWk6=1.
If(Category.3=4 & NonMand.3=1) iNonWk6=1.
If(Category.4=4 & NonMand.4=1) iNonWk6=1.
If(Category.5=4 & NonMand.5=1) iNonWk6=1.
If(Category.6=4 & NonMand.6=1) iNonWk6=1.
If(Category.7=4 & NonMand.7=1) iNonWk6=1.
If(Category.8=4 & NonMand.8=1) iNonWk6=1.
If(Category.9=4 & NonMand.9=1) iNonWk6=1.
If(Category.10=4 & NonMand.10=1) iNonWk6=1.
If(Category.11=4 & NonMand.11=1) iNonWk6=1.
If(Category.12=4 & NonMand.12=1) iNonWk6=1.
If(Category.13=4 & NonMand.13=1) iNonWk6=1.
If(Category.14=4 & NonMand.14=1) iNonWk6=1.
If(Category.15=4 & NonMand.15=1) iNonWk6=1.
If(Category.16=4 & NonMand.16=1) iNonWk6=1.
If(Category.17=4 & NonMand.17=1) iNonWk6=1.
If(Category.18=4 & NonMand.18=1) iNonWk6=1.
If(Category.19=4 & NonMand.19=1) iNonWk6=1.
If(Category.20=4 & NonMand.20=1) iNonWk6=1.
If(Category.21=4 & NonMand.21=1) iNonWk6=1.
If(Category.22=4 & NonMand.22=1) iNonWk6=1.
If(Category.23=4 & NonMand.23=1) iNonWk6=1.
If(Category.24=4 & NonMand.24=1) iNonWk6=1.

If(Category.1=4 & Home.1=1) iNonWk7=1.
If(Category.2=4 & Home.2=1) iNonWk7=1.
If(Category.3=4 & Home.3=1) iNonWk7=1.
If(Category.4=4 & Home.4=1) iNonWk7=1.
If(Category.5=4 & Home.5=1) iNonWk7=1.
If(Category.6=4 & Home.6=1) iNonWk7=1.
If(Category.7=4 & Home.7=1) iNonWk7=1.
If(Category.8=4 & Home.8=1) iNonWk7=1.
If(Category.9=4 & Home.9=1) iNonWk7=1.
If(Category.10=4 & Home.10=1) iNonWk7=1.
If(Category.11=4 & Home.11=1) iNonWk7=1.
If(Category.12=4 & Home.12=1) iNonWk7=1.
If(Category.13=4 & Home.13=1) iNonWk7=1.
If(Category.14=4 & Home.14=1) iNonWk7=1.
If(Category.15=4 & Home.15=1) iNonWk7=1.
If(Category.16=4 & Home.16=1) iNonWk7=1.
If(Category.17=4 & Home.17=1) iNonWk7=1.
If(Category.18=4 & Home.18=1) iNonWk7=1.
If(Category.19=4 & Home.19=1) iNonWk7=1.
If(Category.20=4 & Home.20=1) iNonWk7=1.
If(Category.21=4 & Home.21=1) iNonWk7=1.
If(Category.22=4 & Home.22=1) iNonWk7=1.
If(Category.23=4 & Home.23=1) iNonWk7=1.
If(Category.24=4 & Home.24=1) iNonWk7=1.
Execute.
```

/* Save file as HH-DAP */

/* Non-Mandatory Activities Model System */

```
/* 19. Household Escorting Activities Number Model */
Compute Esc1=0.
Compute Esc2=0.
Compute Esc3=0.
Compute VEsc0=0.
Compute VEsc1=-3.658+0.556*Autosur+0.8*NPresch+2.391*Tran25-2.383*Tran50+1.075*( iPredri6+iDriv6)+
0.519*(iNonwk6+iStud6+iPart6+iFull7).
Compute VEsc2=-6.212+0.662*NNonwk+0.749*NPart+1.835*(Urban+Suburb)-1.748*Tran25+0.519*(iNonwk6+iStud6+iPart6+iFull7).
Compute VEsc3=-7.283.
Compute SumAltE=exp(VEsc0)+exp(VEsc1)+exp(VEsc2)+exp(VEsc3).
Compute PrEsc0=exp(VEsc0)/SumAltE.
Compute PrEsc1=exp(VEsc1)/SumAltE.
Compute PrEsc2=exp(VEsc2)/SumAltE.
Compute PrEsc3=exp(VEsc3)/SumAltE.
Compute RandE= RV.UNIFORM(0,1).
If(RandE>PrEsc0) Esc1=1.
if(RandE>PrEsc0+PrEsc1) Esc2=1.
if(RandE>PrEsc0+PrEsc1+PrEsc2) Esc3=1.
Compute NEsc=Esc1+Esc2+Esc3.
Execute.

/* 21. Household Shopping Activity Number Model */
Compute Shop1=0.
Compute Shop2=0.
Compute Shop3=0.
Compute VShop0=0.
Compute VShop1=-0.971-0.277*NPredri+0.886*PNonwk+0.0000053*Income-0.293*Suburb+0.767*iStud6+0.924*iPart6+0.529*iFull6-
1.14*iNonwk7-0.535*iFull7.
Compute VShop2=-2.539+0.987*NNonwk+0.877*PStud+0.00000089*Income+0.234*NEsc+0.246*Urban+
1.616*iPart6+0.579*iFull6-2.08*iNonwk7-0.535*iFull7.
Compute VShop3=-2.585-0.735*HH1+1.777*PNonwk+0.0000086*Income+0.322*NEsc+0.246*Urban+
1.985*iStud6+1.859*iPart6+1.1*iFull6-2.803*iNonwk7-0.976*iFull7.
Compute AltSumS=exp(VShop0)+exp(VShop1)+exp(VShop2)+exp(VShop3).
Compute PrShop0=exp(VShop0)/AltSumS.
Compute PrShop1=exp(VShop1)/AltSumS.
Compute PrShop2=exp(VShop2)/AltSumS.
Compute PrShop3=exp(VShop3)/AltSumS.
Compute RandS= RV.UNIFORM(0,1).
if(RandS>PrShop0) Shop1=1.
if(RandS>PrShop0+PrShop1) Shop2=1.
if(RandS>PrShop0+PrShop1+PrShop2) Shop3=1.
Compute NShop=Shop1+Shop2+Shop3.
Execute.

/* 22. Household Other Maintenance Activities Number Model */
Compute Other1=0.
Compute Other2=0.
Compute Other3=0.
Compute VOther0=0.
Compute VOther1=-1.941+0.326*NNonwk+0.000006*Income+0.263*NEsc+0.315*NShop-
1.599*iPredri6+0.869*iPart6+0.487*iFull6+1.314*iStud7.
Compute VOther2=-3.753+0.88*NNonwk+0.000026*Income+0.37*NShop+0.959*(iStud6+iPart6)+1.278*iFull6-1.45*iNonwk7+1.314*iStud7.
Compute VOther3=-3.351-0.666*HH1+0.000005*Income+0.265*NEsc+0.657*NShop+1.03*iNonwk6+
0.975*iPart6+0.918*iFull6-1.46*iFull7.
Compute SumAltO=exp(VOther0)+exp(VOther1)+exp(VOther2)+exp(VOther3).
Compute PrOther0=exp(VOther0)/SumAltO.
Compute PrOther1=exp(VOther1)/SumAltO.
Compute PrOther2=exp(VOther2)/SumAltO.
Compute PrOther3=exp(VOther3)/SumAltO.
Compute RandO=RV.Uniform(0,1).
if(RandO>PrOther0) Other1=1.
if(RandO>PrOther0+PrOther1) Other2=1.
if(RandO>PrOther0+PrOther1+PrOther2) Other3=1.
Compute NOther=Other1+Other2+Other3.
Execute.

/* Individual Maintenance Activity Allocation Model */
/* Limitation of this model is that it only allows assignment to first 8 people of household */
/* 23. Assign all Persons=1 maintenance activities
```

```
if(Persons=1 & Esc1=1) PerNoE1=1.
if(Persons=1 & Esc2=1) PerNoE2=1.
If(Persons=1 & Esc3=1) PerNoE3=1.
If(Persons=1 & Shop1=1) PerNoS1=1.
If(Persons=1 & Shop2=1) PerNoS2=1.
If(Persons=1 & Shop3=1) PerNoS3=1.
If(Persons=1 & Other1=1) PerNoO1=1.
If(Persons=1 & Other2=1) PerNoO2=1.
If(Persons=1 & Other3=1) PerNoO3=1.
Execute.
```

/* 24. Escort Activity #1 */

```
if(Persons>1 & Esc1=1) VPerE11=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Esc1=1) VPerE12=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+0.278*Esc1+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Esc1=1) VPerE13=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Esc1=1) VPerE14=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Esc1=1) VPerE15=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Esc1=1) VPerE16=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Esc1=1) VPerE17=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Esc1=1) VPerE18=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
if(Persons=2 & Esc1=1) SumAltE1=exp(VPerE11)+exp(VPerE12).
if(Persons=3 & Esc1=1) SumAltE1=exp(VPerE11)+exp(VPerE12)+exp(VPerE13).
if(Persons=4 & Esc1=1) SumAltE1=exp(VPerE11)+exp(VPerE12)+exp(VPerE13)+exp(VPerE14).
if(Persons=5 & Esc1=1) SumAltE1=exp(VPerE11)+exp(VPerE12)+exp(VPerE13)+exp(VPerE14)+exp(VPerE15).
if(Persons=6 & Esc1=1) SumAltE1=exp(VPerE11)+exp(VPerE12)+exp(VPerE13)+exp(VPerE14)+exp(VPerE15)+exp(VPerE16).
if(Persons=7 & Esc1=1)
SumAltE1=exp(VPerE11)+exp(VPerE12)+exp(VPerE13)+exp(VPerE14)+exp(VPerE15)+exp(VPerE16)+exp(VPerE17).
if(Persons>7 & Esc1=1)
SumAltE1=exp(VPerE11)+exp(VPerE12)+exp(VPerE13)+exp(VPerE14)+exp(VPerE15)+exp(VPerE16)+exp(VPerE17)+exp(VPerE18).
If(Persons>1 & Esc1=1) PrPerE11=exp(VPerE11)/SumAltE1.
If(Persons>1 & Esc1=1) PrPerE12=exp(VPerE12)/SumAltE1.
If(Persons>1 & Esc1=1) PrPerE13=exp(VPerE13)/SumAltE1.
If(Persons>1 & Esc1=1) PrPerE14=exp(VPerE14)/SumAltE1.
If(Persons>1 & Esc1=1) PrPerE15=exp(VPerE15)/SumAltE1.
If(Persons>1 & Esc1=1) PrPerE16=exp(VPerE16)/SumAltE1.
If(Persons>1 & Esc1=1) PrPerE17=exp(VPerE17)/SumAltE1.
If(Persons>1 & Esc1=1) PrPerE18=exp(VPerE18)/SumAltE1.
If(Persons>1 & Esc1=1) RandE1= RV.UNIFORM(0,1).
if(Persons>1 & Esc1=1 & RandE1<=PrPerE11) PerNoE1=1.
if(Persons>1 & Esc1=1 & RandE1>PrPerE11 & RandE1<=PrPerE11+PrPerE12) PerNoE1=2.
if(Persons>1 & Esc1=1 & RandE1>PrPerE11+PrPerE12 & RandE1<=PrPerE11+PrPerE12+PrPerE13) PerNoE1=3.
if(Persons>1 & Esc1=1 & RandE1>PrPerE11+PrPerE12+PrPerE13 & RandE1<=PrPerE11+PrPerE12+PrPerE13+PrPerE14) PerNoE1=4.
if(Persons>1 & Esc1=1 & RandE1>PrPerE11+PrPerE12+PrPerE13+PrPerE14 &
RandE1<=PrPerE11+PrPerE12+PrPerE13+PrPerE14+PrPerE15) PerNoE1=5.
if(Persons>1 & Esc1=1 & RandE1>PrPerE11+PrPerE12+PrPerE13+PrPerE14+PrPerE15 &
RandE1<=PrPerE11+PrPerE12+PrPerE13+PrPerE14+PrPerE15+PrPerE16) PerNoE1=6.
if(Persons>1 & Esc1=1 & RandE1>PrPerE11+PrPerE12+PrPerE13+PrPerE14+PrPerE15+PrPerE16 &
RandE1<=PrPerE11+PrPerE12+PrPerE13+PrPerE14+PrPerE15+PrPerE16+PrPerE17) PerNoE1=7.
if(Persons>1 & Esc1=1 & RandE1>1-PrPerE18) PerNoE1=8.
Execute.
```

/* 25. Escort Activity #2 */

```
if(Persons>1 & Esc2=1) VPerE21=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Esc2=1) VPerE22=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+0.278*Esc2+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Esc2=1) VPerE23=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Esc2=1) VPerE24=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Esc2=1) VPerE25=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Esc2=1) VPerE26=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Esc2=1) VPerE27=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Esc2=1) VPerE28=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
if(Persons=2 & Esc2=1) SumAltE2=exp(VPerE21)+exp(VPerE22).
if(Persons=3 & Esc2=1) SumAltE2=exp(VPerE21)+exp(VPerE22)+exp(VPerE23).
if(Persons=4 & Esc2=1) SumAltE2=exp(VPerE21)+exp(VPerE22)+exp(VPerE23)+exp(VPerE24).
if(Persons=5 & Esc2=1) SumAltE2=exp(VPerE21)+exp(VPerE22)+exp(VPerE23)+exp(VPerE24)+exp(VPerE25).
```

```
if(Persons=6 & Esc2=1) SumAltE2=exp(VPerE21)+exp(VPerE22)+exp(VPerE23)+exp(VPerE24)+exp(VPerE25)+exp(VPerE26).
if(Persons=7 & Esc2=1)
SumAltE2=exp(VPerE21)+exp(VPerE22)+exp(VPerE23)+exp(VPerE24)+exp(VPerE25)+exp(VPerE26)+exp(VPerE27).
if(Persons>7 & Esc2=1)
SumAltE2=exp(VPerE21)+exp(VPerE22)+exp(VPerE23)+exp(VPerE24)+exp(VPerE25)+exp(VPerE26)+exp(VPerE27)+exp(VPerE28).
If(Persons>1 & Esc2=1) PrPerE21=exp(VPerE21)/SumAltE2.
If(Persons>1 & Esc2=1) PrPerE22=exp(VPerE22)/SumAltE2.
If(Persons>1 & Esc2=1) PrPerE23=exp(VPerE23)/SumAltE2.
If(Persons>1 & Esc2=1) PrPerE24=exp(VPerE24)/SumAltE2.
If(Persons>1 & Esc2=1) PrPerE25=exp(VPerE25)/SumAltE2.
If(Persons>1 & Esc2=1) PrPerE26=exp(VPerE26)/SumAltE2.
If(Persons>1 & Esc2=1) PrPerE27=exp(VPerE27)/SumAltE2.
If(Persons>1 & Esc2=1) PrPerE28=exp(VPerE28)/SumAltE2.
If(Persons>1 & Esc2=1) RandE2= RV.UNIFORM(0,1).
if(Persons>1 & Esc2=1 & RandE2<=PrPerE21) PerNoE2=1.
if(Persons>1 & Esc2=1 & RandE2>PrPerE21 & RandE2<=PrPerE21+PrPerE22) PerNoE2=2.
if(Persons>1 & Esc2=1 & RandE2>PrPerE21+PrPerE22 & RandE2<=PrPerE21+PrPerE22+PrPerE23) PerNoE2=3.
if(Persons>1 & Esc2=1 & RandE2>PrPerE21+PrPerE22+PrPerE23 & RandE2<=PrPerE21+PrPerE22+PrPerE23+PrPerE24) PerNoE2=4.
if(Persons>1 & Esc2=1 & RandE2>PrPerE21+PrPerE22+PrPerE23+PrPerE24 &
RandE2<=PrPerE21+PrPerE22+PrPerE23+PrPerE24+PrPerE25) PerNoE2=5.
if(Persons>1 & Esc2=1 & RandE2>PrPerE21+PrPerE22+PrPerE23+PrPerE24+PrPerE25 &
RandE2<=PrPerE21+PrPerE22+PrPerE23+PrPerE24+PrPerE25+PrPerE26) PerNoE2=6.
if(Persons>1 & Esc2=1 & RandE2>PrPerE21+PrPerE22+PrPerE23+PrPerE24+PrPerE25+PrPerE26 &
RandE2<=PrPerE21+PrPerE22+PrPerE23+PrPerE24+PrPerE25+PrPerE26+PrPerE27) PerNoE2=7.
if(Persons>1 & Esc2=1 & RandE2>1-PrPerE28) PerNoE2=8.
Execute.
```

/* 26. Escort Activity #3 */

```
if(Persons>1 & Esc3=1) VPerE31=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Esc3=1) VPerE32=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+0.278*Esc3+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Esc3=1) VPerE33=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Esc3=1) VPerE34=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Esc3=1) VPerE35=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Esc3=1) VPerE36=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Esc3=1) VPerE37=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Esc3=1) VPerE38=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
if(Persons=2 & Esc3=1) SumAltE3=exp(VPerE31)+exp(VPerE32).
if(Persons=3 & Esc3=1) SumAltE3=exp(VPerE31)+exp(VPerE32)+exp(VPerE33).
if(Persons=4 & Esc3=1) SumAltE3=exp(VPerE31)+exp(VPerE32)+exp(VPerE33)+exp(VPerE34).
if(Persons=5 & Esc3=1) SumAltE3=exp(VPerE31)+exp(VPerE32)+exp(VPerE33)+exp(VPerE34)+exp(VPerE35).
if(Persons=6 & Esc3=1) SumAltE3=exp(VPerE31)+exp(VPerE32)+exp(VPerE33)+exp(VPerE34)+exp(VPerE35)+exp(VPerE36).
if(Persons=7 & Esc3=1)
SumAltE3=exp(VPerE31)+exp(VPerE32)+exp(VPerE33)+exp(VPerE34)+exp(VPerE35)+exp(VPerE36)+exp(VPerE37).
if(Persons>7 & Esc3=1)
SumAltE3=exp(VPerE31)+exp(VPerE32)+exp(VPerE33)+exp(VPerE34)+exp(VPerE35)+exp(VPerE36)+exp(VPerE37)+exp(VPerE38).
if(Persons>1 & Esc3=1) PrPerE31=exp(VPerE31)/SumAltE3.
if(Persons>1 & Esc3=1) PrPerE32=exp(VPerE32)/SumAltE3.
if(Persons>1 & Esc3=1) PrPerE33=exp(VPerE33)/SumAltE3.
if(Persons>1 & Esc3=1) PrPerE34=exp(VPerE34)/SumAltE3.
if(Persons>1 & Esc3=1) PrPerE35=exp(VPerE35)/SumAltE3.
if(Persons>1 & Esc3=1) PrPerE36=exp(VPerE36)/SumAltE3.
if(Persons>1 & Esc3=1) PrPerE37=exp(VPerE37)/SumAltE3.
if(Persons>1 & Esc3=1) PrPerE38=exp(VPerE38)/SumAltE3.
if(Persons>1 & Esc3=1) RandE3= RV.UNIFORM(0,1).
if(Persons>1 & Esc3=1 & RandE3<=PrPerE31) PerNoE3=1.
if(Persons>1 & Esc3=1 & RandE3>PrPerE31 & RandE3<=PrPerE31+PrPerE32) PerNoE3=2.
if(Persons>1 & Esc3=1 & RandE3>PrPerE31+PrPerE32 & RandE3<=PrPerE31+PrPerE32+PrPerE33) PerNoE3=3.
if(Persons>1 & Esc3=1 & RandE3>PrPerE31+PrPerE32+PrPerE33 & RandE3<=PrPerE31+PrPerE32+PrPerE33+PrPerE34) PerNoE3=4.
if(Persons>1 & Esc3=1 & RandE3>PrPerE31+PrPerE32+PrPerE33+PrPerE34 &
RandE3<=PrPerE31+PrPerE32+PrPerE33+PrPerE34+PrPerE35) PerNoE3=5.
if(Persons>1 & Esc3=1 & RandE3>PrPerE31+PrPerE32+PrPerE33+PrPerE34+PrPerE35 &
RandE3<=PrPerE31+PrPerE32+PrPerE33+PrPerE34+PrPerE35+PrPerE36) PerNoE3=6.
if(Persons>1 & Esc3=1 & RandE3>PrPerE31+PrPerE32+PrPerE33+PrPerE34+PrPerE35+PrPerE36 &
RandE3<=PrPerE31+PrPerE32+PrPerE33+PrPerE34+PrPerE35+PrPerE36+PrPerE37) PerNoE3=7.
if(Persons>1 & Esc3=1 & RandE3>1-PrPerE38) PerNoE3=8.
Execute.
```

/* 27. Shopping Activity #1 */

```
if(Persons>1 & Shop1=1) VPerS11=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & NShop>0) VPerS12=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Shop1=1) VPerS13=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Shop1=1) VPerS14=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Shop1=1) VPerS15=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Shop1=1) VPerS16=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Shop1=1) VPerS17=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Shop1=1) VPerS18=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
If(Persons=2 & Shop1=1) SumAltS1=exp(VPerS11)+exp(VPerS12).
If(Persons=3 & Shop1=1) SumAltS1=exp(VPerS11)+exp(VPerS12)+exp(VPerS13).
If(Persons=4 & Shop1=1) SumAltS1=exp(VPerS11)+exp(VPerS12)+exp(VPerS13)+exp(VPerS14).
If(Persons=5 & Shop1=1) SumAltS1=exp(VPerS11)+exp(VPerS12)+exp(VPerS13)+exp(VPerS14)+exp(VPerS15).
If(Persons=6 & Shop1=1) SumAltS1=exp(VPerS11)+exp(VPerS12)+exp(VPerS13)+exp(VPerS14)+exp(VPerS15)+exp(VPerS16).
If(Persons=7 & Shop1=1)
SumAltS1=exp(VPerS11)+exp(VPerS12)+exp(VPerS13)+exp(VPerS14)+exp(VPerS15)+exp(VPerS16)+exp(VPerS17).
If(Persons>7 & Shop1=1)
SumAltS1=exp(VPerS11)+exp(VPerS12)+exp(VPerS13)+exp(VPerS14)+exp(VPerS15)+exp(VPerS16)+exp(VPerS17)+exp(VPerS18).
If(Persons>1 & Shop1=1) PrPerS11=exp(VPerS11)/SumAltS1.
If(Persons>1 & Shop1=1) PrPerS12=exp(VPerS12)/SumAltS1.
If(Persons>1 & Shop1=1) PrPerS13=exp(VPerS13)/SumAltS1.
If(Persons>1 & Shop1=1) PrPerS14=exp(VPerS14)/SumAltS1.
If(Persons>1 & Shop1=1) PrPerS15=exp(VPerS15)/SumAltS1.
If(Persons>1 & Shop1=1) PrPerS16=exp(VPerS16)/SumAltS1.
If(Persons>1 & Shop1=1) PrPerS17=exp(VPerS17)/SumAltS1.
If(Persons>1 & Shop1=1) PrPerS18=exp(VPerS18)/SumAltS1.
If(Persons>1 & Shop1=1) RandS1= RV.UNIFORM(0,1).
if(Persons>1 & Shop1=1 & RandS1<=PrPerS11) PerNoS1=1.
if(Persons>1 & Shop1=1 & RandS1>PrPerS11 & RandS1<=PrPerS11+PrPerS12) PerNoS1=2.
if(Persons>1 & Shop1=1 & RandS1>PrPerS11+PrPerS12 & RandS1<=PrPerS11+PrPerS12+PrPerS13) PerNoS1=3.
if(Persons>1 & Shop1=1 & RandS1>PrPerS11+PrPerS12+PrPerS13 & RandS1<=PrPerS11+PrPerS12+PrPerS13+PrPerS14) PerNoS1=4.
if(Persons>1 & Shop1=1 & RandS1>PrPerS11+PrPerS12+PrPerS13+PrPerS14 &
RandS1<=PrPerS11+PrPerS12+PrPerS13+PrPerS14+PrPerS15) PerNoS1=5.
if(Persons>1 & Shop1=1 & RandS1>PrPerS11+PrPerS12+PrPerS13+PrPerS14+PrPerS15 &
RandS1<=PrPerS11+PrPerS12+PrPerS13+PrPerS14+PrPerS15+PrPerS16) PerNoS1=6.
if(Persons>1 & Shop1=1 & RandS1>PrPerS11+PrPerS12+PrPerS13+PrPerS14+PrPerS15+PrPerS16 &
RandS1<=PrPerS11+PrPerS12+PrPerS13+PrPerS14+PrPerS15+PrPerS16+PrPerS17) PerNoS1=7.
if(Persons>1 & Shop1=1 & RandS1>1-PrPerS18) PerNoS1=8.
Execute.
```

/* 28. Shopping Activity #2 */

```
if(Persons>1 & Shop2=1) VPerS21=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Shop2=1) VPerS22=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Shop2=1) VPerS23=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Shop2=1) VPerS24=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Shop2=1) VPerS25=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Shop2=1) VPerS26=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Shop2=1) VPerS27=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Shop2=1) VPerS28=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
If(Persons=2 & Shop2=1) SumAltS2=exp(VPerS21)+exp(VPerS22).
If(Persons=3 & Shop2=1) SumAltS2=exp(VPerS21)+exp(VPerS22)+exp(VPerS23).
If(Persons=4 & Shop2=1) SumAltS2=exp(VPerS21)+exp(VPerS22)+exp(VPerS23)+exp(VPerS24).
If(Persons=5 & Shop2=1) SumAltS2=exp(VPerS21)+exp(VPerS22)+exp(VPerS23)+exp(VPerS24)+exp(VPerS25).
If(Persons=6 & Shop2=1) SumAltS2=exp(VPerS21)+exp(VPerS22)+exp(VPerS23)+exp(VPerS24)+exp(VPerS25)+exp(VPerS26).
If(Persons=7 & Shop2=1)
SumAltS2=exp(VPerS21)+exp(VPerS22)+exp(VPerS23)+exp(VPerS24)+exp(VPerS25)+exp(VPerS26)+exp(VPerS27).
If(Persons>7 & Shop2=1)
SumAltS2=exp(VPerS21)+exp(VPerS22)+exp(VPerS23)+exp(VPerS24)+exp(VPerS25)+exp(VPerS26)+exp(VPerS27)+exp(VPerS28).
If(Persons>1 & Shop2=1) PrPerS21=exp(VPerS21)/SumAltS2.
If(Persons>1 & Shop2=1) PrPerS22=exp(VPerS22)/SumAltS2.
If(Persons>1 & Shop2=1) PrPerS23=exp(VPerS23)/SumAltS2.
If(Persons>1 & Shop2=1) PrPerS24=exp(VPerS24)/SumAltS2.
If(Persons>1 & Shop2=1) PrPerS25=exp(VPerS25)/SumAltS2.
If(Persons>1 & Shop2=1) PrPerS26=exp(VPerS26)/SumAltS2.
If(Persons>1 & Shop2=1) PrPerS27=exp(VPerS27)/SumAltS2.
```

```
If(Persons>1 & Shop2=1) PrPerS28=exp(VPerS28)/SumAltS2.
If(Persons>1 & Shop2=1) RandS2= RV.UNIFORM(0,1).
if(Persons>1 & Shop2=1 & RandS2<=PrPerS21) PerNoS2=1.
if(Persons>1 & Shop2=1 & RandS2>PrPerS21 & RandS2<=PrPerS21+PrPerS22) PerNoS2=2.
if(Persons>1 & Shop2=1 & RandS2>PrPerS21+PrPerS22 & RandS2<=PrPerS21+PrPerS22+PrPerS23) PerNoS2=3.
if(Persons>1 & Shop2=1 & RandS2>PrPerS21+PrPerS22+PrPerS23 & RandS2<=PrPerS21+PrPerS22+PrPerS23+PrPerS24) PerNoS2=4.
if(Persons>1 & Shop2=1 & RandS2>PrPerS21+PrPerS22+PrPerS23+PrPerS24 &
RandS2<=PrPerS21+PrPerS22+PrPerS23+PrPerS24+PrPerS25) PerNoS2=5.
if(Persons>1 & Shop2=1 & RandS2>PrPerS21+PrPerS22+PrPerS23+PrPerS24+PrPerS25 &
RandS2<=PrPerS21+PrPerS22+PrPerS23+PrPerS24+PrPerS25+PrPerS26) PerNoS2=6.
if(Persons>1 & Shop2=1 & RandS2>PrPerS21+PrPerS22+PrPerS23+PrPerS24+PrPerS25+PrPerS26 &
RandS2<=PrPerS21+PrPerS22+PrPerS23+PrPerS24+PrPerS25+PrPerS26+PrPerS27) PerNoS2=7.
if(Persons>1 & Shop2=1 & RandS2>1-PrPerS28) PerNoS2=8.
Execute.
```

/* 29. Shopping Activity #3 */

```
if(Persons>1 & Shop3=1) VPerS31=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Shop3=1) VPerS32=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Shop3=1) VPerS33=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Shop3=1) VPerS34=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Shop3=1) VPerS35=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Shop3=1) VPerS36=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Shop3=1) VPerS37=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Shop3=1) VPerS38=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
If(Persons=2 & Shop3=1) SumAltS3=exp(VPerS31)+exp(VPerS32).
If(Persons=3 & Shop3=1) SumAltS3=exp(VPerS31)+exp(VPerS32)+exp(VPerS33).
If(Persons=4 & Shop3=1) SumAltS3=exp(VPerS31)+exp(VPerS32)+exp(VPerS33)+exp(VPerS34).
If(Persons=5 & Shop3=1) SumAltS3=exp(VPerS31)+exp(VPerS32)+exp(VPerS33)+exp(VPerS34)+exp(VPerS35).
If(Persons=6 & Shop3=1) SumAltS3=exp(VPerS31)+exp(VPerS32)+exp(VPerS33)+exp(VPerS34)+exp(VPerS35)+exp(VPerS36).
If(Persons=7 & Shop3=1)
SumAltS3=exp(VPerS31)+exp(VPerS32)+exp(VPerS33)+exp(VPerS34)+exp(VPerS35)+exp(VPerS36)+exp(VPerS37).
If(Persons>7 & Shop3=1)
SumAltS3=exp(VPerS31)+exp(VPerS32)+exp(VPerS33)+exp(VPerS34)+exp(VPerS35)+exp(VPerS36)+exp(VPerS37)+exp(VPerS38).
If(Persons>1 & Shop3=1) PrPerS31=exp(VPerS31)/SumAltS3.
If(Persons>1 & Shop3=1) PrPerS32=exp(VPerS32)/SumAltS3.
If(Persons>1 & Shop3=1) PrPerS33=exp(VPerS33)/SumAltS3.
If(Persons>1 & Shop3=1) PrPerS34=exp(VPerS34)/SumAltS3.
If(Persons>1 & Shop3=1) PrPerS35=exp(VPerS35)/SumAltS3.
If(Persons>1 & Shop3=1) PrPerS36=exp(VPerS36)/SumAltS3.
If(Persons>1 & Shop3=1) PrPerS37=exp(VPerS37)/SumAltS3.
If(Persons>1 & Shop3=1) PrPerS38=exp(VPerS38)/SumAltS3.
If(Persons>1 & Shop3=1) RandS3= RV.UNIFORM(0,1).
if(Persons>1 & Shop3=1 & RandS3<=PrPerS31) PerNoS3=1.
if(Persons>1 & Shop3=1 & RandS3>PrPerS31 & RandS3<=PrPerS31+PrPerS32) PerNoS3=2.
if(Persons>1 & Shop3=1 & RandS3>PrPerS31+PrPerS32 & RandS3<=PrPerS31+PrPerS32+PrPerS33) PerNoS3=3.
if(Persons>1 & Shop3=1 & RandS3>PrPerS31+PrPerS32+PrPerS33 & RandS3<=PrPerS31+PrPerS32+PrPerS33+PrPerS34) PerNoS3=4.
if(Persons>1 & Shop3=1 & RandS3>PrPerS31+PrPerS32+PrPerS33+PrPerS34 &
RandS3<=PrPerS31+PrPerS32+PrPerS33+PrPerS34+PrPerS35) PerNoS3=5.
if(Persons>1 & Shop3=1 & RandS3>PrPerS31+PrPerS32+PrPerS33+PrPerS34+PrPerS35 &
RandS3<=PrPerS31+PrPerS32+PrPerS33+PrPerS34+PrPerS35+PrPerS36) PerNoS3=6.
if(Persons>1 & Shop3=1 & RandS3>PrPerS31+PrPerS32+PrPerS33+PrPerS34+PrPerS35+PrPerS36 &
RandS3<=PrPerS31+PrPerS32+PrPerS33+PrPerS34+PrPerS35+PrPerS36+PrPerS37) PerNoS3=7.
if(Persons>1 & Shop3=1 & RandS3>1-PrPerS38) PerNoS3=8.
Execute.
```

/* 30. Other Maintenance Activity #1 */

```
if(Persons>1 & Other1=1) VPerO11=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Other1=1) VPerO12=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Other1=1) VPerO13=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Other1=1) VPerO14=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Other1=1) VPerO15=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Other1=1) VPerO16=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Other1=1) VPerO17=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
```

```
if(Persons>7 & Other1=1) VPerO18=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
If(Persons=2 & Other1=1) SumAltO1=exp(VPerO11)+exp(VPerO12).
If(Persons=3 & Other1=1) SumAltO1=exp(VPerO11)+exp(VPerO12)+exp(VPerO13).
If(Persons=4 & Other1=1) SumAltO1=exp(VPerO11)+exp(VPerO12)+exp(VPerO13)+exp(VPerO14).
If(Persons=5 & Other1=1) SumAltO1=exp(VPerO11)+exp(VPerO12)+exp(VPerO13)+exp(VPerO14)+exp(VPerO15).
If(Persons=6 & Other1=1) SumAltO1=exp(VPerO11)+exp(VPerO12)+exp(VPerO13)+exp(VPerO14)+exp(VPerO15)+exp(VPerO16).
If(Persons=7 & Other1=1)
SumAltO1=exp(VPerO11)+exp(VPerO12)+exp(VPerO13)+exp(VPerO14)+exp(VPerO15)+exp(VPerO16)+exp(VPerO17).
If(Persons>7 & Other1=1)
SumAltO1=exp(VPerO11)+exp(VPerO12)+exp(VPerO13)+exp(VPerO14)+exp(VPerO15)+exp(VPerO16)+exp(VPerO17)+exp(VPerO18).
If(Persons>1 & Other1=1) PrPerO11=exp(VPerO11)/SumAltO1.
If(Persons>1 & Other1=1) PrPerO12=exp(VPerO12)/SumAltO1.
If(Persons>1 & Other1=1) PrPerO13=exp(VPerO13)/SumAltO1.
If(Persons>1 & Other1=1) PrPerO14=exp(VPerO14)/SumAltO1.
If(Persons>1 & Other1=1) PrPerO15=exp(VPerO15)/SumAltO1.
If(Persons>1 & Other1=1) PrPerO16=exp(VPerO16)/SumAltO1.
If(Persons>1 & Other1=1) PrPerO17=exp(VPerO17)/SumAltO1.
If(Persons>1 & Other1=1) PrPerO18=exp(VPerO18)/SumAltO1.
If(Persons>1 & Other1=1) RandO1= RV.UNIFORM(0,1).
if(Persons>1 & Other1=1 & RandO1<=PrPerO11) PerNoO1=1.
if(Persons>1 & Other1=1 & RandO1>PrPerO11 & RandO1<=PrPerO11+PrPerO12) PerNoO1=2.
if(Persons>1 & Other1=1 & RandO1>PrPerO11+PrPerO12 & RandO1<=PrPerO11+PrPerO12+PrPerO13) PerNoO1=3.
if(Persons>1 & Other1=1 & RandO1>PrPerO11+PrPerO12+PrPerO13 & RandO1<=PrPerO11+PrPerO12+PrPerO13+PrPerO14) PerNoO1=4.
if(Persons>1 & Other1=1 & RandO1>PrPerO11+PrPerO12+PrPerO13+PrPerO14 &
RandO1<=PrPerO11+PrPerO12+PrPerO13+PrPerO14+PrPerO15) PerNoO1=5.
if(Persons>1 & Other1=1 & RandO1>PrPerO11+PrPerO12+PrPerO13+PrPerO14+PrPerO15 &
RandO1<=PrPerO11+PrPerO12+PrPerO13+PrPerO14+PrPerO15+PrPerO16) PerNoO1=6.
if(Persons>1 & Other1=1 & RandO1>PrPerO11+PrPerO12+PrPerO13+PrPerO14+PrPerO15+PrPerO16 &
RandO1<=PrPerO11+PrPerO12+PrPerO13+PrPerO14+PrPerO15+PrPerO16+PrPerO17) PerNoO1=7.
if(Persons>1 & Other1=1 & RandO1>1-PrPerO18) PerNoO1=8.
Execute.
```

/* 31. Other Maintenance Activity #2 */

```
if(Persons>1 & Other2=1) VPerO21=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Other2=1) VPerO22=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Other2=1) VPerO23=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Other2=1) VPerO24=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Other2=1) VPerO25=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Other2=1) VPerO26=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Other2=1) VPerO27=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Other2=1) VPerO28=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
If(Persons=2 & Other2=1) SumAltO2=exp(VPerO21)+exp(VPerO22).
If(Persons=3 & Other2=1) SumAltO2=exp(VPerO21)+exp(VPerO22)+exp(VPerO23).
If(Persons=4 & Other2=1) SumAltO2=exp(VPerO21)+exp(VPerO22)+exp(VPerO23)+exp(VPerO24).
If(Persons=5 & Other2=1) SumAltO2=exp(VPerO21)+exp(VPerO22)+exp(VPerO23)+exp(VPerO24)+exp(VPerO25).
If(Persons=6 & Other2=1) SumAltO2=exp(VPerO21)+exp(VPerO22)+exp(VPerO23)+exp(VPerO24)+exp(VPerO25)+exp(VPerO26).
If(Persons=7 & Other2=1)
SumAltO2=exp(VPerO21)+exp(VPerO22)+exp(VPerO23)+exp(VPerO24)+exp(VPerO25)+exp(VPerO26)+exp(VPerO27).
If(Persons>7 & Other2=1)
SumAltO2=exp(VPerO21)+exp(VPerO22)+exp(VPerO23)+exp(VPerO24)+exp(VPerO25)+exp(VPerO26)+exp(VPerO27)+exp(VPerO28).
If(Persons>1 & Other2=1) PrPerO21=exp(VPerO21)/SumAltO2.
If(Persons>1 & Other2=1) PrPerO22=exp(VPerO22)/SumAltO2.
If(Persons>1 & Other2=1) PrPerO23=exp(VPerO23)/SumAltO2.
If(Persons>1 & Other2=1) PrPerO24=exp(VPerO24)/SumAltO2.
If(Persons>1 & Other2=1) PrPerO25=exp(VPerO25)/SumAltO2.
If(Persons>1 & Other2=1) PrPerO26=exp(VPerO26)/SumAltO2.
If(Persons>1 & Other2=1) PrPerO27=exp(VPerO27)/SumAltO2.
If(Persons>1 & Other2=1) PrPerO28=exp(VPerO28)/SumAltO2.
If(Persons>1 & Other2=1) RandO2= RV.UNIFORM(0,1).
if(Persons>1 & Other2=1 & RandO2<=PrPerO21) PerNoO2=1.
if(Persons>1 & Other2=1 & RandO2>PrPerO21 & RandO2<=PrPerO21+PrPerO22) PerNoO2=2.
if(Persons>1 & Other2=1 & RandO2>PrPerO21+PrPerO22 & RandO2<=PrPerO21+PrPerO22+PrPerO23) PerNoO2=3.
if(Persons>1 & Other2=1 & RandO2>PrPerO21+PrPerO22+PrPerO23 & RandO2<=PrPerO21+PrPerO22+PrPerO23+PrPerO24) PerNoO2=4.
if(Persons>1 & Other2=1 & RandO2>PrPerO21+PrPerO22+PrPerO23+PrPerO24 &
RandO2<=PrPerO21+PrPerO22+PrPerO23+PrPerO24+PrPerO25) PerNoO2=5.
if(Persons>1 & Other2=1 & RandO2>PrPerO21+PrPerO22+PrPerO23+PrPerO24+PrPerO25 &
RandO2<=PrPerO21+PrPerO22+PrPerO23+PrPerO24+PrPerO25+PrPerO26) PerNoO2=6.
```

```
if(Persons>1 & Other2=1 & RandO2>PrPerO21+PrPerO22+PrPerO23+PrPerO24+PrPerO25+PrPerO26 &
RandO2<=PrPerO21+PrPerO22+PrPerO23+PrPerO24+PrPerO25+PrPerO26+PrPerO27) PerNoO2=7.
if(Persons>1 & Other2=1 & RandO2>1-PrPerO28) PerNoO2=8.
Execute.
```

/* 32. Other Maintenance Activity #3 */

```
if(Persons>1 & Other3=1) VPerO31=0.483*Presch.1+0.607*Predri.1-0.234*Nonwk.1-0.325*Stud.1+0.368*Uni.1+0.297*NonMand.1.
if(Persons>1 & Other3=1) VPerO32=0.427-0.0000034*Income+0.483*Presch.2+0.607*Predri.2-0.234*Nonwk.2-
0.325*Stud.2+0.368*Uni.2+0.297*NonMand.2+2.942*iPresch7+1.879*iStud7.
if(Persons>2 & Other3=1) VPerO33=0.692-0.0000046*Income+0.483*Presch.3+0.607*Predri.3-0.234*Nonwk.3-
0.325*Stud.3+0.368*Uni.3+0.297*NonMand.3+0.502*iStud6+2.539*iPresch7.
if(Persons>3 & Other3=1) VPerO34=0.939-0.0000071*Income+0.483*Presch.4+0.607*Predri.4-0.234*Nonwk.4-
0.325*Stud.4+0.368*Uni.4+0.297*NonMand.4+3.19*iPresch7.
if(Persons>4 & Other3=1) VPerO35=1.344-0.0000084*Income+0.483*Presch.5+0.607*Predri.5-0.234*Nonwk.5-
0.325*Stud.5+0.368*Uni.5+0.297*NonMand.5-0.882*Autosur-0.745*iPredri6+3.502*iPresch7.
if(Persons>5 & Other3=1) VPerO36=1.375+0.483*Presch.6+0.607*Predri.6-0.234*Nonwk.6-0.325*Stud.6+0.368*Uni.6+0.297*NonMand.6.
if(Persons>6 & Other3=1) VPerO37=4.303+0.483*Presch.7+0.607*Predri.7-0.234*Nonwk.7-0.325*Stud.7+0.368*Uni.7+0.297*NonMand.7.
if(Persons>7 & Other3=1) VPerO38=3.521+0.483*Presch.8+0.607*Predri.8-0.234*Nonwk.8-0.325*Stud.8+0.368*Uni.8+0.297*NonMand.8.
If(Persons=2 & Other3=1) SumAltO3=exp(VPerO31)+exp(VPerO32).
If(Persons=3 & Other3=1) SumAltO3=exp(VPerO31)+exp(VPerO32)+exp(VPerO33).
If(Persons=4 & Other3=1) SumAltO3=exp(VPerO31)+exp(VPerO32)+exp(VPerO33)+exp(VPerO34).
If(Persons=5 & Other3=1) SumAltO3=exp(VPerO31)+exp(VPerO32)+exp(VPerO33)+exp(VPerO34)+exp(VPerO35).
If(Persons=6 & Other3=1) SumAltO3=exp(VPerO31)+exp(VPerO32)+exp(VPerO33)+exp(VPerO34)+exp(VPerO35)+exp(VPerO36).
If(Persons=7 & Other3=1)
SumAltO3=exp(VPerO31)+exp(VPerO32)+exp(VPerO33)+exp(VPerO34)+exp(VPerO35)+exp(VPerO36)+exp(VPerO37).
If(Persons>7 & Other3=1)
SumAltO3=exp(VPerO31)+exp(VPerO32)+exp(VPerO33)+exp(VPerO34)+exp(VPerO35)+exp(VPerO36)+exp(VPerO37)+exp(VPerO38).
If(Persons>1 & Other3=1) PrPerO31=exp(VPerO31)/SumAltO3.
If(Persons>1 & Other3=1) PrPerO32=exp(VPerO32)/SumAltO3.
If(Persons>1 & Other3=1) PrPerO33=exp(VPerO33)/SumAltO3.
If(Persons>1 & Other3=1) PrPerO34=exp(VPerO34)/SumAltO3.
If(Persons>1 & Other3=1) PrPerO35=exp(VPerO35)/SumAltO3.
If(Persons>1 & Other3=1) PrPerO36=exp(VPerO36)/SumAltO3.
If(Persons>1 & Other3=1) PrPerO37=exp(VPerO37)/SumAltO3.
If(Persons>1 & Other3=1) PrPerO38=exp(VPerO38)/SumAltO3.
If(Persons>1 & Other3=1) RandO3= RV.UNIFORM(0,1).
if(Persons>1 & Other3=1 & RandO3<=PrPerO31) PerNoO3=1.
if(Persons>1 & Other3=1 & RandO3>PrPerO31 & RandO3<=PrPerO31+PrPerO32) PerNoO3=2.
if(Persons>1 & Other3=1 & RandO3>PrPerO31+PrPerO32 & RandO3<=PrPerO31+PrPerO32+PrPerO33) PerNoO3=3.
if(Persons>1 & Other3=1 & RandO3>PrPerO31+PrPerO32+PrPerO33 & RandO3<=PrPerO31+PrPerO32+PrPerO33+PrPerO34) PerNoO3=4.
if(Persons>1 & Other3=1 & Other3=1 & RandO3>PrPerO31+PrPerO32+PrPerO33+PrPerO34 &
RandO3<=PrPerO31+PrPerO32+PrPerO33+PrPerO34+PrPerO35) PerNoO3=5.
if(Persons>1 & Other3=1 & RandO3>PrPerO31+PrPerO32+PrPerO33+PrPerO34+PrPerO35 &
RandO3<=PrPerO31+PrPerO32+PrPerO33+PrPerO34+PrPerO35+PrPerO36) PerNoO3=6.
if(Persons>1 & Other3=1 & RandO3>PrPerO31+PrPerO32+PrPerO33+PrPerO34+PrPerO35+PrPerO36 &
RandO3<=PrPerO31+PrPerO32+PrPerO33+PrPerO34+PrPerO35+PrPerO36+PrPerO37) PerNoO3=7.
if(Persons>1 & Other3=1 & RandO3>1-PrPerO38) PerNoO3=8.
Execute.
```

/* 33. Calculate # of Maintenance Activities for each individual */

```
if(PerNoE1=1) NEscP1=1.
if(PerNoE1=2) NEscP2=1.
if(PerNoE1=3) NEscP3=1.
if(PerNoE1=4) NEscP4=1.
if(PerNoE1=5) NEscP5=1.
if(PerNoE1=6) NEscP6=1.
if(PerNoE1=7) NEscP7=1.
if(PerNoE1=8) NEscP8=1.
if(PerNoE2=1) NEscP1=NEscP1+1.
if(PerNoE2=2) NEscP2=NEscP2+1.
if(PerNoE2=3) NEscP3=NEscP3+1.
if(PerNoE2=4) NEscP4=NEscP4+1.
if(PerNoE2=5) NEscP5=NEscP5+1.
if(PerNoE2=6) NEscP6=NEscP6+1.
if(PerNoE2=7) NEscP7=NEscP7+1.
if(PerNoE2=8) NEscP8=NEscP8+1.
if(PerNoE3=1) NEscP1=NEscP1+1.
if(PerNoE3=2) NEscP2=NEscP2+1.
if(PerNoE3=3) NEscP3=NEscP3+1.
if(PerNoE3=4) NEscP4=NEscP4+1.
if(PerNoE3=5) NEscP5=NEscP5+1.
if(PerNoE3=6) NEscP6=NEscP6+1.
```

```
if(PerNoE3=7) NEscP7=NEscP7+1.
if(PerNoE3=8) NEscP8=NEscP8+1.

if(PerNoS1=1) NShopP1=1.
if(PerNoS1=2) NShopP2=1.
if(PerNoS1=3) NShopP3=1.
if(PerNoS1=4) NShopP4=1.
if(PerNoS1=5) NShopP5=1.
if(PerNoS1=6) NShopP6=1.
if(PerNoS1=7) NShopP7=1.
if(PerNoS1=8) NShopP8=1.
if(PerNoS2=1) NShopP1=NShopP1+1.
if(PerNoS2=2) NShopP2=NShopP2+1.
if(PerNoS2=3) NShopP3=NShopP3+1.
if(PerNoS2=4) NShopP4=NShopP4+1.
if(PerNoS2=5) NShopP5=NShopP5+1.
if(PerNoS2=6) NShopP6=NShopP6+1.
if(PerNoS2=7) NShopP7=NShopP7+1.
if(PerNoS2=8) NShopP8=NShopP8+1.
if(PerNoS3=1) NShopP1=NShopP1+1.
if(PerNoS3=2) NShopP2=NShopP2+1.
if(PerNoS3=3) NShopP3=NShopP3+1.
if(PerNoS3=4) NShopP4=NShopP4+1.
if(PerNoS3=5) NShopP5=NShopP5+1.
if(PerNoS3=6) NShopP6=NShopP6+1.
if(PerNoS3=7) NShopP7=NShopP7+1.
if(PerNoS3=8) NShopP8=NShopP8+1.

if(PerNoO1=1) NOthP1=1.
if(PerNoO1=2) NOthP2=1.
if(PerNoO1=3) NOthP3=1.
if(PerNoO1=4) NOthP4=1.
if(PerNoO1=5) NOthP5=1.
if(PerNoO1=6) NOthP6=1.
if(PerNoO1=7) NOthP7=1.
if(PerNoO1=8) NOthP8=1.
if(PerNoO2=1) NOthP1=NOthP1+1.
if(PerNoO2=2) NOthP2=NOthP2+1.
if(PerNoO2=3) NOthP3=NOthP3+1.
if(PerNoO2=4) NOthP4=NOthP4+1.
if(PerNoO2=5) NOthP5=NOthP5+1.
if(PerNoO2=6) NOthP6=NOthP6+1.
if(PerNoO2=7) NOthP7=NOthP7+1.
if(PerNoO2=8) NOthP8=NOthP8+1.
if(PerNoO3=1) NOthP1=NOthP1+1.
if(PerNoO3=2) NOthP2=NOthP2+1.
if(PerNoO3=3) NOthP3=NOthP3+1.
if(PerNoO3=4) NOthP4=NOthP4+1.
if(PerNoO3=5) NOthP5=NOthP5+1.
if(PerNoO3=6) NOthP6=NOthP6+1.
if(PerNoO3=7) NOthP7=NOthP7+1.
if(PerNoO3=8) NOthP8=NOthP8+1.

Compute NMaintP1=NEscP1+NShopP1+NOthP1.
Compute NMaintP2=NEscP2+NShopP2+NOthP2.
Compute NMaintP3=NEscP3+NShopP3+NOthP3.
Compute NMaintP4=NEscP4+NShopP4+NOthP4.
Compute NMaintP5=NEscP5+NShopP5+NOthP5.
Compute NMaintP6=NEscP6+NShopP6+NOthP6.
Compute NMaintP7=NEscP7+NShopP7+NOthP7.
Compute NMaintP8=NEscP8+NShopP8+NOthP8.
Compute NMaintP9=0.
Compute NMaintP10=0.
Compute NMaintP11=0.
Compute NMaintP12=0.
Compute NMaintP13=0.
Compute NMaintP14=0.
Compute NMaintP15=0.
Compute NMaintP16=0.
Compute NMaintP17=0.
Compute NMaintP18=0.
Compute NMaintP19=0.
```

```
Compute NMaintP20=0.
Compute NMaintP21=0.
Compute NMaintP22=0.
Compute NMaintP23=0.
Compute NMaintP24=0.

Compute NEscP9=0.
Compute NEscP10=0.
Compute NEscP11=0.
Compute NEscP12=0.
Compute NEscP13=0.
Compute NEscP14=0.
Compute NEscP15=0.
Compute NEscP16=0.
Compute NEscP17=0.
Compute NEscP18=0.
Compute NEscP19=0.
Compute NEscP20=0.
Compute NEscP21=0.
Compute NEscP22=0.
Compute NEscP23=0.
Compute NEscP24=0.

Compute NShopP9=0.
Compute NShopP10=0.
Compute NShopP11=0.
Compute NShopP12=0.
Compute NShopP13=0.
Compute NShopP14=0.
Compute NShopP15=0.
Compute NShopP16=0.
Compute NShopP17=0.
Compute NShopP18=0.
Compute NShopP19=0.
Compute NShopP20=0.
Compute NShopP21=0.
Compute NShopP22=0.
Compute NShopP23=0.
Compute NShopP24=0.

Compute NOthP9=0.
Compute NOthP10=0.
Compute NOthP11=0.
Compute NOthP12=0.
Compute NOthP13=0.
Compute NOthP14=0.
Compute NOthP15=0.
Compute NOthP16=0.
Compute NOthP17=0.
Compute NOthP18=0.
Compute NOthP19=0.
Compute NOthP20=0.
Compute NOthP21=0.
Compute NOthP22=0.
Compute NOthP23=0.
Compute NOthP24=0.
Execute.
```

/* 34. Restructure into Person file */

```
VARSTOCASES /MAKE WorkUni FROM WorkUni.1 WorkUni.2 WorkUni.3 WorkUni.4 WorkUni.5 WorkUni.6 WorkUni.7 WorkUni.8
WorkUni.9
 WorkUni.10 WorkUni.11 WorkUni.12 WorkUni.13 WorkUni.14 WorkUni.15 WorkUni.16 WorkUni.17 WorkUni.18 WorkUni.19 WorkUni.20
 WorkUni.21 WorkUni.22 WorkUni.23 WorkUni.24
 /MAKE NonWk FROM NonWk.1 NonWk.2 NonWk.3 NonWk.4 NonWk.5 NonWk.6 NonWk.7 NonWk.8 NonWk.9 NonWk.10 NonWk.11
NonWk.12 NonWk.13 NonWk.14 NonWk.15 NonWk.16 NonWk.17 NonWk.18 NonWk.19 NonWk.20 NonWk.21 NonWk.22 NonWk.23
NonWk.24
 /MAKE HHPerNo FROM HHPerNo.1 HHPerNo.2 HHPerNo.3 HHPerNo.4 HHPerNo.5 HHPerNo.6 HHPerNo.7 HHPerNo.8 HHPerNo.9
HHPerNo.10 HHPerNo.11 HHPerNo.12 HHPerNo.13 HHPerNo.14 HHPerNo.15 HHPerNo.16 HHPerNo.17 HHPerNo.18 HHPerNo.19
HHPerNo.20 HHPerNo.21 HHPerNo.22 HHPerNo.23 HHPerNo.24
 /MAKE SerPerNo FROM SerPerNo.1 SerPerNo.2 SerPerNo.3 SerPerNo.4 SerPerNo.5 SerPerNo.6 SerPerNo.7 SerPerNo.8 SerPerNo.9
SerPerNo.10 SerPerNo.11 SerPerNo.12 SerPerNo.13 SerPerNo.14 SerPerNo.15 SerPerNo.16 SerPerNo.17 SerPerNo.18 SerPerNo.19
SerPerNo.20 SerPerNo.21 SerPerNo.22 SerPerNo.23 SerPerNo.24
```

```
/MAKE Sen FROM Sen.1 Sen.2 Sen.3 Sen.4 Sen.5 Sen.6 Sen.7 Sen.8 Sen.9 Sen.10 Sen.11 Sen.12 Sen.13 Sen.14 Sen.15 Sen.16 Sen.17 Sen.18
Sen.19 Sen.20 Sen.21 Sen.22 Sen.23 Sen.24
/MAKE Male FROM Male.1 Male.2 Male.3 Male.4 Male.5 Male.6 Male.7 Male.8 Male.9 Male.10 Male.11 Male.12 Male.13 Male.14Male.15
Male.16 Male.17 Male.18 Male.19 Male.20 Male.21 Male.22 Male.23 Male.24
/MAKE Age FROM Age.1 Age.2 Age.3 Age.4 Age.5 Age.6 Age.7 Age.8 Age.9 Age.10 Age.11 Age.12 Age.13 Age.14 Age.15 Age.16 Age.17
Age.18 Age.19 Age.20 Age.21 Age.22 Age.23 Age.24
/MAKE Home FROM Home.1 Home.2 Home.3 Home.4 Home.5 Home.6 Home.7 Home.8 Home.9 Home.10 Home.11 Home.12 Home.13
Home.14 Home.15 Home.16 Home.17 Home.18 Home.19 Home.20 Home.21 Home.22 Home.23 Home.24
/MAKE Work2 FROM Work2.1 Work2.2 Work2.3 Work2.4 Work2.5 Work2.6 Work2.7 Work2.8 Work2.9 Work2.10 Work2.11 Work2.12
Work2.13 Work2.14 Work2.15 Work2.16 Work2.17 Work2.18 Work2.19 Work2.20 Work2.21 Work2.22 Work2.23 Work2.24
/MAKE Part FROM Part.1 Part.2 Part.3 Part.4 Part.5 Part.6 Part.7 Part.8 Part.9 Part.10 Part.11 Part.12 Part.13 Part.14 Part.15 Part.16 Part.17
Part.18 Part.19 Part.20 Part.21 Part.22 Part.23 Part.24
/MAKE Full FROM Full.1 Full.2 Full.3 Full.4 Full.5 Full.6 Full.7 Full.8 Full.9 Full.10 Full.11 Full.12 Full.13 Full.14 Full.15 Full.16 Full.17
Full.18 Full.19 Full.20 Full.21 Full.22 Full.23 Full.24
/MAKE Category FROM Category.1 Category.2 Category.3 Category.4 Category.5 Category.6 Category.7 Category.8 Category.9 Category.10
Category.11 Category.12 Category.13 Category.14 Category.15 Category.16 Category.17 Category.18 Category.19 Category.20 Category.21
Category.22 Category.23 Category.24
/MAKE Work1 FROM Work1.1 Work1.2 Work1.3 Work1.4 Work1.5 Work1.6 Work1.7 Work1.8 Work1.9 Work1.10 Work1.11 Work1.12
Work1.13Work1.14 Work1.15 Work1.16 Work1.17 Work1.18 Work1.19 Work1.20 Work1.21 Work1.22 Work1.23 Work1.24
/MAKE Predri FROM Predri.1 Predri.2 Predri.3 Predri.4 Predri.5 Predri.6 Predri.7 Predri.8 Predri.9 Predri.10 Predri.11 Predri.12 Predri.13
Predri.14 Predri.15 Predri.16 Predri.17 Predri.18 Predri.19 Predri.20 Predri.21 Predri.22 Predri.23 Predri.24
/MAKE School FROM School.1 School.2 School.3 School.4 School.5 School.6 School.7 School.8 School.9 School.10 School.11 School.12
School.13 School.14 School.15 School.16 School.17 School.18 School.19 School.20 School.21 School.22 School.23 School.24
/MAKE Stud FROM Stud.1 Stud.2 Stud.3 Stud.4 Stud.5 Stud.6 Stud.7 Stud.8 Stud.9 Stud.10 Stud.11 Stud.12 Stud.13 Stud.14 Stud.15 Stud.16
Stud.17 Stud.18 Stud.19 Stud.20 Stud.21 Stud.22 Stud.23 Stud.24
/MAKE Uni FROM Uni.1 Uni.2 Uni.3 Uni.4 Uni.5 Uni.6 Uni.7 Uni.8 Uni.9 Uni.10 Uni.11 Uni.12 Uni.13 Uni.14 Uni.15 Uni.16 Uni.17 Uni.18
Uni.19 Uni.20 Uni.21 Uni.22 Uni.23 Uni.24
/MAKE Driv FROM Driv.1 Driv.2 Driv.3 Driv.4 Driv.5 Driv.6 Driv.7 Driv.8 Driv.9 Driv.10 Driv.11 Driv.12 Driv.13 Driv.14 Driv.15 Driv.16
Driv.17 Driv.18 Driv.19 Driv.20 Driv.21 Driv.22 Driv.23 Driv.24
/MAKE Presch FROM Presch.1 Presch.2 Presch.3 Presch.4 Presch.5 Presch.6 Presch.7 Presch.8 Presch.9 Presch.10 Presch.11 Presch.12
Presch.13 Presch.14 Presch.15 Presch.16 Presch.17 Presch.18 Presch.19 Presch.20 Presch.21 Presch.22 Presch.23 Presch.24
/MAKE NonMand FROM NonMand.1 NonMand.2 NonMand.3 NonMand.4 NonMand.5 NonMand.6 NonMand.7 NonMand.8 NonMand.9
NonMand.10
NonMand.11 NonMand.12 NonMand.13 NonMand.14 NonMand.15 NonMand.16 NonMand.17 NonMand.18 NonMand.19 NonMand.20
NonMand.21
NonMand.22 NonMand.23 NonMand.24
/MAKE NEscPer FROM NEscP1 NEscP2 NEscP3 NEscP4 NEscP5 NEscP6 NEscP7 NEscP8 NEscP9 NEscP10 NEscP11 NEscP12 NEscP13
NEscP14 NEscP15 NEscP16 NEscP17 NEscP18 NEscP19 NEscP20 NEscP21 NEscP22 NEscP23 NEscP24
/MAKE NShopPer FROM NShopP1 NShopP2 NShopP3 NShopP4 NShopP5 NShopP6 NShopP7 NShopP8 NShopP9 NShopP10 NShopP11
NShopP12 NShopP13 NShopP14 NShopP15 NShopP16 NShopP17 NShopP18 NShopP19 NShopP20 NShopP21 NShopP22 NShopP23
NShopP24
/MAKE NOthPer FROM NOthP1 NOthP2 NOthP3 NOthP4 NOthP5 NOthP6 NOthP7 NOthP8 NOthP9 NOthP10 NOthP11 NOthP12 NOthP13
NOthP14
NOthP15 NOthP16 NOthP17 NOthP18 NOthP19 NOthP20 NOthP21 NOthP22 NOthP23 NOthP24
/MAKE NMaintPer FROM NMaintP1 NMaintP2 NMaintP3 NMaintP4 NMaintP5 NMaintP6 NMaintP7 NMaintP8 NMaintP9 NMaintP10
NMaintP11 NMaintP12 NMaintP13 NMaintP14 NMaintP15 NMaintP16 NMaintP17 NMaintP18 NMaintP19 NMaintP20 NMaintP21
NMaintP22 NMaintP23 NMaintP24
/KEEP = HHNo TAZ PUMA Persons HH1 Autos AutoSur AutoSh Income NPresch NPredri NDriv NNonwk NStud NPart NFull PPresch
PPredri PDriv PNonwk PStud PPart PFull Rural Suburb Urban CBD Tran25 Tran50 SerialNo iPresch7 iPredri6 iPredri7 iDriv6 iDriv7 iNonwk6
iNonwk7 iStud6 iStud7 iPart6 iPart7 iFull6 iFull7 Work NEsc NShop NOther PerNoE1 PerNoE2 PerNoE3 PerNoS1 PerNoS2 PerNoS3
PerNoO1 PerNoO2 PerNoO3
/NULL = DROP.
```

/* 35. Number of Discretionary Activities Model */

```
Compute Disc1=0.
Compute Disc2=0.
Compute Disc3=0.
Compute VDisc0=0.
Compute VDisc1=-0.24-1.828*NPresch-0.343*PFull-0.317*Tran25-2.67*(iPresch7+iPredri7)-1.566*iNonwk7-0.945*iFull7.
Compute VDisc2=-1.634-1.253*NPresch-1.193*PDriv-1.035*PStud+0.812*CBD-2.132*(iPresch7+iPredri7)-2.392*iNonwk7-1.312*iFull7.
Compute VDisc3=-1.993-2.716*NPresch-0.486*PPart-0.554*Suburb-2.447*iNonwk7-2.374*iFull7.
Compute AltSumD=exp(VDisc0)+exp(VDisc1)+exp(VDisc2)+exp(VDisc3).
Compute PrDisc0=exp(VDisc0)/AltSumD.
Compute PrDisc1=exp(VDisc1)/AltSumD.
Compute PrDisc2=exp(VDisc2)/AltSumD.
Compute PrDisc3=exp(VDisc3)/AltSumD.
Compute RandD= RV.UNIFORM(0,1).
If(RandD>PrDisc0) Disc1=1.
If(RandD>PrDisc0+PrDisc1) Disc2=1.
If(RandD>PrDisc0+PrDisc1+PrDisc2) Disc3=1.
Compute NDisc=Disc1+Disc2+Disc3.
Execute.
```

```
/* Activity Scheduler */
/* Calculate Index Variable */
Compute PerIndex=Category*1000+PAP*100+NMaint+NDisc.
Execute.

/* Run frequencies of PerIndex in ATSdiaries.sav and HH-act.sav */
/* Substitute HH-act missing PerIndex values with values that exist in ATSdiaries.sav */
/* Use previous matching procedure to assign ActIndex Variable */
/* Merge with ATSdiaries.sav */

/* Calculate TourID variable and number of activity types */
if(Act1=1) iWork1=1.
if(Act2=1) iWork2=1.
if(Act3=1) iWork3=1.
if(Act4=1) iWork4=1.
if(Act5=1) iWork5=1.
if(Act6=1) iWork6=1.
if(Act7=1) iWork7=1.
if(Act8=1) iWork8=1.
if(Act9=1) iWork9=1.
if(Act10=1) iWork10=1.
if(Act11=1) iWork11=1.
if(Act12=1) iWork12=1.
if(Act13=1) iWork13=1.
if(Act14=1) iWork14=1.
if(Act15=1) iWork15=1.
if(Act16=1) iWork16=1.
if(Act17=1) iWork17=1.
if(Act18=1) iWork18=1.
if(Act19=1) iWork19=1.
if(Act20=1) iWork20=1.
if(Act21=1) iWork21=1.
if(Act22=1) iWork22=1.
if(Act23=1) iWork23=1.
if(Act24=1) iWork24=1.
if(Act25=1) iWork25=1.
if(Act26=1) iWork26=1.
if(Act27=1) iWork27=1.
if(Act28=1) iWork28=1.
if(Act29=1) iWork29=1.
if(Act30=1) iWork30=1.
if(Act1=2) iSchool1=1.
if(Act2=2) iSchool2=1.
if(Act3=2) iSchool3=1.
if(Act4=2) iSchool4=1.
if(Act5=2) iSchool5=1.
if(Act6=2) iSchool6=1.
if(Act7=2) iSchool7=1.
if(Act8=2) iSchool8=1.
if(Act9=2) iSchool9=1.
if(Act10=2) iSchool10=1.
if(Act11=2) iSchool11=1.
if(Act12=2) iSchool12=1.
if(Act13=2) iSchool13=1.
if(Act14=2) iSchool14=1.
if(Act15=2) iSchool15=1.
if(Act16=2) iSchool16=1.
if(Act17=2) iSchool17=1.
if(Act18=2) iSchool18=1.
if(Act19=2) iSchool19=1.
if(Act20=2) iSchool20=1.
if(Act21=2) iSchool21=1.
if(Act22=2) iSchool22=1.
if(Act23=2) iSchool23=1.
if(Act24=2) iSchool24=1.
if(Act25=2) iSchool25=1.
if(Act26=2) iSchool26=1.
```

```
if(Act27=2) iSchool27=1.
if(Act28=2) iSchool28=1.
if(Act29=2) iSchool29=1.
if(Act30=2) iSchool30=1.
if(Act1=3) iUni1=1.
if(Act2=3) iUni2=1.
if(Act3=3) iUni3=1.
if(Act4=3) iUni4=1.
if(Act5=3) iUni5=1.
if(Act6=3) iUni6=1.
if(Act7=3) iUni7=1.
if(Act8=3) iUni8=1.
if(Act9=3) iUni9=1.
if(Act10=3) iUni10=1.
if(Act11=3) iUni11=1.
if(Act12=3) iUni12=1.
if(Act13=3) iUni13=1.
if(Act14=3) iUni14=1.
if(Act15=3) iUni15=1.
if(Act16=3) iUni16=1.
if(Act17=3) iUni17=1.
if(Act18=3) iUni18=1.
if(Act19=3) iUni19=1.
if(Act20=3) iUni20=1.
if(Act21=3) iUni21=1.
if(Act22=3) iUni22=1.
if(Act23=3) iUni23=1.
if(Act24=3) iUni24=1.
if(Act25=3) iUni25=1.
if(Act26=3) iUni26=1.
if(Act27=3) iUni27=1.
if(Act28=3) iUni28=1.
if(Act29=3) iUni29=1.
if(Act30=3) iUni30=1.
if(Act1=4) iEsc1=1.
if(Act2=4) iEsc2=1.
if(Act3=4) iEsc3=1.
if(Act4=4) iEsc4=1.
if(Act5=4) iEsc5=1.
if(Act6=4) iEsc6=1.
if(Act7=4) iEsc7=1.
if(Act8=4) iEsc8=1.
if(Act9=4) iEsc9=1.
if(Act10=4) iEsc10=1.
if(Act11=4) iEsc11=1.
if(Act12=4) iEsc12=1.
if(Act13=4) iEsc13=1.
if(Act14=4) iEsc14=1.
if(Act15=4) iEsc15=1.
if(Act16=4) iEsc16=1.
if(Act17=4) iEsc17=1.
if(Act18=4) iEsc18=1.
if(Act19=4) iEsc19=1.
if(Act20=4) iEsc20=1.
if(Act21=4) iEsc21=1.
if(Act22=4) iEsc22=1.
if(Act23=4) iEsc23=1.
if(Act24=4) iEsc24=1.
if(Act25=4) iEsc25=1.
if(Act26=4) iEsc26=1.
if(Act27=4) iEsc27=1.
if(Act28=4) iEsc28=1.
if(Act29=4) iEsc29=1.
if(Act30=4) iEsc30=1.
if(Act1=5) iShop1=1.
if(Act2=5) iShop2=1.
if(Act3=5) iShop3=1.
if(Act4=5) iShop4=1.
if(Act5=5) iShop5=1.
if(Act6=5) iShop6=1.
if(Act7=5) iShop7=1.
if(Act8=5) iShop8=1.
if(Act9=5) iShop9=1.
```

```
if(Act10=5) iShop10=1.
if(Act11=5) iShop11=1.
if(Act12=5) iShop12=1.
if(Act13=5) iShop13=1.
if(Act14=5) iShop14=1.
if(Act15=5) iShop15=1.
if(Act16=5) iShop16=1.
if(Act17=5) iShop17=1.
if(Act18=5) iShop18=1.
if(Act19=5) iShop19=1.
if(Act20=5) iShop20=1.
if(Act21=5) iShop21=1.
if(Act22=5) iShop22=1.
if(Act23=5) iShop23=1.
if(Act24=5) iShop24=1.
if(Act25=5) iShop25=1.
if(Act26=5) iShop26=1.
if(Act27=5) iShop27=1.
if(Act28=5) iShop28=1.
if(Act29=5) iShop29=1.
if(Act30=5) iShop30=1.
if(Act1=6) iOth1=1.
if(Act2=6) iOth2=1.
if(Act3=6) iOth3=1.
if(Act4=6) iOth4=1.
if(Act5=6) iOth5=1.
if(Act6=6) iOth6=1.
if(Act7=6) iOth7=1.
if(Act8=6) iOth8=1.
if(Act9=6) iOth9=1.
if(Act10=6) iOth10=1.
if(Act11=6) iOth11=1.
if(Act12=6) iOth12=1.
if(Act13=6) iOth13=1.
if(Act14=6) iOth14=1.
if(Act15=6) iOth15=1.
if(Act16=6) iOth16=1.
if(Act17=6) iOth17=1.
if(Act18=6) iOth18=1.
if(Act19=6) iOth19=1.
if(Act20=6) iOth20=1.
if(Act21=6) iOth21=1.
if(Act22=6) iOth22=1.
if(Act23=6) iOth23=1.
if(Act24=6) iOth24=1.
if(Act25=6) iOth25=1.
if(Act26=6) iOth26=1.
if(Act27=6) iOth27=1.
if(Act28=6) iOth28=1.
if(Act29=6) iOth29=1.
if(Act30=6) iOth30=1.
if(Act1=7) iDisc1=1.
if(Act2=7) iDisc2=1.
if(Act3=7) iDisc3=1.
if(Act4=7) iDisc4=1.
if(Act5=7) iDisc5=1.
if(Act6=7) iDisc6=1.
if(Act7=7) iDisc7=1.
if(Act8=7) iDisc8=1.
if(Act9=7) iDisc9=1.
if(Act10=7) iDisc10=1.
if(Act11=7) iDisc11=1.
if(Act12=7) iDisc12=1.
if(Act13=7) iDisc13=1.
if(Act14=7) iDisc14=1.
if(Act15=7) iDisc15=1.
if(Act16=7) iDisc16=1.
if(Act17=7) iDisc17=1.
if(Act18=7) iDisc18=1.
if(Act19=7) iDisc19=1.
if(Act20=7) iDisc20=1.
if(Act21=7) iDisc21=1.
if(Act22=7) iDisc22=1.
```

```
if(Act23=7) iDisc23=1.
if(Act24=7) iDisc24=1.
if(Act25=7) iDisc25=1.
if(Act26=7) iDisc26=1.
if(Act27=7) iDisc27=1.
if(Act28=7) iDisc28=1.
if(Act29=7) iDisc29=1.
if(Act30=7) iDisc30=1.
if(Act1=8) iHome1=1.
if(Act2=8) iHome2=1.
if(Act3=8) iHome3=1.
if(Act4=8) iHome4=1.
if(Act5=8) iHome5=1.
if(Act6=8) iHome6=1.
if(Act7=8) iHome7=1.
if(Act8=8) iHome8=1.
if(Act9=8) iHome9=1.
if(Act10=8) iHome10=1.
if(Act11=8) iHome11=1.
if(Act12=8) iHome12=1.
if(Act13=8) iHome13=1.
if(Act14=8) iHome14=1.
if(Act15=8) iHome15=1.
if(Act16=8) iHome16=1.
if(Act17=8) iHome17=1.
if(Act18=8) iHome18=1.
if(Act19=8) iHome19=1.
if(Act20=8) iHome20=1.
if(Act21=8) iHome21=1.
if(Act22=8) iHome22=1.
if(Act23=8) iHome23=1.
if(Act24=8) iHome24=1.
if(Act25=8) iHome25=1.
if(Act26=8) iHome26=1.
if(Act27=8) iHome27=1.
if(Act28=8) iHome28=1.
if(Act29=8) iHome29=1.
if(Act30=8) iHome30=1.
Compute
NWork=iWork1+iWork2+iWork3+iWork4+iWork5+iWork6+iWork7+iWork8+iWork9+iWork10+iWork11+iWork12+iWork13+iWork14+iWo
rk15+iWork16+iWork17+iWork18+iWork19+iWork20+iWork21+iWork22+iWork23+iWork24+iWork25+iWork26+iWork27+iWork28+iWork
29+iWork30.
Compute
NUni=iUni1+iUni2+iUni3+iUni4+iUni5+iUni6+iUni7+iUni8+iUni9+iUni10+iUni11+iUni12+iUni13+iUni14+iUni15+iUni16+iUni17+iUni18+
iUni19+iUni20+iUni21+iUni22+iUni23+iUni24+iUni25+iUni26+iUni27+iUni28+iUni29+iUni30.
Compute
NShop=iShop1+iShop2+iShop3+iShop4+iShop5+iShop6+iShop7+iShop8+iShop9+iShop10+iShop11+iShop12+iShop13+iShop14+iShop15+iS
hop16+iShop17+iShop18+iShop19+iShop20+iShop21+iShop22+iShop23+iShop24+iShop25+iShop26+iShop27+iShop28+iShop29+iShop30.
Compute
NDisc=iDisc1+iDisc2+iDisc3+iDisc4+iDisc5+iDisc6+iDisc7+iDisc8+iDisc9+iDisc10+iDisc11+iDisc12+iDisc13+iDisc14+iDisc15+iDisc16+iD
isc17+iDisc18+iDisc19+iDisc20+iDisc21+iDisc22+iDisc23+iDisc24+iDisc25+iDisc26+iDisc27+iDisc28+iDisc29+iDisc30.
execute.
```

/* Restructure into Activities File */

```
VARSTOCASES /MAKE Act FROM Act1 Act2 Act3 Act4 Act5 Act6 Act7 Act8 Act9 Act10 Act11 Act12 Act13 Act14 Act15 Act16 Act17
 Act18 Act19 Act20 Act21 Act22 Act23 Act24 Act25 Act26 Act27 Act28 Act29 Act30
 /MAKE TourNo FROM TourNo1 TourNo2 TourNo3 TourNo4 TourNo5 TourNo6 TourNo7 TourNo8 TourNo9 TourNo10 TourNo11 TourNo12
 TourNo13 TourNo14 TourNo15 TourNo16 TourNo17 TourNo18 TourNo19 TourNo20 TourNo21 TourNo22 TourNo23 TourNo24 TourNo25
 TourNo26 TourNo27 TourNo28 TourNo29 TourNo30
 /MAKE Dur FROM Dur1 Dur2 Dur3 Dur4 Dur5 Dur6 Dur7 Dur8 Dur9 Dur10 Dur11 Dur12 Dur13 Dur14 Dur15 Dur16 Dur17 Dur18 Dur19
 Dur20 Dur21 Dur22 Dur23 Dur24 Dur25 Dur26 Dur27 Dur28 Dur29 Dur30
 /MAKE Prim FROM Prim1 Prim2 Prim3 Prim4 Prim5 Prim6 Prim7 Prim8 Prim9 Prim10 Prim11 Prim12 Prim13 Prim14 Prim15 Prim16
 Prim17 Prim18 Prim19 Prim20 Prim21 Prim22 Prim23 Prim24 Prim25 Prim26 Prim27 Prim28 Prim29 Prim30
 /MAKE iWork FROM iWork1 iWork2 iWork3 iWork4 iWork5 iWork6 iWork7 iWork8 iWork9 iWork10 iWork11 iWork12 iWork13 iWork14
 iWork15 iWork16 iWork17 iWork18 iWork19 iWork20 iWork21 iWork22 iWork23 iWork24 iWork25 iWork26 iWork27 iWork28 iWork29
iWork30
 /MAKE iSchool FROM iSchool1 iSchool2 iSchool3 iSchool4 iSchool5 iSchool6 iSchool7 iSchool8 iSchool9 iSchool10 iSchool11
 iSchool12 iSchool13 iSchool14 iSchool15 iSchool16 iSchool17 iSchool18 iSchool19 iSchool20 iSchool21 iSchool22 iSchool23
 iSchool24 iSchool25 iSchool26 iSchool27 iSchool28 iSchool29 iSchool30
 /MAKE iUni FROM iUni1 iUni2 iUni3 iUni4 iUni5 iUni6 iUni7 iUni8 iUni9 iUni10 iUni11 iUni12 iUni13 iUni14 iUni15 iUni16
 iUni17 iUni18 iUni19 iUni20 iUni21 iUni22 iUni23 iUni24 iUni25 iUni26 iUni27 iUni28 iUni29 iUni30
 /MAKE iEsc FROM iEsc1 iEsc2 iEsc3 iEsc4 iEsc5 iEsc6 iEsc7 iEsc8 iEsc9 iEsc10 iEsc11 iEsc12 iEsc13 iEsc14 iEsc15 iEsc16
```

```
 iEsc17 iEsc18 iEsc19 iEsc20 iEsc21 iEsc22 iEsc23 iEsc24 iEsc25 iEsc26 iEsc27 iEsc28 iEsc29 iEsc30
 /MAKE iShop FROM iShop1 iShop2 iShop3 iShop4 iShop5 iShop6 iShop7 iShop8 iShop9 iShop10 iShop11 iShop12 iShop13 iShop14
 iShop15 iShop16 iShop17 iShop18 iShop19 iShop20 iShop21 iShop22 iShop23 iShop24 iShop25 iShop26 iShop27 iShop28 iShop29 iShop30
 /MAKE iOther FROM iOth1 iOth2 iOth3 iOth4 iOth5 iOth6 iOth7 iOth8 iOth9 iOth10 iOth11 iOth12 iOth13 iOth14 iOth15 iOth16
 iOth17 iOth18 iOth19 iOth20 iOth21 iOth22 iOth23 iOth24 iOth25 iOth26 iOth27 iOth28 iOth29 iOth30
 /MAKE iDisc FROM iDisc1 iDisc2 iDisc3 iDisc4 iDisc5 iDisc6 iDisc7 iDisc8 iDisc9 iDisc10 iDisc11 iDisc12 iDisc13 iDisc14
 iDisc15 iDisc16 iDisc17 iDisc18 iDisc19 iDisc20 iDisc21 iDisc22 iDisc23 iDisc24 iDisc25 iDisc26 iDisc27 iDisc28 iDisc29 iDisc30
 /MAKE iHome FROM iHome1 iHome2 iHome3 iHome4 iHome5 iHome6 iHome7 iHome8 iHome9 iHome10 iHome11 iHome12 iHome13
iHome14
 iHome15 iHome16 iHome17 iHome18 iHome19 iHome20 iHome21 iHome22 iHome23 iHome24 iHome25 iHome26 iHome27 iHome28
iHome29 iHome30
 /KEEP = HHPerNo HHNo TAZ PUMA Persons HH1 Autos AutoSur AutoSh Income NPresch NPredri NDriv NNonwk NStud NPart NFull
 PPresch PPredri PDriv PNonwk PStud PPart PFull Rural Suburb Urban CBD Tran25 Tran50 iPresch7 iPredri6 iPredri7 iDriv6 iDriv7
 iNonwk6 iNonwk7 iStud6 iStud7 iPart6 iPart7 iFull6 iFull7 Sen Male Age Presch Predri Driv NonWk Stud Part Full Category
 Work1 Work2 Uni WorkUni School NonMand Home PAP Start NoTours NWork NUni NShop NDisc
 /NULL = DROP.
```

/* Fill in missing values and calculate TourID */

```
Compute TourID=HHPerNo*10+TourNo.

RECODE
 iWork iSchool iUni iEsc iShop iOther iDisc iHome Dur Prim NWork NUni NShop NDisc (SYSMIS=0) .
EXECUTE .
```

/* Save as Trips.sav */