# Chapter 7: Case Study: Mode Choice Data

“Few things are harder to put up with than the annoyance of a good example.”

- Mark Twain (1835 – 1910) Pudd’nhead Wilson (1884)

### Introduction

In this chapter we provide a detailed description of the case study alluded to throughout the book. You should already be familiar with aspects of the case study from your readings to date. The question for us was whether we detail the case study early in the book, later in the book (as we have here) or discuss aspects of it throughout the book without ever providing the reader with a detailed overview of how the actual study proceeded.

Detailing the case study earlier in the book risked alienating the reader through the use of expert language necessary to relate the hows and whys of the study. By leaving the detailed description to now, we feel that the reader should be equipped with a level of expertise in the language of choice to understand what actually occurred. We will, for this chapter, use the language of the expert (or at least the more informed). If you have absorbed the material in previous chapters, then what we write here should be easily understood.

### Study Objectives

The case study, the data for which we use in later chapters to demonstrate the more practical aspects of choice modelling, was part of a 1994 study into Greenhouse Gas Emissions (GGE) commissioned by the Australian Federal Government. An important feature of the GGE study was to develop a data base to describe the characteristics of the population of households and passenger vehicles in a base year. Households comprise individuals who participate in travel activities; they have available in varying degrees automobiles of many types, as well as public transport. Although a major data component of the GGE study is a household travel survey, administered to over 1400 households in the six capital cities in mainland Australia (excluding Darwin), placing the sampled households in the context of the population requires additional data.

The primary data related to the socioeconomic and demographic data of individuals and households, the characteristics of the population of passenger vehicles, and descriptors of traffic levels and urban locations for residential and work activity in the year 1994. This information was used to develop classes of passenger vehicles (defined by size and vintage), scrappage rates of vehicles, and classes of 'synthetic' households (defined on core classifiers such as life cycle stage and household income, and non-core classifiers such as number of workers). These outputs enabled the study to define population weighted synthetic households, the population of vehicles available for ‘allocation’ to each synthetic household, and the consequent patterns of travel behaviour which provided measures of GGE and other useful outputs such as modal accessibility, vehicle kilometres, consumer surplus and energy consumption.

An important objective of the GGE study was to put in place a set of procedures for both developing and maintaining an ongoing data base for use in future studies of urban passenger transport. It is for this reason that a lot of effort was devoted to careful sourcing and documentation of secondary data. The Institute of Transport Studies at the University of Sydney (hereafter referred to as ITS) set up a specialised Data Sourcing and Maintenance Unit (DSMU) with the initial task of delivering useful data for passenger transport analyses.

The GGE study involved, inter alia, consideration of the effects of a variety of possible policies that might be used to reduce enhanced GGE in urban areas in Australia. An SP approach was justified by the fact that a) some of the proposed strategies (i.e., combinations of instruments) had not been tried, hence, their potential effects had not been observed; and b) some of the levels or ranges of variables representing strategies had not been observed, hence, it was not possible or at least risky to assume that one can extrapolate from known data to these unobserved values. As well, in many cases individuals or households may have reacted to the strategies in a variety of ways and the SP approach used allowed the researchers to examine the types of decisions that may be made and how they interrelate.

Two SP surveys were developed, one addressing the commuter’s choice of mode and departure time when faced with congestion pricing, higher fuel prices, ‘new’ forms of public transport such a bus priority system and light rail; the other addressing the choice of vehicle and fuel types when faced with higher fuel prices for conventional fuels but lower fuel prices for other fuels, the limitations of range and boot space of electric and alternative fuelled vehicles (e.g., LPG and CNG), greater variability in registration fees, and a new regime of vehicle purchase prices. We refer to the first experiment as the ‘mode choice experiment’ and the second as the ‘vehicle choice experiment’.

The process leading to the testable set of instruments in the pilot survey and then the main survey involved a large number of iterations. By the time the full pilot questionnaire was ready, a number of skirmish and pre-pilot tests had already been completed on a small number of respondents, which had resolved most of the items of concern that the main empirical study was likely to face.

To the extent possible, joint estimation of RP and SP models was planned. This meant that it was necessary to design the experiments with a response metric which was common to that of the RP model and that there were some common attributes across both data sets. Some choices such as mode choice were easily transferable between the two data methodologies; and hence, amenable to joint estimation. Other choices however, such as departure time choice on a congestion priced tollway, could not be observed.

The focus in this chapter and book is on the *mode choice experiment for commuters*. The vehicle choice experiment is discussed in detail together with estimation of choice models in Hensher and Greene (2001). Readers interested in seeing how the entire data set was utilised to estimate and apply models for household choice of residential location, vehicle type and fleet size as well as employed individual household member choice of commuter departure time and mode choice and choice of workplace location can refer to Hensher (2002).

### The Pilot Study

The primary objective of the pilot study was to test the contents and logistics of the survey process. More specifically, the research set out to test the following:

(1) Readability of the questionnaires in general;

(2) Ability to complete the entire questionnaire - home interview, household, and commuter questionnaires;

(3) Ability to complete the choice modelling sections of the Home Interview questionnaire;

(4) Correct skips or logic in the questionnaires;

(5) Interviewers clearly understand the study and how it is to be administered;

(6) Interview length;

(7) Additional questions needed;

(8) Omission of questions;

(9) Interviewing process can be carried out smoothly.

The pilot study enabled the testing of the following elements of the interviewing process:

(1) Interviewer briefing;

(2) 40-45 minute interview with respondent;

(3) Drop off and pick up of household and commuter questionnaires;

(4) Interviewer de-briefing.

The initial mode choice experiment included a choice set of six alternatives: a non-toll auto trip, a tolled auto trip, bus, busway, heavy rail and light rail. The public transport options were rotated in the SP design such that for each replication a respondent would only have to consider two public transport modes together with the two automobile options. Six attributes defined a commuter trip by car: travel time, fuel cost, parking cost, a fee to avoid congestion, departure time, and a toll fee. Five attributes defined a public transport trip to work: travel time in the vehicle, frequency of service, travel time walking to the closest public transport stop, travel time walking from the public transport mode to the destination, and the one-way fare. The rotation of the public modes added another attribute to the design. We show the alternatives, attributes and attribute levels in Figure 7.1.

Figure 7.1: Attributes and levels used for the initial mode choice showcards

|  |  |  |
| --- | --- | --- |
| **Travel by Car/Van/Light Truck** | **Free (non-toll) Route** | **Tollway with Congestion Toll** |
| **Travel time** | 15,25,35 minutes | 4, 8, 12 minutes less |
| **Fuel cost ($)** | 0.70, 1.00, 1.30, 1.60, 1.90, 2.20 | (same as Free Route) |
| **Parking cost ($ per day)** | free, 5, 10 | (same as Free Route) |
| **Fee to avoid congestion ($)** | Free route no fee | 0.50, 1.00, 1.50 |
| **Time you have to depart** | When you do now | 30, 20, 10 minutes earlier,  current time,  10, 20, 30 minutes later |
| **What the tolls are used for** | Not applicable | roads/public transport, non transport needs |
| **Travel by Public Transport** | **Train or Bus** | **Busway or Light Rail (Tram)** |
| **Total time spent in vehicle** | 10, 15, 20 minutes | 10, 15, 20 minutes |
| **Frequency of service** | Every 10, 15, 20 minutes | Every 10, 15, 20 minutes |
| **Closest stop to your home** | 10, 15, 20 minutes walk | 10, 15, 20 minutes walk |
| **Closest stop to your destination** | 10, 15, 20 minutes walk | 10, 15, 20 minutes walk |
| **Fare ($)** | 1, 2, 3 (one-way) | 1, 2, 3 (one-way) |

From the experimental design the researchers designed showcards to be shown to each respondent. Rather than produce several surveys corresponding to each of the blocks of the experimental design, the researchers produced a survey that provided space for the respondent to select the most attractive alternative but did not show the choice sets themselves. The choice sets were placed on showcards that the interviewer could show to each respondent. The instructions and an example of the survey response mechanism are shown in Figure 7.2.

Each respondent was given nine choice sets from the full set of 81 choice sets and asked to indicate the actions they might take in the short term and in the longer term. To ensure a meaningful interpretation of the travel times, the researchers identified the current trip length for the commute and segmented the showcard sets into three trip lengths. Three sets of 81 showcards were required. The trip lengths were a) up to 30 minutes, b) 30 - 45 minutes, and c) over 45 minutes. These trip lengths are the same for each urban area, even though the number of commuters in each category was expected to differ. Table 7.1 shows the full experimental design used for the pilot study.

Figure 7.2: Instructions and format of the initial mode choice survey

This section of the survey should be interesting and fun. We're going to show you nine possible future scenarios involving transport conditions and options in your area. To our knowledge, no one has suggested that any of the scenarios you'll see are likely to happen. We're using these scenarios to understand how individuals and households choose to cope with future changes that might make transport more expensive and less convenient than at present.

For example, you're probably aware that pollution levels in many cities have become major health and environmental concerns in many countries. Likewise, as city populations rise and new workplaces spring up in suburbs or edges of cities, road congestion increases, travel becomes less convenient in some areas and more demands are placed on public funds to solve transport problems and meet future needs. Thus, we need your help to try to understand how transport facilities can best serve your needs under a variety of possible future conditions.

What we want you to do is relatively simple. We will show you 9 scenarios that describe possible future transport conditions in your area that might apply to your typical trips to get to/from work or tertiary education. We want you to evaluate each scenario with reference to your most recent trip and other future trips like it.

|  |
| --- |
| **Specifically, we want to know: If the transport conditions described in each scenario were to occur and last for some months or years, what would you be most likely to do to deal with the situation?** |

To answer this question, we give you with a number of possible options from which to choose. Or, if you would choose to do something not included in our list, we give you space to tell us about that choice. So, your job is fairly simple: examine each scenario and think about what it would be like to travel to work or tertiary education in this situation for months or years. Then tell us which actions you would be most likely to take to deal with the situation.

Figure 7.2: Instructions and format of the initial mode choice survey (Cont’d)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Travel By Car/Van/Light Truck** | | **Free (non-toll) Route** | | **Tollway With Congestion Toll** | |
| **Travel time** | | 25 minutes | | 12 minutes less | |
| **Fuel cost** | | $1.60 | | (same as Free Route) | |
| **Parking cost** | | $5.00 per day | | (same as Free Route) | |
| **Fee to avoid congestion** | | Free Route No Fee | | $1.00 | |
| **Time you have to depart** | | When you do now | | 10 minutes early | |
| **What the tolls are used for** | | Not applicable | | Non transport needs | |
| **Travel By Public Transport** | | **Train or Bus** | | **Light Rail (Tram)** | |
| **Total time spent in vehicle** | | 15 minutes | | 20 minutes | |
| **Frequency of service** | | Every 15 minutes | | Every 20 minutes | |
| **Closest stop to your home** | | 10 minutes walk | | 10 minutes walk | |
| **Closest stop to your destination** | | 20 minutes walk | | 15 minutes | |
| **Weekly fare** | | $2.00 (one-way) | | $3.00 (one-way) | |
| **If the above conditions applied to your most recent or typical work or tertiary education trip, what would you be most likely to do to cope with that? Answer each question below as realistically as possible.** | | | | | |
| **Things You Could Do In The Short Term** | | | | | |
| **1. In a typical week, I would probably try to use each mode the following number of times per week (Write number of times in boxes below. Note: there are at most 10 round trips per week.)** | | | | | |
| **Drive alone** | **Share a ride** | **Bus** | **Commuter Train** | **Light Rail (Tram)** | **Busway** |
| r | r | r | r | r | r |
| **2. If you used Drive alone or Rideshare above, how many times per week would you use the Tollway (write numbers in box. Note: there are at most 10 round trips per week)?** r **Drive alone** r **Rideshare** | | | | | |
| **Things You Could Do In The Longer Term** | | | | | |
| **3. Try to change where you work to make trip less expensive, faster and/or more convenient (TICK ONLY 1 BOX AT RIGHT):** r **Yes** r **No** | | | | | |
| **4. Try to change where you live to make trip less expensive, faster and/or more convenient (TICK ONLY 1 BOX AT RIGHT):** r **Yes** r **No** | | | | | |
| **5. Try to do one of the following with how or when you work (TICK ONLY 1 BOX AT RIGHT):** r **Get a more flexible schedule** r **Work at home more** r **Get new shift time(s)** r **Make no work changes** | | | | | |
| **6. Try to do the following with the vehicles you own or operate (TICK ONLY 1 BOX AT RIGHT):** r **Make fewer trips in my vehicle(s)** r **Sell or give up at least one vehicle** r **Trade one or more vehicles on a more fuel efficient or alternative fuel vehicle** r **Convert one or more vehicles to an alternative fuel** r **Make no changes to what I own or how I use them** | | | | | |
| **7. Any other things you might try to do in this situation? Please tell us about them in the space provided:** | | | | | |

Actions available to respondents in the short-term include: i) which mode they would most likely choose for their usual commute, ii) how many trips they would likely make by each mode in a typical week; iii) if they chose (used) drive alone or rideshare, how many times per week would they use the congestion priced tollway. Longer term actions include: i) changing workplace location to make commuting less expensive, faster and/or more convenient; ii) changing residence location to make commuting less expensive, faster and/or more convenient; iii) trying to change how or when they work (more flexible schedule, working at home more, new shift time(s), or making no work changes); iv) changing their vehicle mix or use strategy, such as making fewer trips in vehicle(s), selling or giving up at least one vehicle, trading one or more vehicles on a more fuel efficient or alternative fuel vehicle, converting one or more vehicles to alternative fuels, or making no changes to what they own or use. Both long term and short term actions were tested as part of the pilot study.

Table 7.1: Orthogonal fractional factorial mode choice pilot experimental design

| **Car (with toll)** | | | | **Car (no toll)** | | | **Train or bus** | | | | |  | **Busway or LR** | | | | |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Time** | **Depart** | **Toll** | **Fuel** | Time | **Parking** | **Fuel** | **Time** | **Freq** | **acct** | **eggt** | **Fare** | **Switch** | **Time** | **Freq** | **eggt** | **Fare** | **Fare** | **Block** |
| 1 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 1 | 2 | 2 | 0 | 1 | 2 | 0 |
| 0 | 3 | 1 | 0 | 0 | 2 | 5 | 0 | 2 | 2 | 1 | 0 | 0 | 0 | 2 | 1 | 2 | 2 | 0 |
| 2 | 1 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 0 |
| 1 | 4 | 0 | 0 | 0 | 1 | 6 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 0 | 1 | 0 | 1 | 0 | 0 | 4 | 2 | 1 | 2 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 |
| 0 | 5 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 2 | 0 | 1 | 0 |
| 1 | 0 | 2 | 1 | 2 | 0 | 3 | 0 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 0 |
| 2 | 2 | 1 | 1 | 1 | 2 | 3 | 2 | 2 | 0 | 1 | 2 | 0 | 2 | 0 | 0 | 2 | 1 | 0 |
| 2 | 5 | 2 | 0 | 1 | 0 | 3 | 2 | 0 | 1 | 0 | 2 | 0 | 2 | 1 | 1 | 1 | 2 | 0 |
| 2 | 3 | 1 | 1 | 2 | 0 | 5 | 0 | 0 | 0 | 0 | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| 2 | 4 | 2 | 1 | 1 | 2 | 2 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 2 | 2 | 2 | 1 | 1 |
| 1 | 3 | 2 | 0 | 1 | 0 | 6 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 0 | 2 | 0 | 1 |
| 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 0 | 5 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 1 | 6 | 1 | 1 | 1 | 0 | 0 | 0 | 1 |
| 1 | 5 | 0 | 1 | 2 | 1 | 0 | 2 | 0 | 1 | 2 | 0 | 0 | 1 | 2 | 1 | 2 | 2 | 1 |
| 2 | 2 | 0 | 0 | 0 | 0 | 3 | 1 | 1 | 2 | 2 | 2 | 0 | 2 | 1 | 2 | 0 | 2 | 1 |
| 1 | 1 | 1 | 1 | 0 | 2 | 4 | 2 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| 0 | 0 | 0 | 0 | 1 | 1 | 3 | 0 | 2 | 0 | 2 | 0 | 1 | 2 | 0 | 1 | 1 | 2 | 1 |
| 0 | 1 | 2 | 1 | 0 | 2 | 6 | 0 | 0 | 0 | 2 | 1 | 0 | 2 | 1 | 2 | 2 | 0 | 2 |
| 1 | 2 | 2 | 0 | 2 | 2 | 4 | 2 | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | 2 | 2 |
| 0 | 1 | 0 | 0 | 2 | 1 | 6 | 1 | 0 | 2 | 2 | 2 | 0 | 1 | 1 | 0 | 2 | 1 | 2 |
| 2 | 0 | 2 | 1 | 0 | 0 | 1 | 2 | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 1 | 2 |
| 1 | 3 | 0 | 1 | 2 | 0 | 3 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 |
| 1 | 4 | 1 | 1 | 1 | 0 | 3 | 0 | 2 | 1 | 2 | 2 | 1 | 0 | 1 | 2 | 0 | 2 | 2 |
| 0 | 3 | 1 | 0 | 1 | 2 | 3 | 1 | 2 | 1 | 0 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 2 |
| 2 | 5 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 2 | 0 | 1 | 0 | 2 | 2 | 1 | 0 | 1 | 2 |
| 2 | 5 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 0 | 1 | 1 | 0 | 2 |
| 2 | 1 | 1 | 1 | 2 | 1 | 3 | 1 | 2 | 1 | 1 | 2 | 1 | 0 | 2 | 2 | 0 | 0 | 3 |
| 2 | 1 | 2 | 1 | 0 | 1 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 3 |
| 0 | 5 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 2 | 0 | 3 |
| 1 | 0 | 1 | 0 | 2 | 2 | 6 | 1 | 0 | 0 | 1 | 2 | 0 | 1 | 2 | 1 | 1 | 1 | 3 |
| 1 | 5 | 2 | 0 | 0 | 2 | 3 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 0 | 2 | 1 | 2 | 3 |
| 1 | 2 | 0 | 1 | 1 | 1 | 5 | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 2 | 0 | 3 |
| 0 | 4 | 0 | 0 | 2 | 0 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 1 | 0 | 1 | 1 | 3 |
| 2 | 3 | 0 | 1 | 1 | 2 | 1 | 2 | 0 | 0 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 3 |
| 0 | 3 | 2 | 1 | 1 | 0 | 4 | 0 | 1 | 2 | 2 | 0 | 0 | 2 | 0 | 1 | 2 | 1 | 3 |
| 0 | 1 | 2 | 0 | 1 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 4 |
| 2 | 2 | 2 | 1 | 2 | 1 | 6 | 0 | 1 | 2 | 1 | 0 | 1 | 0 | 0 | 2 | 1 | 1 | 4 |
| 0 | 5 | 0 | 1 | 1 | 0 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 4 |
| 2 | 0 | 1 | 0 | 0 | 2 | 2 | 2 | 0 | 2 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 4 |
| 1 | 3 | 0 | 1 | 2 | 2 | 1 | 0 | 2 | 2 | 0 | 2 | 1 | 2 | 1 | 0 | 2 | 2 | 4 |
| 1 | 5 | 2 | 1 | 0 | 1 | 5 | 2 | 2 | 0 | 2 | 2 | 0 | 1 | 2 | 2 | 0 | 1 | 4 |
| 1 | 3 | 1 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 0 | 2 | 0 | 2 | 2 | 0 | 4 |
| 0 | 4 | 1 | 1 | 1 | 1 | 4 | 1 | 1 | 1 | 1 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 4 |
| 2 | 1 | 0 | 0 | 2 | 0 | 3 | 1 | 0 | 1 | 0 | 0 | 1 | 2 | 2 | 1 | 2 | 1 | 4 |
| 2 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 5 |
| 0 | 0 | 1 | 1 | 2 | 1 | 3 | 2 | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 5 |
| 0 | 4 | 2 | 1 | 0 | 0 | 5 | 2 | 0 | 0 | 1 | 0 | 1 | 2 | 2 | 2 | 1 | 2 | 5 |
| 1 | 5 | 0 | 1 | 0 | 2 | 3 | 1 | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 1 | 5 |
| 0 | 3 | 0 | 1 | 2 | 2 | 2 | 0 | 1 | 1 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 1 | 5 |
| 1 | 2 | 1 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 5 |
| **Table 7.1: Orthogonal fractional factorial mode choice pilot experimental design (cont’d)** | | | | | | | | | | | | | | | | | | |
| **Car (no toll)** | | | | **Car (no toll)** | | | **Train or bus** | | | | |  | **Busway or LR** | | | | |  |
| **Time** | **Depart** | **Toll** | **Tuse** | **Time** | **Parking** | **Fuel** | **Time** | **Freq** | **acct** | **eggt** | **Fare** | **Switch** | **Time** | **Freq** | **eggt** | **Fare** | **Fare** | **Block** |
| 2 | 5 | 2 | 0 | 2 | 0 | 4 | 1 | 2 | 0 | 2 | 2 | 0 | 0 | 1 | 0 | 2 | 0 | 5 |
| 1 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 2 | 2 | 2 | 2 | 1 | 0 | 0 | 1 | 1 | 2 | 5 |
| 2 | 3 | 0 | 0 | 1 | 1 | 6 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 5 |
| 1 | 5 | 1 | 0 | 1 | 2 | 5 | 0 | 1 | 1 | 1 | 0 | 1 | 2 | 1 | 0 | 0 | 1 | 6 |
| 1 | 3 | 2 | 1 | 0 | 0 | 3 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 6 |
| 1 | 1 | 0 | 0 | 1 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 1 | 1 | 6 |
| 2 | 4 | 1 | 0 | 2 | 2 | 3 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 6 |
| 2 | 5 | 0 | 0 | 2 | 1 | 4 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 2 | 2 | 2 | 6 |
| 0 | 1 | 1 | 1 | 2 | 0 | 6 | 2 | 0 | 2 | 0 | 2 | 1 | 2 | 0 | 2 | 0 | 2 | 6 |
| 2 | 3 | 2 | 1 | 1 | 1 | 3 | 0 | 0 | 2 | 2 | 1 | 1 | 1 | 2 | 0 | 1 | 0 | 6 |
| 0 | 0 | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 2 | 1 | 0 | 2 | 0 | 2 | 2 | 6 |
| 0 | 2 | 0 | 1 | 0 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 0 | 2 | 2 | 1 | 1 | 6 | 6 |
| 0 | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 7 |
| 2 | 4 | 0 | 1 | 0 | 2 | 3 | 0 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 0 | 2 | 1 | 7 |
| 0 | 3 | 2 | 0 | 2 | 1 | 3 | 2 | 2 | 2 | 0 | 2 | 1 | 0 | 1 | 1 | 1 | 1 | 7 |
| 1 | 0 | 0 | 0 | 1 | 2 | 4 | 0 | 0 | 2 | 1 | 2 | 0 | 2 | 2 | 2 | 0 | 0 | 7 |
| 0 | 3 | 0 | 0 | 0 | 1 | 3 | 2 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 2 | 2 | 2 | 7 |
| 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 1 | 1 | 2 | 0 | 7 |
| 2 | 5 | 1 | 1 | 0 | 0 | 6 | 0 | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 7 |
| 2 | 1 | 2 | 0 | 2 | 2 | 5 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 0 | 1 | 0 | 2 | 7 |
| 1 | 5 | 1 | 1 | 2 | 0 | 1 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 7 |
| 0 | 5 | 0 | 1 | 1 | 2 | 6 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 2 | 2 | 8 |
| 1 | 4 | 2 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 8 |
| 2 | 3 | 1 | 1 | 0 | 1 | 4 | 1 | 0 | 1 | 2 | 0 | 1 | 2 | 1 | 2 | 1 | 1 | 8 |
| 1 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 2 | 2 | 1 | 0 | 2 | 1 | 1 | 1 | 8 |
| 2 | 0 | 0 | 1 | 1 | 0 | 5 | 1 | 2 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 8 |
| 0 | 5 | 1 | 1 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 8 |
| 2 | 3 | 2 | 0 | 0 | 2 | 0 | 2 | 1 | 0 | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 0 | 8 |
| 1 | 1 | 1 | 1 | 1 | 1 | 3 | 2 | 0 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 2 | 2 | 8 |
| 0 | 2 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | 2 | 1 | 0 | 2 | 8 |

An advantage of posing the survey questions in this way is the ability to model these decisions in a variety of ways to reflect possible issues of interest to policy analysis. For example, it is possible to estimate mode choice models, and forecast the likely effect of changes in fuel costs and congestion pricing on such choices to determine changes in mode choice mixes and numbers of weekly trips. Alternatively, it is possible to recognise that the mode choice decision might be accompanied by a locational or vehicle choice decision and model the joint choices implied in such decisions. An important feature of the surveys was that the researchers deliberately designed them to allow the testing of violations of the IID error assumptions of simple choice models like Multinomial Logit (MNL). Thus, if individuals use nested or hierarchical choice processes, we will be able to estimate these models from the data (discussed in chapters 10 and 11).

This starting experimental design was pre-tested in Australia and in California. The design proved problematic for a number of reasons. The most important concerns identified were associated with 1) the number of replications initially suggested, namely nine per respondent, drawn from 81 showcards, 2) the ability of a respondent to meaningfully identify their long run actions, 3) the suitability of an essentially attitudinal question on support for how the revenue raised from a congestion toll might influence one’s travel choice, and 4) the wording used in the contextual introduction and on each showcard. Concern was expressed about the length of the contextual statement, the reference to ‘future’ scenarios without a clear statement as to when in the future and what assumptions does the respondent make about household conditions at this unknown future date. A number of the attributes were vague in respect of whether their levels referred to a one-way or round trip. The access and egress trip times for public transport, expressed as walk times were problematic for respondents who would use a motorised access/egress mode. Most importantly, with an interest in departure time choice this design was unable to establish the influence that time-of-day road pricing (i.e., congestion pricing) might have on departure time choice and hence peak spreading. Having a toll imposed without a time context is rather limiting.

Together with a number of more minor concerns the ‘first pass’ experimental design was revised substantially for the pilot study.

#### *Pilot Sample Collection*

The sample census collection districts (CCDs) for metro Sydney were selected from a cumulative count of dwellings, by CCD, taken from the 1986 census. From this cumulative list, the total number of dwellings for each particular region (e.g., Statistical Division) was divided by the number of CCDs (start points) required. This provided an interval between dwelling numbers. To determine the first start point or dwelling number, a random number between one and the interval size was selected. This random number represents a dwelling number. This gives an interval between dwelling numbers. The next dwelling and consequential CCD was selected by incrementing the dwelling number by the interval.

This process was then repeated for the number of start points (CCD’s) required. Interviewing commenced at each start point and was continued until five interviews were achieved.

#### *Interviewer Briefing*

On April 15, 1994 an interviewer briefing for the pilot survey was held in Sydney. The field supervisor, field co-ordinator, project director, ITS and the interviewers who were conducting the pilot interviews were all present. A full set of briefing notes was provided by ITS. The interview briefing was held to ensure that the interviewers knew exactly what the study was about, how they were to conduct the interview and how the respondents were supposed to complete the additional questionnaires which were left with them.

Each of the questions in the home interview was reviewed thoroughly and all questions from the interviewers were answered. The choice modelling and choice sets were reviewed carefully and questions were answered by the representative from ITS.

Once the questionnaires were reviewed a practice interview was conducted with all the interviewers.

#### *Interviewing*

Interviewing was carried out face to face using a home interview questionnaire. This was completed by a member of the household who was responsible for making decisions on where the household lives and what vehicle they purchase. The home interview took approximately 45 minutes to be completed. The household and commuter questionnaires were left for the respondent to complete and then were picked up approximately three days later by the same interviewer who left them.

For the pilot study all respondent households had to have a member who commuted to a regular place of work, although in the final study 10% could be a non-commuting household.

Interviews began Saturday April 16 and were completed by Thursday April 21, 1994.

#### *Analysis of Contacts*

The thirteen interviewers each completed five interviews in the pilot study except for one interviewer who completed only three interviews. A total of 58 interviews were conducted. In order to obtain these 58 interviews there were a total of 809 door knocks. Four hundred and four of those were unusable for reasons such as not being home or there was no access to the dwelling. There were 391 people not home at the time of the interviewing and 13 where there was no access to the dwelling, such as a locked gate.

There were 405 total contacts which includes those interviews which were terminated for the following reasons: the eligible person was away at the time of the interview (a child was home), there was contact but the qualified person (commuter) was not there, the refusals, too busy to complete the interview, or the household did not speak English.

One hundred and eighteen contacts were made where the household was not qualified to complete the interview, such as an elderly couple who do not commute. There were four questionnaires deemed to be unreliable due to the responses to questions such as having an income of $1 M and living in a lower income location. The contact, but no access, occurred 5 times which meant there was contact made but the interviewer was not able to gain access due to a security intercom system for example.

Of those 405 contacts there were 158 households who refused to complete the home interview which is a refusal rate of 39%. The response rate was therefore 14%, that is, 58 completed questionnaires out of 405 total contacts.

#### *Interviewer De-Briefing*

On April 21, 1994 the interviewers, field supervisor, field co-ordinator, coding and data processing managers, project director and the ITS representative reconvened for a de-brief of the pilot survey.

The interviewers were each given the chance to discuss issues regarding the interview process, the questionnaires, wording of the questionnaires etc within the meeting. Problems were discussed and suggestions made on the most effective manner in which the problems could be resolved. The skips and logic of the questionnaire were also discussed and changes made where appropriate.

There was no coding or data entry undertaken on the returned data. The data was not being used in the full study, therefore it was unnecessary to follow through to the coding, editing and data entry stages. However, the coding and editing co-ordinators had a great deal of input into the pilot study. They confirmed that all the questions were coded with the right numbers, ‘other specifies’ were completed correctly and questionnaire logic was correct.

Very few changes were made to the survey instruments as a result of the pilot survey. Minor changes were made to the wording of the introduction of the Home Interview Questionnaire and some revision was made to the multiple option responses to some questions as a result of pilot responses. The only problem which emerged from the pilot was concern over securing completed self completion questionnaires. So as to ensure that key data items were obtained the question on the number of kilometres travelled by each household vehicle was added to the Home Interview Questionnaire (as well as being left in the Household Questionnaire for cross reference purposes). Also the question on the commuter's travel patterns to work over the past 7 days, a rich source of data for the commuter's departure time choice model, was moved from the Commuter Questionnaire to the Home Interview as it was found that in a self completion mode respondents had difficulty following through this question. The experience of the main survey proved that this was a correct decision as the question worked very well in the interview situation.

The consistency of the responses to the stated choice questions was also carefully checked. The researchers were satisfied that they had been administered correctly by the interviewers and answered validly. The only change made to either the questions or the showcards was a modification of the registration fee for alternative fuelled vehicles, which was considered to be too high.

### The Main Survey

Data for the main survey was collected by means of three survey instruments: an interviewer administered home interview and two self completion questionnaires which were left with the respondent and collected a few days later. The two self completion questionnaires were a general questionnaire called the Household Questionnaire and a questionnaire specifically for a household commuter called a Commuter Questionnaire.

There was a considerable amount of detailed data relating to the household's vehicle fleet and the commuting patterns of one member of the household which had to be collected in this survey. There were also two stated choice experiments, one on the modal and departure time choices of a household commuter (i.e., the mode choice experiment) and one on the vehicle purchasing preferences of the household (i.e., the vehicle choice experiment). This was too much data to be collected by any one survey instrument. There was certainly too much information to be collected in a telephone interview and the complex stated choice experiments could not be administered in that manner. There was also too much data to be collected in one face to face interview as interviews in excess of 45 to 60 minutes are difficult to secure.

Given these difficulties, the above strategy was employed for a number of reasons. The initial proposal of contacting respondents first with a telephone interview and then inviting them to take part in a home interview and accept some self completion questionnaires was abandoned on the advice of the survey firm. They believed that based on experience it would be more efficient to secure the required response rate by randomly seeking the home interview as the first contact with respondents. It was felt that there was too much opportunity for respondents to later refuse the home interview and the self completion questionnaires even if they had previously agreed to this would ensure that the most important data was collected at the initial point of contact. Supplementary information which was either too detailed to be collected at the home interview or which had to be left out of that questionnaire in order to keep it within a manageable time frame, was asked for in the two self completion questionnaires which were left with the respondent.

The complete questionnaire covered a number of topics and is divided into 6 Sections:

|  |  |  |
| --- | --- | --- |
| **Section 1:** | Your Vehicles | the number and type of vehicles in the household |
| **Section 2:** | Vehicles and the Environment issue | opinions and awareness of the greenhouse gas |
|  |  |  |
| **Section 3:** | Where you live | reasons why the household lives at this location |
|  |  |  |
| **Section 4:** | Your trip to work | some choices on options of traveling to work |
|  |  |  |
| **Section 5:** | Buying a vehicle | some choices of purchasing vehicles |
| **Section 6:** | About you | socio-economic questions |

The aim of the questionnaire was to collect sufficient data on the household's vehicle fleet to determine the number and type of vehicles in the household. More detailed information on those vehicles was collected in the Household self administered questionnaire. Essential data to map the household vehicles into the population of vehicle data bases was sought in section one.

This section was followed by some general questions about the respondent's knowledge and perceptions of environmental problems including the greenhouse effect. This information was used to provide an understanding of the overall level of community awareness of the greenhouse problem which assisted in identifying needs for a community education program.

The third section asked questions about the household's residential location. Specifically, how long had respondents lived in the area, what were the main reasons they chose to live in that area and were they considering moving and if so, why? This data was needed for a residential location model to explain what factors influence the choice made by households as to where to live.

Section four turned to the collecting of data on the journey to work for regular commuters. The respondent who answered this section was required to make regular commutes to a place of work for either full time or part time employment. Of note, the respondent of this section may not necessarily have been the same respondent for the other sections of the questionnaire if that person was not a regular commuter at the time of the survey. Thus the potential existed for two respondents completing the questionnaire, a Primary Respondent who answers sections 1, 2, 3, 5 and 6 and a Commuting Respondent who answers section 4.

Section four of the survey began by asking the commuter questions about their work and travel pattern over the previous seven days. This provided information on the regularity and variations around the regular pattern of respondents commuting activity which comprised an important input for the departure time choice model.

### The Mode Choice Experiment

Section four of the survey also included the refined stated preference mode choice experiment. As with the pilot experiment, to initiate this experiment the trip length in terms of travel time relevant for each respondent’s current commuting trip was first established so that the travel choices could be given in a context which had some reality for the respondent. The travel choice sets are divided into trip lengths of:

Less than 30 minutes Short trip

30 to 45 minutes Medium trip

Over 45 minutes Long trip

In participating in the choice experiments, each respondent was asked to consider a context in which the offered set of attributes and levels represented the only available means of undertaking a commuter trip from the current residential location to the current workplace location. It was made clear that the purpose was to establish each respondent’s coping strategies under these circumstances.

Four alternatives appear in each mode choice scenario; *CAR NO TOLL*, *CAR TOLL ROAD*, BUS or *BUSWAY*, and *TRAIN* or *LIGHT RAIL*. The five attributes for the public transport alternatives are in-vehicle time, frequency of service, closest stop to home, closest stop to destination, and fare. The attributes for the car alternatives are travel time, fuel cost, parking cost, travel time variability, and for the toll road departure time and toll charge. Three levels were selected for each attribute. The design allows for six alternative specific main effect models for car no toll, car toll road, bus, busway, train, and light rail. Linear by linear interactions are estimable for both car models, and generically for the bus/busway and train/light rail models. While cross effects have been assumed negligible, the four alternative design is perfectly balanced across all attributes.

Four alternatives appeared in each travel choice scenario: a) car (no toll), b) car (toll), c) bus or busway, and d) train or light rail. Twelve types of showcards described scenarios involving combinations of trip length (3) and public transport pairs (4): bus vs. light rail, bus vs. train (heavy rail), busway vs. light rail, and busway vs. train. Appearance of public transport pairs in each card shown to respondents was based on an experimental design. Attribute levels are summarised in Table 7.2 and an illustrative show card is displayed in Figure 7.3. The contextual statement for the mode choice experiment is given in appendix 7A.

Table 7.2: The Set of attributes and attribute levels in the mode choice experiment

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| (all cost items are in Australian $'s, all time items are in minutes) | | | | | | | |
| **SHORT (< 30 mins.)** | **Car no toll** | **Car toll rd** | **PUBLIC TRANSPORT** | **Bus** | **Train** | **Busway** | **Light Rail** |
| Travel time to work | 15,20,25 | 10,12,15 | Total time in the vehicle (one-way) | 10,15,20 | 10,15,20 | 10,15,20 | 10,15,20 |
| Pay toll if you leave at this time (otherwise free) | None | 6-10, 6:30-8:30, 6:30-9 | Frequency of service | Every 5,15,25 | Every 5,15,25 | Every 5,15,25 | Every 5,15,25 |
| Toll (one-way) | None | 1,1.5,2 | Time from home to closest stop | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 |
| Fuel cost (per day) | 3,4,5 | 1,2,3 | Time to destination from closest stop | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 |
| Parking cost (per day) | Free,$10,$20 | Free,$10,$20 | Return fare | 1,3,5 | 1,3,5 | 1,3,5 | 1,3,5 |
| Time variability | 0, ±4,±6 | 0,±1,±2 |  |  |  |  |  |
| **MEDIUM (30-45 mins.)** | **Car no toll** | **Car toll rd** | **PUBLIC TRANSPORT** | **Bus** | **Train** | **Busway** | **Light Rail** |
| Travel time to work | 30,37,45 | 20,25,30 | Total time in the vehicle (one-way) | 20,25,30 | 20,25,30 | 20,25,30 | 20,25,30 |
| Pay toll if you leave at this time (otherwise free) | None | 6-10, 6:30-8:30, 6:30-9 | Frequency of service | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 |
| Toll (one-way) | None | 2,3,4 | Time from home to closest stop | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 |
| Fuel cost (per day) | 6,8,10 | 2,4,6 | Time to destination from closest stop | Walk 5,15,25 Bus 4,6,8 | Walk 5,15,25 Bus 4,6,8 | Walk 5,15,25 Bus 4,6,8 | Walk 5,15,25 Bus 4,6,8 |
| Parking cost (per day) | Free,$10,$20 | Free,$10,$20 | Return fare | 2,4,6 | 2,4,6 | 2,4,6 | 2,4,6 |
| Time variability | 0, ±7, ±11 | 0, ±2, ±4 |  |  |  |  |  |
| **LONG (>45 mins.)** | **Car no toll** | **Car toll rd** | **PUBLIC TRANSPORT** | **Bus** | **Train** | **Busway** | **Light Rail** |
| Travel time to work | 45,55,70 | 30,37,45 | Total time in the vehicle (one-way) | 30,35,40 | 30,35,40 | 30,35,40 | 30,35,40 |
| Pay toll if you leave at this time (otherwise free) | None | 6-10, 6:30-8:30, 6:30-9 | Frequency of service | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 |
| Toll (one-way) | None | 3,4.5,6 | Time from home to closest stop | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 | Walk 5,15,25 |
| Fuel cost (per day) | 9,12,15 | 3,6,9 | Time to destination from closest stop | Walk 5,15,25 Bus 4,6,8 | Walk 5,15,25 Bus 4,6,8 | Walk 5,15,25 Bus 4,6,8 | Walk 5,15,25 Bus 4,6,8 |
| Parking cost (per day) | Free,$10,$20 | Free,$10,$20 | Return fare | 3,5,7 | 3,5,7 | 3,5,7 | 3,5,7 |
| Time variability | 0, ±11, ±17 | 0, ±7, ±11 |  |  |  |  |  |

The master design for the travel choice task was a 27 × 320 × 22 orthogonal fractional factorial, which produced 81 scenarios or choice sets. The 27-level factor was used to block the design into 27 versions each with three choice sets containing the four alternatives. Versions were balanced such that each respondent saw every level of each attribute exactly once. The 320 portion of the master design is an orthogonal main effects design, which permits independent estimation of all effects of interest. The two 2-level attributes were used to describe bus/busway and train/light rail modes, such that bus/train options appear in 36 scenarios and busway/light rail in 45. Given the method used to determine which public transport methods were present within a choice set, the bus and LR and train and busway alternatives never appeared within the same choice set. Table 7.3 show the 81 treatment combinations of the experimental design. Table 7.4 shows the correlation matrix for this design (the correlation matrix is for linear effects only). Note that there exist small correlations amongst some of the attributes however these are so small as to be considered equal to zero.

#### *Detailed description of attributes*

In the experiment respondents are asked to consider their daily commute trip. The aim of the experiment is to test a range of instruments for altering mode and departure time choice. There were 12 types of showcards, with three trip lengths and four combinations of public transport. The public transport combinations are: bus versus light rail, bus versus train (heavy rail), busway versus light rail, and busway vs. train. The trip length showcards will be printed in different colours for ease of use by interviewers when matching respondents’ current trip lengths with those on the showcards. The four public transport combinations will appear in each showcard with incidence determined by the statistical design.

Figure 7.3: Example of the format of the mode choice Experiment showcard

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **SA101** |  | 1. **CAR, TOLL ROAD** |  | 2. **CAR, NON-TOLL ROAD** |
|  |  |  |  |  |
| Travel time to work |  | **10 min.** |  | **15 min.** |
| Time variability |  | **None** |  | **None** |
|  |  |  |  |  |
| Toll (one way) |  | **$1.00** |  | **Free** |
| Pay toll if you leave at this time (otherwise free) |  | **6-10 am** |  | **—** |
|  |  |  |  |  |
| Fuel cost (per day) |  | **$1.00** |  | **$3.00** |
| Parking cost (per day) |  | **Free** |  | **Free** |
|  |  |  |  |  |
|  |  | 3. **BUS** |  | 4. **TRAIN** |
|  |  |  |  |  |
| Total time in the vehicle (one way) |  | **10 min.** |  | **10 min.** |
| Time from home to your closest stop |  | WalkCar/Bus **5 min. 4 min.** |  | WalkCar/Bus **5 min. 4 min.** |
| Time to your destination from the closest stop |  | WalkBus **5 min. 4 min.** |  | WalkBus **5 min. 4 min.** |
|  |  |  |  |  |
| Frequency of service |  | **Every 5 min.** |  | **Every 5 min.** |
|  |  |  |  |  |
| Return fare |  | **$1.00** |  | **$1.00** |

Table 7.3: Mode choice experimental design

| **Car (no toll)** | | | | **Car (toll)** | | | | | | **Bus/Busway** | | | | | **Train/Light Rail** | | | | |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Time | Fuel | Parking | Timevar | Time | Tollpred | Toll | Fuel | Parking | Timevar | Time | Freq | Acctime | Eggtime | Fare | Time | Freq | Acctime | Eggtime | Fare | switch1 | Switch2 | BLK |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 0 | 0 |
| 2 | 1 | 1 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| 2 | 0 | 0 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 1 | 2 |
| 1 | 2 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 2 |
| 0 | 1 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 3 |
| 2 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 3 |
| 1 | 2 | 1 | 2 | 2 | 0 | 1 | 2 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 2 | 1 | 1 | 1 | 1 | 3 |
| 0 | 0 | 2 | 1 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 2 | 1 | 2 | 2 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | 4 |
| 2 | 2 | 1 | 0 | 0 | 1 | 2 | 2 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 2 | 2 | 1 | 1 | 4 |
| 1 | 1 | 0 | 2 | 2 | 0 | 1 | 1 | 2 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 4 |
| 2 | 1 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 5 |
| 1 | 0 | 2 | 2 | 2 | 0 | 1 | 0 | 2 | 0 | 1 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 0 | 5 |
| 0 | 2 | 1 | 1 | 1 | 2 | 0 | 2 | 1 | 2 | 2 | 0 | 2 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 1 | 1 | 5 |
| 1 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 6 |
| 0 | 2 | 0 | 2 | 2 | 1 | 0 | 2 | 2 | 1 | 2 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 6 |
| 2 | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 6 |
| 2 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 1 | 0 | 2 | 1 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 1 | 7 |
| 1 | 2 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 2 | 1 | 1 | 7 |
| 0 | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 1 | 7 |
| 0 | 0 | 1 | 2 | 2 | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 2 | 1 | 1 | 0 | 1 | 1 | 2 | 2 | 0 | 0 | 8 |
| 1 | 1 | 2 | 0 | 0 | 2 | 1 | 1 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 8 |
| 2 | 2 | 0 | 1 | 1 | 0 | 2 | 2 | 1 | 0 | 1 | 2 | 0 | 2 | 2 | 1 | 2 | 2 | 0 | 0 | 1 | 1 | 8 |
| 2 | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 1 | 1 | 2 | 0 | 2 | 0 | 1 | 0 | 9 |
| Time | Fuel | Parking | Timevar  Table 7.3: Mode choice experimental design (Cont’d) | Time | Tollpred | Toll | Fuel | Parking | Timevar | Time | Freq | Acctime | Eggtime | Fare | Time | Freq | Acctime | Eggtime | Fare | switch1 | Switch2 | BLK |
| 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 0 | 0 | 0 | 1 | 2 | 1 | 2 | 1 | 1 | 9 |
| 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 0 | 2 | 1 | 1 | 0 | 2 | 2 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 9 |
| 0 | 2 | 0 | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 0 | 2 | 1 | 2 | 2 | 0 | 1 | 0 | 1 | 1 | 0 | 10 |
| 1 | 0 | 1 | 2 | 1 | 1 | 2 | 1 | 0 | 2 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 0 | 2 | 0 | 1 | 1 | 10 |
| 2 | 1 | 2 | 0 | 2 | 2 | 0 | 2 | 1 | 0 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 2 | 1 | 2 | 0 | 0 | 10 |
| 0 | 1 | 2 | 1 | 0 | 0 | 1 | 2 | 2 | 1 | 0 | 1 | 0 | 2 | 1 | 1 | 2 | 0 | 2 | 0 | 0 | 1 | 11 |
| 2 | 0 | 1 | 0 | 2 | 2 | 0 | 1 | 1 | 0 | 1 | 2 | 1 | 0 | 2 | 2 | 0 | 1 | 0 | 1 | 1 | 1 | 11 |
| 1 | 2 | 0 | 2 | 1 | 1 | 2 | 0 | 0 | 2 | 2 | 0 | 2 | 1 | 0 | 0 | 1 | 2 | 1 | 2 | 0 | 1 | 11 |
| 2 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 2 | 0 | 1 | 2 | 1 | 1 | 12 |
| 0 | 1 | 1 | 2 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | 1 | 0 | 1 | 12 |
| 1 | 2 | 2 | 0 | 2 | 0 | 2 | 0 | 1 | 1 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 12 |
| 2 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 0 | 13 |
| 1 | 1 | 1 | 0 | 2 | 0 | 2 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 2 | 2 | 0 | 1 | 2 | 0 | 0 | 13 |
| 0 | 0 | 0 | 2 | 1 | 2 | 1 | 1 | 0 | 0 | 2 | 1 | 2 | 2 | 2 | 0 | 0 | 1 | 2 | 0 | 1 | 1 | 13 |
| 1 | 0 | 0 | 0 | 2 | 0 | 2 | 1 | 1 | 1 | 0 | 1 | 2 | 2 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 1 | 14 |
| 0 | 2 | 2 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 1 | 2 | 2 | 0 | 1 | 2 | 1 | 0 | 14 |
| 2 | 1 | 1 | 1 | 0 | 1 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 1 | 2 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 14 |
| 0 | 2 | 1 | 0 | 2 | 1 | 1 | 0 | 1 | 2 | 1 | 1 | 1 | 2 | 0 | 2 | 1 | 2 | 2 | 0 | 1 | 0 | 15 |
| 2 | 1 | 0 | 2 | 1 | 0 | 0 | 2 | 0 | 1 | 2 | 2 | 2 | 0 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 15 |
| 1 | 0 | 2 | 1 | 0 | 2 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 1 | 15 |
| 1 | 2 | 1 | 1 | 0 | 2 | 2 | 0 | 2 | 0 | 2 | 1 | 1 | 2 | 1 | 0 | 2 | 0 | 0 | 1 | 0 | 1 | 16 |
| 0 | 1 | 0 | 0 | 2 | 1 | 1 | 2 | 1 | 2 | 0 | 2 | 2 | 0 | 2 | 1 | 0 | 1 | 1 | 2 | 0 | 1 | 16 |
| 2 | 0 | 2 | 2 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 2 | 1 | 2 | 2 | 0 | 1 | 1 | 16 |
| 0 | 0 | 2 | 0 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 0 | 0 | 1 | 1 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 17 |
| 1 | 1 | 0 | 1 | 0 | 2 | 2 | 2 | 2 | 0 | 1 | 2 | 2 | 0 | 0 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 17 |
| 2 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 2 | 2 | 1 | 0 | 1 | 1 | 2 | 1 | 0 | 17 |
| 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 0 | 1 | 1 | 18 |
| 0 | 0 | 2 | 2 | 0 | 0 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 2 | 1 | 2 | 1 | 1 | 0 | 18 |
| 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 0 | 1 | 2 | 2 | 0 | 1 | 1 | 1 | 0 | 2 | 0 | 2 | 0 | 0 | 18 |
| 2 | 1 | 0 | 1 | 2 | 2 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 2 | 1 | 2 | 1 | 1 | 1 | 19 |
| Time | Fuel | Parking | Timevar  Table 7.3: Mode choice experimental design (Cont’d) | Time | Tollpred | Toll | Fuel | Parking | Timevar | Time | Freq | Acctime | Eggtime | Fare | Time | Freq | Acctime | Eggtime | Fare | switch1 | Switch2 | BLK |
| 1 | 0 | 2 | 0 | 1 | 1 | 0 | 2 | 2 | 0 | 2 | 1 | 2 | 0 | 1 | 1 | 0 | 2 | 0 | 2 | 1 | 0 | 19 |
| 0 | 2 | 1 | 2 | 0 | 0 | 2 | 1 | 1 | 2 | 0 | 2 | 0 | 1 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 19 |
| 1 | 2 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 1 | 2 | 0 | 1 | 0 | 0 | 2 | 1 | 2 | 1 | 0 | 1 | 20 |
| 0 | 1 | 0 | 2 | 0 | 0 | 2 | 0 | 1 | 2 | 2 | 0 | 1 | 2 | 1 | 1 | 0 | 2 | 0 | 2 | 1 | 1 | 20 |
| 2 | 0 | 2 | 1 | 2 | 2 | 1 | 2 | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 2 | 1 | 0 | 1 | 0 | 0 | 1 | 20 |
| 0 | 1 | 2 | 0 | 1 | 2 | 2 | 0 | 2 | 1 | 2 | 2 | 2 | 1 | 0 | 1 | 2 | 1 | 1 | 0 | 1 | 1 | 21 |
| 1 | 2 | 0 | 1 | 2 | 0 | 0 | 1 | 0 | 2 | 1 | 1 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 2 | 0 | 1 | 21 |
| 2 | 0 | 1 | 2 | 0 | 1 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 0 | 2 | 2 | 1 | 0 | 1 | 21 |
| 0 | 0 | 1 | 0 | 1 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 2 | 2 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 22 |
| 2 | 2 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 2 | 1 | 1 | 0 | 0 | 1 | 2 | 1 | 1 | 0 | 0 | 0 | 22 |
| 1 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 | 1 | 1 | 2 | 0 | 2 | 2 | 1 | 1 | 1 | 22 |
| 2 | 1 | 2 | 2 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 2 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 2 | 1 | 1 | 23 |
| 1 | 0 | 1 | 1 | 2 | 0 | 0 | 2 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 23 |
| 0 | 2 | 0 | 0 | 1 | 2 | 2 | 1 | 2 | 1 | 0 | 1 | 1 | 0 | 1 | 2 | 0 | 2 | 2 | 1 | 0 | 0 | 23 |
| 2 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 2 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 1 | 24 |
| 1 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 0 | 2 | 1 | 1 | 0 | 24 |
| 0 | 2 | 2 | 1 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 0 | 2 | 2 | 1 | 0 | 2 | 0 | 0 | 24 |
| 0 | 1 | 1 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 2 | 1 | 1 | 0 | 2 | 1 | 1 | 1 | 25 |
| 2 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 2 | 2 | 0 | 2 | 1 | 1 | 0 | 2 | 2 | 1 | 0 | 2 | 0 | 1 | 25 |
| 1 | 2 | 2 | 2 | 0 | 2 | 0 | 1 | 1 | 1 | 1 | 0 | 2 | 2 | 1 | 0 | 0 | 2 | 1 | 0 | 0 | 1 | 25 |
| 2 | 2 | 2 | 0 | 1 | 0 | 1 | 1 | 2 | 2 | 2 | 0 | 2 | 2 | 2 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 26 |
| 0 | 0 | 0 | 1 | 2 | 1 | 2 | 2 | 0 | 0 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 26 |
| 1 | 1 | 1 | 2 | 0 | 2 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 2 | 1 | 1 | 26 |

N.b. To determine whether the choice set has bus/busway or train/LR present, the switch factors must be considered concurrently.

Switch1 = 0, Switch2 = 0: bus and train present; Switch1 = 0, Switch2 = 1: bus and busway present;

Switch1 = 1, Switch2 = 0: train and Light Rail present; Swicth1 = 1, Switch2 = 1: busway and Light Rail present

| **BLK** | **PTmode2** | **PTmode1** | **Fare** | **Eggtime** | **Acctime** | **Freq** | **Time** | **Fare** | **Eggtime** | **Acctime** | **Freq** | **Time** | **Timevar** | **Parking** | **Fuel** | **Toll** | **Tollpred** | **Time** | **Timevar** | **Parking** | **Fuel** | **Time** |  |  | Table 7.4: Correlation matrix for mode choice experimental design |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | -6.7E-18 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | **Time** | **CAR (No toll)** |
| 0 | -6.7E-18 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  | **Fuel** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  | **Parking** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  | **Timevar** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  | **Time** | **CAR (Toll)** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  | **Tollpred** |
| 0 | -6.7E-18 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  | **Toll** |
| 0 | -6.7E-18 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  | **Fuel** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  | **Parking** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  | **Timevar** |
| 0 | -6.7E-18 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  | **Time** | **Bus/Busway** |
| 0 | 0 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  | **Freq** |
| 0 | 0 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  | **Acctime** |
| 0 | 0 | -6.7E-18 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  | **Eggtime** |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **Fare** |
| 0 | -6.7E-18 | -6.7E-18 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **Time** | **Train/LR** |
| 0 | 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **Freq** |
| 0 | 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **Acctime** |
| 0 | 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **Eggtime** |
| 0 | 0 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **Fare** |
| 5.6E-18 | 0 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **PTmode1** |  |
| 8.4E-18 | 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **PTmode2** |  |
| 1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **BLK** |  |

*Travel Time to Work*

There were three different sets of showcards representing short (under 30 minutes), medium (30-45 minutes) and long (45 minutes and over) commutes. These were matched to the commute times currently experienced by respondents. Within each set of showcards, there were three levels of travel times. All public transport options had the same levels as each other, allowing for different combinations across the public transport pairs in each replication. Having the levels the same enables the analyst to investigate the influence that image (through the mode-specific constants) plays in determining preferences within the public transport modes after allowing for the influence of the balanced set of attributes and levels in the design. Travel times on the tolled road were selected so that it is never worse than the time on the non-tolled route.

*Pay Toll if You Leave at this Time (otherwise free)*

The tolled route option only had a toll at peak congestion times. The peak over which the toll applied was varied to determine what impact a short, medium and long toll period would have on mode and departure time decisions.

*Toll (one-way)*

The toll only alternative applied to the tolled routes when the respondent’s commute trip commences within the times specified by the previous variable. There are three levels of toll for each travel time set, with toll levels increasing for the longer travel time sets. Tolls in excess of current tolls in the Sydney Metropolitan area were included to assess the impact of increases beyond the then current levels in one City. The toll on the M4 (M standing for Motorway) in Sydney was at the time $1.50 for a car and $2 on the then completed section of the M5. At the time it was anticipated that the toll for the M5 would increase to $4 when the second section was completed. Tolls in the experiment vary from $1 to $6.

*Fuel Cost (per day)*

Fuel cost was varied from the current levels to a tripling of the current levels to assess possible changes commuters will make as a response to large increases in fuel prices. The daily fuel cost for the commute trip on the tolled road was assumed to be equal to or lower than that experienced on the non-tolled route. Fuel costs where allowed up to $15 per day for trips in excess of 45 minutes on a free route, representing a tripling of fuel prices.

*Parking Cost (per day)*

Another method for reducing the attractiveness of private vehicle use, particularly in central city areas, is to increase parking charges. Three levels of parking charge were used in the experiment to see how sensitive respondents were to parking costs. A fixed set of charges ranging from free to $20 were evaluated.

*Travel Time Variability*

This attribute was calculated for private vehicle modes only, with levels based on 0, ±20% and ±30% of the average trip time on “no toll” roads, and 0, ±5%, and ±10% of the average trip time for “tolled routes”. Toll roads were always equal to or better than non-tolled roads on trip reliability.

*Total Time in the Vehicle (one-way)*

For public transport only, this attribute referred to the time spent travelling on a train, bus, light rail or busway. There were three travel time sets to match those of private vehicles. Only two public transport systems were compared or traded off at once to make the experiment more realistic for the respondent. Thus, there were four sets of public transport combinations, listed above, any other combinations being not meaningful. All public transport options shared the same experimental levels enabling the investigation of the role of image in respondent’s preferences.

*Frequency of Service*

This variable gives the number of minutes between each service, and has three levels. The frequency for all modes had a range from a low of 5 minutes to a high of 25 minutes.

*Time from Home to Your Closest Stop*

The distance from the respondent’s home to the public transport stop, in minutes, is measured in both walk time and time travelling by a motorised form of transport. The respondent will be asked to indicate which means of access they would us if they were to use public transport. There are three levels: 5, 15 and 25 minutes walk time, and 4, 6 and 8 minutes by a motorised mode. This same logic is applied to the Time to Your Destination from the Closest Stop except that the only motorised mode available is bus. It is very rare that a commuter will use a car to complete a trip after alighting from public transport. The taxi option is excluded.

*Return Fare*

This variable gives the return fare in dollars. This has three levels, with the same fare sets being used for all public transport modes for each trip length.

#### *Using the Showcards*

The experimental design shown in Table 7.3 was used for each of the three trip lengths such that the attribute levels of the design were assigned different attribute level labels dependent upon the trip length reported by the respondent. These were colour coded as Short trip - pink cards, Medium trip - green cards and Long trip - yellow cards, for easy identification by the interviewers in the field. The 81 choices for each trip length were grouped into 27 sets of three. These were numbered for example S01A, S01B and S01C to S27A, S27B and S27C. The prefix S, M or L was given to identify the trip length. So that the interviewers did not have to carry 81 × 3 cards in the field to all interviews, each interviewer was given a field kit containing three sets of each trip length from which they were instructed to randomly select one relevant set, according to trip length, for each respondent. This procedure also increased the probability of each set being used, thus increasing the variation of choices offered across the sample.

The interviewer was instructed to firstly establish the trip length of the respondent, and then to select at random one set of choice cards from the three that were given for that trip length. For example if it was a long trip the set selected might be L17A, L17B and L17C. The respondent was then shown these choices one at a time and asked to consider the attributes and select their most preferred option for their trip to work. Respondents were not given the option of not making a choice as it was explained that these were to be considered as long run situations and that given that they had to continue to go to work, they had to choose one of these packages of travelling. Interviewers were briefed to rotate the administering of the order of the cards so as to reduce order bias which may have been introduced if they had always been administered in the A, B and C order.

The respondent was also asked some additional questions about the travel choices to clarify the reasoning behind their decision. They were asked to indicate how they considered they would get from their home to the public transport choices, either walk or drive/catch a car/bus, and from the public transport to their work place, either walk or catch a bus. They were also asked that if they had chosen to go by car would they have travelled alone or shared the ride. There were also some questions to determine the impact of the choice made by the respondent on their work place location and residential location and on their departure time for work.

### Revealed Preference Data

As part of the study protocol, each respondent was asked about their current commute experience to work. So as to remain consistent across respondents, the current commute was defined as the last commute to work undertaken. As well as gathering information on the attribute levels of their last mode used, defined as the primary mode, the questionnaire also asked respondents to intimate the attribute levels of a single alternative means of traveling to work as perceived by that respondent. This second mode was deemed the alternative mode.

The above survey strategy was employed to capture RP data such that information on at least one non chosen alternative per respondent was captured. Whilst it would have been better to capture information on all non chosen alternatives, to do so, it was felt, would place increased burden upon respondents in terms of time and cognitive effort required to complete the questionnaire. As such the above represented a compromise solution that allowed in the aggregate for information to be gathered on all non chosen alternatives whilst reducing respondent burden in completing the questionnaire.

The alternatives present for the RP task were somewhat different to those of the SP choice experiment. Given that the busway and light rail alternatives did not exist at the time, these alternatives were not present within the set of alternatives for the RP data. Further, the toll and non toll privately owned vehicle alternatives were classified as drive alone (DA) or ride share (RS). Also present in the RP task but not in the SP task were the alternatives of walk and ‘other’ mode.

### The Household Questionnaire

The Household Questionnaire could be completed by any adult member of the household. There were three sections in this questionnaire. Section 1 asked for information on the household's use of taxis and other public transport. Section 2 expanded the information collected on the vehicles in the household to add to the basic details which were obtained in the Home Interview. Section 3 contained questions on each member in the household to give a profile of the household life cycle stage.

Section 2 asked for detailed information on all the vehicles in the household, information which required the respondent to check their financial records and perhaps consult with other members of the household and was thus considered to be inappropriate to ask in the Home Interview. In that interview we had ordered the vehicles in the household as Vehicle 1, Vehicle 2 etc starting with the vehicle which had been in the household the longest. So that we were sure that the order was consistent in the Household Questionnaire with that assigned in the Home Interview we asked the interviewers to record the first four data items for each vehicle, i.e. make, model, year came into the household and year of manufacture, for each vehicle in the Household Questionnaire, leaving the respondent to complete the remainder of the details.

### The Commuter Questionnaire

The Commuter Questionnaire had to be completed by a member of the household who was a regular commuter to a set work base location for either full or part time employment. It could not be someone who travelled around to different work places, for example, a self employed tradesperson. This commuter also had to be the same person that answered Section 4 in the Home Interview questionnaire which contained the travel choice questions.

The Commuting Respondent was identified by their Person Number as assigned in the Household Questionnaire. There were five sections to this questionnaire. Section 1 contained some general opinion questions relating to environmental issues and possible policy actions as well as some questions on possible life style changes considered by the respondent. Section 2 was a short section with a few questions about the respondent's work situation. Section 3 was an important section collecting details of the respondent's trip to work and the most likely alternative means by which they would make that trip. Section 4 explored the issues of flexible working arrangements such as compressed work weeks and telecommuting and the degree of flexibility available to the commuter in terms of their start and finish times. Section 5 was also a short section with a couple of questions relating to the availability of parking at the commuter's work place. The questionnaire concluded with the commuter's personal income.

#### *The Sample*

The targeted sample size is given in Table 7.5 by capital city.

Table 7.5: Number of interviews for each city

|  |  |
| --- | --- |
| **City** | **Number of Interviews** |
| Sydney | 300 |
| Melbourne | 300 |
| Brisbane | 250 |
| Adelaide | 200 |
| Perth | 200 |
| Canberra | 150 |
| **Total** | **1400** |

A national survey firm was contracted to supply 1400 completed interviews with the sample distribution by capital city as set out in Table 7.5. A completed interview required the three questionnaires of the survey being complete for each household i.e. the Home Interview Questionnaire, the Household Questionnaire and the Commuter Questionnaire. ITS decided which were the key data items to be completed for the interview to be counted as acceptable.

The sample was a stratified random sample of households according to the vehicle fleet size. The survey firm was supplied with ABS data on household fleet size in the categories "zero vehicles, 1 vehicle, 2 vehicles and 3 or more vehicles" for households at a statistical subdivision level for each of the metropolitan areas to be surveyed. Except that for Brisbane it was not appropriate to use the statistical subdivisions sub-area classification because one statistical subdivision (Brisbane City) includes most of the metropolitan area of Brisbane. The sub-area classification to be used for Brisbane is statistical regions. From this tabulation the number of target interviews to be conducted in each sub-area was calculated. Table 7.6 summarises the target interviews in each urban area; Table 7.7 summarises the profile of households by fleet size. From the Australian Standard Geographical Classification the relevant tables to show the mapping between local government areas and the selected sub-areas have been reproduced.

Table 7.6: Targeted number of interviews by location

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Target Interviews by Vehicles in Household**  (Rounded Values) | | | | | | | | | |
|  | **Number of Vehicles** | | | | | | |  | | |
|  | **0** | | **1** | **2** | | **3+** | | **Total** | | |
| **SYDNEY** |  | |  |  | |  | |  | | |
| Inner Sydney | 4 | | 9 | 7 | | 5 | | 25 | | |
| Eastern Suburbs | 3 | | 8 | 7 | | 4 | | 22 | | |
| St George - Sutherland | 5 | | 11 | 10 | | 7 | | 33 | | |
| Canterbury - Bankstown | 3 | | 8 | 7 | | 5 | | 23 | | |
| Fairfield - Liverpool | 3 | | 7 | 6 | | 4 | | 20 | | |
| Outer South Western Sydney | 2 | | 5 | 4 | | 3 | | 14 | | |
| Inner Western Sydney | 2 | | 5 | 4 | | 3 | | 14 | | |
| Central Western Sydney | 3 | | 8 | 6 | | 4 | | 21 | | |
| Outer Western Sydney | 3 | | 7 | 6 | | 4 | | 20 | | |
| Blacktown - Baulkham Hills | 4 | | 8 | 7 | | 5 | | 24 | | |
| Lower Northern Sydney | 4 | | 9 | 8 | | 5 | | 26 | | |
| Hornsby - Ku-ring-gai | 3 | | 6 | 5 | | 4 | | 18 | | |
| Manly - Warringah | 3 | | 7 | 6 | | 4 | | 20 | | |
| Gosford - Wyong | 3 | | 7 | 6 | | 4 | | 20 | | |
| **TOTAL** | 45 | | 105 | 89 | | 61 | | 300 | | |
|  | **Number of Vehicles** | | | | | | | | |
|  | **0** | **1** | | | **2** | | **3+** | | **Total** |
| **MELBOURNE** |  | | | | | | | | |
| Central Melbourne | 3 | | 9 | 9 | | 5 | | 26 | |
| Western Inner Melbourne | 1 | | 5 | 5 | | 3 | | 14 | |
| Western Outer Melbourne | 2 | | 7 | 7 | | 4 | | 20 | |
| Western Fringe Melbourne | 1 | | 3 | 3 | | 2 | | 9 | |
| Northern Inner Melbourne | 1 | | 3 | 3 | | 2 | | 9 | |
| Northern Middle Melbourne | 2 | | 6 | 6 | | 4 | | 18 | |
| Northern Fringe Melbourne | 1 | | 4 | 4 | | 2 | | 11 | |
| Northern Outer Melbourne | 2 | | 6 | 6 | | 3 | | 17 | |
| Eastern Inner Melbourne | 1 | | 5 | 5 | | 3 | | 14 | |
| Eastern Middle Melbourne | 2 | | 8 | 8 | | 5 | | 23 | |
| Eastern Outer Melbourne | 3 | | 10 | 9 | | 5 | | 27 | |
| Eastern Fringe Melbourne | 1 | | 4 | 5 | | 2 | | 12 | |
| Southern Inner Melbourne | 2 | | 7 | 7 | | 4 | | 20 | |
| Southern Outer Melbourne | 2 | | 6 | 6 | | 4 | | 18 | |
| South Eastern Inner Melbourne | 1 | | 5 | 5 | | 3 | | 14 | |
| South Eastern Outer Melbourne | 1 | | 5 | 5 | | 3 | | 14 | |
| Mornington Peninsula Inner | 1 | | 4 | 4 | | 2 | | 11 | |
| Mornington Peninsula Outer | 1 | | 3 | 3 | | 2 | | 9 | |
| Geelong | 1 | | 5 | 5 | | 3 | | 14 | |
| TOTAL | 29 | | 105 | 105 | | 61 | | 300 | |

**Table 7.6: Targeted number of interviews by location (cont’d)**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | **Number of Vehicles** | | | | | | | | |
|  | **0** | | **1** | | **2** | **3+** | | **Total** | |
| **ADELAIDE** | |  | | | | | | | | |
| Northern | | 6 | | 16 | 15 | | 9 | | 46 | |
| Western | | 6 | | 16 | 15 | | 9 | | 46 | |
| Eastern | | 8 | | 22 | 20 | | 12 | | 62 | |
| Southern | | 6 | | 16 | 15 | | 9 | | 46 | |
| TOTAL | | 26 | | 70 | 65 | | 39 | | 200 | |
|  | |  | |  |  | |  | |  | |
| **PERTH** | |  | | | | | | | | |
| Central Metropolitan | | 2 | | 8 | 8 | | 5 | | 23 | |
| East Metropolitan | | 3 | | 11 | 11 | | 6 | | 31 | |
| North Metropolitan | | 6 | | 21 | 21 | | 12 | | 60 | |
| South West Metropolitan | | 4 | | 14 | 14 | | 8 | | 40 | |
| South East Metropolitan | | 5 | | 16 | 16 | | 9 | | 46 | |
| TOTAL | | 20 | | 70 | 70 | | 40 | | 200 | |
|  | |  | |  |  | |  | |  | |
| **CANBERRA** | |  | | | | | | | | |
| Central Canberra | | 3 | | 11 | 12 | | 6 | | 32 | |
| Belconnen | | 4 | | 14 | 14 | | 8 | | 40 | |
| Woden Valley | | 2 | | 7 | 6 | | 4 | | 19 | |
| Weston Creek | | 2 | | 4 | 4 | | 3 | | 13 | |
| Tuggeranong | | 3 | | 11 | 12 | | 6 | | 32 | |
| Queanbeyan | | 1 | | 5 | 5 | | 3 | | 14 | |
| TOTAL | | 15 | | 52 | 53 | | 30 | | 150 | |
|  | |  | | | | | | | | |
| **BRISBANE** | |  | | | | | | | | |
| Brisbane City Inner Ring | | 8 | | 27 | 27 | | 15 | | 77 | |
| Brisbane City Outer Ring | | 7 | | 25 | 25 | | 14 | | 71 | |
| South and East BSD Balance | | 5 | | 16 | 17 | | 9 | | 47 | |
| North and West BSD balance | | 6 | | 19 | 19 | | 11 | | 55 | |
| TOTAL | | 26 | | 87 | 88 | | 49 | | 250 | |

It was not stipulated that interviews had to meet the strict quotas of vehicle fleet size for each statistical subdivision but that the quotas had to be met, within a margin of error of ± 10% for the metropolitan area as a whole. The fleet size profile for all statistical subdivisions was supplied as a guide to the survey firm in determining their sampling clusters, an accepted means of securing an effective sample in the field. Table 7.7 is limited to the metropolitan areas of the capital cities where all surveys were undertaken.

Table 7.7: Summary at urban areawide level of profile of households by fleet size

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **COUNTS OF HOUSEHOLDS** | | | | | |
| **Area** | **Code** | **Number of Motor Vehicles** | | | | | |
|  |  | *0* | *1* | *2* | *3+* | *Not Stated* | *Total* |
| Sydney | 105 | 204,838 | 513,154 | 339,552 | 114,256 | 48,250 | 1,220,050 |
| Canberra | 805 | 8,098 | 38,634 | 32,897 | 11,253 | 1,848 | 92,730 |
| Melbourne | 205 | 129,147 | 389,430 | 361,795 | 133,879 | 34,385 | 1,048,636 |
| Brisbane | 305 | 56,640 | 185,679 | 148,212 | 53,477 | 12,687 | 456,695 |
| Adelaide | 405 | 51,018 | 159,814 | 121,821 | 39,542 | 7,638 | 379,833 |
| Perth | 505 | 41,478 | 156,678 | 142,280 | 54,598 | 8,379 | 403,413 |
| Hunter | 110 | 24,654 | 80,944 | 53,989 | 18,084 | 4,062 | 181,733 |
| Illawarra | 115 | 15,172 | 54,774 | 34,951 | 10,511 | 3,160 | 118,568 |
|  |  | PERCENTAGE (INCLUDING NOT STATED) | | | | | |
| **Area** | **Code** | **Number of Motor Vehicles** | | | | | |
|  |  | *0* | *1* | *2* | *3+* | *Not Stated* | *Total* |
| Sydney | 105 | 17% | 42% | 28% | 9% | 4% | 100% |
| Canberra | 805 | 9% | 42% | 35% | 12% | 2% | 100% |
| Melbourne | 205 | 12% | 37% | 35% | 13% | 3% | 100% |
| Brisbane | 305 | 12% | 41% | 32% | 12% | 3% | 100% |
| Adelaide | 405 | 13% | 42% | 32% | 10% | 2% | 100% |
| Perth | 505 | 10% | 39% | 35% | 14% | 2% | 100% |
| Hunter | 110 | 14% | 45% | 30% | 10% | 2% | 100% |
| Illawarra | 115 | 13% | 46% | 29% | 9% | 3% | 100% |
|  |  | % OF HOUSEHOLDS (BASED ON A STATED RESPONSE) | | | | | |
| **Area** | **Code** | **Number of Motor Vehicles** | | | | | |
|  |  | *0* | *1* | *2* | *3+* | *Not Stated* | *Total* |
| Sydney | 105 | 17% | 44% | 29% | 10% |  | 104% |
| Canberra | 805 | 9% | 43% | 36% | 12% |  | 102% |
| Melbourne | 205 | 13% | 38% | 36% | 13% |  | 103% |
| Brisbane | 305 | 13% | 42% | 33% | 12% |  | 103% |
| Adelaide | 405 | 14% | 43% | 33% | 11% |  | 102% |
| Perth | 505 | 10% | 40% | 36% | 14% |  | 102% |
| Hunter | 110 | 14% | 46% | 30% | 10% |  | 102% |
| Illawarra | 115 | 13% | 47% | 30% | 9% |  | 103% |
|  |  | **ESTIMATED COUNTS OF VEHICLES** | | | | | |
| **Area** | **Code** | **Number of Motor Vehicles** | | | | | |
|  |  | *0* | *1* | *2* | *3+* | *Not Stated* | *Total* |
| ***Values Used*** | | ***0*** | ***1*** | ***2*** | ***3.2*** |  |  |
| Sydney | 105 | 0 | 513,154 | 679,104 | 365,619 |  | 1,557,877 |
| Canberra | 805 | 0 | 38,634 | 65,794 | 36,010 |  | 140,438 |
| Melbourne | 205 | 0 | 389,430 | 723,590 | 428,413 |  | 1,541,433 |
| Brisbane | 305 | 0 | 185,679 | 296,424 | 171,126 |  | 653,229 |
| Adelaide | 405 | 0 | 159,814 | 243,642 | 126,534 |  | 529,990 |
| Perth | 505 | 0 | 156,678 | 284,560 | 174,714 |  | 615,952 |
| Hunter | 110 | 0 | 80,944 | 107,978 | 57,869 |  | 246,791 |
| Illawarra | 115 | 0 | 54,774 | 69,902 | 33,635 |  | 158,311 |
|  |  | % OF VEHICLES (BASED ON A STATED RESPONSE) | | | | | |
| **Area** | **Code** | **Number of Motor Vehicles** | | | | | |
|  |  | *0* | *1* | *2* | *3+* | *Not Stated* | *Total* |
| Sydney | 105 | 0% | 33% | 44% | 23% |  | 100% |
| Canberra | 805 | 0% | 28% | 47% | 26% |  | 100% |
| Melbourne | 205 | 0% | 25% | 47% | 28% |  | 100% |
| Brisbane | 305 | 0% | 28% | 45% | 26% |  | 100% |
| Adelaide | 405 | 0% | 30% | 46% | 24% |  | 100% |
| Perth | 505 | 0% | 25% | 46% | 28% |  | 100% |
| Hunter | 110 | 0% | 33% | 44% | 23% |  | 100% |
| Illawarra | 115 | 0% | 35% | 44% | 21% |  | 100% |

#### *Screening Respondents*

Interviewers were instructed to interview adults over 18 years of age who were involved in the household's decisions as to where to live and buying motor vehicles. It was also important to ensure that a respondent was at home at the time of the interview who fulfilled the commuter criteria to answer Section 4 of the Home Interview Questionnaire. This could be the Primary Respondent who first agreed to the interview, but in the event that this person was not a regular commuter, another commuter in the household could become the Commuting Respondent. Interviewers were instructed that a maximum of 10% of their interviews could be conducted in households which did not have a commuter.

#### *Interviewer Briefing*

Each metropolitan city had two interviewer briefings held between May 9 and May 13, 1994. The briefings were undertaken by the field supervisor in each state. In addition to the field supervisor an ITS representative was present. A full set of briefing notes was provided by ITS. The interviewers were given the briefing notes as well as the set of questionnaires, show cards and choice sets.

The briefing was held to ensure that the interviewers knew exactly what the study was about, how they were to conduct the interview and how the respondents were supposed to complete the additional questionnaires which were left with them. The briefing took the interviewers through each question of the home interview and then all questions from the interviewers were answered thereafter. The choice modelling and choice sets were reviewed carefully and questions were answered by the representative from ITS.

After the questionnaires were reviewed a practice interview was conducted with all interviewers.

#### *Interviewing*

As in the pilot survey interviewing was carried out face to face using a home interview questionnaire. This was completed by a member of the household who was responsible for making decisions on where the household lives and what vehicle(s) they purchase. The home interview took approximately 45 minutes to be completed.

The commuter mode choice and vehicle choice questions were completed in the face to face home interview where the interviewer could answer any questions the respondent had.

The household and commuter questionnaires were left for the respondent to complete and then were picked up approximately three days later by the same interviewer who left them. This procedure differed slightly from state to state however, only in respect to the number of days which the questionnaire was left for the respondent to complete. For example, the interviewers in Sydney left the questionnaire for three days while in Brisbane the questionnaires were picked up the same day as the interview.

Interviews began Saturday May 14 and took longer than anticipated to conduct the required number of interviews within each state. The interviewing was in field for approximately five weeks instead of the scheduled three weeks. The problems were primarily in the zero car households which remained an issue throughout the interviewing process. In the end, each state targeted specific areas, in order to fulfil the quota requirements for household fleet size.

#### *Analysis of Total Contacts*

There were a total of 1,571 interviews conducted throughout the metropolitan cities of Australia of which 1,529 were entered after the editing process. Although the contracted sample size was 1,400 interviews it was necessary to over sample given the likelihood that a proportion of these interviews will be found to be unsuitable for further analysis.

There were a total of 19,752 door knocks. Of these, there were 9,492 interviews which were unusable for reasons such as not home or there was no access to the home. There were 8,970 people not home at the time of the interviewing or where there was no access to the dwelling, such as a locked gate.

There were 10,257 total contacts which includes those interviews which were terminated for the following reasons: the eligible person was away at the time of the interview (a child was home), there was contact but the qualified person (commuter) was not there, the refusals, too busy to complete the interview, or the household did not speak English.

Four thousand, one hundred and sixty eight contacts were made where the household was not qualified to complete the interview, such as an elderly couple who do not commute. There were only fifteen questionnaires deemed to be unreliable due to the responses to questions such as the household reported having fifteen cars and not having a driver’s license.

Contact, but no access, occurred 172 times which meant there was contact made but the interviewer was not able to gain access due to a security intercom system for example. Of those 10,257 contacts there were 2,268 households who refused to complete the home interview which is a refusal rate of 22%. The response rate was 15%, that is, 1571 completed questionnaires out of 10,257 total contacts.

There were only a few variations between the states in regard to the proportion of people who terminated, were away at the time of the interview, were temporarily busy etc. A few noted variations include the high proportion of respondents in Victoria which did not qualify for the study; which was 1,219 out of 400 required compared to the other states such as 726 in NSW.

There was a slight difference between NSW and the other states in terms of their refusal rate. NSW had 721 out of 400 required (1.8%), WA had 343 out of 200 required (1.7%) while SA only had 211 refusals out of 200 required (1.0%). Western Australia had the highest number of people who were not home while the interview was to be conducted, while the ACT had the lowest number of people who were not home at that time.

#### *Questionnaire Check Edit*

ITS was responsible for the first stage of the check edit process. Once the interviews were completed and the household and commuter questionnaires were collected the complete sets of the three questionnaires were sent to ITS. Each questionnaire was examined to ascertain the completeness and validity of the responses. The questionnaires were then sent back to the survey firm for second check editing and the coding process.

#### *Coding and Check Edit*

The survey firm received the questionnaires in stages as ITS completed the check editing. It was agreed ITS would do the majority of the check editing as the survey firm usually takes self completes as they come rather than cross checking the information from other parts of the questionnaire. Therefore, the check edit process completed by the survey firm was more of a procedure of logic checks within the home interview questionnaire.

The ‘other’ and ‘other specify’ were coded by the survey firm. That is, three hundred and fifty questionnaires were used to determine the code frames for each question where there was an ‘other’ or ‘other specify’. In order for a code to be established it had to have been stated at least eleven times. The ‘other’ and ‘other specify’ questions and their code frames were documented in a separate report by the survey firm.

Table 7.8 documents the total number of questionnaires which were keypunched after the coding and editing process. ITS requested there be four different categories in which to put the questionnaires: 1) incompletes, 2) non-commuter, 3) commuter, and 4) other incompletes, as shown in Table 7.8. The incompletes included questionnaires which had only the home interview completed (N=83). The commuters were those who completed all three sections of the questionnaire (N=1204). Non-commuters were the respondents who did not commute and therefore only completed the home interview and the household questionnaire (N154). The other incompletes was a category which ITS devised to represent those which were quite badly incomplete and had other problems such as the personal information was not completed (N=88). The survey firm agreed to attempt to obtain the missing data, however after encountering many aggravated and despondent respondents, this effort was ceased.

Table 7.8: Final questionnaire totals by state (after ITS editing)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **INCOMPLETES** | **NON-COMMUTER** | **COMMUTER** | **OTHER INCOMPLETE** | **TOTAL** |
| **NSW** | 16 | 28 | 246 | 31 | 321 |
| **ACT** | 8 | 14 | 123 | 13 | 158 |
| **VIC** | 25 | 47 | 239 | 17 | 328 |
| **SA** | 21 | 22 | 162 | 19 | 224 |
| **QLD** | 5 | 25 | 244 | 4 | 278 |
| **WA** | 8 | 18 | 190 | 4 | 220 |
| **FINAL TOTAL** | **83** | **154** | **1204** | **88** | **1529** |

#### *Data Entry*

The data entry of the questionnaires was conducted by the survey firm. The questionnaires were all finalised in terms of their responses before any keypunching was completed. That is, nothing was revised on the questionnaires once the keypunching had begun. This process took approximately a week to complete.

#### *SPSS Set Up*

Each question of the questionnaire was set up in SPSS by the survey firm. This process involved keypunching several questionnaires to establish the variable names and lengths within SPSS. Once the variables were created within SPSS a check was run to validate the information was in the right variable. The completed data files were handed over to ITS for analysis. ITS undertook extensive pre-analysis of the base survey data to ensure that the data was 'clean' and ready for analysis.

### The Case Study Data

On the CD-ROM accompanying this primer is the data for the mode choice experiment for the GGE study. With the exception of the exclusion of the non-commuting sample data, the data remains undoctored. It exists as it did in 1994 when first collected and as such exhibits all of the nuisances of real life data (which it is). It is this data set that we will use in the remaining chapters to demonstrate the more practical exercises in choice modelling.

Table 7.9 shows the breakdown for the data by city of the sample sizes for both the SP and RP components of the study (from this point on we refer to capital cities of each state instead of the states themselves as the data was collected in these urban centres and not across the remainder of the states). Note that there exist 338 less respondents for the RP data than the SP data. This is despite the fact that the same respondent completed both the SP and RP component of the survey. Thus these 338 missing respondents for the RP data represent missing data that was either missing at the time of data collection or has been lost for reasons unknown since.

Table 7.9 also breaks down the SP sample data by city into the trip lengths as sampled in 1994. Sampled were 790 commuters with trips to work of less than 30 minutes, 239 with trips to work of between 30 to 45 minutes and 175 commuters with trips to work of greater than 45 minutes. The proportions belonging to each trip length segment for each city are given in brackets.

Table 7.9: Breakdown by city for the SP and RP data sets

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **RP** | **SP** | **30 minutes or less** | **30 to 45 minutes** | **Greater than 45 minutes** |
| Sydney | 167 | 246 | 123 (0.5) | 60 (0.24) | 63 (0.26) |
| Canberra | 96 | 123 | 104 (0.84) | 13 (0.10) | 6 (0.04) |
| Melbourne | 173 | 239 | 148 (0.61) | 51 (0.21) | 40 (0.16) |
| Adelaide | 119 | 162 | 122 (0.75) | 28 (0.17) | 12 (0.07) |
| Brisbane | 167 | 244 | 155 (0.63) | 56 (0.22) | 33 (0.13) |
| Perth | 144 | 190 | 138 (0.72) | 31 (0.16) | 21 (0.11) |
| Total | 866 | 1204 | 790 (0.65) | 239 (0.19) | 175 (0.14) |

Share profiles of RP choices for each of the six cities and the overall totals for all six cities are summarised in tables 7.10 and 7.11. Walk and ‘other’ were eliminated in the RP models because insufficient individuals chose “walk”. ‘Other’ is uninformative.

Table 7.10: Profile of Revealed Preference Modal Share (%) - Chosen Main Mode

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | CAN | SYD | MEL | BRS | ADL | PER | TOTAL |
| Drive alone | 52.0 | 51.0 | 62.4 | 50.0 | 54.3 | 61.4 | 55.3 |
| Ride share | 22.0 | 16.0 | 14.8 | 26.3 | 21.3 | 17.4 | 19.4 |
| Bus | 19.5 | 7.4 | 1.3 | 7.2 | 11.6 | 9.2 | 8.3 |
| Train | 0.0 | 19.8 | 13.5 | 11.0 | 3.0 | 7.1 | 10.4 |
| Walk | 1.6 | 3.3 | 3.0 | 1.7 | 1.2 | 0.5 | 2.0 |
| \*Other | 4.9 | 2.5 | 5.1 | 3.8 | 8.5 | 4.3 | 4.6 |
| Total Number | 123 | 243 | 237 | 236 | 164 | 184 | 1187 |
| \* “other” is taxi, ferry (in SYD, BRS), motorbike and bicycle | | | | | | | |

Table 7.11: Profile of Revealed Preference Modal Share (%) - Alternative Mode

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | CAN | SYD | MEL | BRS | ADL | PER | TOTAL |
| Drive alone | 10.6 | 15.6 | 15.6 | 13.1 | 9.8 | 7.6 | 12.6 |
| Ride share | 22.8 | 21.8 | 21.5 | 24.6 | 25.0 | 24.5 | 23.3 |
| Bus | 41.5 | 23.0 | 15.6 | 24.6 | 28.0 | 28.8 | 25.4 |
| Train | 0.0 | 18.1 | 22.8 | 18.6 | 9.8 | 17.9 | 16.1 |
| Walk | 4.9 | 6.6 | 6.3 | 5.1 | 9.1 | 8.2 | 6.7 |
| \*Other | 20.3 | 14.8 | 18.1 | 14.0 | 18.3 | 13.0 | 16.1 |
| **Total Number** | 123 | 243 | 237 | 236 | 164 | 184 | 1187 |
| \* “other” is taxi, ferry (in SYD, BRS), motorbike and bicycle | | | | | | | |

The data set used for the case study is a combined RP-SP data set consisting of 109 columns and 16,188 rows of data. We provide a detailed description of these variables in Appendix 7B and Appendix 7C. The data set is located on the accompanying CD-ROM in a folder titled Data and is itself in a text (.TXT) format. Once the CD-ROM has been placed in the CD-ROM drive of your computer and the Nlogit program is opened the initial data setup proceeds as follows. Note that we have assumed that the D drive is the CD-ROM for your computer. If this is not the case you will need to change the drive letter in the command line **;file=d:\CaseStudy\SPRP.TXT** to whatever drive letter is appropriate.

**reset**

**read**

**;file=d:\CaseStudy\SPRP.TXT**

**;nobs=16186**

**;nvar=109**

**;names =ID, CITY, SPRP, SPEXP, ALTISPRP, ALTIJ, CHSNMODE, ALTMODE, SPCHOICE, CHOICE, CSET, RPDA, RPRS, RPBUS, RPTN, RPWALK, RPBIKE, SPCART, SPCARNT,SPBUS, SPTN, SPBW, SPLR, CN, SPMISS, RPMISS, SPRPMISS, RPSPWKBK, RPCAR, BEFORPTR, AFTERPTR, MPTRFARE, OPTRFARE, HOMTOPTR, PTRTOWK, HHLDVEH, WKKMVEH, WALKTIME, MPTRTIME, WAITTIME, OPTRTIME, AUTOPASS, MAXPASS, HLDAUTO, AUTONA, AUTOMAKE, AUTOYEAR, AUTOWKKM, AUTOTIME, AUTOWKTM, AUTWKWLK, AUTWKBUS, AUTWKTRN, AUTWKOTH, VEHPPARK, VEHPRKCT, VEHPTOLL,VEHTOLCT, VEHPOTHE, VEHOTHCT, VEHPNOTH, DRPPTRAN, DRPCCARE, DRPSCHOL,DRPTEDUC, DROPWORK, DROPOTHE, DROPDWEL, NODROPOF, DROPTIME, TRIPTIME, DEPTIME, DISDWCBD, VEHSTATU, CHAWKTR, CHADWTR, SPLENGTH, TIME,TIMEVAR, TOLL, TOLLPRED, FUEL, PARKING, FREQ, FARE, START24, ACCTIME, EGGTIME, HWEIGHT, NUMBVEHS, HLDINCOM, NHLDBCAR, NCOMPCAR, NDRIVLIC, HLDSIZE, NWORKERS, WKREMPLY, WKROCCUP, PERAGE, DRIVLIC, PINCOME, PERSEX, PEREDUC, ACCEGGT, CAN, SYD, MEL, BRS, ADL$**

**dstats;rhs=\*$**

The commands as written are entered into a new Text/Command Document and the program initiated by selecting the relevant text before pressing the *Go* button as described in chapter 6. Rather than have to retype commands such as those above every time an analyst wishes to re-explore a previously conducted analysis, Nlogit allows Text/Command Documents to be saved and re-opened at a later time. To save a Text/Command Document the analyst may either press the *Save to* *disk* pushbutton in the toolbar or select the *File* command followed by either *Save* or *Save As* and specify the location and file name for the Text/Command Document. Text/Command Documents are saved as a .LIM format by Nlogit.

*As an aside*, so that the reader does not have to enter the above commands themselves we have saved the Text/Command Document along with the commands shown in the remainder of the chapter on the accompanying CD-ROM. The relevant .LIM file, titled chapter 7, is located on the CD-ROM in the CaseStudy folder. This may be opened either by selecting the *File* command followed by the *Open* command or by selecting the *Open file* pushbuttonon the Nlogit toolbar and locating the file on your CD-ROM drive. Whilst we have provided this file with the relevant commands, we suggest that the reader attempt to write the commands to a new Text/Command Document themselves as the best method of learning in our experience is ‘by doing’. Nlogit can be unforgiving in terms of mistakes made in the writing of commands to Text/Command Documents with tiny mistakes resulting in frustration as the analyst is forced to examine each line of the command looking for the mistake much like a programmer looking through programming code in order to debug an errant program. Learning the nuances of Nlogit’s ‘programming code’ now rather than later may represent a good investment in the long term.

The reader will find it quicker if the data is saved to the hard drive of their computer not as a .TXT format but rather as a .SAV format using Nlogit. Thus, the reader will be required to read the data into Nlogit using the command syntax above, but can save the data as a .SAV file using the following command structure.

**save;file=c:\<File name>.SAV$**

*As an aside*, the .SAV file format of Nlogit is not the same the .SAV file format of SPSS. The two are incompatible despite sharing the same file extension.

The reader will be required to specify the drive letter (we have assumed C above) and the location of the drive (not **<File name>** as we have shown) to where the file will be saved. The .SAV file format is similar to a spreadsheet file meaning that the names of the variables are saved as the first row of data and do not have to be read into Nlogit separately. As such, the reader will find that using the .SAV file format will save a significant amount of time in placing the data into the Nlogit program.

Once saved as a .SAV file, the analyst may load (not read) the data into Nlogit during future sessions using the command syntax shown below. Note that as with the read command, the file location must be specified, however the names of the variables are no longer required as these are now included as part of the file. The **reset** command is necessary only if an existing data set is open as Nlogit will attempt to add any new data to the end of an open data set. Whilst it is not necessary to use the **reset** command for the first session, both authors have found it is a good habit to use it anyway.

**reset**

**load;file=c:\XXXXXXXXXXXXXXXXXXXXXXX.SAV$**

### Formatting Data in Nlogit

We have already discussed the **reset**, **read** and **create** commands in chapter 6 and it is not necessary to reiterate our earlier statements here. We do however draw the reader’s attention to the different way in which we now use the **create** commands. Previously we used the **create** command to construct new variables within the data set, the values of which were not contingent upon the values of already existing variables. By including the **;if** statement as below, the value taken by the newly created variables are conditional upon the level taken by a second variable. For example, the command

**create**

**;if(wkremply=1)ftime=1**

**;if(wkremply=2)ptime=1**

**;if(wkremply=3)ftime=-1**

**;if(wkremply=3)ptime=-1$**

creates two new variables, *ftime* and *ptime* such that *ftime* takes the value one if the existing variable wkremply equals one, minus one if *wkremply* equals three, and zero otherwise and *ptime* takes the value one if the existing variable wkremply equals two, minus one if *wkremply* equals three, and zero otherwise. So why have we done this?

Examining the levels taken by the variable *wkremply* reveals that one equates to the surveyed decision maker being full-time employed, two to the decision maker being part-time employed and three to the decision maker being self employed (note that the study examined commutes to work and therefore there exists no need to provide a value for unemployed decision makers). Whilst the analyst could employ (no pun intended) the variable as is within a choice model, the model produced would have a single parameter associated with the *wkremply* variable. Given a single parameter the above suggests a change in utility as we move from a full-time to a part-time employed decision maker, being the exact same change observed as we move from a part-time to self-employed decision maker. For classificatory variables this is meaningless. This is the exact problem discussed in chapter 6 that lead us to effects coding (or dummy coding).

A close examination of the create command above suggests that the *wkremply* variable has been recoded as shown in Table 6.14. The astute reader will note that we have used the create command in Nlogit to effects code the variable as described earlier in chapter 6. In this instance the self employed category will be the base level.

Table 7.12: Effects coding for the wkremply variable

|  |  |  |
| --- | --- | --- |
| Variable  Attribute Level | ftime | Ptime |
| Full Time | 1 | 0 |
| Part Time | 0 | 1 |
| Self Employed | -1 | -1 |

Had the analyst wished to dummy code the *wkremply* variable instead, the last two lines of the command would be redundant as it is these two lines which code the base level of the variable as minus one. That is, the analyst could dummy code the same variable using the command:

**create**

**;if(wkremply=1)ftime=1**

**;if(wkremply=2)ptime=1$**

This works because the create command generates the desired value for the new variable if the **if** command is true or zero otherwise. As such, when *wkremply* equals three, both *ftime* and *ptime* will equal zero.

Note that we have also effects coded the variables *wkroccup* and *tollpred* but have not made coding changes to any of the remaining variables. As way of explanation, firstly note that we have already effects coded several of the variables within the data set (examine the minimum and maximum values for each of the variables using the **dstats=\*$** command). Those variables that we have dummy coded are, with the exception of the *choice* variable, not to be used as part of any choice models. We will use these variables to select certain segments of data to be used in our modeling. We therefore will not use them directly in the models we employ. Even so, one needs to be careful in examining data using the **dstats** command in this manner as it is possible to observe variables bounded within a 0-1 range which are continuous and not categorical in nature. Such variables do not need to be effects coded as we will show – this highlights the necessity for the analyst to have more than a thorough understanding of the data set before attempting any analysis.

Variables such as number of vehicles (*numbvehs*) and household size (*hldsize*) are continuous in nature and are thus difficult (but not impossible) to effects code. This is because the largest observed value for such variables can often be not inconsiderable (suggesting a large number of possible levels) and as the analyst is required to create L – 1 new variables (where L is the number of levels) for each variable to be effects coded, the number of variables required to be created becomes substantial. For example if it were observed that the maximum household size was 12, then the analyst would have to create 11 household size variables for effects coding (assuming that households sizes cannot be zero or less). One could however group household sizes but we would not recommend this. At the extreme, variables such as income or age may require far too many new variables to warrant such a coding practice.

But what of the SP design attributes? Whilst the experimental design employed suggests categorical levels, the attribute level labels used for all but one of the design attributes (i.e., *tollpred*) were continuous. For example, the design codes as shown in Table 7.3 are 0, 1 and 2 for each alternative mode of transport but the attribute level labels for the bus alternative for commutes of less than 30 minutes duration, were 10, 15 and 20 minutes. The analyst could easily recode the travel time attribute for each mode so that the attributes are effects coded. Doing so would have the benefit of allowing for the testing of non linear impacts upon utility for each mode between changes in travel time from the low level (i.e., 10 minutes for the bus alternative) and the medium level (i.e., 15 minutes) and between the medium level and the high level (i.e., 20 minutes) or between the low and high level. However, one problem with effects coding (or any other form of categorical coding) is that the analyst may only capture information about the models dependent variable (i.e., utility) at the discrete points at which the data is collected (i.e., at 10, 15 and 20 minutes).

But what level of utility do decision makers derive from 12 minutes of travel time? By retaining the variables as continuous in format, the analyst may investigate the level of utility derived for any value of an attribute between the lower and upper value of which data on that variable was collected. As such, the decision to effects code (or dummy code) a continuous variable represents a trade-off between the ability to test for non-linear effects upon the dependent variable (i.e., utility) and the ability to predict values for the dependent variable beyond, but not outside the range of, the values observed within the data set for that variable. The important point to make here is that, whilst not often done (even by the authors), it is theoretically advisable that the analyst investigate models with both continuous and categorically recoded (preferably effects coded) variables to test for non-linear effects and to allow for predictions for values not observed within the data. For this primer we do not recode continuous formatted variables and as such complete only half the story. We ask that the diligent reader recode these variables (at the very least the SP attributes) themselves and test how this recoding impacts upon the models employed within this book. We would welcome knowing the outcome.

*As an aside*, the **create** command with the **;if** statement can be used to recode new variables contingent upon the values taken by more than one variable. For example, assume that the analyst decides to create a new variable dependent on the values taken by the *wkremply* and *wkroccup* variables. A single **;if** statement is used in which the two variables *wkremply* and *wkroccup* are separated by an ampersand character (**&**). Thus

**create**

**;if(wkremply=1 & wkroccup=1)manft=1$**

will create a new variable titled *manft* such that this new variable equals one if *wkremply* and *wkroccup* both simultaneously equal one or equal zero otherwise. This new variable, *manft*, represents the ‘interaction’ between the two currently existing variables.

#### *Getting to know and Cleaning the data*

Before proceeding to the next chapter we invite the reader to get to know the data set using the techniques mentioned in the section titled Data Cleaning located in chapter 6. We leave it to the reader to generate the descriptive statistics and correlation matrices using the command syntax shown in the above mentioned section. Nevertheless, in that section we detailed the test for multicollinearity using auxiliary regressions and noted at the time that we would provide an example later as to how to undertake this test using Nlogit. We provide such an example now. Before we do so however, we note that for the next chapter we utilize only the data for the commute segment with trips to work of less than 30 minutes. Thus to remain consistent with this chapter, we demonstrate the auxiliary regression test on this segment of data only.

To obtain the desired segment of decision makers, it is necessary to use the **;reject** command in order to ignore the data for decision makers from other segments. Two reject commands are required; the first to reject the RP data (we will be using only the SP data in the next chapter; we use the RP data in later chapters) and the second to reject decision makers with commutes of greater than 30 minutes. From Appendix 7A and 7B, the *SPRP* variable indicates whether the data belongs to the SP or RP component of the GGE study and the variable SPLENGTH is used to indicate the trip length segment to which the decision maker belongs. As such the command syntax will be shown below.

**Sample;all$**

**reject;sprp=1$**

**reject;splength#1$**

**dstats;rhs=\*$**

Once the correct commuter segment is selected, the analyst may undertake the auxiliary regression test for multicollinearity. The first step of this test requires the analyst to regress each variable on the remaining explanatory variables. As the data requirements for choice modeling require each alternative to be in a separate row of data, the analyst will be required to select each alternative one at a time and undertake this test. For the mode case study this will constitute a total of 30 auxiliary regressions for the design attributes alone (see the *chapter 7.LIM* file located on the CD-ROM in the CaseStudy folder).

The analyst will begin by using the **;reject** command to select the first alternative.

**reject;altij#1$**

Once the first alternative is selected, the analyst will need to generate the required number of auxiliary regressions. For the mode choice case study, this will involve seven such regressions, considering the SP design attributes only. In Nlogit the command **regress** is used to perform a regression analysis. Following the command **regress** the analyst specifies the dependent or left hand side variable using the command **;lhs = <variable name>**. The explanatory or right hand side variable(s) are specified by the command **;rhs = <variable name(s**)>. If the analyst uses as a variable name, the name **one** (one is a reserved name in Nlogit – you cannot call a variable one), Nlogit will estimate the constant parameter. Omitting the command **one** in the **;rhs = <variable name(s**)> command syntax will mean that no constant parameter will be estimated. As a concrete example, the auxiliary regression for the time attribute on the remaining SP design attributes (including a constant term) will be accomplished with the following Nlogit command syntax.

**regress**

**;lhs = time**

**;rhs = one, timevar, toll, tollpred, fuel, parking$**

Assuming the trip length up to 30 minutes is selected, the above Nlogit command will generate the following output.

*As an aside*, the following has been estimated using post the August 2003 version of Nlogit. This version of Nlogit makes several cosmetic changes to the output provided. The results provided are consistent with pre-August 2003 versions of Nlogit.

+----------------------------------------------------+

| Ordinary least squares regression |

| Model was estimated Sep 09, 2003 at 08:16:34AM |

| LHS=TIME Mean = 12.33685 |

| Standard deviation = 2.050378 |

| WTS=none Number of observs. = 2369 |

| Model size Parameters = 6 |

| Degrees of freedom = 2363 |

| Residuals Sum of squares = 9929.121 |

| Standard error of e = 2.049857 |

| Fit R-squared = .2618905E-02 |

| Adjusted R-squared = .5084922E-03 |

| Model test F[ 5, 2363] (prob) = 1.24 (.2872) |

| Diagnostic Log likelihood = -5058.859 |

| Restricted(b=0) = -5061.965 |

| Chi-sq [ 5] (prob) = 6.21 (.2861) |

| Info criter. LogAmemiya Prd. Crt. = 1.438069 |

| Akaike Info. Criter. = 1.438069 |

| Autocorrel Durbin-Watson Stat. = 2.6746543 |

| Rho = cor[e,e(-1)] = -.3373272 |

+----------------------------------------------------+

+---------+--------------+----------------+--------+---------+----------+

|Variable | Coefficient | Standard Error |b/St.Er.|P[|Z|>z] | Mean of X|

+---------+--------------+----------------+--------+---------+----------+

Constant 12.3942930 .15610769 79.396 .0000

TIMEVAR -.03017156 .05164164 -.584 .5591 1.00084424

TOLL .04201789 .05540962 .758 .4483 1.06669481

TOLLPRED -.07709942 .05172931 -1.490 .1361 .99746729

FUEL .04226011 .05148902 .821 .4118 1.99493457

PARKING -.00791665 .00515860 -1.535 .1249 10.0379907

The regression output of Nlogit is analogous to the regression output from most other statistical packages. Included in the output are the ANOVA or F test, R2 and adjusted R2, parameter estimates, standard errors, t statistics and probability values along with other useful statistics. For the auxiliary regression test for multicollinearity, it is the R2 value that is of interest to the analyst. For the above regression the reported R2 value is 0.002619.

The next step of the test is to use the R2 value to calculate the Ri statistic. Using equation (6.1) where *k* (i.e., the number of explanatory variables in the model) equals six (including the constant term) and *n* (the sample size) is 2369 (given as the number of observations in the output), Ri equals

 1.55189

Comparing the Rtime statistic of 1.55 for the auxiliary regression of the time attribute on the remaining design attributes for the first alternative to the F critical value with four (6-2) and 2364 (2369 – 6 + 1) degrees of freedom (i.e., 2.38) we note that Rtime does not exceed F critical. This suggests that the time attribute is not collinear or correlated with the remaining attributes. Although there exists some correlation, the correlation is not likely to be of significance.

The remaining auxiliary regressions can be estimated using the following commands (these apply only to alternative one. We will still need to test the remaining alternatives by resetting the sample and rejecting the other alternatives one at a time).

**regress**

**;lhs = timevar**

**;rhs = one, time, toll, tollpred, fuel, parking$**

**regress**

**;lhs = toll**

**;rhs = one, time, timevar, tollpred, fuel, parking$**

**regress**

**;lhs = tollpred**

**;rhs = one, time, timevar, toll, fuel, parking$**

**regress**

**;lhs = fuel**

**;rhs = one, time, timevar, toll, tollpred, parking$**

**regress**

**;lhs = parking**

**;rhs = one, time, timevar, toll, tollpred, fuel$**

We omit the Nlogit output for each auxiliary regression however showing the calculated Ri statistic for each below.

Rtimevar =1.73434; Rtoll = 4.83520; Rtollpred = 5.72317; Rfuel = 0.53416; Rparking = 2.07457

The F critical statistic remains equal to 2.38 for each test as the degrees of freedom for each auxiliary regression does not change. As such it can be seen that multicollinearity is not a problem for the *timevar*, *fuel* and *parking* attributes, but the *toll* and *tollpred* Ri statistics exceed the F critical value for the test, suggesting problems involving multicollinearity. Therefore for both the *toll* and *tollpred* attributes, the attribute is collinear or correlated with the remaining. Design orthogonality has been lost!

The above represents a most important learning point for the reader. Whilst significant time and effort was spent in designing an orthogonal experimental design, any resemblance of orthogonality has been lost through missing data and a poor procedure in allocating choice sets to decision makers. One can always say this in hindsight and to be fair to the original researchers, the procedures used in the choice case study represent, even today, the current standard of practice.

The second point to take away from the above discourse is that once the survey has been conducted, the data entered into the computer and cleaned, and the analyst made ready to conduct the analysis (this involves lots of coffee), any problem detected at this stage cannot be satisfactorily rectified unless there exists sufficient time and budget to return to the field. Assuming that there is neither sufficient time nor budget, and knowing now that there exists multicollinearity in the data, what can the analyst do about it? The answer unfortunately is ‘very little’.

The very little consists of three alternatives.

Firstly, the analyst may simply pretend that the problem does not exist (both authors are economists so can do this!). The second alternative consists of manipulating the data to remove any offending multicollinearity (this will require both advanced knowledge of statistics as well as luck). The third alternative, particularly relevant to experimental designs, is to remove observations till one obtains zero correlations (but what bias’ this may introduce is not known). All three alternatives are not preferable and hence it is in the analyst’s best interests to implement strategies pre-survey to minimize correlations before reaching the analysis phase of the project.

*As an aside*, we have created a number of dummy variables within the data set that will allow the reader to remove certain observations from analysis. One such variable, titled *SPMISS* is a dummy variable that will remove any decision maker with missing SP data (i.e., with fewer than three choice sets). Hence, the command **reject ;spmiss = 1** will remove any such decision maker from any future analysis. Nevertheless, doing so is a necessary but not sufficient strategy for the removal of multicollinearity from the experimental design attributes as multicollinearity arises not solely as a result of missing SP observations, but also as a result of different numbers of decision makers being exposed to different blocks of the design. We leave it to the reader to test this.

We have conducted the multicollinearity test for the first alternative only. We leave it to the reader to complete the remaining tests for the remaining alternatives. Also, the thorough reader will conduct these tests, not just with the SP design attributes, but with socio-demographic characteristics.

### Appendix 7A: The Contextual Statement Associated with the Travel Choice Experiment

We would now like to ask some questions about your trip TO work. We need to speak to the person in the household who completed the Commuter Questionnaire.

IF THERE IS NO COMMUTER IN THE HOUSEHOLD GO TO QUESTION 14

How long does it take you to travel to work, door to door, on a normal day (ie. without any abnormal traffic or public transport delays) READ OPTIONS

Less than 30 minutes ....................1

30 to 45 minutes ..........................2

Over 45 minutes ............................3

SELECT THE RELEVANT SET OF CHOICE CARDS FOR THE RESPONDENT’S TRAVEL TIME

We are going to show you 3 possible choices of transport options in your area. We are not suggesting that these changes will happen in your area, we are just using these options to understand how individuals and households choose to cope with possible changes to transport. We need your help to try to understand how transport facilities can best service your needs under a variety of possible conditions.

We would like you to consider each choice with reference to your current trip TO work.

**TRAVEL CHOICE 1.**

CHOOSE A SET OF THREE CARDS AT RANDOM FROM THE TRAVEL TIME SET WHICH IS RELEVANT FOR THE RESPONDENT. TAKE ONE OF THOSE CARDS.

WHAT IS THE NUMBER OF THE CARD \_\_\_\_\_\_\_\_\_\_\_

This is the first choice. (SHOW THE RESPONDENT THE CARD AND EXPLAIN THE FEATURES OF THE OPTIONS)

If these were the options available for your trip to work, which one would you choose?

Car toll route .......................1

Car no toll route ..................2

Bus ........................................3

Train .....................................4

Light rail (Tram) ..................5

Busway ................................6

(A busway is a dedicated lane for buses

which extends for most of your trip)

Which set of times did you consider when you were thinking about getting to/from the public transport options (regardless of whether you chose public transport)?

From home: To your destination:

Walk ................1 Walk ..............................1

Car/bus .............2 Bus ...............................2

If you were to travel by private vehicle on either a toll or a no toll route (regardless of whether you chose these options), would you

Drive alone ..............................................1

Carpool or share a ride as driver ..............2

Carpool or share a ride as passenger .......3

If these were the set of travel choices that were available for your trip to work, do you find them so unattractive that you would seriously consider

Yes No

Changing your work place 1 ..................2

Changing where you live 1 ................2

IF THE RESPONDENT CHOSE EITHER OF THE CAR OPTIONS CONTINUE WITH THE FOLLOWING QUESTION, IF NOT GO TO CHOICE 2.

Given the choice that you have made to travel by private vehicle on a (TOLL/NO TOLL ROUTE) how would this affect the time that you leave home compared with now. Would you leave

Earlier, if so by how many minutes ............1 \_\_\_\_\_\_\_\_mins

Later, if so by how many minutes ..............2 \_\_\_\_\_\_\_\_mins

At the same time ..........................................3

### Appendix 7B: Mode choice Case Study Data Dictionary

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Variable Name** | **Units** | **Data Set** | **Variable description** | **Mean** | **Std.Dev.** | **Minimum** | **Maximum** | **NumbCases** |
| ID | number | SP,RP | Id | 3678.97 | 1584.12 | 1000 | 6503 | 16186 |
| CITY | 1 to 6 | SP,RP | City | 3.54 | 1.58 | 1 | 6 | 16186 |
| SPRP | 1,2 | SP,RP | 1 = RP 2 =SP | 1.89 | 0.31 | 1 | 2 | 16186 |
| SPEXP | 0,1,2,3 | SP | Experiment number | 1.79 | 0.99 | 0 | 3 | 16186 |
| ALTISPRP | 1 to 12 | SP,RP | Combined SPRP modes 1-12 | 8.37 | 2.65 | 1 | 12 | 16186 |
| ALTIJ | 1 to 6 | SP,RP | SP Mode 1 - 6; RP Mode 1 - 6 | 3.01 | 1.76 | 1 | 6 | 16186 |
| CHSNMODE | 0 to 16 | RP | Mode chosen in RP choice set | 1.00 | 3.18 | 0 | 16 | 16186 |
| ALTMODE | 0 to 16 | RP | Alternative mode present in RP choice set | 0.73 | 2.81 | 0 | 16 | 16186 |
| SPCHOICE | 0 to 6 | SP | Travel options to work | 2.86 | 1.95 | 0 | 6 | 16186 |
| CHOICE | 0,1 | SP,RP | Chosen mode | 0.28 | 0.45 | 0 | 1 | 16186 |
| CSET | 2,4 | SP,RP | Choice set size | 3.79 | 0.62 | 2 | 4 | 16186 |
| RPDA | 0,1 | RP | Mode chosen dummy - drive alone | 0.58 | 0.49 | 0 | 1 | 1730 |
| RPRS | 0,1 | RP | Mode chosen dummy - ride share | 0.16 | 0.36 | 0 | 1 | 1730 |
| RPBUS | 0,1 | RP | Mode chosen dummy - bus | 0.09 | 0.29 | 0 | 1 | 1730 |
| RPTN | 0,1 | RP | Mode chosen dummy - train | 0.11 | 0.31 | 0 | 1 | 1730 |
| RPWALK | 0,1 | RP | Mode chosen dummy - walk | 0.02 | 0.15 | 0 | 1 | 1730 |
| RPBIKE | 0,1 | RP | Mode chosen dummy - bicycle | 0.03 | 0.17 | 0 | 1 | 1730 |
| SPCART | 0,1 | SP | Mode chosen dummy - car with toll | 0.22 | 0.42 | 0 | 1 | 14456 |
| SPCARNT | 0,1 | SP | Mode chosen dummy - car with no toll | 0.23 | 0.42 | 0 | 1 | 14456 |
| SPBUS | 0,1 | SP | Mode chosen dummy - bus | 0.12 | 0.32 | 0 | 1 | 14456 |
| SPTN | 0,1 | SP | Mode chosen dummy - train | 0.12 | 0.33 | 0 | 1 | 14456 |
| SPBW | 0,1 | SP | Mode chosen dummy - busway | 0.16 | 0.36 | 0 | 1 | 14456 |
| SPLR | 0,1 | SP | Mode chosen dummy - light rail | 0.15 | 0.35 | 0 | 1 | 14456 |
| CN | 0 to 4 | SP | Alternatives present within choice set | 2.38 | 1.37 | 0 | 4 | 16186 |
| SPMISS | 0,1 | SP | Decision maker has missing choice sets | 0.01 | 0.09 | 0 | 1 | 16186 |
| RPMISS | 0,1 | RP | Decision maker has missing RP data | 0.26 | 0.44 | 0 | 1 | 16186 |
| SPRPMISS | 0,1 | SP,RP | Analyst created variable | 0.26 | 0.44 | 0 | 2 | 16186 |
| RPSPWKBK | 0,1 | RP | Walk and/or Bike alternative present in RP choice set | 0.15 | 0.36 | 0 | 1 | 16186 |
| RPCAR | 0,1 | RP | Car alternative present in RP choice set | 0.02 | 0.13 | 0 | 1 | 16186 |
| BEFORPTR | 1 to 5 | RP | Point before main point | 0.03 | 0.26 | 0 | 5 | 16186 |
| AFTERPTR | 1 to 5 | RP | Point after main point | 0.02 | 0.28 | 0 | 5 | 16186 |
| MPTRFARE | dollars | RP | Cost main form public transport | 0.12 | 0.67 | 0 | 15 | 16186 |
| OPTRFARE | dollars | RP | Cost other form public transport | 0.06 | 0.57 | 0 | 17.5 | 16186 |
| HOMTOPTR | 1 to 6 | RP | Mode of travel from home to first point | 0.14 | 0.72 | 0 | 6 | 16186 |
| PTRTOWK | 1 to 6 | RP | Last pt to work | 0.15 | 0.76 | 0 | 6 | 16186 |
| HHLDVEH | number | RP | Household vehicle used to point | 0.01 | 0.15 | 0 | 4 | 16186 |
| WKKMVEH | km | RP | Vehicle km to/from point | 0.06 | 1.09 | 0 | 60 | 16186 |
| WALKTIME | minutes | RP | Time walking-last trip to work | 0.46 | 2.88 | 0 | 90 | 16186 |
| MPTRTIME | minutes | RP | Time on main public transport | 1.18 | 6.95 | 0 | 95 | 16186 |
| WAITTIME | minutes | RP | Time waiting for public transport | 0.39 | 2.45 | 0 | 60 | 16186 |
| OPTRTIME | minutes | RP | Time on other public transport | 0.23 | 2.24 | 0 | 80 | 16186 |
| AUTOPASS | number | RP | Number & type passengers in car to work | 0.13 | 0.69 | 0 | 6 | 16186 |
| MAXPASS | number | RP | Maximum number of passengers | 0.08 | 0.39 | 0 | 6 | 16186 |
| HLDAUTO | number | RP | Household vehicle driven to work | 0.07 | 0.35 | 0 | 6 | 16186 |
| AUTONA | -1,1 | RP | Car not applicable | -0.99 | 0.17 | -1 | 1 | 16186 |
| AUTOMAKE | number | RP | Make/model of vehicle driven to work | 193.03 | 973.75 | 0 | 9620 | 16186 |
| **Variable Name** | **Units** | **Data Set** | **Variable description** | **Mean** | **Std.Dev.** | **Minimum** | **Maximum** | **NumbCases** |
| AUTOYEAR | year | RP | Year manufacture of car driven to work | 4.17 | 18.36 | 0 | 94 | 16186 |
| AUTOWKKM | km | RP | Distance travelled by car to work | 0.90 | 5.01 | 0 | 120 | 16186 |
| AUTOTIME | minutes | RP | Time spent travelling by car to work | 1.31 | 6.57 | 0 | 120 | 16186 |
| AUTOWKTM | minutes | RP | Time in car to work | 0.05 | 0.71 | 0 | 51 | 16186 |
| AUTWKWLK | number | RP | Walk-from car to work | -0.89 | 0.46 | -1 | 1 | 16186 |
| AUTWKBUS | number | RP | Bus-from car to work | 0.00 | 0.04 | 0 | 2 | 16186 |
| AUTWKTRN | number | RP | Train-from car to work | 0.00 | 0.00 | 0 | 0 | 16186 |
| AUTWKOTH | number | RP | Other mode-from car to work | 0.00 | 0.08 | 0 | 4 | 16186 |
| VEHPPARK | number | RP | Paid parking on last trip to work | -0.99 | 0.14 | -1 | 1 | 16186 |
| VEHPRKCT | dollars | RP | Cost of parking on last trip to work | 0.01 | 0.29 | 0 | 14 | 16186 |
| VEHPTOLL | number | RP | Paid toll on last trip to work | 0.00 | 0.05 | 0 | 2 | 16186 |
| VEHTOLCT | dollars | RP | Toll costs on last trip to work | 0.00 | 0.07 | 0 | 6 | 16186 |
| VEHPOTHE | number | RP | Paid other on last trip to work | 0.01 | 0.12 | 0 | 3 | 16186 |
| VEHOTHCT | dollars | RP | Other costs on last car trip to work | 0.01 | 0.22 | 0 | 20 | 16186 |
| VEHPNOTH | number | RP | Paid nothing on last car trip to work | 0.19 | 0.85 | 0 | 4 | 16186 |
| DRPPTRAN | number | RP | Drop passengers in car at public transport | 0.00 | 0.03 | 0 | 1 | 16186 |
| DRPCCARE | number | RP | Drop passengers in car at childcare | 0.00 | 0.07 | 0 | 2 | 16186 |
| DRPSCHOL | number | RP | Drop passengers in car at school | 0.01 | 0.17 | 0 | 3 | 16186 |
| DRPTEDUC | number |  | Drop passengers in car at tertiary edu | 0.00 | 0.07 | 0 | 4 | 16186 |
| DROPWORK | number | RP | Drop passengers in car at work | 0.01 | 0.27 | 0 | 5 | 16186 |
| DROPOTHE | number | RP | Drop passengers in car at other places | 0.00 | 0.12 | 0 | 6 | 16186 |
| DROPDWEL | number | RP | Drop passengers in car at dwelling | 0.05 | 0.61 | 0 | 7 | 16186 |
| NODROPOF | number | RP | Don’t drop any passengers in car off | 0.21 | 1.20 | 0 | 7 | 16186 |
| DROPTIME | minutes | RP | Time taken to drop passengers from car | 0.05 | 0.96 | 0 | 73 | 16186 |
| TRIPTIME | minutes | RP | Trip time walk and bike | 0.38 | 4.61 | 0 | 145 | 16186 |
| DEPTIME | 24hrtime | RP | Departure time | 86.76 | 272.79 | 0 | 2400 | 16186 |
| DISDWCBD | km | RP | Distance from dwelling to CBD | 2.03 | 9.68 | 0 | 500 | 16186 |
| VEHSTATU | 0,1,2,3 | RP | Vehicle status | 0.06 | 0.29 | 0 | 3 | 16186 |
| CHAWKTR | 1,2 | SP | Move work closer to home | 1.71 | 0.65 | 0 | 2 | 16186 |
| CHADWTR | 1,2 | SP | Move home closer to work | 1.71 | 0.65 | 0 | 2 | 16186 |
| SPLENGTH | 0,3 | SP | SP experiment segment | 1.33 | 0.83 | 0 | 3 | 16186 |
| TIME | minutes | SP | Travel time to work | 19.00 | 12.66 | 0 | 70 | 16186 |
| TIMEVAR | minutes | SP | Time variability | 0.95 | 1.86 | 0 | 7 | 16186 |
| TOLL | dollars | SP | Toll cost | 0.38 | 1.01 | 0 | 6 | 16186 |
| TOLLPRED | dollars | SP | Times applied to tolls | 0.22 | 0.57 | 0 | 2 | 16186 |
| FUEL | dollars | SP | Fuel cost | 2.00 | 3.03 | 0 | 15 | 16186 |
| PARKING | dollars | SP | Parking cost | 4.47 | 7.38 | 0 | 20 | 16186 |
| FREQ | number | SP | Frequency of service | 6.69 | 9.23 | 0 | 25 | 16186 |
| FARE | dollars | SP | Return fare | 1.56 | 2.11 | 0 | 7 | 16186 |
| START24 | 24hrtime | SP | Normal depart time | 825.06 | 309.60 | 200 | 2400 | 15724 |
| ACCTIME | minutes | SP | Public transport access time | 5.10 | 7.59 | 0 | 25 | 16186 |
| EGGTIME | minutes | SP | Public transport egress time | 5.18 | 7.67 | 0 | 25 | 16186 |
| HWEIGHT | number | SP,RP | Household weight | 1.00 | 0.42 | 0.118 | 3.35 | 16186 |
| NUMBVEHS | number | SP,RP | Number of vehicles in household | 1.75 | 1.03 | 0 | 6 | 16186 |
| HLDINCOM | 1 to 11 | SP,RP | Households income | 6.15 | 2.41 | 1 | 12 | 15338 |
| NHLDBCAR | number | SP,RP | Number household business cars | 0.11 | 0.43 | 0 | 6 | 16186 |
| NCOMPCAR | number | SP,RP | Number company cars | 0.10 | 0.31 | 0 | 2 | 16186 |
| NDRIVLIC | number | SP,RP | Number licences in household | 1.99 | 0.96 | 0 | 7 | 16186 |
| HLDSIZE | number | SP,RP | Household size | 2.87 | 1.36 | 1 | 8 | 16186 |
| **Variable Name** | **Units** | **Data Set** | **Variable description** | **Mean** | **Std.Dev.** | **Minimum** | **Maximum** | **NumbCases** |
| NWORKERS | number | SP,RP | Num workers in household | 1.76 | 0.78 | 1 | 5 | 16186 |
| WKREMPLY | 1,2,3 | SP,RP | Employment type | 1.32 | 0.59 | 0 | 3 | 16186 |
| WKROCCUP | 1 to 9 | SP,RP | Occupation category | 3.91 | 2.38 | 0 | 9 | 16186 |
| PERAGE | years | SP,RP | Person age | 38.65 | 11.17 | 16 | 79 | 15352 |
| DRIVLIC | 1,2,3 | SP,RP | Person drivers licence | 1.07 | 0.27 | 0 | 3 | 16186 |
| PINCOME | dollars,000's | SP,RP | Personal income | 32.62 | 16.91 | 0 | 80 | 16155 |
| PERSEX | 1,2 | RP | Person sex | 0.81 | 1.16 | -1 | 2 | 16186 |
| PEREDUC | 1 to 5 | RP | Person highest education | 3.88 | 0.89 | 2 | 5 | 11828 |
| ACCEGGT | number | SP,RP | Access time plus egress time | 10.28 | 13.75 | 0 | 50 | 16186 |
| CAN | 1,0,-1 | SP,RP | Canberra | -0.05 | 0.51 | -1 | 1 | 16186 |
| SYD | 1,0,-1 | SP,RP | Sydney | 0.04 | 0.60 | -1 | 1 | 16186 |
| MEL | 1,0,-1 | SP,RP | Melbourne | 0.04 | 0.60 | -1 | 1 | 16186 |
| BRIS | 1,0,-1 | SP,RP | Brisbane | 0.04 | 0.60 | -1 | 1 | 16186 |
| ADEL | 1,0,-1 | SP,RP | Adelaide | -0.02 | 0.54 | -1 | 1 | 16186 |

### Appendix 7C: Mode choice Case Study Variable Labels

| **Variable Name** | **Labels** |
| --- | --- |
| ID | Respondent ID |
| CITY | 1 = Canberra  2 = Sydney  3 = Melbourne  4 = Brisbane  5 = Adelaide  6 = Perth |
| SPRP | 1 = RP  2 = SP |
| SPEXP | 0 = RP  1= CHOICE SET 1 (SP)  2= CHOICE SET 2 (SP)  3= CHOICE SET 3 (SP) |
| ALTISPRP | 1 = DRIVE ALONE (RP)  2 = RIDE SHARE (RP)  3 = BUS (RP)  4 = TRAIN (RP)  5 = WALK (RP)  6 = BICYCLE (RP)  7 = CAR (TOLL) (SP)  8 = CAR (NOT TOLL) (SP)  9 =BUS (SP)  10 = TRAIN (SP)  11 = LIGHT RAIL (SP)  12 = BUSWAY (SP) |
| ALTIJ | 1 = DRIVE ALONE (RP)  2 = RIDE SHARE (RP)  3 = BUS (RP)  4 = TRAIN (RP)  5 = WALK (RP)  6 = BICYCLE (RP)  1 = CAR (TOLL) (SP)  2 = CAR (NOT TOLL) (SP)  3 =BUS (SP)  4 = TRAIN (SP)  5 = BUSWAY (SP)  6 = LIGHT RAIL (SP) |
| CHSNMODE | 0 = SP  1 = Train (RP)  2 = Bus (RP)  3 = Tram (RP)  4 = Ferry (RP)  5 = Taxi (RP)  8 = Walk (RP)  9 = Motorbike (RP)  10 = Bicycle (RP)  11 = Drive alone (RP)  12 = Drive & household passenger (RP)  13 = Drive + other passenger (RP)  14 = Drive +household passenger & other passenger (RP)  15 = Passenger household vehicle (RP)  16 = Passenger other vehicle (RP) |
| ALTMODE | 0 = SP  1 = Train (RP)  2 = Bus (RP)  3 = Tram (RP)  4 = Ferry (RP)  5 = Taxi (RP)  8 = Walk (RP)  9 = Motorbike (RP)  10 = Bicycle (RP)  11 = Drive alone (RP)  12 = Drive & household passenger (RP)  13 = Drive + other passenger (RP)  14 = Drive +household passenger & other passenger (RP)  15 = Passenger household vehicle (RP)  16 = Passenger other vehicle (RP) |
| **Variable Name** | **Labels** |
| SPCHOICE | 0 = RP  1 = car with toll (SP)  2 = car without toll (SP)  3 = bus (SP)  4 = train (SP)  5 = busway (SP)  6 = light rail (SP) |
| CHOICE | 0 = not chosen  1 = chosen |
| CSET | 2 = RP  4 = SP |
| RPDA | 1 = DRIVE ALONE CHOSEN (RP)  0 = DRIVE ALONE NOT CHOSEN (RP) |
| RPRS | 1 = RIDE SHARE CHOSEN (RP)  0 = RIDE SHARE NOT CHOSEN (RP) |
| RPBUS | 1 = BUS CHOSEN (RP)  0 = BUS NOT CHOSEN (RP) |
| RPTN | 1 = TRAIN CHOSEN (RP)  0 = TRAIN NOT CHOSEN (RP) |
| RPWALK | 1 = WALK CHOSEN (RP)  0 = WALK NOT CHOSEN (RP) |
| RPBIKE | 1 = BICYLCE CHOSEN (RP)  0 = BICYLCE NOT CHOSEN (RP) |
| SPCART | 1 = CAR WITH TOLL CHOSEN (SP)  0 = CAR WITH TOLL NOT CHOSEN (SP) |
| SPCARNT | 1 = CAR WITH NO TOLL CHOSEN (SP)  0 = CAR WITH NO TOLL NOT CHOSEN (SP) |
| SPBUS | 1 = BUS CHOSEN (SP)  0 = BUS NOT CHOSEN (SP) |
| SPTN | 1 = TRAIN CHOSEN (SP)  0 = TRAIN NOT CHOSEN (SP) |
| SPBW | 1 = BUSWAY CHOSEN (SP)  0 = BUSWAY NOT CHOSEN (SP) |
| SPLR | 1 = LIGHT RAIL CHOSEN (SP)  0 = LIGHT RAIL NOT CHOSEN (SP) |
| CN | 0 = Walk and other alternative included (RP)  1 = Bus – Train (SP)  2 = Bus – Light Rail (SP)  3 = Train –Busway (SP)  4 = Busway – Light Rail (SP) |
| SPMISS | 0 = All choice sets present  1= One or more choice sets missing |
| RPMISS | 0 = Respondents RP data present  1 = Respondents RP data missing |
| SPRPMISS | 0 = Use  1 = Reject |
| RPSPWKBK | 0 = Walk and/or bike alternatives not present in RP choice set  1 = Walk and/or bike alternatives are present in RP choice set |
| RPCAR | 0 = Ride share and/or drive alone alternatives not present in RP choice set  1 = Ride share and/or drive alone alternatives are present in RP choice set |
| BEFORPTR | 1 = TRAIN  2 = BUS  3 = TRAM  4 = FERRY  5 = TAXI |
| AFTERPTR | 1 = TRAIN  2 = BUS  3 = TRAM  4 = FERRY  5 = TAXI |
| MPTRFARE | As specified by respondent |
| OPTRFARE | As specified by respondent |
| **Variable Name** | **Labels** |
| HOMTOPTR | 1 = CAR THEN PARK  2 = CAR THEN DROPPED OFF  3 = MOTORBIKE  4 = WALKED  5 = TAXI  6 = BICYCLE |
| PTRTOWK | 1 = CAR THEN PARK  2 = CAR THEN DROPPED OFF  3 = MOTORBIKE  4 = WALKED  5 = TAXI  6 = BICYCLE |
| HHLDVEH | As specified by respondent |
| WKKMVEH | As specified by respondent |
| WALKTIME | As specified by respondent |
| MPTRTIME | As specified by respondent |
| WAITTIME | As specified by respondent |
| OPTRTIME | As specified by respondent |
| AUTOPASS | As specified by respondent |
| MAXPASS | As specified by respondent |
| HLDAUTO | As specified by respondent |
| AUTONA | As specified by respondent |
| AUTOMAKE | As specified by respondent |
| AUTOYEAR | As specified by respondent |
| AUTOWKKM | As specified by respondent |
| AUTOTIME | As specified by respondent |
| AUTOWKTM | As specified by respondent |
| AUTWKWLK | As specified by respondent |
| AUTWKBUS | As specified by respondent |
| AUTWKTRN | As specified by respondent |
| AUTWKOTH | As specified by respondent |
| VEHPPARK | As specified by respondent |
| VEHPRKCT | As specified by respondent |
| VEHPTOLL | As specified by respondent |
| VEHTOLCT | As specified by respondent |
| VEHPOTHE | As specified by respondent |
| VEHOTHCT | As specified by respondent |
| VEHPNOTH | As specified by respondent |
| DRPPTRAN | As specified by respondent |
| DRPCCARE | As specified by respondent |
| DRPSCHOL | As specified by respondent |
| DRPTEDUC | As specified by respondent |
| DROPWORK | As specified by respondent |
| DROPOTHE | As specified by respondent |
| DROPDWEL | As specified by respondent |
| NODROPOF | As specified by respondent |
| DROPTIME | As specified by respondent |
| TRIPTIME | As specified by respondent |
| DEPTIME | As specified by respondent |
| DISDWCBD | As specified by respondent |
| VEHSTATU | 1 = PRIVATE VEHICLE  2 = HOUSEHOLD BUSINESS VEHICLE  3 = COMPANY VEHICLE |
| CHAWKTR | As specified by respondent |
| CHADWTR | As specified by respondent |
| SPLENGTH | 0 = RP  1 = Less than 30 Minutes  2 = 30 to 45 minutes  3 = over 45 minutes |
| **Variable Name** | **Labels** |
| TIME | As per Table 7.2 |
| TIMVAR | As per Table 7.2 |
| TOLL | As per Table 7.2 |
| TOLLPRED | As per Table 7.2 |
| FUEL | As per Table 7.2 |
| PARKING | As per Table 7.2 |
| FREQ | As per Table 7.2 |
| FARE | As per Table 7.2 |
| START24 | As specified by respondent |
| ACCTIME | As per Table 7.2 |
| EGGTIME | As per Table 7.2 |
| HWEIGHT | Household weight variable |
| NUMBVEHS | As specified by respondent |
| HLDINCOM | 1 = Less than 5000  2 = 5000 - 12000  3 = 12001 - 20000  4 = 20001 - 30000  5 = 30001 - 40000  6 = 40001 - 50000  7 = 50001 - 60000  8 = 60001 - 70000  9 = 70001 - 80000  10 = 80001 - 90000  11 = 90001 - 120000 |
| NHLDBCAR | As specified by respondent |
| NCOMPCAR | As specified by respondent |
| NDRIVLIC | As specified by respondent |
| HLDSIZE | As specified by respondent |
| NWORKERS | As specified by respondent |
| WKREMPLY | 1 = Full Time  2 = Part Time  3 = Self Employed |
| WKROCCUP | 1 = Managers and Admin  2 = Professionals  3 = Para-professional  4 = Tradespersons  5 = Clerks  6 = Sales  7 = Plant operators  8 = Laborers  9 = Other |
| PERAGE | As specified by respondent |
| DRIVLIC | 1 = YES  2 = NO  3 = NOT APPLICABLE |
| PINCOME | As specified by respondent |
| PERSEX | 1 = Male  -1 = Female |
| PEREDUC | 1 = PRE-PRIMARYSCHOOL  2 = PRIMARYSCHOOL  3 = SECONDARYSCHOOL  4 = TECH/COLLEGE  5 = UNIVERSITY |
| ACCEGGT | As specified by respondent |
| CAN | 1 = CANBERRA  -1 = PERTH  0 = OTHER |
| SYD | 1 = SYDNEY  -1 = PERTH  0 = OTHER |
| MEL | 1 = MELBOURNE  -1 = PERTH  0 = OTHER |
| **Variable Name** | **Labels** |
| BRS | 1 = BRISBANE  -1 = PERTH  0 = OTHER |
| ADL | 1 = ADELAIDE  -1 = PERTH  0 = OTHER |