Thames Gateway Bridge Value of Time Study

Modelling report

ARUNA SIVAKUMAR
CHARISMA CHOUDHURY
CHARLENE ROHR

DRR-xxxxxx-YYY (document number)

19 February 2009

Prepared for Transport for London

RAND EUROPE

Preface

The Thames Gateway Bridge (TGB) is a new proposed road bridge connecting Beckton to Thamesmead in East London[1]. This bridge is intended to deliver savings in journey times for those wishing to cross the Thames in this area, but those driving over the bridge would be charged a toll. The Thames Gateway Bridge is also a key component of the regeneration plans for the area. Application for the TGB scheme went to public inquiry from June 2005 to May 2006. Following this inquiry, Transport for London engaged Halcrow to undertake further work to quantify and evaluate the impact of the proposed bridge.

A key input into any transport model is "values of time" (VOTs), which are a quantification of how travellers trade off changes in journey time and cost. For the purposes of previous modelling of the impact of the Thames Gateway Bridge VOT values from WebTAG, the UK Department for Transport's transport analysis guidance document were used. As a result of the public inquiry, further evidence on local values was required. RAND Europe, in collaboration with Accent, were therefore commissioned to collect new local evidence on travellers' willingness to pay for time savings. The timescale for the study was very tight, with commencement of the study in December 2007, and results required for the end of March 2008. This timescale limited the number of model specifications that could be tested and further analysis will be proposed to TfL.

The key objectives of the research were to undertake stated preference interviews with potential users of the TGB, in which they would be presented hypothetical choice situations, trading changes in their travel time against changes in their travel costs, thereby allowing determination of local values of time. These valuations would feed into Transport for London's network assignment model to model drivers' choices of route, in particular to identify those travellers who would use the new tolled facility. The assignment model segments travellers into a number of specific user classes, with differing values of time: drivers who use car to travel to work (commuters), those who use their car in the course of work (work travel), those who use their car for other journeys and for those travelling in light goods vehicles (LGVs).

This report sets out the design of the stated preference surveys and the analysis of the collected data. It is highly technical and will therefore be primarily of interest to modellers within Transport for London and Halcrow who will be working on updating the Thames

[1] At the time of writing this project has been cancelled by Boris Johnson, the current Mayor of London.

Gateway Bridge transport models. It may also be of interest to other transport professionals within Transport for London who are working on associated schemes within the East London area. This report focuses on the design and modelling aspects of the stated preference choices.

RAND Europe is an independent not-for-profit policy research organisation that serves the public interest by improving policymaking and informing public debate. Our clients are European governments, institutions, and companies with a need for rigorous, impartial, multidisciplinary analysis.

For more information about RAND Europe or this document, please contact

Charlene Rohr
Director of Modelling

RAND Europe
Westbrook Centre
Milton Road
Cambridge
CB4 1YG
Tel: 01223 353329
crohr@rand.org

Contents

Preface iii

Contents v

List of Figures vii

List of Tables ix

Executive Summary xiii

Acknowledgments xvii

CHAPTER 1 **Introduction** **1**
1.1 Background 1
1.2 Introduction to stated preference discrete choice experiments 1
1.3 Research Methodology 3

CHAPTER 2 **Stated Preference (SP) Survey Design** **5**
2.1 Recruitment 5
2.2 Survey Methodology 6
2.3 Stated Preference Surveys 7
2.3.1 Experiment 1: Abstract time/cost trading 7
2.3.2 Experiment 2: Testing the Tolled Alternative 12

CHAPTER 3 **Survey Data** **17**
3.1 Survey Quotas: Targets and Surveys Achieved 17
3.2 Background Questions 19

CHAPTER 4 **Modelling Framework** **23**
4.1 Data cleaning and preliminary analysis 23
4.2 Model Structure 23
4.3 Segmentation 24
4.4 Dealing with Correlation between Responses and Distributional Forms 25
4.5 Interpreting the model results 25

CHAPTER 5 **Model Findings: First VOT Experiment 29**
5.1 Preliminary Data Analysis 29
5.1.1 Checking for non-trading behaviour.. 29
5.1.2 Checking for lexicographic behaviour 30
5.2 Choice by cost levels.. 30
5.3 Responses to the diagnostic questions.. 31
5.4 Discrete Choice Analysis 36
5.4.1 Final Sample.. 36
5.4.2 Model Results... 36
5.5 Conclusions 42

CHAPTER 6 **Model Findings: Tolled VOT Experiment 43**
6.1 Preliminary Data Analysis 43
6.2 Choice by cost (toll) levels 44
6.3 Responses to the diagnostic questions.. 45
6.4 Model Results 46
6.5 Conclusions 56

CHAPTER 7 **Summary 59**

REFERENCES.. 63
Reference List 65

APPENDICES 67

Appendix A: Pilot Survey Design 69

Appendix B: Pilot Survey Results and Recommendations 81

Appendix C: The Jack-Knife Procedure 109

List of Figures

Figure 1:	Experiment 1: Cost Difference between A and B plotted against % choosing option A	31
Figure 2:	Experiment 1: Cost Difference between B and A plotted against % choosing option B	31
Figure 3:	Cost sensitivities by cost difference ranges (by purpose)	41
Figure 4:	Choices at given levels of cost changes for new tolled bridge	45

List of Tables

Table 1: Proposed Purpose Quotas ... 6

Table 2: Boundary VOT values examined in UK VOT study (1994 prices) ... 8

Table 3: Time differences examined in UK trunk road experiments ... 9

Table 4: Boundary VOTs tested for TGB (£/hour) – Car, commute and "other" purposes & LGV ... 9

Table 5: Boundary VOTs tested for TGB (£/hour) – Car, employer's business ... 10

Table 6: Maximum Cost Changes for Commute and Other Travel and LGVs ... 10

Table 7: Time differences tested for TGB ... 11

Table 8: Examples of Experiment 2 ... 13

Table 9: Experiment 2: Cost (toll) levels used in main survey ... 14

Table 10: Experiment 2: Travel time levels for different trip durations (in minutes) ... 14

Table 11: Experiment 2: Travel distance levels for different trip lengths (in miles) ... 15

Table 12: Value of Time ranges tested in Experiment 2 – for car drivers ... 15

Table 13: Value of Time ranges tested in Experiment 2 – for LGVs ... 15

Table 14: Survey Quotas ... 17

Table 15: Number of surveys obtained by purpose and survey method ... 18

Table 16: What was the main purpose of your car journey? (Q26) ... 18

Table 17: Number of respondents who made journeys across the Thames ... 19

Table 18: Crossings used for journeys across the Thames ... 19

Table 19: Household Income Distribution ... 21

Table 20: Personal Income Distribution ... 21

Table 21: Model fit statistics ... 26

Table 22: Non-trading behaviour in Experiment 1 29
Table 23: Lexicographic behaviour in Experiment 1 30
Table 24: Interviewer judgement of whether the respondent understood the stated preference questions 34
Table 25: Interviewer judgement of the amount of thought the respondent put into making their choices 34
Table 26: Interviewer judgement of degree of fatigue shown by the respondent 35
Table 27: Experiment 1: Basic model by purpose 36
Table 28: Experiment 1: Log-linear cost models by purpose 37
Table 29: Experiment 1: Stepwise cost difference models by purpose 38
Table 30: Experiment 1: Piecewise linear cost difference model 38
Table 31: Experiment 1: Cost sensitivities computed from the piecewise linear cost models 39
Table 32: Experiment 1: Best model with non-linear cost specification 39
Table 33: Experiment 1: Piecewise linear cost difference models by sub-purposes 40
Table 34: Trading Behaviour, SP Experiment 2 44
Table 35: Lexicographic Behaviour, SP Experiment 2 44
Table 36: Basic Model, SP Experiment 2 46
Table 37: Basic car trip models by sub-purpose, SP Experiment 2 47
Table 38: Basic LGV trip models by sub-purpose, SP Experiment 2 47
Table 39: Personal Income segmentation models for car-trips, by sub-purpose 48
Table 40: Non-linear VOT for car-commuters 49
Table 41: Non-linear VOT for car-commuters (non-linear time) 49
Table 42: Income segmented models, without 5 min time changes 50
Table 43: VOT Ratios for Business Trip, by trip duration and income category 51
Table 44: VOT Ratios for Business Trips, by trip length and income category 52
Table 45: VOT Ratios for other Trips, by trip length and income category 52
Table 46: VOT Ratio for individuals who currently paying tolls (compared to those who do not) 53
Table 47: VOT Ratio by trip cost 53

Table 48: VOT Ratio for Other trips, by age 53
Table 49: VOT Ratio for Other trips, by employment status 54
Table 50: VOT Ratio for Other trips, by employment status 55
Table 51: Jack-knife results for car trip models... 56
Table 52: Jack-knife results for the LGV trip model.. 56
Table 53: Final VOTs by income and purpose from Experiment 2 computed from jack-knifed models (in £/hr)... 57
Table 54: Personal income distributions from the SP Sample...................................... 57

Executive Summary

The Thames Gateway Bridge (TGB) is a new proposed road bridge connecting Beckton to Thamesmead in East London[2]. This bridge is intended to deliver savings in journey times for those wishing to cross the Thames in this area, but those driving over the bridge would be charged a toll. The Thames Gateway Bridge is also a key component of the regeneration plans for the area.

A key input into predicting the number of travellers who would use this bridge are travellers' 'values of time' (VOTs), which are a quantification of how travellers trade off changes in journey time and cost. The key objectives of the research, then, were to undertake stated preference (SP) interviews with potential users of the TGB, in which they would be presented with hypothetical choice situations where they could trade changes in their travel time against changes in their travel costs, thereby allowing us to determine local values of time. These valuations would feed into Transport for London's network assignment model to model drivers' choices of route, in particular to identify those travellers who would use the new tolled facility. The assignment model segments travellers into a number of specific user classes, with differing values of time: persons who use car to travel to work (commuters), those who use their car in the course of work (work travel), those who use their car for other journeys and for those travelling in light goods vehicles (LGVs).

Respondents for the surveys were recruited from previous road-side interviews conducted in the area of interest and by 'cold calling' residents in the boroughs on both sides of the Thames, in the region of interest. The SP surveys were administered in two stages – a pilot survey and a main survey. The stated preference interviews were conducted by telephone. A pilot study was undertaken during 11-15 January 2008 and resulted in a total of 141 interviews. Analysis undertaken with the pilot survey data resulted in recommendations to modify the range of VOTs tested by the surveys. In addition, a coding error was discovered in the pilot survey and corrected for the main stage surveys. The main data collection was undertaken between 8-24 February 2008. A total of 1388 interviews were collected. An interim analysis was performed when the first 288 interviews had been collected to ensure that the coding error was corrected.

All survey respondents participated in two SP experiments:

---

2 At the time of writing this project has been cancelled by Boris Johnson, the current Mayor of London.

Experiment 1: Value of Time Experiment. This experiment involved generic time/cost trading with an experimental design as in the 1994 UK VOT survey, which is the basis for the WebTAG non-work values of time. Each choice scenario presented to the respondents involved the choice between two alternative options in which the journey time and cost varied.

Experiment 2: Tolled Value of Time Experiment. In this experiment, respondents were presented with choices between their 'current option' and a 'hypothetical' tolled bridge crossing for their journey across the Thames. The levels of service for each alternative were described by travel time, distance and cost (toll). In this experiment fuel costs were not presented directly, on the basis that the fuel costs are not readily perceived by drivers and that in many cases the fuel cost differences between the current route and the tolled route option would be minimal. Instead, distance was presented. The only explicit changes in the cost are therefore due to changes in toll.

Respondents were presented with eight choice situations in each experiment.

Preliminary analysis of the main survey data indicated that there was no significant bias in the survey responses. The diagnostic questions suggested that there were a few respondents who either did not understand the surveys or did not pay sufficient attention to the questions. Twenty-nine such respondents were eliminated for the discrete choice modelling effort.

Discrete choice models estimated with the data from the first SP experiment revealed the presence of significant non-linearity in cost sensitivity and the best model specification was achieved by introducing piecewise linear cost parameters across the cost difference range tested in the experiment. The VOTs computed from this model fall within an acceptable range when very low and very high cost changes (20p or less and £5 or more) are dropped. However, as discussed in Chapter 5, a non-linear cost leads to VOTs that are dependent on the cost range, which makes calculating unambiguous average VOTs impossible. Moreover, the loss of the observations with very low and very high cost changes means that the sample size is smaller, which makes segmentation of the data difficult.

It is therefore recommended that the experiment 1 data should only provide the basic range of VOTs to support and guide model development with data from the tolled SP experiment. The second (tolled) SP experiment is also more relevant to the TGB project since it focuses on travellers' willingness to pay for time savings and directly tests sensitivity to toll costs. Discrete choice models estimated with this data were very robust and produced consistent results. Income segmentation proved to be significant in explaining the choices made by the respondents, with those persons from higher income households having lower cost sensitivity and therefore higher willingness to pay for time savings than those from lower income households. The basic values of time computed from the final models, taking account of multiple responses per individual through the use of the 'jack-knife' procedure, are presented with standard errors in the following table.

Values of Time from Experiment 2 (jack-knifed) Models (£/hr)

<table>
<tr><th rowspan="2">Income</th><th colspan="2">Car - Commute</th><th colspan="2">Car - EB</th><th colspan="2">Car - Other</th><th colspan="2">LGV</th></tr>
<tr><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th></tr>
<tr><td><10K</td><td>5.12</td><td>2.29</td><td>8.54</td><td>1.15</td><td>6.80</td><td>0.83</td><td rowspan="5">10.43</td><td rowspan="5">1.91</td></tr>
<tr><td>10K-29K</td><td>6.55</td><td>1.05</td><td>10.75</td><td>1.05</td><td rowspan="3">7.70</td><td rowspan="3">0.92</td></tr>
<tr><td>30K-49K</td><td>8.20</td><td>1.43</td><td>10.76</td><td>1.17</td></tr>
<tr><td>>50K</td><td>9.16</td><td>2.76</td><td>12.61</td><td>1.97</td></tr>
<tr><td>Unknown</td><td>5.57</td><td>1.60</td><td>8.33</td><td>1.12</td><td>6.39</td><td>0.88</td></tr>
</table>

To calculate average values of time from these models information on the distribution of personal income for each travel purpose is required. For the base year, the stated preference survey itself could be used to provide such data (see Table 54 in the main survey report for details).

The effects of several other covariates, including trip duration, trip length, trip cost, reimbursement of travel costs (for journeys made for business) and traveller characteristics such as age, employment status and family composition, were also tested, many of which were significant. The relative VOTs for each of these segments are presented in Chapter 6 in the form of ratios. However for calculating the overall average VOTs in the table above the models with only income segmentation were used.

Acknowledgments

This work was undertaken in collaboration with Accent, who assisted on the survey design and undertook the data collection. We would also like to acknowledge the contributions of the project team at Transport for London and Halcrow, and Professor Andrew Daly who provided RAND Europe's continuous review of the research.

CHAPTER 1 Introduction

1.1 Background

The primary objective of the proposed research is to undertake stated preference interviews with potential users of the Thames Gateway Bridge (TGB) to determine local values of time. These values can feed into an assignment model with the following user classes: car commute, car work, car other and LGV.

Because of expected regeneration effects, it was important to identify systematic variations in values of time as part of the model estimation procedure, particularly with regard to such attributes as income, so that future values could be predicted with different population assumptions. Substantial effort was therefore undertaken to conduct tests to investigate how the value of time varied by differing trip and person characteristics.

The following section presents a brief overview of the stated preference discrete choice approach as a means of measuring individual willingness-to-pay. This is followed by an overview of the research methodology adopted in this project.

1.2 Introduction to stated preference discrete choice experiments

The Discrete Choice Modelling (DCM) framework provides an analytical method for understanding and predicting how individuals make decisions between discrete (mutually exclusive) alternatives; for example, whether to travel by bus or train. It is a technique that has been widely used in transport economics and is increasingly used in environmental and health economics.

Within the DCM framework, it is possible to investigate the importance of specific influences on consumers' choices. These modelling techniques provide empirically-derived data for making informed decisions, providing insight into the trade-offs that consumers are prepared to make. For example, how important travellers feel an improvement in travel time is compared to an increase in the costs of their journey.

The use of Stated Preference (SP) choice-based data enables researchers to examine how customers would choose between different hypothetical choice scenarios, such as the use of a new tolled bridge, as was investigated in this study. SP data has many useful statistical properties as the way the hypothetical choices are presented can be controlled, so that there is little or no correlation between explanatory variables, and small and large variations in explanatory variables can be tested. The technique is also data efficient: more than one choice scenario can be presented to respondents within one interview. One of its main drawbacks, however, is that such data are based around what individuals state they would do in hypothetical situations, which may not exactly correspond with what they would do if faced with the same choice in real life.

Substantial analyses of differences between stated preference and revealed preference data have indicated that, although the scales between the different data types are different, because of differing types of errors in the models developed from the data (Ben-Akiva and Morikawa, 1990; Bradley and Daly, 1992), the ratio of model parameters, such as values of time, have not been found to be significantly different. Partly, this may be because the model parameters typically obtained from revealed preference models have larger standard errors and therefore it is difficult to detect significant differences reliably. The use of SP data has therefore become standard in studies to quantify consumer valuations for non-traded goods, as in the example of value of time.

In a SP discrete choice experiment, hypothetical choice situations - where each alternative is described by a set of attributes (travel time, travel distance, travel cost, etc.) - are presented to each individual. Each of the attributes in the experiment is described by a number of levels. The attribute levels are combined using principles of experimental design to define different scenarios, which respondents evaluate in surveys by choosing one of the alternatives within the choice situation, dependent upon the levels offered and their own personal preferences. Of key interest for this study is the trade-offs that travellers are prepared to make when comparing decreases in journey time with increases in journey cost. This provides a measure of willingness-to-pay, or value of travel time, which provides a quantification of the traveller benefits to feed in to a transport model.

Box 1 describes in more detail the theoretical underpinning and statistical modelling for a discrete choice experiment.

Box 1: Theoretical background to modelling discrete choice data

Discrete choice models are used to gain insight into what drives the decisions that individuals make when faced with a number of alternatives. These models are constructed by specifying the range of alternatives that were available to the decision maker, and describing each of these alternatives with a utility equation which reflects the levels of each of the attributes that were present in the choice that they faced. Each term in the model is multiplied by a coefficient which reflects the size of its impact on the decision making process (Ben-Akiva and Lerman, 1985; Train, 2003).

It is the model coefficients that are estimated in the model calibration procedure. The model is based on the assumption that each respondent chooses the alternative that provides him or her with the highest utility. An error term is included on each utility function to reflect unobservable factors in the individual's utility. The estimation can therefore be conducted within the framework of random utility theory, i.e. accounting for the fact that the analyst has only imperfect insight into the utility functions of the respondents.

The most popular and widely available estimation procedure is logit analysis. The estimation procedure produces estimates of the model coefficients, such that the choices made by the respondents are best represented. The standard statistical criterion of Maximum Likelihood is used to define best fit. The model estimation provides both the values of the coefficients (in utility terms) and information on the statistical significance of the coefficients.

Additional terms and non-linear variations in the variables can be added to these utility functions, with the testing of the appropriate forms for the utility functions being an important part of the model estimation process. By examining different functional forms we can investigate whether different groups of respondents place different values on the attributes in the choices, and can also test whether there are certain groups of respondents that are more likely to systematically choose one alternative over another.

1.3 Research Methodology

As part of the project, we undertook surveys in which all respondents were asked to participate in two stated preference (SP) experiments:

Experiment 1: Value of Time Experiment

This experiment involved generic time/cost trading with an experimental design as in the 1994 UK VOT survey, which is the basis for the WebTAG non-work values of time, and is also standard in other West European countries (Accent Marketing and Research and Hague Consulting Group, 1999; Burge et al, 2004). Each choice scenario presented to the respondents involved the choice between two alternative options in which the journey time and cost varied.

Experiment 2: Tolled Value of Time Experiment

In this experiment, respondents were presented with choices between their 'current option' and a 'hypothetical' tolled bridge crossing for their journey across the Thames. The levels of service for each alternative were described by travel time, distance and cost (toll), and were based around the respondent's observed journey, where relevant. For respondents who did not make a journey across the Thames, a hypothetical journey was postulated. In this experiment driving costs were not presented directly, on the basis that the fuel costs are not readily perceived by drivers and that in many cases the fuel cost differences between the current route and the tolled route option would be minimal. Instead, distance was presented. The only explicit changes in the cost are therefore due to the introduction of and changes in toll.

Respondents were presented with eight choice situations in each experiment.

The SP surveys were administered in two stages – a pilot survey and a main survey. The pilot survey was first undertaken to test the survey methodology, the clarity and flow of the questionnaire, the accuracy of all routings, the stated preference design and understanding of the stated preference exercises, and the interview duration. The design of the pilot survey is documented in detail in Appendix A.

Based on the results of the pilot survey, the survey design was modified marginally for the main survey. Specifically, respondents found that some of the cost ranges tested in the SP experiments were unrealistically high. Accordingly, we reduced the value of time (VOT) levels tested in the main survey. Additionally, because of the observed cost sensitivity of LGV drivers in the pilot sample, we used the commute/other values for LGV drivers in the main survey. The findings from the analysis of the pilot survey including the recommended changes in survey design for the main survey are described in detail in Appendix B.

Further, because of a problem in the coding of the first experiment for the pilot survey, we recommended an interim analysis of the SP data results after the first weekend of data collection from the main survey. The results of the interim analysis were reasonable and indicated that the surveys were being administered appropriately. We have not presented the interim results separately in this report. The analysis of the main survey includes the survey records from the interim analysis, but not from the pilot.

The rest of this report is organised as follows. Chapter 2 presents the design used in the main SP survey. Chapter 3 describes the survey data and Chapter 4 describes the modelling framework. Chapters 5 and 6 present the findings from the two SP experiments – the VOT experiment and the Tolled VOT experiment. Chapter 7 summarises our findings.

CHAPTER 2 Stated Preference (SP) Survey Design

This chapter sets out the SP survey methodology and design, beginning with the recruitment strategy and followed by the overall survey methodology. The survey was designed by RAND Europe and administered by Accent.

2.1 Recruitment

For the main survey, respondents were recruited through three methods:

RSI surveys – recruitment from road-side interview (RSI) surveys that TfL commissioned near the Blackwall Tunnel. Respondents intercepted by the RSIs had been asked if they would be prepared to take part in a short telephone survey about travel plans in the local area. If they agreed then their names and telephone number were taken. Mention of an incentive was also made. At some locations the RSI surveys were supplemented by postal self completion cards. Overall, the sample comprised 2,299 names and phone numbers.

Greenwich surveys – recruitment from respondents to the 2006 Greenwich congestion charging feasibility surveys undertaken by Accent for TfL. There were 223 respondents who had agreed to take part in further research for TfL.

Cold calling – recruitment of respondents from both sides of the Thames in the London Boroughs of Barking & Dagenham, Bexley, Bromley, Greenwich, Newham and Tower Hamlets as well as Kent. Following analysis of OD postcodes from the pilot it was agreed to increase the proportion of the sample from areas further from Central London such as Bromley, South Bexley and Kent so that there would be more long distance travellers in the sample. It is noted that respondents from further away from central London did not necessarily make longer trips as the sampling framework included those who did not cross the river.

All three samples were also used to sample LGVs (under 3.5 tonnes).

All respondents were asked whether they had made a car or van journey of over 20 minutes in length across the Thames in the last 6 months, for a specific journey purpose. Respondents who made car journeys (as a driver) for a number of purposes were asked to consider one specific journey based on the quota targets that had been achieved by that point. Respondents who hadn’t made such a journey were asked whether they had made any journeys as a driver 20 minutes in length (that did not cross the Thames) in this same period. If they did, this journey became the basis for the survey questions.

A £5 incentive was offered to maximise the size of the sample.

Car Driver Sample

The target sample was 1,200 interviews with car drivers, as shown in Table 1 below.

Table 1: Proposed Purpose Quotas

Segment	Total
Commute	400
Employer's business	400
Other	400
Total Car	**1200**

Given the clear relationship between income and VOT[3], it was important that the sample incorporated a range of incomes. Examination of the pilot survey data indicated that we were obtaining a data sample with a sufficient range of incomes and therefore no income segmentation was adopted for the main surveys.

LGV Surveys

We proposed to undertake 100-150 SP interviews with LGV drivers directly to provide direct estimates of LGV values of time. This assumes that that LGV drivers are able to take decisions about route choice and paying tolls and apply a reasonable valuation to their time.

2.2 Survey Methodology

We proposed to undertake the surveys using a computer aided telephone interview (CATI) approach. There are a number of benefits of using telephone survey methods, including:

- telephone research combines some of the price advantage of postal research with the personal contact of face-to-face interviewing;
- geographically dispersed interviews can be conducted rather than having to cluster interviews as with face-to-face interviewing;
- telephone interviewing can include open-ended questions and allows for probing and exploration of issues.

Given the simplicity of the SP choice exercises (both are binary choices, with few variables and are based around a journey the respondent has made), it was judged that it would be feasible to undertake the interviews without pre-posting the SP choices. The main benefit of this approach was a higher response rate to undertaking the surveys, which was particularly important given the limited RSI sample. Additionally, the data collection exercise could be undertaken in a (slightly) shorter time, which was important given the very tight timescales for the research.

Comprehension of the choice exercises was explicitly checked as part of the pilot and main analysis.

[3] WebTAG (section 3.12.2 paragraph 11.4.4) gives cross-sectional elasticities between 0.15 and 0.36.

2.3 Stated Preference Surveys

The questionnaire included general background questions about the respondent's journey characteristics, e.g. purpose of trip, time/day of trip, journey origin and destination, vehicle occupancy, journey time, who paid for petrol/parking, cost of petrol/parking, etc..

All respondents were then recruited to participate in two SP experiments:

- Generic time/cost trading (as in the 1994 UK VOT survey, which is the basis for the WebTAG non-work values of time); this was not presented in the context of route choice;
- Tolled Experiment based around a hypothetical bridge across the Thames, involving a route choice between using the bridge and the current route.

The survey was not specific about the TGB, rather it focused on existing trips crossing the river and a hypothetical new bridge for the stated preference tolled crossing experiment. This meant that details and a map of the TGB were not required and also meant that local sensitivities to the TGB were less likely to have caused any problems for the conduct of the surveys.

Finally socio-economic information was collected for the driver and their household situation, including age, gender, employment status, occupation, household composition, car ownership, personal and household income.

Interviews were conducted with respondents regarding commute, other purpose, employer's business and LGV trips.

It is important to emphasise that the business surveys collected the employee's value of business time, which may be different from employer's valuations and that these will not (necessarily) be consistent with the working value in WebTAG. Specifically, because the WebTAG recommended values of time for working time are based on opportunity cost of the travel time to the employer and thus reflect the wage rate, including labour-related overheads[4] they have not been derived from SP experiments. The 1994 UK VOT study did obtain behavioural values for business travellers, based on SP experiments with employees, but these were not incorporated in WebTAG on the basis that the objective of the WebTAG valuations are largely for appraisal. We believe that behavioural valuations are appropriate for the present work and therefore recommended undertaking SP experiments with business travellers.

2.3.1 Experiment 1: Abstract time/cost trading

The first SP experiment essentially followed the structure of the UK/Dutch/Danish time-cost experiments, which have been successfully used in national VOT studies and have been found to reliably collect basic value of time information (see Bradley and Gunn, 1990; Accent Marketing and Research and Hague Consulting Group, 1999; Mackie et al, 2003; Fosgerau et al, 2007 for further details). These experiments were used to collect the data yielding the values that are currently presented in WebTAG, so there were significant benefits to be gained from repeating them in this study. These experiments presented the respondents with a choice of two alternative journeys in which the journey time and cost varied.

The structure of this experiment has a number of useful features:

[4] See www.webtag.org.uk

- the time and cost levels are tailored around the respondents' existing journey in order to provide a degree of realism;
- the design examines both time and cost gains and losses;
- over a series of eight choices, the number of gains and number of losses, for both time and cost, are balanced;
- there are no dominant choices.

There were, however, a number of restrictions placed on the implementation of the design in the UK and the Netherlands as a result of using a paper-based survey approach. These restrictions were reviewed for TGB, in light of the use of the computerised survey approach.

In the UK study all time and cost changes were presented as increments around the existing situation, e.g. 'Travel time 10 MIN LONGER than now', 'Travel cost 150 p LOWER than now'. The existing situation was described as 'THE SAME as now'. One issue encountered in the analysis was the preference for the 'same as now' alternative, a problem labelled as 'inertia'. We believe that inertia could be partly an artefact of the wording in the 'same as now' choices. For TGB, we presented all time and cost levels as absolute values in the choice alternatives, e.g. Journey takes 50 minutes, Journey costs £3.00. This removed the need for any specific reference to 'now' in the choices, although one of the time or cost levels may in fact reflect the observed travelling conditions.

The UK design was also restricted in the number of values of time that could be realistically examined within the first experiment. All respondents evaluated eight different values of time and four different time changes (see Table 2 and Table 3 below). Different time differences were examined for journeys of different duration. Because we were using a computerised survey approach in TGB, we examined a wider range of VOTs and time changes, as these could be randomly varied across the sample.

Table 2: Boundary VOT values examined in UK VOT study (1994 prices)

Level	VOT (£/hr)	VOT (p/min)
1	0.60 £/hr	1 p/min
2	1.20 £/hr	2 p/min
3	2.10 £/hr	3.5 p/min
4	3.00 £/hr	5 p/min
5	4.20 £/hr	7 p/min
6	6 .00£/hr	10 p/min
7	9.00 £/hr	15 p/min
8	15.00 £/hr	25 p/min

Table 3: Time differences examined in UK trunk road experiments

Level	Existing journey duration			
	5-25 min	26-50 min	51-75 min	> 75 min
1	+ 10 min	+ 10 min	+ 15 min	+ 20 min
2	+ 5 min	+ 5 min	+ 10 min	+ 10 min
3	-3 min	-5 min	-10 min	-10 min
4	-5 min	-10 min	-15 min	-20 min

For TGB, the eight VOTs tested in the experiment were chosen randomly from a number of specified ranges (as shown in Table 4 and Table 5 below), in order to test both low and high values, but with the concentration of values in the region of the expected values. The testing of extreme values helps to ensure that range examined covers the VOTs for the entire sample, a criticism of the design in the Danish study. Each respondent was presented one boundary VOT from each of the ranges; one set of ranges was used for car commute/other and LGV, and another set (twice those values) was used for car employer's business.

Table 4: Boundary VOTs tested for TGB (£/hour) – Car, commute and "other" purposes & LGV

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
1.00	2.50	3.75	4.75	6.00	8.00	12.00	18.00
1.25	2.75	4.00	5.00	6.50	9.00	13.00	20.00
1.50	3.00	4.25	5.25	7.00	10.00	14.00	22.00
1.75	3.25	4.50	5.50	7.50	11.00	15.00	24.00
2.00	3.50						26.00
2.25							28.00
							30.00

Table 5: Boundary VOTs tested for TGB (£/hour) – Car, employer's business

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
2.00	5.00	7.50	9.50	12.00	16.00	24.00	36.00
2.50	5.50	8.00	10.00	13.00	18.00	26.00	40.00
3.00	6.00	8.50	10.50	14.00	20.00	28.00	44.00
3.50	6.50	9.00	11.00	15.00	22.00	30.00	48.00
4.00	7.00						52.00
4.50							56.00
							60.00

The following table reports the maximum cost changes that could be tested within each range for commute and other travel and for LGVs, for different time changes. The maximum values for business travellers were twice those reported in Table 6. In terms of implementation, all values could be tested as cost increases. In order to prevent negative cost values being tested, a minimum cost level of 50p was specified when investigating cost decreases.

Table 6: Maximum Cost Changes for Commute and Other Travel and LGVs

		Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
VOT		£2.25	£3.50	£4.50	£5.50	£7.50	£11.00	£15.00	£30.00
Time Change	10 mins	£0.38	£0.58	£0.75	£0.92	£1.25	£1.83	£2.50	£5.00
	20 mins	£0.75	£1.17	£1.50	£1.83	£2.50	£3.67	£5.00	£10.00
	30 mins	£1.13	£1.75	£2.25	£2.75	£3.75	£5.50	£7.50	£15.00

We also proposed that the size of the time change be specified so that it was realistic for the observed journey duration (see Table 7), but with considerable overlap so that we did not only evaluate small time savings for short journeys and larger time savings for longer journeys. Two time difference increments were tested for each respondent and these values were used to define both time gains and losses. The pair of values to be used from within the journey duration band was specified randomly across respondents, so that we considered realistic changes for respondents making short journeys and both small and large changes for respondents making longer journeys.

Table 7: Time differences tested for TGB

Existing journey duration			
20–30 min	31-45 min	46–60 min	61+
5 min	5 min	5 min	5 min
10 min	10 min	10 min	10 min
	15 min	15 min	20 min
		20 min	30 min

Each respondent was presented with eight choice pairs for this experiment; this allowed two choices to be examined in each quadrant of the time/cost plane, i.e. loss/loss, gain/gain, gain/loss, loss/gain.

For a given choice situation, the information on the relevant boundary value of time and time difference was used to calculate a corresponding cost difference to present to the respondent. In some cases for high boundary VOTs with large time differences we get large changes to the cost level, which may in some cases be added to the existing journey cost and in others subtracted. In the latter case it would have been possible for the cost reduction desired to exceed the existing journey cost, which would have resulted in a negative journey cost being presented. In these cases we set the cost to a minimum value of £0.50.

We considered the option of including a check question in the SP choice pairs. This would have taken the form of an additional dominant choice pair added into the experiment to provide a check on the responses provided. Such questions were included in the Dutch and Danish VOT studies, the Dutch study was undertaken as a self-completion postal survey and the Danish survey was undertaken over the Internet. It is our judgement that this was not as necessary for the TGB study as we were using telephone interviewers to guide the respondent through the survey and we could include some diagnostic questions for the interviewer to check with the respondent in a more direct way whether they understood the choices that they were being asked to make.

As the survey was undertaken by telephone, without show material, we developed a script for the interviewer to explain the choices to the respondent, where the times (X) and costs (Y) were produced from the computerised implementation of the experiment design.

Box 2: Introduction and text for the First SP Experiment

We would now like you to consider a series of situations where you have a choice between two different routes for the car journey that we have been discussing. Please imagine that you are making the same journey again, under the same circumstances, except the travel time for the journey could be different because of more or less congestion and your travel costs could also change. Please listen carefully and in each case please tell us which of these two options you would prefer.

If you aren't sure, please ask the interviewer to repeat the question.

Choices 1 through 8:

Which would you prefer: a journey which took X1 minutes and cost Y1 pounds, or one where the journey took X2 minutes and cost Y2 pounds?

Answers:

1 – First option

2 – Second option

2.3.2 Experiment 2: Testing the Tolled Alternative

In the second experiment, respondents who had made a relevant journey across the Thames in the 6 months previous to the survey were presented with choices between their 'current route' and a 'hypothetical' tolled bridge crossing for their journey across the Thames. Respondents who had not made a relevant journey across the Thames in the 6 months previous to the survey were asked to imagine that they were making the same journey as discussed in Experiment 1, but that journey now involved them travelling to a destination on the other side of the Thames. In the second experiment, these respondents were presented with choices between this imagined 'current route' and a 'hypothetical' tolled bridge across the Thames. In both variants of the experiment, the levels of service for each alternative were described by travel time, distance and cost (toll). In this experiment fuel costs were not presented directly, on the basis that the fuel costs are not readily perceived by drivers and that in many cases the fuel cost differences between the current route and the tolled route option would be minimal. Instead, distance was presented. The only changes in the cost were therefore due to changes in toll.

Each respondent was presented with eight choice scenarios. In the first four choice scenarios, the attribute levels of the current route were kept exactly the same as the current trip of the respondent (same travel time, distance and cost) as shown in Table 8a. If the current route incorporated a toll, a toll was included in the cost. The new tolled alternatives always had an improved level of service (in terms of travel time savings and/or distance reductions) but incorporated a (higher) toll. In the fifth to eighth scenarios, the travel times of the current route were slightly varied reflecting the changes in travel time due to congestion effects (Table 8b). The distance and toll values were kept unchanged for all eight cases representing the current route.

Table 8: Examples of Experiment 2

(Current route =40 minutes, distance travelled= 10 miles)

a. Example (Choice scenario 1-4)

Which alternative would you choose?

	Current Route	New Tolled Alternative
Travel Time	40 minutes	30 minutes
Distance Travelled	10 miles	8 miles
Travel Cost	No toll	£2 toll
Choice (mark "X" in preferred option)	☐	☐

b. Example (Choice scenario 5-8)

Which alternative would you choose?

	Current Route	New Tolled Alternative
Travel Time	45 minutes	32 minutes
Distance Travelled	10 miles	12 miles
Travel Cost	No toll	£1 toll
Choice (mark "X" in preferred option)	☐	☐

The structure of this experiment has a number of useful features:

- the time and cost levels of the new tolled alternative were tailored around the respondent's existing journey in order to provide realism;
- the new tolled alternative always had better level of service compared to the current route and was associated with an increase in cost (higher toll);
- the design examined the influence of possible changes in distance;
- there were no dominant choices.

Cost levels

As sensitivity to cost changes was of vital importance for the study, we used a design that allowed us to examine ten different toll levels for each type of vehicle (passenger car and LGV). The toll levels used in the main survey are presented in Table 9.

Table 9: Experiment 2: Cost (toll) levels used in main survey

Level	Toll Levels (all vehicles)
0	0
1	£0.50
2	£1.00
3	£2.00
4	£3.00
5	£4.00
6	£5.00
7	£6.00
8	£8.00
9	£10.00

Changes in attribute levels

The changes in travel time and duration depended on the current trip duration and length. For example, for very short trips (20-30 mins, 2-4 miles) the maximum variation in duration and trip length were constrained to 10 mins and 2 miles respectively whereas for very long trips (>45 mins and 11 miles) maximum variations up to 30 mins and 8 miles were allowed. The complete set of ranges of travel time and distances are presented in Table 10 and Table 11 respectively.

Table 10: Experiment 2: Travel time levels for different trip durations (in minutes)

Levels	Short Duration Trips Travel time: 20-30 mins		Medium Duration Trips Travel time: 30 – 45 mins		Long Duration Trips Travel time > 45 mins	
	Current Route	New Tolled Alternative	Current Route	New Tolled Alternative	Current Route	New Tolled Alternative
0	0		0		0	
1	-5	-5	-5	-5	-5	-5
2	5	-8	5	-8	5	-8
3		-10	10	-10	10	-10
4				-15		-15
5				-20		-20
6						-25
7						-30

Table 11: Experiment 2: Travel distance levels for different trip lengths (in miles)

Current Trip Length	2-4 miles	5 to 8 miles	8 to 11 miles	> 11 miles
Short durations	-1,0,+1	-2,0,+2	-2,0,+2	-2,0,+2
Medium durations	-1,-1,0,+1	-2,-1,0,+2	-5,-2,0,+2	-5,-2,0,+2
Long durations	-1,-1,-1,0,+1	-2,-2,-1,0,+2	-5,-2,-1,0,+2	-8,-5,-2,0,+2

Boundary VOT values

The boundary values of VOT tested in Experiment 2 for each duration band for passenger cars and LGVs are presented in Table 12 and Table 13, respectively.

Table 12: Value of Time ranges tested in Experiment 2 – for car drivers

	Max time saving	Min Time Saving	Max Cost	Min Cost	VoT_upper	VoT_lower
Short Duration	15 min	5 min	£8	£0.50	96 £/hr	2 £/hr
Medium Duration	30 min	5 min	£8	£0.50	96 £/hr	1 £/hr
Long Duration	40 min	5 min	£8	£0.50	96 £/hr	0.75 £/hr

Table 13: Value of Time ranges tested in Experiment 2 – for LGVs

	Max time saving	Min Time Saving	Max Cost	Min Cost	VoT_upper	VoT_lower
Short Duration	15 min	5 min	£8	£0.50	120 £/hr	2 £/hr
Medium Duration	30 min	5 min	£8	£0.50	120 £/hr	1 £/hr
Long Duration	40 min	5 min	£8	£0.50	120 £/hr	0.75 £/hr

We used the following introduction and text script for the second experiment.

Box 3: Introduction and text for the Second SP Experiment

We would now like you to imagine that there is another bridge crossing across the Thames that you could use for the journey that we have been discussing. This crossing would have a toll, which would be collected electronically so you would not have to stop to make your payment. The use of this new bridge would mean that your journey would take you less time, although your journey may be slightly longer (but in this case you would be travelling at a higher speed). Please imagine that you were making the same trip that we have been discussing.

Please listen carefully to each of the choices that will be presented to you and in each case tell us which of these two options you would have used.

If you aren't sure, please ask the interviewer to repeat the question.

Choices 1 through 4:

Your current route is unchanged, that is your journey is #X2# miles and takes #X1# minutes (if there is a toll add 'and you pay a #X3#toll'). Using the new bridge your journey would be #Y2-X2# miles #shorter#/#longer# and would take #X1-Y1# minutes less, but you would have to pay a toll of £#Y3#. Which route would you choose for your journey?

Choices 5 through 8:

Your current route now takes #JTIME-X1# #longer#/#shorter# than your current journey, so your total journey time would be #X1#. The distance is still the same (#X2# miles) (if there is a toll add 'The toll is still £#X3#l). The new bridge means that your journey would be #Y2-X2# miles #shorter#/#longer# and would take #X1-Y1# minutes less, but you would have to pay a toll of £#Y3#. Which route would you choose for the journey?

Answers:

1 – Current route

2 – Tolled bridge

CHAPTER 3 **Survey Data**

This chapter describes briefly the data collected from the main survey. The detailed market research findings are presented in a separate report by Accent.

3.1 Survey Quotas: Targets and Surveys Achieved

The target number of interviews was 1,200 car driver interviews and 150 interviews with LGV drivers. In practice fewer car commuters[5] and car drivers on employer's business and more car other purposes and LGVs were recruited than planned. In total 1,388 respondents participated in the SP experiments, of which 12.5% were making LGV trips, 27% were car drivers on employers' business and 60.5% were car commuters or car drivers making other trips.

Table 14: Survey Quotas

Segment	Target	Achieved
Car – commuting	400	380
Car – employers business	400	361
Car – other	400	429
LGV	150	168
Total	1,350	1,338

Table 15 summarises the number of surveys obtained for each purpose, by survey method.

[5] During fieldwork it appeared that 400 car commuters had been recruited based on quota questions at the beginning of the questionnaire. However, further analysis of detailed journey purpose questions later in the questionnaire led to reclassifying some 'commuters' into the 'other purpose' category

Table 15: Number of surveys obtained by purpose and survey method

		Purpose.			Total
		Car - Commute/ other	Car - Employers business	LGV	
Sample.	RSI	437	134	106	677
	Greenwich Surveys	59	29	4	92
	Cold calling	313	198	58	569
Total		809	361	168	1338

We note, however, that some of the observations with a commute/other purpose code actually reported their journey purpose as travelling for employer's business, when asked about their detailed journey purpose later in the survey (see responses to question on detailed purpose of journey in Table 16 below). These surveys have been recoded as employer's business surveys in the main analysis.

Table 16: What was the main purpose of your car journey? (Q26)

		Purpose.			Total
		Car - Commute/ other	Car - Employers business	LGV	
Q26. What was the main purpose of your car journey?	Not applicable	0	361	168	529
	Commuting to/from a fixed work place	295	0	0	295
	Travelling in the course of business	35	0	0	35
	Any other work visit	12	0	0	12
	Personal business (i.e. visit to doctor, lawyer)	33	0	0	33
	Shopping	103	0	0	103
	Holiday	17	0	0	17
	Visiting friends/relatives	208	0	0	208
	Sport/entertainment	14	0	0	14
	Other leisure	38	0	0	38
	Education	13	0	0	13
	Carry passengers	20	0	0	20
	Other	21	0	0	21
Total		809	361	168	1338

We believe that the limited quota failures should not affect our findings in this report.

3.2 Background Questions

Over 60% of the respondents surveys had made a 20 minute or longer journey for commute, employer's business or other purposes across the Thames in the last 6 months (see Table 17). This journey formed the basis of the first and second experiments. Respondents who did not make a journey of 20 minutes or longer across the Thames in the last six months were asked about another recent journey of 20 minutes or longer, which formed the basis for the first experiment. These respondents were asked to imagine the same trip, crossing the Thames, for the second experiment.

Table 17: Number of respondents who made journeys across the Thames

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Crossed	889	66.4	66.4	66.4
	Did not cross	449	33.6	33.6	100.0
	Total	1338	100.0	100.0	

For those respondents who made journeys across the Thames, the following crossings were used.

Table 18: Crossings used for journeys across the Thames

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not applicable	449	33.6	33.6	33.6
	Blackwall Tunnel	452	33.8	33.8	67.3
	Dartford Tunnel	192	14.3	14.3	81.7
	Queen Elizabeth Bridge	37	2.8	2.8	84.5
	Woolwich Ferry	34	2.5	2.5	87.0
	Other	174	13.0	13.0	100.0
	Total	1338	100.0	100.0	

Other crossings included:

- Albert Bridge
- Battersea Bridge
- Blackfriars Bridge
- Chelsea Bridge
- Vauxhall Bridge
- Tower Bridge
- Wandsworth Bridge
- Waterloo Bridge

- Westminster Bridge

Nearly a quarter of respondents were making journeys between 20 and 30 minutes and about a fifth of respondents were making journeys over 90 minutes. The mean journey time was 72 mins (s.d. = 60 mins). The maximum reported journey time was 12 hours.

In order to participate in the SP choices, journey costs are required. Past experience has indicated that car drivers are particularly poor at estimating journey costs, and therefore we presented an approximate cost and asked whether they agreed with this estimate. Approximate costs were derived using the following cost assumptions:

Car, non-work travellers:	15p/mile
Car, travellers for employer's business:	30p/mile
LGVs:	30p/mile

These costs are based on WebTAG calculations (assuming an average speed of travel of 25.3 kph[6]) and information published by the AA and FTA.

The calculated costs were checked with respondents. In general, respondents had fairly good agreement with the estimated costs (76.5% of respondents agreed with the costs presented). Where the respondents did not agree with the costs presented to them we revised the figures until they were acceptable to the respondent. These revised figures were higher, on average, for commuters and LGV drivers (around £2.50) and half as much, on average, for respondents making business trips (around £5.50).

Another important background question is about the respondent's annual income (for car journeys only, LGV drivers are not asked about income). In the survey, we inquired about both personal and household income (note we do not ask respondents from single-adult households the household income question). We observed a 17.5% refusal rate for household income and a 13.0% refusal rate for personal income. The income distributions are presented Table 19 and Table 20 below.

6 Average network speed provided by Halcrow in an e-mail (14.12.2007)

Table 19: Household Income Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not applicable	168	12.6	12.6	12.6
	Less than £9,999	43	3.2	3.2	15.8
	£10,000 - £19,999	109	8.1	8.1	23.9
	£20,000 - £29,999	155	11.6	11.6	35.5
	£30,000 - £39,999	170	12.7	12.7	48.2
	£40,000 - £49,999	121	9.0	9.0	57.2
	£50,000 - £59,999	120	9.0	9.0	66.2
	£60,000 - £74,999	88	6.6	6.6	72.8
	£75,000- £99,999	67	5.0	5.0	77.8
	£100,000 or more	63	4.7	4.7	82.5
	Refused	169	12.6	12.6	95.1
	Don't know	65	4.9	4.9	100.0
	Total	1338	100.0	100.0	

Table 20: Personal Income Distribution

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Not applicable	346	25.9	25.9	25.9
	Less than £9,999	125	9.3	9.3	35.2
	£10,000 - £19,999	177	13.2	13.2	48.4
	£20,000 - £29,999	205	15.3	15.3	63.8
	£30,000 - £39,999	150	11.2	11.2	75.0
	£40,000 - £49,999	71	5.3	5.3	80.3
	£50,000 - £59,999	42	3.1	3.1	83.4
	£60,000 - £74,999	21	1.6	1.6	85.0
	£75,000- £99,999	15	1.1	1.1	86.1
	£100,000 or more	13	1.0	1.0	87.1
	Refused	144	10.8	10.8	97.8
	Don't know	29	2.2	2.2	100.0
	Total	1338	100.0	100.0	

It would seem that we have a sample of individuals in the main survey with higher incomes than is observed across London, on average. Data from the Data management and Analysis Group (DMAG) indicates the following distribution of incomes, on average, within London[7]:

[7] See: http://www.londoncouncils.gov.uk/doc.asp?doc=19944

- 22% of households with income under £15k p.a. (not comparable);
- 53% of households with income under £30k p.a. (compared with 23% of our sample);
- 85% of households with income under £60k p.a. (compared with 54% of our sample).

It is emphasised, however, that we would expect our sample to be biased, because of the inclusion of car owning people who have recently made car journeys only, who are likely to have higher incomes. We do not have information on the expected income distribution of car owning households or people travelling from car owning households in London. Also, what is important for the SP exercise is that we have adequate numbers of observations across all income categories, so that we can test for income effects.

CHAPTER 4 Modelling Framework

The survey data described in the previous chapter was analysed using a discrete choice modelling framework. The model estimation procedure consisted of three broad tasks. The first step involved data cleaning and preliminary analysis to understand the quality of responses and to exclude respondents who have not understood the choice experiment tasks. The second step was the development of the basic discrete choice models, using the data from the two SP experiments separately. The third task was to examine systematic taste heterogeneity and undertake segmentation analyses. Each of these tasks is discussed further in the following sub-sections. This is followed by a sub-section that briefly describes the method adopted in this study to deal with correlation between responses. We conclude the chapter with a discussion of how to interpret the model results.

4.1 Data cleaning and preliminary analysis

Prior to the development of the main models, analysis was undertaken of the choice data to understand the quality of the data. Specifically, the intention was to examine the following factors:

- ranges of values to investigate plausibility of responses;
- frequency tabulations to investigate;
    - plausibility of responses
    - success in obtaining quotas
    - an indication of the amount of missing information (background questions)
- exploration of diagnostic questions to assess the quality of responses;
- analysis of trading behaviour (by quadrants for experiment 1) to examine inertia;
- lexicographic behaviour.

4.2 Model Structure

Each experiment contained binary choices, thus the primary model structure is binary logit. Separate models were estimated initially for each of the two SP experiments, to examine the quality of the data from each experiment and to obtain initial VOTs. The option of pooling the data has also been explored but was not feasible within the scope of this project. Instead, we have used the data from the first SP experiment to support and cross-check the analysis of the tolled SP experiment. The tolled SP experiment reflects more realistically the choices that would be presented to travellers and is likely to provide more relevant results for the TGB project. Moreover, issues with the analysis of the first SP experiment indicate that this is the best approach under the circumstances (for a more detailed discussion, see Chapter 5).

For each of the two experiments, separate models have been developed for three journey purposes for car drivers: commute, employer's business and other. Separate models were also developed for respondents who were driving LGVs.

Since journey quality and traveller characteristic covariates may influence both time valuations and cost valuations separately, we estimated models with separate time and cost coefficients, with the subsequent calculation of the value of time (and its significance), rather than estimation of a model with explicit scaling to provide a direct estimate of value of time (with the correct t-statistic for VOT).

A key component of the analysis was the examination of how the time and cost coefficients vary by:

- size of time/cost change;
- gains and losses;
- across the four time-cost quadrants in experiment 1.

In addition, both non-linear time and cost specifications have been tested. We have also undertaken detailed tests for inertia, i.e. the preference for the current alternative.

The results of these model estimations are presented in detail in Chapters 5 and 6. Standard statistical tests (e.g. likelihood ratio (LR), rho-squared, adjusted rho-squared etc.) were used to identify the best model specifications. Note that for the first SP experiment we present rho-squared values with respect to 0, as a constant is not appropriate given that there is no distinctive association with the alternatives presented to the respondent. Whereas, for the tolled SP experiment, we present rho-squared values with respect to a constant specification, since the models for this experiment are expected to always have a constant, which explains a general preference for a specific alternative, over and above the characteristics of each alternative.

4.3 Segmentation

Once initial model structures were defined, further analysis was undertaken to quantify how time and cost sensitivity vary across a number of dimensions.

An important issue for this study is the influence of income on values of time, particularly given that regeneration is a key focus of the TGB development. As part of the survey we have collected both personal and household income. Tests were undertaken using both to examine the influence of income on the sensitivity of cost and time. It is interesting to note that in the UK Value of Time Study (Accent Marketing and Research and Hague Consulting Group, 1999; Mackie et al, 2003) significant income effects were observed on both cost and time sensitivity.

Further segmentation analysis was undertaken to examine the effects of trip and traveller characteristics on the sensitivity of cost and time, as summarised below:

- Trip characteristics:
    - Trip duration
    - Trip length (distance)
    - Currently tolled/not
    - Actual cost of trip
    - Time of day
    - EB: Reimbursement/not
    - Detailed journey purpose for other journeys and LGVs
- Traveller characteristics:
    - Age
    - Employment status
    - Family size: presence of children, number of children.

4.4 Dealing with Correlation between Responses and Distributional Forms

As proposed, because of the tight timescale for this study, a jack-knife analysis was undertaken on the final model specifications to take account of repeated measurements from individuals and other model misspecification error. The jack-knife approach is described in Appendix C and is judged to be a reasonable way to assess the impact on model error of the correlation of responses from the same individual (for further details see Cirillo et al, 1998).

With further time and budget, it would be possible to look at more complex model structures to take account of correlation between responses and random distributions for values of time (both with and without other time and cost covariates). This analysis could be undertaken in Alogit, Biogeme or other bespoke software, e.g. Gauss.

4.5 Interpreting the model results

In reporting the model we present a number of model fit statistics, as described in Table 21.

Table 21: Model fit statistics

Statistic	Definition
Observations	The number of observations included in the model estimation.
Final log (L)	This indicates the value of the log-likelihood at convergence. The log-likelihood is defined as the sum of the log of the probabilities of the chosen alternatives, and is the function that is maximised in model estimation. The value of log-likelihood for a single model has no obvious meaning; however, comparing the log-likelihood of two models estimated on the same data allows the statistical significance of new model coefficients to be assessed properly through the Likelihood Ratio test.
D.O.F.	Degrees of freedom, i.e. the number of coefficients estimated in this model. Note that if a coefficient is fixed to zero then it is not a degree of freedom.
$Rho^2(0)$	The rho-squared measure compares the log-likelihood (LL(final)) to the log-likelihood of a model with all coefficients restricted to zero (LL(0)): $Rho^2(0) = 1 - LL(final)/LL(0)$ A higher value indicates a better fitting model.
$Rho^2(c)$	If we compare the log-likelihood (LL(final)) value obtained with the log-likelihood of a model with only constants (LL(c)) we get: $Rho^2(c) = 1 - LL(final)/LL(c)$ Again a higher value indicates a better fitting model.

In interpreting the coefficient values the following points should be considered.

- **A positive coefficient** means that the variable level or constant has a positive impact on utility and so reflects a higher probability of choosing the alternatives to which it is applied.
- **A negative coefficient** means that the variable level or constant has a negative impact on utility and so reflects a lower probability of choosing the alternative to which it is applied.
- **Some coefficients are multiplied by continuous variables** and therefore reflect the disutility per unit of the variable, e.g. cost, which reflects the relative disutility per additional pound on the travel cost.
- **Categorical variables may be applied to continuous variables**; these therefore reflect the total utility increase or decrease for that variable, relative to a base situation, e.g. we may find that high income respondents have a different value of cost relative to other travellers.

- **The constants in a model** reflect preferences for the alternatives to which they are applied. For example, the b_AsNow constant in the Experiment 1 models demonstrates the underlying preference for choosing the alternative with the current journey travel time and cost over other alternatives.
- **A *positive* value for a constant** indicates that the respondent is *more likely* to choose that alternative, and a ***negative* value** indicates that the respondent is *less likely* to choose that alternative. The "As Now" constants are positive, indicating that on average these respondents prefer alternatives with the current journey time and cost.

The value shown after each coefficient estimate is the t-ratio. This defines the (statistical) significance of the coefficient estimate; regardless of the sign, the larger the t-ratio, the more significant the estimate. A coefficient with a t-ratio greater than +/-1.960 is estimated to be significantly different from zero at the 95% confidence level. A t-ratio of +/-1.645 is significantly different from zero at the 90% confidence interval.

CHAPTER 5 Model Findings: First VOT Experiment

This chapter presents the findings from the first VOT experiment. A series of checks have been undertaken to understand how respondents have traded in the first experiment and to check respondents' understanding of the choice scenarios within the experiment. Section 5.1 presents the results of preliminary data analyses including checks for non-trading and lexicographic behaviour by the respondents; Section 5.2 presents a simple analysis of the choices made by individuals relative to the costs of the options presented to them; and Section 5.3 presents the responses to the diagnostic questions associated with the first experiment. Section 5.4 presents the discrete choice models estimated from the first SP experiment, and Section 5.5 concludes this chapter with a discussion of the results.

5.1 Preliminary Data Analysis

5.1.1 Checking for non-trading behaviour

One of the first tests undertaken was to investigate the trading behaviour between alternatives within the experiments; this provides some insight into whether respondents engaged with the experiments or just consistently chose the same option, e.g. the first or second alternative, regardless of the cost and level of services offered. Table 22 shows the trading observed across all choices within the Value of Time experiment. There appears to be very little non-trading behaviour in the data with only a little over 1.3% of the respondents consistently choosing the same alternative across all 8 choice observations. It may be noted that if all the respondents trade in the way we expect, then 0.4% of them (1 in 256) will always choose alternative A and 0.4% will always choose alternative B.

Table 22: Non-trading behaviour in Experiment 1

Trading	No. cases	%
Always Option A	12	0.9%
Always Option B	5	0.4%
Trading between alternatives	1321	98.7%
Total	1338	100%

5.1.2 Checking for lexicographic behaviour

Lexicographic behaviour refers to the case where a respondent evaluates the alternatives on the basis of a single (or subset) of attributes. In the value of time experiment, we checked whether the respondents were making their choices on the basis of only time (always choosing the faster option) or only cost (always choosing the cheaper option) rather than trading off time and cost increases and decreases. The results are summarised in Table 23, which shows the number of respondents who always chose the faster and cheaper alternatives, by journey purpose category.

We see from these results that a larger fraction of LGV respondents always choose the faster alternative compared to car drivers, which is intuitive since some LGV drivers are likely to be less sensitive to travel costs. Car commuters on the other hand exhibit the most trading behaviour. These results are quite intuitive.

Table 23: Lexicographic behaviour in Experiment 1

Trading	No. cases			
	Total	LGV	Car - EB	Car - commute/other
Always Faster	52 (3.9%)	13 (7.7%)	15 (4.2%)	24 (3.0%)
Always Cheaper	288 (21.5%)	36 (21.4%)	80 (22.2%)	172 (21.3%)
Trading between alternatives	998 (74.6%)	119 (70.9%)	266 73.6%)	613 (75.7%)
Total	1338	168	361	809

Overall, when considering choices across all respondents, the cheaper alternative was chosen in 67% of the cases, while the faster alternative was chosen in 33% of the cases.

5.2 Choice by cost levels

The analysis above indicates that most respondents have not consistently chosen the same alternative and have taken into account the different costs and time levels offered when making their choices. A further analysis of the data examines how respondents have made choices at each of the different cost levels.

Figure 1 and Figure 2 show the proportion of respondents choosing each alternative at different cost differences between the two hypothetical alternatives. In examining these figures, we are looking to see whether the highest levels of the cost differences considered in the experiments have been high enough to deter respondents from choosing that option (i.e. whether we are able to determine the upper bound of the respondents' value of time). There will be a distribution of value of time across the sample, and ideally our design should be specified to cover the entirety of this distribution. However, equally we do not want to be probing values that are so high that they fall way outside of the value of time of all respondents.

Following are plots of the cost differences between Alternatives A and B in the SP choices against the (aggregate) numbers choosing alternatives A and B, respectively. We see, as expected, that when the price differences are small, about equal portions choose either Alternative A or Alternative B. As the price differentials become larger, smaller numbers choose the more expensive alternative. At price differences of £15 or more, 25% of the respondents choose the most expensive alternative, suggesting that there is undervaluation of large cost differences by some respondents.

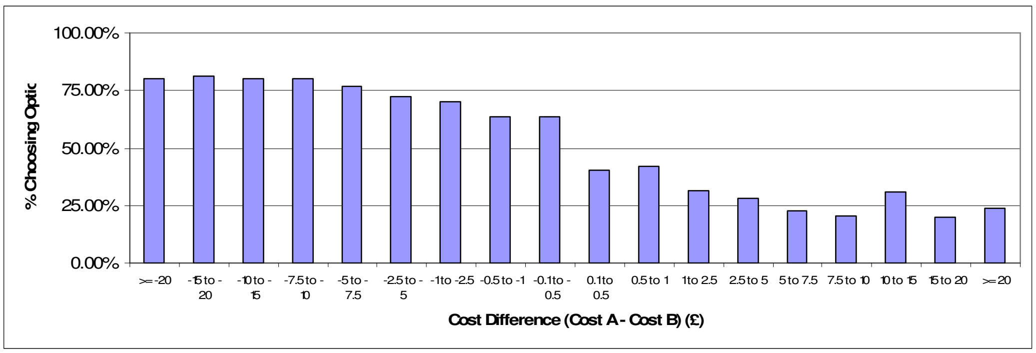


Figure 1: Experiment 1: Cost Difference between A and B plotted against % choosing option A

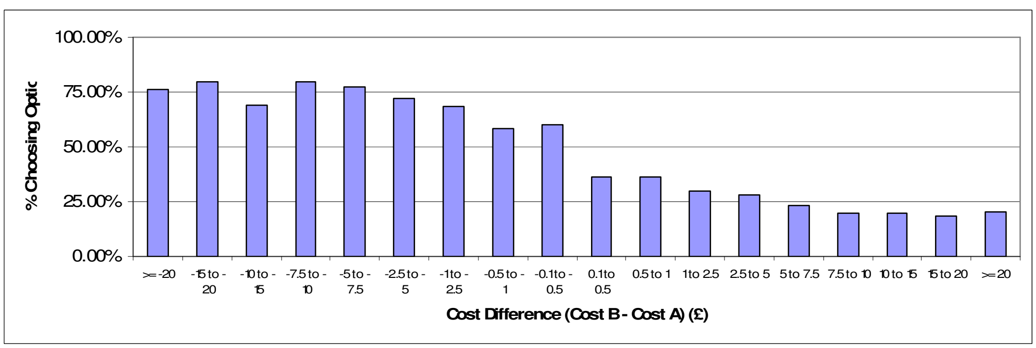


Figure 2: Experiment 1: Cost Difference between B and A plotted against % choosing option B

5.3 Responses to the diagnostic questions

In the survey, respondents were asked a number of diagnostic questions to investigate the extent to which they felt they were able to undertake the exercises.

When asked "Were you able to understand the choice scenarios as they were presented?" only 16 (1.2%) out of 1338 respondents indicated that they were not able to understand the choice scenarios. A cross-section of the comments from these 16 respondents is shown below:

- confusing
- complicated
- abstract over the telephone
- they were all too similar
- it is not the clearest information presented to me.. I am used to things being a lot more obvious
- you would really need to sit down and answer this
- a written questionnaire would be a lot easier so you could take time and analyze these variables
- possibly with more thought I may have revised my answers to some extent.
- I don't get any choice : I get paid for the time I'm at work. I don't care which journey I take - I don't know whether you wanted to know what I would chose (no choice) or what my boss would chose (no idea!)
- if you had asked the question "longer and cheaper, or quicker and dearer?" I would have always chose the quickest one. The options can be confusing.

All these 16 respondents were eliminated from the choice modelling analysis.

We also asked respondents "In the choice scenarios, did you consider the alternatives offered to you realistic?" 993 out of 1338 respondents (74.2%) indicated that they found the alternatives realistic, while 345 did not. This is quite a high proportion of respondents. The first experiment was designed so that all respondents were presented with one choice with an extremely high value of time. This had the result that some respondents saw large price increases, which they felt were unrealistic, e.g.:

- *£34 option not realistic pitted against £6 when all you save is about 20 mins on your journey*
- *£8 vs 50p options*
- *£6.35 option*
- *10. 60... IT DOES NOT COST ME THAT MUCH TO DO THE JOUTNEY NORMALLY*
- *12.40 charge*
- *120 minutes and cost £1.95, or one where the journey took 90 minutes and cost £9.45*
- *18 pounds*
- *20 pounds*
- *30 minutes and cost £6.80, or one where the journey took 40 minutes and cost £1.80*
- *30 min for 11.30.*
- *40 minutes and cost £18.25, or one where the journey took 60 minutes and cost £3.60?*
- *45 minutes and cost £8.50, or one where the journey took 75 minutes and cost £0.50*
- *75 minutes and cost £8.50, or one where the journey took 45 minutes and cost £28.50*
- *95 minutes and cost £22.30, or one where the journey took 90 minutes and cost £22.50*

Several comments also seem to be attributable to the fact that the cost cut-off at 50p results in options of very low cost for some individuals. For instance;

- *10 minute journey for 50p is not very realistic!*
- *20 minutes and cost £0.50, or one where the journey took 90 minutes and cost £12.00*
- *20 MINUTES AT 50P*
- *30 minutes for 50p*
- *30 minutes is for 50p very unrealistic.*

- *50 minutes and cost £0.50*
- *50p alternative*
- *50P FOR 30 MINUTES IS NEVER GOING TO HAPPEN REALISTICALLY*
- *50p for same journey not realistic*
- *50p Journey was no realistic as there is no way the journey would be that cheap in petrol*
- *50p ones*
- *50p option was not realistic*
- *50P TO GET ACROSS LONDON IS JUST NOT REALISTIC*
- *75 minutes at 50p not realistic*

A few individuals did not find any of the alternatives to be realistic.

- *all apart from the 50p options*
- *All of the options seemed ridiculous for that particular journey. My route is the quickest way and there's no cheaper travel option to get there either.*
- *all of them - the variations in cost and time described wouldn't be possible in any circumstance I can think of*
- *all of them*
- *All of them, I don't see how some of them would work, and the expensive ones were just stupid.*
- *all options were not viable*
- *all the choices*
- *all too hypothetical*

There was also a set of people who felt that time savings of 5-10 minutes were not worth it.

- *10 mins either way does not bother me willing to pay a lot if saving time is a lot*
- *10 mins on your day is nothing*
- *15 minutes less or more on a 2 or 3 hours journey are not significant, that is why i didn't give consideration to the questions which were not relevant to my situation (ps:interviewer added: that's why he chose answers randomly).* Note that this individual was eliminated from further analyses.
- *5 mins makes no difference*
- *all of them- to pay a such amount of money for only 5 or 10 minutes it's pointless*

All of these responses were retained in the analysis, on the basis that the design did test some unrealistic choice options, in order to test high values of time.

There was also a response which indicated a different choice mechanism: this respondent was eliminated from further analyses:

- *I don't get any choice. I get paid for the time I'm at work. I don't care which journey I take. I don't know whether you wanted to know what I would chose (no choice) or what my boss would chose (no idea!)*

In additional to the diagnostic questions asked of the respondent, the survey also collected the interviewer's perceptions of the respondent's understanding of the experiments. Reviewing the interviewer's perceptions, we conclude that most respondents have understood the experiment reasonably well. Tables 24 through 26 present the interviewer's responses to the relevant diagnostic questions.

Table 24: Interviewer judgement of whether the respondent understood the stated preference questions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Did not understand at all	5	.4	.4	.4
	Did not understand very much	15	1.1	1.1	1.5
	Understood a little	78	5.8	5.8	7.3
	Understood a great deal	392	29.3	29.3	36.6
	Understood completely	848	63.4	63.4	100.0
	Total	1338	100.0	100.0	

Table 25: Interviewer judgement of the amount of thought the respondent put into making their choices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Gave the questions very careful consideration	626	46.8	46.8	46.8
	Gave the questions careful consideration	505	37.7	37.7	84.5
	Gave the questions some consideration	171	12.8	12.8	97.3
	Gave the questions little consideration	34	2.5	2.5	99.9
	Gave the questions no consideration	2	.1	.1	100.0
	Total	1338	100.0	100.0	

Table 26: Interviewer judgement of degree of fatigue shown by the respondent

`		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Easily maintained concentration throughout the survey	966	72.2	72.2	72.2
	Maintained concentration with some effort throughout the survey	265	19.8	19.8	92.0
	Maintained concentration with a deal of effort throughout the survey	74	5.5	5.5	97.5
	Lessened concentration in the later stages	30	2.2	2.2	99.8
	Lost concentration in the later stages	3	.2	.2	100.0
	Total	1338	100.0	100.0	

The respondents who did not understand at all (either self stated or perceived by the interviewer) or did not give the questions any consideration (perceived by the interviewer) were excluded from the modelling analysis.

Overall, all these diagnostic questions helped us identify potentially inconsistent responses. Although several respondents have complained about high costs, the analysis in Section 6.2 indicates that there are individuals who have selected options with high costs thus justifying our decision to retain the high cost alternatives.

Based on the analysis of the diagnostic questions, we eliminated the following respondents:

(a) respondents who claimed that they were not able to understand the choice scenarios presented to them (16 respondents in the first SP experiment);

(b) respondents for whom the interviewer indicated that they 'did not understand the questions at all' (see Table 24);

(c) respondents identified as 'giving no consideration to the questions' (see Table 25);

(d) respondents who lost concentration in the later stages (see Table 26);

(e) one respondent with missing trip distance (required for calculation of vehicle operating costs, which are essential for the first experiment);

(f) one respondent who commented that 'my wife's disabled so we wouldn't have to pay toll fees' (since we would expect his responses to be atypical and not relevant to this study);

(g) respondents identified from the diagnostic questions of the second SP experiment (this was done to ensure a consistent final sample for analysis).

In total 29 of the 1338 (2.2%) respondents were eliminated for these reasons.

5.4 Discrete Choice Analysis

5.4.1 Final Sample

1388 respondents in total participated in the first Value of Time experiment. Twenty-nine of these were eliminated from the discrete choice analyses based on the results of the preliminary analysis (as discussed above). After correcting for the wrongly reported purposes (see Chapter 3 for more details), the remaining 1309 respondents are distributed across purposes as follows.

LGV:	166 respondents (12.7%);
Car EB:	398 respondents (30.4%);
Car Commute:	290 respondents (22.2%);
Car Other:	455 respondents (34.7%).

These sample sizes appeared sufficient for the estimation of the models.

5.4.2 Model Results

A basic model estimated from the first experiment indicates a negative and significant cost term, but a (wrongly signed) positive and significant time term (suggesting that respondents prefer longer journey times). We also observe a large positive term for choices which have the current time and cost, represented by the b_ASNOW coefficient, suggesting that there is a significant amount of inertial behaviour. As indicated in Table 27, segmenting the data by purpose into Car trips and LGV trips produces similar results.

Table 27: Experiment 1: Basic model by purpose

All Trips			Car Trips			LGV Trips		
Observations	10472		Observations	9144		Observations	1328	
Final Log Likelihood	-6675.5		Final Log Likelihood	-5806.5		Final Log Likelihood	-866.4	
D.O.F	3		D.O.F	3		D.O.F	3	
Rho²(0)	0.080		Rho²(0)	0.084		Rho²(0)	0.059	
Coefficient	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**
b_cost	-0.0999	-8.4	b_cost	-0.0975	-7.7	b_cost	-0.1089	-2.9
b_time	0.0257	9.6	b_time	0.0275	9.6	b_time	0.0166	2.2
b_ASNOW	0.3933	13.2	b_ASNOW	0.4060	12.7	b_ASNOW	0.3157	3.9

A series of analytical models were then estimated to identify the reason for the wrongly signed time term. These included quadrant analysis models, and models that exclude very high or very low cost or time differences between the two alternatives. These analytical models (not presented here) indicated the presence of strong non-linearities in cost sensitivity.

A number of models were then estimated with non-linear cost difference specifications[8]. These include:

(a) Log and linear cost difference models;

[8] Cost is specified in these models as the difference in costs between options B and A

(b) Stepwise cost-difference models;

(c) Stepwise time-difference models;

(d) Piecewise linear cost difference models;

(e) Piecewise linear cost difference and stepwise time difference models.

The results of these models are presented by purpose in Table 28 through Table 30. Effectively, we find that only the models with a non-linear cost specification produce reasonable estimates of the time and cost parameters.

Log and linear cost difference models

The log-linear models (see Table 28) produce significant and negative parameters on both the linear and log cost terms, confirming our hypothesis of non-linearity in utility associated with cost. These models, however, continue to have a positive parameter (though not statistically significant) on time suggesting that the log-linear specification does not completely capture the non-linearity in cost.

Table 28: Experiment 1: Log-linear cost models by purpose

All Trips			Car Trips			LGV Trips		
Observations	10472		Observations	9144		Observations	1328	
Final Log Likelihood	-6495.5		Final Log Likelihood	-5655.4		Final Log Likelihood	-837.8	
D.O.F	4		D.O.F	4		D.O.F	4	
Rho²(0)	0.105		Rho²(0)	0.108		Rho²(0)	0.090	
Coefficient	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**
b_cost	-0.0350	-3.1	b_cost	-0.0365	-3.1	b_cost	-0.0149	-0.4
b_lgcost2	-0.8462	-18.1	b_lgcost2	-0.8268	-16.7	b_lgcost2	-1.0825	-6.9
b_time	0.0014	0.5	b_time	0.0015	0.5	b_time	0.0007	0.1
b_ASNOW	0.4988	16.2	b_ASNOW	0.5111	15.4	b_ASNOW	0.4222	5.0

Stepwise cost difference models

The stepwise cost difference models (see Table 29) were specified to estimate different cost coefficients for the following ranges: < 20p, 20p-50p, 50p-£1, £1-£5, £5-£10, and >£10. These models appear to capture the non-linearity in cost reasonably well and produce significant and negative parameters on all the cost and time parameters. However, the stepwise form of the models introduces discontinuities and makes it impossible to calculate values of time. We therefore proceed to take this non-linear specification a step further by specifying a piecewise linear cost specification.

Table 29: Experiment 1: Stepwise cost difference models by purpose

All Trips			Car Trips			LGV Trips		
Observations	10472		Observations	9144		Observations	1328	
Final Log Likelihood	-6460.2		Final Log Likelihood	-5609.1		Final Log Likelihood	-847.9	
D.O.F	8		D.O.F	8		D.O.F	8	
Rho²(0)	0.110		Rho²(0)	0.115		Rho²(0)	0.079	
Coefficient	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**
b_cstgt10	-0.1319	-10.8	b_cstgt10	-0.1327	-10.4	b_cstgt10	-0.1153	-2.6
b_cst5_10	-0.2917	-16.3	b_cst5_10	-0.2922	-15.3	b_cst5_10	-0.2762	-5.3
b_cst1_5	-0.5324	-18.9	b_cst1_5	-0.5435	-17.9	b_cst1_5	-0.4460	-5.7
b_cst50p1	-1.0569	-12.1	b_cst50p1	-1.0656	-11.6	b_cst50p1	-0.9400	-3.4
b_cst20p50	-2.3199	-16.7	b_cst20p50	-2.3948	-16.0	b_cst20p50	-1.8032	-4.8
b_cstlt20p	-3.0025	-4.7	b_cstlt20p	-2.8159	-4.1	b_cstlt20p	-4.1541	-2.4
b_time	-0.0341	-8.5	b_time	-0.0343	-7.9	b_time	-0.0295	-2.7
b_ASNOW	0.3762	12.4	b_ASNOW	0.3844	11.7	b_ASNOW	0.3167	3.8

Piecewise linear cost difference models

We estimated models with a piecewise linear cost difference specification (see Table 30) for the same cost ranges as in the stepwise cost difference models. These models appear to produce an even better fit to the data suggesting that this specification captures the non-linearity in cost more accurately and that removing the discontinuity improves the representation of cost disutility. Since the cost parameters in this model were specified in an incremental manner, we present the actual cost sensitivities computed for each cost range in Table 31.

Table 30: Experiment 1: Piecewise linear cost difference model

All Trips			Car Trips			LGV Trips		
Observations	10472		Observations	9144		Observations	1328	
Final Log Likelihood	-6325.0		Final Log Likelihood	-5500.7		Final Log Likelihood	-820.6	
D.O.F	8		D.O.F	8		D.O.F	8	
Rho²(0)	0.129		Rho²(0)	0.132		Rho²(0)	0.109	
Coefficient	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**	**Coefficient**	**Estimate**	**t-ratio**
b_cstgt10	0.0461	0.9	b_cstgt10	0.0300	0.6	b_cstgt10	0.3626	1.3
b_cst5_10	0.2444	4.6	b_cst5_10	0.2753	4.8	b_cst5_10	-0.0026	0.0
b_cst1_5	0.7640	4.1	b_cst1_5	0.5940	3.0	b_cst1_5	1.9435	3.7
b_cst50p1	-0.7903	-1.7	b_cst50p1	-0.4694	-0.9	b_cst50p1	-3.0373	-2.3
b_cst20p50	4.8194	7.8	b_cst20p50	4.5523	6.9	b_cst20p50	6.6135	3.9
b_cstlt20p	-5.0962	-15.2	b_cstlt20p	-4.9978	-13.8	b_cstlt20p	-5.6940	-6.2
b_time	-0.0794	-16.3	b_time	-0.0784	-15.0	b_time	-0.0826	-6.1
b_ASNOW	0.3756	12.2	b_ASNOW	0.3833	11.6	b_ASNOW	0.3281	3.9

Table 31: Experiment 1: Cost sensitivities computed from the piecewise linear cost models

	All Trips	Car Trips	LGV Trips
>£10	-0.0159	-0.020	0.180
£5-£10	-0.062	-0.050	-0.183
£1-£5	-0.306	-0.325	-0.18
50p-£1	-1.07	-0.919	-2.12
20p-50p	-0.28	-0.45	0.92
< 20p	-5.10	-5.00	-5.69

Stepwise time difference models

We also estimated models with separate time coefficients for each time difference step of 5 min, 10 min, 15 min, 20 min and 30 min. These models do not fit the data well and do not seem to capture the time and cost sensitivities correctly.

Further extension of this specification to a non-linear cost difference plus stepwise time difference model specification, however, improves the model. This adds further evidence to our hypothesis that there is significant non-linearity in the sensitivities to cost. However, we discarded this extended model since the stepwise time difference parameters do not appear to add any value and only make VOT computations less intuitive.

As evidenced by the above model estimation results, a piecewise linear cost specification best captures the time and cost sensitivities of the respondents. We streamlined the model specification in Table 30 further by collapsing the cost difference ranges to <20p, 20p-£1, £1-£5, >£5. The resulting model is presented in Table 32, with the calculated cost parameters in the third column.

Table 32: Experiment 1: Best model with non-linear cost specification

Observations	10472	
Final log (L)	-6326.8	
D.O.F.	6	
Rho²(0)	0.128	
	Coefficients (t-stats)	**Cost parameters**
b_cstgt5	0.292 (8.6)	-0.033
b_cst1_5	0.485 (4.7)	-0.325
b_cst20p1	3.93 (12.7)	-0.81
b_cstlt20p	-4.74 (-18.3)	-4.74
b_time	-0.0787 (-16.3)	
b_ASNOW	0.376 (12.2)	

The values of time suggested by this model are as follows. The values look reasonable for the most part, except for cost differences greater than £5 or less than 20p. In the former range, the VOT is very high. This may be due to the over-prevalence of very short trips in the high cost difference ranges, since the survey design may produce options with very large cost differences in order to test the high VOT ranges. However, the survey was designed to test a lower range of VOTs than the VOT computed for cost differences greater than £5. It is conceivable then that the high VOT is a result of respondents' inability to perceive and compare specific time-cost combinations. For the very low cost differences, the value is very low.

	VOT (£/hr)
Cost difference ≤20p	1.00
Cost difference >20p & ≤1£	5.83
Cost difference >£1 & ≤ 5£	14.53
Cost difference >£5	143.09

We therefore estimate a model based on the above specification, but dropping cases with very high cost differences. The resulting model is presented in Table 33. We further segmented the data by purpose to estimate separate models for car trips, and LGV trips; and also by sub-purpose to estimate models for car commute trips, car driver trips for employers' business and car driver trips for other purposes. Table 33 presents the model estimation results for all trips, car trips and LGV trips. The cost parameters computed from the model results are also presented in these tables.

Table 33: Experiment 1: Piecewise linear cost difference models by sub-purposes

	All Trips		Car Trips		LGV Trips	
Observations	8744		7626		1118	
Final log (L)	-5350.7		-4644.7		-702	
D.O.F.	5		5		5	
Rho²(0)	0.117		0.121		0.094	
	Coeffs (t-stats)	Cost Coeffs	Coeffs (t-stats)	Cost Coeffs	Coeffs (t-stats)	Cost Coeffs
B_cst1_5	0.506 (4.4)	-0.314	0.400 (3.3)	-0.34	1.18 (3.6)	-0.15
B_cst20p1	3.93 (11.9)	-0.82	4.10 (11.6)	-0.74	2.75 (3.1)	-1.33
B_cstlt20p	-4.75 (-17.2)	-4.75	-4.84 (-16.3)	-4.84	-4.08 (-5.4)	-4.08
B_time	-0.0795 (-14.7)	-0.0795	-0.0785 (-13.4)	-0.0785	-0.0829 (-5.7)	-0.0829
B_ASNOW	0.373 (11.1)		0.383 (10.6)		0.306 (3.3)	

	Car Commute		Car EB		Car 'Other'	
Observations	2034		2478		3114	
Final log (L)	-1185.6		-1552.2		-1862.6	
D.O.F.	5		5		5	
Rho²(0)	0.159		0.096		0.137	
	Coeffs (t-stats)	Cost Coeffs	Coeffs (t-stats)	Cost Coeffs	Coeffs (t-stats)	Cost Coeffs
b_cst1_5	1.12 (4.5)	-0.43	0.211 (0.9)	-0.379	0.316 (1.6)	-0.394
b_cst20p1	4.04 (6.3)	-1.55	4.07 (5.5)	-0.59	4.59 (8.6)	-0.71
b_cstlt20p	-5.59 (-10.0)	-5.59	-4.66 (-7.8)	-4.66	-5.30 (-11.5)	-5.3
b_time	-0.121 (-9.7)	-0.121	-0.0954 (-8.7)	-0.0954	-0.0734 (-7.8)	-0.0734
b_ASNOW	0.441 (6.1)		0.288 (4.7)		0.380 (6.6)	

The VOTs computed from the above models are presented in the following table. Due to the piecewise non-linear cost specification, the VOTs are presented separately for each cost difference range.

	VOT (£/hr)		
	All Trips	Car Trips	LGV Trips
CostDiff ≤ 20p	1.00	0.97	1.22
Costdiff >20p & ≤ £1	5.82	6.36	3.74
Costdiff >£1 & ≤ £5	15.19	13.85	33.16

Figure 3 presents the cost sensitivities for each cost difference range by purpose and sub-purpose. These values are presented in Table 33 under the heading 'Cost Coeffs'. These plots explicitly demonstrate the non-linearity in cost sensitivity.

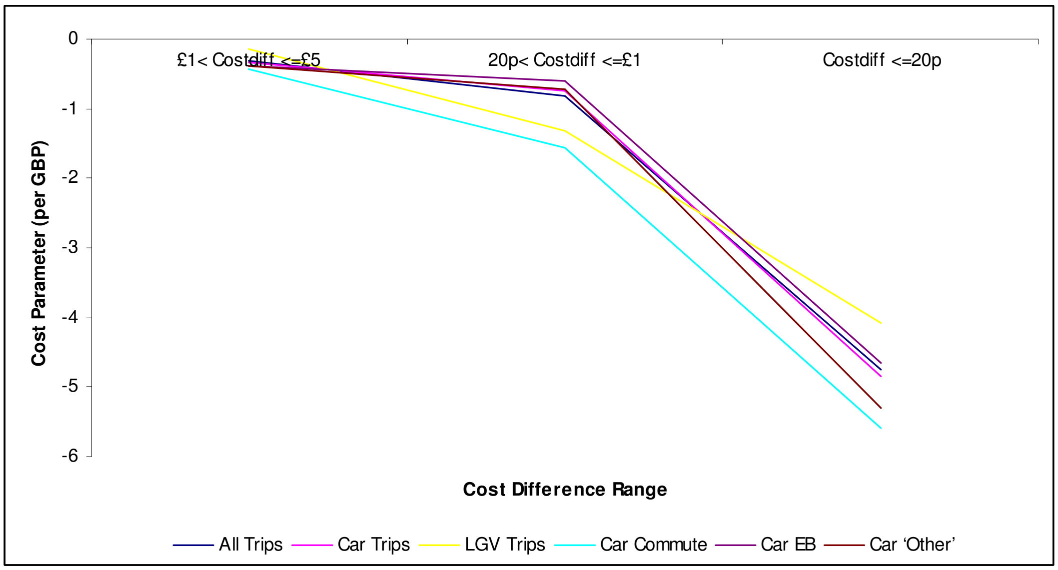


Figure 3: Cost sensitivities by cost difference ranges (by purpose)

Based on this piecewise linear cost difference specification, we also undertook several segmentation tests segmenting the data by personal and household income. Although the results look reasonable, and the models produce negative and significant cost and time parameters, segmentation by income appears to weaken the time parameter and the resultant VOTs are lower than expected (in the 1-3 £/hr range). We concluded that the basic models with linear time and piecewise linear cost specification (identified in Table 33) are the best that can be achieved with this data, in the timescale available for analysis.

5.5 Conclusions

The models estimated with the data from the first SP experiment indicate the presence of strong non-linearity in the sensitivities to cost. This is best captured using a piecewise non-linear cost difference specification, where the differences in cost and time between the two options are used as dependent variables. Separate models were estimated for each of the sub-purposes Car Commute, Car EB, Car Other. Separate models were also estimated for all car trips and LGV trips. The non-linear cost specification remains consistent across purposes and sub-purposes.

The VOTs computed from these models are reasonable and fall in the £5-15/hr range for cost differences ranging between 20p and £5. The problem with the non-linear cost specification, however, lies in implementation. The VOTs computed from such a model are dependent on the value of the cost differences which limits the application of the model. Therefore, we have focussed on the second SP experiment to produce the required values of time. The results of the first experiment will serve as indicators of the accuracy of the second experiment.

CHAPTER 6 Model Findings: Tolled VOT Experiment

This chapter presents the findings from the second (tolled) VOT experiment. A series of checks have been undertaken to understand how respondents have traded in the first experiment and to check respondents' understanding of the choice scenarios within the experiment, along the same lines as those undertaken for the first VOT experiment. Section 6.1 presents the results of preliminary data analyses including checks for non-trading and lexicographic behaviour by the respondents; Section 6.2 presents a simple analysis of the choices made by individuals relative to the costs of the options presented to them; and Section 6.3 presents the responses to the diagnostic questions associated with the second experiment. Section 6.4 presents the discrete choice models estimated from the tolled SP experiment and Section 6.5 concludes this chapter with a discussion of the results.

6.1 Preliminary Data Analysis

Reponses from 1338 respondents were collected for analysis. These data have been analysed and the results of this analysis are reported below. As discussed in Chapter 5, observations from some of the respondents have been excluded in the subsequent model development based on the responses to the diagnostic questions.

Checking for non-trading behaviour

A series of checks have been undertaken to investigate the extent to which respondents traded off cost changes against the level of services, or simply chose the lowest cost option.

One of the first tests undertaken in the model estimation phase was to check that respondents were engaged with the experiments and did not simply consistently choose the same option regardless of the cost and level of services offered. Table 34 shows that a number of respondents (20-25%) consistently chose the "Current Option" alternative in the experiments[9], and few respondents consistently chose "Tolled Bridge" alternative. These results confirm that respondents have not consistently chosen the same alternative

[9] It should be noted that consistently choosing the "current option" alternative is a valid response and indicates that the customer would not wish to pay tolls for any of the service improvements offered. It would be concerning if a very high proportion of respondents behaved in this way, as that would indicate that the travel time improvements offered were perceived not to be of value to a large proportion of the customers, but this is not the case and the vast majority see at least some alternative options that they find attractive.

and have taken into account the different costs and/or service levels offered when making their choices.

Table 34: Trading Behaviour, SP Experiment 2

Trading	Car - commute/other	Car - EB	LGV	Total
Always Current Option	196	51	37	282
Always Tolled Bridge	8	27	10	45
Trading between alternatives	605	283	121	1011
Total Observation	809	361	168	1338

The second test involved testing for lexicographic behaviour. Specifically we checked whether respondents were making their choices only on the basis of time (always choosing the fastest option) or cost (always choosing the cheapest option) or distance (always choosing the shortest route) rather than trading-off the attributes and costs.

Table 35: Lexicographic Behaviour, SP Experiment 2

Trading	Car - commute/other	Car - EB	LGV	Total
Always Cheapest	196	51	37	282
Always Fastest	8	24	7	39
Always Shortest	0	0	1	1
Trading between alternatives	605	286	123	1016
Total Observation	809	361	168	1338

These results repeat those of the previous table to a large extent. In general, there are a number of respondents who consistently chose the “Current” or “Cheapest” alternative in the experiments and a smaller number who consistently chose the “Tolled Bridge” or “Fastest” alternative in the experiments. It may be noted that the cheapest options in this experiment always corresponded to the “Current” options. Therefore it was not possible to uniquely identify if the respondents who consistently chose the “Current” were satisfied with the current offering and would not be prepared to pay more for changes to the service attributes or if the tolls presented to them were higher than they would be prepared to accept (or that they had a political aversion to tolled facilities).

6.2 Choice by cost (toll) levels

The analysis above indicates that majority of the respondents have not consistently chosen the same alternative and have taken into account the different costs (tolls) and time levels offered when making their choices. A further analysis of the data examines how the respondents have behaved at each of the different cost (toll) levels.

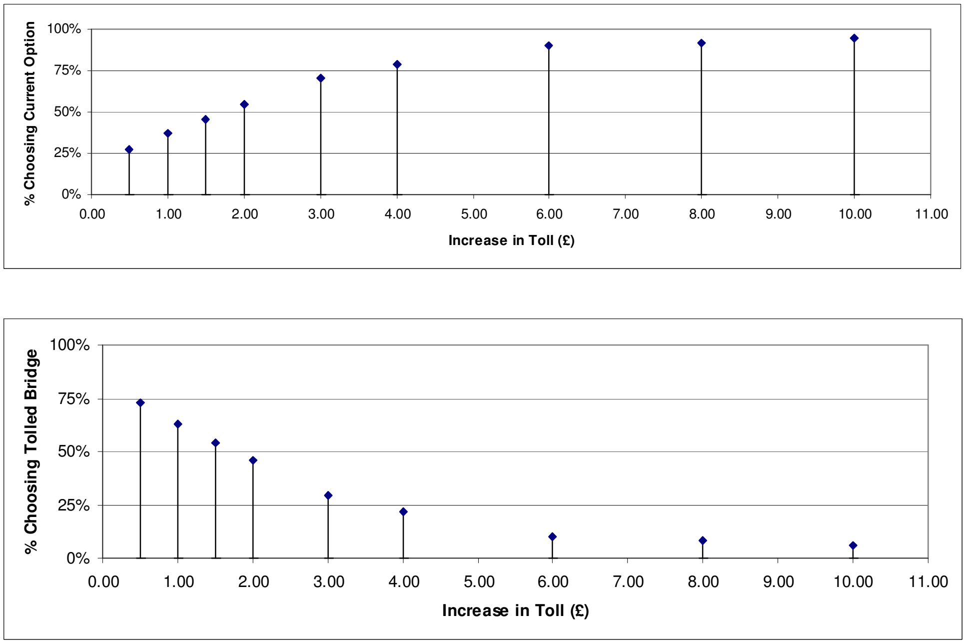


Figure 4: Choices at given levels of cost changes for new tolled bridge

In examining these figures, we are looking to see whether the highest levels of the tolls considered in the experiments have been high enough to deter respondents from choosing that option (i.e. whether we are able to determine the upper bound of the respondents' value of time). There will be a distribution of value of time across the sample, and ideally our design should be specified to cover the entirety of this distribution. However, equally we do not want to be probing values that are so high that they fall way outside of the value of time of all respondents.

From these figures we can observe that in the second experiment most of the alternatives offered become unattractive at a price increase somewhere close to £6 to £8.

6.3 Responses to the diagnostic questions

As in Experiment 1, we have also looked at responses to diagnostic questions to identify inconsistent and/or unreliable responses. In the tolled experiment, seven respondents (out of 1338) indicated that they didn't understand the choice scenarios as presented. Two of them found the figures and details confusing and two felt that the choice will depend on situational constraints. Some of the comments from these respondents are presented below:

- *The question doesn't make sense as the Blackwell tunnel is closer to my location as opposed to the new tunnel. Why pay more and travel further?.*
- *I don't get any choice - I get paid for the time I'm at work. I don't care which journey I take - I don't know whether you wanted to know what I would chose (no choice) or what my boss would chose (no idea!)*
- *There wouldn't be any congestion for the time of day that I travel.*

When asked about if the choice scenarios were realistic or not, 333 respondents responded that they felt some of the scenarios were unrealistic. Among them, the majority (308 respondents) thought that the tolls presented in the experiment were too high. However, the higher toll values (£8 and £10) were included in the experiment to ensure that the design adequately tested the upper bound of VOT and it is not unusual that some of these values will be perceived to be too expensive by many respondents. It may be noted that as observed in the cost analysis (Section 6.2), the higher toll levels were indeed chosen by respondents in some scenarios and justifies the inclusion of these levels in the exercises.

The respondents who did not understand at all (either self stated or perceived by the interviewer) or did not give the questions any consideration (perceived by the interviewer) were excluded from the model analysis. The analysis of the second SP experiment was based on the same sample of respondents as the first experiment, and section 5.3 documents the respondents who were omitted.

6.4 Model Results

Basic model

In the basic model, generic coefficients were estimated for changes in time, cost and distance values and a constant was included for the new tolled bridge option.

Table 36: Basic Model, SP Experiment 2

	All Observations	
Observations	10472	
Final Log Likelihood	-4992.5	
D.O.F	4	
Rho²(c)	0.257	
Coefficient	**Estimate**	**t-ratio**
b_dis	-0.0499	-5.8
b_cost	-0.4896	-40.4
b_time	-0.0709	-24.3
NewBridge	-0.1233	-2.3

As seen in the results, the coefficients of time, cost and distance changes have the expected signs: the utility of an alternative decreasing with increase in time, cost and distance values. We observe a negative utility associated with the new tolled bridge (indirectly capturing a preference for the current option).

For ease of interpretation of results, separate models were estimated for Cars and LGVs. For each of these, separate models for different trip purposes were also tested.

Purpose-specific models

Since VOT values are likely to vary depending on the trip purpose separate models were developed for each category of trip. For car trips, separate models were estimated for commuting, business and other purposes. The results from these models are presented in Table 37 below.

Table 37: Basic car trip models by sub-purpose, SP Experiment 2

	Commute		Business		Other	
Observations	2320		3184		3640	
Final Log Likelihood	-1029.1		-1643.7		-1525.0	
D.O.F	4		4		4	
Rho²(c)	0.279		0.239		0.307	
Coefficient	**Estimate**	**t-ratio**	**Estimate**	**t-ratio**	**Estimate**	**t-ratio**
b_dis	-0.0014	-0.1	-0.0639	-4.3	-0.0752	-4.9
b_cost	-0.5725	-18.8	-0.4304	-23.3	-0.6363	-22.8
b_time	-0.0677	-10.1	-0.0737	-14.2	-0.0761	-14.3
NewBridge	0.0393	0.3	0.0390	0.4	-0.2291	-2.4
VOT (£/hr)	**7.10**		**10.27**		**7.18**	

For LGV trips, separate models were estimated for delivery/collecting of goods, commuting, travelling to/from job (electricians, plumber etc.), non-work and other trips. Because of the small number of Other responses, these were combined with the other non-work responses. The resulting VOTs computed from these LGV trip models range from £5.42/hr to £12.58/hr.

Table 38: Basic LGV trip models by sub-purpose, SP Experiment 2

	Delivery/ Collecting		Commute		Travelling to/from job		Non-work & Other	
Observations	456		160		504		208	
Final Log Likelihood	-225.9		-71.1		-280.0		-94.6	
D.O.F	4		4		4		4	
Rho²(c)	0.238		0.295		0.170		0.268	
Coefficient	**Estimate**	**t-ratio**	**Estimate**	**t-ratio**	**Estimate**	**t-ratio**	**Estimate**	**t-ratio**
b_dis	-0.0504	-1.3	0.0755	1.0	-0.0050	-0.1	-0.0841	-1.4
b_cost	-0.4156	-8.1	-0.4574	-5.1	-0.3143	-8.0	-0.5585	-5.5
b_time	-0.0763	-5.6	-0.0959	-3.9	-0.0611	-5.2	-0.0504	-2.6
NewBridge	-0.3680	-1.5	-0.2325	-0.5	-0.1521	-0.7	0.1497	0.4
VOT (£/hr)	**11.02**		**12.58**		**11.66**		**5.42**	

Income segmentation

An important issue for this study is the influence of income on values of time, particularly given that regeneration is a key focus of the TGB development. As part of the survey we have collected both personal and household income. Tests have been undertaken using both to examine the influence of income on the sensitivity of cost and time[10]. The

[10] The income segments were based on findings from exploratory analysis of the data

segmentation by personal income yielded better results than segmentation by household income and segmentation on cost yielded better results than segmentation on time.

Table 39: Personal Income segmentation models for car-trips, by sub-purpose

		Car-Commute		Car-EB		Car-Other	
Observations		2320		3184		3640	
Final Log Likelihood		-1013.2		-1631.8		-1520.2	
D.O.F		8		7		6	
Rho²(c)		0.29011		0.245		0.310	
Coefficient		**Estimate**	**t-ratio**	**Estimate**	**t-ratio**	**Estimate**	**t-ratio**
b_dis		0.0025	0.121	-0.0653	-4.4	-0.0748	-4.884
b_cost	unknown income	-0.7592	-9.873	-0.5410	-14.9	-0.7279	-14.776
	income > 50K	-0.4597	-6.435	-0.3528	-9.3	-0.6007	-20.4
	income 30K-49K	-0.4929	-14.003	-0.4123	-21.2		
	income 10K-29K	-0.6140	-15.655				
	income<10K	-0.8683	-8.201	-0.5221	-9.8	-0.6821	-14.985
b_time		-0.0663	-9.798	-0.0735	-14.1	-0.0765	-14.291
NewBridge		0.1092	0.919	0.0549	0.6	-0.2255	-2.305

Values of Time			
income<10K	4.58£/hr	8.45£/hr	6.73£/hr
income 10K-29K	6.48£/hr	10.69£/hr	7.64£/hr
income 30K-49K	8.07£/hr		
income > 50K	8.65£/hr	12.50£/hr	
unknown income	5.24£/hr	8.15£/hr	6.30£/hr

Piece-wise linear cost

Models with piece-wise linear cost performed slightly better than the linear cost models in terms of goodness-of-fit. For example, for car-commuters, the values of time reported in Table 40 were computed from a piecewise linear cost model.

Table 40: Non-linear VOT for car-commuters

<table>
<tr><th></th><th>cost difference
<£5</th><th>cost difference
£5-£10</th></tr>
<tr><td>income <=£9000</td><td>3.42 £/hr</td><td>6.08 £/hr</td></tr>
<tr><td>income £10000-£29000</td><td>4.97 £/hr</td><td>6.43 £/hr</td></tr>
<tr><td>income £30000-£49000</td><td>5.20 £/hr</td><td rowspan="2">8.37 £/hr</td></tr>
<tr><td>income => £50000</td><td>7.26 £/hr</td></tr>
<tr><td>unknown income</td><td>3.91 £/hr</td><td>5.88 £/hr</td></tr>
</table>

However, such a model has a value of time that is dependent on the actual cost difference between the tolled and non-tolled alternatives, which is not easy to measure in implementation. A linear cost model was therefore selected for further analyses, while acknowledging the fact that the values of time are likely to be higher for higher cost differences.

Piece-wise linear time

Similarly piece-wise linear specifications were tested on time coefficients as well, and the model results suggest that the values of time are higher for smaller time differences between the tolled and non-tolled alternatives. However, as with the piecewise linear cost models, these models are dependent on the actual time difference and therefore not easy to use. We therefore proceed with the simple linear cost and time specification, which is not greatly inferior, for further analyses.

Table 41: Non-linear VOT for car-commuters (non-linear time)

	time difference <10 min	time difference >10 min
income <=£9000	0.03 £/hr	6.61 £/hr
income £10000-£29000	7.95 £/hr	7.31 £/hr
income £30000-£49000	10.59 £/hr	8.68 £/hr
income => £50000	12.76 £/hr	8.79 £/hr
unknown income	7.20 £/hr	3.00 £/hr

Effects of small time changes

In order to test the effects of small time changes, models were estimated without the 5 minute time changes. This resulted in a higher VOT compared to the model estimated with all data in general, particularly in case of business trips. This is in agreement with findings of previous VOT studies where it was concluded that small time savings were valued less than larger time savings.

We have retained the 5 minute time savings in our final specification for a number of reasons including that the inclusion of such savings are likely to give a more balanced picture of trading over the whole possible range of time savings likely to be made with the proposed infrastructure. The results without the 5 minute changes are presented below. It is noteworthy that there are some small inconsistencies in the patterns of values of time by income group, which would have been dealt with by aggregation of income groups, if we were going ahead with this model specification.

Table 42: Income segmented models, without 5 min time changes

		Car-Commute		Car-Business		Car-Other	
Observations		1922		2677		3073	
Final Log Likelihood		-849.1		-1375.9		-1324.7	
D.O.F		8		8		8	
Rho²(c)		0.298		0.249		0.311	
Coefficient		Estimate	t-ratio	Estimate	t-ratio	Estimate	t-ratio
b_dis		0.0090	0.4	-0.0637	-3.8	-0.0756	-4.5
b_cost	unknown income	-0.7898	-9.2	-0.5341	-14.0	-0.7144	-14.1
	income > 50K	-0.4397	-6.1	-0.3502	-8.8	-0.6604	-6.8
	income 30K-49K	-0.4944	-13.4	-0.4132	-16.8	-0.5974	-13.7
	income 10K-29K	-0.6295	-14.8	-0.4109	-16.3	-0.5989	-17.3
	income<10K	-0.8355	-7.8	-0.5098	-9.1	-0.6865	-14.4
b_time		-0.0632	-8.4	-0.0747	-12.9	-0.0684	-11.8
NewBridge		0.1995	1.4		0.0229	0.2	-0.4

Values of Time

	Car-Commute	Car-Business	Car-Other
income<10K	4.54£/hr	8.79£/hr	5.98£/hr
income 10K-29K	6.02£/hr	10.91£/hr	6.85£/hr
income 30K-49K	7.67£/hr	10.85£/hr	6.87£/hr
income > 50K	8.62£/hr	12.80£/hr	6.21£/hr
unknown income	4.80£/hr	8.39£/hr	5.74£/hr

Effects of trip characteristics

Trip duration

Trip duration was not found to have a significant effect on VOT, particularly in the cases of commuter and other trips. In the case of business trips, VOTs were found to be higher for trip durations > 75 minutes. Table 43 shows the ratio of VOTs by income and trip duration band, for business trips (the average values relate to the average for the specific trip duration and income group). The VOT for short trips (≤ 40 minutes) for individuals with low household income (< £10K) is taken to be the base.

Table 43: VOT Ratios for Business Trip, by trip duration and income category

	Trip duration	Trip duration	Trip duration
	<=40 mins	41-75 mins	>75 mins
income<£10K	1.00	1.00	1.21
income £10K-29K	0.99	1.00	1.20
income £30K-49K	0.98	0.99	1.19
income > £50K	0.98	0.98	1.18
unknown income	0.98	0.99	1.19
Average	0.99	0.99	1.19

Trip length (distance)

Trip length, however, was found to have a significant effect on VOT, particularly in the cases of business and other trips. In both cases, VOTs were found to be lower than average for short (in terms of distance) trips in comparison to longer trips. For commuter trips, VOTs were very similar for all trip lengths.

The conclusion, based on the results presented in Tables 44 and 45, is that the value of time varies little by trip length for business trips and varies more significantly by trip length for other trip purposes. For business trips, the value of time generally increases with trip length. For the other trip purposes, although the VOTs increase with trip length initially, very long trip lengths of greater than 30 miles are associated with lower values of time.

Table 44: VOT Ratios for Business Trips, by trip length and income category

	Trip length <10 miles	Trip length 11-30 mile	Trip length >30 miles
income<10K	0.94	1.00	1.05
income 10K-29K	0.94	1.00	1.05
income 30K-49K	0.94	1.00	1.04
income > 50K	0.94	0.99	1.04
unknown income	0.94	1.00	1.05
Average	0.94	1.00	1.05

Table 45: VOT Ratios for other Trips, by trip length and income category

	Trip length >10 miles	Trip length 11-30 mile	Trip length >30 miles
income<10K	0.72	1.29	1.12
income 10K-29K	0.72	1.27	1.11
income 30K-49K	0.73	1.30	1.12
income > 50K	0.71	1.26	1.09
unknown income	0.72	1.28	1.11
Average	0.72	1.28	1.11

Reimbursement/not

Respondents travelling for business purposes were asked if they would be fully or partly reimbursed for the cost. Approximately 35% of the business travellers indicated that their employers did not have a policy for covering travel costs (though some of them may be provided with a company vehicle for travel), about 46% indicated that they would be reimbursed for their travel costs and 15% indicated that they would be paid a fixed amount to cover travel costs. A variable capturing reimbursement of travel costs for business travel was not found to have a significant effect on cost sensitivity: that is the segmented model did not have a statistically significant improvement in goodness-of-fit compared to the base model with homogenous cost sensitivity.

Currently priced/not

The sensitivity to cost was found to vary significantly among respondents who currently pay tolls to cross the river compared to those who do not, for all trip purposes. Respondents who are currently paying tolls (or congestion charge) were found to be less sensitive to cost differences, that is, they have higher value of time (34% higher on average). The average ratio of VOT among respondents who pay tolls and respondents who do not are reported in Table 46.

Table 46: VOT Ratio for individuals who currently paying tolls (compared to those who do not)

	Commute	Business	Other
VOT currently paying toll / VOT currently not paying any toll	1.30	1.38	1.34

Actual cost of trip

The sensitivity to cost difference was found to vary significantly depending on the actual cost of the trip of respondents. Respondents who have high actual cost of their trip (cost more than £10) were found to be less sensitive to cost differences (higher value of time) compared to respondents who have lower actual cost of trip (cost less than £10), as shown in Table 47.

Table 47: VOT Ratio by trip cost

	Commute	Business	Other	Average
VOT_high_cost/ VOT_low_cost	3.65	1.52	1.09	2.08

Effects of traveller characteristics

In addition to income, information was collected about other socio-economic characteristics of the respondents. Market segmentation tests were undertaken to test if there are significant differences in cost and/or time sensitivity among the different socio-economic segments. We found systematic variations by age and employment status as described below.

Age

We tested whether the time/cost sensitivity is different for young (<25 years) and old people (>55 years) compared to middle aged people for each type of trip. This effect was not found to be significant for commute and business trips but for other trips (which include all non-work trips including leisure trips) the goodness-of-fit of the model with different time sensitivity for different age groups was significantly better compared to the base model (with homogenous time sensitivity). Somewhat counter-intuitively, the VOT was found to be higher for young people compared to middle aged people. The VOT was lowest for old people. The corresponding VOT ratios are shown in Table 48. It is not clear whether this effect would remain, once income effects are taken into account. We would recommend that further analysis be undertaken of all socio-economic effects together.

Table 48: VOT Ratio for Other trips, by age

	Other
VOT_young/ VOT_middle	1.60
VOT_old/ VOT_middle	0.76

Employment status

We also tested whether time sensitivity is different for employed people (full/part time paid/self-employed), students and non-employed people (including home-makers). This effect was not found to be significant for commute and business trips but again for other trips (which includes all non-work trips including leisure trips) the goodness-of-fit of the model with different time sensitivity for different groups was significantly better compared to the base model (with homogenous time sensitivity). The VOT was found to be higher for employed people and students compared to unemployed people. The corresponding VOT ratios are presented in Table 49. Again, it is not clear whether this effect would remain, once income effects are taken into account. We would recommend that further analysis be undertaken of all socio-economic effects together.

Table 49: VOT Ratio for Other trips, by employment status

	Other
VOT_unemployed/ VOT_employed	0.67
VOT_student/ VOT_employed	0.97

Family composition (presence of children)

We also tested whether time or cost sensitivity differed depending on family composition (families with and without children for instance). This effect was however not found to be significant for any trip purposes.

Summary of segmentation on trip attributes and traveller characteristics

In order to compare how much improvement in goodness-of-fit is offered by each of the segmentations presented above, the rho-square values of these extended models were compared (see Table 50).

Table 50: VOT Ratio for Other trips, by employment status

		Final Log-likelihood			Number of parameters			Adjusted rho-squared		
		Com	EB	Other	Com	EB	Other	Com	EB	Other
Zero-coefficient model[11]		-1608.1	-2207.0	-2523.1	0	0	0	n/a	n/a	n/a
Base Model		-1029.1	-1643.7	-1525.0	4	4	4	0.358	0.253	0.394
Income Segmentation		-1013.2	-1631.8	-1520.2	8	7	6	0.365	0.257	0.395
Trip Attributes	Trip Duration and income	-1011.5	-1628.9	-1518.4	10	10	10	0.365	0.257	0.394
	Trip Length and income	-1012.9	-1623.2	-1507.4	10	10	10	0.364	**0.260**	**0.399**
	Reimbursed /not	n/a	-1642.9	n/a	n/a	6	n/a	n/a	0.253	n/a
	Currently priced /not	-1026.8	-1636.4	-1514.7	5	5	5	0.358	0.256	0.398
	Actual cost	-1002.9	-1621.9	-1523.5	6	6	6	**0.373**	**0.262**	0.394
Traveller Characteristics	Family composition	-1028.8	-1642.6	-1499.8	5	5	5	0.357	0.253	**0.404**
	Age	-1025.3	-1643.0	-1519.0	7	7	7	0.358	0.252	**0.395**
	Employment status	-1027.5	n/a	-1519.0	6	n/a	6	0.357	n/a	**0.396**

The segmentations resulting in statistically significant better goodness-of-fit compared to the income segmented model (presented as the final model in the subsequent section) are bold-faced. The results indicate that different segmentations have different magnitudes of impact on the model improvement. In terms of magnitude of improvement the following three can be identified as the most important:

Car-commute: Trip length (distance)

EB: Trip length (distance)

Other: Family composition (whether or not there is a child in the family)

Incorporating all these segmentations in a single model structure will increase the model complexity, but the timescale for the current study has not allowed this analysis to be undertaken.

Corrections for repeated measurements

As proposed, because of the tight timescale for this study, a jack-knife analysis has been undertaken on the final model specifications to take account of repeated measurements from individuals and other model misspecification error. The jack-knife procedure is discussed in more detail in Appendix C. The results for the jack-knifed car trip models are reported in Table 51.

[11] Refers to null log-likelihood

Table 51: Jack-knife results for car trip models

		Car-Commute		Car-EB		Car-Other	
Observations		2320		3184		3640	
Final Log Likelihood		-1013.2		-1631.8		-1520.2	
D.O.F		8		8		6	
Rho²(c)		0.290		0.245		0.310	
Coefficient		Estimate	t-ratio	Estimate	t-ratio	Estimate	t-ratio
b_dis		0.0025	0.1	-0.0657	-4.1	-0.0742	-3.8
b_cost	unknown income	-0.7006	-3.7	-0.5268	-8.1	-0.7151	-9.7
	income > 50K	-0.4257	-3.5	-0.3477	-6.8	-0.5940	-12.9
	income 30K-49K	-0.4758	-6.9	-0.4076	-10.4	-0.6721	-12.5
	income 10K-29K	-0.5953	-8.8	-0.4081	-13.2	-0.0742	-3.8
	income<10K	-0.7621	-2.3	-0.5135	-8.5	-0.7151	-9.7
b_time		-0.0650	-7.9	-0.0731	-13.6	-0.0762	-9.3
NewBridge		0.0828	0.4	0.0476	0.4	-0.2332	-1.6

The model results for LGV trips before and after the jack-knife procedure are presented in Table 52, with the latter having corrected estimates of the standard errors on the coefficients, and hence corrected t-ratios.

Table 52: Jack-knife results for the LGV trip model

Observations	1328				
Final Log Likelihood	-681.7				
D.O.F	4				
Rho²(c)	0.213				
	Naïve estimates			Jack-knife estimates	
Coefficient	Estimate	t-ratio	Coefficient	Estimate	t-ratio
b_dis	-0.0243	-1.1	b_dis	-0.0239	-1.0
b_cost	-0.3842	-13.8	b_cost	-0.3784	-6.8
b_time	-0.0665	-8.9	b_time	-0.0658	-7.3
NewBridge	-0.2100	-1.5	NewBridge	-0.2102	-1.2

6.5 Conclusions

The best models estimated with the data from the second SP experiment are simple linear models segmented by purpose (car commute, car EB, car 'Other' and LGV), with the car trip models further segmented by income. These models are presented in Table 37 through Table 39.

A jack-knife analysis of these models was also performed, the results of which are presented in Table 51 and Table 52. As expected, the jack-knife procedure has the effect of reducing the t-ratios. However, the jack-knifing did not produce any unexpected results and only supports the model development in the rest of this chapter. The jack-knifed models also enable us to calculate the accuracy of the VOTs more accurately.

The VOTs from the final models, together with the standard errors, are presented in the following table.

Table 53: Final VOTs by income and purpose from Experiment 2 computed from jack-knifed models (in £/hr)

<table>
<tr><th rowspan="2">Income</th><th colspan="2">Car - Commute</th><th colspan="2">Car - EB</th><th colspan="2">Car - Other</th><th colspan="2">LGV</th></tr>
<tr><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th></tr>
<tr><td><10K</td><td>5.12</td><td>2.29</td><td>8.54</td><td>1.15</td><td>6.80</td><td>0.83</td><td rowspan="5">10.43</td><td rowspan="5">1.91</td></tr>
<tr><td>10K-29K</td><td>6.55</td><td>1.05</td><td>10.75</td><td>1.05</td><td rowspan="3">7.70</td><td rowspan="3">0.92</td></tr>
<tr><td>30K-49K</td><td>8.20</td><td>1.43</td><td>10.76</td><td>1.17</td></tr>
<tr><td>>50K</td><td>9.16</td><td>2.76</td><td>12.61</td><td>1.97</td></tr>
<tr><td>Unknown</td><td>5.57</td><td>1.60</td><td>8.33</td><td>1.13</td><td>6.39</td><td>0.88</td></tr>
</table>

The standard errors were computed using the formulae

$$s.e. = c_{ratio} \text{ x } VOT$$

$$c_{ratio} = \sqrt{(c_1^2 + c_2^2 - 2rc_1c_2)}$$

where

s.e. is the standard error associated with the value of time (VOT);

c_{ratio} is the coefficient of variation (inverse of t-ratio) of the VOT;

c_1 and c_2 are the coefficients of variation of the cost and time parameters that are used to calculate the VOT;

and r is the correlation of the estimates of the time and cost parameters.

Daly and de Jong (2006) show that this is *not* an approximation but a true estimate of the error of the maximum likelihood VOT which is derived from these models.

To calculate an average value of time, information on (personal) income distributions is required for each purpose. In the base year, we can use the income distributions as observed in the SP survey, as an indication of the possible income distributions of London travellers. It is noteworthy that the income distributions from the SP sample differ substantially by purpose; specifically, there are more low income people making 'other' trips.

Table 54: Personal income distributions from the SP Sample

Income	Car - Commute	Car - EB	Car - Other
<10K	8.3%	7.3%	20.7%
10K-29K	43.4%	35.2%	36.5%
30K-49K	31.0%	33.4%	19.1%
>50K	4.5%	7.0%	3.5%
Unknown	12.8%	17.1%	20.2%
Average VOT (£/hr)	6.94	10.31	7.25

When the purpose-specific income distributions are used, we see that the average values returned from the models are similar to those derived from the simple models (see Table 37). Small difference may exist for the following reasons:

- the values in Table 37 have not been jack-knifed, but those in Table 53 have;
- there may be correlation between income and other attributes, which are not accounted for in the simple model reported in Table 37;
- model error.

We also explored systematic variations in the values of time caused by several trip characteristics and individual socio-economic attributes. These effects are presented in Section 6.4 as VOT ratios, which indicate the relative values of time across the different segments. However, for calculating the overall average VOTs in the table above the models were segmented only by purpose and income as indicated in the table.

CHAPTER 7 Summary

The primary objective of this study was to undertake stated preference interviews with potential users of the TGB to determine local values of time, for input to a network assignment procedure which would predict traffic flows in East London with and without the TGB. To this end a stated preference survey was designed and administered in two stages – a pilot survey and a main survey. The stated preference interviews were conducted by telephone.

A pilot study was undertaken during 11-15 January 2008 and resulted in a total of 141 interviews. Analysis undertaken with the pilot survey data resulted in recommendations to modify the range of VOTs tested by the surveys. In addition, a coding error was discovered in the pilot survey and corrected for the main stage surveys.

The main data collection was undertaken between 8-24 February 2008. A total of 1388 interviews were collected. An interim analysis was performed when the first 288 interviews had been collected to ensure that the coding error was corrected.

All survey respondents participated in two SP experiments:

Experiment 1: Value of Time Experiment. This experiment involved generic time/cost trading with an experimental design as in the 1994 UK VOT survey, which is the basis for the WebTAG non-work values of time. Each choice scenario presented to the respondents involved the choice between two alternative options in which the journey time and cost varied. .

Experiment 2: Tolled Value of Time Experiment. In this experiment, respondents were presented with choices between their 'current option' and a 'hypothetical' tolled bridge crossing for their journey across the Thames. The levels of service for each alternative were described by travel time, distance and cost (toll). In this experiment fuel costs were not presented directly, on the basis that the fuel costs are not readily perceived by drivers and that in many cases the fuel cost differences between the current route and the tolled route option would be minimal. Instead, distance was presented. The only explicit changes in the cost are therefore due to changes in toll.

Respondents were presented with eight choice situations in each experiment.

Preliminary analysis of the main survey data indicated that there was no significant bias in the survey responses. The diagnostic questions suggested that there were a few respondents who either did not understand the surveys or did not pay sufficient attention to the questions. Twenty-nine such respondents were eliminated from the discrete choice modelling effort.

Discrete choice models estimated with the data from the first SP experiment revealed the presence of significant non-linearity in cost sensitivity and the best model specification was achieved by introducing piecewise linear cost parameters across the cost difference range tested in the experiment. The VOTs computed from this model fall within an acceptable range when very high cost changes (£5 or more) are dropped. However, as discussed in Chapter 5, a non-linear cost leads to VOTs that are dependent on the cost range, which is not ideal. Moreover, the loss of the observations with very low and very high cost changes means that the sample size is smaller with associated loss of statistical robustness of the results. Segmentation by income and other characteristics further weaken the time parameter and the resulting VOTs are not sufficiently robust.

It is therefore recommended, given the timescales of the project[12], that the experiment 1 data should only provide the basic range of VOTs to support and guide model development with data from the tolled SP experiment. The second (tolled) SP experiment is also more relevant to the TGB project since it focuses on travellers' willingness to pay for time savings and directly tests sensitivity to toll costs. Discrete choice models estimated from these data were very robust and produced consistent results. Income segmentation proved to be significant in explaining the choices made by the respondents, with those persons with higher incomes having lower cost sensitivity and therefore higher willingness to pay for time savings than those with lower incomes. The basic values of time computed from the final models, taking account of multiple responses per individual through jack-knifing, are summarised below.

Values of Time by income (£/hr)

<table>
<tr><th rowspan="2">Personal Income</th><th colspan="2">Car - Commute</th><th colspan="2">Car - EB</th><th colspan="2">Car - Other</th><th colspan="2">LGV</th></tr>
<tr><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th><th>VOT</th><th>Std. Error</th></tr>
<tr><td><10K</td><td>5.12</td><td>2.29</td><td>8.54</td><td>1.15</td><td>6.80</td><td>0.83</td><td rowspan="5">10.43</td><td rowspan="5">1.91</td></tr>
<tr><td>10K-29K</td><td>6.55</td><td>1.05</td><td>10.75</td><td>1.05</td><td rowspan="3">7.70</td><td rowspan="3">0.92</td></tr>
<tr><td>30K-49K</td><td>8.20</td><td>1.43</td><td>10.76</td><td>1.17</td></tr>
<tr><td>>50K</td><td>9.16</td><td>2.76</td><td>12.61</td><td>1.97</td></tr>
<tr><td>Unknown</td><td>5.57</td><td>1.60</td><td>8.33</td><td>1.13</td><td>6.39</td><td>0.88</td></tr>
</table>

To calculate average values of time from these models information on the distribution of personal income for each travel purpose is required. For the base year, the stated preference survey itself could be used to provide such data (see Table 54 in the main survey report for details).

The VOTs computed from the experiment 1 data corroborate these findings.

The effects of several other covariates were also tested, many of which were significant. The covariates tested include trip characteristics such as trip duration, trip length, trip cost, and

[12] Ideally we would pool the data from the first and second experiments, but this was not feasible within the timescale and budget of the study project.

reimbursement, and traveller characteristics such as age, employment status and family composition. The relative VOTs for each of these segments are presented in Chapter 6 in the form of ratios.

REFERENCES

Reference List

Alogit 4.2 (2005) HCG Software. http://www.alogit.com

Accent Marketing and Research and Hague Consulting Group (1999) "The Value of Travel Time on UK Roads". Report for Department of Transport, The Hague, ISBN 90-9013192-2, available at: http://www.hpgholding.nl/00000099400eaa706/index.html

Ben-Akiva, M. and Lerman, S. (1985) "Discrete Choice Analysis: Theory and Application to Travel Demand". The MIT Press, Cambridge, USA

Ben-Akiva, M. and Morikawa, (1990) "Estimation of Travel Demand Models from Multiple Data Sources, Transportation and Traffic Theory (Proc. Of the 11^{th} International Symposium on Transportation and Traffic Theory), M Koshi, ed. Elsevier, pp. 461-476)

Bissell, A. and Ferguson, R. (1975) 'The Jackknife: Toy, Tool or Two-Edged Weapon?'. Statistician, V. 24, pp79-100.

Bradley, M. and Daly, A. (1991) "Estimation of Logit Choice Models using Mixed Stated Preference and Revealed Preference Information". Presented to 6th International Conference on Travel Behaviour, Quebec, 1991; revised version presented to Duke International Symposium on Choice Modelling and Behaviour, 1993.

Bradley, M. and Daly, A. (1992) "Uses of the Logit Scaling Approach in Stated Preference Analysis". Selected Proceedings of the Sixth World Conference on Transport Research. Lyon, France, pp. 811-823.

Bradley, M. and Gunn, H. (1990) "Stated Preference Analysis of Values of Travel Time in the Netherlands", Transportation Research Record, Issue Number 1285.

Burge, P., Rohr, C., Vuk, G. and Bates, J. (2004) "Review of International Experience in VOT Study Design" European Transport Conference, Strasbourg.

Cirillo, C., Daly, A. and Lindveld, K. (1998) "Eliminating Bias due to the Repeated Measurements Problem in SP Data". In Operations Research and Decision Aid Methodologies in Traffic and Transportation Management, Labbé, M et al. (eds.), Springer.

Daly, A., and de Jong, G. (2006) "Errors in functions of the parameters of statistically estimated models". European Transport Conference, Strasbourg.

Daly, A., Choudhury C. F., Burge P. and Sivakumar A. (2008) "Dealing with Repeated Choices in Stated Preference Data: An Empirical Analysis", European Transport Conference, The Netherlands.

Efron, B. (1979), "Bootstrap Methods: Another Look at the Jackknife", The Annals of Statistics,V. 7., No. 1., pp1-26

Gunn, H. and Burge, P. (2001) "The value of travel time savings: some new evidence" European Transport Conference, PTRC

Fosgerau, M., Hjorth, K., and S.V. Lyk-Jensen (2007) The Danish Value of Time Study, published by the Danish Transport Research Institute.

Mackie, P.J.; Wardman, M.R.; Fowkes, A.S.; Whelan, G.A.; Nellthorp, J.; Bates, J.J. (2003) Value of Travel Time Savings in the UK, published by Institute for Transport Studies, University of Leeds in association with John Bates Services.

McFadden, D. (1974) "Conditional logit analysis of qualitative choice behaviour". In P. Zarembka, ed., Frontiers in Economics, Academic Press, New York, pp. 105-142.

Miller, R. (1974). "The Jackknife: A Review". Biometrica, V. 61, pp. 1-14.

Ortúzar, J. de D., D. A. Roncagliolo and U. C. Velarde (2000) Interactions and independence in stated preference modelling, in J. de D. Ortúzar (ed.), Stated Preference Modelling Techniques: PTRC Perspectives 4, PTRC Education and Research Services Ltd, London.

Ouwersloot, H. and P. Rietveld (1996) "Stated choice experiments with repeated observations", Journal of Transportation Economics and Policy, 30, 203–212.

Reeds, J. A. (1978) "Jackknifing maximum likelihood estimates", The Annals of Statistics, V 6, No. 4, pp 727-739

Train, E. (2003) "Discrete Choice Methods with Simulation". Cambridge University Press.

APPENDICES

Appendix A: Pilot Survey Design

This appendix reproduces a Memorandum discussed with the client at the stage of initiating the pilot survey.

1. Introduction

The key objectives of the proposed research are to undertake stated preference interviews with potential users of the TGB to determine local values of time. We have proposed to undertake surveys for four segments: car commute, car work, car other and LGV.

This note sets out the proposed SP survey methodology and design. There are a couple of issues which remain unresolved at this stage and which are emphasised in bold for comments from the client.

2. Survey Methodology

2.1 Recruitment

We will use three methods for recruiting respondents:

- **RSI surveys:** These took place at six sites (along a north-south screenline located between the Thamesmead/Plumstead/Shooters Hill area and the Blackwall Tunnel) from 20 November to end of November 2007 between 07:00 and 19:00 in a single direction. We understand there will be about 2,160 responses with contact details (45% of all interviews). In addition, 2,300 postcards were also handed out during November. In our proposal we had suggested that an RSI sample with names and phone numbers of at least 3,000 car drivers would be required providing there was a fairly even balance for the three person segments. If not a larger sample would be required. If the RSI sample is not sufficient in terms of numbers of potential respondents, particularly in some of the segments then we would need to augment the sample.
- **'Free-found' interviews** from random digit dialling (RDD) of households. We will recruit car driving respondents from households north and south of the Thames. A sample of telephone numbers will be bought to cover the relevant postcode areas. We suggest that these consist of the London Boroughs of Bexley, Greenwich, Tower Hamlets and Waltham Forest. The list of phone numbers then forms the basis of the sample. The interviewing team will make up to four attempts to contact each number. If they are unsuccessful in obtaining an interview after these calls they will then start the randomising process. This involves changing the last digit of the number by adding one to it. In this way up to ten numbers can be generated from a single start number
- 223 contacts who agreed to be re-interviewed from **2006 Greenwich congestion charging survey** undertaken by Accent for TfL, providing permission is given by TfL. Please note our costs are based on this sample being used.

Respondents will be asked about a specific car journey that they have recently made for a specific purpose. In the pilot we will test the feasibility of basing **all** the surveys around a journey that the respondent has recently made across the river.

TfL Query: Is it reasonable to restrict ourselves to respondents who have made journeys across the Thames by the Blackwall Tunnel, Woolwich Ferry or Dartford Tunnel?

Respondents who have made car journeys for a number of purposes will be asked to consider one specific journey based on achieved quota targets.

A £5 incentive is being offered to maximise the size of the sample.

Car Driver Sample

The target sample is 1,200 interviews with car drivers, as shown in the table below.

Table A1: Proposed Purpose Quotas

Segment	**Total**
Commute	400
Employer's business	400
Other	400
Total Car	**1200**

Given the clear relationship between income and VOT, it is important that the sample incorporates a range of incomes. We have proposed to quota by income in order to obtain a reasonable distribution of observations across income classes. However, the problem with this approach is that we may lose respondents who are unwilling to report incomes and this is an important consideration, given the small RSI samples. For the pilot, we propose to quota across two or three broad (household) income categories. Because of sample-size concerns, we will allow respondents who are unwilling to report their (household) income to participate in the surveys. At the end of the pilot survey, we will review the success of incorporating income as a quota variable.

LGV Surveys

We will undertake 100-150 SP interviews with LGV drivers directly to provide direct estimates of LGV values of time. This assumes that LGV drivers are able to take decisions about route choice and paying tolls and apply a reasonable valuation to their time. We will ask whether drivers are able to take such decisions in the background questions. We will also collect information on whether the drivers are self-employed or not and will compare the resulting valuations across these segments. All LGV drivers will be recruited through the RSI surveys and the sample size is dependent on the numbers of available contacts.

Pilot

We will undertake a pilot of 120 car users (40 per cell in the previous table) and 20 LGV drivers to test the survey methodology, the clarity and flow of the questionnaire, the accuracy of all routings, the stated preference design and understanding of the stated preference exercises, and the interview duration.

For the pilot we will read out the stated preference options to respondents over the telephone. We will evaluate the success of this approach after the pilot, by examining respondent's answers to direct questions about whether they were able to understand the choice exercises and also by examining model results. If the pilot shows that respondents have difficulty with the stated preference task we would recommend a phone-post/e-mail-phone methodology for the main stage, whereby we would contact respondents by telephone and post out relevant show material.

We have assumed a 15-20 minute interview.

2.2 Survey Methodology

We proposed to undertake the surveys using a computer aided telephone interview (CATI) approach. Accent often conducts stated preference surveys by telephone and recommends this approach for the following reasons:

- telephone research combines some of the price advantage of postal research with the personal contact of face-to-face interviewing;
- geographically dispersed interviews can be conducted (to include a wide range of non-customers) rather than having to cluster interviews as with face-to-face interviewing;
- telephone interviewing can include open-ended questions and allows for probing and exploration of issues.

Given the simplicity of the SP choice exercises (both are binary choices, with few variables and are based around a journey the respondent has made), we are proposing to undertake the pilot interviews without pre-posting the SP choices. The benefits of this approach are as follows:

- We will have a higher response rate to undertake the surveys, which is important given the limited RSI sample.
- Interviewers can query directly whether respondents have understood the exercises.
- The data collection exercise can be undertaken in a (slightly) shorter time, which is important given the very tight timescales for the research.

3. Stated Preference Surveys

The questionnaire will include general background questions about the respondent's journey characteristics, e.g. purpose of trip, time/day of trip, journey origin and destination, vehicle occupancy, journey time, who paid for petrol/parking, cost of petrol/parking, frequency including how many times per day and year they make in scope journey (across the screenline).

The survey will not be specific about the TGB, rather it will focus on existing trips crossing the river and a hypothetical new bridge crossing for the stated preference tolled crossing experiment. This means that details and a map of the TGB will not be required and also means that local sensitivities to the TGB should not cause any problems for the conduct of the surveys.

Following the SP exercises respondents will be asked about their awareness and perception of the TGB.

Finally socio-economic information would be collected for the driver and their household situation, including age, gender, employment status, occupation, household composition, car ownership, personal and household income.

3.1 Stated Preference Experiments

We propose that all respondents then participate in two SP experiments:

- Generic time/cost trading (as in 1994 UK VOT survey, which is the basis for the WebTAG non-work values of time);
- Tolled Experiment based around a hypothetical bridge crossing across the Thames.

Interviews will be conducted with respondents regarding commute, other purpose, employer's business and LGV trips.

It is important to emphasise that the proposed surveys will collect the employee's value of business time, which may be different from employer's valuations and that these will not (necessarily) be consistent with the working value in WebTAG. Specifically, because the WebTAG recommended values of time for working time are based on opportunity cost of the travel time to the employer and thus reflect the wage rate, including labour-related overheads[13]\: they have not been derived from SP experiments. The 1994 UK VOT study did obtain behavioural values for business travellers, based on SP experiments with employees, but these were not incorporated in WebTAG on the basis that the objective of the WebTAG valuations are largely for appraisal. We believe that behavioural valuations are appropriate for the present work and therefore recommend undertaking SP experiments with business travellers.

3.11 Experiment 1: Abstract time/cost trading

It is proposed that this experiment follow the structure of the UK/Dutch/Danish time-cost experiments, which have been successfully used in national VOT studies and are judged to reliably collect basic value of time information. These experiments were used to collect the data that forms the values that are currently presented in WebTAG, so there are significant benefits to be gained from repeating them in this study. These experiments presented the respondents with a choice of two alternative journeys in which the journey time and cost varied.

The structure of this experiment has a number of useful qualities:

- The time and cost levels are tailored around the respondents existing journey in order to provide a degree of realism;
- The design examines both time and cost gains and losses;
- Over a series of eight choices, the number of gains and number of losses, for both time and cost, are balanced;
- There are no dominant choices.

There were, however, a number of restrictions placed on the implementation of the design in the UK and the Netherlands as a result of using a paper-based survey approach. These restrictions have been reviewed for TGB, in light of the use of the computerised survey approach.

In the UK study all time and cost changes were presented as increments around the existing situation, e.g. "Travel time 10 MIN LONGER than now", "Travel cost 150 p LOWER than now". The existing situation was described as "THE SAME as now". One issue encountered in the analysis was the preference for the "same as now" alternative, a problem labelled as inertia. We believe that inertia could be partly an artefact of the wording in the "same as now" choices. For TGB, we propose to present all time and cost levels as absolute values in the choice alternatives, e.g. Journey takes 50 minutes, Journey costs £3.00. This will remove the need for any specific reference

[13] See www.webtag.org.uk

to "now" in the choices, although one of the time or cost levels may in fact reflect the observed travelling conditions.

The UK design was also restricted in the number of values of time that could be realistically examined within the first experiment. All respondents evaluated eight different values of time and four different time changes (see Tables A2 and A3 below). Different time differences were examined for journeys of different duration. Because we are using a computerised survey approach in TGB, we propose to examine a wider range of VOTs and time changes, as these can be randomly varied across the sample.

Table A2: Boundary VOT values examined in UK VOT study (p/min, 1994 prices)

Level	VOT
1	1 p/min
2	2 p/min
3	3.5 p/min
4	5 p/min
5	7 p/min
6	10 p/min
7	15 p/min
8	25 p/min

Table A3: Time differences examined in UK trunk road experiment

	Existing journey duration			
Level	5-25 min	26-50 min	51-75 min	> 75 min
1	+ 10 min	+ 10 min	+ 15 min	+ 20 min
2	+ 5 min	+ 5 min	+ 10 min	+ 10 min
3	-3 min	-5 min	-10 min	-10 min
4	-5 min	-10 min	-15 min	-20 min

For TGB, we propose that the eight VOTs be chosen randomly from a number of specified ranges (as shown below), in order to test both low and high values, but with the concentration of values in the region of the expected values. The testing of extreme values helps to ensure that the VOTs for the entire sample fall within the range examined. Each respondent will see one boundary VOT from each of the ranges; separate ranges are proposed for car (commute/other and employer's business) and LGV.

Table A4: Proposed Boundary VOTs for TGB (£/hr) – Car, commute and 'other' purposes

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
1.00	2.50	3.75	4.75	6.00	8.00	12.00	20.00
1.25	2.75	4.00	5.00	6.50	9.00	13.00	24.00
1.50	3.00	4.25	5.25	7.00	10.00	14.00	28.00
1.75	3.25	4.50	5.50	7.50	11.00	15.00	32.00
2.00	3.50						36.00
2.25							40.00
							44.00
							48.00

Table A5: Proposed Boundary VOTs for TGB (£/hr) – Car, employer's business

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
2.0	5.0	7.5	9.5	12.0	16.0	24.0	40.0
2.5	5.5	8.0	10.0	13.0	18.0	26.0	48.0
3.0	6.0	8.5	10.5	14.0	20.0	28.0	56.0
3.5	6.5	9.0	11.0	15.0	22.0	30.0	64.0
4.0	7.0						72.0
4.5							80.0
							88.0
							96.0

Table A6: Proposed Boundary VOTs for TGB (£/hr) - LGV

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
2.0	5.0	7.5	9.5	12.0	16.0	24.0	40.0
2.5	5.5	8.0	10.0	13.0	18.0	26.0	48.0
3.0	6.0	8.5	10.5	14.0	20.0	28.0	56.0
3.5	6.5	9.0	11.0	15.0	22.0	30.0	64.0
4.0	7.0						72.0
4.5							80.0
							88.0
							96.0

We propose that the size of the time change be specified so that it is realistic for the observed journey duration, but with considerable overlap so that we do not only evaluate small time savings for short journeys and larger time savings for longer journeys. We propose that two time difference increments be tested for each respondent and that these values be used to define both time gains and losses. The pair of values to be used from within the journey duration band will be specified randomly across respondents, so that we consider realistic changes for respondents making short journeys and both small and large changes for respondents making longer journeys.

Table A7: Proposed time differences for TGB

Existing journey duration			
20–30 min	31-45 min	46–60 min	61+
5 min	5 min	5 min	5 min
10 min	10 min	10 min	10 min
15 min	15 min	15 min	20 min
	20 min	20 min	30 min

It is proposed that in the pilot survey each respondent be presented with 8 choice pairs for this experiment; this allows two choices to be examined in each quadrant of the time/cost plane, i.e. loss/loss, gain/gain, gain/loss, loss/gain.

For a given choice situation, the information on the relevant boundary value of time and time difference will be used to calculate a corresponding cost difference to present to the respondent. In some cases for high boundary VOTs with large time differences we will get large changes to the cost level, which may in some cases be added to the existing journey cost and in others subtracted. In the latter case it would be possible for the cost reduction desired to exceed the existing journey cost, which would result in a negative journey cost being presented. In these cases we will set the cost to a low cap of £0.50 to maintain realism.

We have considered the option of including a check question in the SP choice pairs. This would take the form of an additional dominant choice pair added into the experiment to provide a check on the responses provided. Such questions were included in the Dutch and Danish VOT studies, the Dutch study was undertaken as a self-completion postal survey and the Danish survey was undertaken over the Internet. It is our judgement that this is not as necessary for the TGB study as we are using telephone interviewers to guide the respondent through the survey and we can include some diagnostic questions for the interviewer to check with the respondent in a more direct way whether they understood the choices that they were being asked to make.

As the survey is being undertaken by telephone, without show material, we have developed a script for the interviewer to explain the choices to the respondent.

Box 1: Introduction and text for the First SP Experiment

We would now like you to consider a series of situations where you have a choice between two different routes for the car journey that we have been discussing. Please imagine that you are making the same journey again, under the same circumstances, except the travel time for the journey could be different because of more or less congestion and your travel costs could also change. Please listen carefully and in each case please tell us which of these two options you would prefer.

If you aren't sure, please ask the interviewer to repeat the question.

Choices 1 through 8:

Which would you prefer: a journey which took X1 minutes and cost Y1 pounds, or one where the journey took X2 minutes and cost Y2 pounds?

Answers:

1 – First option

2 – Second option

3.12 Experiment 2: Testing the Tolled Alternative

In the second experiment, respondents are presented with choices between the 'current route' and a 'hypothetical' tolled bridge crossing for their journey across the Thames. The levels of service for each alternative are described by travel time, distance and cost (toll). Since fuel costs are not easily perceived by the drivers, changes in fuel costs associated with the journey have been ignored. Distance is, instead, presented. The only changes in the cost are therefore due to changes in toll.

Each respondent is presented with eight choice scenarios. In the first four choice scenarios, the attribute levels of the current route are kept exactly the same as the current trip of the respondent (same travel time, distance and cost) as shown in Table A8a. If the current route incorporates a toll, a toll is included in the cost. The tolled alternatives always have improved level of service (in terms of travel time savings and/or distance reductions) but incorporate a (higher) toll. In the fifth to eighth scenarios, the travel times of the current route are slightly varied reflecting the changes in travel time due to congestion effects (Table A8b). The distance and toll values are kept unchanged for all eight cases representing the current route.

Table A8: Examples of Experiment 2

(Current route =40 minutes, distance travelled= 10 miles)

a. Example (Choice scenario 1-4)

Which alternative would you choose?

	Current Route	New Tolled Alternative
Travel Time	40 minutes	30 minutes
Distance Travelled	10 miles	8 miles
Travel Cost	No toll	£2 toll
Choice (mark "X" in preferred option)	☐	☐

b. Example (Choice scenario 5-8)

Which alternative would you choose?

	Current Route	New Tolled Alternative
Travel Time	45 minutes	32 minutes
Distance Travelled	10 miles	12 miles
Travel Cost	No toll	£1 toll
Choice (mark "X" in preferred option)	☐	☐

The structure of this experiment has a number of useful qualities:

- the time and cost levels of the new tolled alternative are tailored around the respondent's existing journey in order to provide realism;
- the new tolled alternative always has better level of service compared to the current route and is associated with an increase in cost (higher toll);
- the design examines possible changes in distance;
- there are no dominant choices.

Cost levels

As sensitivity to cost changes is such an important variable, we have used a design that allows us to examine ten different toll levels for each type of vehicle (passenger car and LGV).

Our initial proposal for these levels is presented in A9.

Table A9: Experiment 2: Proposed cost (toll) levels

Level	Passenger Cars	LGVs
0	0	0
1	£0.50	£0.50
2	£1.00	£1.00
3	£1.50	£1.50
4	£2.00	£2.00
5	£2.50	£3.00
6	£3.00	£4.00
7	£4.00	£6.00
8	£5.00	£8.00
9	£8.00	£10.00

Action: TfL to approve toll levels.

These would be tested in the pilot surveys and an analysis would be undertaken to ascertain whether the range required adjustment for the main surveys, with the expectation that we may be able to reduce the upper limit of the range.

Changes in attribute levels

The changes in travel time and duration depend on the current trip duration and length. For example, for very short trips (20-30mins, 2-4miles) the maximum variation in duration and trip length are constrained to 10mins and 2miles respectively whereas for very long trips (>45mins and 11miles) maximum variations up to 30mins and 8miles are allowed. The complete set of ranges of travel time and distances are presented in Tables A10 and A11 respectively.

Table A10: Travel time attribute levels for different trip durations (in minutes)

Levels	Short Duration Trips Travel time: 20-30 mins		Medium Duration Trips Travel time: 30 – 45 mins		Long Duration Trips Travel time > 45 mins	
	Current Route	New Tolled Alternative	Current Route	New Tolled Alternative	Current Route	New Tolled Alternative
0	0		0		0	
1	-5	-5	-5	-5	-5	-5
2	5	-8	5	-8	5	-8
3		-10	10	-10	10	-10
4				-15		-15
5				-20		-20
6						-25
7						-30

Table A11: Travel distance attribute levels for different trip lengths (in miles)

Current Trip Length	2-4 miles	5 to 8 miles	8 to 11 miles	> 11 miles
Short durations	-1,0,+1	-2,0,+2	-2,0,+2	-2,0,+2
Medium durations	-1,-1,0,+1	-2,-1,0,+2	-5,-2,0,+2	-5,-2,0,+2
Long durations	-1,-1,-1,0,+1	-2,-2,-1,0,+2	-5,-2,-1,0,+2	-8,-5,-2,0,+2

Boundary VoT values

The boundary values of VoT tested in Experiment 2 for each duration band for passenger cars and LGVs are presented in Tables A12 and A13, respectively.

Table A12: Value of Time ranges tested in Experiment 2 – for car drivers

	Max time saving	Min Time Saving	Max Cost	Min Cost	VoT_upper	VoT_lower
Short Duration	15 min	5 min	£8	£0.50	96 £/hr	2 £/hr
Medium Duration	30 min	5 min	£8	£0.50	96 £/hr	1 £/hr
Long Duration	40 min	5 min	£8	£0.50	96 £/hr	0.75 £/hr

Table A13: Value of Time ranges tested in Experiment 2 – for LGVs

	Max time saving	Min Time Saving	Max Cost	Min Cost	VoT_upper	VoT_lower
Short Duration	15 min	5 min	£8	£0.50	120 £/hr	2 £/hr
Medium Duration	30 min	5 min	£8	£0.50	120 £/hr	1 £/hr
Long Duration	40 min	5 min	£8	£0.50	120 £/hr	0.75 £/hr

We propose the following introduction and text script for the second experiment.

Box 2: Introduction and text for the Second SP Experiment

We would now like you to imagine that there is another bridge crossing across the Thames that you could use for the journey that we have been discussing. This crossing would have a toll, which would be collected electronically so you would not have to stop to make your payment. The use of this new bridge would mean that your journey would take you less time, although your journey may be slightly longer (but in this case you would be travelling at a higher speed). Please imagine that you were making the same trip that we have been discussing.

Please listen carefully to each of the choices that will be presented to you and in each case tell us which of these two options you would have used.

If you aren't sure, please ask the interviewer to repeat the question.

Choices 1 through 4:

Your current route is unchanged, that is your journey is #X2# miles and takes #X1# minutes (if there is a toll add 'and you pay a #X3#toll'). Using the new bridge your journey would be #Y2-X2# miles #shorter#/#longer# and would take #X1-Y1# minutes less, but you would have to pay a toll of £#Y3#. Which route would you choose for your journey?

Choices 5 through 8:

Your current route now takes #JTIME-X1# #longer#/#shorter# than your current journey, so your total journey time would be #X1#. The distance is still the same (#X2# miles) (if there is a toll add 'The toll is still £#X3#l). The new bridge means that your journey would be #Y2-X2# miles #shorter#/#longer# and would take #X1-Y1# minutes less, but you would have to pay a toll of £#Y3#. Which route would you choose for the journey?

Answers:

1 – Current route

2 – Tolled bridge

Appendix B: Pilot Survey Results and Recommendations

This text reproduces a memorandum discussed with the client at the conclusion of the pilot survey.

1. Introduction

This note discusses our analysis of the data collected in the pilot phase of the stated preference choice survey for determining Values of Time (VOT) of potential users of the proposed Thames Gateway Bridge (TGB). Within this survey, all respondents were asked to participate in two SP experiments:

A. Experiment 1: Value of Time Experiment

This experiment involved generic time/cost trading as in 1994 UK VOT survey, which is the basis for the WebTAG non-work values of time. Each choice scenario presented to the respondents involved choice of two alternative options in which the journey time and cost varied.

B. Experiment 2: Tolled Value of Time Experiment

In this experiment, respondents were presented with choices between their 'current option' and a 'hypothetical' tolled bridge crossing for their journey across the Thames. The levels of service for each alternative were described by travel time, distance and cost (toll). Since fuel costs are not easily perceived by the drivers, changes in fuel costs associated with the journey have been excluded. Distance is presented instead. The only explicit changes in the cost are therefore due to changes in toll.

Respondents were asked to provide eight choice responses in each experiment. Full details of the design are provided in note MM-08022-001 (circulated previously).

For the pilot survey, respondents were recruited through two methods, as described in Appendix B1:

- RSI surveys;
- 'Free-found' interviews, from random-digit dialling (RDD) of households (referred to as 'cold-calling).

We note that we still do not have permission to use the Greenwich contacts from the 2006 congestion charging feasibility surveys, so this sample was not piloted.[14]

2. Market Research Findings

We proposed to sample 120 interviews with car drivers in the pilot survey, split evenly between commuters, travellers on employer's business and other purposes with 20 interviews with LGV drivers.

[14] It was confirmed at the meeting to discuss the pilot findings (23/01/08) that we had permission to use the Greenwich RSI data for recruitment for the main survey.

In practice we achieved 141 interviews. Just over half (72) were from the RSI sample and 69 were from cold calling. For the RSI sample we used 160 records, a 45% success rate, which means that for the overall RSI sample we should be able to achieve the planned interviews, despite having a smaller RSI sample than expected.

Table B1 summarises the pilot data recruitment characteristics.

Table B1: Pilot data recruitment characteristics

	Cold Calling Sample	RSI sample	Total
	n = 66	n = 75	
Crossed Thames on RSI journey		17 (23%)	17
Crossed Thames in last 3 months	51 (77%)	37 (49%)	88
Crossed Thames in last year	7 (11%)	6 (8%)	13
Didn't cross Thames	8 (12%)	15 (20%)	23
Car	60 (91%)	62 (83%)	122
LGV/Van	6 (9%)	13 (17%)	19
Commuting	20 (30%)	21 (28%)	41
Employer's Business	19 (29%)	21 (28%)	40
Other purposes	21 (32%)	20 (27%)	41

Those respondents who made a trip across the Thames by car/LGV in the last 3 months were asked detailed questions about that recent trip. Those who did not make a trip across the Thames in the last 3 months were asked questions about their last general car/LGV trip, which would not have been across the Thames. Asking about Thames crossings in the last year could be potentially confusing for this latter group, particularly if they did make a journey across the Thames in the last year. We propose that for the main survey we either base the survey around the journey made in the last year, if one has been made, or drop this question.

The average length of the questionnaire was 17 minutes, and there was not any noticeable difference between lengths of interviews of different types of respondent.

There were some minor problems with the background questions in the questionnaire, e.g. in terms of routing between questions, which will be amended for the main survey. Appendix B1 contains a detailed report by Accent of the market research findings from the pilot study.

Overall, it was judged that the pilot worked well and respondents understood the questions and gave sensible answers.

2.1 Review of Key Background Questions

In order to participate in the SP choices, journey costs are required. Past experience has indicated that car drivers are particularly poor at estimating journey costs, and therefore we presented an approximate cost and asked whether they agreed with this estimate. Approximate costs were derived using the following cost assumptions:

Car, non-work travellers: 15p/mile

Car, travellers for employer's business: 30p/mile

LGVs: 30p/mile

These costs are based on WebTAG calculations (assuming an average speed of travel of 25.3 kph[15]) and information published by the AA and FTA.

The calculated costs were checked with respondents. In general, respondents had fairly good agreement with the estimated costs (78% of respondents agreed with the costs presented) with the revised figures being £2.20 higher, on average, for commuters and £0.34 lower, on average, for respondents making business trips. No LGV drivers disagreed with the cost estimates.

Another important background question is about the respondent's income (for car journeys only, LGV drivers are not asked about income). In the pilot survey, we inquired about both personal and household income (note we do not ask respondents from single-adult households the household income question). We observed a 12.3% refusal rate for household income and a 10.3% refusal rate for personal income. These are relatively low and we propose to retain both questions in the main survey. The income distributions from the pilot survey are presented below.

Table B2: Household Income (car drivers)

	%
1 Less than £5,000	1
2 £5,000 - £9,999	4
3 £10,000 - £14,999	2
4 £15,000 - £19,999	3
5 £20,000 - £24,999	7
6 £25,000 - £29,999	3
7 £30,000 - £34,999	9
8 £35,000 - £39,999	7
9 £40,000 - £49,999	15
10 £50,000- £74,999	15
11 £75,000- £99,999	9
12 £100,000 or more	10
13 Refused	9
14 Don't know	6
Base	122

15 Average network speed provided by Halcrow in an e-mail (14.12.2007)

Table B3: Personal income (car drivers, excluding those in one person households)

	%
1 Less than £5,000	5
2 £5,000 - £9,999	8
3 £10,000 - £14,999	5
4 £15,000 - £19,999	11
5 £20,000 - £24,999	17
6 £25,000 - £29,999	6
7 £30,000 - £34,999	8
8 £35,000 - £39,999	4
9 £40,000 - £49,999	14
10 £50,000- £74,999	7
11 £75,000- £99,999	4
12 £100,000 or more	1
13 Refused	10
14 Don't know	1
Base	107

It would seem that we have a sample of individuals in the pilot survey with higher incomes than is observed across London, on average. Data from the Data management and Analysis Group (DMAG) indicates the following distribution of incomes, on average, within London[16]:

- 22% of households with income under 15k (compared with 7% of our sample)
- 53% of households with income under 30k (compared with 21% of our sample)
- 85% of households with income under 60k (not comparable).

It is emphasised, however, that we would expect our sample to be biased, because of the inclusion of car owning people only, who are likely to have higher incomes. We do not have information on the expected income distribution of car owning households in London. Also, what is important for the SP exercise is that we have adequate numbers of observations across all income categories, so that we can test for income effects. If such effects are found, then we can reweight the findings to reflect expected income distributions.

The distributions of other socioeconomic variables in the pilot sample are shown in Appendix II.

3. Stated Preference Results

3.1 Experiment 1: Value of Time Experiment

141 respondents participated in the first Value of Time experiment:

[16] See: http://www.londoncouncils.gov.uk/doc.asp?doc=19944

LGV:	19 respondents (13.5%);
Car EB:	41 respondents (29.1%);
Car Commute/Other:	81 respondents (57.4%).

In the checking of the data, we observed that one respondent reported a journey distance of 999 ('unknown' or 'not applicable'?) for a car commute/other trip, which resulted in non-sensible costs. We have therefore excluded this individual for the rest of this analysis.

Exploratory analysis of the data from the SP experiments indicated that was an error in the coding of the experiment, specifically the travel time across choices varies only by ±5min or ±15min. This lack of variability in travel time influences the analysis results presented in the rest of this section.

This error has been identified in the coding and will be corrected for the main survey. We also proposed to undertake a short interim analysis after the first 50 interviews, to double-check that this experiment is coded correctly and is giving satisfactory results when the data is analysed.

3.1.1 Checking for non-trading behaviour

One of the first tests undertaken was to investigate the trading behaviour between alternatives within the experiments; this provides some insight into whether respondents engaged with the experiments or just consistently chose the same option, e.g. the first or second alternative, regardless of the cost and level of services offered. Table B4 shows the trading observed across all choices within the Value of Time experiment.

Table B4: Testing for non-trading behaviour in Experiment 1

Trading	No. cases	%
Always Option A	2	1.4%
Always Option B	0	0%
Trading between alternatives	138	98.6%
Total	140	100%

As the numbers in B4 indicate, there appears to be no consistent bias within the experiment.

Lexicographic behaviour refers to the case where a respondent evaluates the alternatives on the basis of a single (or subset) of attributes. In the value of time experiment, we checked whether the respondents were making their choices on the basis of only time (always choosing the fastest option) or only cost (always choosing the cheapest option) rather than trading off time and cost increases and decreases. The results are summarised in Table B5.

Table B5: Testing for Lexicographic behaviour in Experiment 1

Trading	No. cases			
	Total	LGV	Car - EB	Car - commute/other
Always Fastest	5	0	2	3
Always Cheapest	23	6	4	13
Trading between alternatives	112	13	35	64
Total	140	19	41	80

A couple of interesting observations can be made from this analysis. First, a larger fraction of commute respondents always choose the cheapest alternative compared to EB respondents, which is intuitive since individual's travelling on employer's business are likely to be less sensitive to travel costs. Second, people driving LGVs choose the cheapest alternative in at least 4 out of the 8 choices, and 6 of the 19 respondents always choose the cheapest alternative, suggesting that the drivers of LGV vehicles are very price sensitive.

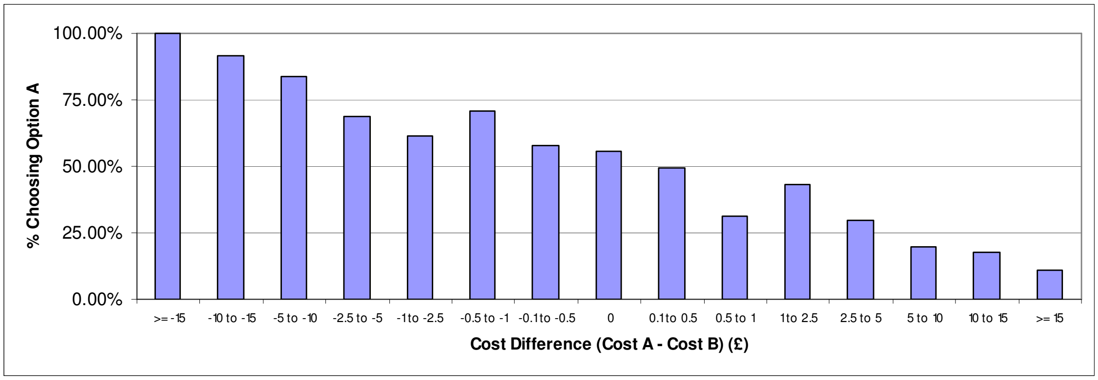
When considering all choices, however, the cheapest alternative was chosen in 65% of the cases, while the fastest alternative was chosen in only 35% of the cases. This may be partly due to the insufficient variability in time in this experiment caused by the coding error.

3.1.2 Choice by cost levels

The analysis above indicates that respondents have not consistently chosen the same alternative and have taken into account the different costs and time levels offered when making their choices. A further analysis of the data examines how the respondents have made choices at each of the different cost levels.

The following figures show the proportion of respondents choosing each alternative at different cost differences between the two hypothetical alternatives. In examining these figures, we are looking to see whether the highest levels of the cost differences considered in the experiments have been high enough to deter respondents from choosing that option (i.e. whether we are able to determine the upper bound of the respondents' value of time). There will be a distribution of value of time across the sample, and ideally our design should be specified to cover the entirety of this distribution. However, equally we do not want to be probing values that are so high that they fall way outside of the value of time of all respondents.

Following are plots of the cost differences between Alternatives A and B in the SP choices against the (aggregate) numbers choosing alternatives A and B, respectively. We see, as expected, that when the price differences are small, about equal portions choose either Alternative A or Alternative B. As the price differentials become larger, smaller numbers choose the more expensive alternative. At price differences of £15 or more pounds, very few respondents choose the most expensive alternative, suggesting that we need to retain some choices with high price differentials in the experiment.



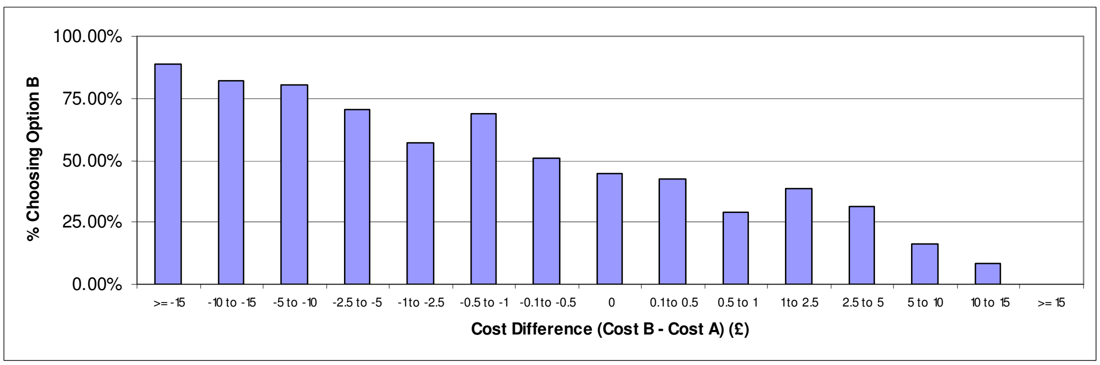


Figure B1: SP Choices at Different Cost Differentials in Experiment 1

3.1.3 Responses to the diagnostic questions

In the survey, we asked respondents a number of diagnostic questions to investigate the extent to which they felt they were able to undertake the exercises.

When asked “Were you able to understand the choice scenarios as they were presented?” 140 of the 141 respondents answered yes. The one respondent that did not feel able to make the comparisons stated his reason as ‘*found it very confusing, too many times and prices’.* However, this respondent does not show any left or right side bias in his responses; and he is observed to have chosen the fastest alternative in 6 of the 8 choices presented to him. Overall, this respondent appears to prefer options with a high implicit Value of Time. In the main survey, we would exclude such respondents from the analysis.

We also asked respondents “In the choice scenarios, did you consider the alternatives offered to you realistic?”. 34 of the 141 respondents indicated that they did not consider the alternatives offered to be realistic.

This is quite a high proportion of respondents. The first experiment was designed so that all respondents were presented with one choice with an extremely high value of time. This had the result that some respondents saw large price increases, which they felt were unrealistic, e.g.:

- *the price differences were too high for the change in time*
- *too expensive for the few minutes saved*
- *some were a bit over the top, especially when we talked about £9 for a short journey*

- *the fact that its only a matter of 5 minutes difference between the journeys and quite a difference in cost (this respondent had a journey time of 180min so a travel time variation of ±5/15 minutes is clearly insufficient; it is expected that this problem will be resolved when the coding error is fixed).*

Another problem was that when these large cost changes were presented as price reductions, the cost increment would actually have been negative, so a minimum of 50p was presented. This minimum value was perceived as being unrealistic for a number of people, e.g.:

- *50p – where does that come from?*
- *I can't get the fuel cost to 50p*
- *couple (of cases) not relevant as how could a trip this length only cost 50p (in this case, the respondent faced a travel time of 50 minutes)*
- *there is no way I could drive 55 miles for 50p (we are checking this cost).*

One individual commented that "*some (games are) a little stupid as same price for different alternatives, therefore no argument*". Upon investigation it was discovered that 4 out of the 8 choices presented to this respondent had the same cost of 50p for both alternatives. (We believe that this is a driver of an electric vehicle, whose reported driving costs were very small). This will result in problems as reported in the SP experiment. We will review this for the main survey.

Another seeming inconsistency was flagged by a respondent who faced a journey cost of £4.20 (same as the original journey cost) as an alternative in every one of the 8 choices. This will be investigated further.

In fact, unreasonable cost was a common theme among many of the comments especially when coupled with short trips. For instance:

- *the higher ones and the seriously low ones were too high/low* (this was from a respondent with original journey cost of £4 who faced costs in the range of 0.50-18 GBP during the SP choices)
- *the higher ones were not realistic and I don't see how the running costs would be higher for shorter journey!*
- *time and price on occasions were too far fetched and the others were too close together*
- *the 35 minutes for £25 for what's normally a 60p trip!*

In general, costs of £15 or more for relatively short trips were flagged by respondents. A telling comment from one of the respondents suggests that a travel cost of £8 is very high for low income individuals.

A few people also questioned the value of such SP experiments. Some felt that such variations in time and cost were not realistic:

- *there wouldn't really be a way to significantly reduce the journey time for the journey I was making*
- *I can't see how the time of the journey could be guaranteed, due to the congestion in all of the areas. plus there would be no way for me to be able to reduce the time of the journey and the petrol costs by half*
- *the big reduction is not sensible – traffic flow would have to be considerably better eg Sunday traffic*
- *because they are not based in reality as my journeys can't have the price and times changed that easily*
- *because I know the traffic and there is no way that they could guarantee to make the journey times shorter*

While some others felt that travel choices are not made so simplistically:

- *it doesn't work like that - you can't make that kind of comparison because you can never be that accurate about timing*
- *the journey time and cost aren't the only factors I would consider - equally important would be the type of road - I prefer dual carriageways and roads without too many junctions, roundabouts etc - I'm quite a cautious driver - so I would need more info than this to make a choice*

One respondent appeared to be driving an electric car with low costs, and therefore found the costs in the SP experiment unreasonable.

Despite these comments, most of the respondents appear to understand the choices and trade appropriately. We are proposing to reduce the range of values of time being investigated in the main survey, to limit the number of extreme costs presented to individuals.

3.1.4 Results from the stated preference experiments

The data collected from the discrete choice experiments has been used to estimate a few models. At this stage the results should be viewed with caution as we only have a small number of observations available and because of the problem in the specification of time.

In reporting the models we present a number of model fit statistics and use several econometric terms, which are described in Appendix B3.

Table B5: Experiment 1: Preliminary estimation results

File	SP1_model1.F12	SP1_model2.F12	SP1_model3.F12
Observations	1128	1128	1128
Final log (L)	-714.2	-703.4	-696.9
D.O.F.	2	5	6
Rho²(0)	0.087	0.1	0.109
Variables	Parameter Estimates		
b_cost	-0.213 (-5.5)	-0.262 (-6.1)	-0.231 (-5.4)
b_time	0.0052 (0.6)		
b_time_p15		-0.0295 (-2.3)	-0.0052 (-0.4)
b_time_p5		0.0428 (1.8)	0.0928 (3.3)
b_time_m5		0.0730 (2.9)	0.0302 (1.1)
b_time_m15		0.0044 (0.4)	-0.0030 (-0.2)
b_ASNOW			0.474 (3.6)

In all of these model results, the cost parameter has the expected sign, but in the first model the time parameter(s) have the incorrect sign. When the time parameter is broken down into gains (plus) and losses (minus), and by the size of change, we see that the 5-minute time change levels have the biggest problems, which is not unexpected (there is substantial evidence that small time savings are not valued by respondents in SP exercises). In fact, in the UK VOT experiment, 3 minute time change levels were tested and it was not possible to identify negative coefficients for these levels, so we have decided to go with a 5 minute time change minimum in this study.

We believe that this problem will be rectified by the correction to the time change levels tested in the main survey.

3.2 Tolled Value of Time Experiment

3.2.1 Checking for non-trading behaviour

The trading observed in the tolled experiment is presented in Table B6. As is shown in the table, some respondents (majority of them car-commuters) always chose the current option.

Table B6: Testing for non-trading behaviour in Experiment 2

Trading	Car - commute/other	Car - EB	LGV	Total
Always Current Option	23	3	4	30
Always Tolled Bridge	4	3	1	8
Trading between alternatives	54	34	14	102
Total Observation	81	40	19	140

The second test involved testing for lexicographic behaviour. Specifically we checked if respondents were making their choices only on the basis of time (always choosing the fastest option) or cost (always choosing the cheapest option) or distance (always choosing the shortest route) rather than trading-off the attributes and costs.

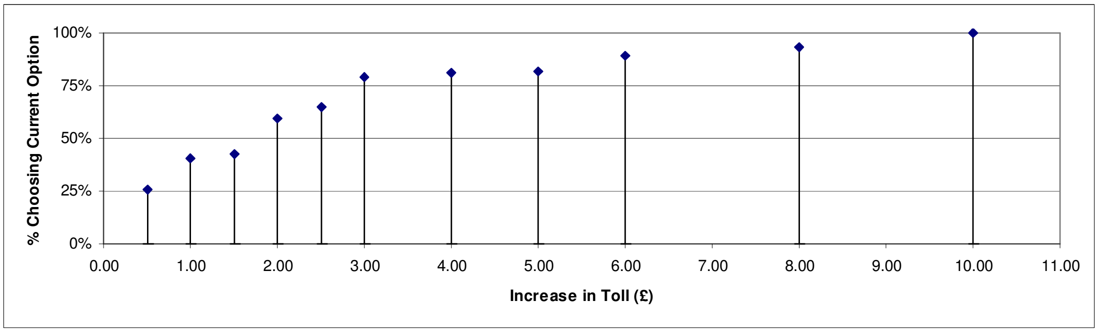
Table B7: Testing for Lexicographic behaviour in Experiment 2

Trading	Car - commute/other	Car - EB	LGV	Total
Always Cheapest	23	3	4	30
fAlways Fastest	3	3	1	7
Always Shortest	0	0	0	0
Trading between alternatives	55	34	14	103
Total Observation	81	40	19	140

These results are encouraging. In general, there are only a small number of respondents who consistently chose the "Current" or "Cheapest" alternative in the experiments and an even smaller number who consistently chose the "Tolled Bridge" or "Fastest" alternative in the experiments. It may be noted that the cheapest options in this experiment always corresponded to the "Current" options. Therefore it was not possible to uniquely identify if the 30 respondents who consistently chose the "Current" were satisfied with the current offering and would not be prepared to pay more for changes to the service attributes or if the tolls presented to them were higher than they would be prepared to accept or that they had a political aversion to tolled facilities). It may be noted that out of these 30 respondents choosing the "Current" options, 6 respondents were paying tolls in their current journey.

3.2.2 Choice by cost (toll) levels

The analysis above indicates that majority of the respondents have not consistently chosen the same alternative and have taken into account the different costs (tolls) and time levels offered when making their choices. A further analysis of the data examines how the respondents have behaved at each of the different cost (toll) levels.



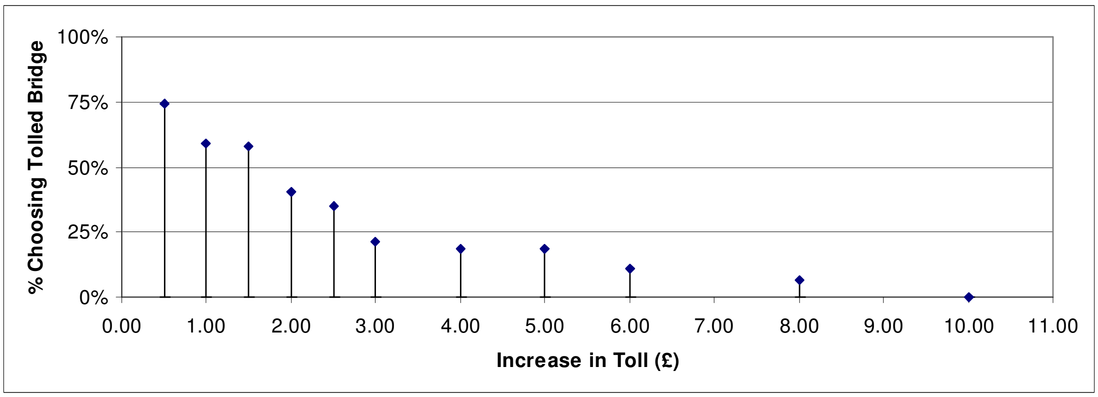


Figure B2: Choices at given levels of cost changes for the new tolled bridge

In examining these figures, we are looking to see whether the highest levels of the tolls considered in the experiments have been high enough to deter respondents from choosing that option (i.e. whether we are able to determine the upper bound of the respondents' value of time). There will be a distribution of value of time across the sample, and ideally our design should be specified to cover the entirety of this distribution. However, equally we do not want to be probing values that are so high that they fall way outside of the value of time of all respondents.

From these figures we can observe that in the first experiment most of the alternatives offered become unattractive at a price increase somewhere close to £6 to £8. It is also worth noting that in the first experiment we observe that in about 64% of the choices the respondents choose the "current option". These charts are encouraging, but suggest that there may be scope to reduce the range of the costs probed in this first experiment, which in turn would allow examination of more intermediate values. It is also encouraging to note that a large proportion of respondents choose the alternative when it is presented with an associated cost decrease.

The distribution of "value of time" of respondents is roughly plotted in Figure B3. Note that this analysis ignores the effects of other variables (e.g. change in distance, inertia for current option etc.) in the choice mechanism and is presented to provide an approximate understanding of the trading behaviour in Experiment 2.

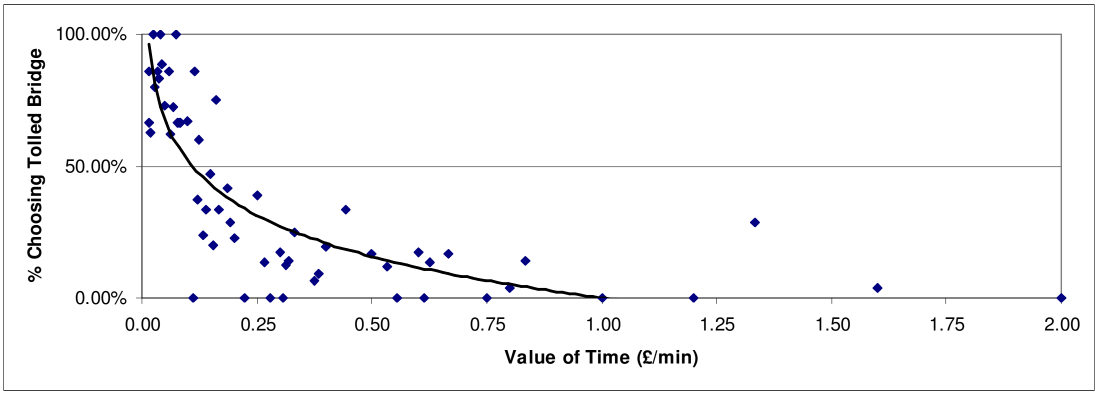


Figure B3: Simplistic distribution of VOT

3.2.3 Responses to the diagnostic questions

In the survey, we asked respondents a number of diagnostic questions to investigate the extent to which they felt they were able to undertake the exercises. When asked "Were you able to understand the choice scenarios as they were presented?" all of the respondents answered yes.

When asked "In the choice scenarios, did you consider the alternatives offered to you realistic?" 119 out of the 140 respondents answered yes. Out of the 21 respondents that did not feel able to make the comparisons:

- 11 stated their reasons as unrealistically high tolls.

- 4 stated their reasons as unrealistic journey times

Some other comments were as follows:

- *I found it complicated because there was too much information to take in.*
- *Some of the choices were the same thing a bit silly (Interviewer indicated that this was on 1 choice only but it coloured her perception)*
- *It doesn't give choice. I may have chosen either depending on the day itself - whether it was vital to be by a certain time or not*
- *I didn't cross a major river on that occasion so it's unrealistic that there would be a toll bridge*
- *All of the ones - I don't cross the Thames for that journey*

One respondent stated political reasons and two did not state any reason.

3.2.4 Results from the stated preference experiments

The data collected from the discrete choice experiments has been used to estimate one model, for all respondents. At this stage the results should be viewed with caution as we only have a small sample available, however, they do provide some insight into whether the experiments are working as intended. It is noted that in this analysis, observations from 2 respondents were excluded because of missing variable values.

In reporting the models we present a number of model fit statistics and use several econometric terms, which are described in Appendix B3.

Table B7: Experiment 2: Preliminary estimation results

Summary Statistics		
Observations	1112	
Final Log Likelihood	-553	
D.O.F.	7	
Rho2(0)	0.283	
Rho2(c)	0.225	
Estimates		
Variables	Coefficients	t-stats
Travel Time	-0.0847	-9.00
Cost - car commute/oth	-0.677	-11.70
Cost - business trips	-0.459	-8.20
Cost - LGV	-0.737	-7.10
Distance reduction	0.00240	0.00
Distance increase	-0.0652	-0.40
Current Option	0.0394	0.10

Calculated VoTs		
Car- commute-other	7.51	£/hr
Car-business	11.07	£/hr
LGV	6.90	£/hr

In general, the coefficients have the correct signs though not all coefficients were statistically significantly different from zero. This is however expected given the small sample of pilot data.

The coefficient of travel time is negative indicating disutility for options involving increased travel times. Cost coefficients are estimated separately for each segment of the sample (car-commuter/other trips, car-employer's business trips and LGVs). The estimation results show highest sensitivity for LGV trips and least sensitivity for commute/other trips. This is intuitive and translates to higher values of time for business trips. It may be noted that the estimated VOTs are well within the range of VOTs tested in the tolled experiment (£0.75-£96 for car drivers and £0.75 to £120 for LGVs).

The change in distance associated with the trip is modelled as dummy variables (indicating if the option involved distance increase or decrease). As expected, the estimated results showed that there is a preference associated with distance reduction and disutility associated with distance increase. It may be noted that the coefficients of distance are however not statistically significant. Also, in the process of model development, a linear coefficient for the distance variable has been tested but did not give intuitive results indicating that the magnitude of change in distance may not be properly perceived by the respondent and their decisions are affected only by the direction of change or that we need more data.

The coefficient "Current Option" captures the inertia to choose the current option in comparison to the new tolled bridge. The coefficient is however statistically not significantly different from zero.

Further analysis has been undertaken to investigate differences between those respondents whose SP choices were based around an existing journey across the Thames and those who were asked to imagine that their journey crossed the Thames. This analysis is reported in Appendix B4.

4. Conclusions

A number of aspects of the TGB pilot survey have gone well.

1. The survey recruitment procedure has been successful

- better success rate than expected with regard to RSI surveys
    - 23% of journeys recruited through RSI surveys crossed the Thames
    - 49% of respondents recruited through the RSI were not making a journey across the Thames, but had made a journey across the Thames in the last 3 months
    - 8% of respondents recruited through the RSI were not making a journey across the Thames, but had made a journey across the Thames in the last year
    - 20% of respondents recruited through the RSI were not making a journey across the Thames and had not made a journey across the Thames in the last year
- large proportion of respondents (77%) contacted through cold-calling had made a journey across the Thames in the last 3 months. An additional 11% had made a journey across the Thames in the last year.

2. The questionnaire itself worked reasonably well and the average time to undertake an interview was reasonable (17 min).

3. In general, respondents were able to understand the choice tasks and we therefore conclude that the telephone survey methodology, without posting choice materials, was successful. The use of this methodology is likely to have had a positive impact on success rates. We therefore propose to retain this methodology for the main surveys.

4. The majority of car drivers provided responses to both the household and personal income questions and thus we propose to retain both questions in the main survey.

5. Respondents have understood the experiment which compared their current alternative with a tolled bridge alternative (Experiment 2). Analysis of respondent trading and preliminary model analysis are promising, for the main study.

As expected, a number of aspects require amendment and/or discussion before the main survey.

1. Persons who made a trip across the Thames by car/LGV in the last 3 months were asked detailed questions about that recent trip. Those who did not make a trip across the Thames in the last 3 months were asked questions about their last general car/LGV trip, which would not have been across the Thames. Asking about Thames crossings in the last year could be potentially confusing for this latter group, particularly if they did make a journey across the Thames in the last year. We propose that for the main survey we either base the survey around the journey made in the last year, if one has been made, or drop this question. Our preference is to base the survey around the journey made in the last year, because tests (not reported) made of the second experiment indicate substantial differences between those respondents who actually made a trip and those who were asked to imagine that they would make a trip.

2. The most important problem in the pilot survey was a coding error in the first experiment, which had the results that respondents were only presented with two time levels: 5 minutes and 15 minutes. The result of this is that many of the choices are unlikely to have made much sense, particularly for longer journeys. We therefore would not expect the resulting models to be reliable, particularly with regard to the time term. We will test to ensure that the error is corrected in the main survey and will undertake an interim analysis after the first 50 surveys to ensure that the process is working correctly. The proposed time changes to be tested in the main survey are shown below.

3. Respondents indicated that many other alternatives presented in the first experiment were not realistic, certainly with regard to the costs presented. These are a result of the aim to test a wide range of values of time, including some very high values. We note that one of the criticisms of the UK and Danish VOT experiments was that the range was not large enough to cover the tail of the VOT distribution curve. We have therefore proposed to test a large range in the TGB study.

The following tables summarise the values of time tested in the experiment. Each respondent receives one value from each of the ranges.

Probably we could reduce the range investigated for LGVs, as this group is more money sensitive than was expected. We will review these values before the main survey.

Table B8: Proposed Boundary VOTs for TGB (£/hr) – Car, commute and 'other' purposes

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
1.00	2.50	3.75	4.75	6.00	8.00	12.00	20.00
1.25	2.75	4.00	5.00	6.50	9.00	13.00	24.00
1.50	3.00	4.25	5.25	7.00	10.00	14.00	28.00
1.75	3.25	4.50	5.50	7.50	11.00	15.00	32.00
2.00	3.50						36.00
2.25							40.00
							44.00
							48.00

Table B9: Proposed Boundary VOTs for TGB (£/hr) – Car, employer's business

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
2.0	5.0	7.5	9.5	12.0	16.0	24.0	40.0
2.5	5.5	8.0	10.0	13.0	18.0	26.0	48.0
3.0	6.0	8.5	10.5	14.0	20.0	28.0	56.0
3.5	6.5	9.0	11.0	15.0	22.0	30.0	64.0
4.0	7.0						72.0
4.5							80.0
							88.0
							96.0

Table B10: Proposed Boundary VOTs for TGB (£/hr) – LGV

Range 1	Range 2	Range 3	Range 4	Range 5	Range 6	Range 7	Range 8
2.0	5.0	7.5	9.5	12.0	16.0	24.0	40.0
2.5	5.5	8.0	10.0	13.0	18.0	26.0	48.0
3.0	6.0	8.5	10.5	14.0	20.0	28.0	56.0
3.5	6.5	9.0	11.0	15.0	22.0	30.0	64.0
4.0	7.0						72.0
4.5							80.0
							88.0
							96.0

4. Additionally, a number of minor amendments will be made to the routing of the questionnaire, as are listed in Appendix B1.

Lastly, we would like to reinstate Q69 and Q70 for the main survey. We proposed to include two additional questions in the pilot SP survey to understand whether respondents are familiar with the Thames Gateway Bridge proposals and if they are their views on these proposals, i.e.:

Q69: Are you aware of the Thames Gateway Bridge proposals?

1. Yes
2. No

And, if yes:

Q70: Are you in favour or against the Thames Gateway Bridge?

1. Strongly in favour
2. In favour
3. Neither
4. Against
5. Strongly Against

6 Don't know

These questions were not approved in time for the pilot survey and were therefore not included in the survey.

The purpose of including such questions is specifically to allow us to test whether respondents with strong views in favour or against the TGB have a substantial influence on the resulting time valuations, which are the main output from this study. In the survey, they are placed after the stated preference questions, which themselves do not make any mention of TGB, in an attempt to minimise bias as a result of such attitudes.

Without the information in Q70 we have no way of identifying such people and as such we cannot test for their influence on the resulting valuations. So, for example, if the sample contains a high proportion of people who are very strongly in favour of the TGB, we may underestimate the real sensitivity to cost and may produce inflated time valuations (and vice-versa if the sample contains a high proportion of people who are strongly against the bridge).

We would be happy to agree not to publish the findings of the question directly, except in the case where Q70 is found to strongly influence the time valuations whereby we would discuss the implication of the findings and the proposed methods to mitigate against bias in the results.

Appendix B1

Note on Thames Gateway Pilot from Accent

Background

Accent and RAND Europe were commissioned by Halcrow/TfL to undertake a study to assess prospective Thames Gateway Bridge (TGB) users' values of travel time.

The key objectives of the research are to undertake stated preference interviews with potential users of the TGB to determine local values of time. These valuations will feed into an assignment model which is likely to be segmented into the following user classes: car commute, car work, car other, LGV and HGV.

Methodology and Recruitment Method

We used a two-pronged approach for recruiting respondents for the SP survey:

- *RSI surveys* – recruitment from the RSI surveys that TfL commissioned near the Blackwall Tunnel. Respondents intercepted by the RSIs had been asked if they would be prepared to take part in a short telephone survey about travel plans in the local area. If they agreed then their names and telephone number were taken. Mention of an incentive was also made. At some locations the RSI surveys were supplemented by postal self completion cards. The RSI sample was also used to sample LGVs (under 3.5 tonnes). Overall, the sample comprises 2,299 names and phone numbers. Please note we still do not have permission to use the Greenwich contacts from 2006 congestion charging feasibility surveys, so this sample was not piloted.

- *Cold calling* – recruitment of respondents who live locally who are likely to use the TGB. We sampled residents from both sides of the Thames in the London Boroughs of Barking & Dagenham, Bexley, Greenwich, Newham and Tower Hamlets. Residents were asked about a specific car journey of over 20 minutes that they have recently made for a specific purpose, preferably across the River Thames. Respondents who made car journeys for a number of purposes were asked to consider one specific journey.

We assumed a 15-20 minute interview and offered a £5 incentive (Boots voucher) for each interview.

Pilot

The pilot was planned to sample 120 interviews car drivers split evenly between commuters, employers business and other purposes and 20 interviews with LGV drivers.

The pilot took place between 11 and 15 January 2008.

In practice we achieved 141 interviews. Just over half (72) were from the RSI sample and 69 were from cold calling. For the RSI sample we used 160 records, a 45% strike rate, which means that for the overall RSI sample we should be able to achieve the planned interviews despite having a smaller RSI sample than expected.

Overall 74% crossed the Thames on their trip. Of the RSI sample only 23% were crossing the Thames on the RSI trip so we sought another valid trip for those who didn't cross the Thames.

	Cold calling sample	RSI sample	Total
	n	n	n
Across Thames	51	54	105
No	15	21	36
Car	60	62	122
Van	6	13	19
Commuting	20	21	41
Employers business	19	21	40
Other purpose	21	20	41

The average length of the interviews was 17 minutes, and there was no noticeable difference between lengths of interviews of different types of respondent.

Overall, the pilot worked well and respondents understood the questions and gave sensible answers.

Although the stated preference exercises were understood (all respondents except one said they were able to understand the choice scenarios as they were presented) some found the levels presented unrealistic: 24% in the first exercise and 16% in the second. In particular, some specific high costs or large time savings were described as unrealistic.

There were some minor problems with the questionnaire. For example, there were some errors in some of the routeing so that, for example, not all the correct respondents were asked which crossing they used.

In addition there were some problems with the quota questions. These are necessarily complex as they deal with three sample sources as well as seeking in scope cross river trips for three car purpose groups and van. These issues will be resolved for the main stage.

Other detailed issues

A definition of commuting needs to be provided since some respondents say commuting when in fact they are on employer's business trips. We suggest "travel to or from normal workplace".

We need to collect name and address within the questionnaire so that we can post incentives.

Q1 Barking needs to be changed to Barking & Dagenham

Q29 "What would you say is the approximate cost per mile of using the van?" needs clarification as to what this includes, for example petrol, hire cost (if applicable), wear and tear.

In Q35 "How would you rate the overall level of traffic congestion during your journey?

extremely congested over most of the journey

moderate congestion, with occasional periods of heavy congestion

moderate congestion

little congestion, with occasional periods of moderate congestion

no or very little congestion"

the options don't cover some circumstances. For example, a few people were driving in from outer London or from outside of London and experienced next to no traffic for most of the length of the journey, but hit very heavy traffic in the centre. We could add option "little congestion, with occasional periods of heavy congestion".

Q44 "Thinking about the destination of that trip, how much did it cost you to park there?" It is not clear whether if the employer paid parking costs it should be recorded here.

Q55. "Thinking about this journey, how much would you have been prepared to pay, in addition to the costs you already pay, to save 15 minutes from this journey?" It is unclear how this should be answered for those on employer's business trips where all costs are paid by employer.

Q58 "Does your company pay for the fuel for your company car(s)?" Need to clarify whether this is for all trips in the company car, or just business trips.

Q60 "If you were to use your private car for business purposes, would your fuel costs be met by your company" Needs a 'not applicable' answer code as it would be impossible to use some vehicles for business trips.

In the stated preference some people who were driving for work and had all their costs met by their company were finding it very hard to answer the options, as it would not really be their choice, and they couldn't necessarily guess what their employer would stipulate that they do.

In the tolled bridge stated preference exercise some respondents were saying that they don't know whether their employer would let them use such a bridge or not in the course of their work journeys.

We suggest that the introduction to the stated preference explicitly deals with employer's business trips.

Q71 "Including full-time and part-time staff, approximately how many people work for your company?" should add "within the UK."

Q79 "Which of the following would best describe your occupation?" should have 'Other' added.

Q80 and Q81 incomes are in very small bands (£5k bands up to £40k) which means this takes a long time to read out. We suggest using broader bands.

Appendix B2: Thames Gateway Pilot Demographics

Cold Calling Sample Borough

	%
1 Barking & Dagenham	15
2 Bexley	47
3 Greenwich	11
4 Newham	15
5 Tower Hamlets	12
Base	66

Age (car drivers)

	%
1 18-24	5
2 25-34	23
3 35-44	33
4 45-54	31
5 55-64	17
6 65 or more	5
7 Refused	1
Base	122

Employment status (car drivers)

	%
1 Full time paid employment	68
2 Part time paid employment	14
3 Full time self-employment	13
5 Student/school pupil	1
7 Unemployed	2
9 Retired	10
10 Looking after home/family	5
11 Other	1
Base	122

Household income (car drivers)

	%
1 Less than £5,000	1
2 £5,000 - £9,999	4
3 £10,000 - £14,999	2
4 £15,000 - £19,999	3
5 £20,000 - £24,999	7
6 £25,000 - £29,999	3
7 £30,000 - £34,999	9
8 £35,000 - £39,999	7
9 £40,000 - £49,999	15
10 £50,000- £74,999	15
11 £75,000- £99,999	9
12 £100,000 or more	10
13 Refused	9
14 Don't know	6
Base	122

Personal income (car drivers excluding those in one person households)

	%
1 Less than £5,000	5
2 £5,000 - £9,999	8
3 £10,000 - £14,999	5
4 £15,000 - £19,999	11
5 £20,000 - £24,999	17
6 £25,000 - £29,999	6
7 £30,000 - £34,999	8
8 £35,000 - £39,999	4
9 £40,000 - £49,999	14
10 £50,000- £74,999	7
11 £75,000- £99,999	4
12 £100,000 or more	1
13 Refused	10
14 Don’t know	1
Base	107

Ethnic Group (car drivers)

	%
1 White - British	78
3 White - any other white background	2
4 Indian	2
5 Pakistani	2
6 Bangladeshi	2
8 Caribbean	2
9 African	4
11 White and Black Caribbean	3
13 White and Asian	1
15 Chinese	1
16 Any other	2
17 Refused	1
Base	122

Gender (car drivers)

	%
1 Male	54
2 Female	46
Base	122

Appendix B3

Interpretation of Stated Preference Experiment Results

In reporting the models a number of model fit statistics has been presented. These are described in Table B11.

Table B11: Model fit statistics

Statistic	Definition
Observations	The number of observations included in the model estimation.
Final log (L)	This indicates the value of the log-likelihood at convergence. The log-likelihood is defined as the sum of the log of the probabilities of the chosen alternatives, and is the function that is maximised in model estimation. The value of log-likelihood for a single model has no obvious meaning; however, comparing the log-likelihood of two models estimated on the same data allows the statistical significance of new model coefficients to be assessed properly through the Likelihood Ratio test.
D.O.F.	Degrees of freedom, i.e. the number of coefficients estimated in this model. Note that if a coefficient is fixed to zero then it is not a degree of freedom.
$Rho^2(0)$	The rho-squared measure compares the log-likelihood (LL(final)) to the log-likelihood of a model with all coefficients restricted to zero (LL(0)): $Rho^2(0) = 1 – LL(final)/LL(0)$ A higher value indicates a better fitting model.
$Rho^2(c)$	If we compare the log-likelihood (LL(final)) value obtained with the log-likelihood of a model with only constants (LL(c)) we get: $Rho^2(c)$: 1 – LL(final)/LL(c) Again a higher value indicates a better fitting model.

In interpreting the coefficient values the following points should be considered.

- **A positive coefficient** means that the variable level or constant has a positive impact of utility and so reflects a higher probability of choosing the alternatives to which it is applied.
- **A negative coefficient** means that the variable level or constant has a negative impact on utility and so reflects a lower probability of choosing the alternative to which it is applied.
- **Some coefficients are multiplied by continuous variables** and therefore reflect the disutility per unit of the variable, e.g. time and cost, which reflect the relative disutility per minute and per pound (or pence), respectively.
- **Categorical variables may be applied to continuous variables**; these therefore reflect the total utility increase or decrease for that variable, relative to a base situation, e.g. we may find that high income respondents have a different value of cost relative to other travellers.
- **The constants in each model** reflect preferences for the alternatives to which they are applied. For example, some groups of people may have a higher disutility for a tolled option, regardless of the costs and time savings.

- **A *positive* value for a constant** indicates that the respondent is *more likely* to choose that alternative, and a ***negative* value** indicates that the respondent is *less likely* to choose that alternative.

The value shown after each coefficient estimate is the t-ratio. This defines the (statistical) significance of the coefficient estimate; regardless of the sign, the larger the t-ratio, the more significant the estimate. A coefficient with a t-ratio greater than +/-1.960 is estimated to be significantly different from zero at the 95% confidence level. A t-ratio of +/-1.645 is significantly different from zero at the 90% confidence interval. We generally seek to estimate coefficients that exceed the 95% confidence interval, although this is not possible with the amount of data available at this stage.

Appendix B4

Testing for effects of river-crossing experience of the respondents

In this section, we investigate if there is any difference in VOT among these two groups of respondents:

- Group1: Respondents who crossed Thames in the last 3 months
- Group2: Respondents who did not cross Thames in the last 3 months

In the pilot survey, 105 respondents (75% of the sample) stated that they had crossed Thames in last 3 months. One of these respondents has been dropped from the analysis discussed here, because of problems in their journey costs. For these respondents, the 'Current Option' in Experiment 2 was based on their actual river crossing trip. For the remaining respondents (25% of the sample), the respondents were asked about a hypothetical trip that involved crossing the Thames (imagining that they were making a journey similar to a recent general trip but to a destination on the other side of the river). There is a possibility that for these respondents, the second experiment may lack behavioural realism, and thus may affect their stated responses.

The trading behaviour observed in the two groups is presented in Table B12. As shown in the table, respondents who did not cross river in last 3 months have a lower tendency to choose the current (cheapest) option that is they have less inertia for the current option and/or have more willingness to pay.

Table B12: Trading behaviour based on river-crossing experience of the respondent

	Crossed Thames in last 3 months	Did not cross Thames in last 3 months
Always Current Option	24.27%	13.89%
Always Tolled Bridge	4.85%	8.33%
Always Cheapest	24.27%	13.89%
Always Fastest	4.85%	5.56%
Always Slowest	17.48%	8.33%
Always Shortest	0.00%	0.00%

The presence of systematic differences in VOT among the two groups was also tested in the model estimation stage using a likelihood ratio test (see Ben-Akiva and Lerman 1985 for details). The unrestricted model here represented the model with different sets of coefficients for the two groups of respondents. In the restricted model assumed same coefficients were assumed for both groups. The results are presented in Table B13.

Table B13: Comparison of estimation results

Unrestricted Model				
Observations	1112			
Final Log Likelihood	-541.6			
D.O.F.	14			
	Group 1 (crossed Thames in the last 3 months)		Group 2 (did not cross Thames in the last 3 months)	
Variables	Coefficients	t-stats	Coefficients	t-stats
Travel Time	-0.0937	-8.80	-0.0532	-2.60
Cost - car commute/other trips	-0.657	-9.70	-0.764	-6.50
Cost - business trips	-0.384	-6.40	-0.812	-5.20
Cost – LGV	-0.634	-5.60	-1.25	-4.10
Distance reduction	0.145	-0.60	-0.297	-0.80
Distance increase	-0.0823	-0.40	0.130	-0.40
Current Option	0.490	1.50	-1.18	2.20

Restricted Model		
Observations	1112	
Final Log Likelihood	-553.0	
D.O.F.	7	
Variables	Coefficients	t-stats
Travel Time	-0.0847	-9.00
Cost - car commute/other trips	-0.677	-11.70
Cost - business trips	-0.459	-8.20
Cost – LGV	-0.737	-7.10
Distance reduction	0.00240	0.00
Distance increase	-0.0652	-0.40
Current Option	0.0394	0.10

Degrees of freedom=7

At 95% Level of Confidence, $\chi^2_{cr}(7) = 14.07$

Likelihood Ratio $= -2\left(L_R - L_{UR}\right) = 22.8 > \chi^2_{cr}(7)$

As seen in the table, the unrestricted model was statistically better than the restricted model at 95% level of confidence indicating that the coefficients are significantly different for the two groups.

Appendix C: The Jack-Knife Procedure

The jack-knife is a parametric approach to estimate the "true" standard errors of estimates in cases where the theory does not provide an exact estimate of the error. The repeated observations for each respondent in a stated preference survey, for instance, are expected to be correlated because the individual has a specific value of time, for example, and accordingly the theoretical estimate of the standard errors of the parameters estimated from this data will not be exact. It is possible to explicitly model this correlation between observations using panel analysis techniques, and in the case of logit choice models a mixed logit formulation. However, this would necessitate the transfer of the model to a different modelling package where we may find disadvantages in other aspects of the modelling, e.g. limitation in reporting and data analysis features. For the purposes of this project, we have therefore employed the jack-knife technique to provide an improved estimate of the standard errors over those provided by the naive estimation that assumes independence between observations.

The jack-knife works by dividing the sample into R non-overlapping random sub-samples of roughly the same size, where R should be at least 10, and in the case of these runs a value of 20 has been used. The procedure is set up such that all observations from a given individual fall in the same sub-sample. One model is then estimated on the full sample and then R additional models are estimated each excluding one of the sub-samples in turn. Each estimation is therefore performed on approximately (R-1)/R of the observations.

For a given variable, suppose that we get estimate β_0 from the full sample, and an estimate β_r for each of the sub-samples r = 1 to R.

The jack-knife estimate of β is then:

$$\beta \quad = \quad R * \beta_0 - (R-1)/R * \Sigma_{r=1,R}\, \beta_r$$

The variance of that estimate is:

$$\sigma^2(\beta) \quad = \quad (R-1)/R * \{ (\Sigma_{r=1,R}\, \beta_r^2) - (\Sigma_{r=1,R}\, \beta_r)^2 / R \}$$

In general, the application of the jack-knife procedure to SP data has confirmed that the coefficient estimates themselves are not greatly affected by the specification error of assuming independent observations. However, the significance of the coefficient estimates is often substantially overstated by the naïve estimation. Thus, when there is an important issue about the significance of a specific variable, it is necessary to test that variable in a jack-knife procedure rather than in a naïve estimation. Generally it is found that when variables are significant at very high levels in a naïve estimation, they remain significant in the jack-knife estimation; but when the significance of a variable in the naïve estimation is marginal, a jack-knife estimation may show that it is not truly significant.

A number of other methods can be used to correct for the interdependence among multiple observations from the same respondent: examples include boot-strap (Efron 1979), and models with specifications that explicitly estimate terms that capture the serial correlation among observations e.g. error component models, mixed logit models with distributions of time and/or cost or VoT). Each approach has benefits and draw-backs, both theoretical and practical (Ouwersloot and Rietveld 1996, Cirillo et al. 1998, Ortúzar et al. 2000, Daly et al. 2008). In particular, the users are referred to the findings of Daly et al. (2008) for comparison of the performance of some of the methods with an empirical analysis using a real-world transport application.