2017

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Final Report

Towards a Holistic Understanding of Quality of Life: An Analysis of Activity-Travel Patterns on Non- Mid-week Days (Project # 2012-024S)

Authors: Xia Jin, Ph.D., Hamidreza Asgari, Fengjiang Hu, and Md Sakoat Hossan, (Florida International University) and Sivaramakrishnan Srinivasan, Ph.D., and Miguel Lugo (University of Florida)

June 2017

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Stride Project 2012-024S

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Xia Jin, Ph.D, AICP

Hamidreza Asgari

Fengjiang Hu

Md. Sakoat Hossan

Florida International University, Miami, FL

Sivaramakrishnan Srinivasan, PhD

Miguel Lugo

University of Florida, Gainesville, FL

Southeastern Transportation Research, Innovation, Development, and Education Center

Gainesville, FL

2017

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ACKNOWLEDGMENTS

Funding for this study was provided by the Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE) (2012-024S).

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ABSTRACT

The practice of travel-demand forecasting has placed substantial emphasis on forecasting travel during a "typical mid-week" (Tuesday – Thursday) day. While this is adequate from the stand point of understanding congestion due to commute, such an approach does not paint a complete picture of the overall travel patterns of people. The intent of this study is to examine the variations in activity-travel patterns across the week days with emphasis on differences between the mid-week days (Tuesday, Wednesday, and Thursday) and the Shoulder week days (Monday and Friday). The focus is on analyzing the maintenance- and discretionary- activity decisions (participation, duration and time of day) as such episodes are not undertaken on a daily basis and are likely to be undertaken on non-working days. Data from two national-level surveys from multiple years are used. While the differences among the weekdays are not as pronounced as differences between weekdays and weekend days, the study demonstrates key differences in participation, duration, and time of day choices across the weekdays. The differences observed from trip-based and time-use surveys are also discussed.

EXECUTIVE SUMMARY

This study is an effort to explore the existing temporal irregularities observed in non-mandatory activity scheduling among individuals. While mandatory activities such as work and school are usually planned on a long-term basis and are less subject to daily variations, non-obligatory errands such as shopping, recreation and social activities well may be fluctuated both in terms of activity participation and activity duration. While there is an extensive body of literature focusing on weekend activity/travel behavior versus regular weekday routines, this study steps further into weekdays only, thereby excluding weekend data from the analysis. In other words, this is an effort to test the hypothesis that claims shoulder days (i.e. Mondays and Fridays) are different from Mid-weekdays (i.e. Tuesdays, Wednesdays, and Fridays) in view of non-mandatory activity/travel planning.

Four major data resources are available, including two waves of the NHTS (National Household Travel Survey, 2001 and 2009) and ATUS (American Time Use Survey, 2003 and 2009). Five different categories of non-mandatory activities are recognized and taken into account, including: HH maintenance, Personal Maintenance, Social, Meal and Exercise. For each dataset, three major steps are accomplished as the following: First, statistical tools are applied to test whether there exists a significant difference among the three weekly sections in terms of engagement or duration. Consequently, a basic joint sample selection model is developed which indicates how the two decisions on activity participation and duration interact based on socioeconomic and demographic variables. And the third step examines the interaction effects of certain socioeconomic or demographic variables on activity engagement. The following results can be highlighted based on the outcomes of this study:

- Statistical tests including the Bonferroni z-test (for participation rates) and ANOVA (for duration) suggest that three activities show the highest magnitude of variation. These include Social, HH maintenance, and out-of-home Meal.

- Embedding temporal impacts into the model seems to be a justified decision, as the models tend to improve in terms of goodness-of-fit and likelihood value. This might provide supportive document for the general hypothesis which questions using a ‘typical’ random weekday for activity/travel behavior in transportation studies.

- The models well support the negative impact of employment on non-mandatory activities (except some counterexamples in the ATUS models). However, such impact turns into a positive impact on Fridays as Friday nights are considered to be the beginning of weekends.

- Similar impacts are observed for some of the individual/household attributes. Irrespective of activity type, it looks that licensed drivers, high-income individuals along with older people are more likely to participate in non-mandatory activities. This fairly reflects the fact that non-mandatory activities are well influenced by dimensions such as time, financial budget, and also accessibility.

- Family roles reflect high interaction impacts on the model, which confirms the influence of household context on daily variations of activity planning.

- Fridays show high positive contributions to the participation model which confirms the transition role of Fridays. Monday interactions, on the contrary, are accompanied by negative coefficients which bode for the fact that individuals are generally more focused on work and other mandatory tasks rather than discretionary/maintenance activities.

- From a general point of view, temporal fluctuations are more significant in terms of engagement rather than durations and this is more tangible when it comes to Mondays.

- Considering the sample selection structure, a negative correlation value is estimated in most cases (statically insignificant otherwise). As engagement turns into frequency in the long-term, this may be an indicator of the reverse impact of frequency over duration.

- A general comparison among the descriptive statistics reveals that ATUS data show less significant fluctuations compared to the NHTS data. However, comparing the models' results does not reflect any distinctive pattern between the two surveys or not even within one dataset (between the two time slots).

- Social and Meals activities on Fridays are likely to be undertaken about 30-50 minutes later in the day on Fridays when compared to other week days. This is evident from both time use and trip based surveys.

- Household maintenance and exercising activities on Mondays and Fridays are about 10-30 minutes earlier in the day compared to mid-week days. These are inferred from only one of the two surveys.

- Both surveys show no statistically significant differences in the start time of personal business activities across the week days.

- This research is expected to deliver a preliminary understanding of how activity scheduling will fluctuate throughout a week, and how different socio-economic and demographic attributes will contribute to such phenomenon. Taking such variations into account will produce more accurate and more reliable estimates of demand analysis which will further contribute to the existing planning models at regional or statewide level.

CHAPTER 1: BACKGROUND

Problem Statement

The practice of travel-demand forecasting has placed substantial emphasis on forecasting travel during a "typical mid-week" (Tuesday – Thursday) day. While this is adequate from the stand point of understanding congestion due to commute, such an approach does not paint a complete picture of the overall travel patterns of people, and consequently, their overall quality of life (while not being stuck in traffic during the commute is certainly important, it is also necessary for people to be able to take care of household maintenance and pursue leisure activities with comfort). This is primarily because non-work/school-related travel desires are often satisfied on days when individuals are not constrained by the work/school activity. By focusing on mid-week periods, it is possible that we are missing a lot of travel for maintenance and discretionary purposes in our travel-modeling and planning exercise. Further, the non-mandatory activities and travel could be pursued at time of day periods that are typically not the "peak" periods. Such activities could be at locations which are generally not the same as those for work trips. Thus, the travel demands during non-mid-week periods might be at different time of day periods and at different parts of the network than those during mid-week periods. Finally, leisure / discretionary activities may be undertaken jointly and for longer durations. These have implications for fuel consumption (larger vehicles to accommodate the travel party), demand management policies (greater use of HOV lanes), and parking demand and air quality (longer activity durations / soak times). In short, vibrant communities require a transportation system that is functional and effective on all days of the week. Achieving this goal begins with a understanding of how travel patterns vary across the days of the week.

In light of the above discussions, the intent of this study is to examine the variations in activity-travel patterns across the week days with emphasis on differences between the mid-week days (Tuesday, Wednesday, and Thursday) and the shoulder week days (Monday and Friday). As such this study differs from a significant volume of literature which focuses on differences between weekdays and weekend days. Further, this study will also look at national-level data in contrast to previous studies that have examined patterns for a specific region such as the San Francisco Bay Area or the Atlanta region. Data from multiple years are examined in this study in contrast to the purely cross-section approach of past research. Finally, the proposed study will examine patterns using a combination of Time-use and Travel (Trip-based) Surveys.

Research Objectives

This study addresses the following major questions by analyzing two "waves" of two national-level time-use/travel surveys (the ATUS and the NHTS):

- What are the differences in the non-work (maintenance and discretionary) activity participation characteristics across the weekdays?
- How do the above differences vary across socio-economic market segments (such as employed individuals with varying levels of work flexibility, home makers, retired

individuals, parents, and urban versus rural dwellers)?

- How have the above differences changed over the last decade? Specifically, are maintenance and discretionary activities being increasing relegated to non-midweek days? How are these temporal trends different across socio-economic segments?
- Do both the travel surveys and time-use survey show similar behavioral patterns?

The focus on maintenance and discretionary activities is motivated by the fact that individuals have maximum flexibility in choosing when to pursue such episodes. Mandatory activities such as work and school are governed to a considerable extent by schedules set by employers/ institutions leaving relatively little room for individual decisions in the short term.

Research Scope

Researchers intend to examine individuals' activity scheduling behavior with an emphasis on variations across different days of the week. Logically, Mandatory activities such as work/school follow a routine daily pattern which decreases the probability of short-term irregularities. Therefore, considering the flexibilities of non-mandatory activity arrangements, this study initially focuses on five categories of non-mandatory activities: Household maintenance, personal maintenance, social, out-of-home meal and exercise. Moreover, instead of performing a day by day analysis, discrete temporal segments of a week are defined and analyzed. These segments include: Mondays, Mid-weekdays and Fridays. Such classification rises from the hypothesis suggesting that there is a gradual continuous transition from a typical weekday to weekends and vice versa. On Fridays, for instance, many companies offer a more flexible work schedule compared to regular days. Universities and academic institutes usually follow the same pattern, offering less class hours and a more elastic program on Fridays. Such gradual variation may emphasize on the importance of Mondays and Fridays, regarded herein as "shoulder days", in terms of a transitioning status between the weekends and mid-week days. Therefore, it maybe noteworthy to consider shoulder days as a new medium category connecting weekends and mid-week days and explore the behavioral differences between shoulder days and mid-weekdays in order to obtain a better understanding towards the daily variations on travel patterns across the days of the week.

It should be noticed that weekend data are excluded and therefore, this research work only focuses on within-weekdays contrasts. Three major dimensions for each activity are investigated. Participation rate, which exhibits the probability of an individual participating in any of the aforementioned activities; duration, which reflects the amount of time allocated to it; and time of day of the start of the first activity episode. The major objective is to highlight the observed dissimilarities in any of these two dimensions between mid-weekdays and shoulder days. In addition, demographic, socio-economic and job-related attributes are explored in order to identify how the dissimilarities in activity engagement vary across socioeconomic and demographic market segments.

It is useful to acknowledge that there is also a significant and growing body of literature on assessing quality of life using measures of subjective wellbeing elicited directly from respondents via surveys. This study does not employ such measures. Rather we focus on assessing day-to-day variations and/or constraints in non-mandatory types of activity-travel behavior (such as leisure

trips) which could have a significant impact of a person's overall quality of life.

Report Organization

The remainder of this report is divided into the following sections: Chapter 2 provides a brief description over the research background and literature review in terms of activity scheduling and daily variations in individuals' behavior. This chapter provides a supportive foundation which sheds light on the importance of incorporating daily fluctuations into planning studies. Chapter 3 presents a general perspective of the data sources used in this research, introducing NHTS and ATUS as the two major surveys at national level, along with discussing why and how these datasets will be useful for the objectives of this study. Section four will go through the methodology and statistical approaches used in this study. Finding and results are presented in chapter 5. This chapter is divided into two major sections: First, descriptive statistics of the data are analyzed and existing temporal fluctuations are highlighted and documented using relevant statistical tests. The second subsection focuses on econometric modeling and results analysis. Chapter 6 presents an analysis of the variations on time of day choices across the week days. Finally, conclusions and recommendations for further research are presented in Chapter 7.

CHAPTER 2: LITERATURE REVIEW

The practice of travel-demand forecasting continues to place substantial (if not all) emphasis on travel behavior for a "typical" day, often a "mid-week" (Tuesday – Thursday) day, and focusing on daily routines and regularities. Although this might be adequate from the stand point of understanding congestion due to commute, such an approach limits the ability to fully capture people's non-work travel patterns as such episodes are not undertaken on a daily basis and are more likely to take place on weekends and shoulder days (Monday and Friday) [*Bhat and Misra, 1999; Bhat et al., 2005; Buliung et al., 2008*]. Consequently, temporal variability analysis, which investigates how consistent individuals' activity/travel decisions are in a temporal framework, becomes a topic of interest. Taking such day to day variations into account is expected to produce more efficient estimation and result in better reflections of behavioral changes in response to policy actions [*Pas, 1986, 1987; Pas and Koppelman, 1986; Bhat et al. 2006; Bhat et al. 2005*].

Several studies have emphasized on temporal variations in terms of both travel behavior and time use patterns. *Ma and Goulias (1997)* used the Puget Sound Transportation Panel (PSTP) data to compare daily activity participation on two different days and two different years. Besides the existing habitual regularities, important temporal variations were observed. Researchers suggested that different time scales should be applied in order to fully capture behavioral variations rising from daily, weekly or monthly habits. For simplicity and to provide a better understanding, some research works suggest that days of the week may be classified into meaningful categories such as weekdays and weekends, or working and non-working days. Based on a weekly time-use data set from Netherlands, *Yamamoto and Kitamura (1999)* explored individuals' time allocation to discretionary activities among workdays and non-work days. A doubly-censored tobit model was developed which reflected significant variations between the two daily categories. In a similar study, *Bhat and Misra (1999)* highlighted the tradeoff in time allocation to in-home and out-of-home discretionary activities between weekends and weekdays. A resource allocation problem was formulated and solved using utility maximization method. Results indicated that age and work durations on weekdays are the most significant contributors to the model.

The idea can be further expanded into a more detailed framework by considering the variations observed on every single day of the week. *Habib and Miller (2008)* modeled both within-day and day-to-day dynamics in activity generation. They inferred Mondays, Thursdays and Sundays had significant differences in terms of "goodness of fit" and "significant variables". *Roorda and Ruiz (2008)* developed structural equations model (SEM) in order to capture the differences/similarities in activity and travel patterns in short and long term horizons. Accordingly, weekday activity/travel patterns are found to be different from weekend patterns. Moreover, an underlying similarity is found between a person's weekday activity/travel schedules from one year to the next. *Buliung et al. (2008)* explored the spatial stability of activity/travel behavior over a one week period. They suggested that non-mandatory activities were less spatially repetitive than obligatory activities. In addition, significant day-to-day fluctuations were observed in individuals' activity/travel behavior. *Kang and Scott (2010)* investigated maintenance and joint activity participations through SEM modeling. Separate models were developed for each of the seven days of the week. Considerable difference was observed between weekdays and weekends. Even on weekdays, no uniform time-use pattern was observed, rejecting the assumption of a "typical"

weekday pattern.

A number of other studies have directly focused on day to day variability of travel characteristics from a traffic congestion perspective. *Muthyalagari et al. (2001)* used descriptive statistics in order to perform a day-to-day comparison of individuals' travel behavior. For each day of the week, measurements such as number of trips, travel times and trip purposes are presented and compared. Accordingly, In general, it is found that Thursday is different from other days. The number of trips, travel times, and travel distances are all considerably larger on Thursday than on other days. Also, it is interesting to note that Friday depicts the lowest trip rates but reasonably comparable travel times and distances indicating that Friday's trips may be of longer duration and length. Focusing on commuters' travel behavior, *Mannering (1989)* showed that both departure time and route choice are subject to variation across different days, with departure time reflecting greater variability. Similar results have been reported by other researchers [*Mahmassani and Chang, 1985, 1986; Mahmassani and Stephan, 1988; Mahmassani and Herman, 1990*].

This study contributes to the literature thorugh providing an explanatory examination of within-weekday irregularities observed in individuals' non-mandatory activity behavior with an emphasis to highlight contrasts between shoulder days (Mondays and Fridays), and mid-weekdays (Tuesday through Thursday). Specifically, social activities, out-of-home meal and Household maintenance are investigated. General descriptive statistics were explored which help the analyst shed light on the existing contrasts primarily observed between the week day categories. Appropriate tests were carried out to investigate the statistical significance of the values. In the second step, which consists of advanced econometric analysis and modeling, a sample selection model was fitted to the dataset. Binary probit and linear regression models were developed simultaneously to predict two major activity dimensions, namely participation and duration. In particular, interactive effects of explanatory variables with weekday categories were taken into consideration. The model results reveal significant interaction effects with the weekday variable in some cases, which confirms the hypothesis that activity participation varies between shoulder days and mid-week days, and this change is influenced by the socioeconomic and demographic segments. The data applied in this study was obtained from the 2009 and 2001 National Household Travel Survey (NHTS), 2009 and 2003 American Time Use Survey (ATUS).

CHAPTER 3: DATA

This chapter provides an outline of the data resources applied in this research effort.

General Overview

This study uses four datasets obtained from the National Household Travel Survey, NHTS (two datasets: 2001 and 2009), along with the American Time Use Survey, ATUS (2003 and 2009). This will provide the analyst with a rich set of information which not only helps compare the intrinsic differences between the two survey approaches, but also highlights the existing trend observed in terms of activity participation during the past decade.

The NHTS data serve as the nation's inventory of daily travel. Data is collected on daily trips taken by households and individuals in those households, over a 24-hour period, and includes several aspects such as: trip purpose (work, shopping, social, etc.), trip mode (car, walk, bus, subway, etc.), travel time, time of day/day of week. These data are collected for all trips, modes, purposes, trip lengths, and all areas of the country, urban and rural. In addition to travel information, a wide range of socio-economic and demographic variables are also provided. In terms of data preparation, one member, 15 years or older, was randomly selected from each household. This is done to be compatible with the American Time Use Survey (ATUS), which relates to another objective of the study that will be performed as future work. The final dataset after excluding weekend data contains information for 18,392 individuals.

The NHTS trip files reports one-day out-of-home travel from 4:00 am to 3:59 am (of the following day) on a specified travel day. The conversion of trips to activities required identifying the time between trip arrival and start of the following trip (DWELTIME). If the calculated time at location was 0, then 5 minutes were assigned to the location, as it is expected that some time was actually spent doing the activity or idle in the location (e.g., dropping off mail); activity end time also includes this 5 minute window. The purpose of the activity was assigned from the mayor trip purpose (WHYTO). Trips that did not end at home by the end of the day, would be assigned the last known trip purpose and duration calculated to 4 am of the following day.

The American Time Use Survey (ATUS) is the Nation's first federally administered, continuous survey on time use in the United States. The goal of the survey is to measure how people divide their time among life's activities. In ATUS, individuals are randomly selected from a subset of households that have completed their eighth and final month of interviews for the Current Population Survey (CPS). ATUS respondents are interviewed only one time about how they spent their time on the previous day, where they were, and whom they were with. The survey is sponsored by the Bureau of Labor Statistics and is conducted by the U.S. Census Bureau.

The major purpose of ATUS is to develop nationally representative estimates of how people spend their time. Many ATUS users are interested in the amount of time Americans spend doing unpaid, nonmarket work, which could include unpaid childcare, eldercare, housework, and volunteering. The survey also provides information on the amount of time people spend in many other activities, such as religious activities, socializing, exercising, and relaxing. In addition to collecting data about what people did on the day before the interview, ATUS collects information

about where and with whom each activity occurred, and whether the activities were done for one's job or business. Demographic information—including sex, race, age, educational attainment, occupation, income, marital status, and the presence of children in the household—also is available for each respondent. Although some of these variables are updated during the ATUS interview, most of this information comes from earlier CPS interviews, as the ATUS sample is drawn from a subset of households that have completed month 8 of the CPS.

Why Four datasets?

The primary sources of travel behavior data are the National Household Travel Survey (NHTS) and the American Time Use Survey (ATUS). Both surveys collected data from a national sample of civilian, non-institutionalized population (*i.e.*, people not living in college dormitories, nursing homes, other medical institutions, prisons, and military bases) of the United States. The NHTS is a U.S. Department of Transportation (DOT) effort sponsored by the Bureau of Transportation Statistics (BTS) and the Federal Highway Administration (FHWA) to collect data on both long-distance and local travel by the American public. Data from the surveys conducted in the years 2001 and 2009 will be used in this analysis. The ATUS is conducted by the Census Bureau under contract with the Bureau of Labor Statistics and collects detailed individual-level daily time use information. The sample is drawn from a subset of households responding to the Current Population Survey (CPS) interviews. Data collection began in January 2003 and has continued yearly since. Samples from the 2003 and 2009 surveys will be used in this analysis.

The choice of using a combination of two surveys is motivated by several factors. First, while both surveys cover all days of the week, the ATUS over-sampled weekend days (50% for weekend versus 50% for the other week days) giving a substantially larger sample for some of the days of interest to this study. Second, unlike the ATUS, the NHTS collected data for all members of the households surveyed (ATUS has data only for one person per household). Third, the surveys also differ in the instrument (trip-based versus time use) administration protocols (such as proxy reporting) which have been shown to impact the survey responses about behavioral patterns. Thus, an analysis using a combination of NHTS and ATUS data can lead to a comprehensive and robust understanding of differences in travel patterns across the different days of the week.

It is also useful to emphasize the importance of the overall large sample sizes from these surveys for the proposed research. While the best possible approach to analyze day-of-the-week variability in travel patterns is to use weekly travel surveys of households, such data do not exist in the United States. When only one-day surveys are available (both NHTS and ATUS are such surveys) and the focus is on maintenance and discretionary activities which are not undertaken on a daily basis, one needs large sample sizes for each day of the week to effectively discern weekly patterns of observationally-identical sets of households. With large samples and national coverage, the NHTS and the ATUS are ideal for such an effort.

The data assembly procedure will involve the following steps: The maintenance activity participation pattern of each respondent (from each of the surveys and each of the waves) will be identified. Such activities will be broadly classified as household maintenance (grocery shopping) and personal maintenance. The disaggregate activity-type classification schemes used in the two surveys will be carefully examined to ensure consistency in definition of such activities. The total duration of the activity and the time of day of the episode are the fundamental aspects of interest

for this study. Other attributes such as location, mode of travel to activity, and trip chaining patterns are not considered to limit the scope.

The discretionary activity participation pattern of each respondent (from each of the surveys and each of the waves) will be identified. Such activities will be broadly classified as solo and joint episodes. Joint episodes are those that are undertaken with one or more household members. The disaggregate activity-type classification schemes used in the two surveys will be carefully examined to ensure consistency in definition of such activities. Once again, the total duration of the activity and the time of day of the episode are the fundamental aspects of interest for this study.

As the fundamental objective of this study is to examine day-of-the-week differences, the corresponding variable from the survey (the survey day) is of critical interest. Several control variables will be identified to serve as explanatory factors in the model. These variables include socio-economic factors such as household composition, income, ethnicity, car ownership, age, gender, household role, employment characteristics, student characteristics, disability; seasonal characteristics such as the month of the year, residential location characteristics, and commute characteristics. Consistency in defining these variables across the surveys will be ensured. The study will draw from the work of Yennamani and Srinivasan (2010) in generating comparable samples across NHTS and ATUS.

CHAPTER 4: RESEARCH APPROACH

This study focuses on the impacts of socio-economic, demographic, and other individual/household attributes on activity participation and duration. In particular, it emphasizes on how any of these characteristics may contribute to the temporal fluctuations across the weekdays. In order to do this, a basic model is initially estimated which only considers those personal and household characteristics. In the next step, specific hypotheses are formulated by adding the interactive effects of the base variables with the weekday category variable (Mondays, Mid-weekdays and Fridays). The attributes explored in this study include: age, driving license, gender, income, work status, residential land use and family roles.

A joint sample selection framework was applied in analyzing the participation and activity duration. Sample selection is a generic problem in social research and arises when the analyst does not observe a random sample of the population of interest. Particularly, this happens when observations are selected so that they are not independent of the outcome variables in the study. Such sample selection therefore leads to biased inferences about the model outcomes. A wide variety (perhaps the majority) of research traditions rely on statistical designs that are susceptible to sample selection biases. To rely exclusively on observational schemes that are free from selection bias is to rule out extensive portions of fruitful research data which is not appealing nor to the analyst neither to the data collectors. Selectivity is not only a source of bias in research, but also the subject of substantive research.

An intuitive appreciation of the ways that selection bias affects inference has always been part of sound research practice. In recent decades, many scientists have formalized the ways that selectivity can affect inferences about social processes. This is done through the use of *models* which count for sample selection bias. These models demonstrate formally how and why bias comes about, and they also show the common formal structure of an array of substantive investigations affected by sample selection bias. In a linear regression model, selection occurs when data on the dependent variable are missing non-randomly conditional on the independent variables. Elementary statistical methods in this situation generally yield biased and inconsistent estimates of the effects of the independent variables. For example, if a researcher uses ordinary least squares (OLS) to estimate a regression model where large values of the dependent variable are underrepresented in a sample, the estimates of slope coefficients may be biased.

Based on the above introduction, a sample selection structure well conforms to the objectives of this study. Focusing merely on activity durations (through a linear regression model) is well expected to result in sample selection bias as not everybody *participated* in the studied activity on the survey day. This will lead to a vast number of zeros in the linear model which will bias the estimated slope of the equation. In order to remove such bias, the framework presented in this research effort consists of two different equations being optimized simultaneously. A binary probit structure was applied for the first stage. In our case, we desire to model the probability to participate in the activity, assuming there is a linear expected utility an individual gets from taking the activity:

$$U_i = \beta_0 + \beta X_i + \gamma_{iMP}(W_{iM}X_i) + \gamma_{iFP}(W_{iF}X_i) + \varepsilon_i \qquad (1)$$

Where X_i denotes a vector of household and individual characteristics for person i. W_{iM}

and W_{iF} are the weekday dummy variables, respectively representing Mondays and Fridays. ε_i is identically and independently distributed as a standard normal distribution with mean zero and variance one.

β represents coefficients of the explanatory variables without interaction, referred to as "main effects'. γ represents coefficients of the explanatory variables interacting with the weekday category variable, referred to as "interaction effects". The interaction effects indicate how the impacts of the socioeconomic and demographic variables on activity participation are different across the three weekday segments.

The latent variable U_i is not observed directly. Instead, the decision on whether or not to participate in the activity is observed through the survey instrument, Y_i . The probability that Y_i equals one is

$$\Pr(Y_i = 1|X_i) = \Pr(U_i \geq 0|X_i) = \Pr(\varepsilon \leq X_i\beta + \gamma_{iMP}W_{iM}X_i + \gamma_{iFP}W_{iF}X_i|X_i) = \quad (2)$$

$$\Phi(X_i\beta + \gamma_{iMP}(W_{iM}X_i) + \gamma_{iFP}(W_{iF}X_i))$$

Where Φ is the cumulative function of a standard normal distribution. This is a standard probit model that can be estimated by a maximum likelihood estimation technique.
Activity duration model applies to those who participated in the activity (non-zero duration,$Y_i = 1$). A multiple linear regression model structure was used. In order to keep duration values positive, natural logarithm of the activity duration is considered as the dependent variable. Similarly, interaction effects are considered to the variations between shoulder days and mid-week days.

$$In(T_i) = \beta_0 + \beta X_i + \gamma_{iMD}W_{iM}X_i + \gamma_{iFD}W_{iF}X_i + \varepsilon_i \quad (3)$$

Where T_i is the activity duration for respondent i.

Maximum likelihood method is used to estimate the probit and regression models in a joint sample selection structure:

$$LL = \sum_{Y_i=0}(1 - Y_i).Ln\big(1 - \Phi(X_i\beta + \gamma_{iMP}W_{iM}X_i + \gamma_{iFP}W_{iF}X_i)\big) + \sum_{Y_i=1} Y_i.Ln\big(\Phi(X_i\beta + \gamma_{iMP}W_{iM}X_i + \gamma_{iFP}W_{iF}X_i)\big).Ln\left(\frac{1}{\sigma}\Phi\left(\frac{In(T_i)-(\beta_0+\beta X_i+\gamma_{iMD}W_{iM}X_i+\gamma_{iFD}W_{iF}X_i)}{\sigma}\right)\right) \quad (4)$$

Taking the above formulas into account, the methodology will be summarized in the following steps for each of the activity types:

1. A basic (main effect) smaple selection model is developed for each of the four datasets. This is done through disregarding the interaction terms in the aforementioned formulas.

2. Different hypotheses are made in view of the existing interactions between socio-economic/demographic attributes and temporal segments throughout the week. Each hypothesis can be expressed in the following format:

"*The socio-economic/deomgraphic attribute type (X) has a significant impact on temporal fluctuations observed in scheduling the activity under study either in terms of activity participation or activity duration*."

This hypothesis can be easily tested using the t value assigned to the interaction variable after the model development.

3. For the NHTS data, eight different attributes are considered: constant, age, gender, driving license, work status, land use, income, and family roles. The number of these attributes will shrink to six for the ATUS data due to lack of driving license and land use variables. As there are three temporal segments available, the 'mid-week' category is taken as base category, therefore leading to two temporal variables existing in the models (Mondays, W_{iM}, and Fridays, W_{iF}). For each of the hypotheses, interaction variables are added to the modeling structure simultaneously for both levels of participation and duration, and the impacts are estimated in terms of interaction coefficients (γ_{iMP}, γ_{iFP} for participation, and γ_{iMD}, γ_{iFD} for duration).

4. Using the t values and the magnitude of interaction coefficients, the hypotheses can be rejected or not. Moreover, the impact of any of the existing attributes can well be estimated based on the magnitude of the relevant interaction coefficient.

CHAPTER 5: FINDINGS AND APPLICATIONS

Descriptive Statistics

This section explores the variation among weekdays in terms of activity engagement and time use. For each activity type, the analysis was carried out in the two aforementioned dimensions: average daily duration and participation rates.

Figure 1 illustrates the participation rates (as in percentage of individuals participated in this activity) for each of the activities, explored across the three day-of-week categories namely Mondays, mid-week days and Fridays. For each of the activity types, temporal fluctuations are observed. However, the significance of the observed differences should be verified from a statistical standpoint. In this regard, participation rates are compared pairwise using "Bonferroni z test". The z-test results are depicted in Table 2. Figure 2 depicts the distribution for activity duration (in minutes represented by the Y-axis) for different day-of-week categories. These average values were computed over positive values, i.e. only including individuals who participated in that activity.

In order to compare activity scheduling aspects among the three temporal subsections, two major tests are applied to the datasets. In terms of participation rate, multi-sample z-test is practiced using the Bonferroni method. The Bonferroni's method is a simple method, allowing several comparison statements to be made, or several confidence intervals to be established. Accordingly, the test will highlight whether or not the ratio of participants is significantly different in one category compared to the remainder. If two categories are different in terms of participation rates, they will be assigned dissimilar alphabetical letters. For duration, as this is a continuous variable, ANOVA (analysis of variance) is used to highlight the existing differences between the three categories. ANOVA is a collection of statistical tests for analyzing difference between group means, with a concentration on the groups' variances. In the corresponding table, if the significance level is less than desired error, there should be at least a significant difference between a pair in the group. Results are then represented in terms of an F test value.

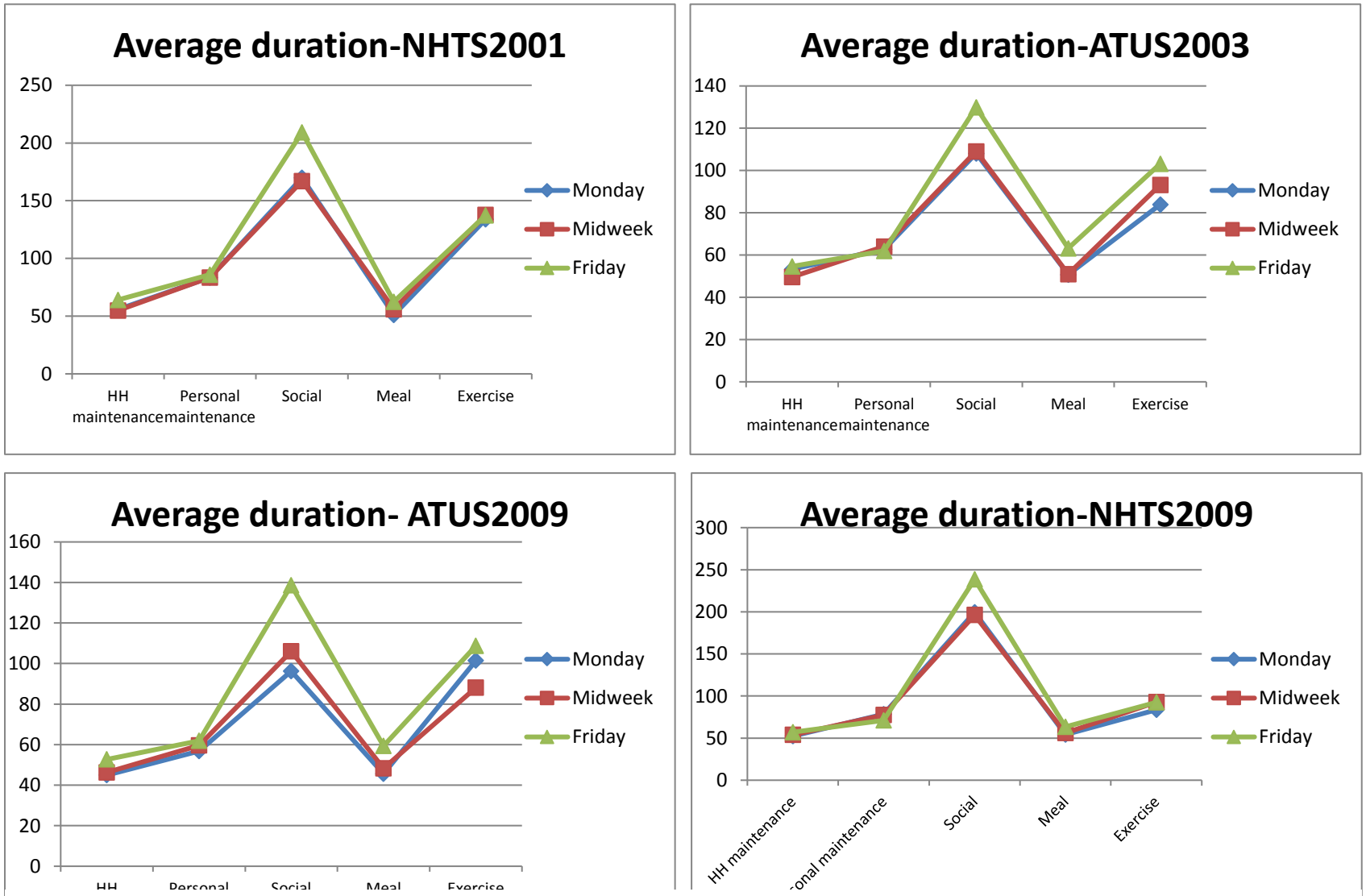


Figure 1. Average daily duration of non-mandatory activities (min)

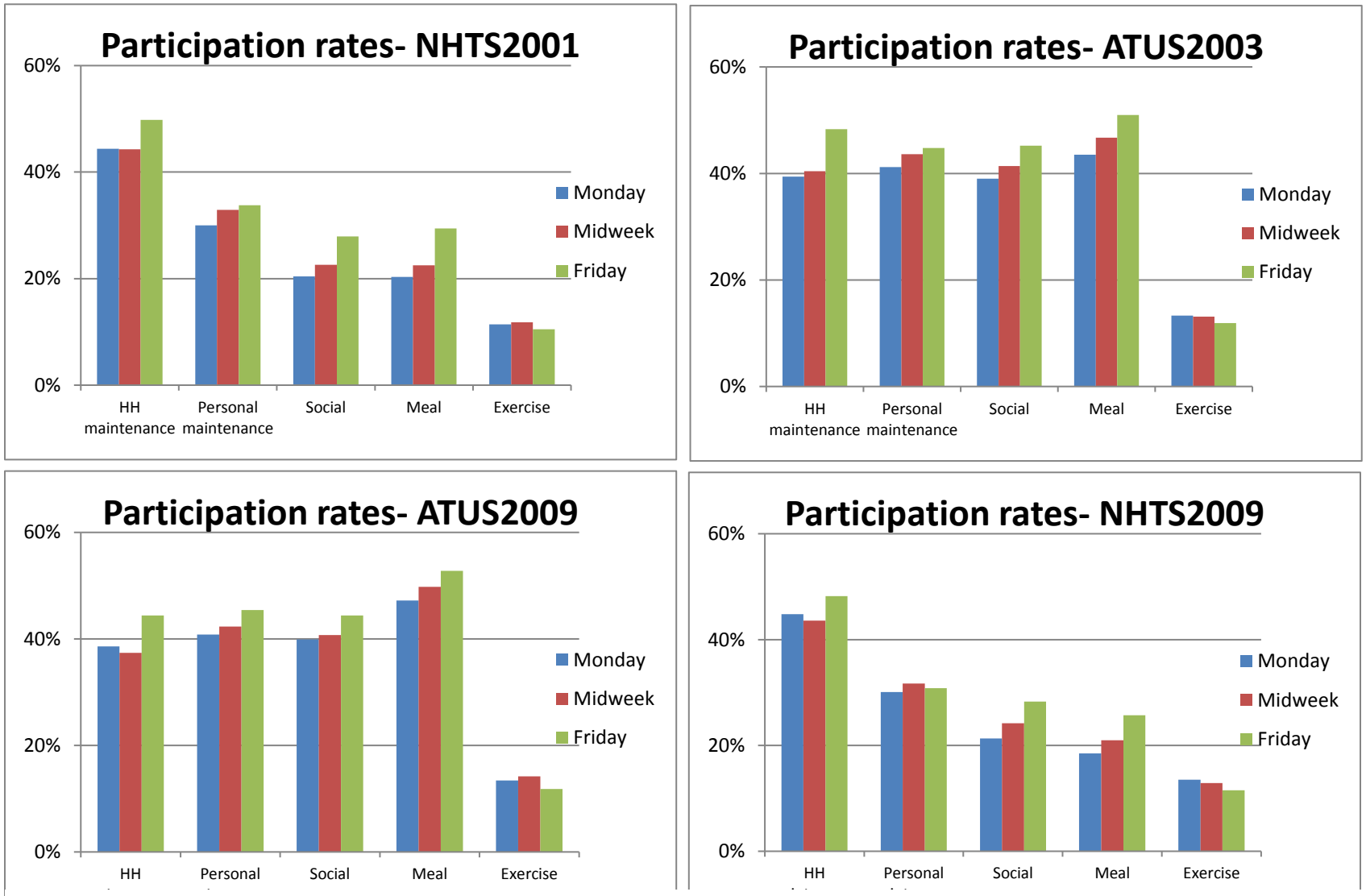


Figure 2. Activity participation rates

Table 1. Comparison Tests Among the Temporal Week Segments

Data	Activity type	Participation Rate			Duration (Anova test)	
		Monday	Midweek	Friday	F	Sig.
NHTS2001	*HH maintenance*	44.4% (a)	44.3% (a)	49.8% (b)	6.897	0.001
	Personal maintenance	30.0% (a)	32.9% (b)	33.8% (b)	0.151	0.859
	Social	20.4% (a)	22.6% (b)	27.9% (c)	19.342	0
	Meal	20.3% (a)	22.5% (b)	29.4% (c)	7.458	0.001
	Exercise	11.4% (a)	11.8% (a)	10.5% (a)	0.053	0.948
NHTS2009	*HH maintenance*	44.8% (a)	43.6% (a)	48.2% (b)	1.929	0.145
	Personal maintenance	30.1% (a)	31.7% (a)	30.8% (a)	1.337	0.263
	Social	21.3% (a)	24.2% (b)	28.3% (c)	13.991	0
	Meal	18.5% (a)	21.0% (b)	25.7% (c)	5.304	0.005
	Exercise	13.5% (a)	12.9% (a,b)	11.5% (b)	0.853	0.426
ATUS2003	*HH maintenance*	39.4% (a)	40.4% (a)	48.3% (b)	3.292	0.037
	Personal maintenance	41.2% (a)	43.6% (a)	44.8% (a)	0.21	0.81
	Social	39.0% (a)	41.4% (a)	45.2% (b)	11.198	0
	Meal	43.5% (a)	46.7% (b)	51.0% (c)	35.514	0
	Exercise	13.3% (a)	13.1% (a)	11.9% (a)	3.376	0.034
ATUS2009	*HH maintenance*	38.6% (a)	37.4% (a)	44.4% (b)	4.05	0.018
	Personal maintenance	40.8% (a)	42.3% (a,b)	45.4% (b)	0.549	0.578
	Social	39.9% (a,b)	40.7% (b)	44.4% (a)	22.643	0
	Meal	47.2% (a)	49.8% (a,b)	52.8% (b)	24.998	0
	Exercise	13.4% (a)	14.2% (a)	11.8% (a)	4.868	0.008

Table 1 presents the outcomes of the two tests. In this regard, the following results may be obtained:

- For the NHTS2001 dataset, social and meal reflect significant temporal fluctuations on both participation rate and duration. Personal maintenance activities show higher participation rates on Mondays while household maintenance are more involved in on Fridays.
- For NHTS2009 dataset, significant differences are observed in both aspects for social and meal activities. For exercise, results indicate that participation rates are significantly different on Mondays and Fridays while mid-weekdays are not significantly different compared to any of these two extremes. HH maintenance activities are yet more likely to be done on Fridays.
- In ATUS2003 dataset, meal shows significant differences in terms of both participation rate and duration. Social activity and HH maintenance show significantly higher engagement rates on Fridays. In terms of duration, all activities show significant variations except personal maintenance.
- In ATUS2009, HH and personal maintenance along with meal shows higher rates on Fridays compared to Mondays. Social activity shows a somewhat unexpected trend as the rates are higher on Fridays compared to Mid-weekdays but not significantly different from Mondays. Like ATUS2003, all activity types except personal maintenance reflect significant variations when it comes to duration.

As an example, let's focus on NHTS2009 dataset. Accordingly, social and meal activity participation rates follow an ascending trend starting from Mondays through Fridays and this observed increase is statistically significant at 95% confidence interval. In terms of household maintenance, only Fridays show significantly higher participation rate, while the desire to engage in exercise activities is higher on Mondays. One interesting finding is that participation rate in personal maintenance does not show significant temporal fluctuations across the week days.
Likewise, some of the results for duration from NHTS2009 can be discussed here. While most activities show similar duration values across different days, one can easily notice how social activity duration remarkably increases on Fridays. Furthermore, across the weekday sections, social activity has the highest duration with an average duration of 206.64 minutes per person. HH maintenance, on the other hand, demonstrates the lowest values with an average duration of 54.19 minutes per person. Accordingly, only two activity types show significantly different durations on different temporal segments of the week. These include social activity (F value = 13.991, P value = 0) and out-of- home meal activity (F value = 5.304, P value = 0).

A quick review of table 1 persuades the authors to focus on social and meal activities as these two show significant fluctuation in all the four datasets and also in both aspects of rates and duration. Later on, it was decided to also include HH maintenance in their investigation as this activity reflects similar behavior in all the four datasets (higher rates on Fridays, no difference on Mondays and mid-weekdays).

Comparison tests based on socio-economic/demographic variables

This section puts an effort towards comparing participation rates and activity durations based on aforementioned statistical tests. The objective is to find out how different individual/household attributes will contribute to temporal fluctuations in activity scheduling. Furthermore, such approach is expected to provide a primary understanding of variables in terms of magnitude and significance in the final model. Detailed statistical tests results are presented in the Appendix.

Social

For the social activities, based on NHTS2009 dataset, more participation rates is seen for both genders at Fridays. While females' participation rate is the lowest one at Mondays, there is no significance difference for males when considering Mondays and mid-weekdays. The same trend is seen in ATUS2003 database, however according to ATUS2009 dataset, only females show more participation rate in Fridays compare to Mondays and mid-weekdays and male show identical participation rate during the week. Considering holding or non-holding driving license illustrated participation rate of both groups is the most at Fridays, while it is significantly higher than Mondays based on ATUS2009 database. The same database reveals that low and medium income groups show significantly lower participation rates on Mondays, with comparable rates on mid-weekdays and Fridays; while high income group shows uniform behavior on Mondays and mid-weekdays with a significant increase on Fridays.

NHTS2001 dataset does not show any significant participation rate variation for low and medium income but it shows a significant higher participation rate for Fridays in compare with Mondays in high income group. On the contrary ATUS2003 database shows significant participation rate of low income group at Fridays in compare with Mondays and similar rate for other income groups. Also according to NHTS2009 dataset, non-workers and multiple job holders show steady rate in the week. NHTS2001 and ATUS2009 database results are identical for multiple job holders. NHTS2009 database shows that single individuals and single parent women do not show significant participation rate variation in the week. By the way the participation rate for married women is significantly variable through the week based on NHTS2001 database. Generally it is a higher participation rate when it moved to the end of the week.

In term of duration, the NHTS2001 database shows again male and female have significant variation through the week. Also based on this dataset (NHTS2001) the license holders, fulltime workers and non-workers show significant fluctuation of duration activity in the week. According to ANOVA test results, except low income, multiple jobs holders and all other personal attributes show high fluctuation in the weekdays. However the ATUS2003 shows only females and nuclear families have significantly higher duration on Fridays.

Meal

Based on NHTS2009 dataset, females do not show different meal activity in the weekdays. This is somehow similar to NHTS2001 and ATUS2009 database results, in which females show similar meal activity engagements on Mondays and mid-weekdays, but they show significantly higher rates for Fridays. On the other hand ATUS2003 dataset shows male reflects look-alike value for Mondays and mid-week days indicating there are no significant activity engagement differences between Mondays and mid-weekdays. Based on NHTS2009 database, licensed drivers showed different meal activities in the weekdays; higher participation rate as it moves from Monday to Friday. However ATUS2003 dataset illustrates both licensed driver and un-licensed driver show similar participation rate for Mondays and mid-weekdays and different but higher participation rates on Fridays.

According to NHTS2009 dataset, all income groups showed more meal activity for Fridays compare to other days of the week, but for high income group the difference between mid-weekdays and Mondays and also between Fridays and mid-weekdays is more significant. Results are the same for NHTS2001 database. ATUS2003 dataset shows a little different result. For high income drivers, the test does not show significant differences between Mondays and Fridays, or between Mondays and mid-weekdays, but there is significant difference between mid-weekdays and Fridays. Low and medium income groups, on the other hand, show significantly different meal engagement for different weekday categories, with lowest participation rates on Mondays and highest participation rate on Fridays.

Moreover the NHTS2009 and NHTS2001 databases illustrate part time workers and multiple job holders do not show significant variations for meal activity engagement. Based on NHTS2001 database, full time worker shows significantly different meal engagement for different

weekday categories. ATUS2009 dataset shows full time worker shows smaller participation rate for Mondays and higher participation rate on mid-weekdays and also Fridays. The NHTS2009 database reveals single individuals (male and female), single parents (male and female), minor individuals (male and female), and other individuals (male and female) do not show significant day-to-day fluctuations. It is the same for NHTS2001 database, except single males which show more meal activity at Friday. Based on ATUS2003 dataset, single males, single parents male, nuclear male, minor individuals (male and female), and other individuals (male and female) do not show significant day-to-day fluctuations. All the classifications show similar participation rates across different weekday categories except married male in ATUS2009 dataset. For all four datasets, it is interesting that there is a general trend towards higher meal engagement when it moves towards the end of the week, although some of the differences are not statistically significant.

Considering duration of meal activity and based on NHTS2009 dataset, females, license holders, medium and high income people, and full time workers reflect significant day-to-day variations. In terms of family roles, males generally do not show significant temporal fluctuations except for male married with kids in this database, while for NHTS2001 dataset, females generally do not show significant temporal fluctuations except for nuclear female and other female. In ATUS2003 dataset all personal attributes reflect significant day-to-day variations except unlicensed drivers, high income group, full-time workers, and non-workers. Like NHTS2009 dataset, males generally do not show significant temporal fluctuations except for married male. Based on ATUS2009 dataset, married male and female, single parent male, and man and woman nuclear show significant temporal fluctuations in duration of meal activity.

HH maintenance

For NHTS2001 and ATUS2003 databases, both males and females show higher participation rates of HH maintenance activities on Fridays, with comparable rates on Mondays and mid-weekdays. However for ATUS2009 dataset, females reflect significant differences in participation rates of HH maintenances between Mondays and Fridays, whereas males do not show any statistically significant difference across weekdays. In both NHTS2009 and NHTS2001 datasets, licensed drivers do not show considerable variation in HH maintenance engagement between Mondays and mid-weekdays, but there is significant difference between Fridays and mid-weekdays. For unlicensed drivers the test does not show significant differences between Fridays and mid-weekdays, but there is significant difference between Mondays and mid-weekdays.

According to NHTS2009 dataset, low income group does not show any significant difference in HH maintenance activities participation rates across mid-weekdays, while they show significant participation rate for Fridays at NHTS2001 dataset. Mid income group, however, show significant difference between Fridays and mid-weekdays (same as NHTS2001 dataset), although there is no significant differences between Mondays and mid-weekdays. High income group, on the other hand, shows uniform behavior on Mondays and mid-weekdays with a significant increase on Fridays. ATUS2003 dataset shows both low income and high income individual have higher participation rates in HH maintenance activities on Fridays, whereas mid income individuals reflect significant difference between Fridays and mid-weekdays. For ATUS2009 dataset, low and

medium income categories do not show significant temporal fluctuations. High income individuals, on the other hand, show significantly different rates on Mondays and Fridays, with no significant fluctuations on mid-weekdays.

Moreover, based on NHTS2009 dataset, all categories in work status except full time workers do not show significant variations for HH maintenance activities. Full time workers show significant difference between Fridays and mid-weekdays, but there is no significant difference between Mondays and mid-weekdays. These rates are somehow similar for NHTS2001 and ATUS2003 datasets either. The NHTS2009 dataset shows all categories except married women and nuclear men do not show significant day-to-day fluctuations. When considering NHTS2001, all categories except single women and married man do not show significant day-to-day fluctuations. It is interesting that there is a general trend towards higher HH maintenance activities at the end of the week for single woman and married man categories in NHTS2009 and NHTS2001 datasets.

In the case of HH maintenance activity duration, NHTS2009 dataset shows all personal attributes do not reflect significant day-to-day variations except for low income individuals, full time workers and multiple job holders. In terms of family roles, all categories except single parent male and male other generally do not show significant temporal fluctuations. For NHTS2001 dataset, gender, medium income, licensed drivers, full time workers and urban dwellers shows reflect significant day-to-day variations. For ATUS2003 dataset, males, full time workers and part time workers activity duration was varying through the weekdays. In this dataset, all categories except married man, single parent male and female other generally do not show significant temporal fluctuations. Varying personal attributes include high income individuals, full time workers and female based on ATUS2009 dataset. Also all categories except single parent female and single female generally do not show significant temporal fluctuations.

Model development and results

The final results of the sample selection models are presented in this section.

Social

The results for the main and interaction effects are respectively shown in tables 2 and 3.

Main effect models

For *NHTS2009* data, as expected, licensed drivers are more prone to participating in social activities. Presence of children and household size, considered as two fundamental household attributes, reflect positive contributions to the model. This is well justified as the number of people in the household has a direct impact on the intensity of their connections and social interactions. It seems that there is a negative association between work and social activity, represented by the negative coefficient of “number of employed members”. This indicate the temporal-spatial constraints imposed by work activity which limits individuals’ (and associated household members’) participation in social activities during the weekdays. In addition, both the desire to participate and the activity duration tends to decrease as individuals grow older.

The model suggests that social activity participation increases in parallel with income, which shows how budget plays an important role in social activities. The high-income category also shows the highest positive contribution to the duration model. In terms of education variables, lower educated categories reflect negative impacts on the model compared to college graduates, which have no significant effect. Considering work status, full time workers are least likely to participate in social activities. They also show negative impact on the duration model. It appears that multiple job holders are more likely to participate in social activities.

Results also indicate that individuals' family roles influence social activity participation and duration. In particular, single females show the highest probability of social activity participation. On the other hand, male single parents are least likely to engage in social events. Only one category affects the duration model which represents married female with kids, who are expected to spend the shortest time.

One distinctive aspect of the sample selection structure is the correlation parameter, which points out how unobserved factors (if there is any) would affect both decision-makings. The model suggests a positive correlation value of 0.037. However, the significance of such correlation is rejected by t-test. This may suggest that based on the existing variables, the two decision makings do not reveal significant correlation.
It is also noteworthy to explore the marginal effects (elasticities) of the applied parameters on both activity participation and duration. This might be more tangible when it comes to duration values rather than participaion probabilities. In terms of individual/household demographics, holding a drivers' license increases the participation probability by almost 0.13, which is the highest impact among all variables in the model. The impact of employed household memebers is also interesting when it comes to social activity duration. As the number of employed members increase by 1 unit, the average social activity duration decreases by 13%. Among different income categories, high income individuals are expected to spend 19% longer durations on social activities. Education has no impact on duration. Considering job status, full time workers on average spend almost 12% shorter durations compared to other worker types. Furthermore, married women with kids tend to spend 25% less time than others.

For *NHTS2001*, results indicate that as individuals grow older, they show less desire to be involved in social activities. Likewise, respondents with incomplete school education along with married males are less likely to participate in social activities. This may confirm the positive correlation between education and social activities. In case of married males, they are expected to cut down on their solo social activities and involve more in familial or joint social activities. Therefore, further exploration is required mainly in terms of the "accompaniment' or 'with-whom?' aspect of their social activities. As expected, licensed drivers are more prone to participate in social activities. Driving a car will certainly provide individuals with higher mobility and accessibility to different locations and activities. Moreover, the positive signs for unemployed and retired individuals confirm the hypothesis that any relaxation of work schedule constraints will provide individuals with more freedom to engage in non-mandatory activities. Not only does 'work' restrain the workers' schedule but also it impacts other household members. This is well explained through the negative coefficient for 'number of employed HH members' in family. Minor individuals (either male or female) also reflect higher tendencies for social activities. This

is expectable as teenage lifestyle includes several solo and joint non-mandatory extracurricular activities which fairly fit in the definition of social activities.

In terms of duration, it is interesting to see that only two variables reflect a positive contribution to the model. They include number of employed HH members, and individuals with incomplete high school education. All other variables perform as constraints, i.e. they tend to decrease the social activity duration. One major outcome is obtained when the two models are viewed jointly. Regardless of those variables which independently impact either of the two models, all common variables show differential effects. In other words, their impacts on the two models are accompanied by opposite signs. Such differential effect will further lead to a significant negative correlation between the two modeling levels. Based on the common sense, the following result may be inferred:

In terms of social activities, the NHTS2001 dataset reflects a negative correlation between participation rate (also implied as frequency) and the average daily duration. In other words, frequent social activities usually involve shorter durations while longer durations are expected to be assigned to less frequent social activities.

Table 2. Main Effect Model-Social

Basic Model - Social																	
		NHTS2009				NHTS2001				ATUS2003				ATUS2009			
		Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
	Parameter	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t
	Intercept	-0.92	-10.85	5.17	29.80	-0.81	-13.28	8.27	58.54	-0.28	-5.49	6.06	79.07	-0.39	-5.18	4.51	30.71
Individual/ Household Demographics	*AGE*	-0.01	-6.26	-0.01	-5.80	0.00	-6.93			-0.01	-8.14			-0.01	-3.98		
	Retired					0.09	6.29					0.12	3.46	0.12	3.25		
	Licensed DRIVER	0.43	9.91			0.29	7.45	-0.67	-6.91								
	.HHSIZE	0.05	2.79													-0.01	-0.67
	No. of employed members in HH	-0.11	-6.00	-0.13	-3.71	-0.11	-7.56	0.18	5.88								
	Household owner	0.15	4.41					-0.08	-2.11								
	Presence of children	0.09	2.09													-0.17	-2.26
	Unemployed or household role					0.10	4.96	-0.15	-3.35								
	No. of adult					-0.02	-2.30										
Income	*Medium income*	0.06	2.22											0.10	2.80		
	High income	0.08	2.63	0.19	4.03												
US Born	*US born*					0.09	2.44	-0.17	-2.06	0.20	6.32			0.12	2.61		
Education	*High school graduate*	-0.10	-4.21											0.10	3.01		
	Incomplete school	-0.18	-4.05			-0.14	-3.65	0.30	3.21								
Family Roles	*Male single*	0.14	2.77											0.11	2.07		
	Woman single	0.23	5.23					-0.11	-2.02			-0.11	-1.80	0.11	2.21		
	Male couple	0.08	2.00			-0.14	-7.50									-0.14	-1.80
	Woman couple	0.13	3.48					-0.25	-5.87							-0.28	-3.70
	Male single parent	-0.17	-2.23							0.17	4.73					0.26	1.96
	Female single parent							-0.27	-3.09	0.25	6.42	-0.18	-2.89				
	Woman nuclear			-0.26	-3.36			-0.49	-4.30								
	Woman other			0.12	1.61	-0.06	-2.55										
	Male nuclear family	-0.10	-2.11														
	MALE UNDER 18					0.50	6.28	-1.02	-5.70	0.21	3.03						
	FEMALE UNDER 18					0.32	4.09	-0.80	-4.50	0.32	3.96	-0.52	-4.20				
	Man other									0.18	3.48			0.66	6.32		
	Woman other													0.58	5.46		
Job Status	*Holding multiple jobs*	0.14	3.08														
	Work full time	-0.35	-11.10	-0.12	-1.95					0.15	5.03	-0.81	-15.91	0.26	6.35	-0.67	-13.92
	Work parttime	-0.11	-2.98							0.19	4.68	-0.49	-7.30	0.21	3.99	-0.39	-5.75
	_Rho	0.04	0.33			-0.97	-348.65			-0.91	-61.47			0.18	1.53		
	_Sigma.LnSocial			1.34	90.90			2.23	58.79			1.62	37.37			1.12	50.33

Table 3. Interaction Effect Model-Social

Interactive Effect - Social																
	NHTS2009				NHTS2001				ATUS2003				ATUS2009			
	Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t
MONDAY	-0.10	-3.58	-0.03	-0.62	-0.07	-2.50	0.12	1.97	-0.06	-1.82	0.07	1.24	-0.01	-0.31	-0.10	-1.81
FRIDAY	0.13	5.08	0.21	4.12	0.16	6.20	-0.07	-1.09	0.10	3.04	0.13	2.43	0.10	2.48	0.27	5.22
Rho	0.01	0.10			-0.97	-348.77			-0.91	-66.34			0.18	1.51		
Log likelihood	-17609.00				-16613.00				-13127.00				-9003.00			
*AGE*MONDAY*	0.00	-3.60	0.00	-0.39	0.00	-2.42	0.00	1.55	0.00	-1.95	0.00	1.45	0.00	-0.50	0.00	-1.40
*AGE*FRIDAY*	0.00	4.10	0.00	2.80	0.00	4.46	0.00	0.09	0.00	1.45	0.00	2.65	0.00	2.00	0.00	3.32
Rho	0.01	0.10			-0.97	-353.05			-0.91	-67.50			0.16	1.30		
Log likelihood	-17620.00				-16627.00				-13139.00				-9015.00			
*DRIVER*MONDAY*	-0.09	-3.13	-0.03	-0.63	-0.06	-2.19	0.12	1.82								
*DRIVER*FRIDAY*	0.13	4.87	0.19	3.61	0.17	6.09	-0.07	-1.14								
Rho	0.03	0.24			-0.97	-349.02										
Log likelihood	-17614.00				-16617.00											
*Male*MONDAY*	-0.09	-2.14	-0.16	-1.94	-0.08	-2.05	0.20	2.20	-0.09	-1.98	0.05	0.73	-0.02	-0.29	-0.11	-1.47
*Male*FRIDAY*	0.18	4.64	0.22	3.13	0.16	4.19	-0.06	-0.62	0.07	1.65	0.13	1.78	0.02	0.31	0.30	4.09
Rho	0.01	0.08			-0.97	-348.55			-0.90	-59.98			0.19	1.58		
Log likelihood	-17621.00				-16640.00				-13143.00				-9014.00			
*INCLOW*MONDAY*	-0.12	-2.80	-0.06	-0.68	-0.05	-1.42	0.06	0.65	-0.04	-0.86	0.04	0.51	-0.01	-0.20	-0.05	-0.56
*INCLOW*FRIDAY*	0.04	0.96	0.05	0.59	0.16	4.05	-0.04	-0.45	0.11	2.40	-0.02	-0.27	0.07	1.08	0.13	1.59
*MONDAY*INCMED*	-0.15	-2.80	0.10	1.00	-0.10	-2.39	0.20	1.94	0.02	0.29	-0.07	-0.77	0.07	0.86	-0.08	-0.90
*FRIDAY*INCMED*	0.07	1.34	0.20	2.23	0.16	3.68	-0.10	-1.00	0.16	2.73	0.13	1.43	-0.02	-0.20	0.27	2.82
*MONDAY*INCHIGH*	-0.04	-0.72	-0.16	-1.57	-0.07	-1.45	0.19	1.61	-0.20	-3.02	0.34	3.01	-0.07	-0.90	-0.18	-1.84
*FRIDAY*INCHIGH*	0.27	5.80	0.34	3.80	0.13	2.69	-0.04	-0.38	0.00	-0.02	0.39	3.99	0.21	3.08	0.35	4.01
_Rho	0.03	0.28			-0.97	-349.36			-0.91	-65.69			0.18	1.56		
Log likelihood	-17599.00				-16618.00				-13117.00				-9003.00			
*WKFT*MONDAY*	-0.07	-1.41	-0.05	-0.47	-0.05	-1.31	0.11	1.21	-0.07	-1.63	0.11	1.45	0.05	0.84	-0.11	-1.42
*WKFT*FRIDAY*	0.26	5.83	0.40	4.29	0.15	3.67	-0.09	-0.93	0.13	2.85	0.23	3.13	0.11	2.02	0.37	4.99
*MONDAY*WKPT*	-0.18	-2.31	-0.14	-0.97	-0.10	-1.30	0.13	0.70	-0.01	-0.07	0.02	0.16	-0.10	-0.94	-0.07	-0.51
*FRIDAY*WKPT*	0.07	0.97	0.33	2.63	0.23	2.97	-0.24	-1.34	0.04	0.45	0.13	0.93	0.12	1.09	0.34	2.38
*MONDAY*MULTJOBS*	-0.13	-1.02	0.05	0.21	-0.13	-1.19	0.20	0.71	0.19	1.74	-0.25	-1.39	-0.25	-1.83	-0.09	-0.45
*FRIDAY*MULTJOBS*	-0.07	-0.66	-0.03	-0.19	-0.05	-0.37	0.10	0.33	-0.08	-0.65	0.16	0.81	0.01	0.09	-0.38	-2.06
_Rho	0.03	0.24			-0.97	-346.54			-0.91	-71.41			0.18	1.57		
Log likelihood	-17601.00				-16638.00				-13119.00				-9000.00			
*URBANHH*MONDAY*	-0.08	-2.67	-0.06	-0.91	-0.07	-2.46	0.14	2.03								
*URBANHH*FRIDAY*	0.15	5.16	0.25	4.47	0.18	6.08	-0.11	-1.65								

Interactive Effect - Social																
	NHTS2009				NHTS2001				ATUS2003				ATUS2009			
	Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t
_Rho	0.01	0.10			-0.97	-345.44										
Log likelihood	-17613.00				-16622.00											
*ROLEMSNGL*MONDAY*	-0.10	-1.04	0.14	0.83	-0.17	-2.01	0.37	1.80	-0.03	-0.32	0.04	0.25	0.20	1.66	-0.07	-0.53
*MONDAY*ROLEWSNGL*	-0.14	-2.05	-0.08	-0.70	0.04	0.68	-0.29	-1.82	-0.09	-1.06	0.11	0.78	0.03	0.25	0.08	0.64
*ROLEMCOUPLE*MONDAY*	-0.06	-0.89	-0.23	-1.96	-0.03	-0.51	0.16	1.35	-0.08	-1.05	0.22	1.57	-0.06	-0.52	-0.08	-0.45
*MONDAY*ROLEWCOUPLE*	-0.07	-1.14	0.08	0.75	-0.15	-2.90	0.30	2.41	-0.10	-1.17	0.15	1.03	0.01	0.10	-0.09	-0.53
*MONDAY*ROLEMSNGLPRNT*	-0.05	-0.26	-0.23	-0.70	-0.03	-0.12	-0.04	-0.08	0.02	0.14	0.13	0.47	0.24	1.11	0.06	0.20
*MONDAY*ROLEWSNGLPRNT*	-0.10	-0.89	0.06	0.26	0.11	0.97	-0.35	-1.22	0.21	2.01	-0.04	-0.21	0.02	0.18	-0.10	-0.52
*MONDAY*ROLEMNUCLEAR*	-0.14	-1.29	-0.14	-0.62	-0.10	-0.65	0.11	0.27	-0.09	-1.28	0.02	0.13	-0.10	-1.14	0.01	0.08
*MONDAY*ROLEWNUCLEAR*	-0.15	-1.61	-0.09	-0.44	-0.05	-0.31	-0.02	-0.04	-0.02	-0.29	-0.06	-0.48	-0.07	-0.77	-0.30	-2.36
*ROLEMMINOR*MONDAY*	0.22	1.11	-0.34	-1.05	-0.01	-0.06	0.33	0.73	-0.09	-0.41	-0.20	-0.60	0.05	0.20	-0.37	-1.44
*ROLEWMINOR*MONDAY*	-0.23	-1.03	-0.12	-0.28	-0.22	-1.13	0.70	1.58	-0.25	-1.30	0.56	1.80	-0.13	-0.53	-0.15	-0.57
*MONDAY*ROLEM_OTHER*	-0.21	-2.27	-0.22	-1.10	-0.08	-1.06	0.04	0.21	-0.15	-1.01	0.04	0.16	-0.16	-0.79	-0.76	-2.71
*ROLEW_OTHER*MONDAY*	-0.09	-1.09	0.15	0.84	-0.04	-0.61	0.07	0.42	-0.09	-0.65	-0.10	-0.44	-0.24	-1.37	-0.30	-1.15
*ROLEMSNGL*FRIDAY*	0.02	0.25	0.09	0.56	0.31	3.66	-0.35	-1.80	0.12	1.15	0.04	0.23	0.14	1.08	0.28	1.82
*ROLEWSNGL*FRIDAY*	0.00	-0.07	0.10	0.91	0.03	0.48	0.10	0.58	0.00	-0.03	-0.04	-0.28	0.10	0.94	0.08	0.66
*ROLEMCOUPLE*FRIDAY*	0.19	3.01	0.13	1.21	0.10	1.93	0.01	0.10	0.05	0.64	0.14	1.01	-0.02	-0.22	-0.02	-0.13
*ROLEWCOUPLE*FRIDAY*	0.11	1.78	-0.01	-0.11	0.21	4.36	-0.20	-1.70	0.03	0.33	0.20	1.46	0.11	1.03	-0.04	-0.24
*ROLEMSNGLPRNT*FRIDAY*	0.40	2.25	0.62	2.30	-0.35	-1.02	1.27	1.52	0.07	0.33	-0.05	-0.16	-0.01	-0.05	0.09	0.26
*ROLEWSNGLPRNT*FRIDAY*	0.05	0.41	0.43	2.07	0.03	0.23	0.25	0.70	0.40	3.70	-0.06	-0.33	-0.09	-0.66	0.33	1.62
*ROLEMNUCLEAR*FRIDAY*	0.20	2.11	0.27	1.69	0.19	1.11	-0.05	-0.12	0.10	1.42	0.27	2.32	0.04	0.41	0.37	3.00
*ROLEWNUCLEAR*FRIDAY*	0.22	2.72	0.46	2.90	0.08	0.46	0.08	0.17	0.15	2.20	0.12	1.03	0.26	3.10	0.42	3.91
*ROLEMMINOR*FRIDAY*	0.55	2.94	0.44	1.52	0.19	0.96	-0.31	-0.73	0.19	1.08	-0.31	-1.25	-0.13	-0.55	0.76	3.19
*ROLEWMINOR*FRIDAY*	0.51	2.78	0.87	2.99	0.07	0.33	0.08	0.16	0.10	0.51	0.27	0.89	0.14	0.58	0.45	1.99
*ROLEM_OTHER*FRIDAY*					0.21	2.74	-0.05	-0.28								
*ROLEW_OTHER*FRIDAY*					0.26	3.55	-0.10	-0.63								
_Rho	0.02	0.19			-0.97	-349.46			-0.92	-73.37			0.20	1.58		
Log likelihood	-17580.00				-16592.00				-13108.00				-8982.00			

Accordingly, in the *ATUS2003* dataset, older individuals tend to lose interest in social activity participation. Among different family roles, single parents, minor individuals, and other males tend to increase the possibility of social activity engagement on a random day. Minor females show the highest effect on the model which may stem from their teenage lifestyle. Moreover, US natives are more probable to attend in social activities compared to immigrants which may bode for how being in a minority population can impact and restrain one's social affairs. The fact that full time and part time workers are more active in social activities is somewhat unexpected and may require further investigation. However, it should be noticed that they both significantly decrease activity duration (by 81% and 49% respectively). Retired individuals have no impact on the participation model but they tend to spend longer durations on social activities. All other variables tend to constrain social activity duration (i.e., they are accompanied by negative coefficients). The sample selection structure also reflects a negative correlation value of -0.91 which is mathematically expected as all the common variables are accompanied by opposite signs (differential effect).

In view of ATUS2009 results, retired individuals, individuals from the medium income group, US natives and high school graduate are more likely to participate in social activities. Like previous models, the tendency towards social activity engagement decreases as people grow older. Among various family roles, single individuals and other family roles (either male or female) also reflect positive contributions to the model. In terms of job status, both full time and part time workers are accompanied by positive coefficients which seem unexpected based on the hypothesis that any type of work activity will restrain individuals' freedom towards non-mandatory activities. Focusing on the duration model, it is interesting that no joint effect of variables is observed in the model structure, except for work arrangement variables. In other words, only work arrangement attributes affect both levels of the model structure and the effects are differential in both cases. While both full time and part time work increase the participation probability, they decrease the activity duration by 67% and 39% respectively. It is also noteworthy to point out the impact of two household structure variables, including HH size and presence of children. Since both variables tend to decrease activity duration, they may bode for how complexity of household structure will result in reduction of non-mandatory activity durations.

Interaction effects

Hypothesis 1- Weekday category

Constant interaction refers to the situation where $X_i = 1$. In other words, only the impact of week day dummy variables are considered by themselves.

The outcomes of the NHTS2009 model confirm the general expectation that Fridays are more likely for social activities. This stems from the nature of Fridays, which are usually regarded as the start of the weekend period where individuals' (mainly workers) are free from work-related constraints and are therefore more likely for non-mandatory activities, including social engagements. The same pattern exists for activity duration where individuals tend to spend longer hours on social activities on Fridays. Considering the marginal effects, social activity durations increase by 21% on Fridays and shrink by 3% on Mondays, regardless of any other individual, household or job-related attributes.

In NHTS2001, Fridays generally impose a positive effect on social activity participation while Mondays are less likely to be chosen for social activities. In terms of duration, however, Mondays tend to increase the duration of social activities by 12%. Fridays, on the other hand, have no significant impact on social activity durations.

ATUS2003 data imply that Fridays increase both the participation probability and duration of social activities. Mondays, on the other hand, are less likely for social participation with no significant impact on duration.

Finally in ATUS2009, Fridays increase both the probability and the duration of social activities. Mondays, on the other hand slightly decrease the activity duration (by 10%) with no impact on participation.

Hypotheses 2, 3 &4- Age, Driving license, Gender

Results for NHTS2009 show that as individuals grow older, they are more likely to engage in social activities on Fridays. In contrast, the probability to do it on Mondays tends to decrease according to the negative coeffeicient suggested by the model. The same pattern is observed for men and licensed drivers. Likewise, men and licensed drivers are expected increase their social activity duration by approximately 20% on Fridays. The impact of licensed drivers on Mondays, however, is minute and negligible (-3%).

NHTS2001 results imply that as individuals grow older, they are more likely to shift their social activities from Mondays to Fridays. The same pattern is observed for licensed drivers and males. In terms of activity duration, age does not seem to have significant effect while licensed drivers and male individuals significantly increase the duration on Mondays (12% and 20%, respectively).

Both age and gender variables in the ATUS2003 data decrease the participation probability on Mondays and increase the duration on Fridays. Furthermore, results for gender interaction indicate that males are more likely to participate on Fridays.

According to ATUS2009, older people are more likely to engage in social activities on Fridays. Furthermore, they are likely to spend longer durations on Fridays. The interaction of age with Mondays has no impact on the model. When it comes to gender, the only significant contribution is correspondent to males on Fridays. Accordingly, males are expected to increase the activity duration by 30% on Fridays.

Hypothesis 5- Income

As shown in table 1, three major income categories are defined. Results for NHTS2009 show that high income individuals (above 75K per year) reflect the highest positive impact on Fridays, both in terms of participation and duration. The marginal effect suggests that high income individuals spend 34% longer durations on Fridays. On Mondays, while all categories are accompanied by negative coefficients, medium income group show the least propensity.

All income-interacted variables for NHTS2001 show statistically significant impacts on

the model, except low and high income categories on Mondays. The same pattern of negative coefficients on Mondays and positive contribution for Fridays is observed. Taking durations into account, the only significant contribution is correspondent to medium-income category on Mondays. Accordingly, medium-income group spend 20% longer durations on social activities on Mondays.

Focusing on ATUS2003, low and medium income categories show a negative contribution to the engagement model on Mondays. While high income category does not show significant impacts on Fridays, they tend to decrease the probability on Mondays. When it comes to duration model, the high income category increases the activity duration on both Mondays and Fridays (34% and 39%, respectively).

In terms of participation, high income group in ATUS2009 reflect a positive contribution to the model on Fridays. When it comes to duration, medium and high income categories respectively increase the duration by 27% and 35%. High income group also tend to spend shorter durations on Mondays.

Hypothesis 6- Work arrangement

According to NHTS2009 data, full time workers are more likely to choose social activities on Fridays and also desire to spend longer durations. This may rise from the fact that full-time workers do not find that much free time on other weekdays and therefore, Friday is regarded as a good opportunity to compensate their lack of social engagement. Part time workers do not show any significant effect in terms of engagement on Fridays. However, they tend to increase the duration on Fridays. Full time and part time workers respectively spend longer hours by 41% and 33%. On Mondays, however, part-time workers are less likely to do social activities. It is interesting to see that holding multiple jobs had no significant impact on any of the decision makings.

In terms of NHTS2001, both full time and part time workers reflect positive contribution to the participation model on Fridays. No significant impact is reported for duration.

Full time workers in ATUS2003 are more prone towards social activities on Fridays in terms of both participation and duration. Furthermore, multiple job holders show a positive impact on the participation model on Mondays

Results from ATUS2009 indicate that full time workers are more likely to engage in social activities on Fridays. Multiple job holders, on the other hand, show lower tendencies towards social engagement on Mondays. Three major contributions are observed regarding the duration model. They include: full time workers, part time workers, and multiple jobholders all on Fridays. In this respect, the first two increase the social duration respectively by 37% and 33%, while the latter will decrease the duration by 38%.

Hypothesis 7- land use

Urban households in NHTS2009 data show positive contribution to the model on Fridays, both in terms of engagement and duration. On Mondays, on the other hand, urban households discourage social engagement. The impact on duration on Mondays is insignificant at 10% level.

Land use variables in NHTS2001 affect both participation and duration. Accordingly, urban residents are more likely to participate in social activities on Fridays. Taking duration model into account, urban households increase the social activity duration by 14% on Mondays and decrease it by 11% on Fridays.

Hypothesis 8- Family roles

The influence of different family roles are investigated in this section. When it comes to NHTS2009, minor men and women have the highest contribution to the engagement model on Fridays with minor women showing the highest positive impact on duration. On Mondays, married men show the shortest duration of social activity (by 22%).

A positive contribution is observed for the following categories in NHTS2001: single males on Fridays, married individuals on Fridays, and other roles on Fridays. Married females show a significant negative contribution to the model on Mondays. Focusing on duration, single individuals on Mondays, married females on Mondays, single males on Fridays, and married females on Fridays have statistically significant impacts on the model.

Regarding participation model in ATUS2003, single female parents are more likely to attend social activities, both on Mondays and Fridays. Likewise, females from nuclear families are more probable to participate on Fridays. Only one category affects activity duration. Accordingly, males from nuclear families increase the social activity duration by 27% on Fridays

Only two categories reflect significant impact on the ATUS2009 model and both are positive. They are: single males on Mondays and females from nuclear families on Fridays. When it comes to duration, a variety of significant impacts are observed. In view of that, females from nuclear families and other males significantly decrease the activity duration on Mondays. On the other hand, single males, females from nuclear families and minor individuals show positive contributions on Fridays. The highest positive impact belongs to Minor males on Fridays with a marginal effect of 76%.

Discussion

Having presented the numeric results of the models in the previous section, this part provides an overall analysis with an emphasis on comparing the results with common sense expectations.

Technically, all the interaction effects will improve the goodness-of-fit of the basic model since they produce a higher log likelihood value, taking the likelihood index as the major goodness-of-fit criterion in this study. Accordingly, this conforms to the general hypothesis that considering daily variations will help provide a better forecast of activity scheduling behavior and that, assuming a ‘typical’ weekday for planning purposes is yet under question.

In terms of main effects, there is evidence that some variables show similar impacts in all the four datasets. For instance, the pobability of engagement in social activities increases as individuals grow older, or native Americans along with are more likely to take part in social

activities. There is also a positive association observed between education level with social activity participation. Specifically, high school graduate are expected to show higher engagement rates compared to less educated individuals. Results form NHTS data also bode fore higher tendencies among high and medium income categories compared to low income individuals. Except for ATUS2009, all datasets reflect positive contribution for minor (under 18 years old) individuals, either in terms of main or interaction effects. This is expectable as teenage lifestyle includes several solo and joint non-mandatory extracurricular events which fairly fit in the definition of social activities. The initial hypothesis that work arrangements restrict any non-mandatory activity participation is well confirmed in the NHTS dataset. However, results from the ATUS dataset reveal some contradictory outcomes as full time work imposes a significant positive contribution to the model which needs to be further investigated. In addition, Among different interaction effects tested in this study, family roles show the highest likelihood values. This confirms the general theory that activity scheduling is usually decided in household context and there should be emphasis on the role of other family members in one's activity planning behavior.

Taking ANOVA and Z-test comparative approaches into consideration, an overall difference can be pointed out among the datasets. Accordingly, the NHTS datasets disclose more significant temporal fluctuations for social activities than the ATUS. Further investigation maybe required mainly in terms of the definition of social activities, and how the activity duration is derived in each of the two datasets. Another major point is the dissimilarity observed in terms of correlation values between participation and duration. In view of that, the updated versions of both datasets (i.e. ATUS2009 and NHTS2009) reflect positive correlation values which bodes for the common impact of unobserved factors on both participation and duration decision makings, while the older versions return negative correlation coefficients. There are a number of issues which can be accounted responsible for this phenomenon. First, one should notice that the models are very sensitive to the variables embedded into the model structure, and that any change in the basic model variables can alter the correlation estimate. Second, this may bode for an underlying difference between the two types of data (Updated versus the old ones) which in turn stems from any behavioral shift or preference in individuals' behavior throughout the study period.

Meal

The results for the main and interaction effects are respectively shown in tables 4 and 5.

Main effect

In view of NHTS2009, licensed drivers are more prone to participating in meal activities. Gender represents positive contribution to the model, which means males are more likely to participating in meal activities compared with female. This is well justified since females are usually less interested in taking outside meal rather prefer homemade meal. Household owner and US born exhibit different direction of impacts on participation and duration. In terms of participation, both attributes show positive impact on the model indicating they are more likely to engage in meal activities. But, in terms of duration, both attributes show negative impact on the model indicating their tendency to spend less duration for the meal activities. In addition, activity duration tends to increase as individuals grow older.

The model suggests that meal activity participation increases in parallel with income, which shows how budget plays an important role in meal activities. However, low-income category does not have any significant impact on meal activity participation. In terms of duration, none of the income category shows any significant impact. That means, how much time an individual spends on meal activities has no relation with his income. Regarding education variables, higher educated categories reflect positive impacts on the model compared to the lower educated categories, which have no significant effect. This implies that, educated individuals are more likely to participate in meal activities. Considering work status, unemployed individuals are least likely to participate in meal activities. This is reasonable, since they have less affordability to bear outdoor meal expenses. Full time workers show negative impact on the duration model indicating their tendency to spend less time for meal activities. This is understandable, since full time workers have more time constraint than any other worker category.

Results reflect that individuals' family roles influence meal activity participation and duration. Single male category positively affects the participation model indicating they are interested to participate in more meal activities. Regarding duration, couple woman, minor male and female show positive impact indicating their tendency to spend more time on meal activities. On the other hand, single males show negative impact, which mean they are less interested to spend longer times for meal activities. Such influence of family role on the model is understandable, since more active individuals are less likely to spend longer duration on meal activity and vice versa.

Taking the marginal effects (elasticities) into account, a US born individual decreases the duration by 0.67, which is the highest (negative) impact among all variables in the model. It means if the number of US born individuals increase by 1 unit in the model, the average meal activity duration decreases by 67%. Among different family role variables, minor male and female are expected to spend 42% and 48% longer durations on meal activities respectively. Regarding income, low income people tend to spend 7% more time than others. Considering job status, full time workers on average spend almost 34% shorter durations compared to other worker types. Furthermore, high school graduates tend to spend 15% more time than others.

Main effect model for NHTS2001 suggests that, household owners are more prone to participating in meal activities. In additon, gender represents positive contribution to the model, which means males are also more likely to participating in meal activities compared with female. This is well justified since females are usually less interested in taking outside meal rather prefer homemade meal and household owners are relatively wealthy person, who can afford frequent outdoor meal expense. The major discouraging individual and household demographic factors that affect meal participation are age, presence of children, and number of adult. This is understandable, since outdoor meal activities are not always suitable for individuals with children. On the other hand, older individuals are reluctant to participate in meal activities by nature. However when older people participates in meal activities, they tend to spend more time on the activities. Perhaps less time constraint influences their decision of longer duration. Retired perosn, who are also older, exhibits similar preferences. But licensed driver tends to spend shorter duration for meal activities.

Table 4. Main Effect Model-Meal

Basic Model - Meal																	
		NHTS2009				NHTS2001				ATUS2003				ATUS2009			
		Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
	Parameter	Est.	t	Est	t	Est.	t	Est	t	Est.	t	Est.	t	Est.	t	Est.	t
	Intercept	-1.51	-26.94	6.83	43.92	-1.26	-23.26	7.15	47.55	-0.64	-15.37	3.94	26.15	0.09	1.09	3.94	61.96
Individual/ Household Demographics	*AGE*			0.01	5.64			0.01	6.03			0.05	1.93	-0.01	-10.30	0.01	9.21
	Gender	0.04	2.55							0.09	2.61			0.10	2.79		
	.HHSIZE							-0.48	-5.56	-0.02	-1.93	-0.02	-2.00				
	Household owner	0.10	2.97	-0.18	-2.19									0.17	4.54		
	No. of employed members in HH					0.03	2.83	-0.17	-5.62								
	Unemployed/HH role					-0.03	-2.23			0.07	3.49						
	Retired											0.07	3.08			0.07	2.25
	no of adult					0.02	2.08							-0.04	-1.95		
	Presence of children											-0.10	-3.36	-0.16	-3.84		
	US born	0.30	7.27	-0.67	-6.66	0.21	5.78					0.06	1.96				
	Licensed DRIVER	0.15	5.29			0.34	8.30	-0.71	-7.12							-0.07	-2.54
Education	*Higher education*	0.19	7.05			-0.09	-6.37										
	High school graduate	0.06	1.87	0.15	2.63	-0.31	-7.66	0.34	3.56			-0.05	-2.28				
	Incomplete school									-0.09	-2.21	-0.15	-4.78				
Income	*Low income*			0.07	1.57									-0.09	-2.44		
	Medium income	0.05	2.49							0.12	3.70						
	High income	0.14	6.81							0.17	4.73			0.11	2.83		
Family Roles	*Male single*	0.09	2.36	-0.26	-2.96	0.22	6.08	-0.35	-4.42								
	Male single parent							-0.36	-2.35					-0.28	-2.67	0.22	2.59
	Female single parent							-0.24	-2.48	0.09	1.89						
	Male couple													-0.11	-1.94		
	Woman couple			0.11	2.50												
	Woman nuclear					0.15	2.11	-0.54	-3.31	-0.09	-1.97	0.06	1.75	-0.11	-2.16	0.07	1.96
	MALE UNDER 18			0.42	2.14			-0.28	-1.81	0.29	3.17						
	FEMALE UNDER 18			0.48	2.53												
	Woman other					-0.08	-3.47										
Job Status	*Unemployed*	-0.04	-2.79														
	Holding Multiple Jobs											-0.08	-2.10				
	Work full time			-0.34	-8.80					0.77	21.96	-0.14	-1.91	0.80	21.75	-0.36	-7.98
	Work part time									0.35	7.97	-0.08	-1.70	0.34	6.90	-0.25	-5.23
	_Rho	-0.97	-343.69			-0.96	-325.55			-0.06	-0.33			-0.67	-14.44		
	_Sigma. Meal			2.19	56.23				2.12			0.66	81.43			0.80	35.27

Table 5. Interaction Effect Model- Meal

		Interactive Effect - Meal															
		NHTS2009				NHTS2001				ATUS2009				ATUS2003			
		Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
		Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est..	t
Weekday	*MONDAY*	-0.09	-3.34	0.17	2.58	-0.07	-2.59	0.03	0.53	-0.06	-1.39	-0.02	-0.70	-0.09	-2.91	0.01	0.20
	FRIDAY	0.15	5.71	-0.11	-1.75	0.21	8.07	-0.21	-3.60	0.08	2.03	0.14	4.24	0.09	2.57	0.18	7.22
	_Rho	-0.97	-340.00			-0.96	-324.00			-0.68	-15.30			-0.05	-0.27		
	Log likelihood			-15359.00				-16566.00				-7972.00				-11304.00	
Age	*R_AGE*MONDAY*	0.00	-3.60	0.00	2.59	0.00	-2.83	0.00	0.56	0.00	-1.14	0.00	-0.72	0.00	-3.88	0.00	0.20
	*R_AGE*FRIDAY*	0.00	4.25	0.00	-1.24	0.00	6.73	0.00	-3.03	0.00	1.83	0.00	3.91	0.00	0.87	0.00	7.16
	_Rho	-0.97	-339.00			-0.96	-323.00			-0.68	-15.40			-0.08	-0.40		
	Log likelihood			-15371.00				-16580.00				-7975.00				-11307.00	
Driving License	*DRIVER*MONDAY*	-0.08	-2.71	0.10	1.58	-0.07	-2.73	0.04	0.66								
	*DRIVER*FRIDAY*	0.17	6.33	-0.15	-2.39	0.21	7.64	-0.19	-3.11								
	_Rho	-0.97	-344.00			-0.96	-325.00										
	Log likelihood			-15357.00				-16568.00									
Male	*R_SEX*MONDAY*	-0.10	-2.55	0.19	2.06	-0.05	-1.55	-0.10	-1.28	-0.04	-0.75	-0.05	-1.06	-0.09	-1.94	-0.02	-0.46
	*R_SEX*FRIDAY*	0.13	3.46	-0.13	-1.56	0.19	5.19	-0.22	-2.76	0.06	0.95	0.15	3.38	0.13	2.61	0.16	4.90
	_Rho	-0.97	-339.00			-0.96	-323.00			-0.67	-14.20			0.01	0.03		
	Log likelihood			-15384.00				-16597.00				-7983.00				-11323.00	
Income	*INCLOW*MONDAY*	-0.12	-2.70	0.22	2.05	-0.08	-2.04	0.07	0.80	-0.05	-0.70	-0.04	-0.67	-0.11	-2.31	-0.03	-0.70
	*INCLOW*FRIDAY*	0.03	0.77	-0.06	-0.62	0.19	4.86	-0.15	-1.73	0.07	0.95	0.06	1.07	0.09	1.73	0.09	2.31
	*INCMED*MONDAY*	-0.05	-0.90	0.13	1.14	-0.05	-1.08	0.01	0.06	0.06	0.86	-0.05	-0.94	0.01	0.23	0.03	0.72
	*INCMED*FRIDAY*	0.22	4.61	-0.17	-1.65	0.22	5.08	-0.22	-2.20	0.03	0.41	0.16	2.78	0.06	0.92	0.19	4.49
	*INCHIGH*MONDAY*	-0.09	-1.85	0.03	0.32	-0.12	-2.40	0.10	0.89	-0.19	-2.43	0.06	1.00	-0.15	-2.17	0.01	0.10
	*INCHIGH*FRIDAY*	0.24	5.51	-0.24	-2.56	0.18	3.72	-0.20	-1.89	0.12	1.54	0.18	3.55	0.09	1.35	0.32	6.78
	_Rho	-0.97	-347.00			-0.96	-324.00			-0.66	-13.60			0.06	0.40		
	Log likelihood			-15350.00				-16571.00				-7971.00				-11297.00	
Worker Type	*WKFT*MONDAY*	-0.12	-2.80	0.34	3.27	-0.11	-2.71	0.11	1.25	-0.03	-0.43	-0.05	-1.18	-0.08	-1.79	0.00	-0.09
	*WKFT*FRIDAY*	0.22	5.77	-0.11	-1.19	0.20	5.02	-0.26	-2.86	0.03	0.51	0.18	4.29	0.03	0.54	0.20	6.59
	*MONDAY*WKPT*	-0.06	-0.83	0.00	-0.03	-0.03	-0.43	-0.13	-0.75	0.05	0.45	-0.06	-0.71	-0.02	-0.25	-0.08	-1.20
	*FRIDAY*WKPT*	0.09	1.30	0.09	0.57	0.25	3.22	-0.28	-1.66	0.10	0.93	0.12	1.27	0.11	1.32	0.07	1.10
	*MONDAY*MULTJOBS*	0.15	1.50	-0.34	-1.45	-0.10	-0.93	-0.17	-0.68	-0.35	-2.60	0.05	0.45	-0.27	-2.36	0.14	1.43
	*FRIDAY*MULTJOBS*	0.01	0.11	-0.08	-0.38	0.12	0.96	-0.26	-0.93	-0.14	-0.95	-0.06	-0.53	0.12	0.93	0.15	1.60
	_Rho	-0.97	-349.00			-0.96	-330.00			-0.67	-14.50			-0.07	-0.36		
	Log likelihood			-15356.00				-16587.00				-7971.00				-11303.00	
Land Use	*URBANHH*MONDAY*	-0.09	-2.91	0.16	2.16	-0.07	-2.34	0.06	0.91								
	*URBANHH*FRIDAY*	0.19	6.54	-0.15	-2.24	0.21	7.07	-0.20	-3.06								
	_Rho	-0.97	-345.00			-0.96	-326.00										
	Log likelihood			-15356.00				-16582.00									

		Interactive Effect - Meal															
		NHTS2009				NHTS2001				ATUS2009				ATUS2003			
		Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
		Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est..	t
Family Role	*ROLEMSNGL*MONDAY*	-0.13	-1.43	0.45	2.11	0.00	0.02	-0.04	-0.23	0.01	0.07	-0.02	-0.27	0.10	0.94	-0.11	-1.37
	*MONDAY*ROLEWSNGL*	-0.01	-0.23	-0.02	-0.12	-0.05	-0.77	-0.02	-0.10	-0.06	-0.64	-0.02	-0.29	-0.12	-1.35	0.04	0.62
	*MONDAY*ROLEMCOUPLE*	-0.10	-1.81	0.12	0.86	-0.05	-1.06	-0.19	-1.77	0.11	0.93	-0.01	-0.12	-0.16	-2.00	0.06	0.98
	*MONDAY*ROLEWCOUPLE*	-0.11	-1.95	0.18	1.24	-0.08	-1.54	0.05	0.48	-0.01	-0.14	-0.08	-0.87	-0.21	-2.44	0.07	0.91
	*MONDAY*ROLEMSNGLPRNT*	-0.08	-0.50	-0.21	-0.56	0.05	0.21	-0.04	-0.08	0.19	0.74	-0.51	-2.47	-0.20	-1.13	0.12	0.84
	*MONDAY*ROLEWSNGLPRNT*	-0.16	-1.27	0.57	1.90	-0.22	-1.64	0.49	1.49	-0.23	-1.58	-0.01	-0.05	-0.21	-1.84	0.20	2.05
	*MONDAY*ROLEMNUCLEAR*	-0.06	-0.63	0.22	0.97	-0.11	-0.72	-0.03	-0.08	-0.26	-2.76	-0.03	-0.42	-0.17	-2.23	0.03	0.57
	*MONDAY*ROLEWNUCLEAR*	-0.07	-0.73	0.12	0.55	-0.26	-1.33	0.69	1.51	-0.15	-1.57	0.14	1.65	0.03	0.41	-0.05	-0.73
	*MONDAY*ROLEMMINOR*	-0.20	-0.79	0.02	0.03	-0.10	-0.44	0.63	1.14	0.71	2.77	-0.28	-1.66	-0.03	-0.13	0.12	0.70
	*MONDAY*ROLEWMINOR*	-0.09	-0.34	-0.30	-0.46	-0.28	-1.35	0.41	0.83	0.52	2.20	-0.18	-1.08	0.13	0.69	-0.08	-0.50
	*MONDAY*ROLEM_OTHER*	-0.14	-1.63	0.24	1.17	-0.05	-0.68	-0.05	-0.28	-0.33	-1.67	0.09	0.55	0.10	0.71	0.00	0.01
	*MONDAY*ROLEW_OTHER*	-0.14	-1.67	0.18	0.95	-0.09	-1.18	0.38	2.28	-0.07	-0.42	-0.20	-1.36	-0.17	-1.16	0.01	0.05
	*ROLEMSNGL*FRIDAY*	-0.05	-0.54	0.27	1.26	0.16	1.71	-0.20	-0.99	0.16	1.30	0.11	1.25	0.30	2.77	0.09	1.17
	ROLEWSNGL*FRIDAY	0.08	1.35	0.10	0.69	0.21	3.08	-0.20	-1.33	-0.05	-0.47	0.05	0.67	-0.02	-0.18	0.12	1.62
	ROLEMCOUPLE*FRIDAY	0.11	1.96	-0.25	-1.94	0.26	5.46	-0.31	-2.93	0.08	0.66	0.22	2.49	0.08	0.95	0.17	2.63
	ROLEWCOUPLE*FRIDAY	0.18	3.31	-0.15	-1.11	0.27	5.69	-0.32	-3.02	0.14	1.24	0.06	0.66	0.03	0.32	0.30	4.55
	ROLEMSNGLPRNT*FRIDAY	0.19	1.34	-0.13	-0.40	0.51	1.83	-0.27	-0.45	0.08	0.33	0.10	0.45	0.25	1.12	0.29	1.89
	ROLEWSNGLPRNT*FRIDAY	0.18	1.68	-0.11	-0.42	0.39	2.80	0.12	0.35	-0.12	-0.82	0.18	1.48	-0.02	-0.18	0.09	1.01
	ROLEMNUCLEAR*FRIDAY	0.26	3.31	-0.11	-0.64	0.18	1.07	-0.08	-0.23	-0.06	-0.64	0.15	2.18	0.06	0.81	0.19	3.54
	ROLEWNUCLEAR*FRIDAY	0.34	4.56	-0.55	-3.26	0.58	3.10	-0.52	-1.34	0.17	1.76	0.22	2.93	0.04	0.50	0.23	3.57
	ROLEMMINOR*FRIDAY	0.22	1.06	-0.73	-1.32	0.39	2.10	-0.69	-1.49	0.40	1.81	-0.15	-0.96	0.14	0.70	-0.20	-1.48
	ROLEWMINOR*FRIDAY	0.28	1.38	-0.13	-0.24	-0.15	-0.62	0.23	0.40	0.31	1.47	-0.15	-0.92	0.49	2.55	-0.18	-1.20
	*ROLEMMINOR*FRIDAY*					0.01	0.08	0.04	0.21					0.25	1.57	0.14	1.27
	*ROLEWMINOR*FRIDAY*					0.03	0.42	-0.04	-0.22					0.23	1.60	0.02	0.20
	_Rho	-0.97	-350.00			-0.96	-328.00			-0.68	-15.10			-0.54	-5.46		
	Log likelihood				-15339.00				-16533.00				-7945.00				-11277.00

The model suggests that meal activity participation increases in parallel with income, which shows how budget plays an important role in meal activities. In the model, low income peoples are actually less interested in meal acitvity participatation, whereas high income individuals are highly interested in the activity. However, medium-income category does not have any significant impact on meal activity participation. In terms of duration, none of the income category shows any significant impact. That means, how much time an individual spends on meal activities has no relation with his income. Considering work status, full time and part time workers are more likely to participate in meal activities. Infact, highest model impacts are shown by full time workers. This is reasonable, since they are relatively wealthy person. Full time workers and part time workers show negative impact on the duration model indicating their tendency to spend less time for meal activities. This is understandable, since both worker types have more time constraint than any other worker category.

Moreover, Results demonstrate that individuals' family roles influence meal activity participation and duration. Accordingly, none of the categories encourages meal activity participation. Male couple, male single parent, and nuclear woman all show negative impacts that means they are less likely to participate in meal activities. Regarding duration, male single parent and nuclear woman show positive impact indicating their tendency to spend more time on meal activities.

It is also worth mentioning the marginal effects (elasticities) of the applied variables on activity participation and duration. Again, durations are more tangible in terms of sensitivity . Accordingly, licensed drivers and retired persons both have the same level of influence but in the oppposite direction. Therefore, combined effect of them are mutually exclusive in the model. Age has a positive impact on the model. On the other hand, income has no impact on the model. Considering job status, full time workers negatively influence activity duration by almost 0.36, which is the highest impact (negative) among all variables in the model. It means, if the number of full time workers increase by 1 unit, the average meal activity duration decreases by 36%. Interestingly, next highest imapct category is also from job status category (part time worker). These findings suggest that job status category are the most important category in the model. Among different family role variables, male single parent and nuclear women are expected to spend 22% and 7% longer durations on meal activities respectively.

As expected, licensed drivers in ATUS2003 data are more prone to participating in meal activities. In fact, they show the highest influence on the model that is 0.34. The model also suggests that, household owners are more prone to participating in meal activities. This is well justified since household owners are relatively wealthy person, who can afford frequent outdoor meal expense. In additon, number of adult represents positive contribution to the model, which means households with more adults are more likely to participating in meal activities. Employment also plays a big role in deciding participation of meal activities. If a household has more number of employed members, they are more likely to participate in the meal activities and vice versa. This is reasonable, since more employed person hsoeuholds are more wealthy as well as they have less time for meal preparation. Unemployed person has the same level of effct on the model but in other way (discourage participation). In terms of duration, older people tend to spend longer time on meal activities. Perhaps less time constraint influences their decision of longer duration. On the

other hand, hosuehold size shows significant negative impact on the model. This indicate that larger households spend less time on outdoor meal acitvities. Similarly, meal activity duration decreases with increase in number of employed members in the household. It appears that licensed drivers are very reluctant on spending times in meal activities, as they show the highest negative impact on the model.

The model does not find any significant income effect on the model. That means, how much time an individual spends on meal activities and how frequent an individual participates in meal activities have no relation with his income. Regarding education variables, higher educated categories reflect negative impacts on the model compared to the lower educated categories, which have no significant effect. It implies that educated people are less likely to participate in meal activities than lower educated people. However, education has no influence on the meal activity duration. Interestingly, no work category shows significant impact on the model for both cases of activity particpation or activity duration.

Results indicate that individuals' family roles influence meal activity participation and duration. In particular, single males show the highest participation probability for meal activities. Nuclear womans are also interested in meal activity participation. On the other hand, woman others are least likely to engage in meal activity. Regarding duration, all the significant family role categories reflect substantial negetive impact on the model, including male single, male single parent, female single parent, woman nuclear, and male minor. This implies that these type of persons spend less time on meal activities.

Exploring marginal effects will produce notable results. This might be more tangible when it comes to duration values rather than participaion probabilities. In terms of individual/household demographics, licensed drivers show the highest impact on the duration by 0.71. It suggests that, as the number of licensed drivers increase by 1 unit, the average meal activity duration decreases by 71%. Household size and number of employed members in the household also exercise negative influence on meal activity duration by 48% and 17% respectively. Age has a positive impact on the model. Whereas, income has no impact on the model. Interestingly, high school graduates positively influence activity duration by almost 0.34, which is the highest impact (positive) among all variables in the model. Among different family role variables, nuclear women tend to spend 54% shorter duration on meal activities, which is the highest influence on the model compared to any other income category. Male single and male single parent show significant reduction in meal activity duration by approximately 35%. Female single parent and male under 18 have relatively less reduction (24% and 28%) in the activity duration.

The main effect model for ATUS2009 suggests that, gender represents positive contribution, which means males are more likely to participating in meal activities compared with female. This is well justified since females are usually less interested in taking outside meal rather prefer homemade meal. Household size has negative effect on the model indicating households with more members are less likely to participate in meal activities. In terms of duration, older people tend to spend longer time on meal activities. Perhaps less time constraint influences their decision of longer duration. On the other hand, hosuehold size shows significant negative impact on the model. This indicate that larger households spend less time on outdoor meal acitvities.

Similarly, meal activity duration decreases in presence of children. This is understandable, since outdoor meal activities are not always suitable for individuals with children. It appears that retired person and US born individuals are more interested on spending times in meal activities, as they show positive impact on the model.

Accordingly, meal activity participation increases in parallel with income, which shows how budget plays an important role in meal activities. However, low-income category does not have any significant impact on meal activity participation. In terms of duration, none of the income category shows any significant impact. That means, how much time an individual spends on meal activities has no relation with his income. Regarding education variables, incomplete school category reflect negative impact on the model compared to the educated categories, which have no significant effect. It implies that lower educated people are less likely to participate in meal activities than higher educated people. In terms of duration, less educated people have negative influence on meal activity duration, especially incomplete school groups who show the highest reluctancy for spending time on meal activities.

Considering work status, full time and part time workers are more likely to participate in meal activities. Infact, they show the highest impact in the model. This is reasonable, since they are relatively wealthy person. Full time workers and part time workers show negative impact on the duration model indicating their tendency to spend less time for meal activities. This is understandable, since both worker types have more time constraint than any other worker category.

Results indicate that individuals' family roles influence meal activity participation and duration. In particular, male minor shows the highest probability of meal activity partication. Female single parents also prefer meal activities. On the other hand, woman nuclears are least likely to engage in meal activities. Regarding duration, nuclear women reflect positive impact on the model, which implies that they tend to spend more time on meal activities.

In terms of interactive effects of individual/household demographics, presence of children shows the highest impact (negative) on the duration by 0.10. Household size also exercises negative influence by 2%. Age, retired person, and US born all have similar level of positive impact on the model. However, income has no impact on the model. Incomplete school category negatively influences activity duration by almost 0.15, which is the highest impact (negative) among all variables in the model. Considering job status, full time workers negatively influence activity duration by almost 0.14. It means, if the number of full time workers increase by 1 unit, the average meal activity duration decreases by 14%. Multiple job holders and part time workers also negatively influence meal activity duration but in a lesser extent. Among different family role variables, only nuclear women have significant influence. They tend to spend 6% shorter duration on meal activities.

Interaction effects

Hypothesis 1- Weekday category

The outcomes of the NHTS2009 model confirm the general expectation that Fridays are

more likely for meal activities. This stems from the nature of Fridays, which are usually regarded as the start of the weekend period where individuals' (mainly workers) are free from work-related constraints and are therefore more likely for non-mandatory activities, including meal engagements. However, the pattern is different for activity duration where individuals tend to spend longer hours on meal activities on Mondays. Considering the marginal effects, meal activity durations increase by 17% on Mondays and shrink by 11% Fridays, regardless of any other individual, household or job-related attributes.

The outcomes of the ATUS2009 model similarly confirm the situation in which Fridays are more likely for meal activities. The same pattern exists for activity duration where individuals tend to spend longer hours on meal activities on Fridays. Considering the marginal effects, meal activity durations increase by 14% on Fridays compared with mid-week, regardless of any other individual, household or job-related attributes.

Based on the results from NHTS2001, Fridays are still more likely for meal activities, taking into account the nature of Fridays as wekend starters. However, the pattern is different for activity duration where individuals tend to spend short durations on Fridays. Considering the marginal effects, meal activity durations shrink by 21% Fridays, regardless of any other individual, household or job-related attributes. The duration effects on Monday are insignificant.

The fact that Fridays are more likely for meal activities is well supported by results from ATUS2003 data. The same story goes for activity duration where individuals tend to spend longer hours on meal activities on Fridays. Considering the marginal effects, meal activity durations increase by 18% Fridays, regardless of any other individual, household or job-related attributes. The duration effects on Monday are insignificant.

Hypotheses 2, 3 &4- Age, Driving license, Gender

Results from NHTS2009 show that as individuals grow older, they are more likely to engage in meal activities on Fridays. In contrast, the probability to do it on Mondays tends to decrease according to the negative coeffeicient suggested by the model. The same pattern is observed for men and licensed drivers. However, the direction is different for activity duration where individuals tend to spend longer hours on meal activities on Mondays. Considering marginal effect, men and licensed drivers are expected to decrease their meal activity duration by approximately 13% and 15% on Fridays, respectively. Age has no impact on duration.

Results for ATUS2009 are somewhat similar in some aspects. For instance, as individuals grow older they are more likely to engage in meal activities on Fridays, while the probability to do it on Mondays tends to decrease. The same pattern is observed for males. Males are expected to increase their meal activity duration by approximately 15% on Fridays. The impacts of gender on Mondays, however, is insignificant. Driving license has no impact on duration.

Results from NHTS2001 also confirm the positive association between individuals' age and meal activity engagement on Fridays. On the contrary, engagement probability on Mondays decreases due to the negative coeffeicient suggested by the model. The same pattern is perceived for men and licensed drivers. However, the direction is different for activity duration where individuals tend to spend short durations on Fridays. The model suggests that, men and licensed

drivers are expected to decrease their meal activity duration by approximately 22% and 19% respectively on Fridays. Age has minimal impact on duration. The duration effects of all the categories on Mondays are insignificant.

Results from ATUS2003 show that older individuals are less likely to engage in meal activities on Mondays. Furthermore, individuals tend to spend longer hours on social activities on Fridays. Male exhibits the similar trend. The model suggests that, males are expected to increase their meal activity duration by approximately 16% on Fridays. Age has minimal impact on duration. The duration effects on Monday are insignificant. Driving license has no impact in the model.

Hypothesis 5- Income

According to NHTS2009 dataset results, high income individuals (above 75K per year) reflect the highest impact on Fridays, both in terms of participation (positive) and duration (negative). The marginal effect suggests that low income individuals spend 22% longer durations on Mondays. On Fridays, while all categories are accompanied by negative coefficients, highincome group shows the least propensity.

Similarly, results from ATUS2009 show that high income individuals (above 75K per year) reflect the highest postive impact on Fridays for duration, and also the highest negative impact on Mondays for participation. The marginal effects suggest that high income individuals spend 18% longer durations on Fridays. On Mondays, high income individuals have 19% less probability to participate in meal activities. For low and medium income individuals, most of the effects are insignificant.

Results from NHTS2001 imply Interesting results. Accordingly, medium income individuals (40k-75K per year) reflect the highest impact on Fridays, both in terms of participation (positive) and duration (negative). The marginal effect suggests that medium income individuals spend 22% shoerter durations on Fridays. On Mondays, while most of the effects are insignificant, only low income and highincome groups show the significant effect on activity particiaption indicating their least interest in meal activity engagement.

High income individuals (above 75K per year) from ATUS2003 data reflect the highest impact on Fridays, both in terms of participation (negative) and duration (positive). The marginal effect suggests that high income individuals are less likely to participate in meal activities on Monday and they tend to spend 32% longer durations in meal activities on Fridays. Low income travelers follow the similar trend but in lesser extent. However, medium income travelers do not show significant impact except duration impact on Fridays.

Hypothesis 6- Work arrangement

Taking NHTS2009 into account, full time workers are more likely to choose meal activities on Fridays. This may rise from the fact that full-time workers do not find that much free time on other weekdays and therefore, Friday is regarded as a good opportunity to compensate their lack of meal engagement. On the other side, full time workers spend 34% longer hours on Mondays. It is interesting to see that part time workers and multiple job holders had no significant impact on

any of the decision makings.

In terms of participation model from ATUS2009, only multiple job holders show significant impact, whereas full time workers are also the only category to show significant impact on Mondays. On Mondays, multiple job holders are less likely to participate in meal activities with marginal effect 35%, which is the highest impact in the model. This may rise from the fact that multiple job holders are under more pressure at the beginning of the week. In terms of duration, the marginal effect suggests that full time workers spend 18% longer durations on Fridays. Spending longer duration for meal activities on Fridays complies with general travel behavior.

Full time and part time workers from NHTS2001 are more likely to choose meal activities on Fridays and desire to spend less duration. This may rise from the fact that they do not find that much free time on other weekdays and therefore, Friday is regarded as a good opportunity to compensate their lack of meal engagement. On Fridays, the workers have approximately 25% higher probability to engage in meal activities. When it comes to the activity duration, they tend to spend approximately 28% shorter duration on Fridays. On Mondays, while most of the effects are insignificant, only full time workers show the significant effect on activity particiaption. It is interesting to see that multiple job holders had no significant impact on any of the decision makings.

Full time workes in ATUS2003 are least likely to choose meal activities on Mondays according to the negative coefficient suggested by the model. When it comes to the activity duration, they tend to spend longer duration on Fridays. The model result suggests that full time workers tend to spend 21% longer duration on Fridays. It is interesting to see that part time workers had no significant impact on any of the decision makings. The only significant effect for multiple job holder suggests that they have 27% less probabiltiy to engage in meal activities on Mondays. This may rise from the fact that multiple job holders are under more pressure at the beginning of the week.

Hypothesis 7- land use

Urban households in NHTS2009 show positive contribution to the model on Fridays in terms of engagement. On Mondays, on the other hand, urban households discourage meal engagement. Like other categories, the pattern is different for activity duration where individuals tend to spend longer hours on meal activities on Mondays.

With respect to NHTS2001, urban households show positive contribution to the model on Fridays in terms of engagement. On the other hand, urban households discourage meal activity engagement on Mondays. Like other categories, the pattern is different for activity duration where individuals tend to spend shorter durations on meal activities on Fridays.

Hypothesis 8- Family roles

The influence of different family roles are investigated in this section. When it comes to participation model in NHTS2009, nuclear men, nuclear women, and minor women are the most influencial category to the model on Fridays. The highest impact (negative) on duration shows by minor men on Fridays by 73%. On Mondays, single parent women shows 57% longest duration of

meal activity.

The influence of different family rolesin ATUS2009 indicate that when it comes to participation; minor male and monor female have the highest contribution to the model. Interestingly, both categories show postive impact indicating they are more likely to participate in meal activities on both Mondays and Fridays, with a higher participation probability on Mondays. The highest impact (negative) on duration shows by single parent male on Mondays. Male couple and nuclear women show the longest duration of meal activity by 23% and single parent male shows 57% shortest duration of meal activity.

The influence of different family roles in NHTS2001 reflect that single male and female, couple male and female, single parent male and female, male minor , and female nuclear have the significant contribution to the participation model on Fridays. The highest engagement impact shows by nuclear women on Fridays. They have 58% higher probability than any other category to get engaged in meal activities on Fridays. Only single parent female shows significant participation impact on Mondays. In terms of duration, only male couple shows significant contribution on Mondays, whereas male and female couple show significant contribution on Fridays.

Outcomes of the ATUS2003 participation model reveals that male and female couple, female single parent, and male nuclear have the significant contribution to the model on Mondays. For Fridays, single male and minor female show the significant contribution. Minor women shows the highest engagement impact on Fridays. They have 49% higher probability than any other category to get engaged in meal activities on Fridays. In terms of duration; male and female couple, male single parent, and male and female nuclear show the significant contribution on Fridays, whereas only women single parent shows the significant contribution on Mondays.

Discussion

Participation point of view implies that, there is a general trend towards higher meal engagement when it moves to the end of the week across all the dataset. Except ATUS 03, other datasets show all possible difference level (a, b, and c) for three different weekday category. Interestingly, ATUS 03 dataset shows only two level of differences (a, b) for same weekday category. In terms of duration; individuals and household characteristics show more significant impacts on weekday categories compared to family role characteristics for all the dataset. Perhaps, restructuring of family roles would be more effective. Further investigation may be required mainly in terms of the definition of meal activities and how the activity duration is derived in each of the two datasets.

In main effect model, there is evidence that some variables show similar impacts in all the four datasets. For instance, the probability of engagement in meal activities increases as individuals grow older or with the licensed status. Males also show higher interest to participate in outdoor meal activities compared with female. Perhaps, females are less interested in taking outside meal and prepare homemade meal fore themselves. According to 2009 datasets, household owners are also interested to participate in outdoor meal activities. This is well justified since household owners are relatively wealthy people, who can afford frequent outdoor meal expenses. NHTS

datasets also suggest that, US born individuals are more likely to prefer outdoor meal activities. This stems from cultural preferences of US born individuals regarding food preparation. In terms of duration, older individuals tend to spend more time on meal activities. Perhaps less time constraint influences their decision of spending longer duration. Retired individuals also express similar preference. This is understandable, since retired persons also have less time constraint. It appears that licensed drivers are very reluctant on spending times in meal activities. Controversial model results are obtained for duration models of US born individuals. NHTS 2009 dataset suggests they decreases average meal activity duration by 67%, whereas ATUS 2003 implies they increase average meal activity duration by 6%. Presence of children discourages meal activities both in terms of participation and duration, so as hosuehold size.

Except NHTS 2001 model, all other models suggest that meal activity participation increases in parallel with income also, which shows how budget plays an important role in meal activities. Education varaibles display interesting impacts on meal activity participation. NHTS dataset suggests that educated individuals are more likely to participate in meal activities, whereas ATUS datasets show no significant impact for educated individuals. Considering work status, ATUS datasets show significant positive impacts for full time and part time workers. Infact, highest model impacts are shown by full time workers. This is reasonable, since they are relatively wealthy people and have more time constraint. In terms of familiy roles, none of the dataset show any definite pattern on meal activity participation. As stated before, restructuring maily roles variable to fewer number of categories may produce significant impacts on meal activities. About durations of meal activity, model results suggest that income has no significant impact. This implies the amount of time an individual spends on meal activities has no relation with his income. On the other hand, education has no definate pattern in any of the dataset. Full time and part time workers show negative impact on the duration model indicating their tendency to spend less time for meal activities. This is understandable, since the workers have more time constraints than any other category.

Interaction effects between pre-selected attributes and the weekday variable are also analyzed for each of the dataset. In each case, the interaction effects are added to the model and their statistical significance is explored through pertinent t tests. The outcomes of the model confirm the general expectation that Fridays are more likely for meal activities. This stems from the nature of Fridays, which are usually regarded as the start of the weekend period where individuals' (mainly workers) are free from work-related constraints and are therefore more likely for non-mandatory activities, including meal engagements. In terms of meal activity duration, controversial model results are obtained for NHTS and ATUS datasets. NHTS models suggest that individuals tend to spend shorter durations on Fridays, whereas ATUS models suggest that individuals tend to spend longer durations on Fridays. Age, gender, and driving license variable also exhibits similar results; where particiaption are higher in Fridays across all the datasets, but similar controversial results are obtained for durations. Regarding income intereaction effect, high income group has the highest participation impact on Fridays and highest duration impact on Fridays. However, as seen before, NHTS and ATUS has controversial effect on duration for income effect also. In general, only full time worker vraiable of work status category has significant impact on interaction effect. Urban household variable is significant only for NHTS datasets, where Fridays are found as the most suitable weekday for meal activity participation with

longer duration. In most cases, family roles do not show any definite pattern. Overall, the interaction effects suggest that Fridays are more likely for meal activities while Mondays are the least likely. In terms of duraion, two different datasets show different types of impact on Fridays irrespective of any specific category which warrants further investigation.

Finally, all datasets reflect negative correlation values which means the impact of unobserved factors on participation and duration reverse each other. For instance, if any unobserved factor affects activity participation in a positive way, it would impact activity duration in a negative way. There are a number of issues which can be accounted for this phenomenon. First, one should notice that the model is very sensitive to the variables embedded into the model structure, and that any change in the basic model variables can alter the correlation estimate. Second, given the fact that ATUS captures one-third amount of NHTS dataset, there may exist discrepancy in ATUS 2009 dataset.

HH maintenance

Main effects

Based on NHTS2009, licensed drivers are more prone to participating in Household maintenance activities. However, the presence of children reflects negative contributions to the model. This is justified as the presence of child in the household has direct constrains on the planning of Household maintenance activities. It seems that there is a negative association between work and Household Maintenance activities, represented by the negative coefficient of "number of employed members". This indicates the temporal-spatial constraints imposed by work activity which limits individuals' (and associated household members') participation in Household maintenance activities during the weekdays. The results show that the desire to participate tend to increase as individuals grow older. In addition, categories, such as US born and Gender (being male) affect the duration model negatively, which means that individuals from these categories are expected to spend the shortest time. Among different categories in income group, medium-income groups are more prone to participating in these activities.

In terms of education variables, higher educated categories and high school graduate reflect positive impacts on the model compared to college graduates, which have no significant effect. Considering work status, full time workers are least likely to participate in Household maintenance activities. They also show negative impact on the duration model. On contrary, it appears that multiple job holders are more likely to participate in Household maintenance activities.

Family roles provide specific impacts on the model. In particular, single female parents show the highest probability of Household maintenance activity participation. Interestingly, only female categories affect the duration model which represents female single, female single parent and female others, who are expected to spend the shortest time.

The model suggests a positive correlation value of 0.003. However, the significance is rejected by the correspondent t test.

Results for NHTS2001 indicate that licensed drivers and unemployed individuals are more

prone to participating in household maintenance activities. Household size, considered as one of fundamental household attributes, reflects positive contributions to the model, which means that the tendency to engage in maintenance activites increases with the addition of the household members. It seems that there is a negative association between work and maintenane activity, represented by the negative coeficient of "number of employed members". This indicates the temporal-spatial constraints imposed by work activity which limits individuals' (and associated household members') participation in these activities during the weekdays. "Gender (being male)" reflect negative contirbutions to the model, which means they are less likely to participate and to send times in these activities. It is interesting to see that Nos of adults in household have positive effect on duration model, whereas Us-born individuals show reluctance to spend more time on these activites. Finally, the result shows that the desire to engage and to spend time in maintenance activites increase as individuals grow older , and especially when they get retired.

The model suggests that income groups have no effect on the participation of the maintenance activites. However, the result also indicates that low income group are more likely to spend times in household maintenance activites. In terms of education variables, both high school graduate and high-school drop-out categories reflect negative impacts on the model compared to higer education graduates, which have no significant effect. Results also indicate that individuals' family roles influence maintenance activity participation and duration. In particular, single males show the highest probability of maintenance activity participation, whereas female minors show the least participation rates. It seems that signle female and female couple show negative association wth the duration model , which means they are expected to spend the shortest time on maintenance activites. Single male parents, on the other hand, are more likely to spend time in maintenance activities.

In view of correlation between choice and duration, the model estimates a positive correlation value of 0.047. However, the significance of such correlation is rejected by t-test. This may suggest that based on the existing variables, the two decision makings do not reveal significant correlation.

Results for ATUS2003 indicate that males have less desire to participate and spend times in household maintenance activities. It seems that there is a negative association between work and maintenane activity, represented by the negative coeficient of "number of employed members". This indicates the temporal-spatial constraints imposed by work activity which limits individuals' (and associated household members') participation in these activities during the weekdays. It is interesting to see that Us-born members in household reflect positive association, which means that they are more likely to engage in participation in maintain activities. However, the results also suggest that Us-born members are less likely to spend time in these activities. In addition, unemployed indiviuals affect the duration model positively implying that they are likely to spend more time in maintainence activities.

The model suggests that low income groups are less likely to spend time in maintenance activities. In terms of education variables, both high school graduate and high-school drop-out categories reflect negative impacts on the model compared to higer education graduates, which have no significant effect.

In view of lifestyle and family roles, female nuclear and single male show the highest probability of maintenance activity participation, whereas male minors show the least inclination. It seems that female categoreis such as single female, single female parent and female minor show negative association wth the duration model , which means they are expected to spend the shortest time on maintenance activites. (Not consistant with the previous result). Considering job status, full time workers tends to participate and to spend less time in maintenance. On average, the full time workers spend almost 35% shorter durations in these activities compared to other worker types.

A positive correlation value of 0.10 is estimated. However, the significance of such correlation is rejected by t-test. This may suggest that based on the existing variables, the two decision makings do not reveal significant correlation.

According to ATUS2009, unemployed individuals are more prone to participating in household maintenance. Male and number of adult in Household reflect negative contirbutions to the model, which means they are less likely to participate and to send time in these activities. The resutl also indicates that individuals who are born in US, are more likely to participate in maintenance activities but are likely spend less time. In addition, it seems that the activity duration tends to increase as individuals grow older , and especially when they get retired.

The model suggests that low income group are less likely to participate in household maintenance activites. In terms of education variables, high school graduate and high-school drop-out categories reflect negative impacts on the model compared to higer education graduates, which have no significant effect. Considering work status, full time workers are least likely to participate and to spend less time in maintenance activities.

Taking family roles into consideration, results imply that female categories, such as single female and signle female parent, show negative association in participation rates. It seems that male minors show the least desire to participate and to spend times in maintenance activities, whereas Male couples are likely to spend longer time in these activities.

The sample selection structure estimates a correlation parameter with a negative value of -0.046. However, the significance of such correlation is rejected by t-test. This may suggest that based on the existing variables, the two decision makings do not reveal significant correlation.

Table 6. Main Effect Model-HH maintenance

Basic Model - HH Maintenance																	
		NHTS2009				NHTS2001				ATUS2003				ATUS2009			
Sample Selection Model		Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
	Parameter	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t
	Intercept	-1.11	-15.19	3.86	37.10	-0.64	-10.13	3.25	25.30	-0.10	-1.85	3.58	20.13	0.02	0.19	3.66	14.96
Demographics	*Age*	0.00	3.34			0.00	2.71	0.01	5.30			0.01	3.86			0.00	
	Gender (male)			-0.32	-10.46	-0.23	-9.61	-0.40	-9.16	-0.12	-3.44	-0.33	-6.55	-0.22	-5.21	-0.37	-6.03
	Licensed driver	0.68	17.40			0.58	16.01										
	HH size					0.01	2.12										
	No. of employed members in HH	-0.08	-5.25	-0.13	-5.19	-0.08	-4.89	-0.14	-5.79	-0.03	-1.68	-0.07	-2.64				
	Unemployed					0.07	3.33	0.13	4.32			0.14	3.23	0.10	2.60		
	Retired					0.12	5.57	0.09	2.72							0.12	2.40
	Nos of adult							0.04	2.18					-0.05	-2.10		
	US born			-0.21	-4.37			-0.11	-2.26	0.16	3.82	-0.18	-2.75	0.14	2.87	-0.16	-2.14
	Household owner			0.08	1.83												
	Presence of children	-0.19	-5.41														
Income	*Low income*	0.16	4.37					0.06	2.04	-0.08	-2.60			-0.09	-2.76		
	Medium Income	0.17	4.22														
	High Income	0.16	4.00														
Education	*Higher education*	0.29	8.17							-0.14	-4.56						
	High School Graduate	0.18	4.82			-0.07	-3.40			-0.32	-8.07			-0.13	-3.39		
	Incomplete school					-0.20	-5.87							-0.34	-6.80		
Family Roles	*Male single*	0.13	3.65			0.22	5.46			0.11	2.01			-0.14	-2.41		
	Female single			-0.14	-3.55			-0.15	-2.68	-0.09	-2.01	-0.15	-2.21				
	Male couple							-0.10	-2.28							0.28	3.45
	Male single parent							0.29	1.76								
	Female single parent	0.25	4.66	-0.21	-3.10			-0.15	-1.76			-0.26	-3.34	-0.15	-2.19		
	Male unclear													-0.12	-2.32		
	Female nuclear	0.20	4.47			0.14	1.95			0.14	3.45	0.11	1.80				
	Female Other			-0.41	-2.13	-0.29	-3.06			-0.35	-3.59			-0.21	-1.84	-0.35	-1.86
	Female minor					-0.31	-3.68					-0.30	-2.23				
	Male other					-0.06	-1.70	0.10	1.70								
	Female other					-0.13	-4.12										
Job Status	*Holding Multiple Jobs*	0.09	2.29														
	Work Full-Time	-0.26	-10.22	-0.28	-6.79					-0.12	-3.55	-0.36	-7.67	-0.13	-3.78	-0.41	-7.47
	Work Part-Time			-0.12	-2.57					0.07	1.69	-0.09	-1.53			-0.21	-3.09
	_Rho	0.00	0.04			0.05	0.62			0.11	0.95			-0.05	0.22		
	_Sigma			1.19	128.32			1.24	124.94			1.12	73.15			1.08	66.54

Table 7. Interaction Effect Model-HH maintenance

Interaction Effect - HH Maintenance																	
		NHTS2009				NHTS2001				ATUS2003				ATUS2009			
Sample Selection Model		Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
	Parameter	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t
Weekday	*MONDAY*	0.02	0.83	0.04	1.22	0.01	0.30	-0.01	-0.19	-0.02	-0.60	0.06	1.30	0.02	0.54	-0.02	-0.42
	FRIDAY	0.12	4.99	0.13	3.96	0.15	5.95	0.16	4.46	0.21	6.53	0.10	2.09	0.18	4.42	0.16	2.80
	_Rho	0.00	-0.03			0.04	0.48			0.11	0.97			-0.04	-0.18		
	Log likelihood			-25269.00				-26412.00				-13295.00				-8636.00	
Age	*Age *MONDAY*	0.00	0.67	0.00	0.77	0.00	0.25	0.00	-0.01	0.00	-1.10	0.00	1.08	0.00	0.11	0.00	-0.37
	*Age *FRIDAY*	0.00	4.25	0.00	3.66	0.00	5.19	0.00	4.20	0.00	5.12	0.00	1.46	0.00	3.66	0.00	2.28
	_Rho	0.00	0.04			0.04	0.54			0.11	0.97			-0.04	-0.21		
	Log likelihood			-25273.00				-26418.00				-13304.00				-8641.00	
Driving License	*Licensed*MONDAY*	0.04	1.51	0.04	1.10	0.01	0.54	-0.02	-0.62								
	*Licensed*FRIDAY*	0.12	4.86	0.13	3.81	0.15	5.78	0.15	3.99								
	_Rho	0.02	0.26			0.07	0.92										
	Log likelihood			-25270.00				-26415.00									
Male	*Male *MONDAY*	0.04	1.06	0.00	-0.01	0.02	0.60	0.04	0.79	-0.06	-1.14	0.22	3.08	0.00	0.04	-0.10	-1.16
	*Male *FRIDAY*	0.11	3.16	0.12	2.35	0.17	4.58	0.18	3.28	0.24	4.88	0.17	2.54	0.14	2.24	0.08	0.90
	_Rho	0.00	-0.04			0.04	0.55			0.11	0.93			-0.05	-0.22		
	Log likelihood			-25281.00				-26426.00				-13300.00				-8648.00	
Income	*Low*MONDAY*	0.04	0.17	0.04	0.82	-0.02	-0.51	0.01	0.09	-0.04	-0.79	0.00	-0.02	-0.02	-0.26	-0.06	-0.70
	*Low*FRIDAY*	0.04	1.47	0.15	2.97	0.16	4.09	0.10	1.79	0.27	5.07	0.13	2.02	0.09	1.27	0.20	2.36
	*Medium*MONDAY*	0.05	1.44	0.07	1.19	0.05	1.23	-0.04	-0.62	0.06	1.05	0.04	0.48	0.01	0.14	0.06	0.62
	*Medium*FRIDAY*	0.05	2.46	0.12	2.03	0.17	3.96	0.18	2.98	0.20	3.30	0.07	0.86	0.25	3.37	0.06	0.64
	*High*MONDAY*	0.05	-0.59	0.05	0.91	-0.05	-1.04	-0.01	-0.21	-0.07	-1.09	0.17	1.88	0.10	1.34	-0.05	-0.50
	*High*FRIDAY*	0.04	3.83	0.15	2.61	0.08	1.76	0.18	2.60	0.20	3.27	0.07	0.89	0.22	3.18	0.20	2.10
	_Rho	0.01	0.11			0.04	0.50			0.12	1.06			-0.01	-0.06		
	Log likelihood			-25267.00				-26414.00				-13291.00				-8635.00	
Worker Type	*Full time worker *MONDAY*	0.02	0.47	0.15	2.34	0.02	0.57	-0.03	-0.52	-0.03	-0.65	0.13	2.00	0.12	2.11	-0.04	-0.47
	*Full time worker*FRIDAY*	0.23	5.75	0.18	3.03	0.14	3.57	0.16	2.96	0.27	5.83	0.14	2.10	0.30	5.27	0.18	2.07
	*Part time worker *MONDAY*	0.01	0.16	0.05	0.56	0.01	0.09	0.04	0.41	-0.03	-0.39	-0.06	-0.56	-0.06	-0.62	-0.18	-1.32
	*Part time worker*FRIDAY*	0.13	1.92	0.25	2.59	0.27	3.51	0.01	0.10	0.06	0.70	0.05	0.43	0.26	2.60	0.15	1.03
	*Multiple jobs*MONDAY*	0.14	1.33	0.22	1.73	-0.12	-1.28	0.04	0.27	0.28	2.42	0.01	0.05	0.10	0.74	0.03	0.17
	*Multiple jobs*FRIDAY*	0.02	0.15	0.04	0.33	-0.17	-1.37	0.16	0.84	0.04	0.34	0.06	0.37	-0.33	-2.18	-0.14	-0.63
	_Rho	0.01	0.17			0.05	0.63			0.11	0.99			-0.03	-0.16		
	Log likelihood			-25256.00				-26423.00				-13295.00				-8628.00	
Land Use	*Urban*MONDAY*	0.02	0.68	0.02	0.50	0.01	0.35	0.02	0.63								

Interaction Effect - HH Maintenance																	
		NHTS2009				NHTS2001				ATUS2003				ATUS2009			
Sample Selection Model		Participation		Duration		Participation		Duration		Participation		Duration		Participation		Duration	
	Parameter	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t	Est.	t
	*Urban*FRIDAY*	0.14	5.06	0.12	3.16	0.17	6.11	0.19	4.77								
	_Rho	0.00	0.01			0.05	0.67										
	Log likelihood			-25271.00				-26411.00									
Family Role	*Male Single * MONDAY*	0.11	1.24	-0.13	-1.35	0.03	0.31	0.14	1.31	-0.05	-0.41	-0.08	-0.58	0.08	0.67	-0.16	-1.08
	*Female Single * MONDAY*	-0.04	-0.75	0.08	0.97	-0.06	-0.99	-0.06	-0.67	-0.08	-0.85	-0.05	-0.40	0.05	0.46	-0.16	-1.26
	*Male Couple *MONDAY*	0.09	1.74	0.04	0.62	0.01	0.26	0.03	0.38	-0.12	-1.51	0.29	2.39	0.01	0.06	-0.16	-0.93
	*Female Couple *MONDAY*	0.05	1.06	0.01	0.19	0.04	0.79	-0.01	-0.16	0.08	0.97	0.06	0.52	0.22	2.12	0.09	0.72
	*Male Single Parent * MONDAY*	-0.17	-1.11	0.30	1.19	0.08	0.37	0.12	0.29	0.16	0.91	0.28	1.18	0.10	0.44	-0.11	-0.35
	*Female Single Parent * MONDAY*	0.18	1.56	-0.06	-0.36	-0.03	-0.29	0.19	1.00	0.11	0.95	-0.33	-2.03	-0.27	-1.71	0.28	1.29
	*Male nuclear * MONDAY*	0.13	1.36	0.21	1.59	-0.16	-1.10	-0.01	-0.05	-0.08	-1.10	0.30	2.70	-0.10	-0.97	-0.07	-0.46
	*Female nuclear *MONDAY*	-0.05	-0.51	0.10	0.84	0.00	0.03	-0.16	-0.76	0.04	0.56	0.00	0.01	0.05	0.55	0.07	0.59
	*Male minor * MONDAY*	-0.10	-0.42	-0.43	-1.08	0.05	0.19	-0.03	-0.07	0.23	0.91	0.73	1.92	0.01	0.05	-0.36	-0.80
	*Female minor * MONDAY*	-0.09	-0.35	-0.37	-0.73	0.16	0.82	-0.36	-1.24	-0.13	-0.68	-0.40	-1.28	0.02	0.09	-0.05	-0.15
	*Male others * Monday*	-0.11	-1.43	-0.09	-0.75	0.08	0.92	-0.02	-0.15	0.00	0.03	0.16	0.77	0.04	0.18	0.38	1.36
	*Female others * Monday*	-0.13	-1.80	0.15	1.38	-0.03	-0.45	-0.10	-1.02	-0.17	-1.20	0.06	0.29	-0.12	-0.68	0.04	0.16
	*Male Single * FRIDAY*	0.07	0.76	0.17	1.70	0.17	1.81	0.16	1.41	0.21	1.79	0.06	0.43	-0.04	-0.34	0.02	0.12
	*Female Single *FRIDAY*	0.05	0.93	0.11	1.41	0.14	2.13	0.12	1.23	0.17	1.77	0.01	0.04	0.15	1.46	0.26	2.19
	*Male Couple *FRIDAY*	0.10	1.78	0.10	1.33	0.17	3.43	0.18	2.57	0.19	2.23	0.03	0.28	0.28	2.49	0.10	0.64
	*Female Couple *FRIDAY*	0.15	2.91	0.11	1.51	0.10	1.93	0.12	1.77	0.00	0.00	0.01	0.08	0.34	3.21	0.17	1.30
	*Male Single Parent*FRIDAY*	0.13	0.89	-0.07	-0.30	0.38	1.32	0.31	0.71	0.33	1.52	0.62	2.26	0.00	0.01	-0.35	-1.11
	*Female Single Parent*FRIDAY*	0.25	2.12	0.36	2.27	0.21	1.53	0.01	0.07	0.51	4.41	-0.05	-0.32	0.14	0.88	0.20	1.16
	*Male nuclear *FRIDAY*	0.33	3.90	0.06	0.51	0.25	1.53	0.12	0.53	0.26	3.47	0.21	2.08	0.14	1.35	0.22	1.63
	*Female nuclear *FRIDAY*	0.13	1.47	0.16	1.52	0.36	1.83	0.60	2.75	0.30	3.87	0.05	0.52	0.21	2.35	0.26	2.35
	*Male minor*FRIDAY*	-0.13	-0.56	-0.83	-1.95	0.34	1.50	-0.17	-0.49	0.52	2.49	0.36	1.39	-0.05	-0.20	0.11	0.26
	*Female minor*FRIDAY*	-0.12	-0.54	0.08	0.17	0.13	0.57	1.06	2.81	0.22	1.11	0.22	0.75	0.24	1.14	0.20	0.76
	*Male others * FRIDAY*					0.12	1.46	0.26	1.95	0.13	0.86	0.36	1.72				
	*Female others * FRIDAY*					0.17	2.18	0.17	1.63	-0.09	-0.66	0.19	0.95				
	_Rho	0.01	0.12			0.07	0.96			0.05	0.38			-0.01	-0.06		
	Log likelihood			-25247.00				-26397.00				-13263.00				-8620.00	

Interaction effects

Hypothesis 1- Weekday category

Hypothesis one tests the effect of weekday category itself, without interaction effects with other variables. Accordingly, the NHTS2009 model generally confirms the fact that Fridays are more likely to see Household maintenance activities. The same pattern exists for activity duration where individuals tend to spend longer hours on Household maintenance activities on Fridays. Considering the marginal effects, Household maintenance activity durations increase by 13% on Fridays and by 4% on Mondays compared with mid-week days, regardless of any other individual, household or job-related attributes.

The outcomes of the NHTS2001 model conforms to the general hypothesis that Fridays are more probable to see maintenance activities. Activity duration follows the same pattern where individuals tend to spend longer hours on maintence activities on Fridays. Considering the marginal effects, these activity durations increase by 16% on Fridays compared with mid-week days, regardless of any other individual, household or job-related attributes. However, the result suggests no significant impact of Monday on these activities compared with mid-week days.

Taking ATUS2003 into consideration, higher probabilities of activity engagement and activity duration are still observed on Fridays, supporting the nature of Fridays as weekend starters. Considering the marginal effects, these activity durations increase by 9% on Fridays compared with mid-week days, regardless of any other individual, household or job-related attributes. However, the result suggests no significant impact of Monday on these activities compared with mid-week days.

The results of the ATUS2009 model reveal that Fridays are more likely to see maintenance activities both in terms of engagement and duration. Considering the marginal effects, these activity durations increase by 16% on Fridays and shrink by 2% on Mondays compared with mid-week days, regardless of any other individual, household or job-related attributes.

Hypotheses 2, 3 & 4- Age, Driving license, Gender

Results from NHTS2009 show that as individuals grow older, they are more likely to engage in Household maintenance activities on Fridays compared to other days. The same pattern is observed for men and licensed drivers. Likewise, men and licensed drivers are expected to increase their Household maintenance activity duration by approximately 13% on Fridays.

According to NHTS2001 results, age increases the probability of getting involved in Household maintenance activities on Fridays compared to other days. Similar pattern is observed for men and licensed drivers. Likewise, men and licensed drivers are expected to increase their Household maintenance activity duration by approximately 17% and 15% respectively on Fridays.

Results from ATUS2003 similarly illustrate that as individuals grow older, they are more likely to participate in Household maintenance activities on Fridays. Identical pattern is also observed for men. Interestingly, men affect the duration model positively for both Mondays and Fridays. They tend to increase their Household maintenance activity duration by approximately 21% and 17% respectively on Mondays and Fridays.

Results show that as individuals grow older, they are more likely to engage in maintenance activities on Fridays. Interestingly, the result indicates no significant effect of age in maintenance activites on Monday. The same pattern is observed for men. However, the impact of age are minute 0.2%, and the gender (begin male) has no signficant effect on these duration model.

Hypothesis 5- Income

In terms of NHTS2009 data, mid income individuals reflect the highest positive impact on Fridays in participation activities while high income individuals show the most positive impact on duration. The marginal effect suggests that high income and low income groups spend 14% longer durations on Fridays. On Mondays, the impacts of all income categories show negligible effect.

Low and Mid income individuals reflect the positive impact on Fridays, in terms of both participation and duration, according to NHTS2001 data. The marginal effect suggests that Mid income individuals spend 18% longer durations on Fridays. However, the impacts of all income categories show negligible impact on Monday.

Similarly for ATUS2003 dataset, Positive effects are observed for both Low and Mid income individuals, in terms of both participation and duration. The marginal effect suggests that Low income individuals spend 13% longer durations on Fridays. However, the impacts of all income categories show negligible impact on Monday

High income individuals (above 75K per year) reflect the highest positive impact on Fridays, in terms of both participation and duration. The marginal effect suggests that high income individuals spend 19% longer durations on Fridays. On Mondays, the impacts of all income categories show negligible effect.

Hypothesis 6- Work arrangement

Full time workers are more prone to choosing Household maintenance activities on Fridays, considering NHTS2009 data. This may rise from the fact that full-time workers do not find that much free time on other weekdays and therefore, Friday is regarded as a good opportunity to compensate their lack of Household maintenance engagement. Part time workers and multiple job holders do not show any significant effect in terms of engagement on Fridays. Moreover, the results suggest that Full time and part time workers respectively spend longer hours by 18% and 24% on Friday. On Mondays, all categories of workers show no impact on household maintenance activities. It is interesting to see that holding multiple jobs has no significant impact on either participation or duration.

In the NHTS2001 data, Full time workers and part time workers are more likely to choose maintence activities on Fridays and also desire to spend longer durations. The result suggests that Full time workers spend longer hours by 16% . It's interesting to see that multiple job holders show no signficant impact in maintenece activity on Friday. On Mondays, all categories of workers show no significant effect to engage in maintenance activities.

The ATUS2003 data indicates that full time workers are more likely to choose maintenance activities on Fridays and also desire to spend longer time (by 13 percent). However, Part time workers and multiple job holders do not show any significant effect in terms of engagement and

spending times on Fridays.
It is interesting to see that holding multiple jobs has significant postitive impact on participation of maintenance activities, whereas the full time workers affect spend longest hours by 13%.

Full time workers and part time workers tend to show higher participation rates and longer durations on Fridays, considering ATUS2009 datsaet. Full time and part time workers respectively spend longer hours by 18% and 14%. On contrary, the multiple job holders show negative association in maintenece activity on Friday. On Mondays , all categories of workers except full-time workers show no significant effect to engage in maintenanc activities. It is interesting to see that full time workers are more likely to choose maintence acitvities on Monday, although they are likely to spend less time on these.

Hypothesis 7- land use

Focusing on NHTS2009, urban households show positive contribution to the model on Fridays, both in terms of engagement and duration. However, the impact on duration and household maintenance participation activities on Mondays is insignificant at 95% confidence interval

According to NHTS2001 dataset, urban households show positive contribution to the model on Fridays, both in terms of engagement and duration. However, the impact on duration and household maintenance participation activities on Mondays is insignificant at 95% confidence interval.

Hypothesis 8- Family roles

For NHTS2009 dataset, Male nuclear individuals have the highest contribution to the participation model on Fridays with minor women showing the highest positive impact on duration. On Mondays, Male nuclear individuals show the shortest duration of Household maintenance activity (by 22%).

Categories such as single female, male couple and female others are more likely to engange in maintenance activities on Fridays, According to NHTS2001 data results. Among differenr groups, female others showing the highest positive impact on duration. On Mondays, however, none of these categoreis show significant effect on maintenance activites.

In the ATUS2003 data, categories such as male couple, single female parent, male nucluear, female nuclear and male minor are more likely to engange in maintenance activities on Fridays with single female parents showing the highest positive impact on duration.

Interestingly, on Mondays, none of these categoreis show significant effect on maintenance activites. However, the result indicates that male couple and male nuclear reflect positive contribution to the duration model, whereas single female parents are less likely to spend time in maintenance activities on Monday.

Exploring the influence of different family roles in ATUS2009 shows that when it comes to engagement, couple groups (both male and female) and female nulear are more likely to engange in maintenance activities on Fridya with female nuclear showing the highest positive

impact on duration. On Mondays, however, only female couples show significant effect in maintenance activites.

Discussion

This part of the report presents the overall analysis with a comparative view of findings of all four datasets. As descibed in previous sections, models are , first, developed to understand the impact of different socio-demograhic and surrounding land-use characteristics on one's decision in participating household maintence activities; then, models are further analyzed for capturing the interaction effect of these attributes on predefined different weekdays, such as Shoulder days, Mid weekdays. From statisical point of view, this incorporation of interaction terms into the basic model are likely to improve the goodness of fit of the model, as found in the models' result. In view of that, althoguh it's expected that models' result, shown in previous sections, should conform to the same behavior characteristics, the findings may vary as datasets differ in many aspects such as sample size, data collection procedure, definition and so on. Hence, a particular emphasis is placed on this to understand whether one's decision varies among different datasets (such as NHTS, ATUS).

In terms of main effects, there is evidence that some variables show similar impacts in all the four datasets. For instance the probability of engagement in maintenance activities increases as individuals grow older, or with the licensed status. Interestingly, male show reluctance towards these activites, although they tend to engage more in acitivities on Fridays. While investigating whether being native has impact or not, it seems that they are likely to spend less times on maintenance activites.

Moreover, the interaction between income and engagement in maintenance acitvities shows some interesting results. Only high income individuals show strong desire to engage in these activities for both 2001 and 2009 datasets.

The initial hypothesis that work arrangements restrict any non-mandatory activity participation is well confirmed in both NHTS and ATUS dataset. But, it is interesting is to see that full time workers seem to participate and to spend more times in maintenance activities on Fridays compared to other weekdays.

Finally, all datasets reflect negative contribution on maintenance activites for minor (under 18 years old) and single individuals, either in terms of main or interaction effects. This is expectable as household maintenance activities are often regarded as mundane tedious works, which are not much exciting for teenage or single lifestyle. In view of that there is a general trend among couples to engage more in maintenance activities on Fridays.

Another performed task of this study is to see whether participation rates and duration time vary among the datasets. Accordingly, the statistical results suggest that there is more statistical variation among different categories in Participation rate compared to duration time. This implies that individuals may be hesitant to engage in maintenance participation, but once decided there is not much difference in their spending pattern. Another important observation from this analysis is NHTS datasets disclose more significant variations for household maintenance activities than ATUS datasets. It requires further investigation mainly on how household maintenance activities

are defined and how activity duration is derived in these datasets.

Finally, all datasets except ATUS 2009 reflect positive correlation values which bode for the common impact of unobserved factors on both participation and duration decision makings, while the ATUS 2009 dataset returns negative correlation coefficients. There are a number of issues which can be accounted for this phenomenon. First, one should notice that the model is very sensitive to the variables embedded into the model structure, and that any change in the basic model variables can alter the correlation estimate. Second, given the fact that ATUS captures one-third amount of NHTS dataset, there may exists some discrepancy in ATUS 2009 dataset, although the model estimates, on average, does not support this statement.

CHAPTER 6: Exploratory Analysis of Time of Day Variations

The analysis thus far has focused on the participation and duration of activities. This chapter examines the variations in the time of day (start time) of the first activity episode of each of the five activity types (household maintenance, personal maintenance, social activities, meals, and exercise). The analysis is presented using data from both the NHTS and the ATUS surveys.

Household Maintenance

Figure 3 presents the temporal profile of the start time of the first household maintenance activity (out of home) across the different weekdays. The top chart presents the results from the NHTS (trip based) survey while the bottom chart presents the results from the ATUS (time use survey). Both surveys show the peaking of activity participation during the late morning period with the ATUS reflecting a later peaking. The ATUS also shows a more-pronounced afternoon peaking which is not evident from the NHTS. Finally, there is no apparent difference in the profiles across the weekdays. Table 8 presents the results of a regression model to examine the impacts of various factors on the choice of the start time. After controlling for a host of explanatory factors, the NHTS data suggests that household maintenance activities on Mondays and Fridays maybe undertaken about 10 minutes earlier in the day when compared to the mid-week days. This effect is only marginally significant (85-90% confidence). The model developed from ATUS shows no statistically significant differences across the weekdays. It is useful to note there that the ATUS does not provide data on whether the respondent had a driver's license and the urban/rural location of the residence. All other explanatory factors are the same across the two models.

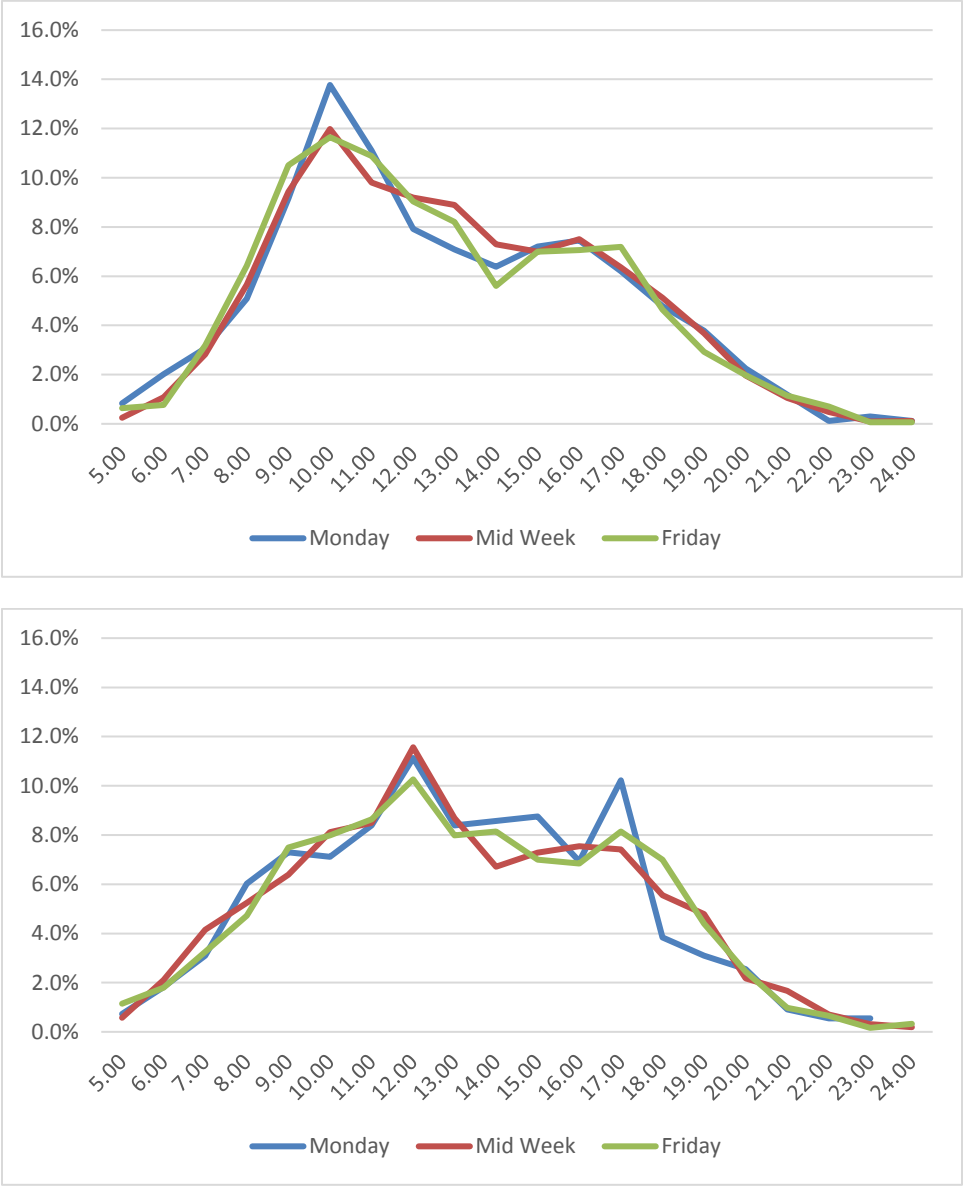


Figure 3 Variations in Start time of Household Maintenance Activities across Weekdays from NHTS (top graph) and ATUS (bottom graph)

Table 8 Factors Impacting the Start Time of Household Maintenance Activities across Weekdays

	NHTS		ATUS	
	Param	t stat	Param	t stat
Day of the Week				
Monday	-10.626	-1.755	-4.205	-0.371
Friday	-9.953	-1.593	-0.909	-0.084
Control Variables				
Respondent age	-2.577	-18.446	-2.216	-6.921
Respondent gender	-2.735	-0.572	-5.455	-0.599
Driver status	-13.644	-1.289		
Born in US	-24.820	-2.906	-37.946	-2.660
Employed role	-0.861	-0.181	51.906	5.287
Household income < $40k	3.287	0.327	-4.059	-0.286
Household income $40k-$74k	7.392	0.724	2.394	0.162
Household income $75k+	11.919	1.139	7.411	0.501
Household owned by a member	-1.193	-0.190	6.543	0.590
Children present in HH	2.411	0.385	-9.433	-0.891
March-May	0.229	0.038	-7.851	-0.667
June-August	-11.350	-1.607	5.488	0.433
September-November	-19.301	-2.650	-3.838	-0.297
Urban	17.194	3.111		
(Constant)	687.628	36.144	661.756	23.556

Personal Maintenance

Figure 4 presents the temporal profile of the start time of the first personal maintenance activity (out of home) across the different weekdays. The top chart presents the results from the NHTS (trip based) survey while the bottom chart presents the results from the ATUS (time use survey). Both surveys show the peaking of activity participation during the morning period with the ATUS reflecting a steeper peaking. Finally, there is no apparent difference in the profiles across the weekdays. Table 9 presents the results of a regression model to examine the impacts of various factors on the choice of the start time. After controlling for a host of explanatory factors, both the models show no statistically significant differences across the weekdays. It is useful to note there that the ATUS does not provide data on whether the respondent had a driver's license and the urban/rural location of the residence. All other explanatory factors are the same across the two models.

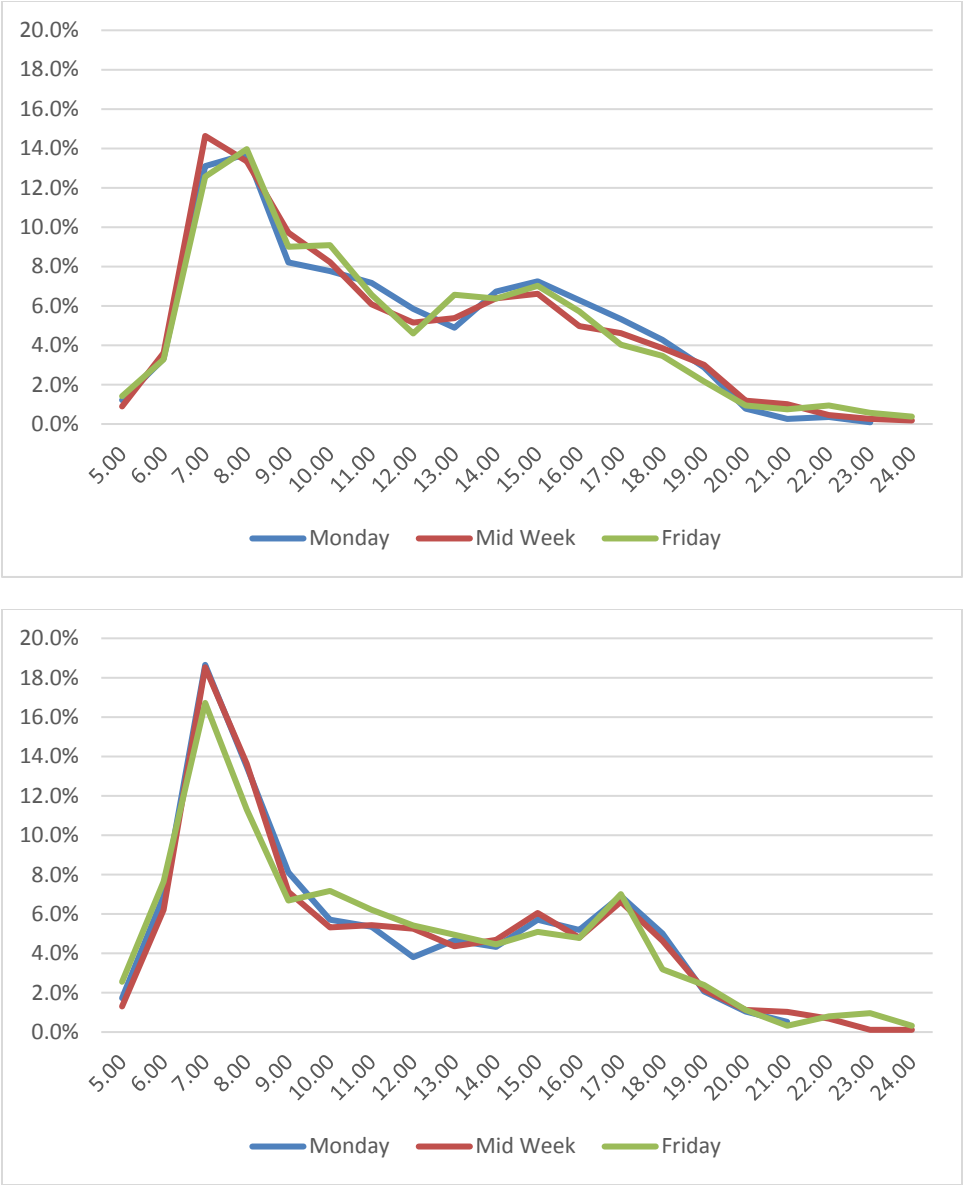


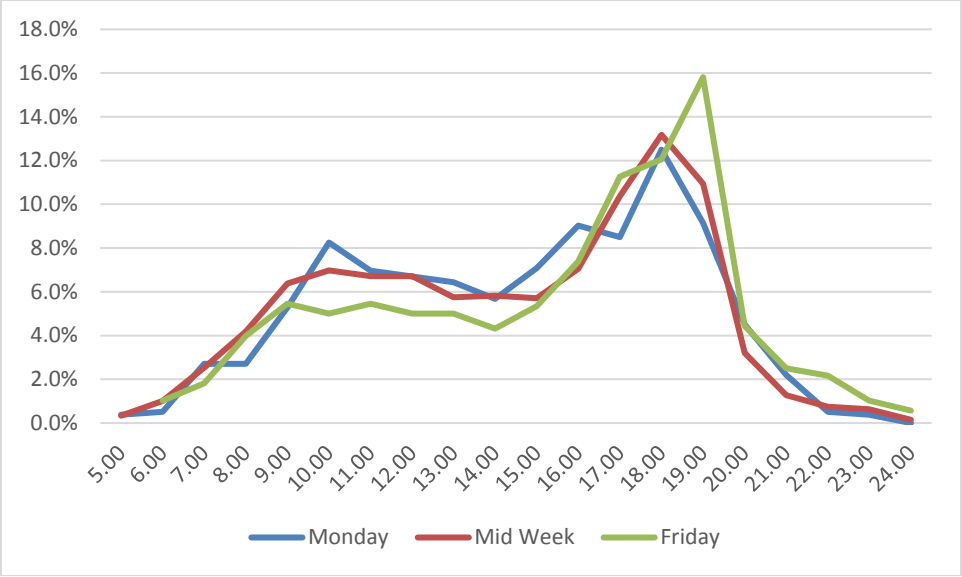
Figure 4 Variations in Start time of Personal Maintenance Activities across Weekdays from NHTS (top graph) and ATUS (bottom graph)

Table 9 Factors Impacting the Start Time of Personal Maintenance Activities across Weekdays

	NHTS		ATUS	
	Param	t stat	Param	t stat
Day of the Week				
Monday	1.918	0.23	-15.265	-1.230
Friday	0.617	0.072	-3.783	-0.314
Control Variables				
Respondent age	-0.589	-3.096	-1.897	-5.273
Respondent gender	44.7	6.789	29.974	3.008
Driver status	-27.986	-2.011		
Born in US	21.979	1.99	36.256	2.382
Employed role	-6.892	-1.073	12.490	1.171
Household income < $40k	1.967	0.148	-9.768	-0.605
Household income $40k-$74k	4.937	0.365	-13.553	-0.810
Household income $75k+	-13.716	-0.994	24.336	1.472
Household owned by a member	10.257	1.228	-1.309	-0.107
Children present in HH	-17.649	-2.243	-101.355	-8.595
March-May	-17.905	-2.224	1.947	0.153
June-August	18.383	1.857	27.981	1.976
September-November	-15.199	-1.57	8.162	0.580
Urban	6.679	0.883		
(Constant)	469.58	18.732	516.527	16.839

Social Activities

Figure 5 presents the temporal profile of the start time of the first social activity (out of home) across the different weekdays. The top chart presents the results from the NHTS (trip based) survey while the bottom chart presents the results from the ATUS (time use survey). The NHTS shows a clear evening peak on all weekdays with general temporal shift towards the later part of the day on Fridays. The ATUS does not reflect this although a larger PM peak on Fridays is observed. The differences between the two surveys reflect how the data are collected. The NHTS is a trip based survey and there is a trip preceding every out of home activity reported. In general, only one activity type may be reported at any location. However, the ATUS is a time use survey and it is not necessary to have every out of home activity preceded by a trip. For instance if a person were to reach work, spend some time in working and then socialize for a bit with his/her coworkers, this socializing activity is picked up by the ATUS and not the NHTS. Table 10 presents the results of a regression model to examine the impacts of various factors on the choice of the start time. After controlling for a host of explanatory factors, the NHTS data suggests that social activities on Fridays maybe undertaken about 45 minutes later in the day when compared to the other weekdays. The model developed from ATUS shows Friday socializing is about 30 minutes later in the day on an average. Both NHTS and ATUS models show no statistically significant difference between Mondays and the mid-week days. It is useful to note there that the ATUS does not provide data on whether the respondent had a driver's license and the urban/rural location of the residence. All other explanatory factors are the same across the two models.



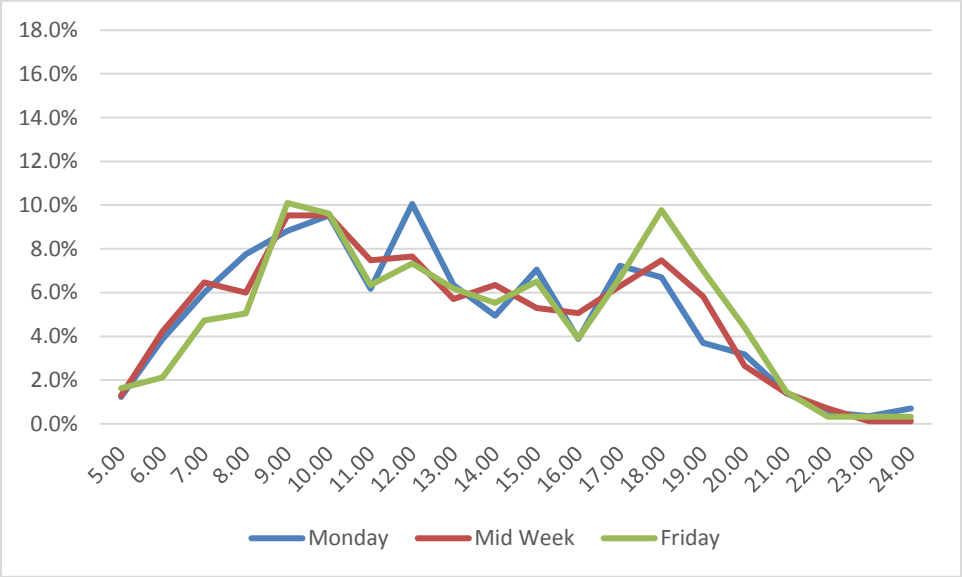


Figure 5 Variations in Start time of Social Activities across Weekdays from NHTS (top graph) and ATUS (bottom graph)

Table 10 Factors Impacting the Start Time of Social Activities across Weekdays

	NHTS		ATUS	
	Param	t stat	Param	t stat
Day of the Week				
Monday	-1.770	-0.183	-1.281	-0.101
Friday	45.848	4.963	29.555	2.394
Control Variables				
Respondent age	-3.174	-15.518	-1.392	-4.131
Respondent gender	25.216	3.469	-23.984	-2.422
Driver status	31.463	2.205		
Born in US	7.924	0.612	-1.474	-0.094
Employed role	6.756	0.931	29.424	2.706
Household income < $40k	24.226	1.610	-21.735	-1.351
Household income $40k-$74k	19.732	1.287	1.291	0.078
Household income $75k+	19.251	1.227	8.952	0.528
Household owned by a member	-6.361	-0.661	8.672	0.709
Children present in HH	5.472	0.596	-40.797	-3.431
March-May	-1.796	-0.196	8.703	0.659
June-August	-18.487	-1.753	38.834	2.734
September-November	-7.313	-0.664	-2.579	-0.179
Urban	1.120	0.133		
(Constant)	721.306	26.599	584.888	19.005

Meals

Figure 6 presents the temporal profile of the start time of the first meals activity (out of home) across the different weekdays. The top chart presents the results from the NHTS (trip based) survey while the bottom chart presents the results from the ATUS (time use survey). The NHTS shows two peaks on all weekdays corresponding to lunch and dinner with general temporal shift towards the later part of the day on Fridays. The ATUS shows a single mid-day peak although a larger PM peak on Fridays is observed. The differences between the two surveys reflect how the data are collected. If lunch is consumes at work, the NHTS does not pick this up as a separate activity if there was no trip involved to go from work place to lunch. However, ATUS would pick up this activity even if lunch was consumed at the desk of the respondent. Therefore, the mid-day (lunch) peak is much more pronounced in the ATUS model. Table 11 presents the results of a regression model to examine the impacts of various factors on the choice of the start time. After controlling for a host of explanatory factors, the NHTS data suggests that meals activities on Fridays maybe undertaken about 50 minutes later in the day when compared to the other weekdays. The model developed from ATUS shows Friday meals is about 30 minutes later in the day on an average. Both NHTS and ATUS models show no statistically significant difference between Mondays and the mid-week days. It is useful to note there that the ATUS does not provide data on whether the respondent had a driver's license and the urban/rural location of the residence. All other explanatory factors are the same across the two models.

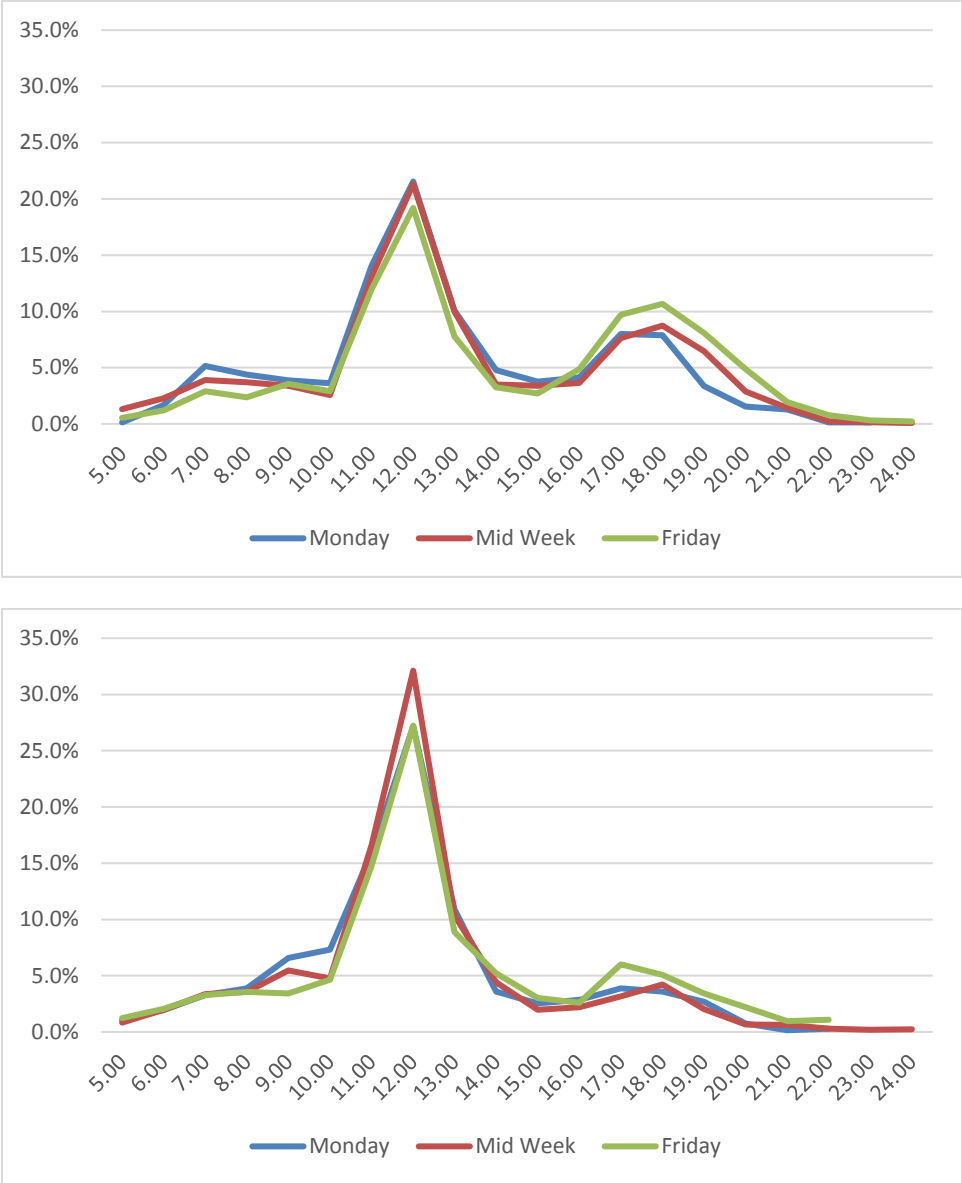


Figure 6 Variations in Start time of Meals across Weekdays from NHTS (top graph) and ATUS (bottom graph)

Table 11 Factors Impacting the Start Time of Meals across Weekdays

	NHTS		ATUS	
	Param	t stat	Param	t stat
Day of the Week				
Monday	-19.381	-2.066	-6.043	-0.664
Friday	50.886	5.767	28.964	3.290
Control Variables				
Respondent age	-1.022	-4.877	-0.616	-2.468
Respondent gender	-34.259	-4.914	-28.356	-4.050
Driver status	-18.153	-1.123		
Born in US	1.882	0.137	26.580	2.523
Employed role	6.489	0.918	-25.405	-2.915
Household income < $40k	9.058	0.616	-2.814	-0.238
Household income $40k-$74k	11.800	0.787	-10.542	-0.889
Household income $75k+	20.798	1.356	-15.026	-1.284
Household owned by a member	-5.815	-0.627	2.808	0.311
Children present in HH	8.760	0.951	-12.981	-1.607
March-May	-15.869	-1.775	1.426	0.154
June-August	-16.564	-1.594	9.853	0.974
September-November	-20.706	-1.923	6.007	0.580
Urban	32.373	3.950		
(Constant)	616.345	21.341	544.631	24.456

Exercise

Figure 7 presents the temporal profile of the start time of the first exercise activity (out of home) across the different weekdays. The top chart presents the results from the NHTS (trip based) survey while the bottom chart presents the results from the ATUS (time use survey). The NHTS shows two peaks on all weekdays with general temporal shift earlier on Fridays. The ATUS shows no peaking (although the morning peaks for Mondays and Wednesdays are more pronounced) while the earlier shift on Fridays is also observed. The differences between the two surveys reflect how the data are collected. Table 12 presents the results of a regression model to examine the impacts of various factors on the choice of the start time. After controlling for a host of explanatory factors, the NHTS model shows no statistically significant difference in exercise start time across the weekdays. However, the ATUS shows that exercising on Mondays and Fridays is about 35-40 minutes earlier than on mid-week days. However these effects are only marginally significant.

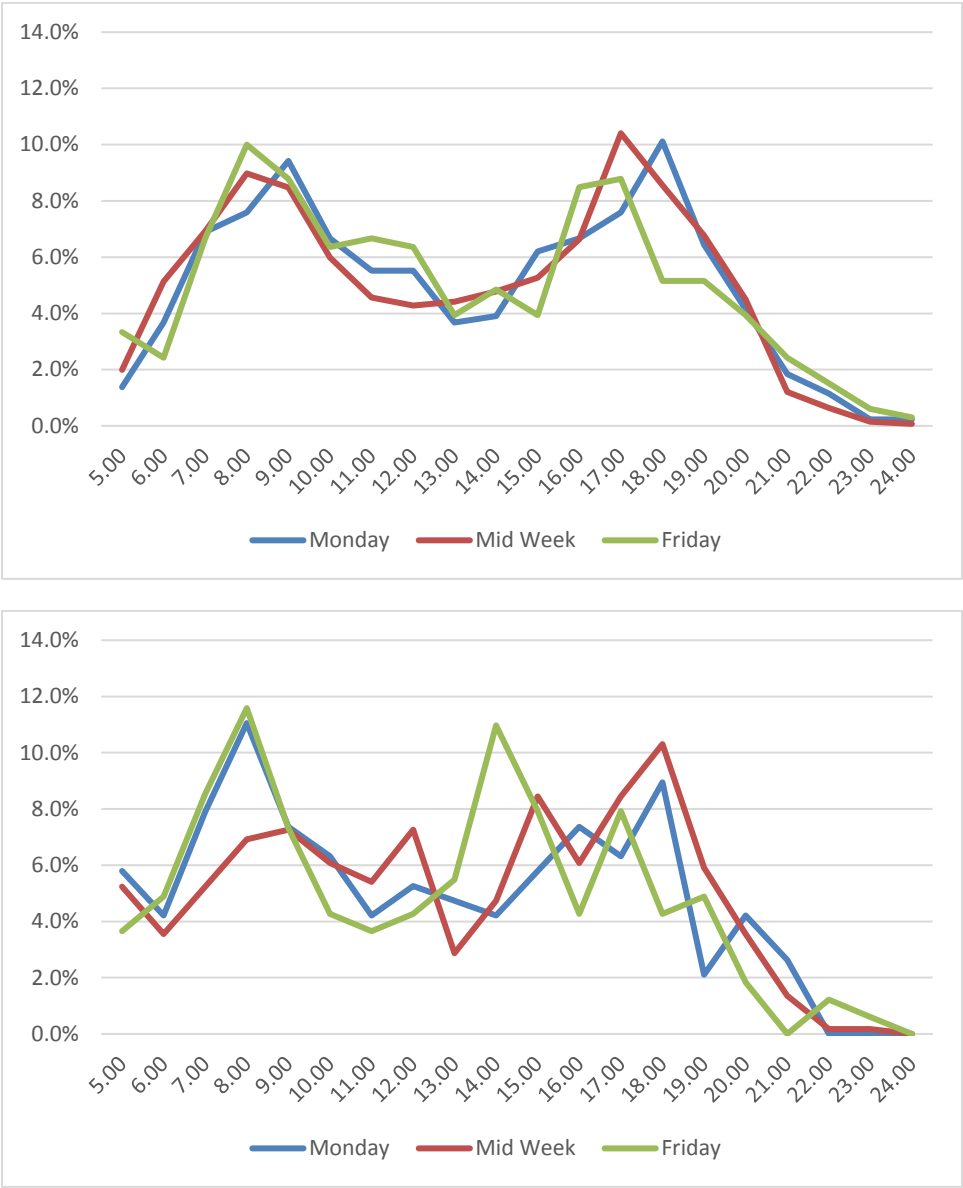


Figure 7 Variations in Start time of Exercise across Weekdays from NHTS (top graph) and ATUS (bottom graph)

Table 12 Factors Impacting the Start Time of Exercise across Weekdays

	NHTS		ATUS	
	Param	t stat	Param	t stat
Day of the Week				
Monday	11.971	0.815	-36.955	-1.648
Friday	-9.921	-0.604	-39.106	-1.641
Control Variables				
Respondent age	-4.813	-14.191	-3.725	-6.289
Respondent gender	9.645	0.837	-14.284	-0.797
Driver status	-32.431	-1.173		
Born in US	40.830	1.933	-67.583	-2.433
Employed role	-2.709	-0.233	72.723	3.819
Household income < $40k	18.666	0.730	11.774	0.399
Household income $40k-$74k	-6.263	-0.242	-10.220	-0.349
Household income $75k+	4.207	0.159	-14.044	-0.489
Household owned by a member	5.379	0.340	-21.675	-0.922
Children present in HH	23.956	1.524	-11.167	-0.513
March-May	17.057	1.105	-21.721	-0.897
June-August	20.888	1.195	-19.672	-0.771
September-November	-16.499	-0.881	-34.422	-1.261
Urban	-5.930	-0.403		
(Constant)	754.928	15.459	768.289	13.580

Chapter 7: Conclusions, Limitations, and Further Research

Conclusion

This study provides a thorough investigation of temporal fluctuations observed in individuals' daily activity/travel behavior. The emphasis was on discretionary and maintenance activities as such errands are more subject to flexibility and variation due to their intrinsic non-mandatory nature. Five different categories of variables were identified, including: Household maintenance (shopping, etc.), Personal maintenance (such as going to the barber's), Social, outdoor exercise, and out-of-home meal. Analytically, two major dimensions of activities were explored. These two include activity *participation* (also referred to as activity *engagement*), and activity *duration.* This comes from an economic perspective towards activity scheduling where each activity (commodity) is subject to two major decision makings of the individual (consumer): First, is the activity selected or not? And if the answer is yes, how long will it take? The existing inter-relation between the two decision makings would justify the researchers to apply the well-known sample selection structure for the two decision makings in a joint econometric model. Accordingly, a binary model is assigned to the *participation* level, while a linear regression model is applied for the logarithm of activity *duration*. The modeling procedure consists of two different phases. In the first phase, the main effects of socioeconomic and demographic variables are tested, referred to as the base model. In order to take temporal impacts into account, a week day category variable (including Mondays, Mid-weekdays, and Fridays) is introduced. Therefore, in the second step, interaction effects of variables with the weekday category index are separately added to the model. The variables considered for the interaction variable include: age, gender, driver's license, income, work arrangement, land use, and family roles. Such analysis is expected to deliver helpful information over how individuals switch their activities among different days of the week. Furthermore, taking four different datasets into consideration, this study is expected to provide helpful contribution to the research field in terms of the existing differences and similarities between the two major data resources, namely NHTS and ATUS.

From an overall perspective, this research effort provides a handful of interesting results. First, incorporating temporal impacts to the model seems to be a justified decision, as the models tend to improve in terms of goodness-of-fit and likelihood value. This provides further support to the general hypothesis which questions using a 'typical' random weekday for activity/travel behavior in transportation studies. Second, the models well support the negative impact of restrictive work arrangements on non-mandatory activities (except some counterexamples in the ATUS models). However, such restriction will turn into a positive impact on Fridays as Friday nights are considered to be the beginning of weekend holidays. Third, irrespective of activity type, it looks as if licensed drivers, high-income individuals along with older people are more likely to participate in non-mandatory activities. This fairly reflects the fact that non-mandatory activities require time, financial budget, and also accessibility. Holding a driver's license will provide individuals with increased accessibility towards non-mandatory activity engagement while money procures the major basis. Older individuals are also expected to have more free time to allocate to non-mandatory errands compared to younger individuals with hectic professional schedules in the society. Fourth, taking temporal interactions into account, Fridays show high positive contributions to the participation model which confirm the 'Friday night' off-work phenomenon. Monday interactions, on the other hand, are accompanied with negative coefficients which bode

for the fact that individuals are generally more focused on work and other mandatory tasks rather than discretionary/maintenance activities. Furthermore, temporal fluctuations are more significant in terms of engagement rather than durations and this is more tangible when it comes to Mondays.

One major aspect of the sample selection structure is the correlation value, which highlights how unobserved factors will impact the two decision makings. A negative correlation value is estimated in most cases (statically insignificant otherwise). As engagement turns into frequency in long-term, the following hypothesis might be made based on the results from this study:

There seems to be a negative association between frequency and duration when it comes to non-mandatory activities. In other words, individuals either take part in short frequent activities, or they tend to spend longer hours when the activity is participated with a lower frequency. Comparing short daily retail shopping activities with a monthly shopping at a wholesale store can be a good example.

Such inference, however, is subject to several statistical inconsistencies. For instance, the models are generally so sensitive to the exogenous variables, i.e. any minute change in the input variables may lead to fundamental changes in the correlation parameter in terms of magnitude and significance. While try and error indicates the tendency of the correlation parameter towards negative values, it should be noticed that such outcome is limited to the variables applied in this study.

The study also added an exploratory analysis of the variations in the time of day of (out of home) activity participation by type across the week days. Social and Meals activities on Fridays are likely to be undertaken about 30-50 minutes later in the day on Fridays when compared to other week days. This is evident from both time use and trip based surveys. IN contrast household maintenance and exercising activities on Mondays and Fridays are about 10-30 minutes earlier in the day compared to mid-week days. These are inferred from only one of the two surveys. Both surveys show no statistically significant differences in the start time of personal business activities across the week days. A comparison of the temporal profiles obtained from the two surveys also reflect the impacts of the nature of data collection.

Limitations

Limitations of this study include both data and model limitations. In terms of data, the fact that cross sectional data is used in order to compare daily fluctuations might be a major issue. In other words, an individual is not compared to oneself but rather compared to another person on a different day which may put the results under question. The literature usually relies on longitudinal panel data where an individual's behavior is observed in a long period (usually one to three weeks) which increases the accuracy of the models. However, one should notice that the main objective of this study is to focus on NHTS and ATUS data, which intrinsically consist of cross sectional information. Therefore, this may not be considered as flaw of this research effort.

Focusing on the models, existing limitations mainly include variable combinations. In this regard, the study relies on existing variables from the two major surveys. However, when it comes to derived variables such as household structure or family roles, one can never be certain whether the best possible definition is already applied. As the models reflect high sensitivity towards the

addition/removal of variables, introducing a new conceptual variable to the model may alter some of the final inferences. Furthermore, it should be noticed that interaction effects are added separately to the main model which does not guarantee whether any combination of interaction variables will provide similar results. This is just a primary step to investigate the solo impacts of various individual and household attributes on temporal fluctuations.

One should also notice that activities are subject to temporal/spatial constraints which will limit individuals' options in terms of number of daily activities, duration and location. The fact that activities interact and influence each other is disregarded in this study.

The national level datasets used in this study did not have detailed spatial coordinates of trip-end locations and therefore the analysis does not consider the effects of land use characteristics on the day-to-day variations.

Future Research

In view of further research, authors would like to provide the following suggestions:

- Optimizing the existing models based on a COMBINATION of interaction variables is perhaps the very first step in continuing this research effort. An optimized combination of interactive variables should be identified where the analysts can perceive the real magnitude of interaction coefficients in presence of other existing attributes.

- Transferability analysis is also expected to shed further light on the issue. Such analysis could be carried out either between two resources (NHTS vs ATUS) or between two different time slots within one set of data (NHTS01 vs NHTS09). The fact that whether models can be transferred between the two surveys and resolving the existing limitations will certainly remove a huge burden of costs and time in further data collection attempts.

- Comparing model results from cross-sectional surveys with the ones from longitudinal data can also open further horizons in terms of data collection.

- Using a more advanced modeling framework such as Structural Equations Modeling (SEM) is expected to provide more reliable results. Considering the fact that activities influence each other in terms of time, budget and spatial constraints and are not planned solely, will emphasize on the importance of a more comprehensive statistical framework.

- Advanced modeling methods such as duration models can also be applied to model temporal profiles.

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APPENDIX I: Social Activities

As mentioned in the text, an effort towards comparing participation rates and activity durations based on statistical tests is made. The objective is to find out how different individual/household attributes will contribute to temporal fluctuations in activity scheduling. Furthermore, such approach is expected to provide a primary understanding of variables' in terms of magnitude and significance in the final model. This appendix presents the subsequent tables for social activities along with interpreting the results. Appendices II and III contain similar contents for meal and HH maintenance activity respectively.

For NHTS2009 dataset-Participation Rate

In order to obtain a better understanding of how individuals' characteristics may contribute to their daily behavioral variations, six different types of categorical attributes are examined. These variables include: gender, driving license, income, work status, land use, and family role. For each of them, a hypothesis can be formulated as whether the variable leads to higher probabilities for activity participation and duration in a certain weekday category. In view of this, descriptive statistics and statistical tests are conducted as presented in Table 13 and Table 14.

Table 13. Participation Rate Based on Categorical Variables (NHTS2009) - Social

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	20.0% (a)	22.2% (a)	27.9% (b)
	Female	22.4% (a)	25.7% (b)	28.6% (c)
Licensed Driver	*Yes*	22.2% (a)	25.0% (b)	29.1% (c)
	No	11.0% (a)	15.7% (a,b)	19.7% (b)
Income	*Low*	20.7% (a)	24.5% (b)	25.3% (b)
	Medium	21.1% (a)	25.4% (b)	28.3% (b)
	High	22.1% (a)	23.4% (a)	31.8% (b)
Work Status	*Full time*	15.5% (a)	17.8% (a)	25.2% (b)
	Part time	21.0% (a)	27.3% (b)	29.3% (b)
	Multiple jobs	19.3% (a)	26.0% (a)	29.1% (a)
	Non-worker	27.1% (a)	29.4% (a)	32.1% (a)
Land Use	*Urban*	22.2% (a)	25.0% (b)	29.1% (c)
	Rural	20.8% (a)	23.7% (a,b)	27.1% (b)
Family Roles	*Single man*	22.1% (a)	24.5% (a)	25.4% (a)
	Single woman	23.1% (a)	27.6% (a)	26.8% (a)
	Married man	20.7% (a)	22.5% (a)	28.9% (b)
	Married woman	23.4% (a)	25.6% (a,b)	29.4% (b)
	Single parent male	18.6% (a,b)	17.8% (b)	30.9% (a)
	Single parent female	23.1% (a)	26.6% (a)	26.9% (a)
	Man nuclear	16.3% (a)	20% (a,b)	26.1% (b)
	Woman nuclear	22.3% (a)	27.7% (a,b)	34.8% (b)
	Minor male	40.9% (a,b)	31.8% (b)	51.1% (a)
	Minor female	22.5% (a,b)	23.5% (b)	46.0% (a)
	man other	16.1% (a)	21.0% (a,b)	25.4% (b)
	Woman other	19.3% (a)	20.7% (a)	23.3% (a)

The social activity participation rates for each of the three weekday segments by various personal and household characteristics are presented in Table 8. For each variable, participation rates are presented for Monday, Mid-Week Day, and Friday. Bonferroni z-tests are conducted to examine whether the differences in participation rates across the weekday categories are statistically significant. The value in the parentheses following each participation rate indicates the results of the z-tests. When the test detect significant differences across all three weekday categories, the values will be all different, e.g. for female. When the same value appears for two or more weekday categories, it means the participation rates do not vary significantly among the

corresponding weekday categories. For example, males do not show different social engagements between Mondays and Mid-week days, but they show significantly higher rates for Fridays. Licensed drivers show significantly different social engagement among all weekday categories, in particular, higher participation rates as we move from Monday to Friday. For non- drivers the test does not show significant differences between Mondays and mid-week days, or between mid-week days and Fridays, but there is significant difference between Mondays and Fridays.

Comparison among income groups also provides interesting outcomes. Accordingly, low and medium income groups show significantly lower participation rates on Mondays, with comparable rates on mid-week days and Fridays. High income group, on the other hand, shows uniform behavior on Mondays and Mid-week days with a significant increase on Fridays. Moreover, non-workers and multiple job holders do not show significant variations. In terms of family roles, single individuals (male or female) and single parent women do not show significant day-to-day fluctuations. It is interesting that there is a general trend towards higher social engagement when it moves towards the end of the week, although some of the differences are not statistically significant.

For NHTS2009 dataset-Daily Duration

Similarly, Table 14 presents average daily social activity durations among the weekday segments by various personal and household variables. The data only include those who actually participated in social activities. According to the ANOVA test results, all personal attributes reflect significant day-to-day variations except for low-income households and multiple job holders. In terms of family roles, males generally do not show significant temporal fluctuations except for single male with kids.

Table 14. Average Daily Duration Based on Categorical Variables (NHTS2009) - Social

Parameter	Classification	Average duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	194.92	208.75	246.05	5.33	0.005
	Female	202.55	187.87	233.24	9.874	0
Licensed Driver	*Yes*	200.32	196.04	235.42	11.234	0
	No	177.84	198.68	287.95	4.248	0.015
Income	*Low*	196.2	182.47	208.06	2.143	0.118
	Medium	197.5	183.18	233.24	5.02	0.007
	High	212.84	224.92	280.64	7.414	0.001
Work Status	*Full time*	176.15	187.46	248.13	10.643	0
	Part time	196.71	184.42	244.27	3.655	0.026
	Multiple jobs	214.2	201.15	217.66	0.145	0.865
	Non-worker	225.3	205.81	271.81	6.377	0.002
Land Use	*Urban*	197.19	196.97	239.77	10.689	0
	Rural	204.7	194.23	235.5	3.472	0.031
Family Roles	*Single man*	213.5	180.84	190.6	0.616	0.541
	Single woman	176.01	170.55	208.16	2.479	0.085
	Married man	182.78	221.3	238.25	1.987	0.138
	Married woman	188.13	211.67	215.27	0.758	0.469
	Single parent male	166.94	173.38	292.12	3.323	0.041
	Single parent female	248.3	198.44	284.93	2.405	0.093
	Man nuclear	192.78	200.63	234.35	0.659	0.518
	Woman nuclear	158.18	154.45	227.89	5.718	0.004
	Minor male	201.72	204	286.75	1.323	0.272
	Minor female	229.22	191.75	450.26	7.662	0.001
	Man other	211.92	228.13	304.11	2.685	0.07
	Woman other	229.22	191.75	450.26	7.662	0.001

These statistical analyses and tests confirm the hypothesis that people do show temporal preferences among the weekday categories for social activities in terms of both participation and activity duration. This provides the basis for the modeling effort presented in the following sections.

For NHTS2001 dataset-Participation Rate

Table 15 illustrates the participation rates along with correspondent z test comparison among the three aforementioned temporal categories. Accordingly, a variety of outcomes are observed. It is interesting to see that medium and high income categories do not show significant temporal fluctuations. Low income individuals, on the other hand, show significantly different rates on Mondays and Fridays, with no significant fluctuation on mid-weekdays. Among different work arrangements, part-time workers and multiple job holders reflect statistically identical rates throughout the week while non-workers reflect a remarkable increase on Fridays. Among different family roles, only three categories demonstrate significant temporal fluctuations. In view of that, participation rates for married women are significantly variable throughout the week. Moreover, both other male and female roles show significantly higher rates on Fridays.

Table 15. Participation Rate Based on Categorical Variables (NHTS2001) - Social

Parameter	Classification	Participation rate		
		Monday	Midweek	Friday
Gender	*Male*	37.9%(a)	41.4%(a, b)	45.4%(b)
	Female	39.9%(a)	41.4%(a, b)	45.0%(b)
Licensed Driver	*Yes*	21.0%(a)	23.1%(b)	28.5%(c)
	No	14.2%(a)	18.1%(a,b)	22.2%(b)
Income	*Low*	39.1%(a)	41.9%(a, b)	45.2%(b)
	Medium	42.4%(a)	43.6%(a)	48.9%(a)
	High	34.8%(a)	39.6%(a)	41.7%(a)
Work Status	*Full time*	40.7%(a)	43.1%(a, b)	47.2%(b)
	Part time	46.5%(a)	45.4%(a)	47.8%(a)
	Multiple jobs	50.4%(a)	42.0%(a)	45.6%(a)
	Non-worker	36.8%(a)	37.4%(a)	50.2%(b)
Land Use	*Urban*	20.2%(a)	22.4%(b)	28.5%(c)
	Rural	20.9%(a)	23.1%(a,b)	25.9%(b)
Family Roles	*Single man*	41.1%(a)	42.3%(a)	50.6%(a)
	Single woman	43.0%(a)	45.7%(a)	45.4%(a)
	Married man	18.3%(a)	19.0%(a)	22.1%(a)
	Married woman	19.2%(a)	23.1%(b)	30.6%(c)
	Single parent male	20.6%(a)	18.6%(a)	15.0%(a)
	Single parent female	27.7%(a)	25.0%(a)	25.0%(a)
	Man nuclear	18.5%(a)	21.5%(a)	27.9%(a)
	Woman nuclear	20.0%(a)	27.5%(a)	22.2%(a)
	Minor male	38.0%(a)	36.7%(a)	46.0%(a)
	Minor female	27.4%(a)	34.6%(a)	38.1%(a)
	Man other	20.8%(a)	23.0%(a)	30.7%(b)
	Woman other	19.6%(a)	21.5%(a)	31.1%(b)

For NHTS2001 dataset-Daily Duration

The average daily durations of social activity are depicted in table 16, accompanied by an 'ANOVA' F test which helps the analyst identify the significant differences among the three duration values. It is observed that males, females, and licensed drivers show significant temporal variations. Among work arrangements, significant fluctuations are observed for full time workers and non-workers. In terms of family roles, single women along with other roles (male or female) tend to show significantly dissimilar activity durations on different week sections.

Table 16. Average Daily Duration Based on Categorical Variables (NHTS2001) - Social

Parameter	Classification	Average duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	185.61	173.17	217.02	7.934	0
	Female	157.96	162.73	203.17	11.956	0
Licensed Driver	*Yes*	168.51	164.4	206.71	18.314	0
	No	189.1	202.13	240.04	1.124	0.326
Income	*Low*	165.88	170.02	214.71	9.206	0
	Medium	170.01	168.9	201.23	3.546	0.029
	High	179.25	164.37	207.37	4.435	0.012
Work Status	*Full time*	177.23	167.96	204.47	5.041	0.007
	Part time	169.76	169.59	208.15	1.558	0.212
	Multiple jobs	173.97	193.92	204.69	0.207	0.814
	Non-worker	184.8	167.91	223.28	6.663	0.001
Land Use	*Urban*	173.74	167.33	208.24	13.972	0
	Rural	158.39	166.4	212.82	5.749	0.003
Family Roles	*Single man*	200.72	182.05	218.32	1.076	0.342
	Single woman	144.53	173.88	202.91	2.92	0.055
	Married man	172.06	155.36	178.8	1.514	0.221
	Married woman	157.57	156.18	182.4	2.209	0.11
	Single parent male	184.29	249	375	0.56	0.579
	Single parent female	136.67	152.71	211.33	1.677	0.19
	Man nuclear	191.07	135.92	231.35	2.143	0.124
	Woman nuclear	95.86	112.36	160.25	1.393	0.254
	Minor male	267.89	211.31	223.3	0.531	0.59
	Minor female	245.12	172.58	219.06	1.796	0.172
	Man other	182.51	198.37	278.15	6.395	0.002
	Woman other	178.27	173.51	248.6	7.41	0.001

For ATUS2003 dataset-Participation Rate

Results for the participation rates are reflected in table 17. Only five categories are revealed to show significant temporal variations. They include: Males, females, low income individuals, full time workers, and non-workers. For each of the categories, there is no significant difference between Mondays and mid-weekdays. However, participation rates on Fridays are significantly higher than on Mondays. For all other variables, no significant difference is observed among the three weekday categories.

Table 7. Participation Rate Based on Categorical Variables (ATUS2003) - Social

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	37.9%(a)	41.4%(a,b)	45.4%(b)
	Female	39.9%(a)	41.4%(a,b)	45.0%(b)
Income	*Low*	39.1%(a)	41.9%(a,b)	45.2%(b)
	Medium	42.4%(a)	43.6%(a)	48.9%(a)
	High	34.8%(a)	39.6%(a)	41.7%(a)
Work Status	*Full time*	40.7%(a)	43.1%(a, b)	47.2%(b)
	Part time	46.5%(a)	45.4%(a)	47.8%(a)
	Multiple jobs	50.4%(a)	42.0%(a)	45.6%(a)
	Non-worker	36.8%(a)	37.4%(a)	50.2%(b)
Family Roles	*Single man*	41.1%(a)	42.3%(a)	50.6%(a)
	Single woman	43.0%(a)	45.7%(a)	45.4%(a)
	Married man	32.7%(a)	36.6%(a)	38.5%(a)
	Married woman	32.0%(a)	36.9%(a)	37.4%(a)
	Single parent male	41.8%(a)	42.5%(a)	45.7%(a)
	Single parent female	39.3%(a)	39.0%(a)	45.3%(a)
	Man nuclear	37.3%(a)	40.2%(a)	44.0%(a)
	Woman nuclear	39.3%(a)	39.0%(a)	45.3%(a)
	Minor male	46.2%(a)	61.2%(a)	64.4%(a)
	Minor female	49.1%(a)	59.3%(a)	66.7%(a)
	Man other	45.1%(a)	47.4%(a)	49.3%(a)
	Woman other	35.6%(a)	43.3%(a)	38.1%(a)

For ATUS2003 dataset-Daily Duration

Same pattern (absence of statistically documented difference) is also observed when it comes to duration values (table 18). In this regard, only females from nuclear families show significantly higher durations on Fridays.

Table 18. Average Daily Duration Based on Categorical Variables (ATUS2003) - Social

Parameter	Classification	Average Duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	106.96	109.78	129.43	0.201	0.818
	Female	109.02	108.62	130.33	0.957	0.384
Income	*Low*	113.38	117.49	121.9	0.274	0.76
	Medium	99.42	98.32	128.15	0.454	0.635
	High	110.85	104.78	148.24	1.387	0.25
Work Status	*Full time*	80.51	76.37	111.13	0.034	0.967
	Part time	118.03	119.32	139.51	0.666	0.514
	Multiple jobs	84.9	83.77	125.56	0.249	0.78
	Non-worker	133.84	129.75	138.31	0.209	0.811
Family Roles	*Single man*	131.39	124.54	128.28	0.919	0.4
	Single woman	121.64	125.73	113.3	0.684	0.505
	Married man	113.33	102.55	112.52	0.197	0.821
	Married woman	115.56	113.69	123.78	0.43	0.651
	Single parent male	115.48	108.96	104.19	0.742	0.479
	Single parent female	101.56	87.02	112.36	0.766	0.466
	Man nuclear	75.78	81.87	131.14	0.755	0.47
	Woman nuclear	96.78	99.29	138.88	2.868	0.057
	Minor male	167.89	159.29	171.34	0.361	0.698
	Minor female	150.12	115.29	163.23	0.892	0.412
	Man other	117.08	160.72	150.21	0.524	0.593
	Woman other	82.94	106.5	166.69	0.251	0.778

For ATUS2009 dataset-Participation Rate

Table 19 presents participation rates along with the results of the z-test in parentheses. Accordingly, all variables except for females, high income group and females from nuclear families show identical participation rates throughout different weekday categories. These three categories reflect higher participation rates on Fridays compared to Mondays and mid-weekdays.

Table 19. Participation Rate Based on Categorical Variables (ATUS2009) - Social

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	41.1%(a)	41.7%(a)	42.9%(a)
	Female	39.0%(a)	39.8%(a)	45.5%(b)
Income	*Low*	38.6%(a)	39.6%(a)	40.8%(a)
	Medium	46.5%(a)	44.8%(a)	44.3%(a)
	High	38.0%(a)	39.9%(a)	48.7%(b)
Work Status	*Full time*	43.2%(a)	42.5%(a)	47.2%(a)
	Part time	39.4%(a)	44.3%(a)	48.3%(a)
	Multiple jobs	34.3%(a)	40.9%(a)	47.6%(a)
	Non-worker	31.3%(a)	37.8%(a)	39.9%(a)
Family Roles	*Single man*	46.5%(a)	39.3%(a)	44.2%(a)
	Single woman	39.5%(a)	38.0%(a)	42.0%(a)
	Married man	35.6%(a)	37.7%(a)	37.4%(a)
	Married woman	39.9%(a)	37.2%(a)	42.9%(a)
	Single parent male	50.0%(a)	44.0%(a)	41.2%(a)
	Single parent female	40.0%(a)	41.6%(a)	35.6%(a)
	Man nuclear	37.5%(a)	40.2%(a)	42.9%(a)
	Woman nuclear	36.8%(a)	39.5%(a)	49.8%(b)
	Minor male	66.7%(a)	66.1%(a)	62.2%(a)
	Minor female	57.6%(a)	62.3%(a)	68.4%(a)
	Man other	35.6%(a)	46.4%(a)	42.9%(a)
	Woman other	31.0%(a)	35.6%(a)	46.9%(a)

For ATUS2009 dataset-Daily Duration

Likewise, a comparison of average daily durations is provided in table 20. Among different work arrangements, multiple job holders and non-workers show no significant differences through the week. Same situation exists for some specific family roles including single women, married individuals, and single parents.

Table 20. Average Daily Duration Based on Categorical Variables (ATUS2009) - Social

Parameter	Classification	Average Duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	96.11	103.2	141.37	11.513	0
	Female	96.34	108.56	136.69	11.276	0
Income	*Low*	108.02	114.64	137.34	3.396	0.034
	Medium	92.42	94.04	129.23	6.109	0.002
	High	82.65	106.96	134.38	7.484	0.001
Work Status	*Full time*	68.19	80.29	120.43	25.336	0
	Part time	93.23	108.05	133.36	2.797	0.062
	Multiple jobs	61.85	84.02	82.03	0.929	0.397
	Non-worker	139.3	138.95	173.56	1.488	0.228
Family Roles	*Single man*	108.18	113.73	154.26	2.765	0.065
	Single woman	125.58	124.44	144.03	0.863	0.423
	Married man	109.92	106.29	109.89	0.031	0.97
	Married woman	100.34	101.85	102.22	0.006	0.994
	Single parent male	100.59	128.82	165.79	0.936	0.397
	Single parent female	82.81	96.55	129.87	1.954	0.145
	Man nuclear	84.36	81.84	119.35	3.813	0.023
	Woman nuclear	74.6	97.64	136.41	8.787	0
	Minor male	93.7	107.24	200.65	5.355	0.006
	Minor female	86.58	117.42	172.65	2.648	0.075
	Man other	56.06	129.27	213.28	6.51	0.002
	Woman other	91.5	139.46	178.61	1.928	0.152

APPENDIX II: Meal activities

For NHTS2009 dataset-Participation Rate

The meal activity participation rates for different weekday categories by various personal and household characteristics are presented in Table 21. Male and licensed drivers show significantly different meal engagement among all weekday categories, in particular, higher participation rate as it moves from Monday to Friday. For low income drivers the test does not show significant differences between Mondays and mid-week days, or between mid-week days and Fridays, but there is significant difference between Mondays and Fridays. Medium income group shows comparable participation rates on Mondays and Mid-week days, with higher participation rate on Fridays. High income group, on the other hand, shows significantly different meal engagement for different weekday categories, with lowest participation rates on Mondays and highest participation rate on Fridays. Moreover, part time workers and multiple job holders do not show significant variations for meal activity engagement. In terms of family roles, single individuals, single parents, minor individuals, and other individuals do not show significant day-to-day fluctuations. It is interesting that there is a general trend towards higher meal engagement when it moves towards the end of the week, although some are not statistically significant.

Table 8. Participation Rate Based on Categorical Variables (NHTS2009) – Meal

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	19.5%(a)	22.4%(b)	27.0%(c)
	Female	17.7%(a)	20.0%(a)	24.6%(a)
Licensed Driver	*Yes*	19.3%(a)	22.0%(b)	26.9%(c)
	No	8.60%(a)	10.7%(a)	12.5%(a)
Income	*Low*	15.8%(a)	18.2%(a,b)	19.9%(b)
	Medium	19.3%(a)	21.1%(a)	28.3%(b)
	High	21.5%(a)	25.2%(b)	32.1%(c)
Work Status	*Full time*	19.2%(a)	22.3%(b)	30.0%(c)
	Part time	21.0%(a)	19.7%(a)	23.9%(a)
	Multiple jobs	24.6%(a)	22.2%(a)	28.2%(a)
	Non-worker	15.8%(a)	19.7%(a,b)	23.9%(b)
Land Use	*Urban*	18.3%(a)	21.5%(b)	26.7%(c)
	Rural	18.9%(a)	19.9%(a,b)	23.0%(b)
Family Roles	*Single man*	21.5%(a)	25.2%(a)	24.0%(a)
	Single woman	18.5%(a)	19.0%(a)	20.6%(a)
	Married man	19.4%(a)	23.6%(a,b)	27.4%(b)
	Married woman	18.3%(a)	22.0%(a)	27.3%(b)
	Single parent male	19.8%(a)	19.1%(a)	30.9%(a)
	Single parent female	15.0%(a)	19.5%(a)	23.7%(a)
	Man nuclear	20.7%(a)	21.7%(a)	32.2%(b)
	Woman nuclear	18.3%(a)	20.4%(a)	32.1%(b)
	Minor male	11.4%(a)	10.1%(a)	21.3%(a)
	Minor female	12.5%(a)	12.6%(a)	20.0%(a)
	Man other	17.7%(a)	20.5%(a)	23.9%(a)
	Woman other	16.2%(a)	18.7%(a)	21.6%(a)

For NHTS2009 dataset-Daily Duration

Table 22 presents average daily meal activity durations among the weekday categories by various personal and household variables. According to the ANOVA test results; female, license variable, medium and high income people, and full time worker reflect significant day-to-day variations. In terms of family roles, males generally do not show significant temporal fluctuations except for male married with kids.

Table 9. Average Daily Duration Based on Categorical Variables (NHTS2009) - Meal

Parameter	Classification	Average Duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	54.48	57.99	59.84	0.547	0.579
	Female	54.06	54.14	66.01	7.686	0
Licensed Driver	*Yes*	53.14	55.91	63.75	6.334	0.002
	No	83.68	56.24	52.28	2.634	0.075
Income	*Low*	56.07	58.05	56.19	0.113	0.893
	Medium	52.56	50.97	62.72	3.923	0.02
	High	50.85	55.08	67.88	7.111	0.001
Work Status	*Full time*	47.73	43.25	56.67	9.078	0
	Part time	56.85	61.38	77.37	2.058	0.129
	Multiple jobs	48.8	50.14	56.66	0.334	0.716
	Non-worker	52.47	55.73	58.03	0.285	0.752
Land Use	*Urban*	54.7	54.9	64.91	7.009	0.001
	Rural	53.28	58.59	58.63	0.467	0.627
Family Roles	*Single man*	62.24	52.17	66.19	1.51	0.222
	Single woman	53.09	58.98	69.24	1.799	0.166
	Married man	53.91	62.96	56.55	1.43	0.24
	Married woman	58.45	61.19	76.36	4.305	0.014
	Single parent male	33.82	52.74	53.36	0.527	0.592
	Single parent female	56.12	35.13	53.57	3.984	0.021
	Man nuclear	56.68	41.8	70.39	5.96	0.003
	Woman nuclear	53.02	40.73	52.22	1.683	0.187
	Minor male	40	100.47	46.9	0.378	0.689
	Minor female	26	45.93	70.7	2.063	0.147
	Man other	52.25	67.16	51.74	1.188	0.307
	Woman other	48.82	51.18	59.4	0.973	0.379

These statistical analysis and tests confirms the hypothesis that people do show temporal preferences among the weekday categories for meal activities in terms of both participation and activity duration.

For NHTS2001 dataset-Participation Rate

The meal activity participation rates for different weekday categories by various personal and household characteristics are presented in Table 23. For each variable, participation rates are presented for Monday, Mid-Week Day, and Friday. Females show similar meal activity engagements on Mondays and Mid-week days, but they show significantly higher rates for Fridays.

Comparison among income groups also provides interesting outcomes. For low income drivers the test does not show significant differences between Mondays and mid-week days, or between mid-week days and Fridays, but there is significant difference between Mondays and Fridays. Medium income group shows comparable rates on Mondays and mid-week days, with significantly higher participation rates on Fridays. High income group, on the other hand, shows significantly different meal engagement for different weekday categories, with lowest participation rates on Mondays and highest participation rate on Fridays. Similar to high income group, full time worker shows significantly different meal engagement for different weekday categories. Moreover, part time workers and multiple job holders do not show significant variations among the categories for meal activity engagement. In terms of family roles, single female, single parents (male and female), minor individuals (male and female), and other individuals (male and female) do not show significant day-to-day fluctuations. It is interesting that there is a general trend towards higher meal engagement when it moves towards the end of the week, although some of the differences are not statistically significant.

Table 10. Participation Rate Based on Categorical Variables (NHTS2001) - Meal

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	19.5%(a)	22.4%(b)	27.0%(c)
	Female	17.7%(a)	20.0%(a)	24.6%(b)
Income	*Low*	15.8%(a)	18.2%(a,b)	19.9%(b)
	Medium	19.3%(a)	21.1%(a)	28.3%(b)
	High	21.5%(a)	25.2%(b)	32.1%(c)
Work Status	*Full time*	19.2%(a)	22.3%(b)	30.0%(c)
	Part time	21.0%(a)	19.7%(a)	23.9%(a)
	Multiple jobs	24.6%(a)	22.2%(a)	28.2%(a)
	Non-worker	15.8%(a)	19.7%(a,b)	23.9%(b)
Family Roles	*Single man*	15.8%(a)	19.7%(a,b)	23.9%(b)
	Single woman	18.5%(a)	19.0%(a)	20.6%(a)
	Married man	19.4%(a)	23.6%(a,b)	27.4%(b)
	Married woman	18.3%(a)	22.0%(a)	27.3%(b)
	Single parent male	19.8%(a)	19.1%(a)	30.9%(a)
	Single parent female	15.0%(a)	19.5%(a)	23.7%(a)
	Man nuclear	20.7%(a)	21.7%(a)	32.2%(b)
	Woman nuclear	18.3%(a)	20.4%(a)	32.1%(b)
	Minor male	11.4%(a)	10.1%(a)	21.3%(a)
	Minor female	12.5%(a)	12.6%(a)	20.0%(a)
	Man other	17.7%(a)	20.5%(a)	23.9%(a)
	Woman other	16.2%(a)	18.7%(a)	21.6%(a)

For NHTS2001 dataset-Daily Duration

Table 24 presents average daily meal activity durations among the weekday categories by various personal and household variables. The data only include those who actually participated in meal activities. Consequently, all personal attributes reflect significant day-to-day variations except multiple job holders. In terms of family roles, females generally do not show significant temporal fluctuations except for nuclear female and other female.

These statistical analysis and tests confirms the hypothesis that people do show temporal preferences among the weekday categories for meal activities in terms of both participation and activity duration.

Table 11. Average Daily Duration Based on Categorical Variables (NHTS2001) - Meal

Parameter	Classification	Average duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	45.63	48.21	59.81	14.218	0
	Female	45.74	48.44	58.86	11.031	0
Income	*Low*	44.49	47.12	53.35	3.688	0.025
	Medium	45.35	46.9	58.42	6.674	0.001
	High	50.85	55.08	67.88	7.111	0.001
Work Status	*Full time*	44.18	46.96	58.32	18.818	0
	Part time	40.74	46.46	62.81	4.772	0.009
	Multiple jobs	41.19	52.6	52.77	1.806	0.167
	Non-worker	46.05	47.24	68.4	4.201	0.016
Family Roles	*Single man*	52.11	52.81	66.03	2.537	0.08
	Single woman	49.26	55.14	55.04	0.72	0.487
	Married man	52.46	49.2	66.85	6.896	0.001
	Married woman	48.99	55.09	62.3	1.557	0.212
	Single parent male	36.39	56.34	70.29	3.208	0.046
	Single parent female	37.5	43.77	49.32	1.766	0.174
	Man nuclear	40.56	45.7	54.18	4.796	0.009
	Woman nuclear	45.78	44.29	59.66	8.619	0
	Minor male	40.17	41.54	41.54	0.017	0.983
	Minor female	47.73	37.41	38.96	1.202	0.304
	Man other	41.43	47.65	63.4	1.612	0.203
	Woman other	35.22	45.7	85.34	3.765	0.026

For ATUS2003 dataset-Participation Rate

The meal activity participation rates for different weekday categories by various personal and household characteristics are presented in Table 25. Males reflect look-alike values for Mondays and mid-week days indicating there are no significant activity engagement differences between Mondays and Mid-week days. Both licensed driver and un-licensed driver show similar participation rate for Mondays and mid-week days and different but higher participation rates on Fridays.

Table 12. Participation Rate Based on Categorical Variables (ATUS2003) - Meal

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	22.3%(a)	24.0%(a)	30.4%(b)
	Female	18.7%(a)	21.4%(b)	28.5%(c)
Licensed Driver	*Yes*	20.4%(a)	22.5%(a)	28.7%(b)
	No	21.1%(a)	22.2%(a)	29.9%(b)
Income	*Low*	18.8%(a)	23.0%(b)	29.0%(c)
	Medium	21.2%(a)	23.6%(b)	30.6%(c)
	High	12.0%(a,b)	11.2%(b)	18.0%(a)
Work Status	*Full time*	19.5%(a)	22.9%(b)	29.9%(c)
	Part time	22.8%(a)	22.2%(a)	32.0%(b)
	Multiple jobs	18.8%(a)	23.4%(a)	34.5%(b)
	Non-worker	18.5%(a)	19.6%(a)	23.4%(a)
Land Use	*Urban*	20.5%(a)	22.7%(b)	29.4%(c)
	Rural	19.9%(a)	21.9%(a)	29.2%(b)
Family Roles	*Single man*	28.5%(a)	28.8%(a)	35.4%(a)
	Single woman	19.1%(a)	20.6%(a)	27.8%(b)
	Married man	21.5%(a)	23.3%(a)	32.4%(b)
	Married woman	20.6%(a)	22.7%(a)	31.9%(b)
	Single parent male	26.5%(a)	30.2%(a)	40.0%(a)
	Single parent female	16.2%(a)	19.5%(a)	32.1%(b)
	Man nuclear	21.0%(a)	28.7%(a)	29.5%(a)
	Woman nuclear	17.1%(a)	26.0%(a)	53.7%(b)
	Minor male	14.0%(a)	14.1%(a)	26.0%(a)
	Minor female	12.9%(a)	24.1%(a)	14.3%(a)
	Man other	19.9%(a)	21.0%(a)	21.8%(a)
	Woman other	16.3%(a)	18.9%(a)	18.9%(a)

Comparison among income groups also provides interesting outcomes. For high income drivers, the test does not show significant differences between Mondays and Fridays, or between Mondays and mid-week days, but there is significant difference between mid-week days and Fridays. Low and medium income groups, on the other hand, show significantly different meal engagement for different weekday categories, with lowest participation rates on Mondays and highest participation rate on Fridays.

Similar to low and medium income groups, full time workers show significantly different meal engagement for different weekday categories. Part time workers and multiple job holders, however, show similar participation rate for Mondays and mid-week days and different but higher

participation rates on Fridays. Moreover, non-workers do not show significant variations among the categories for meal activity engagement. In terms of family roles; single male, single parents male, nuclear male, minor individuals (male and female), and other individuals (male and female) do not show significant day-to-day fluctuations. It is interesting that there is a general trend towards higher meal engagement when it moves towards the end of the week, although some of the differences are not statistically significant.

For ATUS2003 dataset-Daily Duration

Table 26 presents average daily meal activity durations among the weekday categories by various personal and household variables. The data only include those who actually participated in meal activities. According to the ANOVA test results, all personal attributes reflect significant day-to-day variations except non-drivers, high income group, full-time workers, and non-workers. In terms of family roles, only married males, married and single parent females show significant temporal fluctuations.

Table 13. Average Daily Duration Based on Categorical Variables (ATUS2003) - Meal

Parameter	Classification	Average Duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	48.38	58.15	60.65	4.412	0.012
	Female	53.86	54.18	64.28	5.585	0.004
Licensed Driver	*Yes*	50.87	55.57	62.64	7.672	0
	No	55.81	66.15	61.15	0.419	0.658
Income	*Low*	51.97	55.96	64.32	3.375	0.034
	Medium	52.4	56.64	63.26	2.045	0.13
	High	50.53	55.75	59.16	1.038	0.355
Work Status	*Full time*	51.62	56.95	60.17	1.323	0.267
	Part time	43.06	58.1	66.24	4.7	0.01
	Multiple jobs	33.39	56.64	58.92	3.206	0.043
	Non-worker	52.38	53.39	61.76	1.265	0.283
Land Use	*Urban*	53.32	56.64	63.47	4.995	0.007
	Rural	44.3	54.09	59.71	2.951	0.053
Family Roles	*Single man*	61.01	64.56	67.36	0.189	0.828
	Single woman	56.02	67.98	73.72	1.979	0.139
	Married man	44.69	60.58	61.43	5.411	0.005
	Married woman	52.35	53.82	64.42	3.543	0.029
	Single parent male	34.89	33.85	61.62	1.997	0.149
	Single parent female	39.48	33.82	84.26	6.758	0.002
	Man nuclear	39.94	44.62	59.89	1.136	0.325
	Woman nuclear	45.17	32	49.07	1.864	0.161
	Minor male	45.43	33	40.54	0.211	0.811
	Minor female	40.38	51.78	41.5	0.134	0.875
	Man other	46.95	52.01	53.48	0.161	0.851
	Woman other	61.7	48.15	48.52	1.65	0.193

These statistical analysis and tests confirms the hypothesis that people do show temporal preferences among the weekday categories for meal activities in terms of both participation and activity duration.

For ATUS2009 dataset-Participation Rate

The meal activity participation rates for different weekday categories by various personal and household characteristics are presented in Table 27. Females do not show different meal activity engagements between Mondays and Mid-week days, or between Mid-week days and Fridays, but they show significantly different rates between Mondays and Fridays.

Table 27. Participation Rate Based on Categorical Variables (ATUS2009) - Meal

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	48.6%(a)	52.1%(a)	57.8%(b)
	Female	39.5%(a)	42.6%(a,b)	45.5%(b)
Income	*Low*	36.2%(a)	39.8%(a)	45.0%(b)
	Medium	53.0%(a)	51.8%(a)	54.6%(a)
	High	50.6%(a)	54.9%(a)	58.3%(a)
Work Status	*Full time*	57.8%(a)	62.1%(b)	63.2%(b)
	Part time	40.4%(a)	42.6%(a)	47.8%(a)
	Multiple jobs	45.9%(a)	57.5%(a,b)	63.2%(b)
	Non-worker	28.5%(a)	31.2%(a,b)	39.6%(b)
Family Roles	*Single man*	49.7%(a)	50.8%(a)	59.4%(a)
	Single woman	39.0%(a)	42.7%(a)	43.1%(a)
	Married man	42.3%(a)	48.5%(a,b)	54.3%(b)
	Married woman	36.5%(a)	42.4%(a)	45.8%(a)
	Single parent male	45.5%(a)	46.9%(a)	60.0%(a)
	Single parent female	38.9%(a)	44.7%(a)	45.4%(a)
	Man nuclear	52.8%(a)	57.3%(a)	60.9%(a)
	Woman nuclear	43.2%(a)	41.8%(a)	44.8%(a)
	Minor male	46.2%(a)	46.1%(a)	49.2%(a)
	Minor female	37.7%(a)	43.8%(a)	53.3%(a)
	Man other	54.9%(a)	53.1%(a)	59.4%(a)
	Woman other	36.7%(a)	42.1%(a)	50.0%(a)

Comparison among income groups also provides interesting outcomes. For low income drivers the test shows similar participation rate for Mondays and mid-week days and different but higher participation rates on Fridays. Medium and high income group shows similar rates across different weekday categories. Regarding work status, full time worker shows smaller participation rate for Mondays and higher participation rate on Mid-Week days and Fridays. Part time worker do not show significant variations among the categories for meal activity engagement. Moreover, multiple job holders and non-worker show similar meal activity engagements between Mondays and Mid-week days, or between Mid-week days and Fridays, but they show significantly different rates between Mondays and Fridays. In terms of family roles, all the classifications show similar participation rates across different weekday categories except married man. It is interesting that there is a general trend towards higher meal engagement when it moves towards the end of the week, although some of the differences are not statistically significant.

For ATUS2009 dataset-Daily Duration

ANOVA results for activity durations are shown in Table 28. Accordingly, all personal attributes reflect significant day-to-day variations except non-workers. In terms of family roles; married male and female, single parent male, and man and woman nuclear show significant temporal fluctuations.

Table 28. Average Daily Duration Based on Categorical Variables (ATUS2009) - Meal

Parameter	Classification	Average Duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	50.33	49.51	62.4	19.81	0
	Female	51.14	52.39	64.09	16.378	0
Income	*Low*	51.49	51.27	58.03	3.322	0.036
	Medium	50.9	50.72	62.59	10.589	0
	High	50.27	51.04	70.33	23.942	0
Work Status	*Full time*	48.14	47.82	62.12	37.124	0
	Part time	47.72	54.23	62.49	3.362	0.035
	Multiple jobs	47.29	43.53	66.03	9.658	0
	Non-worker	48.38	55.16	68.33	1.265	0.283
Family Roles	*Single man*	56.32	59.18	69.85	1.809	0.165
	Single woman	58.02	59.27	62.69	0.296	0.744
	Married man	54.75	51.18	66.54	8.846	0
	Married woman	53.14	54.37	76.98	12.796	0
	Single parent male	47.96	46.28	72.9	3.108	0.049
	Single parent female	51.11	46.46	48.61	0.383	0.682
	Man nuclear	41.98	43.97	55.62	12.091	0
	Woman nuclear	46.75	50.17	63.85	9.148	0
	Minor male	51.83	39.6	40.72	1.409	0.249
	Minor female	40.05	42.56	39.21	0.181	0.835
	Man other	61.33	58.4	73.2	0.936	0.394
	Woman other	50.55	52.2	67.93	1.689	0.188

These statistical analysis and tests confirms the hypothesis that people do show temporal preferences among the weekday categories for meal activities in terms of both participation and activity duration.

APPENDIX III: HH maintenance activity

For NHTS2009 dataset-Participation Rate

The household maintenance activity participation rates for different weekday categories by various personal and household characteristics are presented in Table 29.

Table 29. Participation Rate Based on Categorical Variables (NHTS2009) - HH Maintenance

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	45.0%(a, b)	41.6%(b)	47.3%(a)
	Female	44.7%(a)	45.2%(a)	48.8%(b)
Licensed Driver	*Yes*	47.2%(a)	45.4%(a)	50.2%(b)
	No	17.2%(a)	24.3%(b)	26.3%(b)
Income	*Low*	46.5%(a)	46.1%(a)	48.1%(a)
	Medium	47.3%(a, b)	43.8%(b)	48.8%(a)
	High	41.0%(a)	41.9%(a)	48.4%(b)
Work Status	*Full time*	37.4%(a)	36.0%(a)	45.2%(b)
	Part time	50.2%(a)	47.3%(a)	53.0%(a)
	Multiple jobs	49.3%(a)	42.1%(a)	50.5%(a)
	Non-worker	47.6%(a)	48.0%(a)	49.3%(a)
Land Use	*Urban*	44.9%(a)	44.0%(a)	49.0%(b)
	Rural	44.6%(a)	42.7%(a)	46.0%(a)
Family Roles	*Single man*	56.4%(a)	51.8%(a)	54.4%(a)
	Single woman	45.9%(a)	48.1%(a)	48.5%(a)
	Married man	49.8%(a)	45.5%(a)	50.8%(a)
	Married woman	49%(a, b)	46.7%(b)	52.7%(a)
	Single parent male	26.7%(a)	34.2%(a)	37.0%(a)
	Single parent female	48.1%(a)	42.0%(a)	50.0%(a)
	Man nuclear	36.1%(a, b)	30.5%(b)	43.8%(a)
	Woman nuclear	41.4%(a)	43.8%(a)	48.3%(a)
	Minor male	20.5%(a)	16.2%(a)	17.0%(a)
	Minor female	17.5%(a)	23.5%(a)	14.0%(a)
	Man other	38.1%(a)	40.1%(a)	43.8%(a)
	Woman other	38.4%(a)	42.1%(a)	46.8%(a)

Males do not show different HH maintenance rates between Friday and Mondays, or between Mondays and Mid-week days, but they show significantly higher rates between Friday and Mid-week days. Licensed drivers do not show significant difference in maintenance engagement between Monday and Mid-week days, but there is significant difference between Fridays and Mid-week days. For non-drivers the test does not show significant differences between Fridays and mid-week days, but there is significant difference between Mondays and mid-week days.

Comparison among income groups also provides interesting outcomes. Accordingly, low income groups do not show any significant difference in participation rates across week days. Mid

income groups, however, show significant difference between Friday and mid-week days, although there is no significant differences between Monday and Mid-week days. High income group, on the other hand, shows uniform behavior on Mondays and Mid-week days with a significant increase on Fridays.

Moreover, all categories in work status except full time workers do not show significant variations for maintenance activities. Full time workers show significant difference between Friday and Mid-week days, but there is no significant difference between Monday and Mid-week days. In terms of family roles, all categories except Married woman and Man nuclear do not show significant day-to-day fluctuations. It is interesting that there is a general trend towards higher maintenance activities at the beginning and end of the week for Married women and Man nuclear categories.

For NHTS2009 dataset-Daily Duration

Results for household maintenance activity durations are presented in table 30. None of the personal attributes reflect significant day-to-day variations except for low income individuals, full time workers and multiple job holders. In terms of family roles, all categories except single parent male and male other generally are insignificant.

Table 30. Average Daily Duration Based on Categorical Variables (NHTS2009) - HH Maintenance

Parameter	Classification	Average Duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	46.28	46.2	50.98	1.288	0.276
	Female	57.25	59.09	61.27	0.755	0.47
Licensed Driver	*Yes*	52.28	53.51	56.78	1.766	0.171
	No	56.3	58.86	61.62	0.146	0.864
Income	*Low*	54.61	55.06	62.71	3.158	0.043
	Medium	53.09	54.81	52.94	0.129	0.879
	High	48.36	49.15	52.37	0.65	0.522
Work Status	*Full time*	43.6	38.91	44.2	2.797	0.061
	Part time	53.6	51.56	60.35	1.099	0.334
	Multiple jobs	55.57	39.68	53.26	3.607	0.028
	Non-worker	60.46	66.56	61.95	0.912	0.402
Land Use	*Urban*	50.92	52.11	56.11	2.061	0.127
	Rural	55.83	57.86	59.32	0.241	0.786
Family Roles	*Single man*	42.9	55.45	52.84	1.121	0.326
	Single woman	57.22	60.25	63.02	0.32	0.727
	Married man	50.23	45.83	52.34	1.384	0.251
	Married woman	59.59	63.26	60.41	0.429	0.651
	Single parent male	59.17	30.52	43.13	3.633	0.029
	Single parent female	46.52	47.77	58.65	1.407	0.246
	Man nuclear	45.54	35.75	38.77	1.451	0.235
	Woman nuclear	58.37	55.42	61.87	0.474	0.622
	Minor male	26.89	50.83	16.88	0.602	0.553
	Minor female	33.14	46.46	47.14	0.198	0.821
	Man other	39.36	46.55	61.58	2.741	0.065
	Woman other	58.1	57.04	61.24	0.278	0.757

For NHTS2001 dataset-Participation Rate

Table 31 illustrates the participation rates along with correspondent z test comparison among the three aforementioned temporal categories. Accordingly, a variety of outcomes are observed.

Table 14. Participation Rate Based on Categorical Variables (NHTS2001) - HH Maintenance

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	41.4%(a)	40.7%(a)	46.6%(b)
	Female	46.8%(a)	47.2%(a)	52.6%(b)
Licensed Driver	*Yes*	46.4%(a)	46.1%(a)	51.9%(b)
	No	24.5%(a)	25.8%(a)	29.7%(a)
Income	*Low*	43.9%(a)	43.9%(a)	50.3%(b)
	Medium	46.5%(a,b)	44.4%(b)	50.3%(a)
	High	42.0%(a)	45.2%(a)	47.7%(a)
Work Status	*Full time*	45.2%(a,b)	45.0%(b)	49.1%(a)
	Part time	43.9%(a)	42.0%(a)	54.1%(b)
	Multiple jobs	41.1%(a)	44.0%(a)	42.7%(a)
	Non-worker	47.9%(a)	49.2%(a)	53.4%(a)
Land Use	*Urban*	44.4%(a)	44.4%(a)	50.8%(b)
	Rural	44.2%(a)	44.0%(a)	46.8%(a)
Family Roles	*Single man*	50.5%(a)	49.2%(a)	55.5%(a)
	Single woman	46.8%(a)	49.8%(a,b)	54.8%(b)
	Married man	41.6%(a)	41.5%(a)	47.6%(b)
	Married woman	51.0%(a)	49.3%(a)	53.4%(a)
	Single parent male	41.2%(a)	37.2%(a)	55.0%(a)
	Single parent female	46.2%(a)	47.0%(a)	54.8%(a)
	Man nuclear	32.1%(a)	37.1%(a)	47.5%(a)
	Woman nuclear	51.4%(a)	51.0%(a)	64.8%(a)
	Minor male	18.0%(a)	15.8%(a)	26.0%(a)
	Minor female	30.6%(a)	24.6%(a)	26.2%(a)
	Man other	38.2%(a)	35.3%(a)	39.6%(a)
	Woman other	40.5%(a)	42.2%(a)	48.9%(a)

It is interesting to see that both male and female show higher participation rates of maintenances on Friday, with comparable rates on Mondays and Midweek. In terms of income variables, high income individual do not show significant temporal fluctuations. On the other hand, low income individuals show significant different rates on Friday, whereas medium income individuals show differences between Mid-weeks and Fridays. Both Licensed drivers and urban dwellers show significantly higher participation rates in maintenance activities on Friday, with comparable rates on Mondays and Mid-week.

Comparison among different work status also provides interesting outcomes. Accordingly, Full time workers show significant difference in participation rates between Fridays and Mid-week days. Part time workers, on the other hand, show significantly higher rates on Fridays. Other

categories in the working status group do not show much significant differences across the weeks.

In terms of family roles, none of the categories except single woman and married man show significant day-to-day fluctuations. It is interesting that there is a general trend towards higher maintenance activities at the end of the week for single woman and married man categories.

For NHTS2001 dataset-Daily Duration

Table 32 presents average daily household maintenance activity durations among the weekday categories by various personal and household variables. The data only include those who actually participated in maintenance activities. According to the ANOVA test results some categories reflect significant day-to-day variations. These include gender, medium income, licensed drivers, full time workers and urban dwellers. In terms of family roles, minors (both male & female) and male categories, such as married man, single parent male, show significant temporal fluctuations.

Table 32. Average Daily Duration Based on Categorical Variables (NHTS2001) - HH Maintenance

Parameter	Classification	Average duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	48.09	48.31	60.35	5.216	0.005
	Female	61.41	59.43	66.87	2.641	0.071
Licensed Driver	*Yes*	53.85	54.38	62.81	6.297	0.002
	No	91.23	64.97	84.49	2.015	0.135
Income	*Low*	57.13	58.33	61.69	0.444	0.642
	Medium	54.75	50.81	66.29	6.567	0.001
	High	54.38	55.77	64.05	1.572	0.208
Work Status	*Full time*	55.05	55.7	64.52	2.516	0.081
	Part time	56.58	54.51	66.09	0.799	0.45
	Multiple jobs	58.78	56.54	76.34	0.625	0.536
	Non-worker	67.27	67.54	70.06	0.088	0.916
Land Use	*Urban*	57.88	54.33	65.38	7.361	0.001
	Rural	49.36	56.85	59.67	1.848	0.158
Family Roles	*Single man*	47.79	49.55	56.8	0.509	0.601
	Single woman	61.58	62.65	74.83	1.479	0.228
	Married man	48.4	48.07	60.97	3.128	0.044
	Married woman	61.89	55.91	58.83	1.06	0.347
	Single parent male	40.14	39.84	86.45	2.368	0.103
	Single parent female	63.92	61.47	56.15	0.072	0.93
	Man nuclear	33.08	40.08	52.59	0.713	0.492
	Woman nuclear	59.64	49.98	81.74	2.031	0.134
	Minor male	33.33	44.46	33.85	0.212	0.81
	Minor female	34.26	85.51	126.82	3.059	0.053
	Man other	52.63	50.61	64.52	0.868	0.421
	Woman other	62.34	62.61	71.76	1.026	0.359

For ATUS2003 dataset-Participation Rate

Table 33 demonstrates participation rates the three temporal categories. Accordingly, a variety of outcomes are observed. It is interesting to see that both males and females show higher participation rates on Friday, with comparable rates on Mondays and Midweek.

Table 33. Participation Rate Based on Categorical Variables (ATUS2003) - HH Maintenance

Parameter	Classification	Participation rate		
		Monday	Midweek	Friday
Gender	*Male*	34.9%(a)	36.7%(a)	45.4%(b)
	Female	43.0%(a)	43.2%(a)	50.7%(b)
Income	*Low*	36.3%(a)	37.8%(a)	47.3%(b)
	Medium	43.8%(a,b)	41.8%(b)	49.5%(a)
	High	40.0%(a)	43.1%(a)	50.4%(b)
Work Status	*Full time*	37.5%(a)	37.7%(a)	48.4%(b)
	Part time	45.2%(a)	46.8%(a)	48.5%(a)
	Multiple jobs	48.9%(a)	40.1%(a)	50.9%(a)
	Non-worker	43.4%(a)	43.8%(a)	56.8%(b)
Family Roles	*Single man*	39.9%(a)	42.1%(a)	49.4%(a)
	Single woman	37.2%(a)	39.9%(a)	46.8%(a)
	Married man	34.2%(a)	39.1%(a,b)	45.3%(b)
	Married woman	46.2%(a)	43.1%(a)	43.9%(a)
	Single parent male	41.8%(a)	35.4%(a)	48.6%(a)
	Single parent female	45.1%(a)	42.8%(a)	60.0%(b)
	Man nuclear	32.8%(a)	35.4%(a)	46.2%(b)
	Woman nuclear	47.5%(a)	47.5%(a)	58.6%(b)
	Minor male	23.1%(a,b)	16.4%(b)	32.2%(a)
	Minor female	32.1%(a)	30.9%(a)	44.4%(a)
	Man other	36.6%(a)	37.6%(a)	42.0%(a)
	Woman other	35.6%(a)	43.8%(a)	38.1%(a)

In terms of income variables, both low income and high income individual show higher participation rates in maintenance activities on Friday, whereas mid income individuals reflect significant difference between Fridays and Mid-week. Comparison among different work status also provides interesting outcomes. Accordingly, Full time workers and non-workers show significantly higher participation rates on Fridays, while others in this group show no significant difference. In terms of family roles, married male, females and male minor show significant variation in participation rates on Fridays. It seems that there is a general trend towards higher maintenance activities at the end of the week for these categories.

For ATUS2003 dataset-Daily Duration

Similarly, Table 34 presents average daily household maintenance activity durations among the weekday categories by various personal and household variables. The data only include those who actually participated in maintenance activities. According to the ANOVA test results, all personal attributes don't reflect significant day-to-day variations except for male, full time workers and part time workers. In terms of family roles, all categories except married man, single parent male and female other generally do not show significant temporal fluctuations.

Table 34. Average Daily Duration Based on Categorical Variables (ATUS2003) - HH Maintenance

Parameter	Classification	Average duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	48.78	41.1	46.29	3.519	0.03
	Female	56.25	55.1	60.72	1.795	0.166
Income	*Low*	54.54	54.89	55.19	0.011	0.989
	Medium	48.88	44.74	51.49	1.803	0.165
	High	54.99	47.73	53.05	1.599	0.203
Work Status	*Full time*	45.05	38.68	44.83	3.985	0.019
	Part time	52.32	51.94	65.42	2.531	0.08
	Multiple jobs	45.33	42.26	47.43	0.211	0.81
	Non-worker	65.89	62.91	73.97	1.417	0.243
Family Roles	*Single man*	35.4	46.58	38.01	1.452	0.236
	Single woman	61.87	53.37	59.74	0.971	0.38
	Married man	58.49	48.43	40.92	3.067	0.047
	Married woman	56.12	62.4	63.11	0.558	0.573
	Single parent male	35.83	41.48	70.76	2.655	0.077
	Single parent female	37.74	45.62	42.46	0.663	0.516
	Woman nuclear	57.97	56.75	62.46	0.82	0.441
	Minor male	61.22	39.28	71	1.181	0.315
	Minor female	40.82	47.16	50.85	0.123	0.885
	Man other	46.77	38.58	57.17	1.491	0.229
	Woman other	75.12	47.15	94.84	3.797	0.024

For ATUS2009 dataset-Participation Rate

Table 35 illustrates the participation rates along with correspondent z distribution comparison tests. A variety of outcomes are observed. Accordingly, females reflect significant differences in participation rates of maintenances between Mondays and Fridays, whereas males don't show any statistically significant differences throughout the week. In terms of income variables, low and medium income categories do not show significant temporal fluctuations. High income individuals, on the other hand, show significantly different rates on Mondays and Fridays, with no significant fluctuations on mid-weekdays. Furthermore, participation rates for women nuclear also reveal the same pattern with high income individuals having higher rates on Friday. Other categories in family roles do not show much significant differences across the temporal segments. Among different work arrangements, no category reflects statistically identical rates during the week.

Table 35. Participation Rate Based on Categorical Variables (ATUS2009) - HH Maintenance

Parameter	Classification	Participation Rate		
		Monday	Midweek	Friday
Gender	*Male*	52.4%(a)	56.1%(a)	57.4%(a)
	Female	42.9%(a)	44.5%(a,b)	49.3%(b)
Income	*Low*	40.5%(a)	41.2%(a)	43.1%(a)
	Medium	54.1%(a)	54.3%(a)	54.5%(a)
	High	52.4%(a)	59.7%(a,b)	63.6%(b)
Work Status	*Full time*	63.3%(a)	66.3%(a)	66.7%(a)
	Part time	46.8%(a)	44.8%(a)	47.7%(a)
	Multiple jobs	48.5%(a)	60.3%(a)	58.5%(a)
	Non-worker	25.3%(a)	32.6%(a)	36.4%(a)
Family Roles	*Single man*	49.0%(a)	52.3%(a)	55.8%(a)
	Single woman	39.5%(a)	41.6%(a)	39.6%(a)
	Married man	49.7%(a)	47.3%(a)	49.0%(a)
	Married woman	46.6%(a)	44.1%(a)	51.9%(a)
	Single parent male	52.9%(a)	47.0%(a)	50.0%(a)
	Single parent female	40.0%(a)	41.2%(a)	42.5%(a)
	Man nuclear	54.5%(a)	62.6%(a)	62.7%(a)
	Woman nuclear	40.2%(a)	45.8%(a,b)	54.4%(b)
	Minor male	76.7%(a)	70.2%(a)	70.3%(a)
	Minor female	66.7%(a)	65.1%(a)	63.2%(a)
	Man other	46.7%(a)	60.9%(a)	59.5%(a)
	Woman other	46.6%(a)	42.2%(a)	59.2%(a)

For ATUS2009 dataset-Daily Duration

Similarly, Table 36 presents average daily household maintenance activity durations among the weekday categories. According to the ANOVA test results, none of the personal attributes tend to reflect significant day-to-day variations except for high income individuals, full time workers and female. In terms of family roles, all categories except single parent female and single female generally turn out to be insignificant in view of temporal fluctuations.

Table 36. Average Daily Duration Based on Categorical Variables (ATUS2009) - HH Maintenance

Parameter	Classification	Average duration			ANOVA	
		Monday	Midweek	Friday	F value	Sig.
Gender	*Male*	36.39	39.71	42.26	0.809	0.445
	Female	50.35	50.7	58.86	3.382	0.034
Income	*Low*	46.72	49.65	57.81	2.039	0.131
	Medium	47.67	45.04	47.54	0.192	0.825
	High	36.96	41.42	50.66	4.022	0.018
Work Status	*Full time*	33.94	35.32	45.31	5.922	0.003
	Part time	43.4	44.24	52.1	1.159	0.315
	Multiple jobs	36.42	47.82	38.9	0.761	0.469
	Non-worker	64.25	52.4	63.53	1.973	0.141
Family Roles	*Single man*	38.25	35.89	38.53	0.087	0.916
	Single woman	43.96	61.27	59.37	2.679	0.07
	Married man	42.96	53.04	55.31	1.022	0.361
	Married woman	53.61	51.98	64.76	1.587	0.206
	Single parent male	24.69	28.88	18.83	0.54	0.585
	Single parent female	54.33	36.27	53.72	3.747	0.025
	Man nuclear	33.32	36.43	39.87	0.281	0.755
	Woman nuclear	46.42	49.69	57.34	1.473	0.23
	Minor male	12.57	27.04	25	0.657	0.524
	Minor female	71.5	44.46	76	1.416	0.25
	Man other	39.73	41.45	35.78	0.1	0.905
	Woman other	65.9	44.95	37.73	2.032	0.137