UNIVERSITY OF LEEDS

M6 TOLL STUDY: MODELLING OF PASSENGER CHOICES

FINAL REPORT

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Executive Summary

The M6 Toll road (M6T) is the United Kingdom's first toll motorway. The 27 mile (43km) three lane motorway was designed to alleviate traffic congestion around Birmingham and was built under a public-private partnership scheme. The road was fully opened on 14th December 2004 and generated £45 million in revenue in its first full year of operation. On opening, the standard toll for cars was £2 but this has increased significantly to a current charge of £4. Its existence supports a range of choice modelling opportunities using Stated Preference (SP) and Revealed Preference (RP) data.

The research reported here was conducted as part of the project "A Study of the Impact of M6 Toll Road, Stage 2: Travel Demand Analysis, Utilisation and Willingness to Pay Study" undertaken by a consortium of Faber Maunsell, the Institute for Transport Studies University of Leeds, Hugh Gunn Associates and 4Cast. It covered both passenger and freight traffic and both willingness to pay research and detailed profiling of M6T users.

This document is concerned with passenger traffic and with motorists' willingness to pay toll to save time. Other reports cover the analysis of the freight market (Fowkes et al., 2008) and the characteristics of M6T use and users (Faber Maunsell, 2008). The results reported here are being used in application software to determine the impact of different tolling scenarios on the demand for the tolled road and on the surrounding road network.

The principal aims of this analysis of private motorists' behaviour were to:

- Develop a transferable model explaining motorists' willingness to switch to a tolled route to save time;

- Explain the extent to which motorists might change departure time as well as route in response to off-peak pricing or time savings.

The study objectives did not cover other dimensions of travel decision making, such as mode, destination or frequency choice. These are regarded to be less significant behavioural responses in the context of the provision of new tolled roads.

Within these broad objectives, we wished to account not only for time-toll trading but also to examine the extent to which a broad range of other attributes, relating to traffic conditions and the infrastructure, might influence motorists' decision making. We therefore set ourselves a range of research hypotheses to investigate, in line with the wide range of issues that we stated would be addressed in our proposal. We also took the opportunity to address some issues of a methodological nature.

The hypotheses we set out to test are broadly categorised into: whether they relate to how motorists respond to a range of variations in journey cost, including toll and fuel, and in time, including departure and in-vehicle time; the extent to which aspects of SP design and presentation influence the empirical findings; the heterogeneity of preferences across motorists; and a range of residual modelling issues.

Cost Hypotheses

- Does the response to toll depend upon the level of toll charge?
- Are there differences in sensitivity to higher and lower tolls?

- Does the reported sensitivity to toll depend upon whether tolls are being varied on an existing tolled motorway, whether tolls are being introduced on an existing untolled motorway or whether the toll charge is part of a possible new motorway?
- To what extent are fuel costs accounted for in route choice and, where they are, how does the fuel cost and toll coefficients compare?

Time Hypotheses

- Does the sensitivity to time variations differ according to the conditions of travel? At its simplest, are route specific time valuations apparent? More generally, we wish to test if the time sensitivity depends on a range of driving conditions and infrastructure.
- Is the sensitivity to time savings influenced by the duration of the actual journey in which it is offered?
- Do the benefits per minute of time saved depend upon the amount of time saved?
- Do earlier and later departures than desired have the same disutility?
- Are the unit valuations of earlier and later time dependent upon the extent of the departure time shift?
- How does variability in travel time influence behaviour and what is its value relative to mean travel time?

SP Specific Hypotheses

- Does offering travel times as differences relative to another route yield different valuation estimates than when absolute time values are used?
- Is the sensitivity to time and toll dependent upon the number of alternatives offered in the SP exercise and the number of other attributes included?
- How are the coefficient estimates impacted by the degree of realism with which respondents perceive the attributes offered to them?
- Does purchasing a time saving made up of three separate toll roads lead to a different valuation than if the same time saving is purchased as an extended toll motorway?

Preference Heterogeneity

- How are the sensitivities to time and cost systematically influenced by socio-economic and trip characteristics?
- To what extent is there random variation in preferences across the sample?

Other Issues

- To what extent can route specific constants be unpacked into valuations relating to a range of variables not typically entered into route choice models?
- Does the presence of information relating to traffic conditions have a bearing on route choice?
- To what extent are the SP responses and parameters estimated on them corroborated by RP evidence?
- How does the value of time vary over time, and are there differential rates of growth according to whether the numeraire in which the monetary valuation is expressed is toll or other driving costs?

The existence of the M6T as the first tolled motorway in Great Britain provides an ideal real-world context upon which to base SP experiments exploring time and cost trading through route choice. It will be familiar to the vast majority if not all of those

travelling in the corridor and it allows an opportunity to validate the SP responses and parameters against actual choices.

Given the wide range of issues we wished to explore, a large number of SP experiments have been designed. A series of focus groups (Faber Maunsell et al, 2006) contributed to the specification of these SP exercises and the range of attributes to cover. The SP exercise can be broadly categorised into:

- Route choice exercises
- Route and Departure time choice exercises
- Abstract choice exercises

The route choice SP exercises reported here offered choices within a corridor as part of a longer journey. The corridors were:

- The 27 mile M6T corridor
- An 80 mile corridor between M6 Junction 16 (Stoke) and the M1 Junction 18
- A 150 mile corridor between M6 Junction 19 (Knutsford in Cheshire) and M1 Junction 11 (Dunstable in Bedfordshire)

Variations within these generic SP types were created in terms of the number of attributes and alternatives included, the range of toll charges and time savings, the means of presentation, and extensions to the existing M6T or completely new tolled motorways.

In addition, a series of SP route choice exercises, based around end-to-end journeys of different durations, addressed the issue of travel time variability. They offered the possibility of paying a toll to travel via the M6T which was characterised by fewer variables and on average quicker journey times.

The route and departure time choice exercises were based around the M6T corridor the Stoke-M1 corridor. These contained four alternatives, the M6 and the M6T each at the current departure time and some different departure time. Motorists were offered the possibility of saving time and of paying lower tolls by changing their departure time.

The abstract choice exercises presented choices between ‘unlabelled alternatives’ (A and B). One of these aimed to estimate the relative valuation of time spent driving in six different types of traffic. The other two were aimed at obtaining time valuations of infrastructure characteristics and road conditions. These were: lane width, number of lanes, proportion of HGVs, road surface, information provision, speed cameras and lighting.

We also conducted a repeat of the 1994 UK value of time study SP exercise for motorway users. This was conducted amongst those intercepted who were not in-scope for the SP exercises based around the possibility of using the M6T. The aim of this aspect of the study was to test whether the sensitivity to toll charge exhibited the same variation over time as the sensitivity to other driving costs. It would also contribute to the limited evidence base relating to inter-temporal variations in the value of time.

In addition, the SP data is supplemented with RP data relating to actual choices between the M6T, the existing M6 and an A road alternative.

All the SP exercises were administered as mail-back self completion questionnaires. Surveys were conducted in November 2006 at road-side interview sites, motorway service areas and through postal contact of a database of M6T users. All respondents were presented with two SP exercises. The first covered a route choice context whilst the second was generally one of the abstract choice contexts but was in some cases a route choice exercise. Completed questionnaires were returned by 3235 motorists, yielding 29158 SP choice observations. The repeat of the 1994 SP exercise yielded 787 motorists and almost 6000 choice observations.

Extensive analysis has been conducted on the large amount of data collected. In general, the data appears to be of good quality and supports the development of robust SP and RP models which have generally provided very reasonable results covering a wide range of issues. A considerable amount of fresh empirical evidence is presented that contributes significantly to the existing body of evidence in this area, with some results providing new insights into motorists' behaviour and preferences in the context of inter-urban journeys.

The basic models yield a value of time of around 10 pence per minute for non-business travel. This is very much in line with previous research for longer distance car travel. However, as is often the case in SP studies, the value of time of around 12 pence per minute for business travellers was only a little higher.

The route choice analysis does not support a different value of time for the M6T relative to the M6. This was confirmed in the abstract choice SP exercise which dealt with this issue. Nor is there compelling evidence for a higher value of time on A roads. To some extent this conflicts with evidence we have found in support of the value of time varying with traffic conditions.

Numerous studies have found the value of time to increase with journey duration. We found both the preference for the M6T and also the value of time (but not both simultaneously) to increase with journey duration. The effect on the value of time was confirmed in the RP data. The values of time for different journey times and the associated elasticity implied by our SP modelling are as follows:

	VoT	**Elas**
30m	7.54	0.06
60m	7.93	0.09
120m	8.57	0.14
180m	9.12	0.17
240m	9.62	0.20
300m	10.08	0.22

We have here offered times savings which are large by the standards of typical SP studies. In place of time savings of the order of 2, 5, 10 and 15 minutes, we have offered savings of 15, 30, 45 and 60 minutes and indeed some in excess of an hour. Despite this, we have not found any compelling support for the unit value of time varying by the size of the time saving. This is not though to say that the unit value of time does not differ for very small time savings.

A wide range of toll charges were covered across the large number of SP exercises. There was a greater degree of sensitivity to toll charges that were an increase on the then prevailing toll level of £3.50 than for reductions. The toll coefficient is 13% higher for increases, consistent with evidence from meta-analysis that toll charge is associated with a higher level of disutility than other costs presumably due to protest

response. However, the introduction of tolls on the existing M6 did not attract any protest. The toll coefficient is 38% lower when an entirely new motorway is being considered and 15% lower when relating to an extension of the M6T. In the latter cases, any protest towards tolls may be expected to be tempered by a desire to see new and improved motorways and respondents could be expected to have a stronger desire to see a new motorway than an extension to the M6T. They may therefore inflate their stated willingness to pay. We might therefore treat responses to choice experiments which deal with new motorways with some caution

When we account for the employer paying the toll, the toll coefficient for reductions in tolls is very similar to the fuel price coefficient for those who stated that they took fuel costs into account in making their stated choices. This is encouraging. It also suggests that it is the toll coefficient for reductions that are the most appropriate to use.

When we do not account for the 65% who do not consider fuel costs in their SP responses, the fuel cost coefficient falls by 69%. This draws into some doubt values of time based either in part or entirely upon a fuel cost numeraire when no account has been made for those who do not consider fuel. However, for forecasting purposes, it is appropriate to use separate coefficients for the two types of motorist.

The value of earlier and later departures is very similar and the unit value varies little between one and two hour departure time shifts. A minute of departure time shift is equivalent to 0.4 minutes of in-vehicle time and this seems reasonable.

We tested the impact of a wide range of socio-economic and trip characteristics on how motorists respond to time and cost variations and on their preferences for the M6T over the other routes all else equal.

We found a strong and monotonic effect from the perceived level of reliability of each route. This had the effect of reducing the alternative specific constants (ASCs) favouring the M6T but by no means did it remove them. Compared to a perceived very unreliable route and for the average journey of around 2½ hours, a very reliable route was worth around 20 minutes, a reliable route was worth 14 minutes, a sometimes reliable route was worth 9 minutes and an unreliable route was worth 4 minutes.

There was a monotonic reduction in the toll coefficient across 6 household income categories, ranging from less than £20,000 to over £100,000 per annum. Whilst such a relationship is impressive by the standards of much empirical evidence, the effect on the value of time was surprisingly weak, implying an income elasticity of 0.2 or less when SP studies typically achieve a cross-sectional income elasticity of around 0.5.

A random parameters model, which allowed the toll coefficient to follow a lognormal distribution for each income group, extended the monotonic relationship to 9 income categories. This is the most impressive freely estimated effect that we are aware of in an extensive literature on this subject.

There were only a limited number of other statistically significant effects from a large number of socio-economic, attitudinal and trip factors that were tested. The only effect discerned on the time coefficient was for those travelling with other adults where the value of time was around 10% less.

The ASCs favouring the M6T were found to vary with several factors. Those who would never consider using the M6T were implied to have a negligible ASC. Whilst males and those who object to paying tolls had a weaker preference for the M6T and those aged over 65 and those with others in the car were more inclined to the M6T, the effect on the M6T is less than 33%.

We tested whether offering journey times as changes on the current level rather than as absolute amounts impacted on the coefficient estimates. We also tested whether the perceived credibility of the times and costs offered had a bearing on the responses provided. We have concluded that there is no evidence to support variations in the time coefficients according to whether time is presented in absolute or difference form. Nor does the means of presentation impact on the scale of the model whilst presenting differences does not induce size effects that are not present when absolute values are offered. The perceived credibility of attributes does not impact on their coefficient estimates and does not have a large impact on the scale of the model. This is, though, in the context that only one attribute was presented in difference form, whereas it is not uncommon that SP exercises present several attributes in difference form, and of course it is possible that credibility varies across SP scenarios whereas we here simply asked for an overall evaluation across all scenarios.

The travel time variability SP exercise has not produced credible results. This is despite following what is now a fairly standard approach in this context of offering five varying journey time scenarios and arguably having a relatively realistic scenario where the M6T provided a means of achieving both quicker and less variable journey times rather than the more typical but less realistic trade-off of less variability but at the expense of longer average times.

It is not uncommon that studies of motorists' time valuations distinguish between different types of time. The simplest distinction is between free flow and congested time but some recent studies have specified three categories of free flow, slowed down and stop-start. We have here distinguished between six categories of time. The types of time and relative valuations are:

Free Flow	1.00
Busy	1.05
Light Congestion	1.11
Heavy Congestion	1.31
Stop Start	1.20
Grid Lock	1.89

Whilst not a monotonic effect, the results are both impressive and original. They correspond reasonably with a valuation of around 1.5 in the British context which is obtained for the valuation of what is termed congested time relative to free flow.

The other abstract choice exercises also provided a number of interesting findings. The value of time would increase by 0.7% for every percentage point increase in the proportion of HGVs on a route. We were also able to detect an effect from the proportion of HGVs on actual route choice.

Wide lanes (3.75m) reduce the value of time by 5% compared to standard lanes (3.35m) whilst narrow lanes (3.0m) increase the value of time by 9%. 4 lane motorways would have a 7% lower value of time compared to standard 3 lane motorways whilst 2 lanes motorways would increase the value of time by over 10%.

Deteriorations in standards therefore seem to be more highly valued than improvements.

With regard to road surface, which can impact on both noisiness and ride quality, a concrete surface adds 12% to the value of time compared to a standard surface whilst high level jointed sections of motorway increase the value of time by 9%. However, as in the route choice models, there is no justification for distinguishing between the disutility of travel time on the M6 and M6T surfaces. It would seem that it is the noise associated with the road surface rather than the ride quality that drives the different values of time.

An additional speed camera on a journey is valued at 1.26 minutes whilst the presence of lighting reduces the value of time by 10%.

We have been able to develop what seem like robust RP models which provide a firm basis for rescaling of the SP parameters to e consistent with actual choices and thereby appropriate for forecasting. Combining the RP and SP data in a jointly estimated single model does not materially alter the results obtained by the stand-alone SP model. The scale parameters estimated indicate that the SP based parameters would have to be inflated by a factor of 1.5 for forecasting purposes. We proceeded to introduce random taste variation into this model for the alternative specific constants relating to the M6T and for the sensitivity to toll. The taste variation that is present is not particularly large, consistent with the limited variations in model parameters according to socio-economic characteristics.

These joint models provide a suitable means for forecasting the effects of different toll scenarios and different time saving benefits on the demand for a tolled road and on the surrounding road network. Another aspect of the study is undertaking this task. Despite covering a large number of variables and allowing the time coefficients to vary by route, we are left with relatively large constants favouring the M6T which we have been unable to 'unpack' into the factors causing this preference. However, this is not just present in the SP models but also manifests itself in the RP data to a broadly similar degree.

The repeat of the 1994 study turned out to be a well worthwhile exercise conducted at low marginal cost as part of the main data collection exercise. As with other studies that have conducted repeat exercises, there is evidence that the value of time is not increasing anything like in line with income as the Department for Transport's conventions would predict. Indeed, as is apparent in other repeat studies of motorists' choices, there is evidence that the value of time is falling over time.

As for preferences towards toll and other driving costs, there is no support for differential rates of change over time. We might have expected motorists to become less sensitive to toll, much as they became less sensitive to parking charges over time, once they became accustomed to such charges. However, this is not empirically supported.

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1. INTRODUCTION

1.1 Aims

The invitation to tender stated that:

> *"The principal aim of this study is to understand how toll levels on an interurban trunk road influence travel demand in circumstances where there is a choice between a tolled route and alternative free routes*.
>
> *This understanding needs to be both detailed and quantitative. It should enable predictions to be made of the effects of different toll levels on travel patterns, and on traffic levels, by type of user, at different time periods and on different sections of the toll road, and on related sections of the surrounding network. The resulting quantitative representation of demand for the toll road needs to incorporate a broad range of behavioural and attitudinal factors that are known to influence travel, the available alternatives to the toll road, the influences of congestion and travel time reliability and other perceived attributes of the available travel alternatives.*
>
> *This study will use these findings to obtain a detailed quantitative analysis of tolling policies on a major interurban tolled facility. Whilst the principle focus is on the analysis of travel demand, the achievement of the study objectives will require the design, building and use of a simple strategic model of the West Midlands road network".*

In the light of this and our research proposal, the inception report (Faber Maunsell et al., 2006) stated that:

> *"……. the focus of the study is a generic understanding of the influence of tolls on traveller choice in an interurban context and not an evaluation study of the M6T road per se. The opening of the M6T road provides a unique opportunity to conduct the required research in an environment where:*
>
> - *travellers are actually faced with a choice, and hence make real decisions with regards to tolls*
> - *the profile of M6T users can be defined and*
> - *the change in travel demands and patterns across the area has been monitored with a specific view to identifying changes brought about by the M6T.*
>
> *It is very important to understand this distinction between a study of the M6T impact, which this stage of the work is not, and a study to provide better understanding and informed decision making based around the M6T as a convenient case study.*
>
> *Our interpretation of the overall objectives, derived from our review of the brief and a series of discussions with DfT representatives and the Steering Group during the Inception Phase, is that:*
>
> - *the study is to provide an improved understanding of how to model toll roads*
> - *the study is to provide clear evidence of the main traveller responses to tolls and their relative magnitude and importance*

- *the study is not an evaluation of the M6T*
- *the study should ideally assist the DfT in forming a view as to the success, or overall value for money, of interurban toll roads.*

Underlying the above is the paramount need to establish the key drivers of choice in a tolled environment, the appropriate market segmentation to enable adequate modelling of responses, and the sensitivity of responses to changes in toll."

Given these overall objectives, the aims of this analysis of private motorists' behaviour undertaken as part of this study were to:

- Develop a transferable model explaining motorists' willingness to switch to a tolled route to save time;

- Explain the extent to which motorists might change departure time as well as route in response to off-peak pricing or time savings.

The study objectives did not cover other dimensions of travel decision making, such as mode, destination or frequency choice. These are regarded to be less significant behavioural responses in the context of the provision of new tolled roads.

Within these broad objectives, we wished to account not only for time-toll trading but also to examine the extent to which a broad range of other attributes, relating to traffic conditions and the infrastructure, might influence motorists' decision making. We therefore set ourselves a range of research hypotheses to investigate, in line with the wide range of issues that we stated would be addressed in our proposal.

1.2 Research Hypotheses

A key aspect of the research was not only to estimate models to explain motorists' propensity to use tolled roads to save time, but was to test a number of methodological issues, and these have influenced the range of SP exercises that have been designed. These research hypotheses stem from our interpretation of the issues that needed to be examined given the overall objectives of the research.

The hypotheses we set out to test are broadly categorised into: whether they relate to how motorists respond to a range of variations in journey cost, including toll and fuel, and in time, including departure and in-vehicle time; the extent to which aspects of SP design and presentation influence the empirical findings; the heterogeneity of preferences across motorists; and a range of residual modelling issues.

Cost Hypotheses

- Does the response to toll depend upon the level of toll charge?
- Are there differences in sensitivity to higher and lower tolls?
- Does the reported sensitivity to toll depend upon whether tolls are being varied on an existing tolled motorway, whether tolls are being introduced on an existing untolled motorway or whether the toll charge is part of a possible new motorway?
- To what extent are fuel costs accounted for in route choice and, where they are, how does the fuel cost and toll coefficients compare?

Time Hypotheses

- Does the sensitivity to time variations differ according to the conditions of travel? At its simplest, are route specific time valuations apparent? More generally, we wish to test if the time sensitivity depends on a range of driving conditions and infrastructure.
- Is the sensitivity to time savings influenced by the duration of the actual journey in which it is offered?
- Do the benefits per minute of time saved depend upon the amount of time saved?
- Do earlier and later departures than desired have the same disutility?
- Are the unit valuations of earlier and later time dependent upon the extent of the departure time shift?
- How does variability in travel time influence behaviour and what is its value relative to mean travel time?

SP Specific Hypotheses

- Does offering travel times as differences relative to another route yield different valuation estimates than when absolute time values are used?
- Is the sensitivity to time and toll dependent upon the number of alternatives offered in the SP exercise and the number of other attributes included?
- How are the coefficient estimates impacted by the degree of realism with which respondents perceive the attributes offered to them?
- Does purchasing a time saving made up of three separate toll roads lead to a different valuation than if the same time saving is purchased as an extended toll motorway?

Preference Heterogeneity

- How are the sensitivities to time and cost systematically influenced by socio-economic and trip characteristics?
- To what extent is there random variation in preferences across the sample?

Other Hypotheses

- To what extent can route specific constants be unpacked into valuations relating to a range of variables not typically entered into route choice models?
- Does the presence of information relating to traffic conditions have a bearing on route choice?
- To what extent are the SP responses and parameters estimated on them corroborated by RP evidence?
- How does the value of time vary over time, and are there differential rates of growth according to whether the numeraire in which the monetary valuation is expressed is toll or other driving costs?

1.3 Beyond Scope

We do not claim that the behavioural research reported here is entirely original. Rather it does provide some new insights into travel behaviour and adds to the existing body of evidence in the broad areas of travel choice modelling, the demand for tolled roads and stated preference.

This study does not contain a review of relevant literature and it was beyond the scope of the study to search for other empirical evidence against which to appraise our findings. Nonetheless, where we have readily been able to compare results with other evidence we have done so.

1.4 Structure of Report

Chapter 2 sets out the principles underpinning the numerous SP designs that have been used whilst chapter 3 describes the SP designs in detail.

Data collection and key characteristics are covered in chapter 4 and the approach to modelling is detailed in chapter 5.

Chapter 6 reports initial route choice models, describing the process of pooling data from different designs.

Chapter 7 reports the results of the hypothesis tests addressed by the route choice models and reports a preferred SP multinomial logit model prior to incorporating RP data and addressing random taste variation.

The design and presentational issues relating to SP exercises that have been addressed in this study are reported in chapter 8.

Chapter 9 reports on the travel time reliability SP route choice exercise whilst the abstract choice SP exercises dealing with travel time and road conditions are discussed in chapter 10.

Chapter 11 reports the RP models, both as stand alone models and jointly estimated with the SP data, and also specifies random parameters models.

This study has repeated the 1994 UK National Value of Time Study's motorway user SP exercise. Chapter 12 reports analysis of both the newly collected data and the 1994 data.

Concluding remarks are provided in chapter 13. The appendices provide details of the SP exercises used and also reproduce the questionnaires used.

2. PRINCIPLES UNDERLYING STATED PREFERENCE DESIGNS

The list of issues raised above required three basic designs. These are:

- A route choice exercise
- A combined route choice and departure time choice exercise
- Abstract choice exercises containing 'unlabelled' alternatives

All the SP exercises had to be designed within the constraints of a self-completion paper based questionnaire. The emphasis placed on ensuring the sample was drawn at random from the overall database of travellers combined with the time restrictions for interviews at the toll booths and roadside interview points and the wide geographical dispersion of trips meant that a paper-based approach was effectively imposed. Hence the flexibility afforded by computer presentation was not available.

Standard orthogonal fractional factorial designs have been used. These have the property of zero correlation amongst the attributes. This zero correlation is not maintained when we pool across different designs, although this process does not induce large correlations, and indeed zero correlation of input variables does not imply zero correlation of logit coefficient estimates. Other design principles offer the prospect of achieving more precise coefficient estimates but the practical benefits of such approaches are not proven. In any event, the sample sizes aimed for here can be expected to support the estimation of robust models.

Respondents were offered two SP exercises. The first was always a route choice exercise involving eight out of a set of sixteen scenarios. The second SP exercise could be any one of the three generic types of exercise, but with an emphasis on covering departure time choice and the various traffic and infrastructure related variables addressed by the abstract choice exercises. The full set of combinations of questionnaires offered is listed in Appendix 1.

2.1 Route Choice

The existence of the M6T as the first tolled motorway in Great Britain provides an ideal real-world context upon which to base SP experiments exploring time and cost trading through route choice. It will be familiar to the vast majority if not all of those travelling in the corridor and it allows an opportunity to validate the SP responses and parameters against actual choices.

This context also allows important insights into the contentious issue of stated response to toll variations. The incentives to strategic biasing of responses to toll variations when a toll exists in practice may well be different to the incentives that exist when tolls are introduced on an existing, free motorway or when a new motorway funded by tolls is being considered.

Given a paper based means of presentation, and that we are basing the SP exercise around an actual rather than hypothetical journey, the requirement that realistic attributes are offered to respondents can be dealt with in three possible ways:

- The SP exercise can be based on the current journey, with a series of different SP exercises produced according to journey duration and screening of motorists in order to allocate the most suitable design.

- The SP exercise could be based around the current journey, but with attributes other than toll specified as variations on the current levels.

- The SP exercise could offer choices which relate to a specific section of a journey, with all else held constant.

We opted for the final approach for the standard route choice exercises that did not cover reliability.

The first option would have involved the creation of a great many additional questionnaires whilst the necessary screening at roadside interviews was deemed at worst impractical and at best very costly. In any event, large parts of the journey are common regardless of whether the M6T is chosen or not and hence we do not have to consider these as a variable from a modelling perspective.

With regard to the second option, it is in our view preferable to present absolute values rather than changes relative to some reference point, particularly given that in some designs several attributes would have to be specified as variations. Nonetheless, we do report some fresh empirical evidence on this issue in section 8.

The current situation is that the respondents when approaching the M6T are faced with a choice of whether to use it or not. For some drivers, there is additionally the opportunity of travelling via A roads in order to avoid the notoriously congested section of the M6 around Birmingham that the M6T offers relief from.

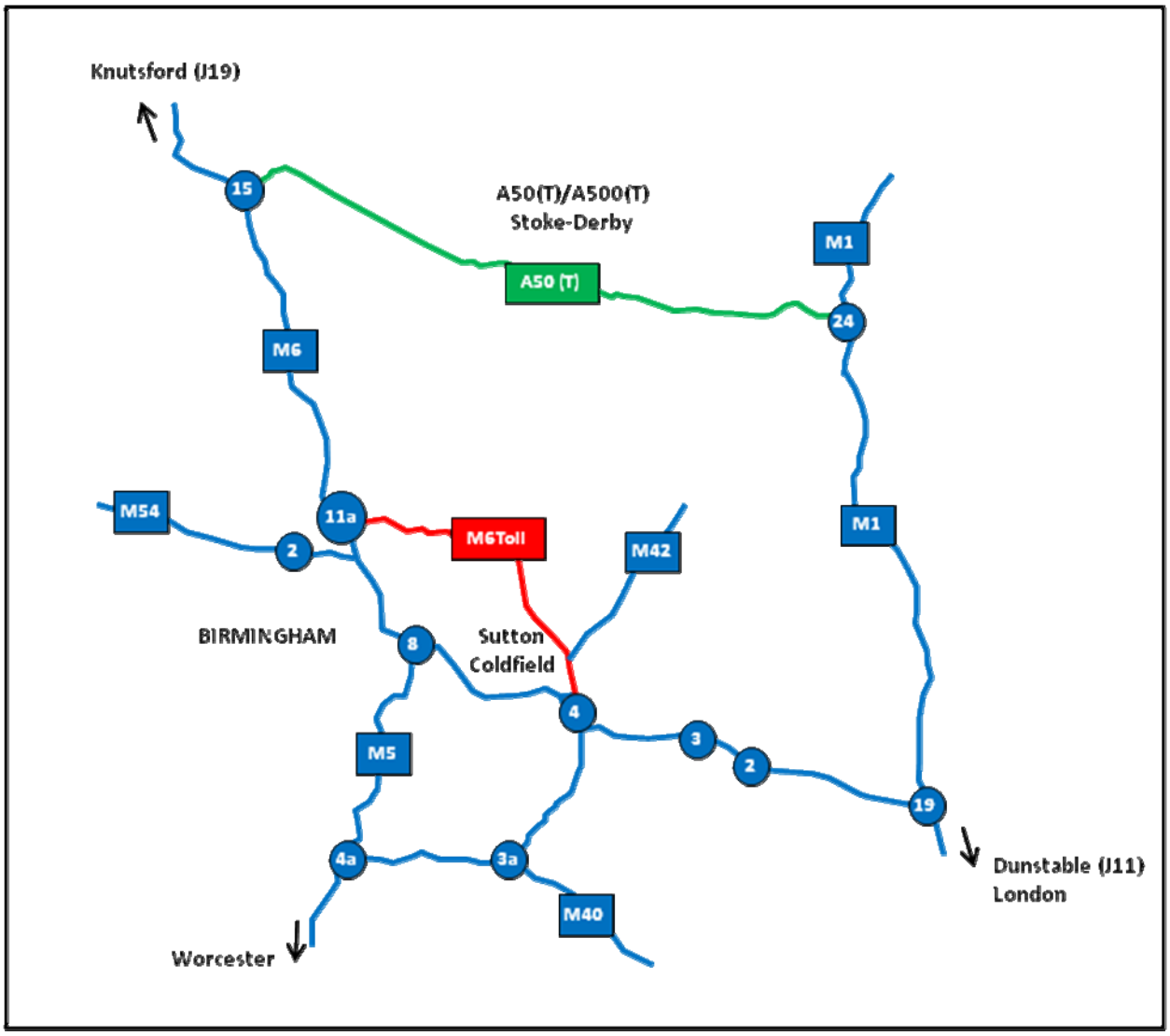
Given that the current context is one where there is a clear choice of using a toll road for only a part of the journey, and that this will be the case with the provision of new tolled facilities, there is not only no need to present the SP scenarios as representing the entire journey but it seems preferable to base the SP around only that portion where the decision is relevant, provided it is set in the context of an entire journey. The corridor in question is depicted in Figure 2.1.

This situation clearly differs from, say, a national road user charging scheme, and indeed from an SP exercise covering mode or destination choice, where the entire journey would have to be considered within the SP exercise. It also differs from choice contexts addressing travel time variability, discussed below, which need to be based on the overall journey.

As a general principle, we felt it unrealistic to vary the time spent on the existing M6T itself. There would be no reasonable explanation because it is uncongested and hence the free flow time is the only realistic time whilst we did not wish to imply journey times that involved driving in excess of the speed limit. However, variations in the amount of M6T time were introduced through SP exercises which offered extensions to the existing tolled motorway. We felt a limited amount of variation in time was then believable, for example, on the grounds that the distance of the route might vary.

The time on the M6T would be around 20 minutes. For the SP exercises based solely on the M6T corridor, this 20 minute journey time was specified. However, with hindsight, we should also have informed respondents that the M6T portion of a longer corridor would involve 20 minutes. Subsequent modelling has had to assume a value of 20 minutes for the M6T part of a longer travel time, although it emerged that this assumption will not have caused problems given limited variation in the value of time by route.

Figure 2.1: The M6T and Survey Corridor



With the exception of the exercises dealing with travel time variability, the route choice SP exercises were based around the following three corridors:

- The 27 mile M6T corridor between Junctions 4 and 11a;
- An 80 mile corridor between M6 Junction 15 (Stoke) and the M1 Junction 19;
- A 150 mile corridor between M6 Junction 19 (Knutsford) and M1 Junction 11 (Dunstable).

The choice context in the 27 mile M6T corridor is basically the one we are interested in and could in principle be applied to all 'in-scope' motorists whatever the length of their journey. However, focussing solely on this would seriously limit the scope for examining many of the hypotheses set out in the introduction.

The reasons for offering the Stoke to M1 corridor are that it is then realistic to introduce the A50/A500 as a free alternative to the often highly congested M6, thereby introducing a wider range of time-cost tradeoffs and, because it is 10 miles shorter, permitting sensible fuel cost variations to be introduced that support analysis of the relative magnitude of toll and fuel coefficients. It also allows analysis of whether the SP results depend upon the context and permits the evaluation of

extended M6T options offering larger time savings but higher tolls. Clearly, this context is not suitable for those whose current journeys where the M6T could be used do no cover the whole length of the corridor.

The third route choice context, suitable for those making very long distance journeys, provides the opportunity to provide a wider set of time-toll trade-offs, as well as evaluating preferences towards an entirely new tolled motorway.

The remaining route choice context covers motorists' responses to travel time variability and contrasts with the previous three above in that it actually specifies end-to-end journey times, of which a portion covers the M6T corridor. An SP exercise addressing travel time variability cannot be based solely on the M6T or Stoke-M1 corridor since the consequences of unreliability relate to late arrivals at the destination, or to amendments to departure times, and the reliability of a particular section of route does not correspond with the reliability of the overall journey. These SP exercises need to be tailored to the actual journey being made for realism, and screening to support such customisation was feasible for those contacted at the motorway service areas.

If we do not introduce toll into the trade-off, then we must trade-off a quicker but less reliable route with a slower but more reliable route. This might seem odd. Why should quicker routes be less reliable? The reverse might be expected. Given the choice context here it makes considerable sense to introduce toll. The use of the M6T makes the journey more reliable as well as quicker, but it is more expensive. This seems to be a more realistic trade-off than is typically the case for analysis of car travel time variability valuations.

2.2 Route and Departure Time Choice

2.3 Abstract Choice

Abstract choice contexts are those which have no corresponding real world context, such as offering choices between option A and option B which are characterised by, say, different levels of time and cost. Valuation studies almost always use such choice contexts since the results cannot be influenced by extraneous factors related to real-world alternatives.

The purpose of these valuation exercises is, by definition, not to forecast behaviour but instead to value attributes that might be impacting on the alternative specific constants and to provide additional insights into attributes in the route choice exercise. For example, the presence of route specific constants is not conducive to transferability, but valuation results might enable the 'unpacking' of these constants. Similarly, time valuations might vary with traffic conditions which can be explored in an abstract choice exercise that specifically addresses this issue but cannot sensibly be covered in a route choice exercise covering a range of other attributes.

We had proposed to examine a range of other factors, relating to the infrastructure and to travel conditions, that might have an impact on route choice and the route specific constants, and these are covered in these abstract choice exercises which were offered as supplementary to the main SP exercises based around route choice.

3. THE STATED PREFERENCE EXERCISES

Table 3.1 provides details of the SP exercises, identifying the corridors the SP exercises were based upon, and the routes and attributes covered.

Table 3.1: SP Exercises

Corridor	Term	Routes	Attributes	Comment
Route Choice Exercises				
Stoke-M1	SP1A-1	M6 v M6T v A50/A500	Time, Toll, Fuel	Absolute Times
	SP1A-2	M6 v M6T v A50/A500	Time, Toll, Fuel	Absolute Times
	SP1A-3	M6 v M6T v A50/A500	Time, Toll, Fuel	M6T quicker
	SP1A-4	M6 v M6T v A50/A500	Time, Toll, Fuel	M6 slower
	SP1A-5	M6 v M6T v A50/A500	Time, Toll	No fuel
	SP1A-6	M6 v M6T v A50/A500	Time, Toll	No fuel
	SP1C-1	M6 v M6T v A50/A500	Time, Toll, Fuel	Toll on M6
	SP1C-2	M6 v M6T v A50/A500	Time, Toll, Fuel	Toll on M6
	SP2A-1	M6 v M6T v A50/A500	Time, Toll, Fuel	Extended M6T
	SP2A-2	M6 v M6T v A50/A500	Time, Toll, Fuel	Higher Toll
	SP2A-3	M6 v M6T	Time. Toll	Omit A Road and Fuel
	SP2B	M6 v 7 M6Ts	Time, Toll	Nth and Sth Extensions
Knutsford-Dunstable	SP2C	New Motorway v M6 v M6T	Time, Toll	
M6T Corridor	SP1B-1	M6 v M6T v (A Road)	Time, Toll	Absolute Times
	SP1B-2	M6 v M6T	Time, Toll	Absolute Times
	SP1B-3	M6 v M6T	Time, Toll	M6T quicker
	SP1B-4	M6 v M6T	Time, Toll	M6 slower
	SP1B-5	M6 v M6T	Time, Toll	Different tolls
	SP1B-6	M6 v M6T	Time, Toll, Information	M6 Roadworks
	SP1B-7	M6 v M6T	Time, Toll, Information	M6 Accident
	SP1B-8	M6 v M6T	Time, Toll, Information	M6 Congestion
Route Choice Exercises (Reliability)				
Current Journey	SP6-1	M6 v M6T	5 times, toll, big delay	Around 2½ hours
	SP6-2		5 times, toll, big delay	Around 1½ hours
	SP6-3		5 times, toll, big delay	Around 1 hour
	SP6-4		5 times, toll, big delay	Around 3½ hours
	SP6-5		5 times, toll, big delay	Around 4½ hours
Current Journey	SP7	M6 v M6T	Late Arrival, Toll	Pay toll to reduce or remove late time
Route and Departure Time Choice Exercises				
M6T Corr	SP8A	M6T v M6	Time, Toll, Dep Time	
Stoke-M1	SP8B	M6T v M6	Time, Toll, Dep Time	
Abstract Choice Exercises				
15 miles	SP3-1A	Route A v Route B	Types of Time	FF & SS v LC
45 miles	SP3-1B			FF & SS v LC
15 miles	SP3-2A		Free Flow (FF)	B & G v HC
45 miles	SP3-2B		Busy (B)	B & G v HC
15 miles	SP3-3A		Light Congestion (LC)	B & SS v LC
45 miles	SP3-3B		Heavy Congestion (HC)	B & SS v LC
15 miles	SP3-4A		Stop Start (SS)	FF & HC v B
45 miles	SP3-4B		Gridlock (G)	FF & HC v B
20 miles	SP4-1	Route A v Route B	Time, HGV, Cameras,	
45 miles	SP4-2		Information, Lane Width	
20 miles	SP5-1	Route A v Route B	Time, Surface, Lighting,	
45 miles	SP5-2		Lanes	

Note: All designs involved 16 scenarios except SP3 which involved 9. The former were split into two sets of eight for presentation to respondents. These are denoted by a and b in Table A1.1 but the distinction is not made here.

3.1 Route Choice Exercises

Stoke-M1 Corridor (SP1A) Designs

Design SP1A-1 is reported in Appendix 2 and what was offered to respondents is reproduced in part in Figure 3.1. The M6T is quicker than both the M6 and the A road as would be expected. Given the degree of congestion that can occur on the M6, and that the A road is actually shorter, it is not unreasonable to offer scenarios where the A road offers a quicker option than the M6 within the corridor.

Figure 3.1: Stoke-M1 Corridor (SP1A) Presentation

We would now like you to consider the following eight situations which refer to three different routes between the M1/M6 intersection (marked B) and Junction 15 near Stoke (marked A) as illustrated by this map.

Travel times could vary depending on traffic conditions.

If these were the situations that you and your group would have expected for the journey you were actually making when contacted, please state in each case which route you would have used.

SITUATION 1	Journey Time	Cost of Fuel	Toll	Your Choice
M6	1 hour 45 minutes	£10.00		○
M6 Toll	1 hour 30 minutes	£10.00	£3.50	○
A50/A500	1 hour 50 minutes	£9.00		○

In practice, the M6 exhibits considerable variation in journey time. This is desirable from a design perspective, and will produce more precise time coefficients than otherwise, and is plausible given that the section of the M6 around Birmingham exhibits considerable variations in journey time according to traffic levels.

Although the M6T is congestion free, the corridor also includes time on the M6 and thus this option's time can vary along with the A road as a result of different levels of congestion.

The fuel cost is held constant on the M6 and M6T across all 16 scenarios but varies between two levels on the A road. However, it should be noted that any respondent was only given one level of fuel cost difference (either £10 versus £9 or else £10 versus £7.50) because it was felt that varying petrol cost on the A road would not be plausible, Given that an important aspect of our investigation was the extent to which fuel is considered and its utility weight relative to that for toll, our design exhibits the

required variation in fuel cost across designs but is plausible for any particular individual.

The toll charges were chosen partly with the time-cost trade-offs in mind but also to offer both increases on the then current toll level of £3.50 and reductions. This, along with the toll variations in other designs, would allow testing of asymmetrical responses to toll increases and reductions.

Design SP1A-2 is the same as SP1A-1 except it offers another two fuel cost differences of either £10 versus £8.50 or £10 versus £7 to supplement the fuel cost differences in SP1A-1 given the importance of this variable to our investigations.

Design SP1A-3 is exactly the same as SP1A-1 but the M6T journey times were presented as minutes quicker than the M6 time instead of being offered as absolute journeys times whereas SP1A-4 presented absolute M6T journey times but the M6 journey times as minutes slower than the M6T time.

Fuel costs are removed entirely in SP1A-5 and SP1A-6 but the remaining attributes are exactly the same as the previous designs with the exception of the latter offering a different range of tolls. These changes allow analysis of the effect of removing fuel costs on the other coefficient estimates and contribute to the analysis of toll variations.

Boundary values denote the value of time where there is indifference between two options. Table A2.1 reports boundary values for design SP1A-1. It can be seen that these cover a wide range and sensible trade-offs between time and cost are being offered.

Stoke-M1 Corridor (*SP1C) Designs*

The SP1C-1 design is exactly the same as SP1A-1 except that a toll is introduced to use the M6. The same variation applies to SP1C-2 relative to SP1A-2. These M6 tolls are set out in Table A2.2 in Appendix 2. The purpose of these exercises was to determine whether the response to the introduction of tolls on an existing toll free motorway is the same as the response to toll variations on an existing tolled motorway. As can be seen from Table A2.2, they also cover an additional range of time-cost trade-offs.

Stoke-M1 Corridor Extended M6T (SP2A) Designs

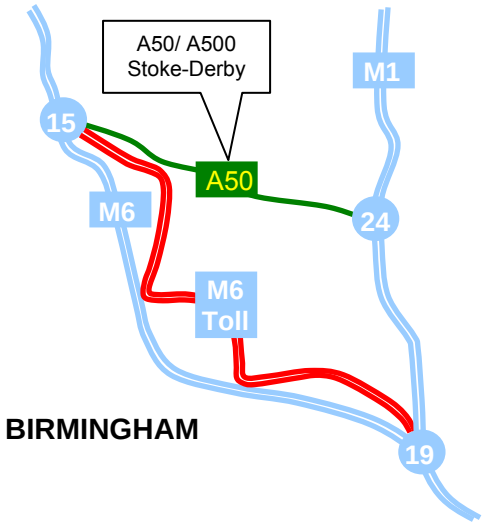
The SP2A designs offer an extended M6T throughout the whole Stoke-M1 corridor, and what was offered to respondents is reproduced in part in Figure 3.2. The purpose of these exercises is to provide variation in the time spent on the M6T, to contribute to the estimation of the disutility of time spent on the M6T relative to other roads, and to provide insights into larger toll variations and time savings than could reasonably be offered in the other exercises base on the existing M6T.

Figure 3.2: Stoke-M1 Corridor Extended M6T (SP2A) Presentation

We would now like you to consider the following eight situations which refer to three different routes between the M1/M6 intersection (marked B) and Junction 15 near Stoke (marked A) as illustrated by this map.

The three routes are the current M6, the A500/A5 route and an extended M6Toll. Travel times could vary depending on traffic conditions.

If these were the situations that you and your group would have expected for the journey you were actually making when contacted, please state in each case which route you would have used.



SITUATION 1	Journey Time	Cost of Fuel	Toll	Your Choice
M6	1 hour 45 minutes	£10.00		○
Extended M6 Toll	1 hour 15 minutes	£10.00	£2.00	○
A50/A500	2 hours 15 minutes	£7.00		○

The design SP2A-1 is the same as SP1A-2 except for the shorter journey time on the M6T of either 65 or 75 minutes as opposed to between 75 and 100 minutes. This design is given in Appendix 3. A wide range of time-cost trade-offs is apparent from the implied boundary values of time. SP2A-2 increases the toll charges from between £2 and £7.50 to between £3 and £10, given the larger time savings on offer, whilst SP2A-3 then removes the A road and hence the basis for the fuel cost variation.

Stoke-M1 Corridor Extended 'in Bits' M6T (SP2B) Design

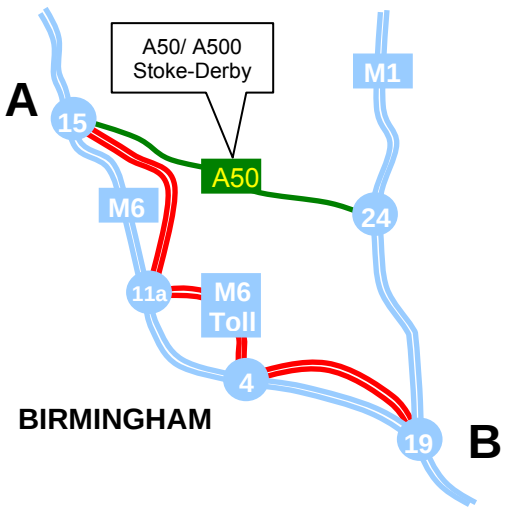
Whilst the SP2A designs offer an 'all-or-nothing' extended M6T, the SP2B design instead considers improvements 'in bits' by adding Northern and Southern extensions to the existing M6T which together would cover the entire Stoke-M1 corridor, as with SP2A, but the respondent is left with the option of purchasing any, none or all of the time savings associated with the M6T, Northern extension and Southern extension. Effectively, respondents have a choice between the M6 and an additional seven options. The design is set out in Appendix 4 and what was offered to respondents is reproduced in part in Figure 3.3.

Figure 3.3: Stoke-M1 Corridor Extended 'in Bits' M6T (SP2B) Presentation

We would now like you to consider the following eight situations which refer to your journey between the M1/ M6 intersection (marked B) and Junction 15 near Stoke (marked A) as illustrated by this map. You have the choice between travelling on the existing M6 the whole way or saving time by paying a toll to travel on:

- The existing M6 Toll
- A northern extension of the M6 Toll between J11a and J15
- A southern extension of the M6 Toll between J4 and the M1.

If these were the situations that you and your group would have expected for the journey you were actually making when contacted, please state which of the toll routes you would have used.



SITUATION 1	Journey time	Toll	Your choice
M6	1 hour 40 minutes		
M6 Toll	Saves you 20 minutes	£2.50	Yes ○ No ○
M6 Toll Northern extension	Saves you 10 minutes	£1.00	Yes ○ No ○
M6 Toll Southern extension	Saves you 5 minutes	£1.00	Yes ○ No ○

The purpose of this exercise is to support the analysis of non-linear effects, in terms of different amounts of time saving and toll payment, and to determine whether there is any difference in stated behavioural response between offering a single time saving or an equivalent time saving 'in bits'.

Knutsford-Dunstable New motorway (SP2C) Design

This design is based on a new 150 mile motorway between Knutsford in Cheshire and Dunstable in Bedfordshire that parallels the existing M1 and M6 route but would offer considerable time savings. Whilst it provides a broader range of time and toll trade-offs and extends the range of toll charges that can sensibly be offered, it also allows examination of whether sensitivity to toll charges on an as yet un-built motorway are the same as on an existing tolled motorway or a currently free motorway.

The design is reported in Appendix 5 and what was offered to respondents is reproduced in part in Figure 3.4. The option of using the existing M6T is retained but fuel costs were not included since we did not feel it reasonable that they would differ much between routes.

Figure 3.4: Knutsford-Dunstable New motorway (SP2C) Presentation

We would now like you to consider a situation where there is a new 150 mile motorway parallel to the M6 from Junction 19 near Knutsford to Junction 11 on the M1 near Dunstable. A toll would be payable to use this road.

You have the choice of travelling on this new road or using the existing M6. You could also save time on the existing M6 by using the M6 toll.

Please consider each of the eight situations set out below. If these were the situations that you and your group would have expected for the journey you were actually making when contacted, please state in each case which route you would have used.

SITUATION 1	Journey Time	Toll	Your Choice
M6	3 hours 10 minutes		○
M6 Toll	2 hours 50 minutes	£6.50	○
New Motorway	2 hours	£15.00	○

M6T Corridor (SP1B) Designs

Turning now to the M6T corridor itself, those making short journeys that cover the M6T corridor but not the Stoke-M1 corridor were offered an SP route choice exercise that focussed simply on the section of journey where the M6T parallels the M6. What was offered to respondents is reproduced in part in Figure 3.5.

Figure 3.5: M6T Corridor (SP1B) Presentation

We would now like you to consider the following eight situations which relate to the possibility of travelling on the M6 or using the M6 toll road.

Travel times on the M6 could vary depending on the travel conditions.

If these were the situations that you and your group would have expected for the journey you were actually making when contacted, please state in each case which route you would have used.

SITUATION 1	Journey Time	Toll	Your Choice
M6	35 minutes		○
M6 Toll	20 minutes	£3.50	○

There is no natural A road alternative here and hence only one of the 8 designs offered an A road. Given the latter, and that the difference in distance between the motorways and rival A roads could only be small, we did not feel that there was any sound basis for introducing fuel cost variations.

The design for SP1B-1 is given in Appendix 6 and a broad range of time-cost trade-offs are offered as indicated by the implied boundary values. The toll levels are the same as for SP1A-1. The M6T time is fixed given that it was felt unrealistic to vary it whilst the M6 is 70 minutes less than in SP1A-1. The A road is slower than using the M6T but can on occasions be quicker than the M6. Large variations in travel time are plausible on the latter given the significantly different levels of congestion experienced on this route according to traffic and travelling conditions.

The remaining SP1B designs remove the A road. SP1B-2 is exactly the same as SP1B-1 except for the omission of the A road. SP1B-3 and SP1B-4 are the same as SP1B-2 but respectively present the M6T time as being quicker than the absolute M6 time and the M6 time as being slower than the absolute M6T time. SP1B-5 offers a different range of tolls, with two being lower than the then current level of £3.50.

The final three designs introduce information. Respondents were additionally presented with situations where there would be information on the conditions on the M6. SP1B-6 offered four levels of information. These could be:

- Delays on the M6
- Delays on the M6 due to Roadworks
- Roadworks on the M6: Expect 25 minute Delay
- No Delays on M6

SP1B-7 and SP1B-8 replaced roadworks as the cause of delays with accident and congestion respectively.

Travel Time Variability (SP6) Designs

These designs addressed the issue of travel time variability. The basic concept is that the M6T offers the opportunity to achieve more reliable journeys than the M6, and that it is the congested section of the M6 around Birmingham which is the source of unreliability. It is through payment of the M6T toll that the better reliability is achieved.

Unlike typical SP exercises relating to car travel time variability, where the trade-off is between mean time and variability in travel time, here we are able to present one route as both quicker on average and more reliable since the trade-off is introduced through cost. This is arguably more realistic than the conventional approach since routes which are specified to be slower might tend to be perceived as inherently more unreliable.

We chose to present travel time variability as a range of travel times rather than as the consequences of unreliability in terms of a pattern or probability of late arrival times at the destination. Five journey times were used in line with what is typically offered in such studies. What was offered to respondents is reproduced in part in Figure 3.6.

Figure 3.6: Travel Time Variability (SP6) Presentation

We would now like you to consider the following eight situations which represent different levels of journey time reliability when using the M6 and M6 Toll roads. These are represented by the journey times that might typically occur on five separate occasions. Each journey time is equally likely.

In addition, there might from time to time be a major disruption on the M6 that would involve around a 3 hour delay.

If these were the situations that you and your group would have expected for the journey you were actually making when contacted, please state in each case which route you would have used.

	Range of journey times					**Average time**	**Major disruption**	**Toll**	**Your choice**
M6	3 hrs	3 hrs	3 hrs	3 hrs 30m	4 hrs	3 hrs 18	Once every 3 months		○
M6 Toll	2 hrs 20m	2 hrs 25m	2 hrs 30m	2 hrs 35m	2 hrs 40m	2 hrs 30m		£7.50	○

The problem with concentrating on late arrival times is that some people do not have preferred arrival times but could still value variability, whilst measuring variability in journey times is more practical than measuring variations in travellers' late arrivals. It is also possible that those with very high values of late time depart sufficiently early to ensure that they will never incur late time and thus to present them with a late time of, say, 30 minutes would not be particularly meaningful. Moreover, given the increasingly uncertain world in which we live and are becoming accustomed to live in, some individuals might have a preferred arrival time which is a band or it might simply be that they want to arrive at 'ten-ish'. Hence the concept of precise late arrivals might also be alien to such individuals.

This means of presentation requires customisation to the actual journey made. This was achieved by creating five different designs based around the current journey times. Since the reliability SP was offered to those contacted at the MSAs, it was feasible to conduct this screening.

We felt that offering arrange of different levels of reliability for both the M6 and M6T would complicate an already demanding task. We therefore restricted the M6T to have the same level of reliability in each scenario, with the M6 allowed to have four different levels. The times offered for the five journey durations are presented in Tables A7.2 to A7.6 in Appendix 7. A feature of the designs is that it is possible to compare two M6 scenarios with the same mean time but different variances, to compare two M6 scenarios which have different mean times but the same variance, and to compare two M6 scenarios in terms of different means and variances.

'Late Running' SP7 Design

The final design based solely around route choice is one that was stimulated by some comments that arose in the focus groups (Faber Maunsell et al., 2006)

regarding why the M6T was chosen. Some respondents used it when they were thought that they were going to be late as a means of making up some time.

The intention was to keep this exercise simple yet provide a further means of valuing aspects on unreliability. Hence the respondent was told that they were approaching the M6T corridor and that they were running late. They were provided with different late times should they choose to use the M6 or the M6T. The design is given in Table A8.1 in Appendix 8 and what was offered to respondents is reproduced in part in Figure 3.7.

Figure 3.7: Late Running (SP7) Presentation

We would now like you to imagine that you are travelling along the M6 and that you are running late.

You have the chance of using the M6 Toll to make up some time on your journey.

Please consider the following eight situations.

Each indicates how late you would expect to arrive at your destination dependent on your choice.

If you and your group were faced with these situations, please state which route you would have used.

Situation 1	**Expected late arrival time**	**Toll**	**Your choice**
M6	45 minutes late		○
M6 Toll	On time	£4.00	○

With hindsight, this was too simplistic. Firstly, the difference in late time and the difference in travel time on the two routes were not separately specified, and indeed the two are perfectly correlated. Secondly, we should have been clearer what a late time of zero meant. It was meant to mean an on-time arrival but of course is consistent with arriving early.

3.2 Route and Departure Time Choice

Route and Departure Time Choice (SP8) Designs

The route and departure time choice designs were, for reasons discussed in section 2.2, based around changes to the current departure time in return for a lower toll on the M6T and quicker journey times.

Separate SP exercises were designed relating to the M6T corridor and to the Stoke-M1 corridor to mimic those offered in the SP exercises relating solely to route choice. The designs are reported in Appendix 9 and Table A9.1 and A9.2. What was offered to respondents is reproduced in part in Figure 3.8 for the M6T corridor.

Figure 3.8: Route and Departure Time Choice M6T Corridor (SP8) Presentation

We would now like you to imagine that you have the opportunity to use the M6 Toll at a lower charge if you depart at a different time. Travel times would also be different as traffic conditions vary by time of day.

Please consider the 8 situations below which relate to the section of your journey where the M6 Toll provides an alternative route, and indicate whether you would use the M6 or the M6 Toll at your current departure time or at the different departure time indicated. For each situation please make just one choice.

SITUATION 1	Departure time	Journey Time	Toll	Your Choice
M6	As now	1 hour 20 minutes		○
M6	2 hours earlier	40 minutes		○
M6 Toll	As now	20 minutes	£3.50	○
M6 Toll	2 hours earlier	20 minutes	Free	○

Four levels of departure time change are offered. These are departing one or two hours either earlier or later. This enables analysis of the extent to which earlier and later departure time shifts are valued differently and whether the unit valuation of a departure time shift depends on the amount of change to departure time.

The M6T toll is lower if the departure time is changed, and in some cases it is zero. The M6T option's journey time is quicker for the amended departure when it covers the Stoke-M1 corridor (SP8B), since then some of the time includes that on the congested M6. Given the M6T is uncongested, we did not feel it realistic to vary the M6T option's journey time when the exercise related only to the M6T corridor (SP8A).

Not only do these designs provide insights into the extent to which motorist are prepared to change departure time, they also provide a broader range of times and tolls to support the analysis of non-linear effects.

3.3 Abstract Choice Exercise

The abstract choice exercises address the relative disutility of time spent in different driving conditions as well as the fixed and duration related valuations of different types of infrastructure provision. The latter were identified in a series of focus groups (Faber Maunsell et al., 2006) that were undertaken with drivers in the corridor.

Travel Time Differentials (SP3) Designs

The first British value of time study (MVA et al. 1987) established that there were differences in the value of time according to the conditions in which that time was spent. It found that the value of time spent in congested traffic conditions, defined as time spent moving slowly or stopped due to congestion, was valued around 40% higher than time spent in free-flow conditions. This was the first study in Britain to examine such differentials, admittedly using a crude distinction.

There have been differences of interpretation of these findings. Some view the differential to be driven largely by the greater unreliability implied by congested time.

In addition, the inherently greater realism in varying congested than free flow time might also have been a contributory factor, to the extent that unrealistic variations in free flow time are ignored. Nonetheless, it is not unreasonable to expect a premium on time spent in more difficult and frustrating driving conditions.

The study decided to pursue this dimension, and indeed it was a feature of our proposal. We were impressed by the work undertaken for the UK railway industry which examined how the degree of competition that car offers to rail varies with road conditions (Steer Davies Gleave, 2003). We followed the same sensible conventions regarding the classification and description of driving conditions. These were:

- *Free flowing:* You can travel at your own speed with no problems over-taking
- *Busy:* You can travel pretty much at the speed limit, but you are forced to change lanes every now and then
- *Light congestion:* You can travel close to the speed limit most of the time, but you have to slow down every so often for no apparent reason
- *Heavy congestion:* Your speed is noticeably restricted, frequent gear changes required
- *Stop start:* You are forced to drive in a "stop-start" fashion
- *Gridlock:* You are only able to move at a crawl at best, and spend quite a lot of time stationary

These descriptions were used in the SP exercise, alongside a pictorial representation as set out in Appendix 10. What was offered to respondents is reproduced in part in Figure 3.9.

The SP designs are set out in Appendix 11. The SP exercises were based around offering a choice between a mix of 'good' and 'bad' travel conditions and travel conditions that are somewhere between but fixed across the journey. Any design therefore includes only three different traffic conditions, for reasons of relative simplicity, which are quite different from each other, for reasons of clarity.

The combinations used, chosen to cover all levels but to offer a clear distinction between different conditions, are specified in Table A11.1. These were for motorway journeys of 15 or 45 miles, and Tables A11.2 and A11.3 show the times offered.

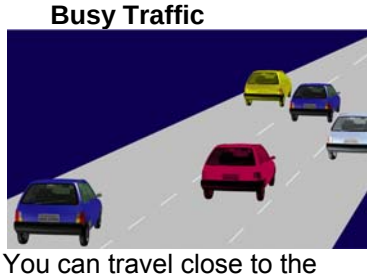
Thus, for example, SP3_2A offers drivers the choice, within a 15 mile journey, between option A which is characterised by varying amounts of both busy and gridlock time and option B which is always heavily congested.

Figure 3.9: Travel Time Differentials (SP3) Presentation

Now we would like you to imagine that you were making a motorway journey of around 15 miles. Please consider the following eight situations where you have the choice of two motorways (A and B) and state which option you would choose if the traffic conditions were as illustrated by the following:

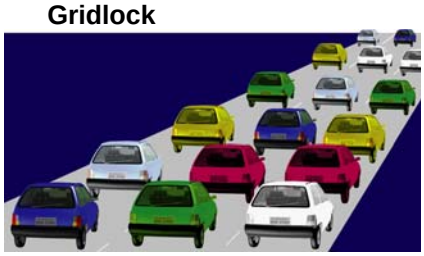
- In option A, traffic on the journey is either busy, or what could be described as gridlocked.
- In option B, there is always heavy congestion.

Busy Traffic



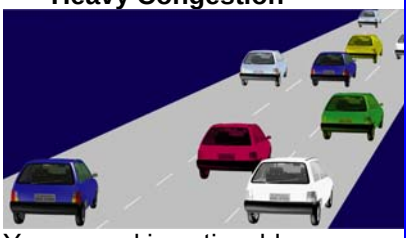
You can travel close to the speed limit most of the time, but you have to slow down every so often for no apparent reason.

Gridlock



You are only able to move at a crawl at best, and spend quite a lot of time stationary.

Heavy Congestion



Your speed is noticeably restricted and frequent gear changes are required.

SITUATION 1	Journey time in busy traffic	Journey time in Gridlock	Journey time in heavy congestion	Your Choice
Option A	15 minutes	10 minutes		○
Option B			15 minutes	○

Travel Conditions (SP4) Designs

This SP exercise related to a motorway journey of either 20 or 45 miles and the choice between two unlabelled alternatives described in terms of journey time, the proportion of traffic made up by heavy goods vehicles (HGVs), the number of speed cameras present, the level of information provided and the width of the lanes.

The designs, including the levels used for each attribute, are set out in Tables A12.1 and A12.2 in Appendix 12. What was offered to respondents is reproduced in part in Figure 3.10.

Figure 3.10: Travel Conditions (SP4) Presentation

Now we would like you to imagine that you were making a motorway journey of around 45 miles. Please consider the following eight situations where you have the choice of two motorways (A and B) and state which you would choose if the conditions were as described. The road conditions include:

- The percentage of the traffic made up of Heavy Goods Vehicles (HGVs);
- The presence of speed cameras;
- Roadside information on whether there are delays;
- Width of lanes (in metres).

SITUATION 1	% of HGVs	Speed Cameras	Lane Width	Information	Journey Time	Your Choice
Option A	2%	1 speed camera en route	Standard (3.35m)	None	30 mins	○
Option B	33%	No speed cameras	Narrow (3.0m)	None	25 mins	○

Travel Conditions (SP5) Designs

This exercise related to a motorway journey of either 20 or 45 miles and the choice between two options described in terms of journey time, the quality of the road surface, the number of lanes and the presence of lighting. The designs, including the levels used for each attribute, are set out in Tables A13.1 and A13.2 in Appendix 13. What was offered to respondents is reproduced in part in Figure 3.11.

The road surfaces were the M6T, the high level, jointed M6 as around Birmingham, a concrete section of the M6 and the standard M6. Respondents were then asked to rate, on a ten point scale, each road surface in terms of noise and bumpiness.

Figure 3.11: Travel Conditions (SP5) Presentation

Now we would like you to imagine that you were making a journey of around 20 miles. Please consider the following eight situations where you have the choice of two motorways (A and B) and state which you would choose if the conditions were as described. The road surface could be as on the:

- M6 Toll road
- The high level, jointed section of the M6 around Birmingham
- The concrete section of the M6
- The normal M6 surface

SITUATION 1	Road Surface	Lighting	Lanes	Journey Time	Your Choice
Option A	M6 Toll	No	3	20 minutes	○
Option B	High Level (jointed)	No	3	15 minutes	○

4. DATA COLLECTION AND CHARACTERISTICS

4.1 Survey Procedure

The M6 Toll Study involved the collection of two major sets of survey data in order to gain a greater understanding of the composition of the M6 Toll user market and the willingness to pay tolls and the relative importance of specific trip attributes in the decision making process. The first survey, which is referred to as the utilisation survey, was undertaken with a random sample of M6 Toll users who were contacted at the M6 Toll booths and through the M6 TAG database held by the M6 Toll operating company (Faber Maunsell, 2008). This survey collected a wide range of data on the characteristics of the respondent, the details of their usage of the M6 toll road, and their reasons for using the toll road in preference to the non tolled alternatives. The questionnaire used in the survey is shown in Appendix 15.

The second set of survey data that was collected in the study was the SP surveys exploring travellers' willingness to pay. The SP survey sample was to be drawn so as to include a representative sample of users and non-users of the M6 Toll road. The utilisation survey with the M6 Toll users provided the mechanism for the distribution of SP questionnaires to users of the toll road and the approach adopted is described later. But in order to obtain SP surveys with non users of the toll road a data collection strategy was devised that combined motorway slip roadside interview (RSI) surveys and surveys at motorway service areas (MSAs) as a means of making contact with travellers in scope.

The location of the respective surveys is shown in Figure 4.1 and the following section describes in some detail the rationale behind the selection of the survey locations and the measures that were taken to ensure that a representative sample was collected and that where any response bias occurred, due to the self complete nature of the SP survey, that this could be corrected for and appropriate weightings applied to the survey data.

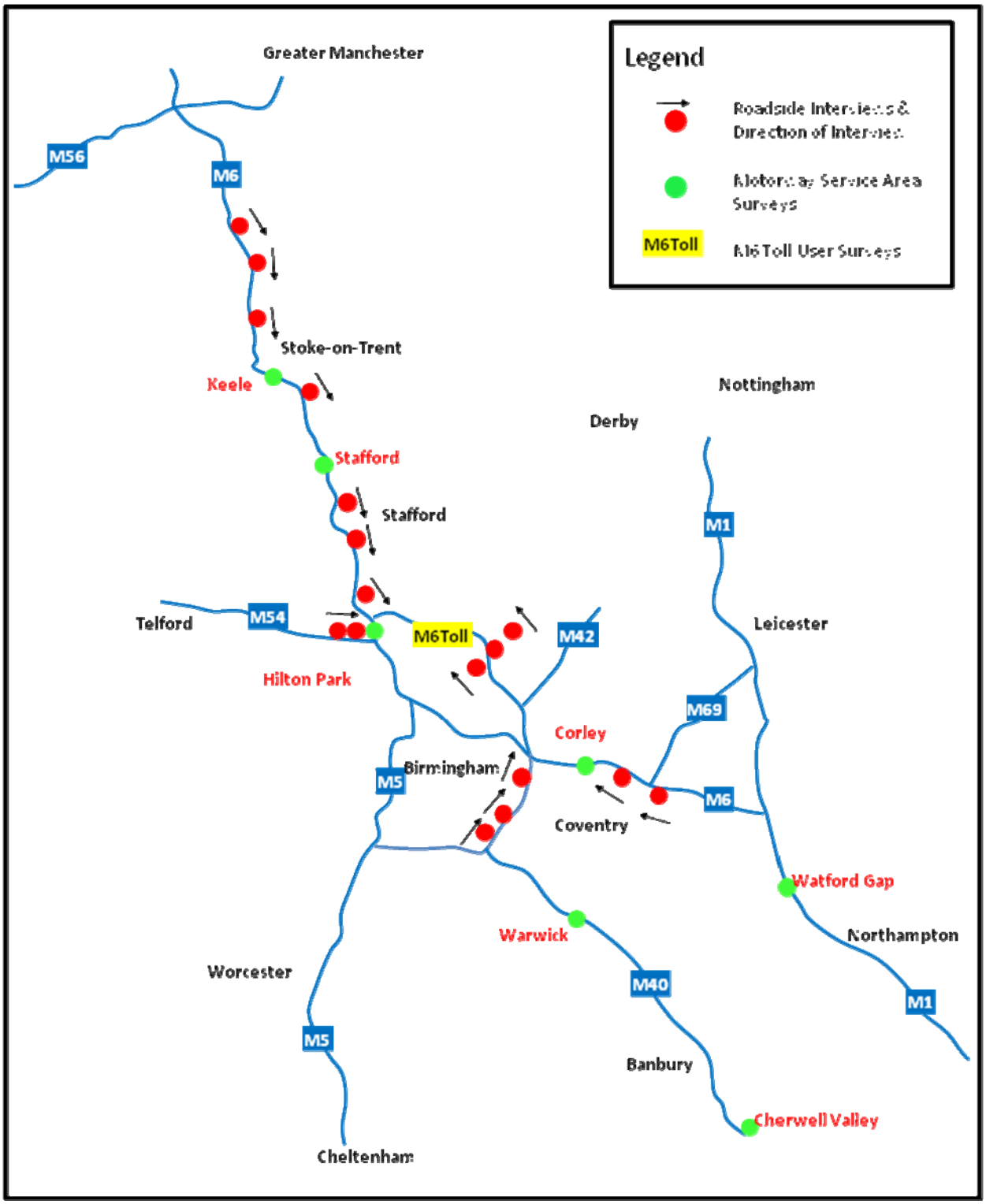
Consequently, the SP questionnaires were distributed through a combination of RSIs, contacts at MSAs and by post to a database of M6T users. The survey locations were selected to capture those who would be travelling in the M6T corridor, although clearly not all would be and hence motorists were screened for an appropriate journey. The surveys were conducted in November 2006.

All respondents were presented with two SP exercises. The first covered a route choice context whilst the second was generally one of the abstract choice contexts but in some cases a route choice exercise was offered. The combination of SP exercises offered is set out in Table A1.1 in Appendix 1.

At the MSAs and motorway slip RSIs, those who were not in scope for the M6 Toll Study were handed a repeat of the 1994 UK value of time study questionnaire for motorway users (HCG et al., 1999) adjusted as necessary for inflation and income growth but otherwise identical.

The principles behind the data collection procedure were representivity and cost effectiveness. Considerable efforts were made in specifying the form of data collection and its undertaking to ensure that a 'random' sampling approach was adopted within each survey type to ensure that bias was minimised for each survey type.

Figure 4.1: Location of M6 Toll Study Surveys



It was recognised that differential response rates would arise from the respective surveys and as such measures were taken to ensure that appropriate expansion factors could be applied to each survey record so as to reflect the overall market shares. In summary, the recruitment procedure for passengers of interest was:

- Surveys at MSAs to capture long distance movements through the corridor with a particular emphasis on non M6T users to obtain a representative sample for the Willingness To Pay (WTP) data but additionally to obtain M6T utilisation data at low marginal cost;

- Surveys at the M6T cash and card payment booths to collect data for the utilisation survey and the WTP data at low marginal cost. TAG users were contacted separately through the Midland Expressway Limited (MEL) customer database; and

- RSIs on selected motorway slip roads to the north and south of the M6T to capture non-M6T users making shorter journeys for which the probability of using a motorway service area is relatively low.

There are two main issues relating to survey bias that were borne in mind in the selection of the sampling methodology. Firstly, inability to contact particular market segments; using a random sampling approach every person of interest should have an equal contact probability. Secondly, once contacted there should be an equal probability of the respondent completing the survey. However, barriers to completion of the survey do exist and often include the following:

Not interested - material needs to generate interest by being attractively presented and well produced. The potential respondent should feel it worthwhile to take part in the survey, because it is important to them;

No time - material should be as concise as possible; and

Not able to understand – material should be as easy to understand as possible.

The approach adopted in the study was to ensure that random contact was made in each of the three different surveys and that due to the potential response bias in the self completion survey data was collected that would enable corrections to be made during the data expansion and weighting so as to achieve a representative sample. The processes adopted for each of the three survey types are described below.

4.1.1 M6T User Surveys – Toll Booths and TAG Database

The main M6T user surveys took place at each of the M6T toll booths and, subject to M6T operator agreement, the following procedure took place to ensure that a random sample was derived and that any survey response bias could be identified and corrected for:

- Carry out a standard roadside type interview survey with every fifth driver passing through the cash and car payment toll booths in order to provide a random sample of M6T users for market profiling and response bias control. This collected data on journey purpose, car occupancy, and journey length;

- Issue the M6T toll utilisation survey (Appendix 15) to all users of the cash and card payment toll booths over a four day period covering Thursday to Sunday;
- Obtain from the M6T operator counts of tickets issued by type covering the same time period so that the returns can be expanded to give an overall picture of M6T users;

- On return of the utilisation survey forms, which collected the primary information outlined in the terms of reference, and additional questions such as usage of motorway service areas, a sample of the users were then selected for issuing of SP survey forms where they had indicated their willingness to participate. The correct SP forms could then be allocated based on the details of the trip made; and

- Issue the M6T utilisation survey forms to a random sample of TAG users through MEL and on return of the utilisation survey forms the allocation of SP forms was undertaken.

This two stage process enabled the appropriate SP design to be distributed to each respondent who was willing to take part in the survey. By having a process where utilisation forms were distributed to all those passing through the toll booths and having a truly random interview to obtain control data on the composition of the sample the SP returns can then be weighted to correct for any response bias.

It should be noted that before expanding and weighting the data the surveys with M6T users that were obtained from the MSA and RSI surveys were added to the M6T user base so that a single expansion to M6T count data was undertaken and hence any double counting effects for M6T users across the three survey types was eliminated.

4.1.2 Motorway Service Area Surveys

The primary objective of the Willingness to Pay surveys undertaken at MSAs was to capture longer distance trips that use the M6T corridor but are not users of the M6 Toll. Inevitably in the course of the surveys M6T users were also identified and in order to correctly weight these surveys, and account for any double counting, the M6 Toll utilisation survey collected information on usage of MSAs by M6T users and this enabled corrections to the weightings to be made.

The survey took place in two stages with trips in scope identified from a short random interview and the appropriate SP questionnaires issued directly on-site or by post on receipt of self complete postcards.

In order to overcome any possible bias through using MSAs, and to enable appropriate weighting factors to be derived, the following survey process was used:

- Place automatic traffic counters at the entry to each MSA to provide classified vehicle counts by hour for a two week period;

- Undertake random sampling at each MSA by using a screening question to identify travellers in scope, a record of all screening approaches took place to enable sample expansion;

- For in scope travellers, collect basic information to enable the correct SP questionnaire to be identified and ascertain willingness to participate in a further survey, and to provide sufficient information to enable any response bias to be corrected for such as journey purpose, group size and length of journey;

- Either issue the SP questionnaire on site or post it out after analysis of the screening questionnaires; and

- Undertake an analysis of the M6T toll booth survey to identify the propensity to make stops at MSAs by each market segment (purpose, income, journey length, etc.). The M6T toll booth survey included a question asking whether the respondent had stopped at a MSA and, if so, where, or would be stopping. This analysis enabled the identification of any MSA sampling bias and measures taken to correct for it.

To obtain a random contact sample for screening and control of the responses at the MSAs the following approach was adopted:

- At the petrol station carry out a short interview with every fifth car that enters the petrol station. The interview was undertaken whilst the driver was filling up as this did not require them to be stopped; and

- At the entry to the main building approach and obtain a short interview with every fifth group that enters the building and issue postcard survey forms to all groups entering the building.

Figure 4.1 above showed the location of the selected service areas. The criteria for the selection of the MSAs was to maximise the potential capture rate of long distance trips that pass through the M6T corridor. This meant selecting service areas to the north on the M6 as far as Keele, and to the south on the M1 and M40 as far as Watford Gap and Cherwell Valley. It was considered that the further north and south one went the proportion of contacts who were in scope for the study would rapidly decrease and hence there would be a marginal return on the cost of the surveys.

As previously discussed, the M6T users identified from this survey were added to the overall M6T survey sample. The returned MSA data for all trips was then fully expanded to the automatic count data collected at the entrance to the service areas through the following process:

- Calculate expansion factors from the returned surveys to match the screening interviews by purpose, group size and journey length; and

- Calculate expansion factors from the screening interviews to the count data by time of day and day of week.

The combination of these expansion factors correctly weights the data to account for response bias. The data from each of the MSAs was then grouped together and a sector system defined to which the data was aggregated by purpose and separately by M6T users and non-users. This expanded data then enables the proportion of M6T users to be calculated for each sector to sector movement and this can then be used in conjunction with the expanded M6T user data from the previous stage (the M6T toll booth expanded data) to calculate the estimated total numbers of non users for each sector to sector movement. This then enables a further factor to be derived which can be used to weight the MSA non user data to match the expected control total.

4.1.3 Motorway Slip Road Interviews

The final surveys undertaken were RSIs at selected locations in the area of interest. The previous surveys described above provided coverage of all M6T users and a sample of longer distance non users through the MSAs. This left a gap in the sampling frame in that all other non user trips through the M6T corridor were not covered and it was agreed with the study sponsor that the most appropriate way to make the required random contacts was through the use of RSIs. In order to identify a cost effective method for providing a wide coverage of trips of interest, the following issues were taken into account in order to establish the best sites for undertaking the RSI surveys:

- That duplication of interviews should be minimised by primarily interviewing in one direction, either southbound from the north of the M6T, or northbound from the south of the M6T;

- That to the south of the M6T the trips of interest dissipate down three corridors, the M6/M1, the M42, and the M40 and that this means that the proportion of trips of interest on any one slip road is much lower than on the M6 to the north. Consequently, it was considered that a greater return would be achieved by interviewing to the north of the M6 and in a southbound direction and hence a greater concentration of sites was placed to the north;

- That there was also a need to have a selection of sites immediately to the south of the M6T so that trips commencing in the southern part of Birmingham and Coventry and travelling beyond J18 of the M6 could also be intercepted to increase the overall coverage;

- That local trips in the M6T corridor from Tamworth and Sutton Coldfield required RSIs on local roads parallel to the M6T; and

- That the surveys were to cover as much of the relevant market for trips that would not use an MSA as possible. We defined the market in relation to five sectors, North West, North Midlands, West Midlands, South Midlands and South East.

Based on the above principles RSIs were undertaken on entry slip roads on the M6 southbound from junction 18 to junction 12, on the M54 eastbound at junctions 1 and 2, on the M42 eastbound at junctions 4 to 6, on the M6 northbound at junctions 2 and 3, and on a local screen line to the west of Sutton Coldfield. These are shown diagrammatically in Figure 4.1.

A similar process of expansion and weighting of the data was undertaken to create a set of short and medium non-user trips that reflected the proportion of users/non users from the RSI data and the overall level of M6T use. The expansion and weighting process used is described in greater detail in Appendix 16

4.2 M6T Study Data Characteristics

Prior to discussing the characteristics of the study database, relating to the SP sample achieved, it is pertinent to present a few statistics relating to the response rates achieved for each survey type to demonstrate that a robust and random sample frame has been achieved by survey type.

The surveys with M6T users were undertaken at toll booths and through the TAG user base. At the toll booths a sample of 24% of the drivers passing through the booths were interviewed to get control totals for purpose, journey distance and vehicle occupancy that could then be used to adjust any response bias from returned questionnaires. All drivers passing through the booths were issued with a utilisation survey and around 20% of these surveys were returned completed. Of the returned utilisation surveys 43% indicated that they were willing to take part in a further survey, i.e. the SP exercise, and the appropriate SP design was then sent out. With regard to TAG users a random sample of 30% of the registered TAG users were sent a utilisation survey form and a response rate of 25% returned utilisation surveys was achieved.

In total 51% of the M6 Toll booth and TAG users who were issued with an SP experiment returned completed surveys.

At the MSA areas screening interviews to identify trips in scope and then determine purpose, trip length and other primary trip characteristics were undertaken at random, with 19% of those people using the surveyed service areas during the time periods covered by the surveys. With regard to passenger travel, those who were making trips of interest, that is were travelling through the M6T corridor, were issued with the appropriate SP design and a response rate of 17% was achieved. This is lower than the SP survey response rate for the M6T surveys due to the fact that in the former the SP had only been issued to those who specifically stated they would take part, whereas at the MSA areas everybody who was contacted was given an SP form if they were in scope.

At the RSIs the average sample rate for the roadside interview was 13% of all vehicles. Of the roadside interviews 25% were defined as trips in scope for the M6T study and these were issued with a self complete SP questionnaire. With regard to car passengers, those who were making trips of interest, that is were travelling through the M6T corridor, were issued with the appropriate SP design and a response rate of 25% was achieved.

Making an allowance for the different approaches adopted to the issuing of SP forms the respective response rates, when considered on a comparative basis, were;

- M6T toll booths and TAG users 22% of those originally contacted for the screening survey;
- MSAs 17%;
- RSIs 25%.

The respective SP response rates are therefore similar and in view of the processes adopted to secure a random sample, the information collected to enable response bias to be corrected, and the capability to create expansion factors that reweight the responses to the estimated market shares, we are confident that a representative sample has been obtained.

Completed questionnaires were returned by 3275 motorists. After removing those who had driven light goods vehicles for the purpose of deliveries or services, we were left with 3234 respondents.

The number of SP respondents and responses by type of SP exercise is reported in

Table 4.1. It can be seen that the sample sizes for each of the generic SP types are ample. As far as the choice between the M6T and other routes is concerned, its popularity is clear. This is in line with the actual choices amongst our sample of motorists.

Two SP exercises were offered to each respondent. As is apparent in Table A1.1 in Appendix 1, the second tended to relate to an abstract choice exercise, but 1213 respondents conducted two route choice SP exercises. The second route choice exercise related to either the extended M6T, reliability or departure time choice.

Table 4.1: SP Responses by SP Exercises

Design	Context	Inds	Obs	Choices
SP1A	Stoke-M1 Corridor	991	7652	M6: 1309 (17%) M6T: 4900 (64%) A: 1443 (19%)
SP1B	M6T Corridor	1266	9738	M6: 2726 (28%) M6T: 6486 (67%) A: 526 (5%)
SP1C	Stoke-M1 Corridor	150	1169	M6: 136 (11%) M6T: 757 (65%) A: 276 (24%)
SP2A	Stoke-M1 Extended M6T	422	3210	M6: 498 (16%) M6T: 2137 (66%) A: 575 (18%)
SP2B	Extended M6T in Bits	225	1625	M6: 250 (15%) M6T: 550 (34%) Nth: 82 (5%) Sth:11 (1%) M6TNth:262 (16%) M6TSth: 22 (1%) NthSth: 41 (3%) All: 407 (25%)
SP2C	Knutsford-Dunstable NewM6	136	1042	M6: 305 (29%) M6T: 556 (54%) A: 181 (17%)
SP3	Travel Time Differentials	956	8426	A: 5271 (63%) B: 3155 (37%)
SP4	Travel Conditions I	341	2708	A: 1279 (47%) B: 1429 (53%)
SP5	Travel Conditions II	370	2948	A: 1361 (46%) B: 1587 (54%)
SP6	Travel Time Variability	692	4687	M6: 1458 (28%) M6T: 3728 (72%)
SP7	Late Running	224	1737	M6: 651 (37%) M6T 1086 (63%)
SP8	Route and Departure Time	627	4722	M6: 522 (11%) M6T: 1855 (39%) M6 Earlier: 82 (2%) M6T Earlier: 1124 (24%) M6 Later: 178 (4%) M6T Later: 961 (20%)

Based on the data collected it has been possible to apply an expansion factor to each returned SP questionnaire that is based on the respective response rates for the survey, and total throughput at the respective times of the survey. The expansion factors have been derived to represent a typical week's data and the results of the expansion process have been calibrated so that the observed M6T traffic volumes are replicated. This process indicates that the M6T has a capture rate amongst car drivers of around 60% which is consistent with the actual choices of those in the SP survey data who were contacted at the RSIs and MSAs.

We now provide some simple tabulations that characterise the sample collected, prior to reporting some cross-tabulations of key variables. We do not repeat here the entire question underpinning a variable. These can be obtained from Appendix 14 which reproduces the questionnaire. However, we have given the questionnaire number to which the table relates

A word of warning is necessary here. The figures reported tend to relate to the whole sample and not to the representative sample based on the MSA/RSI surveys. The characteristics of the overall sample are not greatly different from the MSA/RSI sample. In terms of a key difference between data sources, that of route chosen, we demonstrate that this has little impact on the results obtained. However, section 4.2.2 reports cross-tabulations of data source and several key variables.

4.2.1 One-Way Tabulations

The sources of the data are detailed in Table 4.2. The majority of the data was obtained by postal returns from a data base of existing M6T users.

Table 4.2: Data Source

	Frequency	Percent
RSI/MSA	1245	38.5
Postal to M6T User	1989	61.5
Total	3234	100.0

The sample in its entirety is therefore not random in terms of actual route. However, as described above, the RSI and MSA based data can be taken as representative and is subsequently used to correct for the consequences of this element of choice based sample.

Only a small proportion were making one-way or multi-stage journey. Otherwise, there is a reasonable balance between those who were on outward and return legs.

Table 4.3: Which Leg of Your Journey Were You On (Q2)?

	Frequency	Percent
Multistage	112	3.5
One Way Trip	28	0.9
Outward	1740	53.8
Return	1320	40.8
Missing	34	1.1
Total	3234	100.0

Table 4.4 indicates that we have a good spread of travel across days. About 1% of the sample had departed at 5am or before whilst 15% departed between 5 and 7am. 20% departed in each of 7-9am, 9-11am and 11am-3pm, with 10% departing between 3 and 5pm, 5% after 5pm and the others not denoting a departure time.

Table 4.4: Day of Travel (Q3)

	Frequency	Percent
Monday	462	14.3
Tuesday	327	10.1
Wednesday	633	19.6
Thursday	439	13.6
Friday	473	14.6
Saturday	201	6.2
Sunday	583	18.0
Missing	116	3.6
Total	3234	100.0

Table 4.5 reports the journey purpose distribution. Most trips were for business but there is also a large proportion visiting friends and relatives. Commuting is the next most significant type of trip, with 13.5%, but none of the others exceed 10%.

Table 4.5: Journey Purpose (Q4)

	Frequency	Percent
Employer's business	1098	34.0
Holiday	142	4.4
Personal business	189	5.8
Recreation/leisure	194	6.0
Shopping	26	0.8
Short break	114	3.5
To/from work/education	435	13.5
Visiting friends/relatives	880	27.2
Other Leisure	135	4.2
Missing – not given	21	0.6
Total	3234	100.0

Almost all (96%) indicated that they were the main driver (Q7). By far the most were travelling alone, as can be seen in Table 4.6. Those who were accompanied were generally travelling with only one other person.

Table 4.6: Occupancy (Q5)

	Frequency	Percent
None	1987	61.4
1 other	903	27.9
2 others	183	5.7
3 others	117	3.6
4 others	35	1.1
5+ others	8	0.2
Missing – not given	1	0.0
Total	3234	100.0

As is apparent from Table 4.7, very few were travelling with children, defined as those aged 16 or less.

Table 4.7: Child Occupants (Q6)

	Frequency	Percent
None	1004	31.0
1 Child	128	4.0
2 Children	70	2.2
3 Children	25	0.8
4 Children	2	0.1
5+ Children	2	0.1
Not Applicable (Alone)	1987	61.4
Missing – not given	16	0.5
Total	3234	100.0

Table 4.8 lists the choices made for the actual journey. It can be seen that the M6T dominates for the entire sample. However, this sample is partly derived from a data base of M6T users. A truer picture of the actual market shares of each route within the corridor is given by the RSI/MSA sample. After removing those who did not indicate which route they had chosen, the shares of the M6T, M6 and A roads option are 63%, 27% and 10% amongst the RSI/MSA sample. It can be deduced that 3% of the 'postal to M6T users' made a journey that actually did not involve the M6T. This is likely to be the most recent in-scope journey. Note that all provided details of the M6T as an alternative route. .

Table 4.8: Route Choice (Q8)

	All Sample		RSI/MSA	
	Frequency	**Percent**	**Frequency**	**Percent**
A Roads	151	4.7	119	9.6
M6	344	10.6	314	25.2
M6T	2656	82.1	729	58.6
Missing – not given	83	2.6	83	6.7
Total	3234	100.0	1245	100.0

Note: Some would not have had a sensible A road option.

Table 4.9 provides details of the reported and network journey times for the actual route chosen and for the complete journey not just that in the M6T corridor. The average time for the 2902 (89.7%) who reported their actual journey time was 2 hours 33 minutes. For the 2964 (91.7%) for whom we have network times, the average journey time was 2 hours 21 minutes. Few had journey times in excess of 6 hours. The reported and network distributions only really differ in terms of the proportions split between the two shortest categories.

Table 4.9: Journey Times for Chosen Route (Q9)

	Reported		Network	
Network	**Frequency**	**Percent**	**Frequency**	**Percent**
≤ 45 mins	446	13.8	141	4.4
46-75 mins	394	12.2	662	20.5
76-120 mins	527	16.3	572	17.7
121-180 mins	552	17.1	689	21.3
181-240 mins	515	15.9	625	19.3
241-360 mins	374	11.6	218	6.7
>360 mins	94	2.9	57	1.8
Missing	332	10.3	270	8.3
Total	3234	100.0	3234	100.0

Note: Missing includes cases where the times were available for each route but the route chosen was not known. Some network times are missing as for some respondents the origin or destination addresses were missing, Since the network times were derived for the full journey length, it was not then possible to derive the network times.

Respondents were not asked for details of journey length. The network distance averaged 184 km with a standard error of 2.26. 10th, 25th, 50th, 75th and 90th percentiles were 40, 80, 174, 263 and 327 km. The average speed is around 80kph.

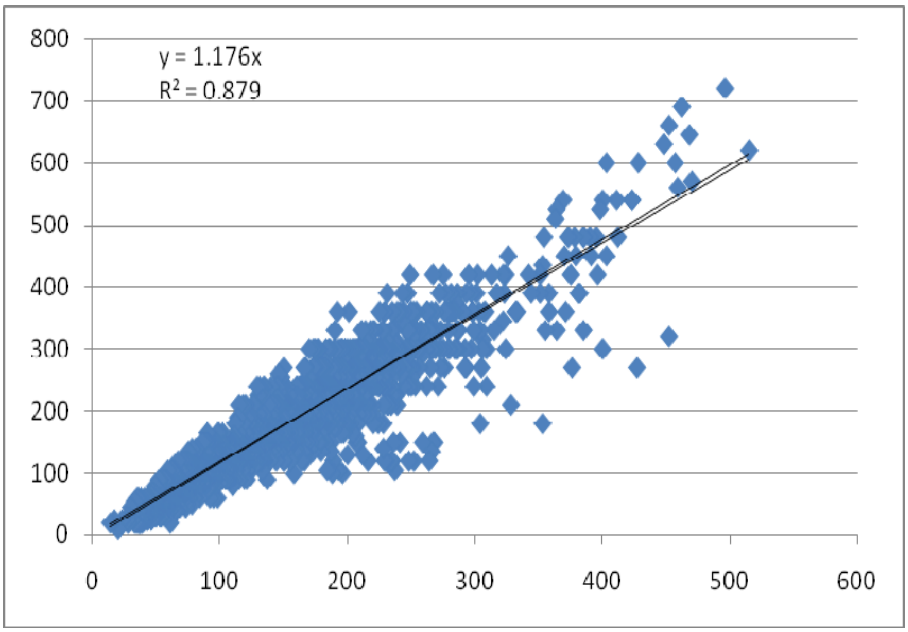
For the observations where data on both the reported and network times exists for the actual journey, the reported time averaged 2 hours 42 minutes whilst the corresponding figure for the network time was 2 hours 18 minutes. The relationship between the reported and observed times is plotted in Figure 4.2, it shows a correlation between the two times of 0.88.

Comparing times across routes for the 847 who provided times for all three routes, the mean time reported for the M6 was 172 minutes, with a standard error of 3.8. The corresponding figures for the M6T and A Road were 139 minutes (3.5) and 192 minutes (4.5). As expected, the M6T provides the quickest route and the A Road the slowest.

The ordering is preserved with the network times, although the differences are much less pronounced. The mean M6 time was 146 minutes with a standard error of 1.5. The mean M6T time was 138 minutes with a standard error of 1.4 whilst the figures for the A road were 157 minutes and 1.5. Note that the M6T time is very similar for the reported and network data.

We return to a discussion of the reported and network journey time data in Chapter 11 which deals with the RP models.

Figure 4.2: Network v Reported Times for Actual Route



We enquired as to the source of the respondents' reported journey time estimates, although this was not specific to route. The results are presented in Table 4.10. The findings that stand out are that most of the possible sources had a very limited impact on the estimated journey time estimates with the exception of previous experience which for almost 90% of respondents was the basis of their reported journey times.

No doubt the pattern of responses would be different for first time and infrequent users.

Table 4.10: All Stated Sources of Journey Time Estimates (Q10)

	Frequency	Percent
Journey Planner	353	10.9
Previous Experience	2847	88.0
Expected Speeds	341	10.5
Traffic and Travel News	212	6.6
Friends and Colleagues	145	4.5

Note: Multiple responses were permissible. Percentages are for those who stated a particular source and hence sum to more than 100.

We also enquired whether respondents had to be at their destination for a specific time. The results in Table 4.11 indicate that the majority had no such constraint. Of those who did have an arrival time constraint, a somewhat greater proportion stated that they could be up to a specific number of minutes late. The mean permissible arrival time for those who stated that they could be late was 25 minutes.

Table 4.11: Arrival Time Constraints (Q11)

	Frequency	Percent
No, could arrive at any time	2020	62.5
Yes (but no reporting of minutes)	396	12.2
Yes and could be up to X mins late	805	24.9
Not given	13	0.4
Total	3234	100.0

The number of Heavy Goods Vehicles (HGVs) on a route could possibly affect driver behaviour. We asked for perceptions of the proportion of HGVs on each route. The proportion not providing an answer was 14% for the M6, 12% for the M6T and 31% for the A Roads.

After removing those who did not provide an answer, the average perceived HGV proportions on the M6, M6T and A road were 43%, 10% and 28% respectively. The observed average proportions of HGV's on the respective roads are 29%, 4%, and 14% respectively. The relative proportions are correct but in all cases the perceived total is overestimated.

When we split by route chosen, the perceived proportions of HGVs on the M6, M6T and A road were 40%, 16% and 24% for M6 users. For M6T users the figures were 42%, 8% and 27% and for A road users they were 45%, 12% and 29%. There is little variation in the reported proportion of HGVs by route according to the route chosen There could have been more variation by route chosen either because this attribute was important in choice or else because of the common bias of reporting chosen options to be somewhat better than rejected ones.

Table 4.12 lists the quartiles of HGV proportions for each route. There is a large spread on both the M6 and A roads and the higher proportions are in line with the high mean levels of HGV proportion. Table 4.12 also splits the spread of perceptions

of the extent of HGV traffic by the route actually used and, in line with the mean figures, the patterns are similar across route chosen.

Table 4.12: Quartile HGV Proportions (Q12)

All	M6	M6T	A
20th Percentile	25%	4%	10%
40th Percentile	35%	5%	20%
60th Percentile	45%	10%	30%
80th Percentile	55%	15%	40%
M6 Users			
20th Percentile	20%	3%	10%
40th Percentile	35%	8%	15%
60th Percentile	45%	17%	25%
80th Percentile	50%	20%	40%
M6T Users			
20th Percentile	25%	3%	10%
40th Percentile	35%	5%	20%
60th Percentile	45%	8%	25%
80th Percentile	55%	15%	40%
A Users			
20th Percentile	25%	4%	15%
40th Percentile	40%	5%	20%
60th Percentile	50%	10%	30%
80th Percentile	60%	20%	45%

Another potentially important determinant of route choice is the perceived reliability of each route. Note that this is not just the reliability on the section of route in the M6T corridor but the question was couched in terms of the reliability of arrival at the destination.

Tables 4.13, 4.14 and 4.15 indicate the reliability of the M6, M6T and A Roads respectively, distinguishing according to which route was chosen for the actual journey made.

Overall, the M6 is generally regarded to be unreliable, no doubt due to the congestion that can occur, whilst in stark contrast the M6T is seen to provide a high level of reliability. The A Roads are perceived to be somewhere between the two.

Splitting by current route chosen, we observe more variance than for perceived levels of HGV traffic. M6T users are strongly of the view that the M6T offers a much more reliable journey than the M6, with the A road being perceived to be better than the latter on the whole but with a relatively high degree of unfamiliarity. This pattern of perceived reliability will to some extent influence actual and stated choices.

The M6 users themselves recognise the M6T to be more reliable than their chosen route, although not by the same margin as for M6T users and this may be driving behaviour. A surprisingly large proportion was not aware of the M6T's reliability. They were also quite unfamiliar with the reliability of the A road although the pattern of reliability was otherwise perceived to be similar to the M6.

The A road users recognise the high reliability of the M6T route and perceive the M6 to be less reliable than the A road although with quite a high degree of uncertainty regarding their unchosen routes.

Table 4.13: M6 Reliability (Q13)

	M6T User		M6 User		A User	
	Freq	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**
Very reliable	22	0.8	10	2.9	1	0.7
Reliable	50	1.9	27	7.8	3	2.0
Usually reliable	255	9.6	83	24.1	10	6.6
Sometimes unreliable	617	23.2	87	25.3	23	15.2
Unreliable	767	28.9	58	16.9	34	22.5
Very unreliable	719	27.1	63	18.3	34	22.5
Don't know	226	8.5	16	4.7	46	30.5
Total	2656	100.0	344	100.0	151	100.0

Table 4.14: M6T Reliability (Q13)

	M6T User		M6 User		A User	
	Freq	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**
Very reliable	1280	48.2	65	18.9	58	38.4
Reliable	796	30.0	75	21.8	33	21.9
Usually reliable	443	16.7	52	15.1	18	11.9
Sometimes unreliable	55	2.1	11	3.2	1	0.7
Unreliable	16	0.6	0	1.7	1	0.7
Very unreliable	0	0.0	0	0.0	0	0.0
Don't know	66	2.5	135	39.2	40	26.5
Total	2656	100.0	344	100.0	151	100.0

Table 4.15: A Roads Reliability (Q13)

	M6T User		M6 User		A User	
	Freq	**Percent**	**Freq**	**Percent**	**Freq**	**Percent**
Very reliable	12	0.5	1	0.3	7	4.6
Reliable	96	3.6	17	4.9	23	15.2
Usually reliable	502	18.9	60	17.4	67	44.4
Sometimes unreliable	643	24.2	78	22.7	31	20.5
Unreliable	475	17.9	41	11.9	16	10.6
Very unreliable	222	8.4	20	5.8	2	1.3
Don't know	706	26.6	127	36.9	5	3.3
Total	2656	100.0	344	100.0	151	100.0

In most cases, the respondent was responsible for payment of the toll charge, although in a third of cases the employer would reimburse the £3.50 cost.

Table 4.16: Payment of M6 Toll Charge (Q15)

	Frequency	**Percent**
Employer	1066	33.0
Other passenger	56	1.7
Self	1960	60.6
Shared between group	36	1.1
Missing – not given	116	3.6
Total	3234	100.0

We examine the extent to which fuel costs are considered in both actual and SP decision making in far more detail in chapter 6. In particular we might expect the influence of fuel costs on actual choices to depend upon the size of the fuel cost difference between routes and for their impact on SP choices to be a function of their credibility. Table 4.17 indicates that the vast majority of respondents did not take fuel costs into account when making decisions.

Table 4.17: Differences in Fuel Costs Influence Actual Route Choice (Q18)

	Frequency	Percent
No	2687	83.1
Yes	519	16.0
Missing – not given	28	0.9
Total	3234	100.0

Table 4.18 reports the frequency of trip making within the M6T corridor where there is a possibility that the M6T could be used. This relates to trips of any purpose. It can be seen that the vast majority will be familiar with travel in the corridor.

Table 4.18: Trip Frequency (Q19)

	Frequency	Percent
Daily	266	8.2
Several times a week	346	10.7
Weekly	305	9.4
Several times a month	539	16.7
Monthly	274	8.5
Several times a year	1219	37.7
Once a year	124	3.8
Less than once a year	75	2.3
First time today	63	1.9
Missing – not given	23	0.7
Total	3234	100.0

We also asked for the number of trips made in the M6T corridor that year and also how many of these involved the M6T for those who had made previous journeys (Q24). We return to this below.

Table 4.19 reports when the decision to use the M6T was made. The vast majority decided prior to setting out. Of the remainder, more decided during the course of the journey than when approaching the M6T.

Table 4.19: When Made Decision as to Whether or Not to Use M6T (Q20)

	Frequency	Percent
Approaching the M6 Toll	190	5.9
During the course of journey	465	14.4
Never considered using M6T	155	4.8
Prior to setting out	2385	73.7
Missing - Not Given	39	1.2
Total	3234	100.0

Table 4.20 indicates what did influence a decision to use the M6T or not for the 655 who decided during the course of the journey. Observed traffic conditions had the largest impact on decisions, followed by signs indicating delays on the M6. Radio messages influenced the decisions of 30% of those who decided en route but all other factors had a negligible impact on decision making.

Table 4.20: Influences on Decision During Journey to Use M6T or Not (Q21)

	Frequency	Percent
Sign Indicating Delays on M6	291	44.4
Observed Traffic conditions	402	61.4
Other Passenger Influence	25	3.8
Radio Messages	194	29.6
Wanted Break from the M6	68	10.4
Wanted to Make up some time	94	14.4
Observed Road Works	80	12.2

Note: Multiple answers permitted. Percent denotes proportion of people who stated this as an influence and thus sums to more than 100%.

Four attitudinal questions were asked relating to toll payments where respondents had to indicate their degree of agreement with a specific statement.

Table 4.21 indicates that there would be quite a strong degree of opposition to paying for tolls on existing motorways. However, paying for tolls on existing motorways is acceptable to a clear majority if fuel duty were scrapped in return as Table 4.22 shows.

Table 4.21: Object to Paying Tolls on Existing Motorways (Q23)

	Frequency	Percent
Strongly agree	1327	41.0
Agree	757	23.4
Neither agree nor disagree	385	11.9
Disagree	506	15.6
Strongly disagree	171	5.3
Missing response	88	2.7
Total	3234	100.0

Table 4.22: Tolls on Existing Motorways Acceptable if Fuel Duty Scrapped (Q23)

	Frequency	Percent
Strongly agree	880	27.2
Agree	1346	41.6
Neither agree nor disagree	418	12.9
Disagree	283	8.8
Strongly disagree	211	6.5
Missing response	96	3.0
Total	3234	100.0

Comparing Tables 4.23 and 4.21 clearly shows that the attitude to paying tolls for new motorways is somewhat different than for paying tolls on existing motorways. The much lesser objection to tolls when they cover new motorways is something that will be pursued in the SP modelling. And the results in Table 4.24 continue in a similar vein, with a majority feeling that tolls are a sensible means of funding additional road infrastructure.

Table 4.23: Object to Paying Tolls to Use New Motorways (Q23)

	Frequency	Percent
Strongly agree	337	10.4
Agree	441	13.6
Neither agree nor disagree	819	25.3
Disagree	1281	39.6
Strongly disagree	260	8.0
Missing response	96	3.0
Total	3234	100.0

Table 4.24: Tolls Sensible Means of Funding Road Infrastructure (Q23)

	Frequency	Percent
Strongly agree	335	10.4
Agree	1421	43.9
Neither agree nor disagree	563	17.4
Disagree	501	15.5
Strongly disagree	325	10.0
Missing response	89	2.8
Total	3234	100.0

We enquired about household annual income before the deduction of tax. The distribution is given in Table 4.25. A wide range of incomes is covered without domination by a particular category or group of categories.

Table 4.25: Annual Household Income (Q32)

	Frequency	Percent
Less than £10k	70	2.2
£10k to £19k	235	7.3
£20k to £29k	399	12.3
£30k to £39k	429	13.3
£40k to £49k	386	11.9
£50k to £59k	338	10.5
£60k to £69k	254	7.9
£70k to £79k	177	5.5
£80k to £89k	120	3.7
£90k to £99k	75	2.3
Over £100k	197	6.1
Do not wish to disclose	503	15.6
Missing response	51	1.6
Total	3234	100.0

Table 4.266 indicates a good spread across the different age categories whilst the sample is dominated by male respondents as is clear in Table 4.27.

Table 4.26: Age Group (Q31)

	Frequency	Percent
Under 18	2	0.0
18 to 24	75	2.3
25 to 34	429	13.3
35 to 44	774	23.9
45 to 54	901	27.9
55 to 64	735	22.7
65 to 75	230	7.1
75+	49	1.5
Missing response	39	1.2
Total	3234	100.0

Table 4.27: Gender (Q30)

	Frequency	Percent
Female	963	29.8
Male	2241	69.3
Missing response	30	0.9
Total	3234	100.0

Questions addressed the credibility of the SP times and fuel costs offered. This issue is examined in detail in chapter 8.

4.2.2 Cross-Tabulations

The descriptive statistics presented so far are simple frequency distributions. There are some joint distributions which are of particular interest here. For example, those with higher incomes might be expected to travel farther whilst there will also be correlations between journey purpose and income and between journey purpose and journey duration.

There were 2465 cases where both the income level and the journey time for the actual journey were reported. Using the mid-points of the income categories, the correlation between the journey time and income level was only -0.07. When we split by business travel, commuting and other travel, the correlations between income and journey time were 0.03, 0.04 and -0.02. The absence of any link between income and journey duration is also apparent by journey purpose.

The low degree of correlation between income and journey duration is quite clear in Table 4.28 which presents the mean journey durations for each income group.

Table 4.28: Actual Journey Times (Q9) by Income Group (Q32)

Income	Mean	Obs	SD	SE
Less than £10k	153	61	116.9	14.9
£10k to £19k	168	202	115.3	8.1
£20k to £29k	166	353	120.3	6.4
£30k to £39k	161	398	114.6	5.7
£40k to £49k	150	359	108.9	5.7
£50k to £59k	132	316	90.6	5.0
£60k to £69k	152	231	97.4	6.4
£70k to £79k	138	174	87.2	6.6
£80k to £89k	152	111	111.0	10.5
£90k to £99k	146	74	87.4	10.1
Over £100k	146	186	89.3	6.5
Missing	157	495	110.6	4.9
Total	153	2960	107.0	1.9

Note: Journey times as reported in minutes

The mean income levels by journey purpose were £57.4k (0.86) for business travellers, £55.4k (1.41) for commuters and £44.6k (0.79) for other travellers. It would therefore seem that there is not a great deal of difference in income levels by journey purpose, with leisure travel as expected having the lowest mean incomes and business travel having the highest.

Table 4.29 presents the income distribution by purpose. These do not differ by much, although the larger proportions in the lowest three income categories and the smaller proportions in the higher categories is noticeable for the other purpose.

Table 4.29: Income Levels (Q32) by Journey Purpose (Q4)

Income	Business		Commuting		Other		Total	
Less than £10k	0	0%	5	1.3%	65	4.8%	70	2.6%
£10k to £19k	24	2.5%	17	4.5%	194	14.2%	235	8.8%
£20k to £29k	99	10.5%	36	9.6%	264	19.4%	399	14.9%
£30k to £39k	153	16.2%	65	17.3%	211	15.5%	429	16.0%
£40k to £49k	156	16.5%	60	16.0%	170	12.5%	386	14.4%
£50k to £59k	135	14.3%	60	16.0%	144	10.6%	339	12.6%
£60k to £69k	122	12.9%	33	8.8%	99	7.3%	254	9.5%
£70k to £79k	87	9.2%	38	10.1%	52	3.8%	177	6.6%
£80k to £89k	58	6.2%	19	5.1%	43	3.2%	120	4.5%
£90k to £99k	38	4.0%	14	3.7%	23	1.7%	75	2.8%
Over £100k	71	7.5%	29	7.7%	97	7.1%	197	7.3%
Total	943	100.0%	376	100.0%	1362	100.0%	2681	100.0%

The journey times do differ by journey purpose. The mean journey time for business trips is 137 minutes with a standard error of 2.7. The corresponding figures for commuting are 74 and 2.8 and for other trips are 189 and 2.9. As expected, the mean travel time is lowest for commuting trips, although these are high in comparison with more typical commuting trips and are a function of this particular context. Other trips are on average longest.

Table 4.30 provides a cross-tabulation of journey time band and journey purpose. Two thirds of commuting trips are 75 minutes or less. Some of the longer commuting trips may well be infrequent commuters who, for example, travel to a remote work location on a Monday and return home later in the week. Most of the business trips are for three hours or less whereas a considerable number of other journeys exceed three hours.

Table 4.30: Actual Journey Times (Q9) by Journey Purpose (Q4)

	Business		Commuting		Other		Total	
≤ 45 min	129	11.7%	151	34.7%	166	9.8%	446	13.8%
46-75mins	153	13.9%	130	29.9%	111	6.5%	394	12.2%
76-120 mins	246	22.4%	70	16.1%	211	12.4%	527	16.3%
121-180 mins	232	21.1%	30	6.9%	290	17.0%	552	17.1%
181-240 mins	161	14.7%	18	4.1%	336	19.8%	515	15.9%
241-360 mins	64	5.8%	4	0.9%	306	18.0%	374	11.6%
>360 mins	14	1.3%	1	0.2%	79	4.6%	94	2.9%
Missing	99	9.0%	31	7.1%	202	11.9%	332	10.3%
Total	1098	100.0%	435	100.0%	1701	100.0%	3234	100.0%

Note: Journey times as reported.

We might expect the frequency of making trips across all purposes within the corridor to depend upon income level. Table 4.31 reports a cross-tabulation of income and trip frequency which indicates that there is a tendency to make more trips as income increases.

Table 4.31: Trip Frequency in Corridor (Q19) by Income Group (Q32)

	<£30k		£30-70k		>£70k		Total	
Daily	21	3.0%	136	9.7%	68	12.0%	225	8.4%
Several times a week	44	6.3%	177	12.6%	77	13.5%	298	11.1%
Weekly	49	7.0%	141	10.0%	76	13.4%	266	9.9%
Several times month	90	12.8%	267	19.0%	96	16.9%	453	16.9%
Monthly	61	8.7%	123	8.7%	41	7.2%	225	8.4%
Several times a year	337	47.9%	464	33.0%	192	33.7%	993	37.1%
Once a year	44	6.3%	46	3.3%	8	1.4%	98	3.7%
Less than once year	24	3.4%	24	1.7%	5	0.9%	53	2.0%
First time today	27	3.8%	18	1.3%	6	1.1%	51	1.9%
Missing - Not given	7	1.0%	11	0.8%	0	0.0%	18	0.7%
Total	704	100.0%	1407	100.0%	569	100.0%	2681	100.0%

Table 4.32 provides details of car occupancy for each journey purpose. Almost all business trips are made alone. This is even more the case with commuting trips and is not surprising given the comparatively long distance nature of commuting trips that can make use of the M6T will reduce the opportunities for car sharing. Slightly more than a third of trips for other purposes are made alone and the largest category here is 45% for 2 people travelling together. 18% of other trips involved 3 or more travellers.

Table 4.32: Occupancy (Q5 & Q6) by Journey Purpose (Q4)

	Business		Commuting		Other		Total	
None	958	87.2%	407	93.6%	622	36.6%	1987	61.4%
1 other	115	10.5%	19	4.4%	769	45.2%	903	27.9%
2 others	17	1.5%	9	2.1%	157	9.2%	183	5.7%
3 others	7	0.6%	0	0.0%	110	6.5%	117	3.6%
4 others	0	0.0%	0	0.0%	35	2.1%	35	1.1%
5+ others	0	0.0%	0	0.0%	8	0.5%	8	0.2%
Missing – not Given	1	0.1%	0	0.0%	0	0.0%	1	0.0%
Total	1098	100.0%	435	100.0%	1701	100.0%	3234	100.0%

As is indicated in Table 4.33, and as would be expected, arrival time constraints are much more of an issue for business and commuting trips. However, in all cases, there are somewhat larger numbers who have some flexibility in arriving on time as opposed to a fixed constraint.

Table 4.33: Arrival Time Constraints (Q11) by Journey Purpose (Q4)

	Business		Commuting		Other		Total	
No	504	45.9%	183	42.1%	1333	78.4%	2020	62.5%
Yes	217	19.8%	78	17.9%	101	5.9%	396	12.2%
Yes and could be up to ... mins late	373	34.0%	171	39.3%	261	15.3%	805	24.9%
Not Given	4	0.4%	3	0.7%	6	0.4%	13	0.4%
Total	1098	100.0%	435	100.0%	1701	100.0%	3234	100.0%

Of those business travellers who stated that they had a fixed arrival time but could be up to a certain minutes late, the mean permissible lateness was 23 minutes with a standard error of 0.7. The corresponding figures for commuting were 22 and 1.1 and for other trips were 31 and 1.0.

As for who would pay the toll, the vast majority of those on business trips would have the toll reimbursed by their employer. However, around 16% would pay themselves, presumably because they are self employed, they receive a per diem travel allowance or the company does not permit use of the M6T. A surprisingly large proportion of commuters do or would have the toll reimbursed by their employer, perhaps because what are commuting trips on some days become part of a business trip on others whilst, as would be expected in the vast majority of other trips, the toll cost is borne by the respondent or another occupant.

Table 4.34: Payment of Toll (Q15) by Journey Purpose (Q4)

	Business		Commuting		Other		Total	
Employer Reimburses	893	81.3%	112	25.7%	61	3.6%	1066	33.0%
Other passenger	1	0.1%	0	0.0%	55	3.2%	56	1.7%
Self	180	16.4%	305	70.1%	1475	86.7%	1960	60.6%
Shared between group	1	0.1%	4	0.9%	31	1.8%	36	1.1%
Missing - Not Given	23	2.1%	14	3.2%	79	4.6%	116	3.6%
Total	1098	100%	435	100%	1701	100%	3234	100%

We conclude this section of cross-tabulations by examining the characteristics of the sample according to whether it was obtained from the RSI//MSA procedure or from postal questionnaires to a database held by the M6T operator.

For those who had made previous journeys in the M6T corridor that year, they were asked how many times they had used the M6T out of how many journeys (Q24). Only 51 (1.9%) stated that they had not made a previous journey in the corridor that year. This is less than the 138 (4.2%) implied in Table 4.18 not to have made a previous trip that year. A possible reason for this could be one of units, given that question 24 relates to single journeys of which the outward leg might have been the first but which is not detected by question 19 which relates to a journey.

The mean number of single trips was 37.2 with a standard error of 1.41, although this will vary by, amongst other things, journey purpose. Amongst the 2663 respondents who provided relevant data, the M6T had a 74% market share for all previous journeys made in the corridor that year.

Table 4.35 reports the mean proportion of trips within the M6T corridor that involved the M6T by data source and according to the frequency of trips. Five categories of the latter, from 1 to 5 trips through to over 50 trips, are specified.

Table 4.35: Proportion of Times Use M6T by Frequency (Q24) and Data Source

	RSI or MSA			Postal to M6T User		
Frequency	**Mean**	**SE**	**Obs**	**Mean**	**SE**	**Obs**
1-5	0.73	0.025	212	0.88	0.013	311
6-10	0.67	0.019	327	0.82	0.010	573
11-20	0.54	0.033	139	0.80	0.017	257
21-50	0.64	0.031	148	0.79	0.018	239
51+	0.56	0.030	182	0.68	0.019	275
Total	0.64	0.012	1008	0.80	0.006	1655

Note: We have removed those who did not fully answer the question.

Overall, the market share of the M6T was 80% for the postal survey. The proportion varies little except for the most frequent users were it is notably less. Only 1.2% stated that they had not used the M6T for relevant trips in the past year whilst 49.6% stated that they had always used it.

As far as the RSI/MSA sample is concerned, the market share of the M6T across all trips made that year averages 64%. This corresponds very closely with the figure of 63% M6T use for the number of intercepted trips using the RSI/MSA survey method. Only 8.9% stated that they had never used the M6T for relevant trips whilst 35.7% stated that they always used it.

Table 4.36 provides the mean reported journey times by data source. It can be seen that those contacted using the postal survey have longer reported journey times. The difference is significant (t=6.79). The distribution of the sample across different journey time categories followed similar patterns but with the postal survey having slightly larger proportions of the longer journey times and the RSI/MSA sample have slightly larger proportions of the shorter journey times.

Table 4.36: Reported Journey Times (Q9) by Data Source

Data Source	Mean	SE	Obs
RSI/MSA	134.84	3.02	1152
Postal to M6T User	161.63	2.58	1834
Total	151.29	1.98	2986

The journey purpose splits by data source are given in Table 4.37. The proportion of commuters is the same for the two data sources. However, the RSI/MSA sample has a larger proportion of business travel and a lower proportion of travellers on other purposes. The journey purpose data relates to the purpose of the trip that was being made at the point when the respondent was first contacted and therefore reflects a specific trip on a specific day. As the roadside interviews were undertaken on conventional average weekdays only, and the M6T Toll Booth surveys and MSA surveys included some weekend surveys the observed differences between the data sources are consistent with the proportional purpose travel differences between weekday and weekend travel on long distance trips.

Table 4.37: Journey Purpose (Q4) by Data Source

Journey Purpose	RSI/MSA		Postal to M6T User		Total	
Business	496	39.8%	602	30.3%	1098	34.0%
Commuting	168	13.5%	267	13.4%	435	13.5%
Other	581	46.7%	1120	56.3%	1701	52.6%
Total	1245	100.0%	1989	100.0%	3234	100.0%

Table 4.38 records the frequency of making a trip where the M6T could be used split according to data source. The two samples correspond extremely closely.

Table 4.38: Trip Frequency in M6T Corridor (Q19) and Data Source

	RSI/MSA		Postal to M6T User		Total	
Daily	127	10.2%	139	7.0%	266	8.2%
Several times a week	124	10.0%	222	11.2%	346	10.7%
Weekly	119	9.6%	186	9.4%	305	9.4%
Several times a month	181	14.5%	358	18.0%	539	16.7%
Monthly	97	7.8%	177	8.9%	274	8.5%
Several times a year	460	36.9%	759	38.2%	1219	37.7%
Once a year	47	3.8%	77	3.9%	124	3.8%
Less than once a year	48	3.9%	27	1.4%	75	2.3%
First time today	28	2.2%	35	1.8%	63	1.9%
Missing - Not Given	14	1.1%	9	0.5%	23	0.7%
Total	1245	100.0%	1989	100.0%	3234	100.0%

Finally, we report the household income distribution by data source in Table 4.3.9. The income distributions in the two samples are broadly comparable.

Table 4.39: Household Income (Q32) and Data Source

Income	RSI/MSA		Postal to M6T User		Total	
Less than £10k	25	2.0%	45	2.3%	70	2.2%
£10k to £19k	74	5.9%	161	8.1%	235	7.3%
£20k to £29k	164	13.2%	235	11.8%	399	12.3%
£30k to £39k	154	12.4%	275	13.8%	429	13.3%
£40k to £49k	143	11.5%	243	12.2%	386	11.9%
£50k to £59k	139	11.2%	199	10.0%	338	10.5%
£60k to £69k	102	8.2%	152	7.6%	254	7.9%
£70k to £79k	65	5.2%	112	5.6%	177	5.5%
£80k to £89k	48	3.9%	72	3.6%	120	3.7%
£90k to £99k	29	2.3%	46	2.3%	75	2.3%
Over £100k	74	5.9%	123	6.2%	197	6.1%
Not disclosed	206	16.5%	297	14.9%	503	15.6%
Missing	22	1.8%	29	1.5%	51	1.6%
Total	1245	100%	1989	100%	3234	100%

5. MODELLING APPROACH

By far the most common method used to explain discrete data in transport research is some form of logit model. The logit model which is used to analyse choices at the disaggregate (individual) level is based on the assumption that each individual chooses that alternative from the n on offer which yields maximum utility (U) or satisfaction. Thus individual i choose alternative 1 if:

$$U_{i1} > U_{in} \quad for\ all\ n, n \neq 1$$

In turn, the overall utility for each alternative is made up of the part-worth utilities associated with a range of explanatory variables. However, the demand analyst cannot possibly observe all the influences on each individual's choices, whilst others are difficult to measure or too minor to merit inclusion. An error term (ε_i) is therefore introduced to represent the net effect of the unobserved influences on an individual's choices. Hence as far as we are concerned, individual i bases decision making on what might be termed random utility which for alternative k (U_{ik}) is made up as:

$$U_{ik} = V_{ik} + \varepsilon_{ik}$$

V_{ik} is the observable part of utility, termed deterministic utility. In the case of the choice between n options with different costs (C) and levels of travel time (T), the deterministic utility associated with option 1 for individual i could be represented as:

$$V_{i1} = \alpha T_{i1} + \beta C_{i1}$$

The utility for other options are specified in an entirely analogous fashion. As analysts, by definition we can proceed only by observation of V_{ik}, yet this ignores the influence of what is to us unobservable. We cannot be sure that alternative 1 is preferred if V_{i1} is the highest, yet the analysis must proceed on the basis of this observable component of utility alone.

The way forward is to specify the problem as one of explaining the probability of an individual choosing a particular alternative. We would expect the likelihood of choosing alternative 1 to increase as its overall random utility increases. The probability that an individual chooses alternative 1 (P_{i1}) from the n on offer can be represented as:

$$P_{i1} = \Pr\left[\left(V_{i1} + \varepsilon_{i1}\right) > \left(V_{in} + \varepsilon_{in}\right)\right] \quad for\ all\ n, n \neq 1$$

By assuming some probability distribution for the ε_{in}, the probability of choosing alternative 1 can be specified solely as a function of the observable component of utility. Assuming that the errors associated with each alternative have a type I extreme value distribution and are independently and identically distributed yields the familiar multinomial logit model (MNL):

$$P_{i1} = \frac{e^{V_{i1}}}{\sum_{k=1}^{n} e^{V_{ik}}}$$

Where choices are made amongst just two alternatives, the logit model simplifies to:

$$P_{i1} = \frac{1}{1 + e^{(V_{i2} - V_{i1})}}$$

The coefficients in the disaggregate logit model's utility function are estimated by maximum likelihood to provide the best explanation of individuals' discrete choices.

More sophisticated estimation techniques, such as random parameters logit, allow the parameters in the utility function to have a distribution across the sample rather than assuming them to be fixed across all individuals. Similarly, some estimation techniques allow more flexible forms of utility function to be directly estimated.

The estimated coefficient weights (α and β) denote the relative importance of the variables. We will have expectations as to the sign of the coefficient estimates. A variable which as it becomes larger is disliked more, such as both cost and travel time, will have a negative coefficient weight.

In this study, we deal with continuous variables, such as time, toll, fuel and departure time shift, but we also cover a range of categorical variables, such as a particular road surface or the provision of a particular type of information. The levels of these variables are represented by dummy variables. For example, suppose there are four levels of road surface. We would specify these, alongside time and cost, as follows:

$$V_i = \alpha T_i + \beta_1 C_i + \lambda_2 d_{2i} + \lambda_3 d_{3i} + \lambda_4 d_{4i} + ...$$

d_2, d_3 and d_4 are dummy variables denoting the presence (1) or not (0) of the second, third and fourth levels of road surface. The coefficients denote the utility of the presence of these levels relative to the arbitrarily omitted category (here 1). If then level 2 is superior to level 1, λ_2 will be positive, otherwise it will be negative.

This same procedure can be used in what is termed piecewise estimation to determine whether the response to continuous variables is linear or not. Thus suppose there were four toll levels of £2, £3, £4 and £5. We could arbitrarily specify £2 to be the base and d_2, d_3 and d_4 to represent the £3, £4 and £5 toll levels. Their coefficients would indicate the extent to which the relationship between utility and toll is linear or not.

Alternatively, we might hypothesise that instead of having an additive effect on utility, the road surface effect depends on the duration of the journey. This is the same as saying that the value of time depends upon road surface. We would then specify the utility function as:

$$V_i = \alpha T_i + \beta_1 C_i + \lambda_2 d_{2i} T_i + \lambda_3 d_{3i} T_i + \lambda_4 d_{4i} T_i + ...$$

The time coefficient for the base surface category is α but it is $\alpha+\lambda_2$ for the second road surface category.

The logit model produces standard errors for each of its coefficient estimates, allowing t ratios and confidence intervals to be derived. These are interpreted in the same manner as for the more familiar multiple regression analysis. The critical value is commonly taken to be two. However, we are prepared to retain variables whose

coefficients have t ratios of less than two if the estimates are expected to influence choice and are plausible even though not so precisely estimated.

The ρ^2 statistic is a measure of goodness of fit, analogous to the more familiar R^2 measure of regression analysis. However, the interpretation of what is a reasonable figure is somewhat different. Louviere et al. (2000) state that, "Values of ρ^2 between 0.2 and 0.4 are considered to be indicative of extremely good model fits. Simulations by Domencich and McFadden (1975) equivalence this range to 0.7 to 0.9 for a linear function". ρ^2's of around 0.1 are typical of the goodness of fit obtained in standard SP travel choice models.

The standard logit model assumes that the unobserved influences on choice are independent. However, it is likely that, because each individual performs multiple choices, there will be a degree of correlation in the errors within the choices made by each individual. As a consequence, the t ratios will be higher than they should be, and thereby we will be given a false indication as to the precision with which the coefficients are estimated.

The procedure we have here used to account for what is termed the repeat measurements problem is to use the jack-knife procedure within the Alogit version 4 package (Hague Consulting Group, 2000). This procedure involves taking repeated samples from the overall data and estimating models to each of these data sets. The overall standard errors for each coefficient are a function of the standard errors obtained across the different model runs.

The valuation of an attribute denotes the monetary equivalence of the change in utility brought about by a change in that attribute. For example, the value of time is the monetary equivalent of a reduction or improvement in travel time. It therefore represents the most that an individual is prepared to pay for a time saving or the minimum compensation that would be required in the event of a time loss.

The marginal value of a variable is defined as the ratio of the marginal utility of that variable and the marginal utility of money. In the case of the linear-additive utility function above, the marginal value of time is simply the ratio of the travel time coefficient and the cost coefficient (α/β). In this case, the monetary value is constant, and the average and marginal values are the same.

To handle systematic taste variation with respect to socio-economic variables, we follow the standard procedure of specifying dummy variable interaction terms as discussed in section 7.8. We have specified dummy variables for different levels of journey time saving and toll levels to assess whether the marginal utility differs with the size of a time saving or with the absolute level of toll. Section 7.2 specifies utility functions which allow various coefficient estimates to vary according to the duration of the actual journey whilst 7.3 specifies utility functions which examine whether the unit value of time depends upon the amount of time saved.

One of the features of the coefficients of discrete choice logit models is that they are estimated in units of residual variation. This allows the unobserved factors to have their appropriate influence on choice. The greater the amount of random error in a model then the smaller the coefficient estimates will be. In turn, the forecast shares will tend to the equal shares, which in the extreme case is what applies when decisions are purely random.

The issue of scaling is not a problem in calculating relative values, since they are derived as ratios of coefficient estimates and hence the scale cancels out. However, its entire purpose is to give the appropriate scale to the coefficients and forecast choice probabilities given the underlying degree of randomness in behaviour.

For accurate forecasting of real-world behaviour, a necessary condition is that the errors in an SP model are representative of the errors that influence actual behaviour. This is unlikely to be the case given that respondents are not committed to behave in accordance with their stated preferences. The widely held view is that SP models should, for forecasting purposes, have their coefficients rescaled to be consistent with actual choices.

An additional point here is that we have a wide variety of SP models. Pooling across these is very sensible, since it makes better use of data and avoids having to, for example, estimate the incremental effect of, say, business travel for a wide range of models and instead estimate a single effect. The results would surely not be consistent if only for reasons of sampling distribution. However, if we pool data across SP exercises, differences in scale, as a result of differences in random error, could result in drawing erroneous conclusions about attribute value variation which are attributable to differences in scale across the exercises which deal with specific features rather than to genuine differences in attribute values.

Our procedure in pooling across data sets, whether it is RP and SP data sets, or more usually, as will be seen, across different SP data sets, is to use the Bradley-Daly method (Bradley and Daly 1991). This approach is widely employed and makes use of the hierarchical logit formulation and its scaling properties. The upper nest, of whatever type of data, will represent the units in which the model is estimated. All other forms of data are entered as lower nests. Each alternative is a single alternative within its lower nest, such that the log sum parameter estimated to its utility serves to allow for differences in scale.

We have used ALOGIT (Hague Consulting Group, 2000) for speed of estimation, prior to using purpose written code to estimate mixed logit models on our large data sets[1]. The latter code allows taste variation to be examined, by estimating two parameters for selected variables. One represents the mean utility effect and the other the standard deviation of the effect. The latter denotes the extent to which the coefficient estimate varies across the sample.

[1] The model has been estimated using CIMLogit, software developed at ITS Leeds by Dr Richard Connors and Dr Nicolás Ibáñez and based in MATLAB.

6. INITIAL ROUTE CHOICE RESULTS: POOLING DATA

6.1 Introduction to the Modelling

We commence the analysis by estimating separate models for each of the route choice SP exercises listed in Table 3.1. These generic exercises along with the number of separate models estimated for each specific exercise are as follows:

- Stoke-M1 Corridor Route Choice (SP1A): *6 models*
- M6T Corridor Route Choice (SP1B): *8 models*
- Stoke-M1 Corridor Route Choice with Tolled M6 (SP1C): *2 models*
- Stoke-M1 Corridor Route Choice with Extended M6T (SP2A): *3 models*
- Stoke-M1 Corridor Route Choice M6T Extended 'in Bits' (SP2B): *1 model*
- Knutsford to Dunstable New Motorway (SP2C): *1 model*
- M6T Corridor Route and Departure Time Choice (SP8A): *2 models*
- Stoke-M1 Corridor Route and Departure Time Choice (SP8B): *2 models*

6.1.1 Initial Models

We first report these 25 models in sections 6.2 to 6.8. These provide a general impression of the quality of the SP responses and indicate any unexpected variations in the value of time across models for which it might be prudent to account in subsequent pooled models. Section 6.9 provides an assessment of the robustness of the models estimated by comparing the implied values of time with other evidence.

The models are all estimated using ALOGIT (Hague Consulting Group, 2000) with the jack-knife procedure and 20 draws used to address the repeat observations issue. All models are linear-additive. Their general specification is as follows:

- A full set of alternative specific constants (ASCs) for the relevant choice context. The convention is that the base ASC (set to zero) is always for the M6.
- Journey time in minutes is denoted by TIME and is constrained to be the same across routes in these initial models.
- In the route and departure time choice models, EARLIER and LATER denote the departure time switch in minutes
- TOLL denotes the toll charge in pence. Separate toll coefficients are estimated for the M6 where it is introduced (SP1C) and for the new motorway (SP2C).
- We have allowed for possible variations in the value of time by journey purpose by allowing the toll to differ for business travel. This term (EBTOLL) is an interaction of whether the journey was for employer's business and the toll level. Its coefficient is therefore the <u>only</u> incremental effect in these base models.
- FUEL-YES denotes the fuel price in pence. Note that this relates <u>only</u> to those who reported that they considered the fuel cost in making their choices. For the others, fuel was set to zero.

We also report for each model the t ratio associated with the coefficient estimate (in parentheses), the implied value of time in toll units and its t ratio, the ρ^2 goodness of fit statistic specified with respects to a constants only model, the number of choice observations and the share of these choice observations across the alternatives.

6.1.2 *Pooling Across Models within a Generic SP Exercise*

We then proceed to examine whether pooling across specific SP exercises within a generic design is empirically justified. Pooling of data across the route choice SP exercises allows for more precise coefficient estimates than if separate models are estimated for different designs. It also allows a single analysis, with the benefit of a single set of results, of the effects of socio-economic and trip characteristics on model parameters. However, it is necessary to allow for any scale differences across data sets because not to do so could erroneously attribute to coefficient estimates in pooled models what is really a scale difference

These models use the hierarchical logit formulation of Bradley and Daly (1991). The upper nest is specified to be one of the specific SP exercises and has an implicit scale of one. The coefficient estimates are in units of residual variation of the SP exercise in this upper nest. All other SP exercises are specified in a lower nest and the scale factor (θ) allows for differences between the scales of the SP data in the lower nest. Thus if a θ of 0.5 is returned, it indicates that the scale of the SP exercise to which it relates is half that of the base in the upper nest; that is, its coefficients are half and its standard deviation of errors double.

This procedure requires that there are two or more common coefficients across the pooled data sets. The convention we have adopted here is to constrain all time and cost variables to have the same parameters across SP exercises. However, we have followed the usual practice in this area of allowing the ASCs to vary by SP exercise, not least because the ASCs are heavily dependent on market share of each alternative in the sample..

In the reporting of the models, in sections 6.10-6.13, the upper nest is clearly denoted by reporting a θ of one. This is usually the first exercise listed in Table 3.1 for any generic exercise. For each of the other SP exercises within a generic design a separate θ parameter is estimated and reported.

6.1.3 *Pooling Across Generic SP Designs*

This follows the same procedure as for pooling across SP exercises within a generic design. The analysis is reported in section 6.14.

Once we have arrived at a preferred pooled specification, we address the issue of the unrepresentative nature of the sample in terms of the actual share of each route and the need for and impact of weighted estimation to reflect our best estimate of the proportion using each route in practice. This is covered in section 6.15.

There is little point combining the ‘late running SP route choice exercise (SP7) with the other route choice estimates since it only has one parameter (toll) in common with the other designs.

Nor have we included in the pooling process the models relating to reliability (SP6). Whilst these contain time and toll, the former is a mean journey time which could be taken to be different in nature to a single journey time. Thus there is again only a single common variable. Another reason was, as will be reported in Chapter 9, because of difficulties in obtaining plausible results from this data, and hence we proceeded in the modelling process here without it.

6.2 Models for Stoke - M1 Corridor (SP1A)

The six SP models for the Stoke-M1 corridor are reported in Table 6.1. ASCs are specified for the M6T (ASC_{M6T}) and the A road alternative (ASC_A) with the M6 as the base. As indicated in Table 3.1, the SP exercises all involved a choice between the M6, M6T and A road alternative, with the following features

- SP1A-1: Time, Toll and Fuel, Absolute times
- SP1A-2: Time, Toll and Fuel, Absolute times
- SP1A-3: Time, Toll and Fuel, M6T quicker
- SP1A-4: Time, Toll and Fuel, M6 slower
- SP1A-5: Time and Toll. Absolute times
- SP1A-6: Time and Toll, Absolute times

The general impression is that the data is of good quality. In our experience, the ρ^2 goodness of fit measures are notably high, somewhat better than the value of around 0.1 typically achieved by SP travel choice exercises. This, and the correct sign and highly significant coefficient estimates, is encouraging. When we did not allow for those who take fuel cost into account in decision making, the fuel cost coefficient was far from statistically significant.

Table 6.1: Stoke – M1 Route Choice Results (SP1A)

	SP1A-1	**SP1A-2**	**SP1A-3**	**SP1A-4**	**SP1A-5**	**SP1A-6**
ASC_A	-0.7016 (5.1)	-0.5437 (3.3)	-0.8480 (4.2)	-1.3495 (6.0)	-0.4544 (5.3)	-0.7592 (3.4)
ASC_{M6T}	2.1157 (12.3)	2.3547 (10.6)	2.0915 (6.1)	2.2553 (8.2)	1.5391 (8,2)	1.9174 (4.6)
TIME	-0.0663 (16.3)	-0.0648 (13.2)	-0.0495 (7.5)	-0.0607 (7.2)	-0.0741 (14.9)	-0.0988 (6.1)
TOLL	-0.0067 (29.4)	-0.0061 (13.8)	-0.0049 (5.9)	-0.0065 (11.2)	-0.0069 (14.3)	-0.0089 (10.6)
EBTOLL	0.0011 (3.0)	0.0004 (1.0)	0.0001 (0.1)	0.0011 (1.8)	0.0010 (2.6)	0.0014 (1.3)
FUEL-YES	-0.0071 (8.8)	-0.0039 (3.8)	-0.0071 (4.3)	-0.0091 (5.1)	n.a.	n.a.
VoT	9.9 (16.7)	10.6 (11.5)	10.7 (5.6)	9.3 (7.1)	10.7 (12.3)	11.1 (6.1)
ρ^2(constant)	0.287	0.247	0.214	0.264	0.260	0.300
Individuals	331	176	81	84	242	77
Observations	2547	1366	627	652	1860	600
M6	425 (17%)	197 (14%)	107 (17%)	132 (20%)	382 (21%)	66 (11%)
M6T	1578 (62%)	935 (68%)	430 (69%)	401 (62%)	1081 (58%)	475 (79%)
A	544 (21%)	234 (17%)	90 (14%)	119 (18%)	397 (21%)	59 (10%)

As is not uncommon in SP exercises, the value of time for business travel is not greatly different to the value for other purposes. Even where the incremental effect on the toll coefficient (EBTOLL) is significant, it reflects only a small effect.

The reported values of time, which relate to commuting and other, vary little across the designs and seem highly plausible, averaging 10.4 pence per minute. However, the average business value of 11.9 is not expected to reflect employers' valuations.

There is a strong preference for the M6T over the M6 all else equal, ranging from around 20 to around 40 minutes. However, the A road is felt to be inferior to the M6 all else equal. These ASCs will be affected by the extent to which the time valuation varies by route and the sampling process amongst a number of other factors.

6.3 Models for Stoke - M1 Corridor (SP1C)

These SP exercises are similar to SP1-A in offering choices between the M6, M6T and A roads characterised by time, toll and fuel. They differ only in terms of the introduction of a toll to the M6 in some scenarios. Hence we do not expect a great deal of difference to those who had no toll on the existing M6 (SP1A). This turns out to be the case, as is apparent from the two models reported in Table 6.2.

Table 6.2: Stoke – M1 Route Choice Results (SP1C)

	SP1C-1	SP1C-2
ASC_A	0.0410 (0.1)	-0.0753 (0.3)
ASC_{M6T}	1.6485 (6.3)	2.1988 (5.4)
TIME	-0.0540 (9.5)	-0.0944 (10.2)
$TOLL_{M6T}$	-0.0045 (7.9)	-0.0066 (12.5)
$TOLL_{M6}$	-0.0004 (0.2)	-0.0021 (0.8)
EBTOLL	0.0010 (1.8)	0.0001 (0.2)
FUEL-YES	-0.0041 (2.4)	-0.0055 (2.4)
VoT	12.0 (6.8)	14.3 (8.8)
ρ^2 (constants)	0.181	0.336
Individuals	83	67
Observations	643	526
M6	84 (13%)	52 (10%)
M6T	395 (61%)	362 (69%)
A	164 (26%)	112 (21%)

Note: The value of time is expressed in terms of $Toll_{M6T}$.

The models and their implied values of time are plausible, with again highly significant coefficient estimates a good fits. The notable result here is that the toll coefficient on the M6 ($TOLL_{M6}$) is not statistically significant in either of the models reported. This is due to large correlations between the M6 toll coefficient estimate and the M6T constant, a correlation that is broken when data is pooled across different SP exercises.

6.4 Models for M6T Corridor (SP1B)

As indicated in Table 3.1, the M6T corridor SP exercises had the following features:

- SP1B-1: M6 v M6T v A Road, Time and Toll, Absolute times
- SP1B-2: M6 v M6T, Time and Toll, Absolute times
- SP1B-3: M6 v M6T, Time and Toll, M6T quicker
- SP1B-4: M6 v M6T, Time and Toll, M6 slower
- SP1B-5: M6 v M6T, Time and Toll, Different tolls
- SP1B-6: M6 v M6T, Time, Toll and Roadwork Information, Absolute times
- SP1B-7: M6 v M6T, Time, Toll and Accident Information, Absolute times
- SP1B-8: M6 v M6T, Time, Toll and Congestion Information, Absolute times

The results for the 8 M6T corridor models reported in Table 6.3 are similar to those for the Stoke-M1 corridor, with plausible values of time for non-business trips, a strong preference for the M6T over the M6, very good fits to the data and highly significant coefficient estimates.

Table 6.3: M6T Corridor Route Choice Results (SP1B)

	SP1B-1	SP1B-2	SP1B-3	SP1B-4	SP1B-5	SP1B-6	SP1B-7	SP1B-8
ASC_A	-0.374 (4.3)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
ASC_{M6T}	1.4990 (8.5)	1.4177 (5.8)	2.3610 (10.3)	1.6754 (7.5)	1.3317 (5.5)	2.5270 (8.9)	3.1818 (9.7)	2.0677 (7.3)
TIME	-0.0916 (26.2)	-0.0684 (7.2)	-0.0602 (8.7)	-0.0753 (8.8)	-0.0869 (10.5)	-0.0534 (4.1)	-0.0243 (2.0)	-0.0366 (3.8)
TOLL	-0.0070 (16.7)	-0.0067 (8.5)	-0.0078 (12.9)	-0.0081 (12.0)	-0.0084 (14.0)	-0.0065 (12.7)	-0.0065 (12.4)	-0.0053 (10.0)
EBTOLL	-0.0011 (2.4)	-0.0011 (1.9)	-0.0010 (1.8)	-0.0012 (2.3)	-0.0004 (0.4)	-0.0000 (0.1)	-0.0002 (0.5)	-0.0003 (0.5)
M6Delay due to	n.a.	n.a.	n.a.	n.a.	n.a.	0.2306 (1.2)	0.0962 (0.6)	-0.007 (0.1)
Exp25m Delay	n.a.	n.a.	n.a.	n.a.	n.a.	-0.6308 (3.7)	-0.7897 (4.5)	-0.6789 (4.1)
No M6 Delays	n.a.	n.a.	n.a.	n.a.	n.a.	0.8760 (4.2)	0.9073 (4.6)	0.9757 (4.5)
VoT	13.1 (14.8)	10.2 (6.1)	7.7 (7.6)	9.3 (7.7)	10.3 (8.0)	8.2 (4.0)	3.7 (2.0)	6.9 (3.7)
ρ^2 (c)	0.301	0.286	0.319	0.331	0.299	0.242	0.2340	1.090
Inds	306	114	138	127	142	146	153	140
Obs	2366	872	1037	968	1097	1118	1192	1092
M6	430 (18%)	304 (35%)	338 (33%)	365 (38%)	259 (24%)	335 (30%)	324 (27%)	371 (34%)
M6T	1410 (60%)	568 (65%)	695 (67%)	603 (62%)	838 (76%)	783 (70%)	868 (73%)	721 (66%)
A	526 (22%)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.

Note: The causes of delays in SP1B-6, SP1B-7 and SP1B-8 were specified to be roadworks, accidents and congestion respectively.

There is a hint that the value of time is higher in the one exercise (SP1B-1) where three routes are offered. When pooled across the different exercises, the value of time for non-business averages 10.7 pence per minute which is very similar to the Stoke-M1 corridor (SP1A).

The provision of information indicating delays on the M6 with the reason for the delay has no significant difference to the base category of the provision of information stating that there are delays but with no reason given. The 25 minute delay information does have a strong negative effect, and it is similar across the three causes specified. As expected, the absence of delays has a positive coefficient and again the effect is similar across the three reasons. The results do not provide support for distinguishing between different causes of delay.

The most notable feature of the results is that the value of time is lower when information on travel conditions on the M6 is provided. It works through into somewhat higher ASCs favouring the M6T and very much lower time coefficients. The provision of information not only seems to have reduced the sensitivity to time variations, as might be expected, it has reinforced preferences towards the M6T presumably as a result of raising awareness of the congestion that can often be experienced on the M6. We shall return to this issue in sections 6.11 and 6.14.

6.5 Models for Extended M6T (SP2A) Stoke-M1 Corridor

There were three extended M6T exercises as follows:

- SP2A-1: M6 v M6T v A50/A500, Time, Toll and Fuel
- SP2A-2: M6 v M6T v A50/A500, Time, Toll and Fuel, Higher tolls
- SP2A-3: M6 v M6T, Time and Toll

Table 6.4: Extended M6T Route Choice Results (SP2A)

	SP2A-1	**SP2A-2**	**SP2A-3**
ASC_A	-0.0469 (0.2)	-0.4142 (3.0)	n.a.
ASC_{M6T}	3.2125 (7.7)	1.5378 (5.7)	2.3861 (4.2)
TIME	-0.0645 (9.3)	-0.0547 (18.1)	-0.0356 (4.6)
TOLL	-0.0069 (8.0)	-0.0049 (19.0)	-0.0047 (8.9)
EBTOLL	0.0003 (0.4)	0.0010 (3.3)	0.0005 (0.8)
FUEL-YES	-0.0053 (3.3)	-0.0061 (7.5)	n.a.
VoT	9.4 (6.6)	11.2 (14.2)	7.6 (4.4)
ρ^2 (constants)	0.284	0.228	0.211
Individuals	112	242	68
Observations	851	1835	524
M6	44 (5%)	309 (17%)	145 (28%)
M6T	708 (83%)	1050 (57%)	379 (72%)
A	99 (12%)	476 (26%)	n.a.

The value of time does vary across the three designs covering the extended M6T (SP2A) and reported in Table 6.4. Nonetheless, on average the value for non-business travel of 9.6 is little different to that for the Stoke-M1 (SP1A) designs despite the larger time savings offered. The fits achieved are again good and the main coefficient estimates are highly significant.

As would be expected, the preference for the M6T (ASC_{M6T}) tends to be higher than for the shorter M6T in the Stoke-M1 and M6T corridor designs.

6.6 Models for M6T Extended in Bits (SP2B) Stoke-M1 Corridor

The SP2B results, where Northern and Southern extensions to the M6T are introduced and hence the M6T is extended 'in bits', are reported in Table 6.5. This exercise can be regarded as more difficult than the others, and the low ρ^2 goodness of fit measure may be indicative of this.

There are effectively 8 alternatives that motorists can here choose from. Hence we can specify 7 constants. With the base set as the M6, the constants are specified for the existing M6T alone (ASC_{M6T}), the Northern section alone (ASC_N), the Southern section alone (ASC_S), the M6T and Northern section ($ASC_{M6T\&N}$), the M6T and Southern section ($ASC_{M6T\&S}$), the Northern and Southern section ($ASC_{N\&S}$) and all three sections (ASC_{ALL}).

Table 6.5: Extended in Bits M6T Route Choice Results (SP2B)

ASC_{M6T}	2.2791 (9.4)	ρ^2 (constants)	0.052
ASC_N	-0.3822 (1.6)	Individuals	225
ASC_S	-2.1529 (5.1)	Observations	1625
$ASC_{M6T\&N}$	2.2011 (7.4)	M6	250 (15%)
$ASC_{M6T\&S}$	-0.0522 (0.1)	M6T	550 (34%)
$ASC_{N\&S}$	-0.1817 (0.5)	North	82 (5%)
ASC_{ALL}	3.4751 (10.0)	South	11 (1%)
TIME	-0.0440 (8.2)	M6T&North	262 (16%)
TOLL	-0.0079 (15.4)	M6T&South	22 (1%)
EBTOLL	0.0009 (1.2)	North&South	41 (3%)
VoT	5.6 (7.2)	All	407 (25%)

The strong preference for the M6T apparent in the previous SP exercises is retained, and it is not surprising that the preference for all three tolled routes combined (ASC_{ALL}) is even stronger. The ASCs vary considerably, broadly in line, as would be expected, with the preferences amongst each alternative. The Northern extension, either alone or with the M6T, is clearly more popular than the Southern extension. To some extent this might have been influenced by the smaller time saving offered by the Southern section, but there might also have been a framing effect here given that the Southern section was the third offered of the three tolled options.

The estimated value of time of 5.6 pence per minute is low. This is not the result of short distance journeys since this SP exercise was not offered to those making the shortest journeys. As is apparent from Table 6.8, there is no reason to suspect somewhat lower values as far as distance or the mix of journey purposes are concerned.

In part the lower valuations could stem from the generally improved driving conditions, and we shall return to this later, but some very high correlations were apparent amongst some of the ASCs and the time and toll coefficient estimates which could have had a bearing. The subsequent pooled models offer the possibility of overcoming these correlations.

6.7 Models for Knutsford to Dunstable New Motorway (SP2C)

The results relating to the SP exercise which offered a new motorway between Knutsford and Dunstable alongside the current M6 and M6T options are reported in Table 6.6. ASCs are specified for the new motorway (ASC_{NEW}) and the M6T (ASC_{M6T})

Table 6.6: Knutsford – Dunstable New Motorway Route Choice Results (SP2C)

	I	II
ASC_{M6T}	1.8013 (8.3)	0.9944 (2.2)
ASC_{NEW}	1.1851 (2.3)	0.7251 (0.6)
TIME	-0.0231 (4.1)	-0.0249 (2.3)
TollM6T	-0.0048 (7.7)	-0.0040 (4.6)
TollNEW	-0.0031 (5.3)	-0.0026 (2.6)
EBTOLL	0.0006 (1.5)	0.0001 (0.1)
VoT-M6T	4.8 (3.2)	6.2 (2.5)
VoT-NEW	7.5 (3.8)	9.6 (2.0)
ρ^2 (constants)	0.155	0.147
Individuals	136	48
Observations	1042	360
M6	305 (29%)	129 (36%)
M6T	556 (54%)	156 (43%)
New	181 (17%)	75 (21%)

Model I contains all those who completed this questionnaire. Not surprisingly, the new motorway is preferred to the existing M6, even though relatively few chose it. More surprisingly is the even stronger preference for using the M6 for most of the journey and the M6T around the congested Birmingham section.

Motorists were less sensitive to toll on the new road than on the existing M6T. We might expect this given that they do not want tolls to increase on the M6T but tolls might be needed to justify the new motorway which they are not in any way committed to use.

The value of time is low, compared to the other SP exercises. In considering why this might be so, it became apparent very late in the project that some had been given this questionnaire who were not making a journey that could use the new motorway between Dunstable and Knutsford.

From the reported origins and destinations, we identified that this SP exercise would only have been realistic for 48 of the 136 individuals. Model II is estimated on these 48 individuals. Although we might have expected a greater proportion to use the new motorway given that it is more practical to do so, the figure hardly differs.

The ASCs are now lower, and reflect variations in the market shares of each route. The time and toll coefficients are not greatly different. However, because the time

coefficient increases and the toll coefficients fall, Model II exhibits noticeably higher values of time, much more in line with what might be expected.

We did not have the opportunity to amend the subsequent models which contain all the SP2C data and hence 682 choices from 88 individuals ideally would have been removed. However, we note that this is only 2.3% of all the data used in our subsequently pooled models. This, and the fact that there is not a great deal of difference in model parameters, leads us to be confident that the retention of these 88 individuals will not have materially altered the final pooled models nor the conclusions drawn from their results.

6.8 Models for Route and Departure Time Choice (SP8)

The final route choice exercise covered here addresses both route and departure time choice and is reported in Table 6.7. Initial models took the form of a multinomial logit model covering six options. The first two covered the M6 and M6T at the existing departure time. The other four options respectively related to the M6 and M6T for the earlier departure and the M6 and M6T for the later departure.

However, combining the M6 and M6T alternatives for earlier and later departures into two alternatives, one relating to the M6 at some different time than the actual time and one relating to the M6T at a different time, made no material difference to the values of earlier and later time estimated or to other model parameters. It is this model that is reported in Table 6.7.

Table 6.7: Route and Departure Time Choice Results (SP8)

	M6T Corridor (SP8A)	**Stoke – M1 (SP8B)**
ASC_{M6T}	1.5679 (11.9)	1.8038 (4.7)
TIME	-0.0470 (11.1)	-0.0361 (4.2)
EARLY	-0.0208 (23.8)	-0.0178 (7.3)
LATE	-0.0211 (20.5)	-0.0164 (6.5)
TOLL	-0.0062 (20.4)	-0.0038 (4.7)
EBTOLL	0.0015 (4.1)	0.0018 (1.6)
VoT	7.6 (13.0)	9.5 (4.9)
VoE	3.4 (24.3)	4.7 (5.9)
VoL	3.4 (22.9)	4.3 (5.2)
ρ^2(constants)	0.141	0.113
Individuals	558	69
Observations	4183	539
M6 Now	502 (12%)	27 (5%)
M6T Now	1631 (39%)	215 (40%)
M6 Different	251 (6%)	27 (5%)
M6T Different	1799 (43%)	270 (50%)

The goodness of fit statistics is respectable but not as good as typically achieved in the simpler route choice exercises. Nonetheless, the precision with which the coefficients are estimated is generally very high.

The strong preference for the M6T apparent in the other SP exercises is retained here. The lower values for the M6T corridor is presumably due to the shorter distances involved than for the Stoke – M1 corridor sample.

The values of earlier and later time are very similar and not significantly different. Nor is there a great deal of difference between these values for the two SP exercises. The ratios of the values of earlier and later time relative to in-vehicle time are in the range 0.44 and 0.49 which seem reasonable.

6.9 Evaluation of Initial Models

These initial models allow us to assess whether the data collected is of satisfactory quality and provides a firm basis for more detailed analysis. There is little question that it is adequate from a quantity perspective.

There are a number of desirable features of the results presented. For example: the coefficient estimates are of the correct sign and generally highly significant; the goodness of fit achieved is typically well above that commonly achieved; the fuel cost coefficients, after accounting for those who consider fuel costs in decision making, are broadly comparable with the toll coefficients; there is a preference for the M6T over other roads, all else equal, and a dislike of the A roads; and the values of time do not vary much across different SP exercises within a generic design. Inspection of these initial results also reveals interesting differences in the sensitivity to toll across situations, the impact of information on the other parameter estimates and variations in route specific preferences.

However, an important test of robustness is the extent to which the implied valuations seem plausible and the degree of consistency with other evidence. We have commented that the values of time generally seem plausible but how do they compare with other evidence?

For reference, we provide values of time from two sources. These are official Department for Transport valuations that are recommended for use in scheme appraisal (Department for Transport, 2006) and the values implied by a model estimated on a very large data set of British empirical evidence to explain variations in values of time in meta-analysis reported in Wardman (2004).

The official Department for Transport values of time for quarter 4 2006 prices and incomes are around 43 pence per minute for business travel, 10 pence per minute for commuting and 9 pence per minute for other.

The meta-analysis equation, for values of time in quarter 4 2006 prices and incomes is:

$$VoT = 1.16 GDP^{0.723} D^{0.259} e^{-5.114 + 0.498 EB + 0.100 C}$$

VoT denotes the value of time in pence per minute, GDP is gross domestic product per capita, with here an index of 4037, D is distance in miles, EB denotes the journey purpose of employer's business and C is commuting. The business values represent those typically obtained from SP exercises but which cannot be taken as representative of wage-rate based employers' valuations.

Table 6.8 reports values of time obtained using this equation for each SP design and journey purpose and their mean trip length.

As would be expected, the average distance is relatively low for SP1B and SP8A since these focussed on the M6T corridor. Nonetheless, there is not a great deal of variation in the value of time across the different SP exercises and the values for commuting and other are very similar to the DfT recommended values.

Throughout the models estimated, the incremental effect of employer's business (EB) travel is not large. This is not uncommon in SP studies. Nonetheless, the values are lower than those typically obtained, as can be seen by comparison with the business values derived from the meta-analysis. However, what is very encouraging is that the values of time for non-business travel are similar to those implied by a large body of British evidence.

Table 6.8: Meta-Analysis and Estimated Values of Time (pence per minute)

	Business		**Commuting**		**Leisure**		**Estimated**	
	Miles	**VoT**	**Miles**	**VoT**	**Miles**	**VoT**	**EB**	**NonEB**
Stoke-M1 Corridor (SP1A)	117	15.9	83	9.8	162	10.5	11.9	10.4
M6T Corridor (SP1B)	81	14.5	36	7.9	114	9.6	12.0	10.7
Stoke-M1 Corridor (SP1C)	133	16.5	125	10.9	188	11.0	15.0	13.2
Extended M6T (SP2A)	117	15.9	82	9.8	164	10.6	11.6	9.6
Extended M6T in Bits (SP2B)	97	15.2	57	8.9	148	10.3	6.3	5.6
New motorway (SP2C)	92	15.0	42	8.2	135	10.1	9.1	7.5
Route and Dep Time (SP8A)	78	14.4	34	7.8	115	9.6	9.7	7.6
Route and Dep Time (SP8B)	116	15.9	137	11.2	193	11.0	18.0	9.5
All	98	15.2	50	8.6	141	10.2	12.1	10.2

Note: Pence per minute in quarter 4 2006 prices and incomes

We also estimate valuations of departure time shift and some reference valuations to assess our estimates against would be useful. A meta-analysis (Wardman, 2001a) also provides valuations for departure time shifts. It did not uncover strong evidence that the valuations of earlier and later departures were materially different but it did find that the money value of departure time shifts depended on the amount of adjustment time with an elasticity of almost one.

From the equation estimated to explain variations across studies, the implied valuations of 1 and 2 hour departure time shifts in equivalent units of car in-vehicle time were 0.97 and 1.86 for business travel, 0.75 and 1.43 for commuting and 0.23 and 0.45 for leisure travel. In some respects, these numbers are not particularly useful for benchmarking, varying as they do. As an alternative, the overall ratio of valuations of departure time shifts relative to valuations of time for car users averaged 0.61. Given the latter, and that anyway our data set is dominated by leisure travel, then the estimated ratios of just short of 0.5 seem reasonable.

In summary, the valuation results are very encouraging in several respects and indicate that the SP data is of good quality and provides a firm basis for subsequent, more detailed analysis.

It should also be noted that these results have been recovered without resort to the sometimes contentious issue of removing 'non-traders' or 'illogical preferences'.

We now turn to pooling of data across the so-far separately estimated SP exercises.

6.10 Pooling Stoke-M1 Corridor Data for Existing M6T

This pooling combines all the data for the eight models (six SP1A and two SP1C designs) that deal with the existing M6T in the context of the Stoke-M1 corridor.

We have already seen that the values of time do not vary greatly across the different exercises and thus pooling with common valuations seems justified. Table 6.9 reports the pooled models for the SP1A and SP1C data.

Table 6.9: Pooled Stoke-M1 Corridor (SP1A and SP1C) Models

	I	II	III	IV	V
ASC_{A}	-	-	-	-0.5850 (11.9)	-0.5890 (12.0)
ASC_{M6T}	-	-	-	1.9726 (15.4)	1.9843 (15.0)
ASC_{A-A1}	-0.6547 (5.6)	-	-	-	-
ASC_{M6T-A1}	1.9815 (13.2)	-	-	-	-
ASC_{A-A2}	-0.8218 (6.9)	-	-	-	-
ASC_{M6T-A2}	2.5087 (10.6)	-	-	-	-
ASC_{A-A3}	-0.9089 (3.9)	-	-	-	-
ASC_{M6T-A3}	2.4391 (12.7)	-	-	-	-
ASC_{A-A4}	-1.1615 (5.1)	-	-	-	-
ASC_{M6T-A4}	1.7736 (9.8)	-	-	-	-
ASC_{A-A5}	-0.4208 (5,3)	-	-	-	-
ASC_{M6T-A5}	1.5421 (11.4)	-	-	-	-
ASC_{A-A6}	-0.5320 (4.3)	-	-	-	-
ASC_{M6T-A6}	1.4469 (8.3)	-	-	-	-
ASC_{A-A}	-	-0.6350 (11.3)	-0.6291 (12.2)	-	-
ASC_{M6T-A}	-	1.9482 (15.4)	2.0297 (14.4)	-	-
ASC_{A-C1}	-0.0293 (0.2)	-	-	-	-
ASC_{M6T-C1}	2.6625 (6.5)	-	-	-	-
ASC_{A-C2}	-0.1062 (0.4)	-	-	-	-
ASC_{M6T-C2}	2.6601 (7.9)	-	-	-	-
ASC_{A-C}	-	-0.0019 (0.0)	-0.0361 (0.2)	-	-
ASC_{M6T-C}	-	2.5851 (8.9)	1.9366 (2.6)	-	-
Time	-0.0688 (21.2)	-0.0699 (19.1)	-0.0686 (18.4)	-0.0694 (19.3)	-0.0692 (19.3)
$Time_{C1-2}$	-	-	-0.0073 (0.3)	-	-
TollM6T	-0.0062 (23.8)	-0.0062 (19.2)	-0.0063 (18.9)	-0.0062 (19.8)	-0.0062 (19.5)
$TollM6T_{C1-2}$	-	-	0.0009 (0.5)	-	-
TollM6	-0.0008 (0.5)	-0.0010 (0.7)	-0.0009 (0.6)	-0.0041 (3.4)	-0.0039 (3.0)
FuelYes	-0.0064 (12.3)	-0.0053 (10.6)	-0.0053 (11.4)	-0.0052 (10.1)	-0.0053 (10.5)
θ_{A1}	1.0	1.0	1.0	1.0	1.0
θ_{A2}	0.89 (1.8)	1.06 (0.8)	1.06 (0.8)	1.06 (0.8)	1.06 (0.8)
θ_{A3}	0.80 (2.1)	0.94 (0.6)	0.94 (0.5)	0.94 (0.6)	0.94 (0.6)
θ_{A4}	0.94 (0.7)	0.92 (1.8)	0.93 (0.7)	0.91 (1.1)	0.92 (1.0)
θ_{A5}	1.04 (0.7)	0.83 (2.9)	0.83 (3.1)	0.83 (3.1)	0.83 (3.0)
θ_{A6}	1.41 (2.7)	1.05 (0.5)	1.04 (0.4)	1.04 (0.4)	1.03 (0.3)
θ_{C1}	0.72 (3.2)	0.73 (3.9)	0.69 (1.5)	0.78 (2.9)	-
θ_{C2}	1.09 (0.8)	1.15 (1.4)	1.11 (0.3)	1.24 (2.4)	-
θ_{C1-2}	-	-	-	-	0.95 (0.6)
ρ^2 (c)	0.243	0.233	0.234	0.232	0.231
Log Lik	-5842.05	-5918.41	-5914.09	-5926.03	-5939.50
Obs	8821				

Note: Scale (θ) t ratios are with respect to one.

Although the previous results indicate we are justified in proceeding with a single value of time across data sets, it is common practice to allow the ASCs to vary. This is reported in Model I. The ASC for the A route for the fourth SP1A exercise is denoted $ASC_{A\text{-}A4}$ whilst $ASC_{M6T\text{-}C2}$ is the ASC for the M6T for the second SP1C exercise.

There is not a large amount of variation across the M6T ASCs and indeed the A road ASCs are broadly similar. However, the exceptions here are the ASCs relating to the SP1C designs. It turns out that these are highly correlated with the M6 toll coefficient which is presumably the cause of its low value and insignificance.

Model II combines the ASCs for the A road and M6T but retains a distinction between the SP1A and SP1C designs. Whilst this would not be justified on statistical grounds, given the reduction in the log-likelihood for the increased degrees of freedom, we do feel this simplification seems sensible given the similarity in Model I of the ASCs that are constrained to be the same in Model II. The ASCs for the SP1C designs are different to those for the SP1A designs and this reflects the correlation problem previously mentioned.

The models estimated on the separate data sets and reported in Tables 6.1 and 6.2 hint at higher values of time in SP1C. We tested this in Model III by specifying incremental effects for time ($Time_{C1\text{-}2}$) and toll ($TollM6T_{C1\text{-}2}$) for the SP1C designs. These turned out to be far from statistically significant.

Model IV constrains the ASCs for the M6T and A road to be the same across all designs to overcome the correlation problem with the ASCs in the SP1C design. This results in the toll coefficient for the M6 becoming significant. Whilst we might expect it to be higher than for the M6T, on account of protest response, the toll level itself is lower on the M6 which may contribute to the difference.

The models are arbitrarily estimated in units of SP1A1. Its scale factor ($\theta_{A1)}$ is set at 1. The units of the other models are all relative to this.

It can be seen that most of the scales are little different from 1. Two of the larger differences are for SP1C1 and SP1C2 in Model IV. However, when they are combined to allow a single scale for SP1C, which in many respects might not seem unreasonable given the similarity of the designs, the resulting scale is similar to one.

The pattern of scales in Model V, and the pattern of ASCs in previous models, would seem to justify a single ASC for each of the M6T and the A road across the designs and would suggest that there is little problem in the convenient simplification of treating all the different SP1A and SP1C exercises as if they had the same scale.

As would be expected, given the findings reported here, the estimated value of time in the pooled model of 11.2 pence per minutes closely resembles those reported for the separate models.

6.11 Pooling M6T Corridor Data

Table 6.10 reports models that pool across the 8 route choice exercises that were based on the M6T corridor (SP1B). All but one of the SP exercises offered binary choices between the M6 and M6T with the remaining exercise (SP1B-1) additionally offering an A road.

The models estimated on the separate SP exercises and reported in Table 6.3 indicated that there was no difference in impact from the information variables according to whether the cause of delay was roadworks, accidents or congestion. However, the results did suggest that the value of time could be higher for the design which offered three routes (SP1B-1) and that it is variation in the time coefficient that is the cause of this. There were also lower values of time for the designs that included information (SP1B6-8) with the effect more pronounced on the time coefficient but possibly also on the toll coefficient and quite clearly also on the ASC.

Table 6.10: Pooled M6T Corridor (SP1B) Models

	I	II	III	IV
ASC_A	-0.2394 (2.9)	-0.3404 (4.2)	-0.2966 (3.3)	-0.2837 (3.1)
ASC_{M6T}	-	1.5957 (12.1)	1.6803 (12.1)	1.7213 (11.8)
ASC_{M6T-B1}	1.8593 (9.9)	-	-	-
ASC_{M6T-B2}	1.3985 (10.6)	-	-	-
ASC_{M6T-B3}	1.4839 (7.4)	-	-	-
ASC_{M6T-B4}	1.1831 (7.1)	-	-	-
ASC_{M6T-B5}	0.9813 (5.9)	-	-	-
ASC_{M6T-B6}	2.0744 (8.1)	-	-	-
ASC_{M6T-B7}	1.9360 (7.7)	-	-	-
ASC_{M6T-B8}	1.6138 (9.4)	-	-	-
$ASC_{M6T-B678}$	-	0.5868 (3.2)	0.7114 (1.5)	0.6832 (3.5)
Time	-0.0680 (9.0)	-0.0616 (9.5)	-0.0615 (9.5)	-0.0606 (9.6)
$Time_{B1}$	-	-	-0.0307 (4.2)	-0.0307 (4.3)
$Time_{B678}$	-	-	0.0289 (3.0)	-
Toll	-0.0062 (10.0)	-0.0059 (10.5)	-0.0062 (10.4)	-0.0062 (10.4)
$Toll_{B678}$	-	-	0.0009 (1.4)	-
M6 delays due to	-0.3531 (1.6)	-0.1764 (1.3)	-0.1616 (1.2)	-0.2177 (1.5)
Exp 25m delays	-0.3912 (2.4)	-0.8156 (5.2)	-0.7483 (4.1)	-0.8635 (5,4)
No M6 delays	1.1233 (4.4)	0.6188 (4.1)	0.5059 (3.9)	0.6287 (4.0)
θ_{B1}	1.14 (1.1)	1.29 (2.3)	1.06 (0.5)	1.07 (9.5)
θ_{B2}	1.0	1.0	1.0	1.0
θ_{B3}	1.08 (0.5)	1.11 (0.7)	1.12 (0.8)	1.11 (0.7)
θ_{B4}	1.16 (1.1)	1.05 (0.4)	1.07 (0.5)	1.07 (0.5)
θ_{B5}	1.28 (1.6)	0.94 (0.5)	0.96 (0.3)	0.96 (0.3)
θ_{B6}	0.93 (0.6)	1.09 (0.6)	1.04 (0.3)	1.04 (0.3)
θ_{B7}	0.98 (0.1)	1.20 (1.3)	1.28 (1.7)	1.17 (1.1)
θ_{B8}	0.83 (1.7)	0.79 (2.0)	0.90 (0.6)	0.79 (1.8)
ρ^2(constants)	0.261	0.252	0.259	0.259
Log Lik	-4989.74	-5048.14	-4998.70	-5001.83
Observations	9738			

Note: Scale (θ) t ratios are with respect to one. Terms that denote incremental effects are $ASC_{M6T-B678}$, $Time_{B1}$, $Time_{B678}$ and $Toll_{B678}$

The base scale was selected to be that for the first of the binary choice exercises (SP1B-2) and is denoted θ_{B2}.

Model I's constants for the M6T are similar with the possible exception of the three exercises where information was provided. This is because the base category is delays on the M6 and mentioning this can be expected to make the ASC_{M6T} larger.

As a result, Model II combines the ASCs for the M6T across exercises (ASC_{M6T}) but with an incremental term for SP1B-6, SP1B-7 and SP1B-8 ($ASC_{M6T\text{-}B678}$). The incremental term is significant and shows a stronger preference for the M6T on these routes. Whilst this model is statistically inferior than Model I, the similarity of the ASCs would seem to justify combining them.

Model III additionally specifies an incremental term for the time coefficient for SP1B-1 ($Time_{B1}$) as well as incremental effects on time ($Time_{B678}$) and toll ($Toll_{B678}$) from the SP designs which contained information. When this is done then $ASC_{M6T\text{-}B678}$ becomes insignificant and the incremental toll effect was also insignificant. However, when we remove these two terms, the incremental time coefficient was negative which contradicts the findings of the separate models reported in Table 6.3 which indicate a lower value of time.

We therefore specified Model IV which contains both significant and correct sign incremental effects ($Time_{B1}$ and $ASC_{M6T\text{-}B678}$)

The estimated value of time of 14.7 for SP1B-1 and 9.8 for the remainder reflect the values estimated on the separate models. Whilst the incremental effect for design SP1B-1 is here quite large, we found that in subsequent models which contained socio-economic variables this effect did not remain statistically significant.

Across all the models, there is no strong evidence pointing to the need to specify separate scales across the different SP1B exercises.

6.12 Pooling Extended M6T Data (Stoke-M1 Corridor)

There were three versions of the SP2A exercise, which presented an M6T extended along the entire M1-Stoke corridor, with the third one removing the A road and fuel. The separately estimated models reported in Table 6.4 imply some variation in scale, particularly for SP2A-1, and there is also reasonable variation in the value of time across the three designs.

The pooled models are reported in Table 6.11. The constants for the A roads in the first two exercises and the M6T in all three exercises are very similar in Model I. As a result Model II, which constrains the constants to be the same across SP exercises, is statistically superior to Model I.

The base scale relates to SP2A-1 (θ_{A1}). It can be seen that the other two SP exercises (θ_{A2} and θ_{A3}) have a lower scale parameter, indicating that the residual variation in SP2A-1 is lower than for the other two designs. Indeed, we can combine the scales for SP2A-2 and SP2A-3 since they are not significantly different. This is reported as Model III.

Incremental terms were specified to allow the time coefficient and, separately, the toll coefficient to vary across designs but no significant effects were obtained.

The value of time in Model III is 10.7 which is plausible and resembles the weighted average of the separately estimated values in Table 6.4.

Table 6.11: Pooled Extended M6T (SP2A) Models

	I	II	III
ASC_{A}	-	-0.4309 (2.9)	-0.4477 (2.8)
ASC_{M6T}	-	2.6504 (8.6)	2.6693 (8.6)
ASC_{A-A1}	-0.3012 (1.5)	-	-
ASC_{M6T-A1}	2.6639 (10.1)	-	-
ASC_{A-A2}	-0.4226 (2.9)	-	-
ASC_{M6T-A2}	2.3039 (4.6)	-	-
ASC_{M6T-A3}	2.1557 (4.6)	-	-
Time	-0.0664 (11.2)	-0.0709 (12.1)	-0.0707 (12.0)
Toll	-0.0060 (10.1)	-0.0066 (13.1)	-0.0066 (12.9)
FuelYes	-0.0070 (8.5)	-0.0073 (8,7)	-0.0074 (8.7)
θ_{A1}	1.0	1.0	1.0
θ_{A2}	0.77 (3.0)	0.71 (5.1)	-
θ_{A3}	0.70 (3.0)	0.61 (4.5)	-
θ_{A23}	-	-	0.69 (5.8)
ρ^2(constants)	0.226	0.225	0.225
Log Likelihood	-1983.98	-1985.51	-1986.50
Observations	3210		

Note: Scale (θ) t ratios are with respect to one.

6.13 Pooling Route and Departure Time Choice Data

The remaining SP exercises which covered route choice which had variants which can be pooled are SP8A which deals with route and departure time choice within the M6T corridor and SP8B which is based on the same choice context for the Stoke-M1 corridor. The pooled models are reported in Table 6.12.

Table 6.12: Pooled Route and Departure Time Choice (SP8A and SP8B) Models

	I	II
ASC_{M6T}		1.7501 (13.5)
ASC_{M6T-8A}	1.6052 (11.7)	-
ASC_{M6T-8B}	3.8121 (4.2)	-
Time	-0.0450 (11.1)	-0.0398 (10.4)
Early	-0.0207 (24.9)	-0.0198 (22.7)
Late	-0.0210 (21.4)	-0.0199 (19.6)
Toll	-0.0055 (22.0)	-0.0050 (19,6)
θ_{SP8A}	1.0	1.0
θ_{SP8B}	0.52 (5.0)	0.87 (1.8)
ρ^2(constants)	0.128	0.123
Log Likelihood	-4620.67	-4646.80
Observations	4722	

Note: Scale (θ) t ratios are with respect to one.

The separate models reported in Table 6.7 suggested that there might be more random error in SP8B. We specified the base scale to be for SP8A (θ_{SP8A}) and indeed it emerged that the scale is different for SP8B in line with the findings of the separate models. Whilst the ASCs in Model I favour the M6T, as expected, that for SP8B is very large. It turned out that there was a very large correlation of -0.85 between $ASC_{M6T\text{-}8B}$ and the scale parameter (θ_{SP8B}) that was presumably contributing to this very large effect.

We therefore constrained the ASCs to be the same for the two designs. The results, in Model II, continue to indicate a difference in the scale of the two exercises, although by no means as large as for Model I and not quite significantly different from one.

The other results in Model II seem plausible, with values of time, earlier time and later time of 8.0. 4.0 and 4.0 pence per minute. These are broadly in line with the separately estimated values of Table 6.7. When we specified the time coefficient and separately the toll coefficient to be different, to allow the value of time to be higher for SP8B, the former effect was not far from significant but the latter was not remotely significant.

6.14 Pooling Across all Route Choice Data Sets

We now proceed to pool the data not just across the generic designs which have different versions but across all the SP route choice data, with the exception of that relating to reliability. In addition to the pooling covered above, we can introduce the data relating to the Northern and Southern extensions to the M6T (SP2B) and the new long distance motorway between Knutsford and Dunstable (SP2C) that do not have different versions but which nonetheless might have different scales to the other SP designs.

The results reported in sections 6.10 to 6.13 indicate that:

- It is reasonable to pool data across the Stoke-M1 corridor (SP1A) designs without rescaling
- Whilst it is reasonable to combine the Stoke-M1 corridor exercises where there was never a toll on the M6T (SP1A) and where a toll was introduced (SP1C), we shall retain a distinction given that the contentious nature of the former might induce a different degree of residual variation and hence scale
- It is reasonable to pool data across the M6T corridor (SP1B) designs without rescaling, although we at least initially retain a distinction for SP1B-1 given that it contains an additional alternative
- It would seem prudent to allow for different scales between SP2A-1 and the other two SP2A designs relating to the extended M6T and between the route and departure time choices for the M6T corridor (SP8A) and the Stoke-M1 corridor (SP8B).

Given the addition of the M6T extended in bits (SP2B) and Knutsford-Dunstable new motorway (SP2C) exercises to the data set, we therefore have the 10 scales set out in Table 6.13, with one (SP1A) arbitrarily set to one. Hence the other scale (θ) coefficients denote the divergence from the SP1A scale.

There is also the issue of the ASCs. The findings above were generally supportive of combining ASCs across data sets, and in pooling all data sets we found that the

incremental effect on the M6T ASC when information was provided did not retain its statistical significance of prior models.

We have here specified the ASCs for the M6T and, where appropriate, for the A road, for the:

- M6T corridor: SP1B and SP8A ($ASC_{M6TCorridor}$, $ASC_{ACorridor}$)
- Stoke-M1 corridor: SP1A, SP1C and SP8B ($ASC_{M6TStoke\text{-}M1}ASC_{AStoke\text{-}M1}$)
- Extended M6T in Stoke-M1 corridor, SP2A ($ASC_{M6TExtended}$, $ASC_{AExtended}$)

For the Northern and Southern extensions to the existing M6T within the Stoke-M1 corridor (SP2B), including the existing M6T, we have specified the following constants:

- M6T constant ($ASC_{M6TBits}$)
- Northern extension constant (ASC_{NTH})
- Southern extension constant (ASC_{STH})
- M6T and Northern extension constant (ASC_{M6TNTH})
- M6T and Southern extension constant (ASC_{M6TSTH})
- Northern and Southern extension constant (ASC_{NTHSTH})
- M6T, Northern and Southern extension constant (ASC_{ALL3})

And finally, for the new, tolled long distance M6 between Knutsford and Dunstable (SP2C), we have the following constants:

- M6T constant ($ASC_{M6TLong}$)
- New motorway constant (ASC_{NewM6})

This is the full set of constants, with the omitted constant relating to the M6,

The models pooled across all the route choice based experiments, and estimated on 29158 observations, are reported in Table 6.13. In all three models reported, and as might be expected from the previously reported findings, we obtain correct sign coefficient estimates that are highly significant and good fits to the data.

In Model I, the preference for the M6T is clear and there is also a dislike for the A road compared to the M6. It is not surprising that $ASC_{M6TStoke\text{-}M1}$ exceeds $ASC_{M6TCorridor}$ due to a journey duration effect whilst $ASC_{M6TExtended}$ is even higher because of both the duration effect but also, more importantly, because the tolled road is here much longer.

The ASCs for the A roads indicate that these are inferior routes to reasonably similar degrees across SP designs. However, the valuation in corresponding time units of around 5 minutes is not large.

The ASCs for the extensions to the M6T should be treated with caution, given the small numbers choosing some of these options to which the relatively small sample size could have contributed. For example, there are only 11 choices (1%) for the Southern extension, 22 choices (1%) for the M6T and Southern and 41 choices (3%) for the Northern and Southern extensions. Nonetheless, ASC_{All3} denoting a preference for all three tolled routes in SP2B is relatively strong as might be expected

Table 6.13: Models Pooled Across All SP Route Choice Data

	I	II	III
$ASC_{M6TCorridor}$	1.6380 (26.6)	1.6747 (36.5)	1.4952 (36.7)
$ASC_{ACorridor}$	-0.3753 (12.6)	-0.3809 (13.2)	-0.4819 (28.3)
$ASC_{M6TStoke-M1}$	2.1104 (37.5)	2.1238 (37.7)	1.9674 (28.3)
$ASC_{AStoke-M1}$	-0.5537 (14.5)	-0.5644 (14.7)	-0.5418 (13.4)
$ASC_{M6TExtended}$	2.5796 (17.3)	2.6836 (18.4)	2.2456 (20.6)
$ASC_{AExtended}$	-0.2541 (1.8)	-0.2456 (1.7)	-0.3384 (2.5)
$ASC_{M6TBits}$	1.2352 (11.0)	1.3254 (11.4)	1.2510 (10.4)
$ASC_{M6TLong}$	1.5874 (5.4)	1.6173 (5.2)	1.0735 (7.6)
ASC_{NewM6}	1.3849 (3.2)	1.4061 (3.1)	1.1745 (3.8)
ASC_{NTH}	-0.4964 (2.8)	-0.5787 (2.8)	-0.6135 (3.0)
ASC_{STH}	-1.8748 (5.5)	-2.1416 (5.6)	-2.1991 (5.8)
ASC_{M6TNTH}	1.0253 (6.5)	1.0741 (6.2)	0.9747 (5.4)
ASC_{M6TSTH}	-0.8718 (2.7)	-1.0756 (3.4)	-1.2005 (3.8)
ASC_{NTHSTH}	-0.5005 (3.3)	-0.6309 (3.4)	-0.7239 (4.0)
ASC_{ALL3}	1.7926 (9.0)	1.9074 (10.5)	1.7651 (9.4)
Time	-0.0624 (27.3)	-0.0637 (35.4)	-0.0579 (42.1)
Early	-0.0243 (27.2)	-0.0248 (27.8)	-0.0228 (33.1)
Late	-0.0246 (29.8)	-0.0251 (26.3)	-0.0227 (27.5)
Toll	-0.0061 (31.3)	-0.0062 (40.0)	-0.0056 (39.3)
FuelYes	-0.0054 (12.8)	-0.0054 (12.1)	-0.0053 (12.5)
Delays M6	Base	Base	Base
M6 Delays due to	0.2942 (5.0)	0.3045 (5.6)	0.3503 (5,8)
Exp 25m Delay	1.1960 (13.5)	1.2247 (14.3)	1.1909 (13.8)
No M6 delays	-0.3500 (4.5)	-0.3577 (4.4)	-0.2930 (3,8)
Value of Time	10.2 (29.0)	10.3 (37.4)	10.3 (40.7)
Value of earlier	4.0 (28.9)	4.0 (31.3)	4.1 (35.5)
Value of Late	4.0 (30,3)	4.1 (29.9)	4.1 (31.0)
θ_{SP1A}	1.0	1.0	1.0
θ_{SP1C}	0.95 (0.9)	1.0	1.0
θ_{SP1B-1}	1.27 (3.5)	1.24 (3.6)	1.0
$\theta_{SP1B-2-8}$	1.03 (0.9)	1.0	1.0
θ_{SP2A-1}	1.12 (1.8)	1.0	1.0
$\theta_{SP2A-2-3}$	0.77 (14.8)	0.74 (12.6)	1.0
θ_{SP8A}	0.82 (4.3)	0.80 (6.4)	1.0
θ_{SP8B}	0.62 (6.3)	0.62 (6.3)	1.0
θ_{SP2C}	0.54 (6.0)	0.53 (6.0)	1.0
θ_{SP2B}	1.11(1.5)	1.0	1.0
ρ^2 (constants)	0.206	0.205	0.199
Log Likelihood	-20786.1	-20789.9	-20959.6
Observations	29158		

Note: Scale (θ) t ratios are with respect to one. The incremental effect on the M6T constant when information was specified in the SP1B designs, which was apparent in Table 6.10, was not statistically significant in this pooled model.

As for the SP exercise offering a new tolled motorway paralleling the existing M6 and the M6T option, the constants ($ASC_{M6TLong}$ and ASC_{NewM6}) are both in favour of the tolled, faster routes which are hardly surprising. However, we might have expected the preference towards the new motorway, other things equal, to be somewhat

stronger than the preference for the existing M6T within this controlled comparison. The relatively small proportion choosing the new motorway (17%) compared to the M6T (54%) and the existing M6 (29%) might be a contributory factor here.

The values of in-vehicle time, earlier time and later time are all plausible and consistent with previous evidence whilst the toll charge tends to have a slightly stronger effect than does fuel cost for those who consider fuel in the decision making. It is encouraging that these two cost coefficients are similar.

Four of the scale factors in Model I are not significantly different from one. Model II constrains these scales to be one. This makes little difference to the remaining scales or to the other parameter estimates.

Model III constrains all the SP exercises to have the same scale. Again this has very little effect on the other parameter estimates. This process seems justified on the grounds of convenience in estimation given that it does not impact on other parameter estimates and the freely estimated scales are in any event not greatly different from one. Moreover, the two scales farthest from unity (θ_{SP8B} and θ_{SP2C}) cover only 5% of the data.

All subsequent modelling reported of the pooled SP data is of the form of Model III with the scales constrained to be the same across the different SP exercises.

6.15 Weighting Observations

The analysis so far has primarily focussed on the pooling of data across the different SP exercises, and as a part of these estimations values of time have been obtained that have been assessed in terms of their plausibility and fit with other evidence.

However, these value of time estimates, being averages across the sample obtained, may well be influenced by split amongst M6T and other route users in the data set. We could reasonably expect the values of time to vary by user type.

Although variations in valuations by socio-economic and trip characteristics are the subject of subsequent analysis, it is important to determine the extent to which the sampling has influenced our results and the need for any reweighting of the sample to correct for this.

Table 6.14 reports models estimated separately for M6T users, M6 users and A road users. Given the relatively small number of observations for the M6 and A road users, and the absence of choices for some alternatives, some constants cannot be estimated and must be removed to enable a model to be estimated.

As would be expected, the M6T users have the strongest preference in favour of the M6T. Although the A road users are estimated to be much more sensitive to fuel cost variations, the precision with which this is estimated means we cannot place much confidence in it.

As far as the valuations are concerned, the M6T users have the highest values, followed by the M6 users and the A road users. This ordering is to be expected. The differences in the values is by no means trivial. However, the results do not indicate that the scale of the model varies to any considerable extent across user types.

It would be sensible to explore the impact of weighting the observations given the observed variations in value of time by user type.

Table 6.14: Models Split By User Type

	M6T User	M6 User	A Road Users
$ASC_{M6TCorridor}$	1.8375 (40.6)	0.3675 (2.0)	0.6233 (1.6)
$ASC_{ACorridor}$	-0.5630 (7.1)	-1.0406 (3.8)	0.8880 (3.2)
$ASC_{M6TStoke\text{-}M1}$	2.1708 (26.4)	0.6324 (3.00	1.9877 (2.6)
$ASC_{AStoke\text{-}M1}$	-0.5327 (9.9)	-0.9508 (7.6)	0.0381 (0.1)
$ASC_{M6TExtended}$	2.4544 (19.9)	1.2721 (3.6)	2.6231 (3.2)
$ASC_{AExtended}$	-0.3907 (3.1)	-0.2409 (1.1)	-0.7948 (0.9)
$ASC_{M6TBits}$	1.7905 (8.7)	0.6403 (2.6)	-
$ASC_{M6TLong}$	1.7092 (7.3)	-0.1473 (0.7)	2.1255 (3.0)
ASC_{NewM6}	1.8532 (5.2)	0.1327 (0.3)	1.8220 (0.9)
ASC_{NTH}	-0.1012 (0.4)	-1.2694 (1.6)	-
ASC_{STH}	-1.5902 (3.1)	-	-
ASC_{M6TNTH}	1.5809 (5.9)	0.3745 (1.2)	-
ASC_{M6TSTH}	-0.4626 (0.8)	-2.1805 (3.0)	-
ASC_{NTHSTH}	-0.1193 (0.5)	-1.1883 (2.5)	-
ASC_{ALL3}	2.5315 (8.0)	0.4719 (0.8)	-
Time	-0.0629 (55.1)	-0.0518 (12.7)	-0.0494 (8.7)
Early	-0.0254 (33.3)	-0.0201 (9.6)	-0.0174 (8.3)
Late	-0.0244 (21.7)	-0.0227 (5.6)	-0.0198 (7.7)
Toll	-0.0060 (44.3)	-0.0054 (10.7)	-0.0059 (14.1)
FuelYes	-0.0049 (10.3)	-0.0066 (4.7)	-0.0088 (1.2)
Delays M6	Base	Base	Base
M6 Delays due to	0.2971 (2.5)	0.1590 (0.4)	0.5772 (1.8)
Exp 25m Delay	1.3147 (9.5)	0.5588 (1.4)	1.3002 (3.2)
No M6 delays	-0.3006 (2.9)	-0.9404 (4.5)	0.1722 (0.7)
Value of Time	10.48 (41.1)	9.56 (19.0)	8.37 (8.6)
Value of earlier	4.23 (31.1)	3.72 (8.5)	2.95 (8.1)
Value of Late	4.01 (22.3)	4.11 (5.7)	3.36 (7.8)
ρ^2 (constants)	0.222	0.164	0.151
Log Likelihood	-16059.2	-2326.5	-1098.8
Observations	24277	2604	1427

After removing those who did not provide details of their actual choice, we are left with 3151 observations. As reported in Table 6.15, 4.8% chose an A road, 10.9% chose the M6 and 84.3% chose the M6T.

Table 6.15: Split of Sample By Route and Source of Data

	RSI/MSA	All Sample	Weight
A Road	119 (10.2%)	151 (4.8%)	2.13
M6	314 (27.0%)	344 (10.9%)	2.48
M6T	729 (62.8%)	2656 (84.3%)	0.75

As discussed in detail in Chapter 4, the data was collected either through roadside interviews (RSIs) or by contact at motorway service areas (MSAs) or else by postal questionnaires to a database of M6T users. The overall sample is therefore clearly unrepresentative of the share of each route in the corridor.

However, the sample obtained through the RSIs and at the MSAs can be taken to be reasonably representative. Table 6.15 also denotes the shares of each route in the RSA/MSA sample.

We can therefore weight each observation to make the share of each route in the sample used in SP modelling the same as the RSI/MSA sample. These weights are given in Table 6.15. However, this implies that the number of observations is different to that collected, and hence a further weighting of 1.036 is applied to all observations so that the effective sample size is unaffected.

The unweighted and weighted models are reported in table 6.16. The former is the same as Model III previously reported in Table 6.13.

It can be seen that the weighting procedure does have a large impact on the ASCs, with a lesser preference for the M6T as might be expected given the re-balancing towards the M6 and A road users. However, the weighting makes very little difference to the time, cost and other parameter estimates. Nonetheless, subsequent models apply the weights set out above.

Table 6.16: Weighted and Unweighted Models

	Unweighted	**Weighted**
$ASC_{M6TCorridor}$	1.4952 (36.7)	1.1699 (15.8)
$ASC_{ACorridor}$	-0.4819 (28.3)	-0.4256 (4.2)
$ASC_{M6TStoke\text{-}M1}$	1.9674 (28.3)	1.7139 (17.6)
$ASC_{AStoke\text{-}M1}$	-0.5418 (13.4)	-0.5997 (10.1)
$ASC_{M6TExtended}$	2.2456 (20.6)	2.0307 (14.2)
$ASC_{AExtended}$	-0.3384 (2.5)	-0.2870 (1.8)
$ASC_{M6TBits}$	1.2510 (10.4)	0.8382 (4.9)
$ASC_{M6TLong}$	1.0735 (7.6)	0.6115 (4.9)
ASC_{NewM6}	1.1745 (3.8)	0.6960 (2,3)
ASC_{NTH}	-0.6135 (3.0)	-1.0798 (4.1)
ASC_{STH}	-2.1991 (5.8)	-2.5195 (3.6)
ASC_{M6TNTH}	0.9747 (5.4)	0.5220 (2,2)
ASC_{M6TSTH}	-1.2005 (3.8)	-1.7017 (5.0)
ASC_{NTHSTH}	-0.7239 (4.0)	-1.2115 (3.1)
ASC_{ALL3}	1.7651 (9.4)	1.1011 (4.7)
Time	-0.0579 (42.1)	-0.0540 (28.5)
Early	-0.0228 (33.1)	-0.0209 (24.7)
Late	-0.0227 (27.5)	-0.0216 (24.0)
Toll	-0.0056 (39.3)	-0.0053 (32.7)
FuelYes	-0.0053 (12.5)	-0.0057 (9.1)
Delays M6	Base	Base
M6 Delays due to	0.3503 (5,8)	0.3490 (4.3)
Exp 25m Delay	1.1909 (13.8)	1.0634 (7.3)
No M6 delays	-0.2930 (3,8)	-0.3127 (3.1)
Value of Time	10.3 (40.7)	10.2 (24.8)
Value of earlier	4.1 (35.5)	4.0 (22.6)
Value of Late	4.1 (31.0)	4.1 (22.2)
ρ^2 (constants)	0.199	0.180
Log Likelihood	-20959.6	-22648.3
Observations	29158	

7. ROUTE CHOICE RESULTS: TESTS OF HYPOTHESES

We have selected a preferred model form that pools data across all the route choice SP exercises but where we do not feel the need to allow for different scales across these exercises. This is essentially the model in Table 6.16 that applies weights to account for the over-sampling of M6T users. The model is based on 29158 observations from 2495 respondents. Note that 1213 respondents conducted two route choice SP exercises.

So far we have examined the main effects attributable to the SP design variables in the conventional form of linear-additive utility functions. This was because the primary purpose of the analysis was to establish whether the different SP exercises yielded sensible results and issues involved in pooling data across these exercises.

We now turn to more detailed analysis of functional form and address the key hypotheses relating to motorists' sensitivity to time and cost variations and the intervening effects of socio-economic variables and trip characteristics as set out in section 1.2.

The structure of this chapter is as follows. Section 7.1 examines whether the value of time varies by route type. Section 7.2 reports analysis of the impact of journey duration on key model parameters. Whether the unit value of time varies with the size of the time saving is considered in section 7.3 whilst section 7.4 reports analysis of variations in motorists' sensitivities to toll charges. Section 7.5 considers the impact of motorists' considering fuel costs in making their SP choices, section 7.6 examines the values of earlier and later departures and section 7.7 reports on the impact of information provision on key model parameters. Section 7.8 contains a test of whether in these repeated observation models there is a failure of the errors to satisfy the assumptions of the multinomial logit model resulting in biased coefficient estimates. Finally, section 7.9 reports analysis of the effects of socio-economic and trip characteristics on model parameters.

7.1 Route Specific Values

The models reported so far estimate a single time coefficient for all routes, with any route specific effects captured by what turn out to be large alternative specific constants (ASCs). However, if the route specific effects are time dependent, we would expect the time coefficient to vary by route. In other words, the disutility of travel time will vary across routes due to, for example, the different traffic conditions and quality of the infrastructure.

Table 7.1 specifies the same pooled model using the same notation as reported in sections 6.12 and 6.13. As with all the pooled models subsequently reported, weighting is applied to correct for the over-representation of M6T users. The difference here compared to the models reported in sections 6.12 and 6.13 is that the time coefficient is allowed to vary according to whether the time is spent on the M6, the M6T, the A road or on a combination in the SP2B exercise which provides Northern and Southern extensions to the M6T. The latter, termed $Time_{Bits}$, reflects a mixture of time spent on the M6 and the M6T.

Model I finds the coefficient estimates for time spent on the M6 ($Time_{M6}$) and on the M6T ($Time_{M6T}$) to be very similar. Given that the $Time_{Bits}$ coefficient represents a mix of the two, it is hardly surprising it is little different. The most noticeable result is for the time coefficient relating to A roads ($Time_{A}$). Whilst this is somewhat larger than

the other coefficient estimates, and this is not unreasonable given a preference for motorways over A roads can be expected, the result will have been influenced by large correlations with the ASCs relating to the A roads. These were around -0.7. Another symptom of this is that $ASC_{ACorridor}$, $ASC_{AStoke\text{-}M1}$ and $ASC_{AExtended}$ all favour the A road over the M6 which is both unexpected, particularly given the size of these constants which in some cases approximate those for the M6T, and inconsistent with the results for the separately estimated models in chapter 6 where the ASCs for the A road generally found it to be inferior to the M6 other things equal.

Table 7.1: Route Specific Valuations

	I	II	III	IV
$ASC_{M6TCorridor}$	1.3271 (7.5)	1.1788 (6.6)	1.2824 (18.0)	
$ASC_{ACorridor}$	0.4248 (3.4)	-	-	
$ASC_{M6TStoke\text{-}M1}$	1.8874 (10.0)	1.7127 (8.9)	2.0433 (20.8)	
$ASC_{AStoke\text{-}M1}$	1.5839 (5,2)	-	-	
$ASC_{M6TExtended}$	2.3178 (4.4)	1.7643 (3.2)	2.1853 (16.1)	
$ASC_{AExtended}$	1.9063 (6.5)	-	-	
$ASC_{M6TBits}$	1.5441 (2,0)	1.4279 (1.9)	0.8839 (3.2)	
$ASC_{M6TLong}$	0.7823 (2,6)	0.5943 (1.9)	0.6739 (3.5)	
ASC_{NewM6}	1.1069 (1.0)	0.4372 (0.4)	0.8252 (3.6)	
ASC_{NTH}	-0.3537 (0.4)	-0.4245 (0.5)	-1.0673 (3.6)	
ASC_{STH}	-1.8374 (1.6)	-1.8915 (1.7)	-2.5675 (4.3)	
ASC_{M6TNTH}	1.1969 (1.6)	1.0317 (1.4)	0.5947 (2.2)	
ASC_{M6TSTH}	-1.0151 (1.2)	-1.1634 (1.4)	-1.6398 (4.1)	
ASC_{NTHSTH}	-0.4182 (0.5)	-0.5157 (0.8)	-1.0988 (3.3)	
ASC_{ALL3}	1.3709 (2.4)	0.9699 (1.7)	1.1934 (3.5)	
Time	-	-	-0.0508 (24.1)	-
$Time_{M6}$	-0.0488 (23.7)	-0.0524 (26.0)	-	-0.0713 (34.6)
$Time_{M6T}$	-0.0495 (6.2)	-0.0498 (6.3)	-	-0.0701 (26.8)
$Time_{A}$	-0.0679 (25.0)	-0.0557 (31.2)	-	-0.0811 (38.0)
$Time_{Bits}$	-0.0554 (5.7)	-0.0588 (5.9)	-	-0.0775 (38.5)
ρ^2 (constants)	0.182	0.180	0.175	0.134
Log Likelihood	-22606.7	-22645.3	-22786.5	-23932.8

Note: Only time related coefficients and ASCs reported. The other coefficients vary little across models and compared with the models in sections 6.12 and 6.13.

Model II and subsequent models therefore remove the ASCs relating to the A roads. The constants in Model II are not greatly different and the removal of the A road ASCs has the effect of making the $Time_A$ coefficient similar to the other coefficients. Indeed, Model II does not provide support for variations in the disutility of time by route, and in this respect it is similar to Model I, even though it is a statistically inferior model.

Model III specifies a single time coefficient. This is clearly inferior in statistical terms to Model II. In part this is because there are correlations amongst the route specific time coefficients and the ASCs in Model II which will assist in model fit. Nonetheless, the time coefficient is in line with the separate coefficients in Model II which do not provide any strong support for distinguishing time by type of route.

Model IV removes the ASCs. The model is, unsurprisingly, very much inferior to the other models. However, the pattern of the coefficient estimates is not greatly different to Model II, with a slight indication that, if anything, the A roads have a higher disutility of travel time than the motorways.

To back up the findings with respect to route specific values of time reported in Table 7.1, particularly given that some high correlations between ASCs and route specific time coefficients does not help matters, we also report the results for the two SP exercises which most clearly address this issue. These are the exercise which offers the extended M6T (SP2A) and the exercise which presents the new motorway (SP2C). The results are respectively reported in Tables 7.2 and 7.3. In estimating these two models, we have used weights that apply specifically to the two sets of respondents.

The three SP2A exercises offer a choice between travelling entirely on the M6, on an extended M6T and in two cases on an A road. It is therefore the exercise which most clearly provides insights into the relative valuation of time spent on each route.

Tables 6.11 and 6.13 showed that the difference in scale within the SP2A designs is amongst the largest in our data set. Hence we have for the purposes of this analysis retained the scale differences.

Table 7.2: SP2A Route Specific Results

	I	II	III	IV	V
ASC_A	-	-	-1.3711 (1.0)		-
ASC_{M6T}	-	-	3.6476 (2.3)	4.4295 (2.7)	-
ASC_{A-1}	-0.3697 (0.8)	-0.7769 (0.7)	-	-	-
ASC_{M6T-1}	2.2109 (8.7)	3.2900 (2.6)	-	-	-
ASC_{A-2}	-0.0604 (5.5)	-0.8177 (0.9)	-	-	-
ASC_{M6T-2}	1.3096 (2.4)	2.3676 (1.6)	-	-	-
ASC_{M6T-3}	1.1816 (2.6)	2.2687 (1.8)	-	-	-
Time	-0.0605 (7.4)	-	-	-	
$Time_{M6}$	-	-0.0615 (6.9)	-0.0767 (7.2)	-0.0698(10.9)	-0.0778(10.7)
$Time_{M6T}$	-	-0.0766 (3.5)	-0.0977 (4.4)	-0.0973 (4.4)	-0.0501 (6.4)
$Time_A$	-	-0.0579 (6.4)	-0.0684 (9.1)	-0.0730(10.5)	-0.0813(10.3)
Toll	-0.0048 (5,4)	-0.0049 (5.3)	-0.0066 (8.5)	-0.0066 (8.7)	-0.0063 (9.1)
FuelYes	-0.0077 (5.2)	-0.0078 (5.4)	-0.0088 (6.0)	-0.0087 (6.1)	-0.0086 (5.8)
θ_1	1.0	1.0	1.0	1.0	1.0
θ_2	0.82 (1.3)	0.81 (1.4)	0.62 (5.9)	0.62 (6.1)	0.63 (5.9)
θ_3	0.76 (1.5)	0.74 (1.6)	0.52 (3.0)	0.54 (2.8)	0.52 (2.7)
ρ^2 (C)	0.208	0.209	0.203	0.203	0.200
Log Lik	-2161.1	-2157.9	-2173.6	-2174.6	-2182.9
Obs	3210				

Note: Scale (θ) t ratios are with respect to one. The weights for the M6, M6T and A road were 3.31, 0.70 and 2.13. This makes little difference to the results.

Model I specifies relevant constants for each specific SP2A design. These are for the M6T for each of the three exercises (ASC_{M6T-1}, ASC_{M6T-2} and ASC_{M6T-3}) and the A road for the two exercises where it appeared (ASC_{A-1} and ASC_{A-2}). However, it contains only a single time coefficient.

Allowing the time coefficient to be route specific, as in Model II, leads to an improved fit although there is no clear pattern in the route specific time coefficients. Indeed, the M6T time coefficient is surprisingly large. The pattern of results for the ASCs seems to merit single terms for the A road and the M6T, as in Model III. The ASC for the A road is insignificant, as in the previous models, and hence is removed in Model IV.

What is noticeable about Model IV is the very large ASC for the M6T. This could well stem from a very high correlation of -0.89 with the M6T time coefficient in this exercise, thereby also explaining why the latter is relatively large. Indeed, Model V removes ASC_{M6T} and the M6T time coefficient falls considerably. However, we cannot take this as reliable evidence that time on the M6T has a lower disutility than the other roads since it is not realistic that ASC_{M6T} is zero and the value for the latter clearly influences the former.

Table 7.3 reports analysis of the SP2C data relating to the Knutsford-Dunstable new motorway. It distinguishes the ASC into one for the new motorway (ASC_{New}) and one for the M6T (ASC_{M6T}) relative to the existing M6. In Model I a single time coefficient is estimated. When the time coefficient splits between the time spent on the M6 ($Time_{M6}$) and on the M6T or new motorway ($Time_{M6TNew}$), as in Model II, both ASCs become insignificant as is the $Time_{M6TNew}$ coefficient, whilst there is hardly any improvement in fit. There are strong correlations between the ASCs and time coefficients underpinning these poor results. As a result, we have removed both the insignificant ASCs, with Model III relying on the route specific time coefficients to detect any difference. The latter indicate only a marginal preference for time spent on the M6T over the M6.

Table 7.3: SP2C Route Specific Results

	I	II	III
ASC_{New}	1.7226 (4.6)	0.2370 (0.1)	-
ASC_{M6T}	1.3230 (5.5)	0.7259 (1.6)	-
Time	-0.0226 (4.3)	-	-
$Time_{M6}$	-	-0.0246 (3.6)	-0.0483 (5.3)
$Time_{M6TNew}$	-	-0.0171 (1.5)	-0.0435 (5.9)
Toll	-0.0035 (6.3)	-0.0035 (5.5)	-0.0031 (6.7)
ρ^2 (constants)	0.135	0.135	0.135
Log Lik	-997.6	-997.4	-998.1
Obs	1042		

Note: The weights for the M6, M6T and A road were 2.06, 0.73 and 1.17. This makes little difference to the results.

Although the results are not as clear-cut as we would have liked, there is no strong support for distinguishing the time coefficient between the M6 and the M6T, although there is more support for the A roads having a higher time disutility. We will return to this issue both in more complete models and also in section 10.3 when it is addressed in one of the route specific SP exercises (SP5) that deals with different travel conditions. We note here that broadly the same conclusions are there reached.

7.2 Journey Duration

It is not uncommon that studies identify a positive effect on the value of time from journey duration, and there are a range of reasons why the value of time might increase with duration. For example, an activity must be important if considerable time is spent in pursuing it and thus the opportunity cost of time travelling can be expected to be high. The discomfort of travel might also increase more than proportionately with duration. A possible confounding effect is that those with higher incomes travel farther and that SP exercises for longer journeys offer larger travel time savings. However, we have seen (Table 4.28) that there is very little correlation between journey time and income in our data set.

Table 7.4 reports models which do not in any way force a journey duration effect but which investigate whether any such effects are apparent through piecewise estimation and the use of a large number of actual time categories. The time categories are: 45 minutes or less (1); 46-75 minutes (2); 76-120 minutes (3); 121-180 minutes (4); 181-240 minutes (5); 241-360 minutes (6); over 360 minutes (7), and where the actual journey time was not known (8). The specification of the utility function to allow the ASC to vary with duration is:

$$U = ASC + \sum_{i=2}^{8} \alpha_i d_i + ...$$

where the d_i are dummy variables for 7 of the 8 time categories and here the arbitrarily omitted category is 45 minutes or less (1). ASC relates solely to the base category of 45 minutes or less whereas for, say, category 6 (241-360 minutes of actual time) the constant is ASC+α_6. The equivalent function to allow the sensitivity to time to vary by duration is:

$$U = \beta T + \sum_{i=2}^{8} \lambda_i d_i T + ...$$

T is the SP journey time. The time coefficient for the base actual time category is β whilst for category 4 (121-180 minutes) it is $\beta+\lambda_4$. Analogous functions are specified to examine whether the sensitivity to earlier and later time and to toll depend on the actual time category.

The more monotonic the effect across more category specific coefficients then the greater the confidence we can have that journey duration really does impact on relevant parameters of route choice models.

Two sets of models are reported, according to whether we use the network data or the reported data for the actual journey made. Two other reported permutations are based around whether we allow the time coefficients to vary or the ASCs to vary with journey duration. We have continued with the absence of the A road ASCs given their incorrect sign.

Table 7.4: Piecewise Estimation of Journey Duration Effects

	I	II	III	IV
	Reported	Network	Reported	Network
$ASC_{M6TCorridor}$	1.0985 (16.5)	1.0823 (9.5)	0.9632 (9.4)	0.9908 (3.6)
$ASC_{M6TStoke\text{-}M1}$	1.5095 (13.6)	1.4839 (8.9)	1.3290 (8.2)	1.3523 (4.0)
$ASC_{M6TExtended}$	1.1708 (5.3)	1.0875 (2.7)	1.2213 (5.3)	1.2414 (3.2)
$ASC_{M6TLong}$	0.6994 (4.4)	0.7431 (5.0)	0.5471 (4.2)	0.5468 (4.3)
ASC_{NTH}	-1.9867 (10.1)	-1.9851 (9,8)	-1.9545 (9.6)	-1.9591 (10.9)
ASC_{STH}	-3.5072 (6,1)	-3.5088 (8.1)	-3.4682 (6.9)	-3.4810 (6.2)
ASC_{M6TSTH}	-2.3788 (9.5)	-2.3796 (9.6)	-2.3844 (9.6)	-2.3833 (9.5)
ASC_{NTHSTH}	-1.9513 (6.9)	-1.9510 (6.8)	-1.9368 (6.9)	-1.9421 (7.0)
ASC_{ALL3}	0.5075 (1.8)	0.4365 (1.2)	0.5426 (2.0)	0.5784 (1.6)
Incremental Effect of Actual Time on ASCs for M6T				
46-75 mins			-0.0664 (0.6)	-0.1939 (0.7)
76-120 mins			0.1871 (1.3)	0.4935 (1.5)
121-180 mins			0.4335 (2.6)	0.3154 (1.2)
181-240 mins			0.4938 (5.5)	0.3777 (1.3)
241-360 mins			0.4388 (2.2)	0.5990 (1.9)
361+ mins			1.0071 (3.5)	1.0202 (2.2)
Unknown			0.0835 (0.3)	-0.0374 (0.1)
$Time_{M6}$	-0.0454 (24.1)	-0.0436 (7.0)	-0.0522 (26.7)	-0.0524 (25.3)
$Time_{M6T}$	-0.0352 (9.6)	-0.0323 (3.2)	-0.0468 (14,8)	-0.0459 (14.9)
$Time_{A}$	-0.0508 (26.8)	-0.0489 (7.8)	-0.0575 (28.0)	-0.0577 (26.7)
$Time_{Bits}$	-0.0363 (16.2)	-0.0344 (5.2)	-0.0459 (15.1)	-0.0457 (11.8)
Incremental Effect of Actual Time on Time Coefficients				
46-75 mins	-0.0011 (0.4)	0.0008 (0.1)		
76-120 mins	-0.0049 (1.1)	-0.0169 (1.8)		
121-180 mins	-0.0121 (2.6)	-0.0118 (1.6)		
181-240 mins	-0.0149 (6.1)	-0.0130 (1.8)		
241-360 mins	-0.0105 (2.1)	-0.0157 (1.7)		
361+ mins	-0.0255 (3.2)	-0.0285 (3.0)		
Unknown	-0.0004 (0.1)	0.0000 (0.0)		
Earlier	-0.0207 (10.2)	-0.0202 (7.2)	-0.0208 (27.0)	-0.0209 (28.2)
Later	-0.0213 (9.7)	-0.0209 (7.7)	-0.0215 (19.0)	-0.0216 (19.6)
Incremental Effect of Actual Time on Earlier/Later Coefficients				
46-75 mins	-0.0002 (0.1)	-0.0013 (0.5)		
76-120 mins	-0.0002 (0.1)	-0.0027 (0.8)		
121-180 mins	-0.0012 (0.4)	-0.0004 (0.1)		
181-240 mins	-0.0021 (0.6)	0.0027 (0.9)		
241-360 mins	0.0080 (1.4)	-0.0004 (0.1)		
361+ mins	0.0004 (0.1)	-0.0043 (0.5)		
Unknown	-0.0004 (0.1)	0.0022 (0.4)		
Delays M6	Base	Base	Base	Base
M6 delays due to	0.3039 (4.9)	0.3097 (5.1)	0.3408 (5.8)	0.3556 (5.5)
Exp 25m delays	1.0125 (8.6)	1.0111 (8,7)	1.0653 (8,8)	1.0647 (8.1)
No M6 Delays	-0.3556 (4.6)	-0.3494 (4.6)	-0.3268 (4.2)	-0.3107 (4.3)
Toll	-0.0053 (30.2)	-0.0053 (30.4)	-0.0053 (29.5)	-0.0054 (30.0)
FuelYes	-0.0061 (9.3)	-0.0061 (9.0)	-0.0062 (9.5)	-0.0061 (9.0)
ρ^2 (constants)	0.185	0.186	0.185	0.187
Log Likelihood	-22517.3	-22480.3	-22524.4	-22465.6

In Model I, there is an almost monotonic increase in the time coefficient across the six reported time categories. In contrast, there is clearly no variation in the earlier and later time coefficients across time bands. The effects on the time coefficient in Model II, based on network times, also indicate an increase in the unit value of time with duration. Again there is no effect on the earlier and later time coefficients. These models indicate that the value of time increases with journey duration, as might be expected. The goodness of fit is higher for the network data.

Turning to Models III and IV, where the ASCs for the M6T alone are allowed to vary with duration, the goodness of fit is also better for the network data. Across the six duration bands, the results indicate that the preference for the M6T increases with duration, although the relationship is not as striking as for in-vehicle time coefficients.

The models which allow the ASCs to vary (III and IV) and those which allow the time coefficients to vary (I and II) are not directly comparable since the latter offer many more but admittedly insignificant incremental effects. The effects of the earlier and later time coefficients in Models I and II are all insignificant. When these are removed, the log-likelihoods for Models I and II were -22535.8 and -22493.4 respectively. Thus the models which allow the ASCs to vary are statistically superior to those which allow the time coefficients to vary.

We were also able to detect an effect of journey duration on the sensitivity to toll, in separate models which did not allow the time coefficients to vary by duration. As the journey duration increased, respondents were less sensitive to toll. This was apparent using both piecewise estimation and subsequently using a single continuous function. Nonetheless, the effects were minor. For example, the strongest effects, for both reported and network data, were for journeys over 6 hours where the toll coefficient was only about 20% lower than for journeys of 45 minutes or less.

We have therefore not persisted with the duration segmentation on the earlier and later time coefficients, nor on the toll coefficient. Instead, Table 7.5 reports models where a continuous effect has been specified on the time coefficients and ASCs. .

For the effects of journey duration on the travel time coefficient, we have specified a function of the form:

$$U = \alpha T + \beta AT^{\lambda} T + ...$$

where AT is the actual time for the journey made and T is the SP journey time. The marginal utility of travel time (MU_T) is therefore a function of the actual time:

$$MU_T = \alpha + \beta AT^{\lambda}$$

Similarly, we have separately allowed the ASC for the M6T (ASC_{M6T}) to vary with journey duration as:

$$U = ASC_{M6T} + AT^{\lambda} ASC_{M6T} + ...$$

whereupon the ASC will depend upon the actual journey time.

The value of λ was indirectly estimated by an iterative search process, in intervals of 0.1, with the selected value being that which achieved the best fit.

A value of λ of zero means that the actual journey duration does not impact on the ASC or time coefficient. A value of λ greater (less) than one implies that the incremental ASC or time coefficient increases more (less) than proportionately with journey duration, although the variation in the overall time coefficient or ASC also needs to take the base coefficient or ASC into account.

Table 7.5: Continuous Estimation of Journey Duration Effects

	I	II	III	IV
	Reported	**Network**	**Reported**	**Network**
$ASC_{M6TCorridor}$	1.1713 (16.0)	1.1825 (16.5)	0.9935 (13.7)	0.9259 (10.6)
$ASC_{M6TStoke\text{-}M1}$	1.6343 (18.3)	1.6168 (16.7)	1.4173 (11.6)	1.3231 (9.6)
$ASC_{M6TExtended}$	1.5313 (9.0)	1.5069 (10.0)	1.4050 (8.0)	1.3504 (7.5)
$ASC_{M6TLong}$	0.5223 (4.4)	0.5242 (3.1)	0.3178 (2.4)	0.2506 (1.9)
ASC_{NTH}	-2.0021 (8.9)	-1.9989 (15.2)	-1.9654 (8.5)	-1.9439 (8.6)
ASC_{STH}	-3.4929 (5.4)	-3.5332 (6.8)	-3.4468 (5.3)	-3.4241 (5.3)
ASC_{M6TSTH}	-2.3706 (8.4)	-2.3756 (7.9)	-2.3777 (8.4)	-2.3851 (8.5)
ASC_{NTHSTH}	-1.9455 (5.6)	-1.9514 (7.0)	-1.9268 (5.5)	-1.9180 (5.5)
ASC_{ALL3}	0.8245 (3.2)	0.7844 (2.3)	0.7014 (2.8)	0.6416 (2.5)
$ASC_{M6T}*AT^{\lambda}$	-	-	0.0017 (3.4) λ=1.0	0.0043 (3.9) λ=0.9
$Time_{M6}$	-0.0451 (15.5)	-0.0425 (10.5)	-0.0521 (25.9)	-0.0522 (25.9)
$Time_{M6T}$	-0.0393 (11.7)	-0.0366 (8.2)	-0.0477 (14.7)	-0.0482 (14.7)
$Time_{A}$	-0.0504 (16.9)	-0.0478 (12.3)	-0.0574 (27.4)	-0.0574 (27.4)
$Time_{Bits}$	-0.0358 (11.6)	-0.0333 (6.7)	-0.0456 (16.9)	-0.0467 (16.8)
$Time*AT^{\lambda}$	-0.00025 (2.9) λ=0.7	-0.00031 (2.7) λ=0.7	-	-
Earlier	-0.0207 (24.5)	-0.0207 (25,4)	-0.0208 (24.8)	-0.0209 (24.8)
Later	-0.0214 (23.6)	-0.0214 (23.7)	-0.0215 (23.7)	-0.0216 (23.7)
Delays M6	Base	Base	Base	Base
M6 delays due to	0.3050 (3.9)	0.2960 (2.3)	0.3276 (4.3)	0.3259 (4.4)
Exp 25m delays	1.0100 (7.1)	0.9997 (6.3)	1.0421 (7.5)	1.0369 (7.3)
No M6 Delays	-0.3567 (3.6)	-0.3632 (3.6)	-0.3383 (3.5)	-0.3393 (3.6)
Toll	-0.0053 (33.7)	-0.0053 (30.4)	-0.0053 (34.1)	-0.0053 (33.6)
FuelYes	-0.0061 (9.5)	-0.0061 (14.5)	-0.0061 (9.6)	-0.0062 (9.5)
Log Likelihood	-22589.8	-22579.3	-22574.6	-22568.6
ρ^2 (constants)	0.182	0.183	0.183	0.183

Given that the terms relating to unknown times were so far from significant, these were removed from the models reported here.

What is encouraging, and rather convenient, is that the λ coefficients recovered by this iterative search process for the effects on the time coefficients were the same for the reported and network data. They were very similar in the case of the ASCs. Indeed, the λ coefficient does not vary greatly across all four models.

The network data provides the better fit, in both cases, whilst the interactions with the ASCs are statistically superior to the interactions with the time coefficients. The positive λ coefficients are in line with the freely estimated effects apparent in Table

7.4, whilst the other coefficients are not greatly different from those reported in that table.

The implied monetary values of time and values of the ASCs for each model are given in Table 7.6. The range of values seem sensible.

Table 7.6: Implied M6T Values of Time and ASC by Duration

	Model I	Model II	Model III	Model IV
30m	7.93	7.54	30.78	29.35
60m	8.24	7.93	31.85	31.00
120m	8.76	8.57	33.99	34.08
180m	9.20	9.12	36.13	37.00
240m	9.60	9.62	38.27	39.83
300m	9.97	10.08	40.40	42.58

Note: Money value of M6T time in toll units (I and II). Time value of $ASC_{M6TStoke\text{-}M1}$ in M6T time units (III and IV).

The point elasticity of the value of time with respect to journey time across a range of actual travel times are set out in Table 7.7. These compare to the somewhat higher (distance) elasticity of 0.22 estimated from meta-analysis by Wardman (2004) and duration elasticities of 0.36 for business, 0.41 for commuting and 0.32 for other purposes from the re-analysis of the 1994 UK Value of Time study data by Whelan and Bates (2001). All these seem implausibly high in the context of the large range of travel times relevant to inter-urban travel.

The latter work allowed the sensitivity to cost to vary with the level of cost. This could explain the differences between the results if, due to different traffic speeds, the variation in times was greater than the variation in costs. However, given that we are here dealing largely with motorway travel, the variations in speeds ought not to be large and segmentation by cost would be expected to provide similar results.

Table 7.7: Value of Time Duration Elasticities

	Model I	Model II
30m	0.05	0.06
60m	0.07	0.09
120m	0.11	0.14
180m	0.14	0.17
240m	0.16	0.20
300m	0.18	0.22

When we included the journey duration effect on both the ASCs and the time coefficients, it was not possible to obtain significant coefficients for both incremental effects. Hence we do not report this simultaneous segmentation but instead proceed with incremental effects on either the time coefficients or the ASCs.

There could be a confounding effect here from either journey purpose or income, Those with higher incomes tend to have higher values of time and to travel farther.

Table 6.8 indicates that those on business travel farther on average than commuters but it is leisure travellers who travel farthest. Analysis reported in section 7.9 finds that the duration effect is retained in models which also account for journey purpose and income effects. More importantly though, the results presented in Table 4.28 and in the surrounding discussion indicate quite conclusively that income has no effect on journey duration in our sample of motorists.

7.3 Size of Time Savings

The SP exercises cover a wide range of time savings offered by the M6T, and its extended variants, over the current M6 and A roads. We have examined whether the size of the time saving is having an effect on the unit value of time.

The logit model can be respecified in terms of differences between routes. This is convenient if we wish to examine variations in a unit valuation according to, say, the size of the time difference since we can segment, using dummy variables, according to the time difference or alternatively specify a function that is non-linear in differences. If there are three routes, then two time differences represent the competition between the three routes in time terms.

In doing this, we have specified the utility function relating to time in difference form as follows:

$$U_{M6T} = \sum_{i=1}^{n} \alpha_i d_{1i}(T_{M6} - T_{M6T}) + \sum_{i=1}^{n} \beta_i d_{2i}(T_A - T_{M6T}) + \sum_{i=1}^{n} \gamma_i d_{3i}(T_{M6} - T_{New})$$

where T_{M6}, T_{M6T}, T_A and T_{New} denote the journey time on the M6 alternative, existing and extended M6T alternatives, A road alternatives and the new motorway.

The terms d_{1i}, d_{2i}, and d_{3i} are dummy variables denoting n different categories of time difference for each of the three differences in route times to which separate coefficients are estimated.

For the M6T corridor SP exercises (SP1B), in all but one case only the first difference needs to be specified, with additionally the difference between the A road and M6T specified in the remaining case. The SP1A and SP1C exercises based on the Stoke-M1 corridor contain the first two difference terms, as do two of the three SP2A exercises. The exercise relating to the Knutsford-Dunstable new motorway (SP2C) does not contain an A road but does make use of the final term in the above equation as well as the first. For the M6T extended in bits (SP2B) only the first term is used but it is specified seven times to represent the differences between the M6 and the other seven options.

The purpose of this function is to determine whether variations in the α_i, β_i and γ_i across time saving categories indicate that the unit value of time depends upon the size of the time saving offered by the M6T, the extended M6T or new motorway. The results of the piecewise estimation are given in Tables 7.8 and 7.9. Table 7.8 reports the results for the time difference between the M6 and M6T, with the exception of the fifth row where the difference is between the time on the existing and new motorway in exercise SP2C.

Model I simply specifies a common coefficient for the relevant time difference regardless of level. The coefficients are positive, which is to be expected given that

larger time savings on the M6T are preferred. The coefficients are generally lower than those reported in, say, Table 7.1 but the lower goodness of fit reflects more residual variation in a model of this type and this will deflate the coefficient estimates.

Table 7.8: Piecewise Estimation of Time Saving Effects (M6T over M6)

		I	II
1	SP1AC, SP2C ($Time_{M6}$ -$Time_{M6T}$)		
	≤15		0.0775 (8.0)
	16-30		0.0363 (9,6)
	31-45		0.0387 (13.8)
	46-60		0.0304 (12,4)
	>60		0.0289 (9.7)
	All	0.0300 (14.9)	
2	SP1B ($Time_{M6}$ -$Time_{M6T}$)		
	≤15		0.0387 (5.0)
	16-30		0.0464 (12.4)
	31-45		0.0484 (16.3)
	46-60		0.0455 (18.8)
	All	0.0425 (14.0)	
3	SP2A ($Time_{M6}$ -$Time_{M6T}$)		
	≤15		-
	16-30		0.0796 (12.2)
	31-45		0.0805 (18.4)
	46-60		0.0594 (18.5)
	>60		0.0513 (20.3)
	All	0.0452 (16.7)	
4	SP2B ($Time_{M6}$ -$Time_{M6T}$)		
	≤15		-0.1880 (12.7)
	16-30		0.0259 (6.0)
	31-45		0.0371 (12.1)
	46-60		0.0484 (19.8)
	>60		0.0606 (27.8)
	All	0.0639 (8.7)	
5	SP2C ($Time_{M6}$ –$Time_{New}$)		
	≤15		-
	16-30		-
	31-45		-
	46-60		0.0613 (13.1)
	61-75		0.0491 (18.8)
	75+		0.0397 (18.2)
	All	0.0393 (18.0)	
6	SP8 ($Time_{M6}$ -$Time_{M6T}$)		
	≤15		0.0597 (5.4)
	16-30		0.0452 (11.6)
	31-45		0.0383 (13,4)
	46-60		0.0324 (16.0)
	>60		0.0146 (2.9)
	All	0.0332 (13.1)	
	Log Likelihood	-24436.4	-23881.8
	ρ^2 (constants)	0.115	0.135

Model II allows the time coefficient to depend on the time saving category. The results are pooled across different designs where there are a common set of time differences. Thus the first row covers the time differences between the M6T and M6 for the Stoke-M1 corridor designs (SP1A, SP1C) based on the existing M6T and the difference between the M6 and existing M6T that is apparent in the Knutsford-Dunstable new motorway design (SP2C) which offers the same time differences. This leaves row 5 to cover the difference between the existing and new motorway that is also offered in SP2C. Row 2 relates to the M6T corridor (SP1B), row 3 to the extended M6T design (SP2A) and row 4 to the design that extends the M6T in bits (SP2B), whilst row 6 separates out the route and departure time SP exercises (SP8).

Thus a time difference between the M6 and M6T ranging between 46 and 60 minutes has a coefficient of 0.0304 for designs SP1A, SP1C and SP2C (Row 1) but 0.0455 for design SP1B (Row 2). The coefficients appear more in line with those reported in Table 7.1 whilst there is a considerable improvement in fit.

Rows 1, 3, 5 and 6 support a unit valuation that falls as the time saving increases, and indeed the variation is appreciable. The direction of change is in line with both prospect theory and the more conventional property of diminishing marginal utility. Nonetheless, row 4 indicates that the unit valuation increases with the size of the time saving, with some support from the results in row 2.

Table 7.9 provides the same results for the M6T time savings over the A road. This is for the Stoke-M1 corridor designs (SP1A, SP1C) in row 1, the M6T corridor (SP1B) in row 2 and the extended M6T (SP2A) in row 3.

Table 7.9: Piecewise Estimation of Time Saving Effects (M6T over A Road)

		I	II
1	SP1AC ($Time_A$ -$Time_{M6T}$)		
	≤15		0.0207 (2.3)
	16-30		0.0291 (8.8)
	31-45		0.0318 (16.1)
	46-60		0.0291 (14.3)
	All	0.0345 (13.0)	
2	SP1B ($Time_A$ -$Time_{M6T}$)		
	≤15		-0.0432 (4.4)
	16-30		0.0211 (4.1)
	31-45		0.0175 (9.1)
	All	0.0164 (3.8)	
3	SP2A ($Time_A$ -$Time_{M6T}$)		
	≤15		-
	16-30		-0.0394 (5.4)
	31-45		-0.0035 (0.9)
	46-60		0.0086 (3.5)
	>60		0.0047 (1.7)
	All	0.0148 (6.8)	
	Log Likelihood	-24436.4	-23881.8
	ρ^2 (constants)	0.115	0.135

The results in Table 7.9 provide no useful insights. Taken together, the results of Model II do not provide compelling evidence for departing from the conventional position of a constant unit value of time.

Table 7.10 reports a model that pools across the different SP designs, distinguishing only between the time differences between the M6T and M6 and the time differences between the M6T and A road. This effectively draws all the patterns of results together into a single net effect for the two types of time difference. We can see that apart from the coefficients for the smallest time difference, which are in both cases out of line with all the other coefficients, there is very little variation across the remaining five and four time differences respectively.

Table 7.10: Combined Piecewise Estimation of Time Saving Effects

All M6 ($Time_{M6}$ -$Time_{M6T}$)		All A ($Time_A$ -$Time_{M6T}$)	
≤15	0.0202 (2.8)	≤15	-0.0061 (0.6)
16-30	0.0427 (11.6)	16-30	0.0229 (6.2)
31-45	0.0433 (15.2)	31-45	0.0215 (11.3)
46-60	0.0371 (15.4)	46-60	0.0211 (13.5)
61-75	0.0421 (18.0)	>60	0.0137 (7.9)
75+	0.0378 (13.1)		
Log Likelihood	-24534.4	ρ^2 (constants)	0.112

We conducted further analysis into this duration effect by specifying time differences between alternatives but allowing non-linear effect as follows:

$$U_{M6T} = \alpha_i (T_{M6} - T_{M6T})^{\lambda_1} + \alpha_2 (T_A - T_{M6T})^{\lambda_2}$$

If the λ_1 and λ_2 coefficients are greater (less) than one, then the unit valuation increases (falls) as the time difference increases. Values of one indicate that there is no variation in the unit valuation according to the level of time saving. The results are presented in Table 11.

Table 7.11: Non-Linear Continuous Functions of Time Savings

	I	II	III	IV	V
$Time_{Diff}$	-	-	-	0.0291 (22.8) λ=1.0	0.0131 (25.5) λ=1.2
$Time_{M6}$- $Time_{M6T}$	0.1694 (31.1) λ_1=0.7	0.0425 (32.9) λ_1=1.0	0.0165 (32.1) λ_1=1.2	-	-
$Time_A$- $Time_{M6T}$	0.0061 (13.5) λ_2=1.3	0.0144 (10.6) λ_2=1.0	0.0086 (13.0) λ_2=1.2	-	-
Toll	-0.0045 (30.5)	-0.0045 (31.0)	-0.0045 (31.5)	-0.0040 (30,2)	-0.0043 (30.9)
Log lik	-24644.1	-24769.8	-24728.0	-25058.4	-24787.7
ρ^2(C)	0.108	0.103	0.105	0.093	0.102

Model I is the best fit for separately estimated values of λ_1 and λ_2, using an iterative search procedure across different values in intervals of 0.1. This model indicates that the best fit implies only limited variation in the unit value according to the size of the time saving, and indeed contradictory effects for the two sets of time difference. Model II constrains both λ_1 and λ_2 to be one. Clearly this has a worse fit than Model I. When the constraint of the two being equal is maintained but the best fitting single value of λ estimated, as in Model III, the results indicate only a small variation from a constant unit effect.

Models IV and V constrain α_1 and α_2 as well as λ_1 and λ_2 to be the same. Model IV which specifies a constant unit value is clearly statistically inferior to other models. Departing from this by finding the best fit for a single λ in Model V implies only a limited degree of variation in the value of time. For example, at a 30 minute saving the value of time is 7.2 pence per minute, increasing to 8.3 for a 60 minute saving.

Finally in this investigation of size effects, we estimated a model of the form:

$$U_{M6T} = \alpha T_{M6T} + \gamma T_{M6T}(T_{M6} - T_{M6T})$$
$$U_A = \beta T_A + \delta_1 d_1 T_A T_{Diff} + \delta_2 d_2 T_A T_{Diff}$$

The marginal utility of time for the M6T is α plus γ multiplied by the time difference between the M6 and M6T. Note this is not simply a pure effect on the marginal utility of time for the M6T since the T_{M6} term will impact on the utility of the M6. We also allowed the marginal utility of time on the A road to vary around β according to the absolute time difference between the A road and M6 (T_{Diff}) and whether the A road offers a gain on the M6 (d_1) or a loss (d_2). The results are reported in Table 7.12.

Table 7.12: Continuous Estimation of Size Effects

$ASC_{M6TCorridor}$	1.2541 (17.1)
$ASC_{M6TStoke\text{-}M1}$	1.3985 (11.5)
$ASC_{M6TExtended}$	1.7472 (14.3)
ASC_{NTH}	-2.1539 (6.8)
ASC_{STH}	-3.6454 (5.4)
ASC_{M6TSTH}	-2.3311 (7.6)
ASC_{NTHSTH}	-2.0200 (4.8)
ASC_{ALL3}	0.7874 (4.5)
$Time_{M6}$	-0.0463 (14.1)
$Time_{M6T}$	-0.0434 (17.3)
$Time_{A}$	-0.0510 (15.2)
$Time_{Bits}$	-0.0309 (9.0)
TimeALoss	-0.00022 (5.3)
TimeAGain	0.000077 (2.5)
$Time_{M6\text{-}M6T}$	0.000064 (1.7)
Early	-0.0194 (20.3)
Late	-0.0201 (21.1)
Delays M6	Base
M6 delays due to	0.2667 (3.3)
Exp 25m delays	0.9468 (6.4)
No M6 Delays	-0.3882 (3.9)
Toll	-0.0051 (32.2)
FuelYes	-0.0062 (9.2)
Log Likelihood	-22664.4
ρ^2 (constants)	0.180

The marginal utility of time on the M6T is found to diminish as the time saving increases. However, the effect ($Time_{M6\text{-}M6T}$) is not significant and is in any event

relatively minor. For a time difference of 10 minutes, the value of time is 8.4 pence per minute, falling to 7.8 pence per minute for a 60 minute time difference.

The model recovers a statistically significant effect on the $Time_A$ coefficient for both gains (TimeAGain) and losses (TimeALoss) relative to the M6. The unit value of time increases as the loss becomes larger and falls as a saving becomes larger. The value of time on an A road is 9.9 pence per minute for a 5 minute gain relative to the motorway falling only slightly to 9.6 pence per minute for a 30 minute saving. The corresponding figures for 5 and 30 minute losses relative to the free motorway are 10.2 and 11.3 pence per minute.

In summary, we do not feel that the data supports the presence of a size effect. Note, however, that we are not here dealing with very small time savings of a few minutes since it is unlikely that these are relevant to the case of new tolled roads. Some of the models are quite clear that there is no such effect. Whilst others are more suggestive of an effect, the results are not entirely consistent with each other and the amount of variation in the unit value of time tends to be relatively small.

7.4 Toll Charge

There are a range of important issues to be considered here:

- Do gains and losses in toll have the same impact on decision making?
- Does the marginal disutility of toll depend upon the level of the toll charge?
- Are the responses to toll dependent on whether they occur on an existing toll motorway, on an extension to an existing toll motorway, on an entirely new toll motorway, or are introduced on an existing toll free motorway?

A wide range of toll levels are here covered, as is apparent from Table 7.13.

Table 7.13: Toll Levels Covered in SP Designs

Design	Toll Levels (pence)	Base	Comments
SP1A (Stoke-M1)	200, 350, 500, 750. 100, 200, 400, 500.	200 200	SP1A Designs 1-5 SP1A Design 6
SP1B (M6T Corridor)	200, 350, 500, 750. 100, 200, 400, 500. 150, 250, 400, 650.	200 200 250	SP1B Designs 1-4 SP1B Design 5 SP1B Designs 6-8
SP1C (Stoke-M1)	200, 350, 500, 750. 0, 100, 200.	200 200	Tolls on M6T Tolls on existing M6
SP2A (Extended M6T)	200, 350, 500, 750. 300, 550, 800, 1000.	200 300	SP2A Design 1 SP2A Designs 2-3
SP2B (Extended in Bits)	250, 350, 450. 100, 150, 200, 250. 100, 150, 200, 250. 350, 400, 450, 500, 550, 600, 650, 700. 350, 400, 450, 500, 550, 600, 650, 700. 200, 250, 300, 350, 400, 450, 500. 450, 600, 650, 700, 800, 850.	450 250 250 450 450 450 450	M6T North South M6T and North M6T and South North and South All
SP2C (New motorway)	750, 1000, 1500, 2000. 200, 350, 500, 650.	750 200	New motorway Existing M6T
SP8 (Departure Time)	200, 350, 500, 750. 0, 100, 200.	200 200	Current Depart Time Different Depart Time

The exercises generally cover both gains and losses on the toll charge of £3.50 at the time of the surveys. However, SP1C included tolls on the existing M6, SP2C covers tolls on a new motorway whilst SP2A and SP2B offer some large toll levels to complement those of SP2C and also cover the extension of an existing tolled motorway.

The initial modelling of toll effects specified a piecewise model, involving dummy variables to represent each toll level relative to a base. This takes the form:

$$U = \sum_{i=2}^{n} \alpha_i d_i + ...$$

The d_i are dummy variables for each of n-1 toll levels and their coefficients are interpreted relative to the base (omitted) category, here specified as level 1.

The base levels used in the modelling are specified in Table 7.13 above, and are repeated in Table 7.14 containing the results. They were chosen to be as similar as possible to assist interpretation.

Table 7.14 reports the estimated coefficients for the toll levels along with their t ratios and also the unit effect after 'normalising' for the size of the toll. From the previously reported models, a rough benchmark for the unit toll coefficient is around -0.0055.

Common parameters are estimated where a common base can be specified. So, for example, SP1A, SP1B, SP1C, SP2A, SP2C, SP8A and SP8B all contain a 200p toll charge which can be used as a base. Nonetheless, we have kept SP2B separate, even though it has a 250p base which also occurs in some SP1B exercises, because of the somewhat different nature of how the toll charge is arrived at, whilst SP1C and SP8 were kept separate where they respectively involved the introduction of tolls on the M6 and lower tolls on the M6T in return for departing at a different time.

The results presented in Table 7.14 seem to indicate that that there is a diminishing marginal utility of toll charge as the toll increases. This is apparent for design SP2B, with a monotonic reduction in the unit disutility across a large number of tolls in excess of 450p. Diminishing effects are also apparent for SP2A, relative to the 300p base, and also for the SP1, SP2A, SP2C and SP8 designs relative to the current toll of 350p.

We can inspect where the unit toll effects are relatively low or high, bearing in mind the -0.0055 benchmark. The SP2A coefficients relative to a 300p base are high, although this is not so for the SP2A coefficients where the base is 200p. High coefficients are also apparent for SP2B and SP8, whilst those for SP1C where the toll is reduced are relatively low. The results do not provide any clear indication that the marginal utility with respect to toll is greatly different between increases and reductions in toll (eg, SP8 versus SP1C, and comparison of increases versus decreases in SP2B).

The SP2B results seem to indicate a relatively large dislike of tolls when the M6T is extended, contrary to what might be expected, and this is also the case for SP2A at least when a 300p toll is the base but not when SP2A is pooled with the other designs and the base is 200p. The SP2C design, covering the new motorway, does not seem to have coefficients greatly different from the benchmark.

Table 7.14: Piecewise Estimation of Toll Effects

Design/Level	Coeff (t)	UnitEffect	Design/Level	Coeff (t)	Unit Effect
1. SP1, SP2A, SP2C, SP8			**6. SP2B**		
100	2.025 (6.1)	0.0203	200	2.299 (2.5)	0.0092
200=Base	-	-	250	2.095 (6.3)	0.0105
350	-0.432 (7.7)	-0.0029	300	1.028 (1.7)	0.0068
400	-1.419 (7.0)	-0.0071	350	1.169 (5.6)	0.0117
500	-1.738	-0.0058	400	0.713 (2.6)	0.0143
750	(27.9)	-0.0055	450 = Base	-	-
	-3.041		500	-0.824 (3.4)	-0.0165
	(39.3)		550	-1.225 (4.5)	-0.0123
2. SP2C			600	-1.788 (6.1)	-0.0119
750=Base	-	-	650	-2.202 (6.7)	-0.0110
1000	-1.556 (4.1)	-0.0062	700	-2.708 (6.6)	-0.0108
1500	-3.299 (6.1)	-0.0044	800	-3.499 (6.8)	-0.0100
2000	-7.951 (5.5)	-0.0064	850	-3.533 (6.5)	-0.0088
3. SP1B					
150	3.565 (9.9)	0.0356	**7. SP2B**		
250=Base	-	-	100	1.807 (3.9)	0.0120
400	0.5322 (2.1)	0.0036	150	1.178 (2.7)	0.0118
650	-3.144	-0.0079	200	0.8510 (1.9)	0.0170
	(16.0)		250 = Base	-	-
4. SP2A					
300=Base	-	-	**8. SP8**		
550	-2.263	-0.0091	Free	1.506 (14.8)	0.0075
800	(13.1)	-0.0076	100	1.092 (9.6)	0.0109
1000	-3.805	-0.0061	200=Base	-	-
	(20.8)				
	-4.254				
	(21.3)				
5. SP1C					
Free	-0.5335	-0.0027			
100	(2.9)	-0.0050			
200=Base	-0.5032	-			
	(2.3)				
	-				

The pattern of results from this piecewise estimation is not particularly clear, with the possible exception of a diminishing marginal utility as tolls increase. This pattern of results could be due either to some protest or strategic biasing against higher tolls, whereupon the spreading of a fixed disutility across larger tolls even with constant marginal utility would imply diminishing estimated average and marginal effects, or due to a genuine non-linearity.

We now turn to specific formulations of the utility function to test particular hypotheses relating to toll sensitivity as set out above. These are all for utility functions which enter toll (T) in its usual linear-additive form but with additional terms to test these hypotheses. This takes the form:

$$U = \alpha T + \beta d_1 + \lambda\, d_2 T$$

The dummy variables d_1 and d_2 represent some feature of the toll or the context in which it is charged. Here the dummy variable term d_1 represents a factor that might be expected to have a constant (additive) effect on utility independent of the toll level. This might be a protest against the introduction of tolls on a currently untolled motorway, whereupon we would expect β to be negative. The interaction term composed of dummy variable d_2 allows the utility effect to depend upon the level of toll, We might hypothesise that the sensitivity to toll is different for increases on the current toll level. Thus d_2 would denote tolls in excess of 350p, whereupon the toll coefficient would be $\alpha+\lambda$, otherwise it is α. Additional interactions can be entered as appropriate.

An additive dummy variable was specified simply to denote whether or not a route had a toll. This was found to be far from significant. Nor was there a remotely significant effect when an incremental term was entered to denote the introduction of a toll on an existing free motorway.

An incremental toll effect was specified for increases on the current level of 350p. This was an interaction of a dummy variable denoting an increase in toll and the toll variable itself. A significant negative coefficient was returned, consistent with the results of the piecewise estimation.

The focus groups (Faber Maunsell et al., 2006) seemed to detect a resistance to paying a 500p toll on the existing M6T. If such a threshold did exist, it might not apply to an extended M6T. The results in Table 7.14 do not suggest that any such threshold exists for the existing M6T covered in SP1A, SP1B, SP1C and SP8. Nonetheless, we specified a threshold interaction effect for tolls £5 or over. The coefficient estimate of -0.00011 was of the right sign, although small relative to the toll coefficient of -0.0054 and far from significant (t=0.83). The incremental effect relating to a toll increase on the current toll of £3.50 was statistically superior.

Through the specification of dummy variable interactions with the toll variable, the toll coefficient was allowed to vary across entire new motorways, as in SP2C, the longer M6T (SP2A) and the Northern and Southern extensions to the M6T (SP2B). The latter was far from significant. However, significant effects were obtained for the toll coefficients for the entirely new motorway and for the extended M6T. These denoted lower toll coefficients in these SP exercises.

We examined whether the response to toll (T) was linear or not by specifying a power term to the toll variable. This took the form:

$$U = \alpha T^{\lambda}$$

The linear assumption implies a λ of unity. Specifying this function across all toll levels, we found that any departure from this special case of λ equal to one actually led to a worse fit.

Restricting this function to the toll levels beyond the current level, with a separate linear term for other toll levels, it was possible to obtain a better fit by departing from linearity. A λ of 0.7 provided the best fit. However, the dummy variable interaction for tolls greater than £3.50 was not then significant. Of the two formulations, the latter provided the better fit and hence was retained.

Table 7.15 reports the models containing the significant effects on the toll coefficient that have been detected. These are all interaction terms which impact on the sensitivity to toll.

In Model I, the toll coefficient for increases on the current toll (Toll>£3.50) is 13% higher than for the toll when it is not an increase on the current level. Whilst this is not particularly large, it is very much in line with other evidence. For example, the large scale meta-analysis reported in Wardman (2004) found that values with a toll numeraire were 19% lower all other things equal.

Table 7.15: Incremental Toll Effects

	I	II
$ASC_{M6TCorridor}$	1.3353 (10.9)	1.3004 (10.5)
$ASC_{M6TStoke\text{-}M1}$	1.8729 (17.1)	2.0396 (16.7)
$ASC_{M6TExtended}$	1.9992 96.2)	2.0594 (6.1)
$ASC_{M6TLong}$	0.7840 (5.9)	0.8017 (6.4)
ASC_{NTH}	-1.9776 (8.6)	-1.9985 (8.8)
ASC_{STH}	-3.4614 (5.3)	-3.4810 (5.4)
ASC_{M6TSTH}	-2.2912 (8.0)	-2.2904 (8.1)
ASC_{NTHSTH}	-1.9687 (5.6)	-1.9706 (5.6)
ASC_{ALL3}	1.7819 (5.4)	1.8339 (5.4)
$Time_{M6}$	-0.0523 (25.7)	-0.0530 (25.9)
$Time_{M6T}$	-0.0615 (13.3)	-0.0626 (13.3)
$Time_{A}$	-0.0576 (27.3)	-0.0583 (27.2)
$Time_{Bits}$	-0.0445 (15.2)	-0.0447 (15.1)
Earlier	-0.0201 (21.2)	-0.0199 (21.1)
Later	-0.0209 (19.1)	-0.0208 (19.0)
Delays M6	Base	Base
M6 delays due to	0.3330 (4.1)	0.3449 (4.5)
Exp 25m delays	1.0641 (7.3)	1.0667 (7.2)
No M6 Delays	-0.3424 (3.3)	-0.3454 (3.5)
Toll	-0.0047 (17.3)	-0.0052 (17.3)
Incremental Toll Effects		
EmpPay	-	0.0015 (9.0)
Toll> £3.50	-0.00062 (4.3)	-0.00059 (9.8)
Toll New Motorway	0.0020 (3.4)	0.0026 (4.1)
Toll Extended M6T	0.00082 (3.2)	0.00068 (2.4)
FuelYes	-0.0061 (9.6)	-0.0060 (9.8)
Log Likelihood	-22603.3	-22357.3
ρ^2 (constants)	0.182	0.190

It is not surprising that the coefficient for toll on the entirely new motorway is less than that for toll on the extended motorway which in turn is less than that for toll on the existing motorway. Given that the new and extended motorways all include tolls of over 350p, the relevant comparison is with the base toll coefficient and the incremental effect for tolls over 350p.

The toll coefficient is 38% lower when new motorways are being considered and it is 15% lower when relating to an extension to the M6T. Relative to the toll coefficient without any amendment for the 350p effect, the corresponding figures are 43% and 17%.

The fuel cost coefficient is specified only for those who consider fuel cost. By the same token, we can allow for those who do not consider toll. It emerged that the only significant effect here was from whether the employer pays, with sharing the toll and some other person paying having no effect.

Model II contains an incremental term for those who stated that the employer would pay the M6T in practice (EmpPay). We might have expected this term to imply zero sensitivity to toll for these respondents. The fact that this is not the case could be because respondents have not answered along these lines in the SP exercise, treating it as personal travel, or because they might not actually claim the toll back due to the transaction costs involved.

As for the most appropriate toll coefficient to use, we would argue that the incremental effect for tolls in excess of 350p should be ignored as discerning protest response. There is also an argument that the incremental effects for new and extended roads is also reflecting a bias towards paying tolls to send a positive message about the provision of new tolled roads. The most appropriate toll coefficient is then the main effect without any incremental effects.

The toll and fuel coefficients are little different in Model II when the toll coefficient allows for the employer paying. They are both precisely estimated but, with a t ratio of 1.2, they are not significantly different from each other. Whilst the toll and fuel coefficients could both be biased, to broadly similar degrees, this similarity is encouraging.

It could be argued that the incremental effect for toll increases is not detecting a response bias but is only reflecting a widely held view that losses are valued more highly than gains. But it might then be reasonable to expect non-linear effects of a reduced marginal sensitivity for larger toll increases in line with prospect theory or an increasing marginal sensitivity in line with diminishing marginal utility. Whilst the former was detected when tested for, it was not statistically superior to the additive effect relating to all increases on the current level.

Given that the possible protest response has been isolated by the incremental term for toll increases, and that this is broadly in line with other evidence indicating a divergence between toll and other cost coefficients obtained from meta-analysis, we are inclined to view the base toll coefficient along with the fuel coefficient after allowing for whether they impact on decision making to be our most reliable indicators of underlying preferences.

The toll coefficients for new or extended motorways are lower, appreciably so in the former case, and their relative magnitude is plausible. This finding could reflect strategic biasing of responses and we would not recommend that these effects are carried through into forecasting.

7.5 Fuel Cost Consideration

When allowance is made for those who do not consider fuel costs, and those who in effect do not have to consider toll charge, there is an encouraging degree of similarity between the estimated sensitivities to toll and fuel variations, as was apparent in Table 7.15.

The model reported in Table 7.14 is the same as that in Table 7.15 except that the fuel coefficient is specified for all respondents and not only those 35% who stated

that they took fuel into account. This has a dramatic effect on the fuel cost coefficient, reducing it from a very precisely estimated figure of -0.0061 to a much lower and less precisely estimated figure of -0.0019.

This is a very large divergence, much larger than we might expect in a mode choice context where costs might be expected to feature more in decision making. Whilst it is appropriate to base behavioural response in the route choice context on the fuel coefficient estimated on all motorists, including those who do not consider it, it is not appropriate to base value of time estimates on it since it will inflate the actual willingness to pay to save time to the extent that fuel is not considered. Thus some doubts must be cast on values of time derived from such choice contexts, and indeed from abstract choice contexts, where there is the possibility that a significant number have failed to consider costs in their decision making and no allowance has been made for this.

Table 7.16: Fuel Coefficient for All Respondents

$ASC_{M6TCorridor}$	1.3373 (10.9)
$ASC_{M6TStoke\text{-}M1}$	1.8729 (17.0)
$ASC_{M6TExtended}$	1.8208 (5.5)
$ASC_{M6TLong}$	0.7450 (5.8)
ASC_{NTH}	-1.9800 (8.7)
ASC_{STH}	-3.4661 (5.3)
ASC_{M6TSTH}	-2.2943 (8.1)
ASC_{NTHSTH}	-1.9707 (5.6)
ASC_{ALL3}	1.7595 (5.3)
$Time_{M6}$	-0.0519 (24.6)
$Time_{M6T}$	-0.0607 (12.9)
$Time_{A}$	-0.0559 (27.6)
$Time_{Bits}$	-0.0440 (14.8)
Early	-0.0200 (21.2)
Late	-0.0208 (19.3)
Delays M6	Base
M6 delays due to	0.3213 (4.0)
Exp 25m delays	1.0481 (7.2)
No M6 Delays	-0.3524 (3.4)
Toll	-0.0046 (17.3)
Incremental Toll Effects	
Toll> £3.50	-0.00062 (4.3)
Toll New motorway	0.0021 (3.3)
Toll Extended M6T	0.0010 (3.7)
FuelAll	-0.0019 (3.0)
Log Likelihood	22897.5
ρ^2 (constants)	0.171

We developed a model to explain whether the respondent stated that they considered petrol in the SP exercises as a function of:

- the credibility of the petrol costs on the motorways (very, probably, no – too high, no – too low)
- the credibility of the petrol costs on the A roads (very, probably, no – too high, no – too low)

- journey purpose
- who would pay the toll charge (in the absence of information on who would pay the petrol cost)
- whether the respondent would consider differences in petrol costs in their actual route choices between the routes

This analysis is based on those who conducted designs 1-4 of SP1A, SP1C or designs 1-2 of the SP2A exercise. Fuel was not introduced in the other exercises.

The results are reported in Table 7.17 for the 998 respondents where complete information was provided on all the above variables. Of these 382 (38%) stated that they had considered petrol costs in the SP exercise.

It is not possible to estimate relationships which provide a very complete account of whether fuel was considered. The goodness of fit was low and only three terms had a significant influence. Surprisingly, the credibility of the fuel costs offered did not have an influence. The significant influences, each of which had the expected sign, related to whether fuel was considered in practice, whether the trip was for commuting and whether the toll was not paid by the respondent in practice.

Table 7.17: Whether Fuel Considered in SP Choices

ASC-Not Consider	0.6568 (7.3)
Actual Consider	1.5770 (8.3)
Commute	0.4469 (1.7)
Not Pay Toll	-0.3339 (2.3)
ρ^2	0.064

Only 16% of the sample considered petrol costs in their actual route choice, although this context is not exactly the same as the SP scenarios presented. If the respondent considers petrol costs for their actual choice, they were more likely to consider petrol in the SP exercise as were commuters who make the journey more frequently and hence for whom fuel cost will generally be more of an issue.

We did not ask whether the fuel was paid by someone else but we did ask whether the toll would be reimbursed and this would be so for 34% of the sample. Those who would not pay the toll are less likely to consider fuel in their SP choices.

The motorway fuel costs (which were specified to be the same) were found to be very credible by 5%, probably credible by 78%, too high by 11% and too low by 6%. The A road fuel costs were found to be very credible by 3%, probably credible by 75%, too high by 8% and too low by 14%. The perceived credibility of the presented fuel costs on the motorway route and the A road were entered into the model in several ways. The only significant effect was obtained for a variable denoting that fuel was perceived to be too low on at least one route. Such respondents were actually more likely to consider fuel costs. We do not find this result itself to be credible and hence did not retain it.

Given that a factor in whether the fuel cost is considered in the SP exercise is whether fuel cost is considered in actual decision making, we developed a model to explain the latter. The results are presented in Table 7.18.

The larger the difference in costs between routes (FuelDiff) the more likely it is that fuel costs are considered. Those on employers business (EB) were less likely to consider fuel costs whilst those with larger fuel costs (Fuel) were found to be less concerned with fuel cost. No other significant influences were detected,

Table 7.18: Fuel Costs and Actual Route Choices

Constant	-1.515 (14.5)
EB	-0.179 (1.7)
FuelDiff	0.093 (6.9)
Fuel	-0.008 (2.2)
FuelDK	-0.554 (3.7)
Consider	463
Not Consider	2553
Rho Sq	0.030

Note: FuelDiff and Fuel in pounds. FuelDK denotes petrol cost not reported.

7.6 Earlier and Later Time

There are two issues here to be tested. Firstly, whether earlier and later departures have equivalent disutility. Secondly, whether the unit value of displacement time depends on the amount of displacement time.

Whilst it is useful to pool the route and departure time SP data (SP8) with the other route choice data, since it contributes to the estimation of ASCs and to time and toll sensitivities, we can simply look at SP8 in isolation as far as earlier and later time are concerned,

Changes to departure times were specified as one or two hours earlier than the current departure or else one or two hours later. The models so far reported have distinguished between earlier and later time, although the two are far from significantly different, but they have not distinguished by the amount by which the departure time changes. Unpacking this a little, we can specify separate terms for the each of the levels of earlier and later time. When we replace the earlier and later time terms with two dummy variables each denoting the different magnitudes of earlier or later time, we obtain the coefficient estimates reported in Table 7.19. Transforming them into a per minute effect, we find that there is little support for distinguishing according to the amount of departure time change as well a close similarity of the earlier and later time valuations.

Table 7.19: Level Specific Earlier and Later Time Coefficients

	Coeff (t)	**Per Min Effect**
Earlier 1 hr	-1.1612 (13.5)	0.019
Earlier 2 hrs	-2.5331 (24.7)	0.021
Later 1 hr	-1.4502 (18.3)	0.024
Later 2 hrs	-2.4940 (24.2)	0.021

7.7 Effect of Information Provision

There was some evidence from the SP1B results reported in section 6.4 that the value of time was lower where information was provided. This implies that the information is taking some of the influence on decision making that would otherwise be attributed to journey time.

However, in subsequent models with somewhat larger data sets, there was no statistically significant effect from information provision on either the time coefficient estimates or the ASCs.

7.8 Testing for the 'Ecological Fallacy'

Bates and Terzis (1997) pointed out the possibility of coefficient bias resulting from a failure to take account of the clustered sample effect (repeated observations) when labelled choices such as the routes used here are present. In the worst cases, the problem can be apparent through the manifestation of wrong sign coefficient estimates. More worrying is that the coefficient estimates might be biased without the analyst being aware of it since the results pass the test of credibility in terms of sign, significance and implied valuations.

The general error assumption in the multinomial logit model implies that the variation in the ASCs within the responses for a single individual is the same as that for the ASCs between individuals. A problem arises when this is not the case, and a failure to allow for heterogeneity in the ASC can work through into biased estimates of model parameters in general.

The problem arises where the variation in the ASCs within the responses for a single individual is inconsistent with the general error assumption in the multinomial logit model. Estimation of a single constant across individuals and a failure to allow for this heterogeneity in the ASC can work through into biased estimates of model parameters in general.

We tested whether this was a problem by estimating two models to our pooled SP data set. One was a standard multinomial model, which characterises all modelling reported so far, and the other a random parameters logit model estimated using purpose developed software[2]. The latter was specified to allow normally distributed variation across the ASCs associated with each individual. Note the variation is allowed across but not within individuals.

The results are reported in Table 7.20. The random parameters logit model reports parameter estimates for the mean effect and for the variation around this mean effect in terms of a standard deviation.

It can be seen that as a result of allowing for this preference heterogeneity, the goodness of fit improves considerably. As a result of there being less residual variation in the random parameters model, its coefficients tend to be larger. Indeed, where only a single parameter is estimate, its t ratio tends to improves.

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[2] This software was developed by Nicolas Ibáñez and Richard Connors, of ITS, and is estimated using MATLAB.

Table 7.20 also reports the values of each term relative to both toll and time on the M6. It can be seen that there is a high degree of correspondence between the valuations implied by both standard and random parameters model. It is only for a few ASCs, and notably those which are not precisely estimated, where there is a large discrepancy between the two models. Hence we conclude that the problem being tested here is not present in our models.

Table 7.20: Standard and Random Parameters Logit Models

	Multinomial Logit			**Random Parameters Logit**			
		Toll Value	$Time_{M6}$ **Value**	**Mean Parameter**	**SD Parameter**	**Toll Value**	$Time_{M6}$ **Value**
$ASC_{M6TCorridor}$	1.4614 (41.0)	270	25.8	2.2018 (29.3)	1.9723 (32.8)	286	28.3
$ASC_{M6TStoke\text{-}M1}$	1.8040 (40.7)	334	31.8	2.4259 (31.0)	1.8243 (28.6)	315	31.2
$ASC_{M6TExtended}$	1.7326 (21.9)	265	30.6	2.4817 (13.8)	2.9342 (17.5)	322	31.9
ASC_{M6TNew}	0.7981 (10.5)	148	14.1	1.1037 (5.2)	2.1468 (10.5)	143	14.2
ASC_{NTH}	-2.0505 (15.8)	380	36.2	-3.2379 (8.4)	2.0656 (5.2)	420	41.7
ASC_{STH}	-3.7360 (12.1)	692	65.9	-5.1078 (5.1)	-1.7308 (2.6)	663	65.7
ASC_{M6TNTH}	-0.0990 (1.2)	18	1.7	-0.7220 (3.0)	2.3476 (9.0)	94	9.3
ASC_{M6TSTH}	-2.3776 (10.8)	440	41.9	-3.5672 (6.2)	1.7009 (4.8)	463	45.9
ASC_{NTHSTH}	-2.0642 (12.5)	382	36.4	-3.5944 (7.4)	2.3080 (6.0)	467	46.3
ASC_{ALL3}	0.8153 (10.5)	151	14.3	0.3961 (0.9)	4.6455 (9.6)	51	5.1
$Time_{M6T}$	-0.0520 (30.9)	9.6	0.9	-0.0684 (33.9)		8.9	0.9
$Time_{M6}$	-0.0567 (56.7)	10.5	1.0	-0.0777 (60.8)		10.1	1.0
$Time_{A}$	-0.0617 (56.7)	11.4	1.1	-0.0833 (60.4)		10.8	1.1
$Time_{Bits}$	-0.0431 (28.0)	8.0	0.8	-0.0626 (34.7)		8.1	0.8
Toll	-0.0054 (75.7)	1.0	0.1	-0.0077 (74.5)		1.0	0.1
FuelYes	-0.0056 (23.2)	1.0	0.1	-0.0052 (15.7)		0.7	0.1
EarlierTime	-0.0224 (39.6)	4.1	0.4	-0.0311 (47.0)		4.0	0.4
Later Time	-0.0223 (40.7)	4.1	0.4	-0.0307 (48.9)		4.0	0.4
Log Likelihood	-21082.0			-18164.9			
ρ^2 (constants)	0.206			0.316			
Observations	29158						

7.9 Socio-Economic and Trip Characteristics

We have examined whether the socio-economic, attitudinal and trip characteristics of individuals impact on their sensitivity to changes in travel time, departure time, cost or on their route specific preferences.

The method adopted to explore these effects is the standard procedure of specifying dummy variable terms, either as additive or interaction effects, to determine whether a particular level of a socio-economic or trip characteristic induces a different sensitivity to changes in time and cost or different alternative specific constants. The process is in part guided by theoretical expectations; for example, we might expect the sensitivity to cost variations to differ across income groups.

The utility function with respect to an ASC, time (T) and cost (C) might be specified in the form:

$$U = ASC + \sum_{i=1}^{I}\sum_{j=2}^{J}\gamma_{ij}d_{ij} + \alpha_0 T + \sum_{i=1}^{I}\sum_{j=2}^{J}\alpha_{ij}d_{ij}T + \beta_0 C + \sum_{i=1}^{I}\sum_{j=2}^{J}\beta_{ij}d_{ij}C + ...$$

There are I categorical variables with J levels each. The dummy variables (d_{ij}) are specified for all but one level of each variable. Thus the constant term is modified by the γ_{ij}, the time coefficient is modified by α_{ij} and the cost coefficient is modified by β_{ij}. Thus if a particular category of a socio-economic variable was responsible for a lower sensitivity to cost relative to the arbitrarily omitted category, we would expect the appropriate β to be positive.

The variables covered by this segmentation analysis were:

- Journey purpose, of business, commuting, holidays/short breaks, visiting friends and relatives, and other leisure
- Leg of journey
- Time of travel
- Other occupants, distinguishing between adults and children
- Whether the respondent was the main driver
- The proportion of traffic on each route made up of HGVs
- The perceived reliability of each route, in terms of arrival time at destination, according to the categories of very reliable, reliable, usually reliable, sometimes unreliable, unreliable and very unreliable
- Whether the respondent had to be at their destination at a particular time
- Whether the toll would be paid by the respondent, shared with others or reimbursed by the employer
- Frequency of trip making in the M6T corridor
- Whether the decision to use the M6T or not was made prior to setting out, during the course of the journey, as the M6T was approached or whether the M6T was never even considered, and what influenced the decision if it was made during the course of the journey
- Attitudes to toll payment, including level of agreement with tolls on existing motorways, using tolls to replace fuel duty, tolls and new motorways and tolls as a sensible means of funding additional road infrastructure. Response scales were strongly agree, agree, neither agree nor disagree, disagree and strongly disagree
- Age group, collected as under 18, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74 and over 74.
- Gender
- Income group, obtained as annual household income before tax in bands of under £10k, £10-19k, £20-29k, £30-39k, £40-49k, £50-59k, £60-69k, £70-79k, £80-89k, £90-99k and £100k and over. Respondents could state that they did not wish to disclose their income.

Purpose

The initial analysis reported in chapter 6 found a disappointing degree of variation from journey purpose.

We might expect the toll coefficient to vary by purpose. Commuters would be frequent payers, and hence an income effect might be apparent whereupon they become more sensitive to toll. On the other hand, those on business journeys can be expected to be less sensitive to toll because they do not personally incur the cost.

There was variation in the toll coefficient for business travellers but, as with the results presented in chapter 6, this was very limited. Moreover, this disappeared when we specified a term indicating whether the employer pays. Including the latter was statistically superior to including the former.

With regard to the time coefficients, some perverse results were apparent. Business travellers had a lower time coefficient than leisure travellers, as also did commuters. Similarly, a significant route specific constant showed business travellers to be less favourable towards the M6T which again seems odd.

These effects are not confounded with a duration effect since they were still apparent when journey duration and income effects were specified. We therefore did not retain these journey purpose effects.

Where journey purpose had more of a reasonable impact was on the valuations of departing earlier and later. Commuters had a higher value of departing later as did business travellers although not to the same extent. However, there were no differences in earlier departure time valuations. Those travelling for holidays or short breaks and those visiting friends or relatives had lower values of both earlier and later departures but they were sufficiently similar that they could be combined into a single term representing adjustment time (Adj).

Leg of Journey

No discernible differences were apparent according to leg of journey

Time of Travel

There was no clear pattern in time parameters or ASCs according to time of travel categories.

Occupancy

Given that occupancy could conceivably impact on all the coefficients, we estimated separate models for alone and group travel. Both the toll and fuel coefficients were similar for the two categories (-0.0053 and -0.0049 for toll, -0.0059 and -0.0061 for fuel). Nor did the departure time coefficients differ, but there was a hint of variation in the ASCs and the travel time coefficients.

When we focussed on the ASCs, we found that those with other occupants were more inclined to use the M6T. This seems sensible, given that the time benefits will accrue to more people. However, as far as the marginal utility of time is concerned, there were no significant differences for those with children. There was a significant influence from those travelling with adults and those travelling with any others. The former was the stronger effect. It denoted that those travelling with other adults had a lower marginal utility of time, presumably because the company provided makes the travel time less onerous.

Main Driver

No differences were apparent between the parameters for whether the respondent was the main driver or not, although it would be difficult to detect any effect given that 96% of respondents were the main driver.

Proportion of HGVs

Whilst this does not vary for any individual within the SP exercise, it will vary across individuals and routes and therefore could explain different preferences for the M6T according to perceptions of how the traffic is made up of HGVs and indeed it could be expected to influence the marginal utility of time.

Given that the SP choice context in which differences in the proportion of HGVs is most likely to have an impact is that based on the M6T corridor (SP1B, SP8-1), initial analysis was restricted to these scenarios. However, no significant effect could be discerned.

Even when we broadened the analysis to include the existing M6T scenarios within the Stoke-M1 corridor (SP1A, SP1C, SP8-2), and additionally allowing for an impact on the marginal utility of time, no statistically significant impacts could be recovered.

Note however that an effect could be detected on actual choices, as discussed in section 11.3 below, whilst the SP4 exercise which specifically addresses the issue of HGVs, and which is reported in section 10.2, did obtain significant results.

Reliability

As with HGVs, this is a variable that will not vary across SP scenarios but will vary across individuals and routes. Since it relates to perceptions of arrival time reliability, the analysis need not be restricted to the routes within the M6T corridor. However, the perceptions relate to the currently existing routes, depicted in SP1A, SP1B, SP1C and SP8, and not to the other alternatives, and this is determined the interactions specified in the model.

Four categories of perceived reliability were found to have a significant effect. These were for very reliable, reliable, usually reliable/sometimes unreliable, and for a category covering those who did not know. A monotonic and statistically significant relationship of the expected form was apparent for the three first categories. A significant effect could not be estimated for the remaining category of unreliable.

Destination Arrival Time Constraint

This did not have a significant effect on preferences.

Toll Payment

Relative to a base of paying the toll oneself, there are three other categories. These were share the cost, another passenger paid or the cost is reimbursed by the employer.

The only significant effect was from whether the employer reimbursed the cost when, as expected, there was a lower sensitivity to cost, although not a zero effect as might

be expected. When we entered an additional interaction with business travel, this was not significant. The fact that the sensitivity to cost is not zero could be because respondents have not answered along these lines in the SP exercise, treating it as personal travel, or because they might not actually claim the toll back due to the transaction costs involved.

M6T Corridor Trip Frequency

This data was collected as a categorical variable, as in Table 4.18. Various combinations were tested. Whilst it was possible to estimate some significant coefficients, there was no consistent or theoretically expected pattern to the results.

When Made M6T Decision

Whilst there were a number of statistically significant effects here, particularly relating to factors that influenced decision making during the course of the journey, they tended to have the wrong sign.

The only significant effect that we believe should be persisted with here was the somewhat large aversion to using the M6T, as expressed through a route specific constant, for those who stated that in practice they never considered using the M6T. This effect is hardly surprising.

Attitudes to Toll Payment

The results of this analysis, although hard to implement in practice, were particularly disappointing. A number of significant but wrong sign effects were estimated. We have not persisted with these, and moreover we are not sure of the reasons underpinning these estimates.

The only significant and sensible effect was that those who strongly object or object to paying for tolls on an existing motorway had a less favourable constant relating to the M6T.

Age Group

We allowed the various age categories to impact on the ASCs, time coefficients and departure time coefficients, and the sensitivity to toll. The only significant effect was that those aged 65 or more had a stronger preference for the M6T.

Gender

Males were found to be less likely to use the M6T, in terms of an incremental impact on the route specific constants, and were less averse to changing their departure time. However no other gender specific effects were discerned.

Income

Whilst the results of a number of segmentation analyses have been disappointing, and this can raise doubts about the quality of SP data obtained, the results for the income segmentation are extremely encouraging and add to our confidence in the quality of the data.

We specified five income categories plus a category relating to those who did not wish to disclose their income relative to a base of those with incomes less than £20k

per annum. The five income categories other than the latter were £20-39k, £40-59k, £60-79K, £80-99K and £100k and over.

The effects on the fuel coefficient were often insignificant and did not by any means suggest a clear pattern. By contrast, the incremental effects on the toll coefficient were very impressive, denoting a monotonic reduction in the sensitivity to toll charge as income increased[3].

Table 7.21 reports models with statistically significant and expected sign coefficients for the incremental effects covering the socio-economic and trip characteristics. The incremental effects are denoted by italics. ASCs for the M6T for the 3 exercises containing information were far from significant, as was an incremental variation in time values, and are therefore not included.

Two models are reported according to whether trip duration is allowed to impact on the ASC or on the time coefficients. Reintroducing scales for the different SP designs made no material difference to the results.

Whilst the monotonic income effect is both encouraging and rare, it should be noted that the variation in the value of time with income will not be large. Indeed, when we converted the income categories into amounts of income the implied income elasticity was only 0.2.

The other effects also tend to be relatively minor, with the exception of, as might be expected, the variable denoting that the M6T would never be considered whilst differences in reliability across routes could have quite large effects not that far removed from some of the route specific constant. For example, a very reliable M6T compared to an unreliable M6 is equivalent to a journey time difference of around 11 minutes.

[3] Subsequent models, reported in Chapter 11, were able to discern a monotonic effect across 9 income groups.

Table 7.21: Impact of Socio-Economic Variables

$ASC_{M6TCorridor}$	1.2830 (8.4)	1.0985 (7.7)
$ASC_{M6TStoke\text{-}M1}$	1.7110 (11.0)	1.4896 (8.7)
$ASC_{M6TExtended}$	1.4477 (4.1)	1.3480 (3.9)
$ASC_{M6TLong}$	1.0090 (6.4)	0.7880 (4.9)
ASC_{NTH}	-1.2498 (6.5)	-1.2248 (6.3)
ASC_{STH}	-2.6989 (4.7)	-2.6700 (4.6)
ASC_{M6TNTH}	0.7339 (4.8)	0.7101 (4.5)
ASC_{M6TSTH}	-1.4945 (4.9)	-1.5115 (4.9)
ASC_{NTHSTH}	-1.2076 (3.3)	-1.1965 (3.3)
ASC_{ALL3}	1.4280 (7.4)	1.3930 (7.6)
ASC_{M6T}Never M6T	-1.1218 (6.1)	-1.1140 (6.2)
ASC_{M6T}Male	-0.3475 (3.3)	-0.3466 (3.3)
ASC_{M6T}Age65+	0.4664 (2.4)	0.4453 (2.3)
ASC_{M6T}Others	0.3529 (4.2)	0.2985 (3.5)
ASC_{M6T}ObjectTolls	-0.4769 (5.2)	-0.4791 (5.2)
Very Reliable	1.1384 (9.6)	1.1454 (9.8)
Reliable	0.7527 (6.5)	0.7646 (6.8)
Usually/Sometime Reliable	0.4602 (6.4)	0.4635 (6.6)
Unreliable	0.1776 (2.0)	0.1795 (2.0)
Acttim**λ	-	0.00046 (3.8)λ=1.3
$Time_{M6}$	-0.0509 (20.8)	-0.0588 (34.9)
$Time_{M6T}$	-0.0527 (15.5)	-0.0626 (14.0)
$Time_{A}$	-0.0561 (24.2)	-0.0639 (36.6)
$Time_{Bits}$	-0.0460 (14.2)	-0.0570 (20.5)
Time*Acttim**λ	-0.00011 (3.3) λ=1	-
Time-OthAdults	0.0068 (2.4)	0.0057 (2.1)
Earlier	-0.0257 (17.5)	-0.0254 (17.4)
Later	-0.0235 (11.7)	-0.0237 (11.9)
Later-EB	-0.0035 (2.2)	-0.0035 (2.2)
Later-Comm	-0.0064 (2.3)	-0.0066 (2.4)
Adj-HolsSB	0.0077 (2.6)	0.0081 (2.7)
Adj-VFR	0.0050 (2.7)	0.0053 (2.9)
Adj-Male	0.0036 (2.6)	0.0036 (2.5)
M6 delays due to	0.3819 (4.8)	0.4078 (5.1)
Exp 25m delays	1.1082 (6.5)	1.1423 (6.7)
No M6 Delays	-0.3668 (3.8)	-0.3450 (3.7)
Toll	-0.0062 (13.6)	-0.0063 (13.7)
Toll-Inc£20k-39k	0.0004 (1.1)	0.0004 (1.1)
Toll-Inc£40k-59k	0.0009 (2.0)	0.0009 (2.0)
Toll-Inc£60k-79k	0.0011 (2.6)	0.0011 (2.6)
Toll-Inc£90k-99k	0.0014 (3.2)	0.0014 (3.2)
Toll-Inc£100k+	0.0022 (4.6)	0.0022 (4.5)
Toll-IncDK	0.0006 (1.3)	0.0006 (1.3)
EmpPay	0.0014 (9.5)	0.0014 (9.5)
Toll>£3.50	-0.00080 (4.9)	-0.00078 (4.7)
Toll New motorway	0.0024 (4.5)	0.0025 (4.5)
Toll Extended M6T	0.00091 (2.7)	0.00093 (2.8)
FuelYes	-0.0057 (9.8)	-0.0057 (9.8)
ρ^2 (constant)	0.248	0.248
Log Likelihood	-20775.62	-20762.05

8. STATED PREFERENCE DESIGN AND PRESENTATIONAL ISSUES

Having addressed the hypotheses relating to time variation, cost variation and some of the preference heterogeneity set out in section 1.2, we now turn to a consideration of the SP specific hypotheses also listed there.

8.1 Credibility of Time and Fuel Costs

One of the fundamental requirements of the design of SP experiments is that the scenarios offered to individuals should be realistic. This has been a concern since the earliest applications. At its simplest level, credibility relates to the absolute values offered and the extent to which they could occur in practice. Credibility also extends to how the attribute values are combined, such that some attribute levels in themselves might be perceived as realistic but not when they are offered together. For example, respondents might find it incredible that a faster car is more fuel efficient or that a more unreliable route actually has a lower mean journey time.

When an SP exercise related to a currently available route (*SP1A, SP1B, SP1C*), we asked whether the journey times offered were regarded to be very credible, probably credible, not at all credible (too quick), or not at all credible (too slow). For those *SP1A* exercises containing fuel costs and the *SP1C* exercises, we asked whether the fuel costs offered were very credible, probably credible, not at all credible (too high) or not at all credible (too low). It is important to assess the credibility of fuel costs as well as journey time since there are doubts surrounding the extent to which fuel costs are perceived to vary by not greatly different routes and the extent to which they are taken into account in route choice. As a result, we have 822 individuals who reported on the credibility of both time and fuel costs providing 6361 choice observations.

There were five attributes that were rated in terms of their credibility. These were the journey times by the M6, M6T and A roads and the fuel costs by the M6 and M6T motorways (as a common fuel cost) and the A roads. Table 8.1 reports the results. The most common response was probably credible for all attributes. The pattern of responses does not vary greatly across the attributes.

Table 8.1: Reported Credibility

	Very	**Probably**	**Not at all (Too quick/ high)**	**Not at all (Too slow/ low)**	Missing
M6 Time	42 (5.1%)	544 (66.2%)	106 (12.9%)	45 (5.5%)	85 (10.3%)
M6T Time	153 (18.6%)	528 (64.2%)	41 (5.0%)	44 (5.4%)	56 (6.8%)
A Road Time	12 (1.5%)	505 (61.4%)	131 (15.9%)	50 (6.1%)	124 (15.1%)
M6/M6T Fuel	47 (5.7%)	586 (71.3%)	91 (11.1%)	47 (5.7%)	51 (6.2%)
A Road Fuel	27 (3.3%)	522 (63.5%)	56 (6.8%)	108 (13.1%)	109 (13.3%)

The degree of credibility might impact on the coefficient estimates. For example, if fuel costs are not believable they might be ignored whilst unrealistic journey times may be modified in decision making. However, there might be additional effects on all coefficients through the scale of the model. Given that a logit model's coefficients are inversely related to the error variance, we might expect a different scale where the lack of credibility has increased the amount of response error.

We have therefore allowed for different scales according to the pattern of credibility responses. The various combinations we have used are set out in Table 8.2. The largest category, accounting for 44% of individuals, is where all three times and both fuel costs are regarded to be very or probably credible. In contrast, only around 7% of the sample feels that all the times and fuel costs were not at all credible. The other category includes a significant amount of missing responses.

Table 8.2: Combinations of Credibility

		Freq	%
1	All very/probably credible	363	44.2
2	All not at all credible	56	6.8
3	Times credible but fuel not credible	39	4.7
4	Times not credible but fuel credible	11	1.3
5	Times credible	22	2.7
6	Times not credible	11	1.3
7	Fuel credible	141	17.2
8	Fuel not credible	65	7.9
9	Other	114	13.9
	Total	822	100

Table 8.3 reports various models which have examined the credibility issue. All but Model III allow the scale to vary across the categories specified in Table 8.2. Category 1, where all time and fuel attributes were reported to be very or probably credible, was specified as the base and all models are therefore estimated in units of residual deviation for this category. Scale factors less than one therefore indicate that the category has more residual variation than the base.

Model I allows the scale to vary across different categories of credibility and also the coefficients of relevant attributes to vary with perceived credibility. Note that because the fuel is the same for the two motorway routes the incremental credibility effect is the same for each.

The first thing to note in Model I is that reported credibility does not have a significant impact on the coefficient estimates. In stark contrast, the noticeable exception here is with those who did not actually report a credibility assessment (denoted as ‘missing’). These have larger, and generally significantly larger, coefficient estimates across our five attributes. Reasons for this are not immediately apparent. One possible but important factor is that those who have responded strategically, and who might be expected to be more sensitive to time and cost variations to varying degrees according to their strategic preferences, are precisely those who did not wish to answer the follow up question relating to credibility.

We expect the scales to be less than one, given that the base relates to category 1 where all times and costs are perceived as credible and therefore where we would expect least residual variation. This turned out to be the case, although there is no clear relationship between expected and estimated scale. For example, we would expect θ_2 to be lowest on the basis that all the times and costs are regarded to be not at all credible. However, even θ_2 is not far from 1 and indeed is not significantly different from 1.

Table 8.3: Impacts of Credibility on Scale and Coefficients

	I	II	III	IV
ASC_M6T	1.3602 (2.7)	1.3640 (2.7)	1.2512 (2.7)	1.3031 (2.6)
ASC_A	0.4414 (0.7)	0.4796 (0.8)	0.4385 (0.98	0.3656 (0.6)
$Time_{M6}$	-0.0674 (15.6)	-0.0637 (14.1)	-0.0599 (13.6)	-0.0636 (14.0)
$Time_{M6T}$	-0.0544 (12.4)	-0.0550 (14.0)	-0.0512 (17.7)	-0.0544 (15.0)
$Time_{A}$	-0.0681 (9.7)	-0.0736 (18.0)	-0.0691 (20.9)	-0.0731 (19.9)
$Time_{M6}$ (Very Credible)				
Probably Credible	0.0020 (0.8)	-	-	-
Not at All (Too quick)	0.0012 (0.4)	-	-	-
Not at All (Too slow)	0.0044 (1.5)	-	-	-
Missing	-0.0110 (2.7)			
$Time_{M6T}$ (Very Credible)				
Probably Credible	-0.0027 (1.6)	-	-	-
Not at All (Too quick)	-0.0020 (0.6)	-	-	-
Not at All (Too slow)	-0.0016 (0.4)	-	-	-
Missing	-0.0179 (3.3)			
$Time_{A}$ (Very Credible)				
Probably Credible	-0.0074 (1.1)	-	-	-
Not at All (Too quick)	-0.0070 (1.0)	-	-	-
Not at All (Too slow)	-0.0042 (0.6)	-	-	-
Missing	-0.0237 (2.6)	-	-	-
Time (Very Credible)				
Probably Credible	-	-0.0018 (1.5)	-0.0017 (1.5)	-
Not at All (Too quick)	-	-0.0019 (1.0)	-0.0018 (1.1)	-
Not at All (Too slow)	-	0.0007 (0.4)	0.0009 (0.5)	-
Missing		-0.0171 (4.0)	-0.0146 (4.5)	-
Toll	-0.0061 (24.2)	-0.0061 (24.2)	-0.0058 (37.7)	-0.0059 (22.1)
FuelYes	-0.0055 (5.0)	-0.0062 (6.9)	-0.0057 (7.1)	-0.0064 (9.6)
$Fuel_{M}$ (Very Credible)				
Probably Credible	-0.0003 (0.4)	-	-	-
Not at All (Too quick)	-0.0003 (0.5)	-	-	-
Not at All (Too slow)	-0.0005 (0.6)	-	-	-
Missing	-0.0016 (1.8)	-	-	-
$Fuel_{A}$ (Very Credible)				
Probably Credible	-0.0001 (0.2)	-	-	-
Not at All (Too quick)	0.0000 (0.1)	-	-	-
Not at All (Too slow)	0.0000 (0.1)	-	-	-
Missing	-0.0013 (1.4)	-	-	-
Fuel (Very Credible)				
Probably Credible	-	-0.0002 (0.4)	-0.0002 (0.4)	-
Not at All (Too high)	-	-0.0002 (0.4)	-0.0002 (0.4)	-
Not at All (Too low)	-	-0.0002 (0.3)	-0.0001 (0,3)	-
Missing	-	-0.0016 (2.0)	-0.0015 (2.1)	-
θ_1	1.0	1.0	1.0	1.0
θ_2	0.79 (1.5)	0.72 (2.4)	1.0	0.90 (0.9)
θ_3	0.87 (1.1)	0.88 (1.0)	1.0	0.88 (1.0)
θ_4	0.74 (0.8)	0.76 (0.8)	1.0	0.75 (0.9)
θ_5	0.77 (1.7)	0.77 (1.6)	1.0	0.73 (1.5)
θ_6	0.85 (0.5)	0.90 (0.4)	1.0	0.71 (0.8)
θ_7	0.89 (1.4)	0.90 (1.3)	1.0	0.91 (1.1)
θ_8	1.01 (0.1)	0.89 (1.4)	1.0	0.97 (0.4)
θ_9	0.91 (0.9)	1.00 (0.0)	1.0	0.99 (0.1)
Log Likelihood	-4146.3	-4155.0	-4164.3	-4254.2
ρ^2 (constants)	0.269	0.267	0.266	0.250
Observations	6361			

Note: The scale (θ) t ratio is specified relative to one.

Model II constrains the incremental credibility effects to be the same across the three time coefficients and two fuel coefficients in an attempt to obtain statistically significant outcomes. It can be seen that this procedure has not been successful and there remains no significant incremental effect other than for the missing category. θ_2 is a little lower, and is now significantly different from one and all the other scales are less than one. However, in general the scales do not differ greatly from one.

Model III constrains all the scales to equal one. It is clearly a worse fit than Model II where the scales are freely estimated. Even when the scales are constrained to one, and therefore any credibility effect is attributed to the incremental time and fuel coefficients, the latter remain far from significant.

Model IV removes the incremental effects on the time and fuel coefficients thereby leaving the scale factors to discern any credibility effect. Whilst there are some variations in the scale coefficients, and noticeably θ_2 is close to one, the results do not indicate any great impact of credibility on the scale coefficients.

In summary, we do not find convincing evidence to support the hypothesis that the perceived credibility of the presented attributes has a material influence on the relevant coefficient estimates or on model scale.

8.2 Presentation

The basic design for those in the Stoke-M1 corridor is given in Table 8.4. The choice is one between the M6, the M6T and an A road alternative. For realism, fuel cost is not varied between the M6 and M6T but a distance difference means it is sensible to offer a lower fuel cost on the A road. Note, however, that again for realism the eight choices offered to any respondent from the overall sixteen contained only one fuel cost difference of either £7.50 or £9. Given that the M6T motorway relates to only a portion of the 'M6T alternative', it is entirely reasonably to vary the journey time on the latter on account of varying levels of congestion on the M6 portion.

Table 8.4: Stoke-M1 Route Choice Design

M6 Time	M6T Time	A Road Time	M6T Toll	M6/M6T Fuel	A Road Fuel
105	90	110	£3.50	£10.00	£9.00
105	100	125	£7.50	£10.00	£9.00
105	75	135	£2.00	£10.00	£7.50
105	80	100	£5.00	£10.00	£7.50
120	90	125	£5.00	£10.00	£7.50
120	100	110	£2.00	£10.00	£7.50
120	75	100	£7.50	£10.00	£9.00
120	80	135	£3.50	£10.00	£9.00
130	90	135	£7.50	£10.00	£7.50
130	100	100	£3.50	£10.00	£7.50
130	75	110	£5.00	£10.00	£9.00
130	80	125	£2.00	£10.00	£9.00
140	90	100	£2.00	£10.00	£9.00
140	100	135	£5.00	£10.00	£9.00
140	75	125	£3.50	£10.00	£7.50
140	80	110	£7.50	£10.00	£7.50

To assist in the estimation of the fuel cost coefficient, a revised design was also used which differed only in terms of the fuel costs on the A road being £8.50 and £7.00.

Some respondents were offered these SP exercises as designed, that is, with absolute journey times characterising each route. Some others were offered the exact same design as in Table 8.4 but instead the M6T time was presented as minutes quicker than the absolute M6 time. Another set of respondents, amongst those with the slightly lower fuel costs, were presented the exact same design but with the M6 specified as minutes slower than the M6T time.

The basic design for the M6T corridor is given in Table 8.5. For the SP designs used to test the presentation issue, no A road alternative was offered. Motorists simply decide whether they would purchase the time saving offered by the M6T at the specified toll charge for that section of route where the M6T provides a substitute to the existing M6.

Table 8.5: M6T Corridor SP Design

M6 Time	M6T Time	M6T Toll
35	20	£3.50
35	20	£7.50
35	20	£2.00
35	20	£5.00
50	20	£5.00
50	20	£2.00
50	20	£7.50
50	20	£3.50
60	20	£7.50
60	20	£3.50
60	20	£5.00
60	20	£2.00
70	20	£2.00
70	20	£5.00
70	20	£3.50
70	20	£7.50

Note that the journey time by the M6T route is here fixed since we felt it unrealistic to vary it given the prevailing free flow traffic conditions.

Some respondents were offered the absolute journey times whilst others were presented with the exact same design but with the M6T specified as minutes quicker than the M6 or the M6 specified as minutes slower than the absolute M6T time.

Table 8.6 reports coefficients which indicate whether the presentation of journey times as differences impacts on the time coefficients for both the M6T corridor and the Stoke-M1 corridor. The goodness of fit measures are atypically large whilst the main effects are highly statistically significant.

Table 8.6: Time Coefficients and Presentation

	Stoke-M1 Corridor		M6T Corridor	
ASC_A	0.7041 (1.1)	0.6531 (1.0)	n.a.	n.a.
ASC_M6T	1.4474 (2.7)	1.3974 (2.6)	1.5356 (11.9)	1.4989 (11.1)
Time_M6 + M6 Slower	-0.0592 (12.1)	-0.0599 (11.9) 0.0036 (3.0)	-	-
Time_M6T + M6T Quicker	-0.0500 (13.2)	-0.0501 (13.0) 0.0034 (1.3)	-	-
Time_A	-0.0721 (23.3)	-0.0719 (23.6)	n.a.	n.a.
Time + M6T Quicker + M6 Slower	-	-	-0.0687 (16.0)	-0.0707 (16.8) 0.0160 (1.6) 0.0002 (0.1)
Toll	-0.0060 (25.1)	-0.0059 (26.3)	-0.0067 (15.3)	-0.0070 (18.4)
Fuel_Yes	-0.0065 (10.4)	-0.0065 (10.2)	n.a.	n.a.
$\theta_{Quicker}$	0.93 (0.7)	0.85 (1.4)	1.07 (0.6)	0.99 (0.1)
θ_{Slower}	0.93 (0.9)	1.03 (0.4)	1.07 (0.5)	1.06 (0.5)
Log Likelihood	-3455.0	-3447.3	-1732.1	-1726.7
ρ^2	0.257	0.258	0.300	0.302
Observations	5192		3970	

Note: The scale (θ) t ratio is specified relative to one.

The θ coefficients allow for different scales of the data relating to quicker and slower journey times. It can be seen that for both the Stoke-M1 and M6T corridor models there is little variation in the scales.

The toll coefficient and the fuel coefficient specified for those who stated that they account for fuel in decision making are encouraging similar whilst a value of motorway time of around 10 pence per minute is highly plausible. As might be expected, the A road has a higher level of travel time disutility.

Incremental effects are specified for the time coefficients for the situations where quicker and slower times were presented. In the case of the M6T corridor, the constant journey time on the M6T means that we cannot distinguish the time coefficient by route.

On the Stoke-M1 corridor, the time coefficient is significantly different when time is presented as minutes slower on the M6 but it is only 6% smaller. On the other hand, the incremental effect for quicker times on the M6T is not statistically significant.

Turning to the results for the M6T corridor, neither of the incremental coefficients relating to the M6T presented as quicker or the M6 presented as slower are statistically significant.

There is no compelling evidence that the time coefficients vary according to whether time is presented in absolute or difference form. However, we might hypothesise that the presence of size effects are more likely where differences are presented since more emphasis is placed upon the size of the time variation.

The models in Table 8.7, for the Stoke-M1 corridor, and representing quicker ($\theta_{Quicker}$) and slower (θ_{Slower}) time presentations significantly different from one. Table 8.8, for the M6T corridor, are specified in terms of differences. The purpose of this is so that we can examine whether the unit value of time depends upon the size of a time

difference, by specifying a time difference squared, and in turn whether presenting times as differences induces a size effect.

Model I in Table 8.7 is a standard model for the Stoke-M1 SP data. The $Time_{M6\text{-}M6T}$ difference is specified relative to the M6T alternative and hence its coefficient should be positive. Since the $Time_{A\text{-}M6}$ term relates to the A Road alternative its coefficient should be negative. In all the models, the goodness of fit is high and the scale factors are little different from one.

Table 8.7: Stoke-M1 Corridor: Presentation and Size Effects

	I	II	III
ASC_M6T	2.4559 (20.0)	2.7357 (16.2)	2.7154 (16.2)
ASC_A	-0.9015 (8.3)	-0.8842 (8.0)	-0.8769 (8.0)
$Time_{M6\text{-}M6T}$	0.0539 (17.7)	0.0357 (6.6)	0.0343 (5.4)
$Time_{A\text{-}M6}$	-0.0713 (23.2)	-0.0747 (16.4)	-0.0751 (17.2)
$Time_{M6\text{-}M6T}^2$	-	0.00026 (3.2)	-
$Time_{A\text{-}M6}^2$	-	-0.00013 (0.9)	-
$Time_{M6\text{-}M6T}^2$-Absolute	-	-	0.00031 (3.4)
$Time_{M6\text{-}M6T}^2$-Quicker	-	-	0.00044 (3.5)
$Time_{M6\text{-}M6T}^2$-Slower	-	-	0.00002 (0.3)
$Time_{A\text{-}M6}^2$-Absolute	-	-	-0.00004 (0.2)
$Time_{A\text{-}M6}^2$-Slower	-	-	-0.00010 (3.5)
Toll	-0.0060 (24.9)	-0.0060 (25.2)	-0.0060 (25.5)
FuelYes	-0.0066 (10.5)	-0.0065 (10.6)	-0.0065 (10.5)
$\theta_{Quicker}$	0.94 (0.6)	0.94 (0.6)	0.87 (1.3)
θ_{Slower}	0.93 (0.9)	0.92 (1.1)	1.08 (0.9)
Log Likelihood	-3449.2	-3446.9	-3435.5
ρ^2	0.258	0.258	0.261
Observations	5192		

Note: The scale (θ) t ratio is specified relative to one.

Model II contains the two time differences additionally as squared terms. The results indicate that as the time saving offered by the M6T over the M6 becomes larger then the unit value of time increases. A 10 minute time saving adds 3% to the value of time whilst a 60 minute saving adds 21%. In contrast, the much smaller differences between the A road and M6 do not impact on the unit value of time.

Model III allows the size effect to vary according to presentation, bearing in mind that for the A road and M6 difference the only presentational difference was for when the M6 was specified to be slower than the M6T. Hence for the $Time_{A\text{-}M6}$ difference there is no quicker scenario.

As far as the time difference between the M6 and M6T is concerned, there is an apparent size effect for the absolute time presentation and also a similar effect for the scenarios where the M6T was presented as quicker than the M6. However, no such effect is apparent for when the M6 is presented as slower.

With regard to the difference between the A road and the M6, there is only one presentational effect and that is whether the M6 was presented as slower than the M6T. Whilst the effect is significant, it is minor.

The scales relating to the presentation of quicker ($\theta_{Quicker}$) and slower (θ_{Slower}) times are insignificantly different from one in all models.
representing quicker ($\theta_{Quicker}$) and slower (θ_{Slower}) time presentations significantly different from one.

Table 8.8 reports similar analysis for the M6T corridor, where the time difference is solely between the M6 and M6T. Model I is the standard model which does not contain any size effects. Such effects are permissible in Model II but are not significant. Model III distinguishes the size effect according to whether the design offers absolute times, the M6T quicker than the M6 or the M6 slower than the M6T. It can be seen that none of these three dimensions have a statistically significant influence. Nor are the scales representing quicker ($\theta_{Quicker}$) and slower (θ_{Slower}) time presentations significantly different from one.

Table 8.8: M6T Corridor: Presentation and Size Effects

	I	II	III
ASC_M6T	1.5356 (11.9)	1.2511 (5.8)	1.2528 (6.0)
$Time_{M6\text{-}M6T}$	0.0687 (16.0)	0.0907 (5.2)	0.0902 (4.8)
$Time_{M6\text{-}M6T}^2$	-	-0.00035 (1.4)	-
$Time_{M6\text{-}M6T}^2$-Absolute	-	-	-0.00034 (1.2)
$Time_{M6\text{-}M6T}^2$-Quicker	-	-	-0.00029 (1.2)
$Time_{M6\text{-}M6T}^2$-Slower	-	-	-0.00038 (1.5)
Toll	-0.0067 (15,3)	-0.0068 (15.3)	-0.0067 (15.6)
$\theta_{Quicker}$	1.07 (0.6)	1.07 (0.6)	1.05 (0.4)
θ_{Slower}	1.07 (0.5)	1.06 (0.5)	1.09 (0.7)
Log Likelihood	-1732.1	-1731.4	-1730.7
ρ^2	0.300	0.300	0.300
Observations	3970		

Note: The scale (θ) t ratio is specified relative to one.

In summary, we find no convincing evidence to support a size effect as a function of the means of presentation.

8.3 Design Dimensions

The wide range of SP exercises conducted here allow testing of a wide range of design dimensions. These relate to the number of alternatives offered and the number of attributes per alternative.

Given the attention paid to other aspects of this study, we are not in a position to report models which test the effect of design dimensions. We intend to conduct such analysis and report it at a suitable opportunity.

8.4 Summary

This chapter has focussed on two particular issues. These are whether the presentation of attributes as differences rather than absolute values impacts on the results and whether there is any effect on model parameters from the degree of credibility with which the attribute levels are regarded. The findings of this analysis are:

- There is no evidence to support variations in the time coefficients according to whether time is presented in absolute or difference form. Nor does the means of presentation impact on the scale of the model.

- Presenting differences does not induce size effects that are not present when absolute values are offered

- The perceived credibility of attributes does not impact on their coefficient estimates and does not have a large impact on the scale of the model.

However, we note two points. Firstly, only one attribute was here presented in difference form. It is not uncommon that SP exercises present several attributes in difference form and the effect on appropriate coefficients and model scales might then be different to the findings reported here. Secondly, it is of course possible that credibility varies across SP scenarios, whereas we have here simply asked for an overall evaluation across all scenarios.

9. TRAVEL TIME VARIABILITY

The travel time variability SP exercise offered choices between travelling via the M6T with a low level of travel time variability but paying a toll and the M6 with on average longer travel times and a much greater spread. Five travel times were used to represent the distribution of travel times on each route. From these, the mean and standard deviation of travel time can be calculated for each route. Details of the SP designs and the precise wording and presentation used are given in section 3.1 and Appendix 7.

We did not pool this data with the other route choice data on the grounds of the limited number of common variables, particularly since respondents might react differently in an SP exercise to a single travel time of X minutes and a mean travel time of X minutes.

Five separate SP exercises were offered according to the distance bands of 2½ hours (SP6-1), 1½ hours (SP6-2), 1 hour (SP6-3), 3½ hours (SP6-4) and 4½ hours (SP6-5).

The results for each SP type are reported in Table 9.1. The toll coefficient is precisely estimated and varies little across the different models. It is very much in line with the toll coefficients estimated in the main route choice models reported previously. However, in other respects the results are very poor.

Table 9.1: Travel Time Variability Results By Design

	SP6-1	**SP6-2**	**SP6-3**	**SP6-4**	**SP6-5**
ASC_M6T	3.3731 (5.0)	3.4193 (7.2)	1.8289 (6.6)	2.9564 (5.7)	2.6836 (6.4)
Mean Time	-0.0049 (0.5)	0.0050 (0.6)	-0.0609 (5.0)	-0.0026 (0.4)	-0.0120 (2.1)
SD Time	-0.0094 (0.9)	-0.0015 (0.2)	0.0334 (3.1)	-0.0077 (0.9)	0.0077 (1.2)
Toll	-0.0054 (8.0)	-0.0043 (7.7)	-0.0042 (8.7)	-0.0051(10.1)	-0.0049 (9.0)
EBToll	-0.0054 (0.9)	0.0007 (1.4)	0.0001 (0.2)	0.0002 (0.2)	0.0007 (1.1)
Monthly	1.0570 (3.7)	0.9894 (3.4)	0.4223 (1.9)	0.1940 (0.5)	0.1001 (0.4)
Fortnightly	-0.1032 (0.4)	-0.2579 (1.1)	-0.1982 (0.9)	-0.4558 (1.8)	-0.6659 (2.8)
Weekly	0.2547 (1.0)	0.3607 (1.8)	0.0588 (0.3)	-0.6015 (1.8)	-0.6115 (2.7)
ρ^2 (constants)	0.187	0.136	0.137	0.172	0.162
Observations	704	946	1046	921	1070

A noticeable feature of the results is the very large constant favouring the M6T, generally in excess of £5. For a value of time of 10 pence per minute, this implies ASCs of over 50 minutes, far in excess of those previously estimated. The cause of these implausibly large ASCs seems to be large correlations between the toll coefficient and the ASC exceeding -0.8. Nor are the results for the large delays in

line with expectations. The base category is a large delay every 3 months. The weekly large delay is only significant in one model whilst the monthly large delay is always wrong sign. The coefficient estimates for the mean and standard deviation of time are mainly insignificant. Indeed, when the standard deviation coefficient estimate is most significant it is actually wrong sign!

Table 9.2 reports a single model pooled across the five SP exercises. The scales do not vary greatly across the different data sets.

The pattern of results is hardly surprising given the results in Table 9.1. The ASC in Model I is very large and highly significant whilst the standard deviation is not significant and the results for the large delays are poor. The mean time coefficient has a low t ratio for the amount of data available and the implied value of time of 2.25 pence per minute is very low. The results were little different when non-traders were removed.

Given the large correlation between the toll and the ASC, Model II removes the latter term altogether. Although the goodness of fit is reduced somewhat, many properties of the model are somewhat better. The time coefficient is much more precisely estimated and the value of time of 11.8 pence per minute is very much in line with the findings of the standard route choice models reported previously. The standard deviation of time is equal to 0.46 minutes of travel time. Although lower than an oft-cited value of around 0.7 (Bates et al., 2001), this figure does not seem unreasonable. The results for the large delays are now a little more plausible but, as with other models reported in this study, the incremental effect of employer's business on the toll coefficient (EBToll) is minor and turns out to be statistically insignificant.

Table 9.2: Travel Time Variability: Pooled Model

	I	II
ASC_M6T	2.9941 (9.9)	0.0
Mean Time	-0.0115 (2.6)	-0.0309 (6.7)
SD Time	0.0018 (0.5)	-0.0142 (4.4)
Toll	-0.0051 (10.6)	-0.0026 (7.6)
EBToll	0.0005 (1.8)	0.0005 (1.8)
Monthly	0.5836 (3.8)	-0.0777 (0.8)
Fortnightly	-0.3149 (3.0)	-0.7571 (6,5)
Weekly	-0.1211 (1.3)	-0.6858 (7.2)
θ_{sp6-1}	1.0	1.0
θ_{sp6-2}	0.86 (1.1)	0.87 (1.0)
θ_{sp6-3}	0.79 (1.7)	1.36 (1.2)
θ_{sp6-4}	0.97 (0.3)	1.03 (0.2)
θ_{sp6-5}	0.98 (0.2)	1.06 (0.5)
ρ^2 (constants)	0.146	0.084
Observations	4687	4687

Note: The scale (θ) t ratio is specified relative to one. We were not able to obtain a respectable model for an ASC constrained to approximate the values obtained in the standard route choice models.

Whilst these results without the ASC are reasonable in several respects, they are conditional upon the very unreasonable assumption, particularly given previous evidence reported here, that there is no ASC in favour of the M6T.

Given the problems encountered here, we experimented with piecewise estimation where different coefficient estimates were obtained for different levels of mean travel time and also variability of travel time. This did not provide any insights into the pattern of results obtained above. Nor did segmenting by journey purpose lead to any sign of improved results. Our view was that it was more productive to concentrate on the many other aspects of this study than to commit resources into any further more detailed investigation of this data set.

Our conclusion here is that Model II in Table 9.2 is the best that can be obtained in terms of the valuations of mean and standard deviation of travel time. Nonetheless, we must concede that it seems likely that respondents have not related to this relatively complex SP exercise in the manner that we would have wished and the exercise has essentially failed. This is disappointing because we here have a realistic real-world trade-off context where respondents can pay for reliability, by choosing the M6T, which is not typically present in other such studies.

10. TYPE OF TRAVEL TIME AND ROAD CONDITIONS

We now turn to the abstract choice exercises which examined a range of different road and travel conditions. These were covered by exercises SP3, SP4 and SP5.

10.1 Type of Time

This SP exercise (SP3) examined the relative disutility of time spent in different traffic conditions. Details of the SP designs and the precise wording and presentation used are given in section 3.3 and Appendices 10 and 11.

Eight different SP exercises were used, offering trade-offs between the same type of time for the whole journey and a mixture of two other types of time as follows:

- Free flowing and stop start versus light congestion: 15 miles (SP3-1A)
- Free flowing and stop start versus light congestion: 45 miles (SP3-1B)
- Busy and gridlock versus heavy congestions: 15 miles (SP3-2A)
- Busy and gridlock versus heavy congestions: 45 miles (SP3-2B)
- Busy and stop start versus light congestions: 15 miles (SP3-3A)
- Busy and stop start versus light congestions: 45 miles (SP3-3B)
- Free flowing and heavy congestion versus busy: 15 miles (SP3-4A)
- Free flowing and heavy congestion versus busy: 45 miles (SP3-4B)

We adopted this approach to avoid offering too many types of time in any one scenario, which might have proved too difficult, and to provide a clear contrast between a specific type of time for certain and two different types of time, one of which was expected to be valued more highly and one less highly than the type of time offered for certain.

There were 8426 valid observations obtained from 956 individuals.
Table 10.1 presents the results of the 8 separate models. The rows list the types of time in order of expected disutility.

The goodness of fit statistics ($\rho^2(C)$) are very much in line with those typically achieved by SP travel choice models. All the coefficient estimates are of the correct sign and are generally highly significant.

However, in only 3 cases (SP3-2A, SP3-3A, SP3-2B) do the coefficient estimates exhibit the expected relativities. It is noticeable that the coefficient estimates for the longer journeys tend to be somewhat lower, denoting that there is more residual variation in these SP exercises. The $\rho^2(C)$ statistics mirror this, but it is not clear what has caused this pattern of results.

Table 10.1: Separate Models for Types of Time (SP3) SP (Whole Sample)

	SP3-1A 15 miles	**SP3-2A 15 miles**	**SP3-3A 15 miles**	**SP3-4A 15 miles**	**SP3-1B 45 miles**	**SP3-2B 45 miles**	**SP3-3B 45 miles**	**SP3-4B 45 miles**
Free Flow	-0.0998 (6.7)			-0.0857 (5.5)	-0.0433 (4.4)			-0.0351 (4.4)
Busy		-0.0429 (2.8)	-0.1105 (8.4)	-0.1771 (16.6)		-0.0445 (6.3)	-0.0355 (4.3)	-0.0453 (9.1)
Light Cong	-0.1546 (16,0)		-0.1452 (16.9(		-0.0528 (10.5)		-0.0368 (7.0)	
Heavy Cong		-0.1034 (10.2)		-0.1646 (9.5)		-0.0522 (11.3)		-0.0349 (2.3)
Stop Start	-0.1307 (8.5)		-0.1457 (10.8)		-0.0401 (2.6)		-0.0225 (1.4)	
Grid Lock		-0.1287 (7,9)				-0.0609 (4.4)		
Obs	1240	937	1468	1196	931	1019	726	909
%A:%B	67:33	58:42	57:43	70:30	67:33	54:46	60:40	67:33
ρ^2(C)	0.140	0.080	0.150	0.172	0.092	0.098	0.051	0.063

Inspection of the data revealed a significant number of non-traders in the sense that they always chose the same option in 9 choice scenarios. There is no obvious dominance of one option over the other in our designs, and nor is there any compelling reason to always prefer one alternative over the other as might exist in a mode choice context due to strong mode specific preferences.

We find it hard to believe that anyone should always prefer one particular option and we therefore proceeded to remove these non-traders.

Removing the non-traders reduces the sample by 37% to 5306 choice observations obtained from 618 individuals. 235 individuals had always chosen option A and 103 had always chosen option B. The results for the 8 separate models are reported in

Table 10.2.

What is noticeable is the considerable improvement in model fit. The goodness of fit statistics are generally rather impressive. As a result, the t ratios of the coefficient estimates tend to be better even though there has been an appreciable reduction in sample size.

We also now obtain rather better behaved results, with the expected monotonic effect amongst the coefficient estimates apparent in five of the eight cases (SP3-2A, SP3-3A, SP3-4A, SP3-2B and SP3-4B) and not far removed from this in two other cases.

Table 10.2: Separate Models for Types of Time (SP3) SP (Exclude Non Traders)

	SP3-1A 15 miles	**SP3-2A 15 miles**	**SP3-3A 15 miles**	**SP3-4A 15 miles**	**SP3-1B 45 miles**	**SP3-2B 45 miles**	**SP3-3B 45 miles**	**SP3-4B 45 miles**
Free Flow	-0.1634 (8.0)			-0.1380 (6.8)	-0.0843 (7.1)			-0.0749 (6.4)
Busy		-0.0916 (4.1)	-0.1707 (9.4)	-0.2452 (16.8)		-0.0851 (7.9)	-0.0714 (5.7)	-0.0787 (10.4)
Light Cong	-0.2332 (16.9)		-0.2322 (18.9)		-0.0872 (11.7)		-0.0661 (8.4)	
Heavy Cong		-0.1788 (11.4)		-0.2752 (11.0)		-0.0938 (12.9)		-0.0880 (3.8)
Stop Start	-0.2283 (10.1)		-0.2414 (12.0)		-0.0792 (3.8)		-0.0448 (2.0)	
Grid Lock		-0.2591 (10.0)				-0.1079 (5.4)		
Obs	821	556	1020	805	552	652	407	493
%A:%B	64:36	53:47	60:40	64:36	57:43	53:47	55:45	55:45
ρ^2(C)	0.319	0.238	0.330	0.345	0.235	0.259	0.155	0.199

We proceeded to combine the results into a single model to obtain a unique set of relativities and obtain the benefit of estimating to a much larger data set than for any of the separate models.

Table 10.3 presents pooled models. The types of time are in order of expected disutility and scales of each of the separate exercises are represented by the θ terms, with that for SP3-1A arbitrarily set to one.

Model I, despite having a good fit and highly significant coefficient estimates, does not yield results for the time coefficients which are consistent with expectations or with the previous results. What is noticeable is that the scale for the longer journeys (SP3-1B, SP3-2B, SP3-3B, SP3-4B) is somewhat lower, implying larger residual variation.

Model II introduces a constant for alternative A (ASC-A). In SP exercises with unlabelled alternatives, we do not generally expect a preference for one option over the other all else equal. However, a net preference for option A, which contains the two types of time, was apparent. When this constant is introduced, the relative magnitude of the time coefficients becomes more sensible.

Table 10.3: Pooled Types of Time Model – Non Traders Omitted

	I	II	III	IV
ASC-A	-	0.8264 (7.5)	-	-
ASC-FFBU	-	-	1.7620 (7.3)	1.5020 (8.3)
ASC-LCHC	-	-	1.1500 (6.1)	0.9965 (7.4)
Free Flow	-0.2031 (14.4)	-0.1816 (14.1)	-0.1924 (13.8)	-0.1826 (21.9)
Busy	-0.2258 (14.8)	-0.1937 (13.9)	-0.2019 (13.9)	-0.1885 (23.7)
Light Congestion	-0.2327 (17.2)	-0.2055 (16.4)	-0.2131 (16.1)	-0.2025 (25.8)
Heavy Congestion	-0.2258 (13.3)	-0.2310 (13.2)	-0.2518 (11.7)	-0.2225 (22.5)
Stop Start	-0.2050 (12.9)	-0.2424 (13.9)	-0.2311 (13.1)	-0.2163 (16.2)
Grid Lock	-0.2255 (9.0)	-0.3358 (9.9)	-0.3642 (9.0)	-0.3047 (14.3)
θ_{SP3-1A}	1.00	1.00	1.00	1.00
θ_{SP3-1B}	0.32 (17.9)	0.40 (13.8)	0.39 (14.4)	0.39 (26.4)
θ_{SP3-2A}	0.75 (2.8)	0.69 (3.8)	0.66 (4.2)	1.00
θ_{SP3-2B}	0.41 (13.1)	0.40 (13.6)	0.36 (14.7)	0.39 (26.4)
θ_{SP3-3A}	0.99 (0.1)	0.96 (0.4)	0.97 (0.4)	1.00
θ_{SP3-3B}	0.28 (19.4)	0.32 (16.4)	0.30 (17.1)	0.39 (26.4)
θ_{SP3-4A}	1.04 (0.5)	1.08 (0.9)	0.99 (0.0)	1.00
θ_{SP3-4B}	0.33 (16.7)	0.39 (12.5	0.38 (13.3)	0.39 (26.4)
Log-Likelihood	-2648.82	-2614.76	-2611.70	-2611.70
ρ^2 (constants)	0.265	0.274	0.275	0.272
Observations	5306			

Note: t ratio of the scale parameters (θ's) are calculated with respect to one.

We tried to give some meaning to this unexpected constant, particularly since its inclusion improves the pattern of results. We might be prepared to accept a preference for the option with only a single type of time on the grounds that this is easier to evaluate or due to a 'risk aversion' type preference for a single type of time rather than two quite different types of time. However, this would reflect itself in a preference for option B rather than A. Note, however, that ASC-A is not particularly large, equivalent to 4.6 minutes of free flow time and 2.5 minutes of grid lock time.

We explored whether instead there was any constant utility associated with a particular form of time, so for example, underlying a preference for free flow time simply where it is present but independent of the utility associated with the amount of free flow time. It emerged that constant preferences were apparent for the different types of time, with stronger preferences as might be expected for the better driving conditions. The best model is reported as Model III, where there are ASCs for free flow and busy (ASC-FFBU) and for light and heavy congestion (ASC-LCHC) relative to the two other categories of stop-start and gridlock.

The preference for free flow and busy is equivalent to 9.2 minutes of free flow time or 4.8 minutes of grid lock time. The corresponding figures for the preference for light and heavy congestion were 6.0 and 3.2 minutes. Despite that this constant effect

could detract from the strength of the variation in time values, the results in Model III look quite sensible. Model III is statistically superior to both Models I and II. Model IV constrains the scales to be the same within the shorter and longer SP exercises. Whilst there is a pattern here suggested, the constraint does not improve the model fit.

Table 10.4 expresses the time disutility's relative to a base of free flow time for preferred Model III. The valuations increase throughout except for the valuation of stop-start time. There is little difference between free flow time, busy and light congestion. Heavy congestion has a relatively high premium whilst gridlock is particularly disliked.

Where a distinction is made between different types of car travel time, previous studies tend to limit it to time spent in free flow conditions and time spent in congested traffic conditions. A review of British evidence relating to the relative valuation of time spent in congested and free flow traffic (Wardman, 2001a), covering 21 observations, found the ratio to average 1.48 with a standard error of 0.07. The range was between 1.04 and 2.01. The results presented here are consistent with the review evidence which seems to relate most closely to heavy congested conditions.

Table 10.4: Time Relativities

	Model III
Free Flow	1.00
Busy	1.05
Light Congestion	1.11
Heavy Congestion	1.31
Stop Start	1.20
Grid Lock	1.89

10.2 Travel Conditions: HGVs, Lane Width, Speed Cameras, Information

What we have termed SP4 was an abstract choice context that offered trade-offs between journey time, the proportion of HGVs on the route, lane width, speed cameras and information provision. Details of the SP designs and the precise wording and presentation used are given in section 3.3 and Appendix 12. Defining terms we have:

- Time: Journey time in minutes
- HGV: Proportion of HGVs (eg, 25% is represented as 25)
- HGV*Time: Interaction of HGV and time
- Info0: No information provided
- Info1: Information on whether delays
- Info2: Information on whether delays and cause of delays
- Info3: Information on amount of delays and cause
- Wide: Dummy variable for wide (3.75m) lane
- Wide*Time: Interaction of Wide and Time
- Standard: Base category of a standard (3.35m) lane
- Narrow: Dummy variable for narrow (3.0m) lane relative to standard
- Narrow*Time: Interaction of Narrow and Time
- Police Cam: Dummy variable denoting presence of police speed cameras

- SC0: No speed cameras
- SC1: 1 speed camera on the journey
- SC2: 2 speed cameras on the journey
- SC3: 3 speed cameras on the journey
- SC4: 4 speed cameras on the journey
- SC: number of speed cameras on the journey

Table 10.5 reports the two separate models for the shorter (SP4-1) and longer (SP4-2) distance trips. The goodness of fit for the shorter distance is somewhat better, and the lesser residual variation can be expected to cause it to have larger coefficients. This turns out to be the case for Time and HGV which are both highly significant in each model. The preference for wide lanes is apparent, although not significant in either model, whilst narrower lanes are disliked.

The information coefficients seem sensible for SP4-1 but are hampered by insignificance in SP4-2. There is evidence that speed cameras are disliked although the ordering of the coefficients is not quite as we would have wished.

Table 10.5: Separate Travel Conditions (SP4) Models

	SP4-1	**SP4-2**
Time	-0.1358 (12.9)	-0.0708 (10.9)
HGV	-0.0561 (7.7)	-0.0383 (7.3)
Info0	Base	Base
Info1	-0.0634 (0.3)	-0.0504 (0.5)
Info2	0.4764 (3.3)	-0.0416 (0.4)
Info3	0.5738 (3.5)	0.1713 (1.5)
Wide	0.1976 (1.3)	0.0871 (1.6)
Standard	Base	Base
Narrow	-0.2082 (1.7)	-0.3283 (3.5)
Police Cam	-0.4265 (2.3)	-0.6819 (5.7)
SC0	Base	Base
SC1	-0.4524 (2.1)	-
SC2		-0.5640 (3.1)
SC3	-1.1202 (5.0)	
SC4		-0.3593 (1.8)
ρ^2 (c)	0.241	0.109
Observations	1057	1651
Option A	486 (46%)	793 (48%)
Option B	571 (54%)	858 (52%)

Table 10.6 reports the findings of the models that are estimated on data pooled across the shorter distance (SP4-1) and longer distance (SP4-2) exercises. $\theta_{SP4\text{-}2}$ indicates the extent to which the scale for the longer distance exercises differs from the shorter distance. As expected, the scale indicates more residual variation in the longer distance exercise.

Model I is based on the 2708 SP choices provided by the 341 individuals. The coefficients for Time and HGV are highly significant. Information on whether there are delays (Info1) is not significant whilst information on whether there are delays and the causes of them (Info2) and information on the amount of delay expected and its

causes (Info3) have similar coefficients. The latter two are valued at around 2.7 minutes of travel time.

Table 10.6: Pooled Travel Conditions (SP4) Models

	I	II	III	IV
Time	-0.1313 (11.9)	-0.1596(12.6)	-0.1483 (12.5)	-0.1450 (13.3)
HGV	-0.0627 (9.0)	-0.0627 (8.5)	-	-
HGV*Time	-	-	-0.0010 (4.5)	-0.0009 (5.1)
Info 0	Base	Base	Base	Base
Info1	-0.0242 (0.2)	0.0862 (1.2)	-0.0688 (0.5)	-0.0240 (0.2)
Info2	0.3528 (3.0)	0.4262 (3.7)	0.1449 (1.8)	0.1295 (2.1)
Info3	0.3701 (3.3)	0.4266 (3.3)	0.2888 (2.6)	0.2372 (2.9)
Wide	0.1610 (1.5)	0.1934 (1.9)	-	-
Wide*Time		-	0.0077 (3.3)	0.0084 (3.5)
Standard	Base	Base	Base	Base
Narrow	-0.3613 (3.1)	-0.5168 (4.1)	-	-
Narrow*Time		-	-0.0134 (4.1)	-0.0144 (4.6)
Police Camera	-0.7714 (5.6)	-0.9396 (5.2)	-0.3728 (1.9)	-0.4038 (2.2)
SC0	Base	Base	Base	Base
SC1	-0.8250 (4.1)	-0.8497 (3.7)	-0.1591 (1.5)	-
SC2	-0.5824 (2.3)	-0.5146 (1.8)	-0.5416 (1.4)	-
SC3	-1.3810 (6.2)	-1.4313 (5.3)	-0.8012 (3.5)	-
SC4	-0.2829 (0.9)	-0.3219 (1.2)	-0.4696 (1.5)	-
SC	-	-	-	-0.1829 (2.7)
θ_{SP4-2}	0.51 (8.2)	0.59 (5.3)	0.59 (4.7)	0.62 (3.9)
Log Likelihood	-1597.6	-1243.2	-1248.5	-1258.1
ρ^2 (c)	0.147	0.214	0.213	0.209
Observations	2708	2316		
A (SP4-1)	486 (18%)	422 (18%)		
B (SP4-1)	571 (21%)	555 (24%)		
A (SP4-2)	793 (29%)	593 (26%)		
B (SP4-2)	858 (32%)	746 (32%)		

Note: t ratio of scale (θ) with respect to one.

Police speed cameras are disliked as too are the number speed cameras. The latter effect is not monotonic. The reason for this might be the different scale of the two SP exercises, since 1 (SC1) and 3 (SC3) speed cameras related to the shorter distance exercise and 2 (SC2) and 4 (SC4) related to the longer distance exercise but we cannot specify common parameters across exercises given this dummy variable specification. Nonetheless, it is disappointing that SC4 denotes a lesser impact than SC2.

Model II and the other two models are based on a data set which removes those who always chose the same option in all the choice scenarios. Model II has a somewhat better fit than Model I but otherwise is not greatly different. A one percentage point increase in HGVs is valued at 0.39 minutes whilst, in the context of this trip, wide lanes are valued at 1.21 minutes better than standard lanes and narrow lanes are valued at 3.23 minutes worse than standard lanes. Thus there is a greater dislike of the narrower lanes than preference for the wider lanes.

Instead of constraining HGVs and lane width to have the same valuation regardless of journey duration, which is not realistic, Model III specifies interaction terms which allow these valuations to be time dependent. This does not achieve as good a fit as Model II and the impact of information is reduced. .The value of time is increased by 0.7% for every one percentage point increase in the proportion of HGVs, wide lanes reduce the value of time by 5% and narrow lanes increase the value of time by 9%. These results seem sensible, However, despite being correct sign and significant, the results for speed cameras remain disappointing. Despite being statistically inferior to Model II, we have a preference for it on the grounds of its inherently more reasonable properties.

As a result of the poor results for speed cameras, we estimated Model IV which specifies a variable denoting the number of speed cameras which imposes the desired monotonic effect. This model returns a valuation of an additional speed camera on a journey to be equal to 1.26 minutes.

10.3 Travel Conditions: Road Surface, Lighting and Lanes

The final abstract choice SP exercise (SP5) offered trade-offs between journey time, road surface, the number of lanes and whether lighting was provided. Details of the SP designs and the precise wording and presentation used are given in section 3.3 and Appendix 13.

The road surface was described as being like the M6T, like the standard M6, like the high-level (jointed) section of the M6 and like the concrete section of the M6. Motorists should be very familiar with each of these types of surface.

Given that road surface can impact both in terms of smoothness of ride and noise, we asked respondents to rate each of the four surfaces in terms of smoothness of ride and noisiness separately, ranging from one (very quiet/smooth) to ten (very noisy/bumpy). The purpose of this was to make the results potentially more transferable and to aim to discern separate impacts for noise and bumpiness.

We allowed a ‘do not know’ category, although suspect that this response was reported not by those who were unfamiliar but rather those who had a difficulty with the rating exercise since where such responses were given they tended to be given for all surfaces.

The terms we have used in reporting the results are:

- Time: Journey time in minutes
- M6T: Dummy variable denoting the road surface is as the M6T ……..
- M6T*Time: Interaction of M6T and Time
- M6: Base category of road surface is as the M6
- Concrete: Dummy variables denoting concrete road surface
- Concrete*Time: Interaction of concrete and time
- High Level: Dummy variable denoting high level, jointed road surface
- High*Time: Interaction of high level and time
- 4 Lanes: Dummy variable denoting 4 lane motorway
- 4 Lanes*Time: Interaction of 4 Lanes and Time
- 3 Lanes: Base category of 3 lane motorway
- 2 Lanes: Dummy variable denoting 2 lane motorway
- 2 Lanes*Time: Interaction of 2 Lanes and Time

- Lighting: Dummy variable denoting lighting present on motorway
- Lighting*Time: Interaction of Lighting and Time

Table 10.7 reports the two SP5 models. The goodness of fit achieved is respectable in both models. Both models find the M6T surface to be insignificantly different from the M6 surface implicitly represented by Time. However, there is a strong dislike of the other two surfaces. Both models recover a dislike for two lane motorways but it is only for the longer journeys (SP5-2) where there is a significant preference for four relative to three lanes. Both models indicate the presence of lighting is preferred.

Table 10.7: Separate Travel Conditions (SP5) Models

	SP5-1	**SP5-2**
Time	-0.1653 (8.9)	-0.0842 (12.8)
M6	Base	Base
M6T	-0.0827 (0.5)	-0.0606 (0.4)
Concrete	-0.4773 (3.5)	-0.6472 (6.2)
High Level	-0.4649 (3.4)	-0.4021 (3.8)
No Lighting	Base	Base
Lighting	0.6349 (3.5)	0.5722 (4.3)
4 Lanes	0.0187 (0.1)	0.4749 (6.5)
3 Lanes	Base	Base
2 Lanes	-0.3055 (2.3)	-0.5377 (3.1)
ρ^2 (C)	0.243	0.171
Observations	1219	1729
Option A	491 (40%)	870 (50%)
Option B	728 (60%)	859 (50%)

Table 10.8 reports the findings of models pooled across the shorter distance (SP5-1) and longer distance (SP5-2) exercises with θ_{SP5-2} indicating the extent to which the scale for the longer distance exercises differs from the shorter distance.

The 370 respondents yielded 2948 observations for modelling purposes. Model I contains all respondents whereas Models II and III remove the non-traders. This reduces the number of individuals by 5% to 352. Of the 18 omitted, 11 had always chosen option A and 7 had always chosen option B.

Model I has a quite respectable fit. A journey time coefficient is specified, which is highly significant, and then additive effects for the M6T, concrete section and jointed section. The M6T coefficient is far from significant. However, the concrete and high level surfaces are significantly worse. The presence of lighting has the expected sign as do 2 and 4 lanes relative to a base of 3 lanes.

Model II removes the non-traders. There is a positive impact on the goodness of fit but it is only slight. This is not surprising since only 5% of the sample were removed. The pattern of results is similar to Model I.

Model III allows the effects to vary with journey duration, on the grounds that the benefits of different road surfaces, number of lanes and presence of lighting will depend upon exposure. These are the interaction terms (Concrete*Time, High*Time, Lighting*Time, 4 Lanes*Time and 2 Lanes*Time)

Table 10.8: Pooled Travel Conditions (SP5) Models

	I	II	III
Time	-0.1614 (8.3)	-0.1698 (7.6)	-0.1744 (8.2)
M6	Base	Base	Base
M6T	-0.0718 (0.7)	-0.1113 (1.1)	-
M6T*Time	-	-	-0.0024 (0.8)
Concrete	-0.7020 (5.2)	-0.6770 (4.9)	-
Concrete*Time	-	-	-0.0213 (4.8)
High Level	-0.5178 (5.2)	-0.5137 (4.8)	-
High*Time	-	-	-0.0157 (4.6)
No Lighting	Base	Base	Base
Lighting	0.7803 (5.0)	0.6676 (4.1)	-
Lighting*Time	-	-	0.0171 (3.6)
4 Lanes	0.3330 (3.6)	0.3810 (2.9)	-
4 Lanes*Time	-	-	0.0120 (4.4)
3 Lanes	Base	Base	Base
2 Lanes	-0.4606 (3.3)	-0.4351 (3.5)	-
2 Lanes*Time	-	-	-0.0183 (4.0)
θ_{SP5-2}	0.43 (8.7)	0.44 (7.9)	0.49 (8.2)
Log-Likelihood	-1661.2	-1548.6	-1519.9
ρ^2 (C)	0.178	0.194	0.209
Observations	2948	2804	
ChooseA(SP5-1)	491 (17%)	475 (17%)	
ChooseB(SP5-1)	728 (25%)	696 (25%)	
ChooseA(SP5-2)	870 (29%)	798 (29%)	
ChooseB(SP5-2)	859 (29%)	835 (29%)	

Note: t ratio of scale (θ) with respect to one.

Model III is statistically superior to Model II which specifies additive effects. The incremental effect for the M6T surface is far from significant. This result is in line with those reported in section 7.1 where it was concluded that route specific time coefficients for the M6 and M6T were not justified. The remaining effects are highly significant.

Travelling on a concrete surface adds 12.2% to the value of time whilst it is a 9.0% uplift for the high-level jointed surface. The presence of lighting reduces the value of time by 9.8%. With regard to the number of lanes, 4 lanes would reduce the value of time by 6.9% compared to three lanes but 2 lanes would increase the value of time by 10.5%. These results correspond with the lane width results, where an improvement had a lesser effect than a deterioration. These effects on the values of time from surface, number of lanes and lighting seem plausible.

We now turn to models which have made use of the rating data collected to measure perceived smoothness and noisiness of the different surfaces. These models replace the dummy variables relating to each road surface with their corresponding rating of perceived smoothness and perceived noisiness.

There were 240 respondents out of the 352 traders who provided a complete set of noise and smoothness of ride ratings. Table 10.9 reproduces the frequency distribution of responses along with the mean rating and its standard error.

The M6T is seen as a very smooth and very quiet surface. Its distribution is distinctly different to the others and the mean rating very much lower. The standard M6 surface is deemed worse, in terms of both noise and ride quality, but not so nearly as bad as the concrete and high level/jointed sections. It is interesting to note that the concrete surface is regarded to be relatively poor in terms of noise, and this is not unexpected, but other than that the three other surfaces are similar in terms of their noise and smoothness.

Table 10.9: Noise and Smoothness Ratings

		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**	**SE**
Noise	M6T	25	36	22	7	6	0	0	2	1	0	2.36	0.10
	High	0	2	7	9	14	23	20	15	5	5	6.25	0.12
	M6	2	7	14	26	33	14	2	2	0	0	4.43	0.08
	Conc	0	0	2	5	9	14	16	23	15	15	7.41	0.12
Ride	M6T	41	37	13	2	2	0	1	1	2	0	2.13	0.11
	High	1	3	7	8	10	20	16	18	8	9	6.51	0.14
	M6	3	9	18	23	26	13	5	3	0	0	4.37	0.10
	Conc	1	1	6	12	18	14	20	17	5	7	6.31	0.12

Note: 1 denotes very quiet/smooth and 10 very noisy/bumpy.

Table 10.10 reports models which make use of the rating data in place of the dummy variables. All the models remove the few non-traders.

Table 10.10: Travel Conditions (SP5) – Use of Rating Scales

	I	**II**	**III**	**IV**
Time	-0.1961 (7.3)	-0.1964 (6.9)	-0.1679 (6.5)	-0.1686 (6.5)
Time*M6T	-0.0010 (0.2)	-	-	-
Time*Conc	-0.0311 (5.1)	-	-	-
Time*High	-0.0190 (4.1)	-	-	-
Lighting*Time	0.0212 (3.3)	0.0191 (3.0)	0.0161 (2.7)	0.0163 (2.8)
4 Lanes*Time	0.0118 (2.9)	0.0132 (3.1)	0.0101 (2.6)	0.0105 (2.9)
2 Lanes*Time	-0.0170 (2.8)	-0.0148 (2.7)	-0.0156 (2.8)	-0.0158 (2.8)
Noise	-	-0.1208 (1.7)	-	-
Noise*Time	-	-	-0.0043 (2.6)	-0.0051 (6.0)
Smooth	-	-0.0254 (0.4)	-	-
Smooth*Time	-	-	-0.0009 (0.6)	-
θ_{SP5-2}	0.43 (8.5)	0.45 (6.1)	0.49 (6.2)	0.48 (6.2)
Log-Likelihood	-971.8	-983.2	-970.2	-970.5
ρ^2 (C)	0.226	0.217	0.227	0.227
Observations	1845			
ChooseA(SP5-1)	290 (16%)			
ChooseB(SP5-1)	476 (26%)			
ChooseA(SP5-2)	537 (29%)			
ChooseB(SP5-2)	542 (29%)			

Note: t ratio of scale (θ) with respect to one.

Model I simply reproduces the same model (Model III) as in Table 10.8 but on the reduced sample that provided the rating data. It can be see that the pattern of results is similar but the coefficients are higher which is indicative of a lower amount of residual variation. Indeed, the fit is higher than for the previous model.

Model II introduces ratings for noise and smoothness in place of the incremental time terms. The noise coefficient is somewhat larger than the smooth coefficient, and both are correct sign. However, neither are statistically significant and Model II is statistically inferior to Model I according to a likelihood ratio test.

Model III specifies the noise and smoothness ratings as interactions with journey time. Not only does this achieve a better fit than Model II for the same number of variables, it also achieves a better fit than Model I despite having one fewer variable. However, the smoothness coefficient is not significant. A contributory factor here could be the correlation between the noisiness and smoothness ratings, ranging from 0.54 for the concrete surface to 0.76 for the high level section, although it could simply be that noise is much more important than ride quality.

Model IV removes the smoothness rating and suffers only a small deterioration in the log-likelihood such that it is statistically superior to Model III according to a likelihood ratio test. The coefficient on the noise rating is not greatly different from Model III. It indicates that for every one unit increase in the noise rating the value of time increases by 3%.

Taking the mean values from Table 10.9, and relative to time spent on the M6T, the jointed high level value of time would be 10.5% higher, the concrete surface would have a value of time 14.4% higher but the M6 value of time would only be 6.1% higher.

The value of such a model as reported in Table 10.10 which is based on ratings is that it is more transferable and easier to apply than a model based on dummy variables. What is required for application in a particular context is that motorists' ratings of different road surfaces are obtained.

11. REVEALED AND STATED PREFERENCE ROUTE CHOICE MODELS

11.1 RP Data

After removing those who did not indicate their choice and those for whom we could not generate network journey times because the origins and destinations were unknown, we are left with 3031 RP observations. Of these, 4.8% chose an A road, 10.8% chose the M6 and 84.4% chose the M6T.

As described in Chapter 4, the data was collected either through roadside interviews (RSIs) or by contact at motorway service areas (MSAs) or else by postal questionnaires to a database of M6T users. As previously noted, the overall sample is therefore clearly unrepresentative of the share of each route in the corridor. This is important not least because those choosing the M6T can be expected to have higher values of time.

However, the sample obtained through the RSIs and at the MSAs can be taken to be reasonably representative. Table 11.1 denotes the shares of each route in the total sample of usable RP observations and in the RSI/MSA sample.

Table 11.1: Split of Sample By Route and Source of Data

	RSI/MSA	All Sample	Weight
A Road	122 (10.3%)	144 (4.7%)	2.15
M6	325 (27.6%)	329 (10.9%)	2.53
M6T	732 (62.1%)	2558 (84.4%)	0.74

The final column reports the weights we have used in weighted estimation to correct for the unrepresentative sample when the analysis is based on this maximum RP data set of 3031 observations.

We have developed two sets of RP models here. One set is estimated on network data, and contains 3031 observations, whilst the other is based on reported travel times and costs supplemented by network data where reported data is missing. Although then not a pure reported model, this supplementing increases the sample slightly to 3049 choice observations.

The advantage of a model based on reported data is that it can reflect the perceptions that drive actual choices in a way that network data cannot. However, it does suffer one serious shortcoming, and one that seems to be apparent here, that the chosen alternative is reported to be more attractive, perhaps to justify the actual choice made, than it really is. It seems that this here manifests itself in the M6 times being reported to be too long by M6T users. There is also an issue of missing reported data either because the respondent does not know the journey time on the alternative, but has nonetheless made a decision, or does not appreciate that details are required for unchosen as well as chosen routes.

The choice context involves the required time-cost trade-offs: the M6 is free but typically congested to varying degrees; the M6T is quicker but more expensive due to the toll charge; the A road option can sometimes be quicker than the commonly congested M6 but in any event offers a different set of trade-offs relative to the M6T.

However, even though we have the time-cost trade-offs necessary for value of time estimation, a stumbling block is that the toll is the same for all motorists and hence from a statistical point of view cannot be disentangled from those effects discerned by the ASC[4].

Table 11.2 provides details of the extent to which travel times are reported by each route, split by the route chosen for the actual journey. As would be expected, there is a greater tendency to report details for the route chosen, although the degree of not reporting the times for alternative routes amongst motorway users is surprising.

Table 11.2: Reporting of Times by Route Used

Route Used	**A Time**		**M6 Time**		**M6T Time**	
	Reported	Not	Reported	Not	Reported	Not
A Road	95%	5%	23%	77%	50%	50%
M6	27%	73%	94%	6%	36%	64%
M6T	37%	63%	64%	36%	92%	8%

Given concerns about mis-reporting, where the chosen route is cast in a better light relative to the alternatives than it really is, perhaps to justify the actual choice made, we have compared the reported and network based journey times.

Table 11.3 reports the mean reported (REP) and network (NET) times for the three routes, along with the standard error (in brackets) and number of observations, for those using each route. These figures are based on there being for any motorist both network and reported times for a particular, but not every, alternative. Hence the samples for reported and network times are the same for any alternative in the first three rows.

Table 11.3 also reports in the final three rows the differences between the M6T and the two other routes for both the reported and network data for those for whom each type of data was available. Hence the same sample sizes for the reported and network times.

Table 11.3: Origin-Destination Reported and Network Times

Route Used	A_{REP}	$M6_{REP}$	$M6T_{REP}$	A_{NET}	$M6_{NET}$	$M6T_{NET}$
A	86 (5.7) 137	93 (8.0) 34	60 (5.0) 77	84 (5.4) 137	87 (8.8) 34	66 (5.3) 77
M6	161 (14.6) 84	152 (5.9) 310	153 (10.1) 115	125 (9.6) 84	139 (4.2) 310	136 (7.5) 115
M6T	176 (4.0) 933	201 (2.7) 1627	160 (2.2) 2358	140 (2.4) 933	154 (1.9)1627	141 (1.6) 2358
	$M6\text{-}M6T_{REP}$		$M6\text{-}M6T_{NET}$	$A\text{-}M6T_{REP}$		$A\text{-}M6T_{NET}$
A	31.1 (4.4) 30		8.5 (1.0) 30	15.1 (2.0) 70		10.4 (1.1) 70
M6	15.9 (3.5) 120		7.5 (0.4) 120	39.3 (6.0) 61		15.6 (1.4) 61
M6T	34.8 (0.7) 1604		7.8 (0.1) 1604	47.6 (1.6) 933		17.2 (0.4) 933

[4] However, we do have a toll coefficient from the SP modelling which provides a surrogate for its utility effect. The constant toll is not a problem for the process of validating the SP modelling results against actual choices but this was not within the remit of this aspect of the study.

For A road users, the reported times are broadly similar to the network based values. The difference between the A road and the M6T is broadly similar for the network and reported data. However, this is clearly not the case for the difference between the M6 and M6T times, where the M6T is perceived in a much better light relative to the M6 than it really is. Given that these are A road users, it would seem that this latter discrepancy is more due to perceptions than to any justification bias.

The M6 users report journey times consistently higher than the network based times, with the discrepancy largest for the A road. This may well stem from unfamiliarity and a view that A roads must be somewhat slower. They report the difference between the M6 and M6T to be a little larger than the network difference. It is the difference between the A road and M6T where there is the greatest divergence between the network and reported times. Again, given that the M6 users do not use either of these routes, it would seem more reasonable to attribute this divergence to misperception or to previous bad experiences on A roads rather than justification bias.

Finally, the M6T users report all routes to be longer than the network times. Whilst justification bias might lead to under-reporting of the M6T times, the difference between the reported and network absolute times are somewhat larger for the A road and M6. However, when we actually look at the mean differences, the reported difference between the M6 and M6T exceeds the network difference between M6 and M6T by about the same margin as the reported difference between the A road and M6T exceeds the network difference between the same two routes.

Whilst we cannot be definitive about the causes of the discrepancy between reported and network times, it would not be unreasonable to expect some difference to be attributable to the approximations of network models and the fact that they aim to estimate actual rather than perceived times. Nonetheless, the evidence would support an element of misperception influencing the reported times.

11.2 Initial RP Models

We report first what we term initial models which contain only the main effects relating to travel time and cost. The models take the standard form with linear-additive utility functions and times specified in minutes and costs in pence.

11.2.1 *Network RP Models*

Table 11.4 reports four initial models based on the network data. Model I is an unweighted estimation. As might be expected, given its dominant share, the ASC for the M6T is strongly positive. This will in part reflect some of the attractions of the M6T route over the M6 not accounted for in travel time, and in particular any underestimation of the perceived difference by the network data. Analogous reasoning might lead us to expect ASC-A to be negative. It is encouraging that the time coefficient is correct sign and highly significant.

The toll coefficient is insignificant. This is unsurprising since the reported values used here hardly vary across respondents and indeed any such variation is the result of misperception. Had we specified the toll at £3.50 as a ‘network’ value, it would not have been possible to distinguish it from the ASC-M6T and all the disutility associated with the toll would have been detected by the constant term. This very limited variation in the toll level results in a correlation in excess of -0.95 between the toll coefficient and ASC-M6T.

Table 11.4: Initial Network RP MNL Models

	I	II	III	IV
ASC-M6T	1.6360 (4.7)	0.5034 (1.9)	1.8530 (29.8)	1.8578 (30.8)
ASC-A	-0.1695 (1.6)	-0.3502 (4.7)	-0.3443 (4.7)	-0.3403 (4.7)
Time	-0.0906 (11.7)	-0.0887 (16.0)	-0.0895 (16.1)	-0.0890 (16.7)
Toll	-0.0010 (1.0)	-0.0011 (1.5)	-0.005	-0.005
FuelDiff	0.0005 (0.2)	0.0004 (0.3)	0.0005 (0.4)	-
Log-Lik	-1522.32	-2466.22	-2480.25	-2480.32
ρ^2 (constants)	0.050	0.059	0.053	0.053
Obs	3031			

Note: Model I is unweighted and the others are weighted to account for the sample route shares relative to our best estimate of the actual shares.

The fuel costs are the same for the M6 and M6T. The distance of the two routes is so similar that we did not distinguish their fuel costs. We did, however, ask whether the fuel cost on the A road was different and by how much. The fuel coefficient (FuelDiff), specified as the difference between the A road and the motorway routes, is wrong sign although far from significant. Whilst there is the issue of the status of fuel costs in decision making, this has here been addressed by weighting the fuel cost term by a variable denoting whether the respondent stated that fuel costs were borne in mind when making their route choice decision. The limited variation in the fuel cost between routes will have contributed to the results here.

Model II, and all subsequent models, apply the weights in Table 11.1. As expected, the ASC-M6T is reduced when less weight is attached to users of this route. However, there is little difference in the other coefficient estimates

Model III addresses the issue of the large correlation between the toll coefficient and ASC-M6T by imposing a coefficient on the toll variable to isolate its effect. It would be reasonable to take a toll coefficient of around -0.005 as representative of SP models comparable to the RP models here. Given that the ASC-M6T was previously discerning some of the toll effect, imposing this constraint results in a somewhat larger ASC-M6T.

Given a constrained toll coefficient of -0.005, the value of time implied by Model III is 17.9 pence per minute. This is quite a bit higher than the meta-analysis and SP evidence discussed in chapter 6, although the value used as the constrained toll coefficient may have contributed to this. Whilst the scale of the SP coefficient might not be appropriate, this is not of great concern here since we are exploring whether the RP data supports sensible models rather than using the RP models directly for forecasting.

Model IV removes the insignificant fuel cost coefficient. This makes very little difference to the results.

We experimented with making the time coefficients route specific. Whilst the time coefficients were sensible in relation to each other, they were all somewhat lower than the single route specific value reported in Table 11.4. We attribute this to the very large pairwise correlations, in excess of 0.95, between each of the three coefficient estimates.

The ρ^2 goodness of fit, specified with respect to the constants, is low in all four models. Clearly there are other factors that might be expected to be influencing different individual's choices, but the use of network as opposed to reported data can be expected to have a deleterious effect on the goodness of fit to the extent that the reported values reflect the perceptions upon which choices are based and mis-reporting to justify actual choices allows such choices to be more easily explained.

The models reported in Table 11.4 are multinomial logit models. Table 11.5 instead reports hierarchical logit models which allow differential rates of substitutability between routes. Model I combines the two free routes in the lower nest, Model II combines the two motorways in the lower nest whilst Model III combines the two alternatives to the M6 in the lower nest.

Table 11.5: Initial Network RP HL Models

	I	II	III
ASC-M6T	1.8810 (4.7)	1.8240 (23.4)	2.1840 (12.9)
ASC-A	-0.3411 (4.6)	-0.4725 (2.2)	0.1333 (0.6)
Time	-0.0903 (15.6)	-0.0934 (11.1)	-0.0998 (15.0)
Toll	-0.005	-0.005	-0.005
θ	0.94 (0.6)	0.93 (0.7)	0.80 (1.9)
Log-Lik	-2480.10	-2480.07	-2475.34
ρ^2 (constants)	0.053	0.053	0.055

Note: t ratio for scale (θ) specified with respect to unity.

The θ parameter in Models I and II is little different to one, whereupon the hierarchical logit model collapses to the multinomial logit model. Indeed, these models are not statistically superior to Model IV in Table 11.4. Whilst Model III does provide a statistically superior model, the θ parameter is not greatly different from one and would imply only a slight variation in cross elasticities.

11.2.2 *Reported RP Models*

A problem with the reported RP data is that a relatively large number of respondents provide incomplete information, most notably in terms of the times for the alternative routes. There are several ways in which we can handle such missing data in modelling.

We could handle those cases with missing data by denoting them as unavailable. However, this is clearly not always the case since almost all will be aware of at least the two motorway routes if not the A road possibility. Moreover, individuals not reporting the travel times do sometimes report details for reliability, the proportion of HGVs and other variables for routes for which they failed to report the journey time.

Another approach to allow for non-reporting is to specify two dummy variables, one denoting whether, say, the time was reported and the other denoting whether it was not reported. In the former case, the dummy variable is multiplied by the reported journey time. Thus two time related terms enter the model. When the first term takes the value of the reported journey time the second term is zero, and when the second term takes the value one, because the journey time was not reported, the first term is

itself zero. This approach led to a spuriously high fit, since the dummy variable denoting missing data largely related to alternative routes. Moreover, the coefficient estimates on the dummy variables were very large negative figures, as might be expected, but correlations with the journey time coefficients meant that the latter were much lower than when the observations with missing data were simply removed. We therefore did not persist with this approach.

The approach we have adopted was to use the reported times where the full set of times were reported, but otherwise to use the network times. Separate coefficients are estimated for the two types of time. Respondents reported fuel differences between the A road and the motorways. We took a non-response to be no difference.

Table 11.6 reports models estimated on reported data. The number of observations is larger since there are instances where reported data is available but it was not possible to derive network data.

Models I is unweighted and the strong preference for the M6T is again apparent as is a dislike of the A road. Both time coefficients are highly significant, with that for reported data (TimeREP) being notably lower as might be expected given the larger time differences in the reported than network data. The network based time coefficient (TimeNET) is similar to the time coefficient in the network model.

The toll coefficient is not significant, for reasons already discussed. Whilst the fuel cost difference coefficient does not have a completely unrespectable t ratio, and it does improve in other models, the coefficient is nonetheless very low, even though we have allowed for those who do not consider fuel. The small differences in fuel costs may well be a contributory factor here.

Table 11.6: Initial Reported RP MNL Models

	I	II	III	IV	V
ASCM6T	1.6070 (4.6)	0.3997 (1.5)	1.7161 (28.9)	1.7130 (28.8)	1.8320 (32.9)
ASC-A	-0.2328 (2.2)	-0.3800 (5.2)	-0.3735 (5.1)	-0.3770 (5.2)	-0.4589 (6.4)
TimeREP	-0.0435 (10.3)	-0.0561 (15.1)	-0.0565 (15.2)	-0.0566 (15.2)	-0.0672 (17.7)
TimeNET	-0.0811 (10.9)	-0.0882 (16.1)	-0.0892 (16.3)	-0.0895 (16.3)	
Toll	-0.0009 (0.9)	-0.0012 (1.6)	-0.005	-0.005	-0.005
FuelDiff	-0.0004 (1.1)	-0.0005 (1.5)	-0.0005 (1.5)	-	-
Log-Lik	-1489.10	-2415.77	-2428.77	-2429.77	-2446.96
ρ^2 (c)	0.072	0.099	0.094	0.094	0.088
Obs	3049				

Note: Model I is unweighted and the others are weighted to account for the sample route shares relative to our best estimate of the actual shares.

The remaining models all apply weights in estimation. The goodness of fit is a little better than for the network based models, which is to be expected given that reported data more closely reflects the perceptions that underpin actual decisions, whilst any tendency to cast the chosen route in a better light will make the choices easier to explain.

The introduction of weights has the expected effect on the constants but does not have any great impact on the other coefficient estimates. When the toll coefficient is

constrained to equal the value emerging from the SP models, the ASC-M6T becomes much larger, as a result of the correlation of -0.97 between ASC-M6T and the toll coefficient. The implied value of time in Model IV is 17.9 pence per minute for the network based time coefficient, the same as in the network model, while it falls to 11.3 in units of reported time. The latter is very much in line with the SP evidence.

Table 11.7 reports hierarchical logit models for the reported data. Model I combines the two free routes in the lower nest, Model II combines the two motorways in the lower nest whilst Model III combines the two alternatives to the M6 in the lower nest. According to a likelihood ratio test, Models II and III do not provide statistically better models than Model IV in Table 11.6. Indeed, their θ parameters are little different to one. Model I is statistically superior but θ is not greatly different from one and would not imply a great deal of difference in cross elasticities.

Table 11.7: Initial Reported RP HL Models

	I	II	III
ASC-M6T	1.7620 (23.4)	1.6680 (23.4)	1.7730 (20.0)
ASC-A	-0.3710 (4.9)	-0.5695 (3.0)	-0.2634 (2.0)
Time	-0.0653 (11.1)	-0.0595 (13.1)	-0.0596 (12.5)
Toll	-0.005	-0.005	-0.005
θ	0.79 (2.7)	0.89 (1.3)	0.90 (1.2)
Log-Lik	-2426.71	-2429.06	-2429.17
ρ^2 (constants)	0.095	0.094	0.094

Note: t ratio for scale (θ) specified with respect to unity.

11.3 Final RP Models

The preceding results indicate that there is no compelling need to specify a hierarchical formulation in the place of the multinomial logit model.

Along the lines of the SP models, we have explored whether socio-economic and trip characteristics influence, as appropriate, the ASCs or the sensitivity to time and cost variations. Functional form issues have also been explored and additional explanatory factors which vary across individuals but not SP scenarios have been introduced.

The additional main effects entered are the perceived reliability of each route, and the proportion of HGV's on the route. The former can reasonably be taken to represent how reliable the overall journey was expected to take on each route. However, the proportion of HGVs is, at least for the M6T, likely to be dominated by the HGVs on that particular section of route, and this should be borne in mind when interpreting the results.

The segmentation variables were: journey purpose; who pays the toll; when the decision was made about whether to use the M6T, and the factors behind it if a decision was made en-route; attitudes to tolls; income; trip frequency; gender; age; number of occupants, with distinctions between adults and children; and whether the respondent was the driver.

The functional form issues that have been examined are whether larger time savings have different unit value and whether the unit value of time is a function of the overall journey duration.

The models containing significant effects are reported in Table 11.8 for both the network data and the reported data. The final models do not contain many additional variables. Nonetheless, they have a goodness of fit (ρ^2) with respect to constants which far exceeds that typically obtained in choice models and is far better than for the models without the incremental effects.

We specified quadratic terms to discern non-linearities in the sensitivity to time variations. The squared terms were significant but the coefficients relating to time were not significant. This function indicated quite strong increases in the marginal sensitivity to time with journey duration. We therefore proceeded with a more flexible function of the form of

$$U = \alpha T^{\lambda}$$

with a search process across different λs in units of 0.1 to determine that with the best fit. It turned out that the best fitting models were λs of 1.5, indicating strong variation in the marginal utility of time with respect to time. This finding is consistent with that in the SP analysis in the sense that the value of time increases with journey duration.

Table 11.8: Final RP Models

	Network	**Reported/Network**
ASC-M6T	1.0480 (8.3)	0.9710 (7.7)
ASC-A	-0.6346 (7.4)	-0.6550 (7.6)
TimeNET α λ	-0.00476 (15.4) 1.5	-0.00482 (14.9) 1.5
TimeREP α λ	- 	-0.00251 (11.4) 1.5
Toll	-0.005	-0.005
Reliable	1.0190 (12.3)	1.0040 (12.1)
Unreliable	-0.4110 (4.7)	-0.2886 (3.3)
%HGV	-0.0123 (5.0)	-0.0062 (5.0)
NeverCons	-3.8200 (10.5)	-3.7021 (10.2)
ObsTraffic	-0.9484 (4.9)	-0.9650 (5.0)
ObjectNew	-0.4724 (4.3)	-0.4513 (4.1)
SenseNew	0.3907 (3.9)	0.4292 (4.3)
Log Likelihood	-1992.70	-1980.72
ρ^2 (constants)	0.239	0.261

Note: The mean values of %HGV for the M6T (10%), M6 (43%) and A Road (28%) are used where no value was reported. This makes little difference to the coefficient estimate compared to removing missing data.

Analysis of how the unit value of time varies with the size of the time saving did not uncover any effects in either the network or reported data. The relatively minor savings in time offered by the M6T according to the network data may have been a

contributory factor here, although these findings are in line with the findings of the SP analysis.

With regard to the addition of new terms, the reliability of each route was found to have a significant effect. This is in line with the SP analysis. Routes which were very reliable or reliable were more likely to be chosen, and the effect relative to unreliability is stronger than the ASC favouring the M6T. Routes which were unreliable or very unreliable were less likely to be chosen. The base categories are usually reliable and sometimes unreliable.

The proportion of traffic made up by HGVs (%HGV) has the expected effect on choice, although the magnitude of the effect varies across the two models.

The 5% who stated that for their actual journey they never considered the M6T (NeverCons) have a strong alternative specific constant against its use, as would be expected. The effect far exceeds the ASC-M6T. For those who, according to question 21 in Appendix 14, decided on whether or not to use the M6T during the course of their journey, two from the seven possible answers had significant effects. These related to observed traffic conditions (ObsTraffic) and whether the driver wanted to make-up some time.

The coefficient on the variable relating to making-up time was negative, the opposite of what would be expected. It was therefore not retained. Given the negative coefficient for ObsTraffic reduces the likelihood of using the M6T, it would seem that the traffic conditions on the M6 were not as bad as perceived. The SP exercise indicated that information on delays does indeed influence route choice. With hindsight, we could have collected much more detailed information on the factors underpinning decision making when the choice was made en-route since, for example, the observed traffic conditions term does not provide any quantification of expected and subsequently perceived journey times and delays.

Two significant although not particularly strong effects relate to attitudes. Those who would strongly agree or agree with the objection to paying tolls to use new motorways statement (ObjectNew) have a negative incremental ASC for the M6T. Those who strongly agree or agree with the sentiment that tolls are a sensible means of funding additional road infrastructure (SenseNew) have an ASC in favour of the M6T. Whilst significant effects could be discerned from different trip frequency categories, there was no sensible monotonic effect.

We were unable to discern any significant effects from a range of socio-economic interactions. This is typical of RP models, although here a number were not far removed from significant at the usual 5% level. Nonetheless, we note that the SP models did not discern many socio-economic effects.

Table 11.9 denotes the values of time implied by the time coefficients in Table 11.7 so as to support comparison across models given that the functions are non-linear. There is strong variation in the values of time, with the absolute values appearing more plausible for the reported data. The elasticity of the value of time with respect to time is 0.5, higher than obtained in the SP analysis but broadly providing the same message that the value of time increases with duration.

Table 11.9: Implied Marginal Values of Time

	Network	Reported
60 minutes	11.1	5.8
120 minutes	15.6	8.3
180 minutes	19.2	10.1
240 minutes	22.1	11.7
300 minutes	24.7	13.0
360 minutes	27.1	14.3

11.4 Summary of RP Modelling

We cannot draw any firm conclusions about the causes of the discrepancy between reported and network time. However, it would be unreasonable not to expect some difference to be attributable to the approximations of network models and the fact that they aim to estimate actual rather than the perceived times upon which decisions are made. The evidence would support an element of misperception influencing the reported times. However, justification bias can also be expected.

There are a number of encouraging results regarding the RP models, particularly in terms of implied values of time and consistency with the findings of the SP analysis. This would seem to provide a firm basis for joint estimation with the SP data.

We would not expect to find a wide range of significant socio-economic effects in an RP data of this size. Nonetheless, the results are encouraging in that they tend to confirm rather than contradict the SP findings. For example, there are duration effects but no size effects in both the RP and SP models, whilst reliability has a common effect. The RP models are additionally able to detect an effect from the proportion of HGVs, which was not apparent in the main SP route choice models but did emerge as important in our abstract choice SP exercises

We conclude that neither form of data is intrinsically superior to the other on the extent to which it reflects the times that underpin actual decision making. As far as estimating the impact on the marginal utility of time from actual time within the SP data, it makes little difference since the reported and network times for the actual journey are highly correlated. Indeed, we have seen that it did not turn out to have a large effect when introduced as an interaction in our SP models, but that the network data did provide a better fit.

In subsequent RP-SP models, we have used the network times as the interaction term. We have also proceeded to use both the network data and the reported/network data to represent time in the RP component within the RP-SP models estimated.

11.5 Sequential RP and SP Models

We have taken the opportunity to estimate sequential joint RP-SP models. This takes the weights estimated in the SP analysis and creates a new composite utility term to be entered into the RP model. The coefficient on this composite utility indicates the extent to which the scale of the SP coefficients needs to be adjusted to be consistent with actual behaviour conditional upon the relative valuations obtained by the SP analysis being deemed suitable.

From the SP results (eg, the weighted results in

Table 6.16 prior to entering socio-economic variables), we have used a toll coefficient of -0.005, a fuel coefficient of the same amount for those who consider fuel in actual decision making, and a time coefficient of -0.05. We have not made any distinction between the time coefficient applied to network and reported journey times. Hence the composite utility (CU) to which we estimate the scale is, for all three routes, composed as:

$$CU_i = -0.05Time_i - 0.005Toll_i - 0.005Petrol_i$$

The joint models are reported in Table 11.10. A scale (θ) is estimated to CU and the ASCs are freely estimated. The goodness of fit is worse in both cases than when the variables are separately entered outside of the CU function. However, the scales are close to one, indicating a close degree of correspondence between the RP and SP models as far as forecasting is concerned, whilst the ASCs are not dissimilar to those recovered in our SP models. These are encouraging findings.

Table 11.10: Sequential RP-SP Models

	Network	**Reported**
ASC-M6T	2.4060 (20.2)	1.9855 (22.5)
ASC-A	-0.4312 (5.9)	-0.5401 (7.6)
θ	1.1680 (2.1)	0.9929 (0.1)
Log-Lik	-2507.26	-2479.38
ρ^2 (constants)	0.043	0.075

Note: t ratios for θ specified with respect to one.

11.6 Simultaneous RP and SP Models

We here report joint modelling of the RP and SP data. The results are reported in Table 11.11. This uses the Bradley-Daly method which we have used throughout when pooling data. Common parameters are estimated to the RP and SP data except that, as is common practice, the ASCs are specific to the RP and SP data

Model I is based on the network RP data and constrains all the data sets save the RP to have the same scale. Model II is also based on the network RP data but specifies the default scale to be the SP1A exercise but with all the other choice contexts having their own scale. Model III is based on the reported RP data, with the network data used where the reported data is not available. In addition, this model specifies an incremental term (Time-Reported). The time coefficient is either the network or reported data as appropriate. The incremental effect denotes the divergence of the time coefficient caused by being based on reported data.

We have retained the formulation of the preferred SP model of allowing the SP time coefficients to vary with the actual time (AT). This takes the form:

$$U_{SP} = \alpha T_{SP} + \beta AT^{\lambda} T_{SP} + ...$$

where AT is the actual time for the journey made and T_{SP} is the SP related journey time. The marginal utility of travel time (MU_T) is therefore a function of AT:

$$MU_T = \alpha + \beta AT^{\lambda}$$

When it comes to the RP data, AT is not an interaction term but is the independent variable itself. In the pooled RP-SP model, the RP utility functions are specified as:

$$U_{RP} = \alpha AT + \beta \frac{AT^{\lambda+1}}{\lambda+1} + ...$$

-

so that MU_T is the same as for the SP utility function.

Again, a search process is involved in identifying the pre-specified level of λ that provides the best fit.

A number of important comments can be made on the basis of these empirical findings presented in Table 11.11.

- The allowance for scaling makes little material difference to the results
- Combining the RP and SP data does not make a greater difference to the parameters compared to those in Table 7.21 based solely on SP data.
- The RP scale (θ_{RP}) here exceeds one. Given the specification of the model, this denotes that there is less residual variation in the RP data than the SP data. The model is estimated in units of SP residual deviation. For forecasting purposes the coefficients need to be rescaled to be in units of RP residual deviation. This would require that all the coefficients are multiplied by 1.5.
- The λ parameter which drives the variation in the value of time with duration is little different to that in the preferred SP model
- The RP ASCs do not denote any difference between the A Roads and the (congested section of) M6, but there is again a strong preference for the M6T.
- Model III, based on reported/network data, provides a better fit, even after allowing for the extra coefficient, than Model I based purely on network data.
- When separate terms were specified for the two types of RP time, the network RP time coefficient was around -0.05, closely in line with the SP time coefficients, whilst the reported RP time coefficient was around -0.02. Hence the positive coefficient for the incremental *Time-Reported* term.
- The issue of whether to use reported or network travel times does not arise. The SP travel time coefficients are used, after rescaling, and these differ little between whether the RP-SP model is estimated on network or reported data.

The only additional effect that is apparent upon introduction of the RP data is that there is a dislike of HGVs specified as the proportion they form of traffic on the route

in question. The HGV effect was apparent in the pure RP models and is significant in this pooled model despite not being significant in the pure SP models.

Table 11.11: Simultaneous RP-SP Models

	I	II	III
	Network	**Network**	**Report/Network**
$ASC_{M6T\text{-}RP}$	1.7227 (10.2)	1.8653 (11.3)	1.7122 (9.9)
$ASC_{A\text{-}RP}$	n.s.	n.s.	n.s.
$ASC_{M6TCorridor}$	1.1032 (8.1)	1.2115 (9.2)	1.1122 (8.1)
$ASC_{M6TStoke\text{-}M1}$	1.4779 (10.2)	1.5783 (11.6)	1.4929 (10.2)
$ASC_{M6TExtended}$	1.3145 (3.9)	1.4779 (2.4)	1.3283 (3.9)
$ASC_{M6TLong}$	0.9406 (7.1)	1.0097 (7.1)	0.9459 (6.3)
ASC_{NTH}	-1.2026 (6.1)	-1.1752 (4.4)	-1.2086 (6.2)
ASC_{STH}	-2.6554 (4.7)	-2.5790 (4.2)	-2.6602 (5.6)
ASC_{M6TNTH}	0.7956 (4.8)	0.8195 (4.1)	0.7856 (4.8)
ASC_{M6TSTH}	-1.4324 (4.7)	-1.3112 (2.3)	-1.4416 (4.8)
ASC_{NTHSTH}	-1.1529 (3.2)	-1.0818 (2.6)	-1.1596 (3.2)
ASC_{ALL3}	1.4982 (7.6)	1.5181 (7.0)	1.4871 (7.6)
ASC_{M6T}Never M6T	-1.2160 (8.3)	-1.2388 (8.2)	-1.2034 (8.0)
ASC_{M6T}Male	-0.2632 (3.3)	-0.2747 (3.4)	-0.2714 (3.3)
ASC_{M6T}Age65+	0.4643 (3.0)	0.4600 (2.9)	0.4826 (3.0)
ASC_{M6T}Others	0.3814 (6.2)	0.3926 (5.6)	0.3656 (5.5)
ASC_{M6T}ObjectTolls	-0.4026 (5.2)	-0.4018 (5.1	-0.4083 (5.0)
Very Reliable	1.1820 (11.1)	1.1947 (9.9)	1.1765 (10.9)
Reliable	0.8428 (8.3)	0.8552 (8.0)	0.8278 (8.0)
Usual/Sometime Rely	0.5441 (8.9)	0.5631 (8.7)	0.5367 (8.8)
Unreliable	0.2127 (2.8)	0.2248 (2.9)	0.2138 (2.7)
%HGV	-0.0049 (2.5)	-0.0032 (1.9)	-0.0049 (2.4)
$Time_{M6}$	-0.0508 (22.8)	-0.0533 (17.0)	-0.0511 (23.0)
$Time_{M6T}$	-0.0528 (16.1)	-0.0531 (11.8)	-0.0532 (16.0)
$Time_{A}$	-0.0565 (27.7)	-0.0589 (19.8)	-0.0589 (27.8)
$Time_{Bits}$	-0.0466 (14.6)	-0.0488 (11.7)	-0.0469 (14.9)
Time*Acttim**λ	-0.000037 (3.3)	-0.000041 (3.9)	-0.000037 (3.4)
	λ=1.1	λ=1.1	λ=1.1
Time-OthAdults	0.0077 (2.8)	0.0089 (3.3)	0.0072 (2.6)
Time-Reported	-	-	0.0299 (5.5)
Earlier	-0.0249 (17.3)	-0.0264 (12.8)	-0.0250 (17.4)
Later	-0.0233 (11.7)	-0.0246 (10.1)	-0.0234 (11.7)
Later-EB	-0.0037 (2.3)	-0.0046 (2.5)	-0.0032 (2.2)
Later-Comm	-0.0064 (2.3)	-0.0077 (2.5)	-0.0064 (2.9)
Adj-HolsSB	0.0077 (2.6)	0.0088 (2.4)	0.0077 (2.8)
Adj-VFR	0.0051 (2.7)	0.0062 (2.9)	0.0051 (2.7)
Adj-Male	0.0034 (2.5)	0.0037 (2.3)	0.0034 (2.5)
Delays M6	Base	Base	Base
M6 delays due to	0.3055 (4.2)	0.2675 (3.5)	0.3108 (4.7)
Exp 25m delays	1.0395 (5.9)	1.0197 (5.6)	1.0433 (6.0)
No M6 Delays	-0.4436 (3.5)	-0.4747 (4.3)	-0.4390 (4.5)
Toll	-0.0061 (13.4)	-0.0066 (15.3)	-0.0062 (13.5)
Toll-Inc£20k-39k	0.0003 (1.0)	0.0004 (1.0)	0.0004 (0.9)
Toll-Inc£40k-59k	0.0007 (1.8)	0.0008 (2.0)	0.0007 (1.9)
Toll-Inc£60k-79k	0.0010 (2.4)	0.0010 (2.4)	0.0010 (2.5)

Toll-Inc£90k-99k	0.0013 (3.5)	0.0013 (3.4)	0.0014 (3.5)
Toll-Inc£100k+	0.0020 (4.3)	0.0020 (4.0)	0.0020 (4.3)
Toll-IncDK	0.0005 (1.1)	0.0005 (1.2)	0.0005 (1.2)
EmpPay	0.0013 (9.2)	0.0013 (9.7)	0.0013 (9.4)
Toll> £3.m50	-0.0008 (4.9)	-0.0007 (4.3)	-0.0008 (4.9)
Toll New Motorway	0.0025 (4.6)	0.0022 (3.3)	0.0025 (4.6)
Toll Extended M6T	0.0009 (3.0)	0.0008 (1.8)	0.0009 (3.1)
FuelYes	-0.0056 (10.1)	-0.0056 (10.4)	-0.0056 (10.2)
θ_{RP}	1.56 (4.7)	1.52 (4.4)	1.54 (4.8)
θ_{SP1A}	1.0	1.0	1.0
θ_{SP1C}	1.0	0.98 (15.7)	1.0
θ_{SP1B-1}	1.0	1.22 (17.7)	1.0
$\theta_{SP1B-2-8}$	1.0	1.04 (14.0)	1.0
θ_{SP2A-1}	1.0	0.98 (9.2)	1.0
$\theta_{SP2A-2-3}$	1.0	0.84 (9.9)	1.0
θ_{SP8A}	1.0	0.84 (12.5)	1.0
θ_{SP8B}	1.0	0.64 (14.4)	1.0
θ_{SP2C}	1.0	0.76 (9.1)	1.0
θ_{SP2B}	1.0	1.01 (6.6)	1.0
ρ^2 (constants)	0.248	0.251	0.250
Log Likelihood	-22820.3	-22734.0	-22752.2
Observations	32188		

Note: t ratios for scales (θ) are with respect to unity. Incremental terms in italics.

Values of time and their elasticities, implied by Model I and for the M6T for the lowest income group, are reported in Table 11.12. They seem highly plausible.

Table 11.12: Implied M6T Values of Time and Elasticities by Duration

	VoT	**Elas**
30m	8.91	0.03
60m	9.20	0.07
120m	9.83	0.13
180m	10.49	0.19
240m	11.17	0.25
300m	11.87	0.30

11.7 Random Parameters Model

The final model we report addresses random taste variation. It is based on the joint RP-SP models reported in Table 11.11, which contain socio-economic variables as well as main effects. Random taste variation is allowed in the ASCs and the toll coefficients as a result of the estimation of a mixed multinomial logit model based on Model I of Table 11.11 which uses network data in the RP component and which constrains all the scales to be the same.

The model has been estimated using CIMLogit, software developed at ITS Leeds by Dr Richard Connors and Dr Nicolás Ibáñez and based in MATLAB. Given the characteristics of our basic model to which random parameter estimation is applied,

and the number of observations and draws employed (2500), CIMLogit is currently, to the best of our knowledge, the only software that would ensure both convergence and efficient computation times in this context. The estimation time was 13.05h.

The estimation code cannot currently handle both random parameter estimation and rescaling across data sets, and hence the data from the different SP exercises and the RP data are constrained to have the same scale. The results in Table 11.11 indicate that this does not make a great difference to the coefficient estimates and would provide a means of rescaling to be consistent with actual choices. .

Table 11.13 reports the random parameters model. We have allowed the ASC for the M6T to exhibit a normal distribution across the sample, but constrained it to be the same for $ASC_{M6T\text{-}RP}$, $ASC_{M6TCorridor}$, $ASC_{M6TStoke\text{-}M1}$ and $ASC_{M6TExtended}$. The estimated standard deviation is denoted *S*D-ASC_{M6T}. We have also allowed lognormal distributions of the toll coefficients specified for different income categories.

Table 11.13: Random Parameters Model

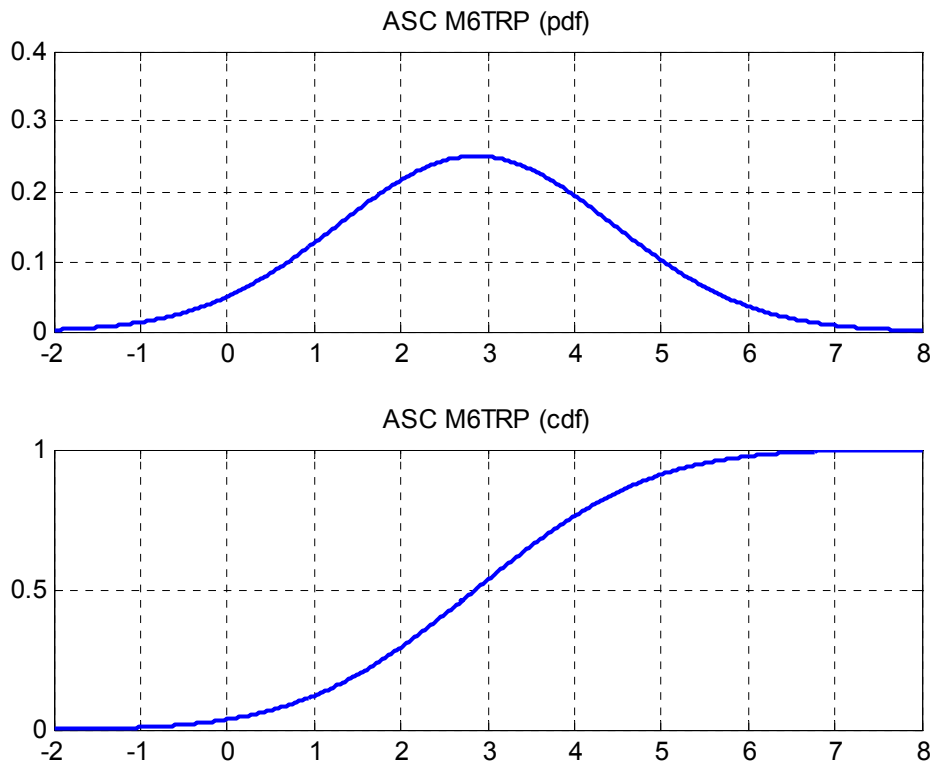
$ASC_{M6T\text{-}RP}$	2.8708 (16.5)	*Adj-HolsSB*	0.0119 (5.4)
$ASC_{A\text{-}RP}$	-0.1487 (1.8)	*Adj-VFR*	0.0076 (5.6)
$ASC_{M6TCorridor}$	1.8276 (13.7)	*Adj-Male*	0.0044 (3.7)
$ASC_{M6TStoke\text{-}M1}$	2.1270 (15.1)	M6 delays due to	0.9887 (7.4)
$ASC_{M6TExtended}$	2.0469 (7.8)	Exp 25m delays	2.3632 (15.1)
$ASC_{M6TLong}$	2.0265 (9.6)	No M6 Delays	-0.3966 (3.1)
ASC_{NTH}	-2.4259 (13.3)	*EmpPay*	0.0023 (11.0)
ASC_{STH}	-4.0472 (12.3)	*Toll> £3.50*	-0.0011 (8.6)
ASC_{M6TNTH}	1.7666 (14.6)	*Toll New motorway*	0.0019 (6.4)
ASC_{M6TSTH}	-0.5260 (2.3)	*Toll Extended M6T*	0.0007 (2.1)
ASC_{NTHSTH}	-1.2102 (6.9)	FuelYes	-0.0051 (16.1)
ASC_{ALL3}	2.8807 (19.6)	TollDK-Mean	-4.7572 (67.8)
SD-ASC_{M6T}	1.5925 (30.7)	TollDK-SD	0.5403 (15.3)
ASC_{M6T}Never M6T	-2.1321 (13.8)	Toll-<£10k-Mean	-4.5456 (35.2)
ASC_{M6T}Male	-0.4061 (4.2)	Toll-<£10k-SD	0.4528 (4.8)
ASC_{M6T}Age65+	0.7497 (4.3)	Toll-£10-29k-Mean	-4.6418 (80.3)
ASC_{M6T}Others	0.4776 (4.7)	Toll-£10-29k-SD	0.5228 (15.7)
ASC_{M6T}ObjectTolls	-0.2665 (4.1)	Toll-£30-39k-Mean	-4.7619 (61.2)
Very Reliable	1.3719 (17.0)	Toll-£30-39k-SD	0.5855 (15.2)
Reliable	1.0393 (13.8)	Toll-£40-49k-Mean	-4.7628 (62.0)
Usual/Sometime Rely	0.7021 (15.3)	Toll-£40-49k-SD	0.5473 (14.9)
Unreliable	0.3049 (5.3)	Toll-£50-59k-Mean	-4.7853 (62.3)
%HGV	-0.0014 (1.1)	Toll-£50-59k-SD	0.4837 (12.7)
$Time_{M6}$	-0.0841 (45.0)	Toll-£60-69k-Mean	-4.8107 (59.8)
$Time_{M6T}$	-0.0802 (38.7)	Toll-£60-69k-SD	0.3999 (9.9)
$Time_{A}$	-0.0898 (46.7)	Toll-£70-89k-Mean	-4.8453 (51.4)
$Time_{Bits}$	-0.0532 (19.4)	Toll-£70-89k-SD	0.4595 (10.4)
Time*Acttim**1.1	-0.000014 (2.7)	Toll-£90-99k-Mean	-4.9740 (28.4)
Time-OthAdults	0.0099 (4.6)	Toll-£90-99k-SD	0.4494 (5.8)
Earlier	-0.0377 (29.8)	Toll-£100k+-Mean	-5.0960 (38.8)
Later	-0.0348 (22.5)	Toll-£100k+-SD	0.4648 (7.8)
Later-EB	-0.0040 (2.6)	ρ^2 (constants)`	0.375
Later-Comm	-0.0106 (5.8)	Log Likelihood	-19117,9

Note: The same λ parameter of 1.1 was used as provided the best fit in the RP-SP logit model reported in Table 11.11. Weights are applied in estimation.

This random parameters specification has increased the ρ^2 goodness of fit statistic from 0.248 to 0.375, albeit with a finer income categorisation as well as the additional random parameters. This is an appreciable improvement in fit. The reduced residual variation means that the coefficients are generally larger than for the models in Table 11.11.

The SD-ASC_{M6T} term representing inter-personal taste variation in the ASC relating to the M6T is highly significant. The distribution of the RP ASC ($ASC_{M6T\text{-}RP}$) around its central estimate of 2.87, along with the cumulative distribution, are depicted by Figure 11.1. The distribution seems reasonable. Although the normal expectation would be for an ASC favouring the M6T, it is not inconceivable that some would not prefer it, and the results show a small proportion having a negative ASC for the M6T.

Figure 11.1: Distributions of M6T ASC for RP Data ($ASC_{M6T\text{-}RP}$)



The model also contains separate coefficients for 10 income categories, one of which denotes that the income is not known. These coefficients are allowed to follow a lognormal distribution, in order to avoid wrong sign values of time which can occur when normal distributions are specified.

For each income category, Table 11.13 reports both a mean and a standard deviation coefficient. In addition to the category representing those for whom the income level is not known (TollDK), there are nine pairs of coefficient estimates. Thus Toll-£30-39k-Mean represents the mean toll coefficient for those with a household income in the range £30 to £39,000 with Toll-£30-39k-SD denoting the standard deviation estimate for the same income group. These are absolute rather than incremental coefficients

In order to return a monotonic income effect, we have only had to combine income bands to a very limited degree. We have combined the £10-19,000 and £20-29,000 income categories and the £70-79,000 and £80-89,000 income categories.

What is impressive is that we can obtain a monotonic effect across nine income categories. Values of time spent on A-roads (VoTA) and of time spent on the M6T (VoTM6T) for each income band are reported in Table 11.14. Mean and median values are given, and because the denominator term in the value of time calculation has a lognormal distribution, the median value exceeds the mean,

Whilst the effect of income on the value of time is a well researched theme, we are not aware of previous research that has obtained a pattern of results as impressive as those reported here. However, as in income segmentations here previously reported, the implied income elasticity is relatively minor.

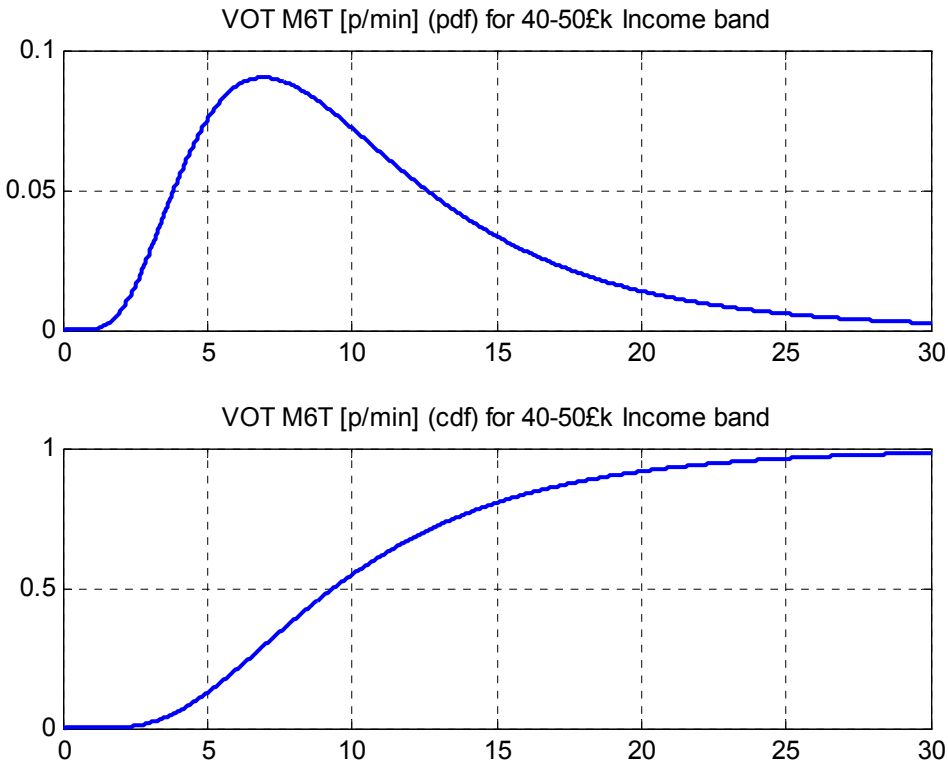
Table 11.14: Values of Time by Income Band

	Median		**Mean**	
	VoTA	**VoTM6T**	**VoTA**	**VoTM6T**
<£10k	8.46	7.55	7.63	6.82
£10-29k	9.31	8.32	8.12	7.25
£30-39k	10.50	9.38	8.85	7.90
£40-49k	10.51	9.39	9.05	8.08
£50-59k	10.75	9.60	9.56	8.54
£60-69k	11.03	9.85	10.18	9.09
£70-89k	11.41	10.19	10.27	9.17
£90-99k	12.98	11.59	11.73	10.48
£100+	14.67	13.10	13.17	11.76
Not Known	10.45	9.33	9.03	8.07

The degree of taste variation in the value of time is illustrated in Figure 11.2. The probability density function and cumulative distribution are reported for the value of time on the M6T for the £40-50,000 income group. Not only are the mean values broadly in line with previously reported values, the distribution of values across individuals seems reasonable. Note however that some of the incremental toll effects are lower in absolute than in the model reported in Table 11.11 even when most other coefficients are larger due to the lower residual variation. It is an unfortunate consequence if important insights obtained through the specification of dummy variable interaction terms which are themselves discerning taste variation are weakened or else lose statistical significance when random coefficient variation is permitted.

The extent of taste variation would seem to be plausible and these variations in parameters will imply somewhat different propensities to use a toll road across the sample. Indeed, the random taste variation is large relative to the limited systematic variation that we could detect in the ASC and particularly the toll coefficient according to socio-economic factors and trip characteristics. However, the two distributions of preferences are assumed to be independent of each other when in fact those with a stronger ASC in favour of the tolled road might also tend to have a lower sensitivity to toll.

Figure 11.2: Distributions of Value of Time (M6T for £40-50k Income Group



12. INTER-TEMPORAL ANALYSIS

12.1 1994 Repeat Data Characteristics

A reduced-scale repeat of the 1994 British national value of time study (HCG et al. 1999) was conducted in parallel to the main study. This was possible, at low marginal cost, because not all those contacted would be in-scope for the main study. The 1994 study covered users of motorways, trunk roads and A roads. We here restricted coverage to motorway users.

Individuals who were not in scope for the main study were handed a version of the repeat study questionnaire. The questionnaires used in the repeat were nearly identical to those used in the original 1994 study. The differences were that income bands and cost levels in the SP experiments were uplifted in line with inflation.

Each questionnaire asked the respondent to provide information relating to their current trip purpose, trip features and socio-economic characteristics. They were also asked about the amount of time they spent per week in paid employment, non-leisure travel and on household work. In addition they undertook three SP experiments.

Two of these SP experiments were given to all respondents.

- The first (Game 1) involved a choice between two unlabelled routes defined by journey time and travel cost. These were specified as variations upon the current times and costs.

- The other (Game 3) involved a choice between a tolled and un-tolled route. The tolled option was always faster but more expensive than the un-tolled option. The times were specified as variations on the current journey time.

In addition, respondents were also given an SP experiment (Game2) which differed according to the length of the journey they were undertaking on the motorway. For some individuals, the SP experiment involved a route choice that included road characteristics (coach/lorry access, number of lanes, hard shoulder). For others it involved a route choice based on departure time. The remainder were given an SP experiment that included a ‘chance of delay’ attribute.

The analyses presented here relate to data from games 1 and 3 only; game 2 has not been analysed.

A total of 7,340 questionnaires were distributed, 1,800 at MSAs and 5,540 at RSIs, and 1,399 were returned. This compares closely with the 1129 motorway questionnaires returned in the original 1994 study (out of a total of 4322 returned across all road user types). The response rate is 19% which is lower than that for the main SP exercise but reflects the fact that at the roadside interview sites it was not practical, due to time constraints, to fully check that each form handed out was applicable to the trip in question and as such in some cases the SP questionnaire issued would not have been relevant.

A number of respondents were removed from the analysis based on criteria set out in the 1994 study. This included that they had provided details of their actual journey time and that this was sensible. Table 12.1 gives the remaining number of individuals and observations for both the 1994 (motorway users only) and 2006 data.

Table 12.1: Sample Sizes after Data Filtering

Purpose	1994	2006
EB	470	284
Commute	151	251
Other	285	252
Total	906	787

Table 12.2 gives the proportion of respondents in each of three journey duration bands (<1hr., 1-2hrs. >2hrs.) for the 1994 and 2006 data and for each journey purpose. The distributions by time band are reasonably similar for the two years.

Table 12.2: Journey Duration by Trip Purpose

Journey Duration	Business				Commute				Other			
	1994		2006		1994		2006		1994		2006	
<1hr	107	22.8%	79	28.0%	84	55.8%	155	61.9%	58	20.4%	75	29.9%
1-2hrs	165	35.1%	105	37.0%	53	35.1%	88	35.1%	81	28.3%	56	22.1%
>2hrs	198	42.2%	99	35.0%	14	9.1%	8	3.0%	146	51.4%	121	48.0%
Total	470	100%	284	100%	151	100%	251	100%	285	100%	252	100%

The 2006 data was subsequently re-weighted to ensure that the same proportion of respondents came from each of three journey length bands as the 1994 data. This re-weighting procedure also adjusted the proportion of drivers/passengers that answered the questionnaire, to match the 1994 results. These reweightings did not greatly impact on the model results.

12.2 Empirical Findings

We here report the analysis of the data collected from a repeat of the 1994 UK national value of time study and set this alongside comparable models estimated on the 1994 data. All values are expressed in 1994 prices in pence and minutes. This is done for motorway users alone and for what are termed Game 1 and Game 3.

Game 1 involved a choice between two unlabelled routes defined by journey time and travel cost. These were specified as variations upon the current times and costs. This game has been the main focus of previous analysis (HCG et al., 1999; Whelan and Bates, 2001).

Game 3 involved a choice between a tolled and un-tolled route. The tolled option was always faster but more expensive than the un-tolled option. The times were specified as variations on the current journey time.

Whilst we had no specific remit to investigate how the value of time varies over time, what is of interest is whether there has been any change in attitudes to toll relative to attitudes to other motoring costs. This would manifest itself in differential rates of change in the value of time according to whether the numeraire was toll or not.

The models were estimated using Alogit version 4 and its jack-knife procedure was used to account for repeat measurements (Hague Consulting Group, 2000).

12.2.1 Game 1 Results

Tables 12.3 and 12.4 report the results for Game 1. The inertia term represents a preference for an option specified to be 'as now' for both time and cost. An inertia effect is apparent for all journey purposes. It does not vary greatly across journey purpose whilst the variation over time, from around 8 minutes in 1994 to between 10 and 14 minutes in 2006, is also limited. We also observe a very similar goodness of fit across the two periods as well as similarities in the pattern of the time and cost coefficients and their absolute values.

Table 12.3: 1994 Game 1 SP Results

	Business	**Commute**	**Other**
Cost	-0.0084 (14.7)	-0.0166 (9.5)	-0.0132 (14.1)
Time	-0.0933 (17.1)	-0.1005 (6.8)	-0.0782 (12.1)
Inertia	0.7070 (14.9)	0.7510 (8.0)	0.6921 (10.5)
Value of Time	11.11 (22.5)	6.05 (10.9)	5.92 (18.7)
Observations	3628	1144	2191
Log-Lik	-2163.22	-684.82	-1248.65
ρ^2(constants)	0.138	0.136	0.176

Table 12.4: 2006 Game 1 SP Results

	Business	**Commute**	**Other**
Cost	-0.0098 (8.9)	-0.0160 (11.9)	-0.0123 (10.9)
Time	-0.0809 (8.9)	-0.0890 (7.2)	-0.0587 (5.1)
Inertia	0.8201 (11.9)	1.1061 (12.8)	0.7762 (10.4)
Value of Time	8.26 (12.7)	5.56 (11.3)	4.77 (7.1)
Observations	2214	1862	1916
Log-Lik	-1353.13	-1103.16	-1147.56
ρ^2(constants)	0.118	0.143	0.134

The results indicate a reduction in the value of time in real terms between the 1994 and 2006 surveys, despite strong income growth in the period. However, only the difference for business travel is significant. The findings are not out of line with those reported by Gunn (2001), and relating to a repeat of the Netherlands national value of time study where there was little change over time, and those reported by Wardman (2001b), relating to a repeat of the Tyne Crossing Study and initially conducted as part of the first national value of time study in Great Britain, where there was also a fall in the real value of time. Such reductions in value of time might, in this instance of car travellers, be attributable to the more comfortable travelling conditions due to significant advances in vehicle design.

12.2.2 Game 3 Results

Table 12.5 and the first set of results in Table 12.6 present the results for game 3. Game 3 pivoted journey time changes off the individual's actual motorway (option B) and trunk road (Option A) alternatives. These times were presented to motorists as variations upon the journey times on these alternatives. Unlike the original study, we have not estimated separate time parameters for the difference in actual journey times and for the variation specified in the SP exercise since the coefficients tended not to be significantly different.

We have though retained the alternative specific constant (ASC) in each model and these indicate a dislike of the tolled road. This ranges between 12 to 30 minutes in 1994 but increases somewhat to between 42 and 57 minutes in 2006. This would seem to indicate increased dislike to tolled roads in 2006. However, the ratios of the 2006 and 1994 values of time for the three journey purposes are 0.91, 1.46 and 0.96 whereas they are 0.74, 0.92 and 0.81 for Game 1. Thus the pattern of value of times is consistent with a diminishing aversion to toll relative to driving cost.

Table 12.5: 1994 Game 3 SP Results

	Business	**Commute**	**Other**
ASC (Toll)	-0.2400 (2.2)	-0.7061 (2.9)	-0.6732 (2.3)
Toll	-0.0038 (8.2)	-0.0095 (5.0)	-0.0042 (5.3)
Time	-0.0191 (9.8)	-0.0370 (4.0)	-0.0220 (4.4)
Value of Time	5.03 (8.3)	3.89 (5.1)	5.24 (4.7)
Observations	3547	1093	1616
Log-Lik	-2196.92	-608.46	-935.07
ρ^2(constants)	0.101	0.158	0.165

Table 12.6: 2006 Game 3 SP Results

	Business	**Commute**	**Other**
ASC (Toll)	-0.6561 (3.5)	-1.7792 (5.5)	-0.8345 (2.7)
Toll	-0.0030 (4.3)	-0.0074 (2.9)	-0.0029 (2.1)
Time	-0.0138 (5.1)	-0.0421 (2.9)	-0.0146 (2.8)
Value of Time	4.60 (4.2)	5.69 (3.2)	5.03 (2.3)
Observations	2139	1518	1365
Log-Lik	-1356.32	-683.35	-826.28
ρ^2(constants)	0.067	0.169	0.106
ASC (Toll)	-0.2400	-0.7061	-0.6732
Toll	-0.0039 (5.4)	-0.0103 (3.9)	-0.0033 (2.0)
Time	-0.0115 (5.5)	-0.0309 (4.5)	-0.0141 (3.5)
Value of Time	2.95 (8.4)	3.00 (5.8)	4.27 (3.1)
Log-Lik	-1367.96	-731.44	-827.91
ρ^2(constants)	0.059	0.111	0.104

The results are therefore ambiguous in terms of how preferences towards toll, relative to other driving costs, have varied over time. The variation in preferences to toll over time would be clearer if it could be attributed to a single coefficient rather than two. Thus the second set of results in Table 12.6 constrains the ASCs to be the same in 2006 as they were in 1994. This attributes all the dislike of tolls to the toll coefficient and has the effect of making it more negative, and hence reducing the value of time, since the constrained ASCs are less negative.

12.2.3 Relative Variations in Values of Time over Time

Table 12.7 summarises the changes for each game and journey purpose. What we observe is that only one difference, the reduction in the value of time for business travel in Game 1, is statistically significant. For Game 3, use of the freely estimated values of time would indicate a lesser reduction in the values, and indeed one increase, but this fails to account for increased toll aversion apparent in the ASC.

Table 12.7 therefore bases the Game 3 results on the models which attribute all the change in toll aversion over time to the toll coefficients by constraining the ASCs to their 1994 levels. When this is done, the reductions in the value of time are larger than for Game 1. Nonetheless, the business values remain the only ones to be significantly different.

We conclude therefore that there is no strong support for differential rates of change in preferences towards toll costs and other motoring costs between 1994 and 2006, but that there is support, once again, for a diminishing value of car travel time for motorists over time. A factor in the latter is that those new to the car market, with relatively low incomes, have relatively low values of time.

Table 12.7: Variations over Time

	Game 1				**Game 3**			
	1994	**2006**	**2006/ 1994**	**t-Stat (Diff)**	**1994**	**2006**	**2006/ 1994**	**t-Stat (Diff)**
Business	11.11	8.26	0.74	3.49	5.03	2.95	0.59	2.97
Commute	6.05	5.56	0.92	0.63	3.89	3.00	0.77	0.96
Other	5.92	4.77	0.81	1.55	5.24	4.27	0.81	0.54

Note: The t statistic relates to the difference in the values of time.

12.3 Comparison with Main Evidence

We can compare the values of time obtained from our repeat 1994 study with those obtained from the SP exercises based around the M6T. Given the results presented above are in 1994 prices, they need to be factored by 1.321 to account for inflation.

For the toll based values of Game 3, we have used the values obtained from the unconstrained model. In 2006 prices, these are 6.08, 7.52 and 6.64 pence per minute for business, commuting and other respectively. These are somewhat lower than the values of around 10 pence per minute estimated to the M6T route choice data.

As for the values of time based on other driving costs and obtained from Game 1, in 2006 prices they are 10.91, 7.34 and 6.30 pence per minute. Again these are low relative to the values of time we have estimated in the M6T route choice exercises for those who considered fuel costs in decision making.

There are a number of possible reasons behind these discrepancies between the M6T route choice based values of time and those derived from the repeat of the 1994 study. The means of presenting time was different, with absolute values in the main study and differences on current times in the repeat study. However, such a conclusion would not be supported by the results reported in chapter 8. The main study was more realistic, based around a real-world choice context, whereas the repeat study was more abstract in nature. There were also layout differences, not least that the repeat study asked many more questions, whilst the main and repeat samples differ in terms of journey duration and socio-economic characteristics.

13. CONCLUSIONS

This study has involved a major data collection exercise covering a wide range of different types of Stated Preference (SP) exercise addressing motorists' propensity to use various forms of new but tolled motorway infrastructure and a range of possible alternatives. In addition, it has collected route choice data relating to motorists' actual Revealed Preference (RP) choices between the tolled M6T, the M6 and an A road alternative. Motorists' willingness to pay for improved travel conditions has also been explored. This represents some novel research not just in the British context.

A wide range of models exploring a large number of issues relating to inter-urban car travel have been estimated. The main model deals with route and departure time choice and is based on almost 30,000 SP observations supplemented with over 3000 RP observations. Several other substantive models have been developed dealing with different types of travel time and different levels of infrastructure provision.

The overall impression is that the models yield very plausible results. For example, the estimated values of time are sensible and the variations by journey duration and type of time are reasonable whilst the results for traffic conditions and infrastructure are realistic. The most disappointing aspects are the limited amount of variation according to socio-economic and trip characteristics and the persistently large alternative specific constants (ASCs) which we would have preferred to attribute to other variables. Nonetheless, these large constants are manifest not just in the SP models but are corroborated in the RP models.

We conclude by commenting upon how our findings have addressed the objectives and hypotheses that we set ourselves in Chapter 1.

<u>Key Objectives</u>

Develop a transferable model explaining motorists' willingness to switch to a tolled route to save time

We have developed a joint RP-SP route and departure time choice model, the culmination of an extensive modelling process that has pooled data across a number of different SP exercises and has been supplemented with RP data. This model, reported in section 11.7, has been estimated on a very large data set. The coefficient estimates are highly significant and the implied values of time are plausible. The large ASCs favouring the M6T are not ideal for the purposes of transferability, and are resilient to the specification of alternative specific time coefficients and additional variables such as reliability. It is clear that there are strong unaccounted for preferences for the M6T.

The model is being used in another aspect of the study to determine the impact of various tolling scenarios on the demand for the tolled road and the surrounding network.

Explain the extent to which motorists might change departure time as well as route in response to off-peak pricing or time savings.

Alternatives relating to departing at different times, in order to save toll or time, and measures of departure time shift, are contained in the final model. The evidence is though restricted to SP data. The valuations of earlier and later time and the propensity to switch departure times seem reasonable.

Research Hypotheses

Are there differences in sensitivity to higher and lower tolls?

The findings reported in section 7.4 indicate that there is a slightly greater sensitivity to toll increases relative to the current level. This is maintained in subsequent models, such as the joint RP-SP and random parameters models in sections 11.6 and 11.7.

Does the response to toll depend upon the level of toll charge?

Other than the toll coefficient being higher across all tolls in excess of the current level, the analysis reported in section 7.4 indicates the toll coefficient does not seem to vary in a systematic way with the level of the toll.

Does the reported sensitivity to toll depend upon whether tolls are being varied on an existing tolled motorway, whether tolls are being introduced on an existing untolled motorway or whether the toll charge is part of a possible new motorway?

As reported in section 7.4, the introduction of tolls on the existing toll-free M6 had no discernible differential effect. The toll coefficient was 38% lower when an entirely new motorway was being considered and 15% lower when relating to an extension of the M6T. In the latter cases, any protest towards tolls may be expected to be tempered by a desire to see new and improved motorways and respondents could be expected to have a stronger desire to see a new motorway than an extension to the M6T. They may therefore inflate their stated willingness to pay. We might therefore treat responses to choice experiments which deal with new motorways with some caution.

To what extent are fuel costs accounted for in route choice and, where they are, how do the fuel cost and toll coefficients compare?

When we account for the employer paying the toll, the coefficient for reductions in toll is very similar to the fuel price coefficient for those who stated that they took fuel costs into account in making their stated choices. This finding is reported in section 7.5 and is encouraging. It also suggests that it is the toll coefficient for reductions that is the most appropriate to use.

When we do not account for the 65% who do not consider fuel costs in their SP responses, the fuel cost coefficient falls by 69%. This draws into some doubt values of time based either in part or entirely upon a fuel cost numeraire when no account has been made for those who do not consider fuel. However, for forecasting purposes, it is appropriate to use separate coefficients for the two types of motorist.

Does the sensitivity to time variations differ according to the conditions of travel? At its simplest, are route specific time valuations apparent? More generally, we wish to test if the time sensitivity depends on a range of driving conditions and infrastructure.

In our route choice exercises, and specifically the analysis reported in section 7.1, the results do not support a different value of time for the M6T relative to the M6. This was confirmed in the abstract choice SP exercise in section 10.3 in terms of noisiness and ride quality related to the surface. Nor is there compelling evidence for a higher value of time on A roads. To some extent this conflicts with evidence we

have found in support of the value of time varying with traffic conditions. This is reported in section 10.1.

It is not uncommon that studies of motorists' time valuations distinguish between different types of time. The simplest distinction is between free flow and congested time but some recent studies have specified three categories of free flow, slowed down and stop-start time. We here distinguished between six categories of time. These were free flow, busy, light congestion, heavy congestion, stop-start and grid-lock.

Whilst not quite a monotonic effect, the results in section 10.1 are both impressive and original. They correspond, on average, reasonably well with a valuation of around 1.5 in the British context which is typically obtained for the valuation of what is termed congested time relative to free flow.

There was variation in the marginal utility of time according to road surface, although not between the M6 and M6T, whilst lighting, the number of lanes, lane width, information provision, the proportion of HGVs on a route and the number of speed cameras all had significant and sensible effects.

Is the sensitivity to time savings influenced by the duration of the actual journey in which it is offered?

In line with much other empirical evidence, the value of time is found to vary with journey duration. As the actual journey increases, section 7.2 finds the time coefficient to increase and also the preference for the M6T in terms of its ASC to increase (although not both simultaneously). The variation seems plausible, and is confirmed in the RP data. However, there was no such effect on the toll coefficient or on the earlier and later time coefficients.

We note here that, unlike a number of other studies (Daly, 2008), we find no evidence that the sensitivity to cost is dependent upon journey duration.

Do the benefits per minute of time saved depend upon the amount of time saved?

Some very large time savings were offered, in excess of an hour. Indeed, the range of time savings was far greater than is typically offered in SP studies of travel behaviour. Despite this, and as reported in section 7.3, there is no convincing evidence to support departure from the conventional position of a constant value of time across different time savings. New tolled roads do not typically deal with small time savings, say of the magnitude of 20 seconds, as often occur in urban transport appraisal. Our analysis does not address the issue of whether the value of time is different for small time savings of, say, less than 5 minutes.

Do earlier and later departures than desired have the same disutility?

The results in section 7.6 and generally throughout the results presented indicate that in aggregate earlier and later departure times have the same disutility. However, there are some variations by journey purpose, with those on business trips and commuters having a greater dislike of departing later.

Are the unit valuations of earlier and later time dependent upon the extent of the departure time shift?

Section 7.6 demonstrates that the unit valuations appear constant, although admittedly only across one and two hour earlier and later times.

How does variability in travel time influence behaviour and what is its value relative to mean travel time?

The SP exercise which dealt with travel time variability was not a success. This is despite the use of what is now the standard depiction of travel time variability as five different journey times and also the use of a realistic choice context where the payment of a toll could purchase less variability and lower mean times.

Nonetheless, it has been possible to detect an influence from the perceived reliability of the different routes on route choice in both the SP and RP models. In the joint RP-SP model reported in section 11.6, compared to a perceived very unreliable route, a very reliable route was worth around 20 minutes, a reliable route was worth 14 minutes, a sometimes reliable route was worth 9 minutes and an unreliable route was worth 4 minutes at the average journey time of around 2½ hours.

Does offering travel times as differences relative to another route yield different valuation estimates than when absolute time values are used?

Section 8.2 indicates that presenting journey times as differences relative to another route does not influence the value of time derived. Nor does it induce any size effect.

Is the sensitivity to time and toll dependent upon the number of alternatives offered in the SP exercise and the number of other attributes included?

Whilst the SP exercises were designed to test whether the number of alternatives and the number of attributes influenced the parameter estimates, this was one aspect of the analysis possibilities that we did not complete.

How are the coefficient estimates impacted by the degree of realism with which respondents perceive the attributes offered to them?

The findings reported in section 8.1 show that the perceived credibility of the times and fuel costs offered does not impact on their coefficient estimates. Nor does it have a large impact on the scale of the model.

Does purchasing a time saving made up of three separate toll roads lead to a different valuation than if the same time saving is purchased as an extended toll motorway?

Although further work could be done here, and the relatively small sample for the SP exercise that offered Northern and Southern extensions to the M6T does not help matters, the results presented in section 6.8 indicate that the estimated values of time are lower in this choice context. In contrast the joint RP-SP model presented in section 11.6 indicates only a slightly lower time coefficient when the time saving is bought ‘in bits’. Whilst the random parameters model in section 11.7 does indicate a lower valuation, this may be related to the specification of preference variation for the M6T ASCs but the absence of such variation, within the context of a small sample, in the ASCs for the Northern and Southern extensions.

How are the sensitivities to time and cost systematically influenced by socio-economic and trip characteristics?

There are only limited variations in model parameters according to socio-economic and trip characteristics, as reported in section 7.9.

We found a strong and monotonic effect from the perceived level of reliability of each route as mentioned above. In our standard logit models, there was a monotonic reduction in the toll coefficient across 6 household income categories, ranging from less than £20,000 to over £100,000 per annum. Whilst such a relationship is impressive by the standards of much empirical evidence, the effect on the value of time was surprisingly weak, implying an income elasticity of 0.2 or less when SP studies typically achieve a cross-sectional income elasticity of around 0.5.

In the random parameters model, we estimated a monotonic income effect across 9 income categories. As far as we are aware, this is the most impressive income segmentation in a well researched area. However, the implied income elasticity remained low.

There were only a limited number of other statistically significant effects from a large number tested. The only effect discerned on the time coefficient was for those travelling with other adults where the value of time was around 10% less.

The ASCs favouring the M6T were found to vary with several factors. Those who would never consider using the M6T were implied to have a negligible ASC. Whilst males and those who object to paying tolls had a weaker preference for the M6T and those aged over 65 and those with others in the car were more inclined to the M6T, the effect on the M6T ASC is less than 33%.

To what extent is there random variation in preferences across the sample?

Models were estimated which allowed the toll coefficient to vary across respondents following a log-normal distribution and the ASC in favour of the M6T to vary according to a normal distribution. Such a model is reported in section 11.7. The spread of these coefficients across the sample seems reasonable but would imply quite different propensities to use a toll road across motorists. The random preference variation is also appreciable relative to the preference variation that could be systematically related to socio-economic variables.

To what extent can route specific constants be unpacked into valuations relating to a range of variables not typically entered into route choice models?

Adding a range of attributes, such as perceptions about route reliability, which had a significant and fairly large effect, and the proportion of HGVs on the route, as well as specifying route specific time coefficients and variables relating to attitudes towards toll roads, all failed to remove the large ASCs in favour of the M6T. The failure to allow for non-linear effects can impact on the ASCs but they were still strongly in favour of the M6T when such functions were specified. These results were apparent in the RP as well as the SP models. There are clearly unexplained preferences for the tolled route.

Does the presence of information relating to traffic conditions have a bearing on route choice?

Although considerable numbers stated that signs influenced their actual choice of route, no significant effect was discerned. However, observed traffic conditions did have a significant effect as reported in section 11.3. In the SP exercises, the variable relating to information did impact on route choice. Compared to information that stated that there were delays on the M6, which tends to be the message that normally exists on the M6, information that there were no delays was valued at 7 minutes whilst stating that there were delays on the M6 and its causes was valued at 5 mins. However, in the abstract choice SP exercise reported in section 10.2, information had a lower valuation, of less than two minutes, presumably because the only benefit was the information itself rather than the avoidance of delays.

To what extent are the SP responses and parameters estimated on them corroborated by RP evidence?

There is a reasonable degree of correspondence between the scales of the RP and SP models and the results obtained by each as is apparent in the findings presented in chapter 11 and elsewhere.

However, this aspect of the overall study has not compared the route choices that would be predicted by the SP and joint RP-SP models with those observed to have occurred for the actual journey made. Another stage of the study is dealing with forecasting issues.

How does the value of time vary over time, and are there differential rates of growth according to whether the numeraire in which the monetary valuation is expressed is toll or other driving costs?

The issue of how the value of time varies over time as indicated by repeat studies has proved to be a controversial one, with the two studies that have been conducted indicating that either the value of time has not increased over time or else it has increased by far less than the growth in income. The results reported in Chapter 12 are very much in line with those previously reported and provide yet more support that there is little or no growth in the value of time over time. Indeed the value of time might be falling! The research here does not, however, provide any insights into the causes of this.

As for preferences towards toll and other driving costs, there is no support for differential rates of change over time. We might have expected motorists to become less sensitive to toll, much as they became less sensitive to parking charges over time, once they became accustomed to such charges. However, this is not empirically supported.

Further Research

A number of issues for further research arise out of the findings that have emerged from the analysis reported here.

- There are preferences for the M6T independent of attitudes towards it and the characteristics of each route. This is not an artefact of the SP method since it is also apparent in real choices. Whether such preferences are unique to the M6T requires further research. For example, comparison with other studies

might indicate the extent to which ASCs depend on the length of the tolled facility or the quality of the existing routes.

- We have conducted the most extensive segmentation of time into different types that we are aware of. Typically up to three categories are included in studies of motorists' time values but here we have specified six. Further corroboration is needed though[5], using more sophisticated means of presentation and exploratory research into motorists' perceptions of and attitudes towards different types of time. It would also be illuminating to explore whether the relative valuations of different types of time vary across the characteristics of motorists and their journeys.

- Some interesting and potentially very significant findings have emerged from our inter-temporal analysis. Further detailed research is required to cast much more light on the theoretical and practical reasons why the value of car travel time is not increasing over time in line with income or indeed might not be increasing at all. It would be illuminating to observe trends in the public transport market. The evidence that attitudes to tolls might change over time also requires further investigation.

- There is scope for more sophisticated analysis of the degree of competition between routes, building upon the multinomial logit model reported here, and for specifying more extensive random taste variation with correlation between the spread associated with different coefficients.

[5] We have repeated this SP exercise in the United States. We obtained a monotonic valuation across the different types of time but otherwise similar results to those obtained here.

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APPENDIX 1: SP Exercises

Table A1. 1: Combinations of SP Exercises Offered

Context	Number of each	First SP		Second SP		Code
M1-Stoke Corridor	**400 of each**	SP1A Absolute Times	SP1A-1a	Extension	SP2A-1b	**1**
			SP1A-1b		SP2A-1a	**2**
			SP1A-2a	Type of Time	SP3-1b	**3**
			SP1A-2b		SP3-2b	**4**
		SP1A Time Saving	SP1A-3a	Traffic Conditions	SP4-2a	**5**
			SP1A-3b		SP4-2b	**6**
		SP1A Time Loss	SP1A-4a	Extension – larger tolls	SP2A-2a	**7**
			SP1A-4b		SP2A-2b	**8**
		SP1A No Fuel	SP1A-5a	Type of Time	SP3-3b	**9**
			SP1A-5b		SP3-4b	**10**
		SP1A Different Tolls	SP1A-6a	Traffic Conditions	SP5-2a	**11**
			SP1A-6b		SP5-2b	**12**
		SP1C Tolls on M6	SP1C-1a	Late Running	SP7a	**13**
			SP1C-1b		SP7b	**14**
			SP1C-2a	Extension no A Road	SP2A-3a	**15**
			SP1C-2b		SP2A-3b	**16**
		SP1A Absolute Times	SP1A-1a	Dep Time Shifts	SP8B-1a	**17**
			SP1A-1b		SP8B-1b	**18**
			SP1A-2a	Extension – 2 additions to M6T	SP2B-1	**19**
			SP1A-2b		SP2B-2	**20**
M6T Corridor	**600 of each**	SP1B Abs-olute Times	SP1B-1a	Traffic Conditions	SP5-1a	**22**
			SP1B-1b		SP5-1b	**21**
		SP1B Remove A Road	SP1B-2a	Type of Time	SP3-1a	**23**
			SP1B-2b		SP3-2a	**24**
		SP1B Time Quicker	SP1B-3a	Traffic Conditions	SP4-1a	**25**
			SP1B-3b		SP4-1b	**26**
		SP1B Time Slower	SP1B-4a	Dep Time Shifts	SP8A-1a	**27**
			SP1B-4b		SP8A-1b	**28**
		SP1B Different Tolls	SP1B-5a	Late Running	SP7a	**29**
			SP1B-5b		SP7b	**30**
		SP1B Information	SP1B-6a	Dep Time Shifts	SP8A-1a	**31**
			SP1B-6b		SP8A-1b	**32**
		SP1B Information	SP1B-7a	Type of Time	SP3-3a	**33**
			SP1B-7b		SP3-4a	**34**
		SP1B Information	SP1B-8a	Dep Time Shifts	SP8A-1a	**35**
			SP1B-8b		SP8A-1b	**36**
MSA	**500 of each**	150 mile new motorway	SP2C_1a	Type of Time	SP3_1b	**37**
			SP2C_1b		SP3_2b	**38**
		Rely 1 hour	SP6-3a	Type of Time	SP3_3b	**39**
			SP6-3b		SP3_4b	**40**
		Rely 2 hour	SP6-2a	Traffic Conditions	SP4_2a	**41**
			SP6-2b		SP4_2b	**42**
		Rely 3 hour	SP6-1a	Traffic Conditions	SP5_2a	**43**
			SP6-1b		SP5_2b	**44**
		Rely 4 hour	SP6-4a	Type of Time	SP3_1a	**45**

			SP6-4b		SP3_2a	**46**
		Rely 5 hour	SP6-5a	Type of Time	SP3_3a	**47**
			SP6-5b		SP3_4a	**48**
		SP1A Abs-lute Times	SP1A-1a	Extension – 2 additions to M6T	SP2B-1a	**49**
			SP1A-1b		SP2B-1b	**50**
		SP1A No Fuel	SP1A-5a	Extension – larger tolls	SP2A-1a	**51**
			SP1A-5b		SP2A-1b	**52**
		SP1B Abs-olute Times	SP1B-1a	Dep Time Shifts	SP8A-1a	**53**
			SP1B-1b		SP8A-1b	**54**

The terms a and b denote the set of eight offered, with a denoting one set of eight scenarios and b denoting the remaining eight.

APPENDIX 2: Stoke-M1 Corridor SP1A Designs

Table A2.1: SP1A-1 Design

Time M6	Time M6T	Time A	Toll	Fuel M6	Fuel A	VoT1	VoT2	VoT3	Scen
105	90	110	350	1000	900	23.3	22.5	17.5	1
105	100	125	750	1000	900	150.0	34.0	30.0	4
105	75	135	200	1000	750	6.7	7.5	3.3	9
105	80	100	500	1000	750	20.0	37.5	25.0	16
120	90	125	500	1000	750	16.7	21.4	14.3	12
120	100	110	200	1000	750	10.0	45.0	20.0	15
120	75	100	750	1000	900	16.7	34.0	30.0	2
120	80	135	350	1000	900	8.8	8.2	6.4	7
130	90	135	750	1000	750	18.8	22.2	16.7	13
130	100	100	350	1000	750	11.7	n.a.	n.a.	10
130	75	110	500	1000	900	9.1	17.1	14.3	5
130	80	125	200	1000	900	4.0	6.7	4.4	8
140	90	100	200	1000	900	4.0	30.0	20.0	6
140	100	135	500	1000	900	12.5	17.1	14.3	3
140	75	125	350	1000	750	5.4	12.0	7.0	11
140	80	110	750	1000	750	12.5	33.3	25.0	14

Note: VoT1 denotes the M6 v M6T boundary value of time in pence per minute. VoT2 and VoT3 denote respectively the boundary values for M6T v A road with and without consideration of fuel cost. These would differ if there were a route specific constant. If, for example, there were a 5 minute preference for the M6T over the M6, VoT1 in the first row would be 35**.** The M6T time includes time on the M6 either side of the M6T within the Stoke and M1 corridor.

The SP1C designs are very similar to the SP1A designs, but instead introduces tolls on the M6. The tolls, and the revised boundary values, are given below

Table A2. 2: Toll Charge for SP1C Designs

Toll M6	VoT1	VoT2	VoT3
0	23.3	22.5	17.5
100	130.0	30.0	26.0
0	6.7	7.5	3.3
200	12.0	27.5	15.0
0	16.7	21.4	14.3
200	0.0	25.0	0.0
0	16.7	34.0	30.0
100	6.3	6.4	4.5
200	13.8	17.8	12.2
0	11.7	n.a.	n.a.
100	7.3	14.3	11.4
0	4.0	6.7	4.4
100	2.0	20.0	10.0
0	12.5	17.1	14.3
200	2.3	8.0	3.0
0	12.5	33.3	25.0

APPENDIX 3: Stoke-M1 Corridor SP2A Extended M6T Designs

Table A3. 1: SP2A-1 Design

Time M6	Time M6T	Time A	Toll	Fuel M6 M6T	Fuel A	VoT1	VoT2	VoT3	Scen
105	65	110	350	1000	850	8.8	11.1	7.8	1
105	75	125	750	1000	850	25.0	18.0	15.0	4
105	75	135	200	1000	700	6.7	8.3	3.3	9
105	65	100	500	1000	700	12.5	22.9	14.3	16
120	65	125	500	1000	700	9.1	13.3	8.3	12
120	75	110	200	1000	700	4.4	14.3	5.7	15
120	75	100	750	1000	850	16.7	36.0	30.0	2
120	65	135	350	1000	850	6.4	7.1	5.0	7
130	65	135	750	1000	700	11.5	15.0	10.7	13
130	75	100	350	1000	700	6.4	26.0	14.0	10
130	75	110	500	1000	850	9.1	18.6	14.3	5
130	65	125	200	1000	850	3.1	5.8	3.3	8
140	65	100	200	1000	850	2.7	10.0	5.7	6
140	75	135	500	1000	850	7.7	10.8	8.3	3
140	75	125	350	1000	700	5.4	13.0	7.0	11
140	65	110	750	1000	700	10.0	23.3	16.7	14

Note: VoT1 denotes M6 v M6T boundary value. VoT2 and VoT3 denote respectively the boundary values for M6T v A road with and without consideration of fuel cost

APPENDIX 4: M6T 'Extended in Bits' in Stoke-M1 Corridor SP2B Design

This SP takes the form of an existing M6T and additional northern and southern section which allow further time savings. The respondent has essentially seven options regarding toll roads:

- Current M6T only
- Northern section only
- Southern section only
- M6T and Northern section
- M6T and Southern section
- Northern and Southern section
- All three

Thus it makes sense to present the journey times as further time savings on the extended portions rather than as the times that would exist under each option.

The times specified for each section were 20 minutes for the Northern, 20 minutes for the current M6T and 25 minutes for the Southern.

The 'sections' on the existing M6 corresponding to those on the M6T and new sections are made up as:

30 40 30 = 100
35 50 35 = 120
40 60 40 = 140

It then remains to work out from these three levels of M6 time what each section saves compared to the M6. These are set out in Table A4. 1.

Table A4. 1: SP2B Design

Time M6	North Saves	M6T Saves	South Saves	North Toll	M6T Toll	South Toll	Scen
100	10	20	5	100	250	100	1
100	10	20	5	150	350	200	4
100	10	20	5	200	350	250	9
100	10	20	5	250	450	150	16
120	15	30	10	100	350	150	12
120	15	30	10	150	250	250	15
120	15	30	10	200	450	200	2
120	15	30	10	250	350	100	7
120	15	30	10	100	350	200	13
120	15	30	10	150	450	100	10
120	15	30	10	200	250	150	5
120	15	30	10	250	350	250	8
140	20	40	15	100	450	250	6
140	20	40	15	150	350	150	3
140	20	40	15	200	350	100	11
140	20	40	15	250	250	200	14

APPENDIX 5: Knutsford-Dunstable New Tolled Motorway SP2C Design

This involves a journey of around 150 miles crossing the M6T corridor where a completely new and tolled motorway is offered alongside the existing M6 options with and without the M6T.

Table A5.1: SP2C Design

Time M6	New M6	Time M6T	Toll New	Toll M6T	VoT1	VoT2	Scen
210	120	170	750	350	8.3	8.0	1
210	135	160	1500	500	20.0	40.0	8
210	120	160	2000	650	22.2	33.8	15
210	135	170	1000	200	13.3	22.9	6
200	120	160	1000	500	12.5	12.5	13
200	135	170	2000	350	30.8	47.1	4
200	120	170	1500	200	18.8	26.0	11
200	135	160	750	650	11.5	4.0	2
190	120	170	1500	650	21.4	17.0	9
190	135	160	750	200	13.6	22.0	16
190	120	160	1000	350	14.3	16.3	7
190	135	170	2000	500	36.4	42.9	14
200	120	160	2000	200	25.0	45.0	5
200	135	170	1000	650	15.4	10.0	12
200	120	170	750	500	9.4	5.0	3
200	135	160	1500	350	23.1	46.0	10

Note: VoT1 is the boundary value comparing the existing M6 with the new motorway and VoT2 is the corresponding figure for the M6T versus the new motorway. An ASC favouring the new tolled M6 would reduce these boundary values.

APPENDIX 6: M6T Corridor SP1B Designs

Table A6. 2: SP1B-1 Design

Time M6	Time M6T	Time A	Toll	VoT1	VoT2	Scen
35	20	40	350	23.3	17.5	1
35	20	55	750	50.0	21.4	4
35	20	65	200	13.3	4.5	9
35	20	30	500	33.3	50.1	16
50	20	55	500	16.7	14.3	12
50	20	40	200	6.7	10.1	15
50	20	30	750	25.0	75.0	2
50	20	65	350	11.7	7.8	7
60	20	65	750	18.8	16.7	13
60	20	30	350	8.8	35.1	10
60	20	40	500	12.5	25.0	5
60	20	55	200	5.0	5.7	8
70	20	30	200	4.0	20.0	6
70	20	65	500	10.0	11.1	3
70	20	55	350	7.0	10.0	11
70	20	40	750	15.0	37.6	14

Note: VoT1 is the boundary value comparing the existing M6 with the M6T and VoT2 is the corresponding figure for the M6T versus the A road. Only one SP1B design contained an A road.

APPENDIX 7: Travel Time Reliability

The basic orthogonal design for the travel time reliability SP exercises is given in Table A7.1.

A large delay on the M6, specified as 3 hours, could occur once every week, fortnight, month or 3 months. Four levels of toll on the M6T were specified.

Travel time variability was specified by five different journey times. It was specified to be the same in all scenarios for the M6T and somewhat less than for the M6. Four different levels of variability were offered for the M6. For each of five journey duration bands, the five journey times used for the M6 and the M6T are set out in Tables A7.2 to A7.6. Respondents were informed of the average journey time.

Table A7. 7: Travel Time Variability (SP6) Basic Design

Large Delay once every	Vary M6T	Vary M6	Toll	Scen
Month	4	0	350	1
Month	4	1	750	8
Month	4	2	200	15
Month	4	3	500	6
Fortnight	4	1	500	13
Fortnight	4	0	200	4
Fortnight	4	3	750	11
Fortnight	4	2	350	2
3 months	4	2	750	9
3 months	4	3	350	16
3 months	4	0	500	12
3 months	4	1	200	14
Week	4	3	200	5
Week	4	2	500	7
Week	4	1	350	3
Week	4	0	750	10

Table A7. 8: SP6-1 Around 2½ Hour Journey

Level	Journey Times	Mean (h & m)	Variance (m)
0 (M6)	2½ hours 2¾ hours 3 hours 3¼ hours 3½ hours	3h 00m	562.5
1 (M6)	3 hours 3¼ hours 3½ hours 3¾ hours 4 hours	3h 30m	562.5
2 (M6)	3 hours 3 hours 3 hours 3½ hours 4 hours	3h 18m	720.0
3 (M6)	2½ hours 3 hours 3½ hours 4 hours 4½ hours	3h 30m	2250.0
4 (M6T)	2h 20 m 2 h 25m 2½ hours 2 h 35m 2 h 40m	2h 30m	62.5

Table A7. 9: SP6-2 Around 1½ Hour Journey

Level	Journey Times	Mean (h & m)	Variance (m)
0 (M6)	1½ hours 1¾ hours 2 hours, 2¼ hours 2½ hours	2h 00m	562.5
1 (M6)	2 hours 2¼ hours 2½ hours 2¾ hours 3 hours	2h 30m	562.5
2 (M6)	2 hours 2 hours 2 hours 2½ hours 3 hours	2h 18m	720.0
3 (M6)	1½ hours 2 hours 2½ hours 3 hours 3½ hours	2h 30m	2250.0
4 (M6T)	1 hr 20m 1 hr 25m 1 hr 30m 1 hr 35m 1 hr 40m	1h 30m	62.5

Table A7. 10: SP6-3 Around 1 Hour Journey

Level	Journey Times	Mean (h & m)	Variance (m)
0 (M6)	1 hour 1¼ hours 1½ hours 1¾ hours 2 hours	1h 30m	562.5
1 (M6)	45 mins 1 hour 1¼ hours 1½ hours 1 ¾ hours	1h 15m	562.5
2 (M6)	1 hour 1 hour 1 hour 1½ hours 2 hours	1h 18m	720.0
3 (M6)	45 m 1 hour 1½ hours 2 hours 2¼ hours	1h 30m	1462.5
4 (M6T)	45m 50m 1 hour 1 hour 10m 1 h 15m	1h 00m	162.5

Table A7. 11: SP6-4 Around 3½ Hour Journey

Level	Journey Times	Mean (h & m)	Variance (m)
0 (M6)	3½ hours 3¾ hours 4 hours 4¼ hours 4½ hours	4h 00m	562.5
1 (M6)	4 hours 4¼ hours 4½ hours 4¾ hours 5 hours	4h 30m	562.5
2 (M6)	4 hours 4 hours 4 hours 4½ hours 5 hours	4h 18m	720.0
3 (M6)	3½ hours 4 hours 4½ hours 5 hours 5½ hours	4h 30m	2250.0
4 (M6T)	3h 20m 3h 25m 3h 30m 3h 35m 3h 40m	3h 30m	62.5

Table A7. 12: SP6-5 Around 4½ Hour Journey

Level	Journey Times	Mean (h & m)	Variance (m)
0 (M6)	4½ hours 4¾ hours 5 hours 5¼ hours 5½ hours	5h 00m	562.5
1 (M6)	5 hours 5¼ hours 5½ hours 5¾ hours 6 hours	5h 30m	562.5
2 (M6)	5 hours 5 hours 5 hours 5½ hours 6 hours	5h 18m	720.0
3 (M6)	4½ hours 5 hours 5½ hours 6 hours 6½ hours	5h 30m	2250.0
4 (M6T)	4h 20 m 4h 25m 4 h 30m 4 h 35m 4 h 40m	4h 30m	62.5

APPENDIX 8: ‘Late Running’ SP7 Design

Table A8. 2: Late Running SP7 Design

Late M6	Late M6T	M6 Toll	Scen
45	0	400	1
45	10	800	8
45	0	250	15
45	20	550	6
30	0	550	13
30	10	250	4
30	0	800	11
30	20	400	2
45	0	800	9
45	10	400	16
45	0	550	7
45	20	250	14
60	0	250	5
60	10	550	12
60	0	400	3
60	20	800	10

APPENDIX 9: Route and Departure Time Choice SP8 Designs

Table A9. 3: SP8A M6T Corridor Design

Time M6 Now	Time M6 Earlier/ Later	Adjust	Toll Now	Toll Earlier/ Later	Time M6T	Scen
80	40	-120	350	0	20	1
80	40	-60	500	100	20	8
70	30	120	750	200	20	15
70	30	60	200	0	20	6
50	30	-120	500	0	20	13
60	40	-60	350	200	20	4
60	40	120	200	100	20	11
50	30	60	750	0	20	2
70	50	-120	750	100	20	9
70	50	-60	200	0	20	16
60	40	120	350	0	20	7
50	30	60	500	200	20	14
70	40	-120	200	200	20	5
70	40	-60	750	0	20	12
80	50	120	500	0	20	3
80	50	60	350	100	20	10

Note: A negative amount of adjustment time means departing earlier.

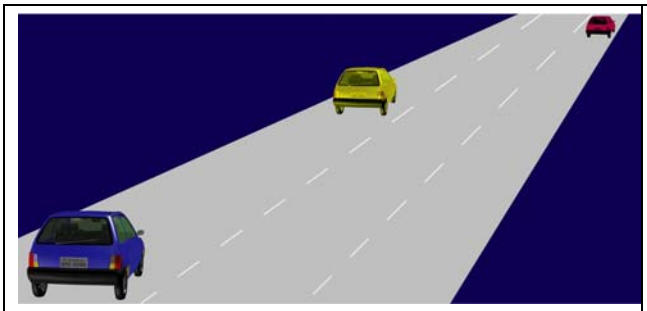
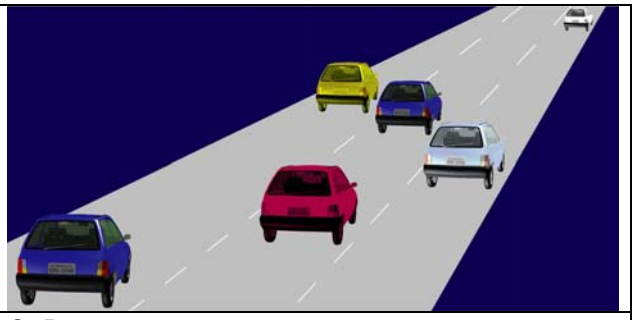
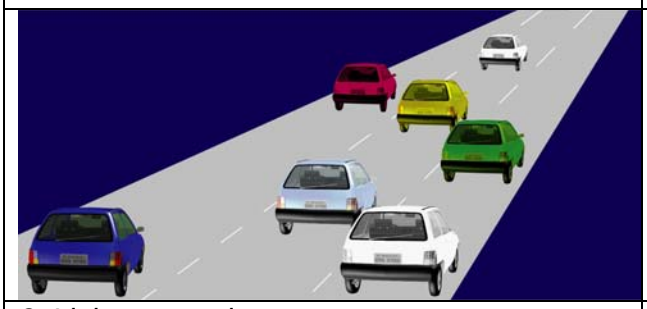
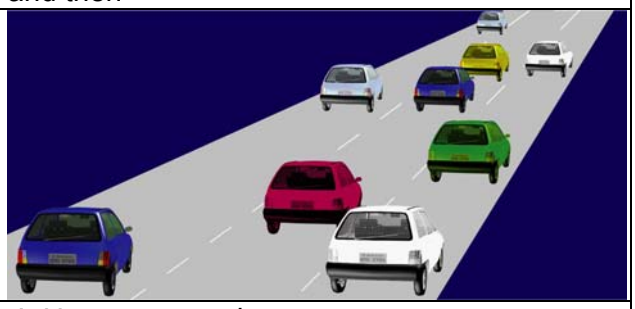
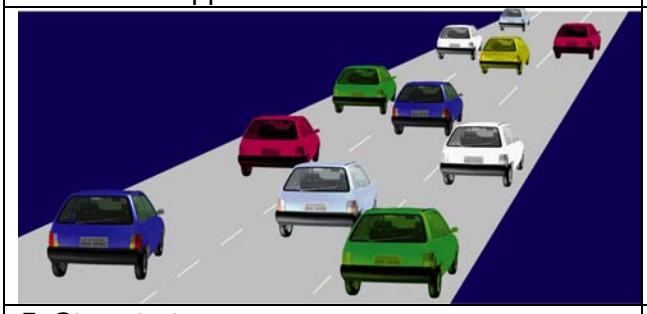
Table A9. 4: SP8B Stoke-M1 Corridor Design

Time M6 Now	Time M6 Earlier/ Later	Adjust	Toll Now	Toll Earlier/ Later	Time M6T Now	Time M6T Earlier/l Later	Scen
140	100	-60	350	0	90	75	1
130	90	-120	500	100	100	70	8
140	100	60	750	200	100	70	15
130	90	120	200	0	90	75	6
140	120	-60	500	0	80	65	13
140	120	-120	350	200	90	60	4
120	100	60	200	100	90	60	11
120	100	120	750	0	80	65	2
130	110	-60	750	100	90	75	9
130	110	-120	200	0	100	70	16
100	80	60	350	0	90	60	7
100	80	120	500	200	90	75	14
130	100	-60	200	200	90	75	5
130	100	-120	750	0	100	70	12
140	110	60	500	0	90	60	3
110	80	120	350	100	80	65	10

Note: A negative amount of adjustment time means departing earlier.

APPENDIX 10: Driving Conditions – Pictorial and Verbal Description

The verbal and pictorial definitions of the six types of driving condition were as set out below. Any one respondent was only exposed to three types of time.

	
1: Free flowing You can travel at your own speed with no problems over-taking	*2: Busy* You can travel pretty much at the speed limit, but you are forced to change lanes every now and then
	
3: Light congestion You can travel close to the speed limit most of the time, but you have to slow down every so often for no apparent reason	*4: Heavy congestion* Your speed is noticeably restricted frequent gear changes required
	
5: Stop start You are forced to drive in a “stop-start” fashion	*6: Gridlock* You are only able to move at a crawl at best, and spend quiet a lot of time stationary

APPENDIX 11: Types of Time SP Exercises

The combinations of times used are set out in Table A11.1. Option A involves two types of travel condition, one of which is better and one of which is worse than the single type of traffic condition specified in Option B.

Table A11. 4: Combinations of Times Offered

Option A	Option B
Free Flowing **(I)** and Stop Start **(II)**	Light Congestion
Busy **(I)** and Gridlock **(II)**	Heavy Congestion
Busy **(I)** and Stop Start **(II)**	Light Congestion
Free Flowing **(I)** and Heavy Congestion **(II)**	Busy

Two different 'skeleton' designs were used relating to journeys of around 15 miles and 45 miles respectively. These are set out in Tables A11.2 and A11.3.

Table A11. 5: Design for Shorter Journeys

Option A		Option B	Scen
Better **(I)**	Worse **(II)**		
5	5	15	1
5	10	20	5
5	15	25	9
10	5	20	4
10	10	25	8
10	15	15	3
15	5	25	7
15	10	15	2
15	15	20	6

Table A11. 6: Design for Longer Journeys

Option A		Option B	
Better **(I)**	Worse **(II)**		
40	20	60	1
40	25	75	5
40	30	90	9
50	20	75	4
50	25	90	8
50	30	60	3
60	20	90	7
60	25	60	2
60	30	75	6

APPENDIX 12: SP4 Designs

The SP design based around a 20 mile motorway journey is set out in Table A12.1.

There were no speed cameras on B and no information provision on A. HGV denotes the proportion of HGVs on motorway A or B.

Table A12. 3: Design SP4-1

HGV A	Info B	Time A	Time B	Speed Camera	HGV B	Lane Wdth A	Lane Width B	Scen
5	0	20	15	0	25	0	1	1
5	1	25	25	3	25	1	2	8
5	2	30	30	1	33	0	2	15
5	3	40	20	2	33	1	1	6
10	0	25	20	1	33	1	2	13
10	1	20	30	2	33	0	1	4
10	2	40	25	0	25	1	1	11
10	3	30	15	3	25	0	2	2
2	0	30	25	2	33	1	2	9
2	1	40	15	1	33	0	1	16
2	2	20	20	3	25	1	1	7
2	3	25	30	0	25	0	2	14
15	0	40	30	3	25	0	1	5
15	1	30	20	0	25	1	2	12
15	2	25	15	2	33	0	2	3
15	3	20	25	1	33	1	1	10

The information levels on option B were:

- 0 No information
- 1 Information on whether delays
- 2 information on whether delays and causes of delays
- 3 information on amount of delay expected and causes

The speed camera levels on option A were:

- 0 No Speed Cameras
- 1 Police speed cameras in operation
- 1 Speed camera
- 3 Speed cameras

The lane widths specified were:

- 0 Wide 3.75m
- 1 Standard 3.35m
- 2 Narrow 3.0m

The SP design based around a 45 mile motorway journey is set out in Table A12.2.

Table A12. 4: Design SP4-2

HGV A	Info B	Time A	Time B	Speed Camera	HGV B	Lane Wdth A	Lane Width B	Scen
5	0	45	40	0	25	0	1	1
5	1	60	60	3	25	1	2	8
5	2	75	50	1	33	0	2	15
5	3	60	50	2	33	1	1	6
10	0	60	50	1	33	1	2	13
10	1	45	50	2	33	0	1	4
10	2	60	60	0	25	1	1	11
10	3	75	40	3	25	0	2	2
2	0	75	60	2	33	1	2	9
2	1	60	40	1	33	0	1	16
2	2	45	50	3	25	1	1	7
2	3	60	50	0	25	0	2	14
15	0	60	50	3	25	0	1	5
15	1	75	50	0	25	1	2	12
15	2	60	40	2	33	0	2	3
15	3	45	60	1	33	1	1	10

Apart from the different journey times, the levels specified for speed cameras on option A were slightly different than for SP4-1. They were:

- 0 No Speed Cameras
- 1 Police speed cameras in operation
- 2 Speed cameras
- 4 Speed cameras

APPENDIX 13: SP5 Designs

The SP design based around a 20 mile motorway journey is set out in Table A13.1. Lanes denotes the number of lanes and light denotes whether lighting would be present or not. Respondents were asked to rate each road surface on a ten point scale in terms of noisiness and bumpiness.

Table A13. 3: SP5-1 Design

Surface A	Surface B	Time A	Time B	Light A	Light B	Lanes A	Lanes B	Scen
M6T	High Lvl	20	15	No	No	3	3	1
M6T	Concrete	25	25	Yes	No	4	2	8
M6T	Std M6	30	30	No	Yes	3	2	15
M6T	High Lvl	40	20	Yes	Yes	4	3	6
Std M6	High Lvl	25	20	No	Yes	4	2	13
Std M6	Concrete	20	30	Yes	Yes	3	3	4
Std M6	Std M6	40	25	No	No	4	3	11
Std M6	High Lvl	30	15	Yes	No	3	2	2
Concrete	High Lvl	30	25	Yes	Yes	4	2	9
Concrete	Concrete	40	15	No	Yes	3	3	16
Concrete	Std M6	20	20	Yes	No	4	3	7
Concrete	High Lvl	25	30	No	No	3	2	14
M6T	High Lvl	40	30	Yes	No	3	3	5
M6T	Concrete	30	20	No	No	4	2	12
M6T	Std M6	25	15	Yes	Yes	3	2	3
M6T	High Lvl	20	25	No	Yes	4	3	10

The SP design based around a 45 mile motorway journey is set out in Table A13.2. Apart from the longer journey times, the levels are the same as for SP5-1.

Table A13. 4: SP5-2 Design

Surface A	Surface B	Time A	Time B	Light A	Light B	Lanes A	Lanes B	Scen
M6T	High Lvl	45	40	No	No	3	3	1
M6T	Concrete	60	60	Yes	No	4	2	8
M6T	Std M6	75	50	No	Yes	3	2	15
M6T	High Lvl	60	50	Yes	Yes	4	3	6
Std M6	High Lvl	60	50	No	Yes	4	2	13
Std M6	Concrete	45	50	Yes	Yes	3	3	4
Std M6	Std M6	60	60	No	No	4	3	11
Std M6	High Lvl	75	40	Yes	No	3	2	2
Concrete	High Lvl	75	60	Yes	Yes	4	2	9
Concrete	Concrete	60	40	No	Yes	3	3	16
Concrete	Std M6	45	50	Yes	No	4	3	7
Concrete	High Lvl	60	50	No	No	3	2	14
M6T	High Lvl	60	50	Yes	No	3	3	5
M6T	Concrete	75	50	No	No	4	2	12
M6T	Std M6	60	40	Yes	Yes	3	2	3
M6T	High Lvl	45	60	No	Yes	4	3	10

Car User Survey

Department for Transport

APPENDIX 14

Thank you for agreeing to answer this questionnaire. The M6 Toll is the first motorway tolling project in the UK. It aims to alleviate congestion on the M6 around Birmingham. This research is being undertaken on behalf of the Department for Transport by the Institute for Transport Studies at the University of Leeds and Faber Maunsell. The purpose of the survey is to investigate motorists' attitudes towards different types of roads and traffic conditions.

We would be very grateful if you could answer the questions below which relate to the journey you were making when contacted. The more information we collect, the better we will be able to plan for the future. It will not take very long to complete the form and there is a prize draw for £1000 for those forms that we receive back within one month. A freepost envelope is provided for you to return your completed questionnaire to us. All information will be treated according to Data Protection legislation.

If you have any queries regarding this survey, please contact Mark Wardman on 0113 343 5349.

Q1 Where did you start and end the journey that you were making when you were initially contacted by us?

	Town or District	County	Postcode if known
Journey started in:			
Journey finished in:			

Q2 Which leg of your journey were you on?

Outward ○	Return ○	Multistage ○	One way trip ○

Q3 At about what time did you set out on this leg of your journey and on what day did you travel?

_____ am / pm	Mon ○	Tue ○	Wed ○	Thu ○	Fri ○	Sat ○	Sun ○

Q4 What was the purpose of your journey?

Employer's business ○	To/from regular work place/education ○	Shopping ○
Visiting friends/relatives ○	Short break ○	Holiday ○
Personal business ○	Recreation/ leisure ○	Other ○ PLEASE SPECIFY _____

Q5 How many other people were you travelling with?

None ○	1 Other ○	2 Others ○	3 Others ○	4 Others ○	5+ Others ○

Q6 And how many of these were aged 16 or less?

None ○	1 Child ○	2 Children ○	3 Children ○	4 Children ○	5+ Children ○

Q7 Were you the main driver?

Yes ○	No ○

Q8 For the journey you were making through the Midlands, you could have used the M6 motorway, the M6 Toll road, or other A roads – such as the A500/A50 between the M1/M6 intersection (M1 J19) and Junction 15 near Stoke. Which route did you use?

M6 ○	M6 Toll ○	'A' Roads ○

Car User Survey

Department for Transport

Q9 At the time you were travelling, how long would you expect your end-to-end journey to take (driving time excluding any time stopped-off) on each route?

M6 Journey Time	Journey Time Using M6 Toll	'A' Roads
hrs ____ mins ____	hrs ____ mins ____	hrs ____ mins ____
Don't know ○	Don't know ○	Don't know ○

Q10 What did you base your estimates of the journey times upon? Please tick all that apply.

Journey planner ○	Previous experience ○	Expected speeds ○
Traffic and travel news ○	Information from friends/colleagues ○	Other ○ PLEASE SPECIFY _____

Q11 Did you have to be at your destination at a particular time?

No, I could arrive at any time ○	Yes ○ and I could be up to _____ minutes late.

Q12 On each route, what proportion of the traffic would you estimate is made up of heavy goods vehicles?

M6 _____%	M6 Toll _____%	A Roads _____%

Q13 How reliable would you say the journey times are on the following routes in terms of arriving at your destination at the expected time:

M6	Very reliable ○	Reliable ○	Usually reliable ○	Sometimes unreliable ○	Unreliable ○	Very unreliable ○	Don't know ○
M6 Toll	Very reliable ○	Reliable ○	Usually reliable ○	Sometimes unreliable ○	Unreliable ○	Very unreliable ○	Don't know ○
'A' Roads	Very reliable ○	Reliable ○	Usually reliable ○	Sometimes unreliable ○	Unreliable ○	Very unreliable ○	Don't know ○

Q14 What is the charge to use the M6 Toll?

£ ____:____	Don't know ○

Q15 Who would/did pay the M6 toll charge?

Employer reimburses ○	Self ○	Shared between group ○	Other passenger / driver ○

Q16 About how much was the cost of the petrol for the journey you made?

£ ____:____	Don't know ○

Q17 Would the route using A roads be any different in petrol cost than using the motorways?

£ ____:____ more/ less PLEASE DELETE AS APPROPRIATE	No difference ○	Don't know ○

Q18 Do differences in fuel costs enter into your decisions as to which route to use?

Yes ○	No ○

Q19 How often do you make a journey such as this where there is the possibility of using the M6 Toll?

First time today ○	Weekly ○	Several times a year ○
Daily ○	Several times a month ○	Once a year ○
Several times a week ○	Monthly ○	Less than once a year ○

Q20 When did you make your decision as to whether or not to use the M6 Toll?

Prior to setting out ○	During the course of the journey ○	Approaching the M6 Toll ○	Never considered using the M6 Toll ○

Q21 If you decided during the course of your journey, which of the following influenced your decision? Please tick all that apply

Observed traffic conditions ○	Sign indicating delays on M6 ○	Radio messages ○	Other passengers influenced decision ○
Wanted a break from the M6 ○	Wanted to make up some time ○	Observed road works ○	Other PLEASE SPECIFY _____

Q23 Please state whether you agree or not with the following statements regarding toll roads:

I would object to paying tolls on existing motorways	Strongly Agree ○	Agree ○	Neither Agree nor Disagree ○	Disagree ○	Strongly Disagree ○
Paying tolls on existing motorways would be acceptable if fuel duty were scrapped.	Strongly Agree ○	Agree ○	Neither Agree nor Disagree ○	Disagree ○	Strongly Disagree ○
I object to paying tolls to use new motorways.	Strongly Agree ○	Agree ○	Neither Agree nor Disagree ○	Disagree ○	Strongly Disagree ○
I think tolls are a sensible means of funding additional road infrastructure.	Strongly Agree ○	Agree ○	Neither Agree nor Disagree ○	Disagree ○	Strongly Disagree ○

Q24 If you have made previous journeys this year when you could have used the M6 Toll, about how many times have you used it?

_____ times out of _____ (single) journeys

Q25 If you did use the M6 Toll for the journey you were making when initially contacted, what level of toll would make you switch to using the M6 instead?

£ ____:____	Don't know ○

Q26 If you did use the M6 Toll for the journey you were making when initially contacted, what reduction in the M6 journey time would be just sufficient to make you switch to using it?

hrs____ mins ____	Don't know ○

Q27 If you did NOT use the M6 Toll for the journey you were making when initially contacted, what level of toll would make you switch to using the M6 Toll instead?

£ ____:_____	Would not switch even if M6 Toll was free ○	Don't know ○

Q28 If you did NOT use the M6 Toll for the journey you were making when initially contacted, what increase in the M6 journey time would be sufficient to make you switch to using the M6 Toll instead?

hrs ____ mins ____	Don't know ○

Q29 What vehicle were you driving on the journey you were making when initially contacted?

Car ○	Motorcycle ○
Light Goods Vehicle, used for making deliveries ○	Light Goods Vehicle, used in providing services ○

Car User Survey

Department for Transport

Q30 Are you:

Male ○	Female ○

Q31 In which age group do you belong?

Under 18 ○	18-24 ○	25-34 ○	35-44 ○	45-54 ○	55-64 ○	65-74 ○	75+ ○

Q32 What is your annual household income before the deduction of tax?

Less than £10k ○	£10k-£19k ○	£20k-£29k ○	£30k-£39k ○
£40k-£49k○	£50k-£59k ○	£60k-£69k ○	£70k-£79k ○
£80k-£89k ○	£90k-£99k ○	Over £100k ○	Do not wish to disclose ○

Thank you for your assistance.

Please return this questionnaire using the freepost envelope provided or alternatively send to the following address:

Faber Maunsell,

FREEPOST ALM1534,

Altrincham,

WA14 2BR.

Those completed forms we receive back within a month of the survey will be entered into a Prize Draw for £1000. If you wish to be entered, please give your name, contact number and/or address below:

Name:	Telephone Number:
Address:	

M6 Toll User Survey

Department for Transport

APPENDIX 15

Why have I been given a questionnaire?

This survey is being carried out by Faber Maunsell on behalf of the Department for Transport (DfT). It is designed to record information on travel patterns.

Why should I complete this form?

The more information we have, the better we will be able to plan for the future. It will not take very long to complete the form and there is a prize draw for **£1000** for those forms that we receive back within one month of the survey. A Freepost envelope is provided for you to return your completed questionnaire to us – no stamp required. The person who was driving at the time of the survey should complete the form. Please complete at the END of your journey.

What will happen to the information?

The surveys are being conducted under the Market Research Society Code of Conduct and any personal information you provide is fully confidential and will not be passed to the DfT in any way that identifies you. If you have any questions about the survey please phone Christine Heaver of Faber Maunsell on 0161 927 8451 (9-5.30, Mon-Fri).

Section 1 – About the journey you were making at the time you were given this questionnaire

Q1.1 **Where did your journey start?**
Please give postcode if known……
If not known,
please give street and City/town/ ……..

Q1.2 **What was the main reason you were at that address?** *Please ✓ one only*

- ❑ 1 Home / place of residence
- ❑ 2 Usual place of work
- ❑ 3 Visiting on business/in connection with work
- ❑ 4 Visiting friends/relations
- ❑ 5 Holiday accommodation / holiday
- ❑ 6 Leisure (not holiday) e.g. day out
- ❑ 7 Personal Business (eg doctor, bank, etc)
- ❑ 8 Education
- ❑ 9 Shopping
- ❑ 10 Other (please specify)

Q1.3 **And where were you travelling to?**

Please give postcode if known ……..……
If not known,
please give street and City/town/ ……..……..

Q1.4 **What was the main reason you were going to that address?** *Please ✓ one only*

- ❑ 1 Home / place of residence
- ❑ 2 Usual place of work
- ❑ 3 Visiting on business/in connection with work
- ❑ 4 Visiting friends/relations
- ❑ 5 Holiday accommodation / holiday
- ❑ 6 Leisure (not holiday) e.g. day out
- ❑ 7 Personal Business (eg doctor, bank, etc)
- ❑ 8 Education
- ❑ 9 Shopping
- ❑ 10 Other (please specify)

Q1.5 **Approximately what time did you set off?** ……am /pm

And at approximately what time did you arrive at your destination? ……am /pm **ACTUAL**

At what time had you EXPECTED to arrive at your destination? ……am /pm **EXPECTED**

At approximately what time did you pass through the M6Toll barrier? ……am /pm

Q1.6 **Which day of the week was this?** *Please ✓ one only*

❑ 1 Mon ❑ 2 Tues ❑ 3 Wed ❑ 4 Thur ❑ 5 Fri ❑ 6 Sat ❑ 7 Sun

M6 Toll User Survey

Department for Transport

Q1.7 **Did you have to arrive at your destination by a particular time?**
Please ✓ one only

Yes I had to be there by a certain time ❑ 1 *GO TO Q 1.8*

No, I could arrive any time I liked ❑ 2 *GO TO Q 1.9*

Q1.8 ***I needed to be at my destination***

no later than ……. minutes after my EXPECTED time *NOW GO TO Q 1.9*

Q1.9 **Did you stop en route, e.g. at a service station?** *Please ✓ one only*

No ❑ 1 *Go to Question 1.10*

Yes ❑ 2
Please say where,
e.g. services, or place name **…. ……..……**

Approximately how long did you stop for? **……** Hours……. mins *NOW GO TO Q 1.10*

Q1.10 **What type of vehicle were you using when making this journey?** *Please ✓ one only*

❑ 1 **Van**	❑ 2 **heavy goods vehicle**	***GO TO Q1.11***
❑ 3 **Bus /Coach**		***GO TO Q1.12***
❑ 4 **car**	❑ 5 **motorcycle/scooter**	***GO TO Q1.13***
❑ 6 **other (specify)**		***GO TO Q1.13***

Q1.11 **GOODS VEHICLE DRIVERS** *Please ✓ one only*

a) Were you driving for…
❑ 1 Shipper ❑ 2 Haulier ❑ 3 Neither

b) What type of load was being carried?

❑ 8 Bulk (Steel, coal, agriculture, aggregates)	❑ 3 General Haulage	❑ 6 Parcels / post
	❑ 4 Food	❑ 7 Non Food Retail
❑ 2 High Value	❑ 5 Low Value	❑ 8 Various

c) At the time you were given the questionnaire, was the vehicle…
❑ 1 Loaded ❑ 2 Part Loaded ❑ 3 Empty *NOW GO TO Q 1.13*

Q1.12 **COACH DRIVERS** *Please ✓ one only*

a) Please indicate how many seats the vehicle has **……seats**

b) What type of service was this?
❑ 1 Charter ❑ 2 Scheduled

c) And how many passengers (approx) were being carried?
(at the time you were given the questionnaire)
passengers *NOW GO TO Q 1.14*

Q1.13 **CAR DRIVERS/MOTORCYCLISTS/GOODS VEHICLES DRIVERS**
How many people, in addition to the driver were in the vehicle (at the time you were using the M6Toll) ?
Please ✓ one only

❑ 1 none – just the driver
❑ 2 one passenger ❑ 4 three passengers
❑ 3 two passengers ❑ 5 four or more passengers *NOW GO TO Q 1.14*

M6 Toll User Survey

Department for Transport

Q1.14 **ALL Who paid for the toll charge when making this trip?** *Please ✓ one only*

- ❑ 1 employer reimburses cost
- ❑ 2 self
- ❑ 3 split between travellers
- ❑ 4 other passenger/driver

Q1.15 **Were you staying away from home on this trip and if so how many nights?** *Please ✓ one only*

- ❑ 1 No: none
- ❑ 2 Yes, one night away
- ❑ 3 Yes, two nights away
- ❑ 4 Yes, three or more nights away

Q1.16 **And was this trip your outward or return leg?** *Please ✓ one only*

- ❑ 1 Outward
- ❑ 2 Return
- ❑ 3 One Way trip

Section 2 – Usage of the M6 Toll Road

Q2.1 **How important were the following in your decision to use the M6 Toll for your journey (on the day you were given the questionnaire)?**
Please ✓ one (1 to 3) for each statement

		Not at all important	Quite important	Very Important
A	It saves time over alternative routes	❑ 1	❑ 2	❑ 3
B	I used it by mistake (in wrong lane/misleading signs)	❑ 1	❑ 2	❑ 3
C	Able to travel at the speed I want to	❑ 1	❑ 2	❑ 3
D	Avoiding routes with lots of HGVs	❑ 1	❑ 2	❑ 3
E	Trying it out	❑ 1	❑ 2	❑ 3
F	Journey times are more predictable than alternative routes	❑ 1	❑ 2	❑ 3
G	Signs on approach warned of congestion on alternative route	❑ 1	❑ 2	❑ 3
H	The smooth road surface	❑ 1	❑ 2	❑ 3
I	Use of Norton Canes services	❑ 1	❑ 2	❑ 3
J	Less stressful to drive on than alternative routes	❑ 1	❑ 2	❑ 3
K	Guarantee of no hold ups	❑ 1	❑ 2	❑ 3
L	Route is more direct for me than any alternative route	❑ 1	❑ 2	❑ 3
M	The scenery/environment is more pleasant than the alternative routes	❑ 1	❑ 2	❑ 3
N	Heard traffic report of congestion/accidents on alternative route	❑ 1	❑ 2	❑ 3
O	Avoiding road works on M6	❑ 1	❑ 2	❑ 3

Q2.2 **Which of the above reasons (A-O) would you say was the MAIN reason?**

_____

If your main reason for using the M6 Toll is not shown above, please tell us what it is.

Q2.3 **How often do you make this journey for this purpose (i.e. between the places given in Q1.1 and Q1.3)**
Please ✓ one only

- ❑ 1 First time today
- ❑ 2 Daily
- ❑ 3 Several times a week
- ❑ 4 Weekly
- ❑ 5 Several times a month
- ❑ 6 Monthly
- ❑ 7 Several times a year
- ❑ 8 Once a year
- ❑ 9 Less than once year

Q2.4 **Approximately how many times would you use these routes when making this journey?**

M6 Toll	**M6 Non Toll**	**A50/A500 route**
❑ 1 Most of the time	❑ 1 Most of the time	❑ 1 Most of the time
❑ 2 more than half the time	❑ 2 more than half the time	❑ 2 more than half the time
❑ 3 about half the time	❑ 3 about half the time	❑ 3 about half the time
❑ 4 less than half the time	❑ 4 less than half the time	❑ 4 less than half the time
❑ 5 very rarely	❑ 5 very rarely	❑ 5 very rarely
❑ 6 never	❑ 6 never	❑ 6 never

M6 Toll User Survey

Department for Transport

Section 3 – About You

Please provide the following information about yourself so that we can check whether we have a representative sample. This information will not be passed to the DfT in any way that could identify you

Q3.1 **Record Gender** *Please ✓ one only*

❑ 1 Male ❑ 2 Female

Q3.2 **What age group do you belong in?** *Please ✓ one only*

❑ 1 Under 18 ❑ 3 25 - 34 ❑ 5 45 - 54 ❑ 7 65 - 74
❑ 2 18 - 24 ❑ 4 35 - 44 ❑ 6 55 - 64 ❑ 8 75 +

Q3.3 *If travelling alone, please GO TO Q 3.4*
How would you describe the other occupants travelling with you today?
Please ✓ all that apply

❑ 1 partner ❑ 3 colleagues ❑ 5 with children (5-16) ❑ 7 pets / other animals
❑ 2 friends ❑ 4 with small children (under 5) ❑ 6 with family (mixed ages)

Q3.4 **Please indicate your approximate household income**
Please ✓ one only

❑ 1 under £10,000 pa ❑ 5 between £40k to £49,999 ❑ 8 over £70k
❑ 2 between £10k to £19,999
❑ 3 between £20k to £29,999 ❑ 6 between £50k to £59,999 ❑ 9 prefer not to disclose
❑ 4 between £30k to £39,999 ❑ 7 between £60k to £69,999 ❑ 0 don't know

Thank you. Please return your completed questionnaire to us in the Freepost envelope provided.
If misplaced, address to:
Faber Maunsell, FREEPOST ALM1534, Altrincham, WA14 2BR

We need your help! We would like to explore your decision to use the M6Toll road in more detail. Please indicate below if you would be prepared to take part in a further short postal survey.

Yes, I will take part in further research… ❑ 1 *Please enter your name and address in the box below*
No, do not send me anything else … ❑ 2

Those completed forms that we receive back within a month of the survey will be entered into a Prize Draw for £1000. If you wish to be entered for this please give your name and provide a phone number or contact address below.

Name
……
Address ……
……Contact phone number
……

APPENDIX 16: Derivation of Expansion Factors for RP/SP Data

Background

In order to undertake the sample enumeration exercise and to correctly weight the SP survey data it is necessary to attach appropriate expansion factors to the RP/SP dataset so that when aggregated they provide a robust estimate of the respective market shares between the M6 Toll, M6 and A road corridor choices.

The RP data has been collected from four separate sources:

- M6 toll booth surveys with postal return questionnaires issued to all drivers and random driver interviews to provide some controls to eliminate respondent bias;
- Questionnaires issued to a random sample of the M6 toll TAG users;
- Questionnaires issued at roadside interview surveys to all those in scope, i.e. those who had/or would pass through the M6 Toll corridor; and
- Questionnaires issued at motorway service stations to travellers in scope in order to catch some longer distance non M6 Toll travellers.

It should be noted at the outset that there are clear limitations in the data coverage which can be summarised as:

- The roadside interview coverage provides partial information on movements through the corridor as firstly it was not practical to cover all slip roads, and secondly because certain proposed surveys were vetoed by the Highways Agency or Police as presenting a potential safety hazard;
- The MSA surveys were also a sample of the available potential stopping points and whilst they were selected so as to capture most of the likely long distance travel of interest it is inevitable that it will not comprise a complete representation; and
- There is extensive potential for double counting with M6 Toll users being observed at the toll booths, the RSI's and the MSA surveys.

An expansion methodology was developed that takes full account of the limitations of the data and eliminates double counting. A primary decision in the development of the expansion factors was that all the RP data should be retained in order to ensure the maximum variability in the data.

Approach

In order to provide some context to the proposed methodology for the data expansion a spatial analysis of the RP data was undertaken. Figure A16.1 shows the distribution of the origins and destinations of the RP data and as expected it is clear that the main movements are south east-west midlands-north west/Scotland. These can be considered in terms of the sectors marked on Figure A16.2 which cover the primary movement areas for traffic in scope for using the M6 Toll. Table A16.1 shows the number of RP records in each primary sector to sector movement.

The definition of a sector system plays an important role in the expansion process as it provides a mechanism to apply control totals to the process. The sectors used in the process covered the areas shown in Figure A16.2 with the sector level definition being at metropolitan area and county level.

The approach to the RP data expansion is described in the following sequence of steps.

Step 1 – expand the M6 TAG user returns to typical weeks TAG usage data obtained from M6 Toll operating company.

Step 2 – expand the M6 Toll booth RP data returns to a typical weeks toll usage based on data obtained from M6 Toll operator on tolls paid by class of vehicle by hour of day for a typical week. In this process the journey purpose corrections to allow for respondent bias were applied to the RP data records. (This corrects for any observed differences in trip purpose or journey length effects between the random driver interview at the toll booth and the RP toll booth returned self complete questionnaires)

Step 3 – create sector-to-sector matrices of expanded and unexpanded (M6 Toll Booth + M6 TAG user records).

Step 4 - create a sector-to-sector matrix of unexpanded M6 User RP records from the RSI and MSA survey records

Step 5 – create sector-to-sector factors to correct for double counting of M6 Toll user trips in the RP data set created from the four separate survey sources. This will be:

$F(M6\ Toll + TAG\ users)_{ij} = U(M6\ Toll + TAG)_{ij} / (U(M6\ Toll + TAG)_{ij} + U(RSI+MSA)_{ij})$

$F(RSI+MSA)_{ij} = U(RSI+MSA)_{ij} / (U(M6\ Toll + TAG)_{ij} + U(RSI+MSA)_{ij})$

Where $U(M6\ Toll + TAG)_{ij}$ = unexpanded sector to sector RP records
$U(RSI+MSA)_{ij}$ = unexpanded sector to sector RP records

Step 6 – amend M6 Toll user RP records expansion factors by applying above correction factors. Then create expanded M6 toll User demand matrix TF(M6 Toll User).

Step 7 – expand the RSI and MSA RP data to the counts observed on days of surveys.

Step 8 – create sector to sector matrices of M6 Toll Users and Non-M6T users from the above expanded RSI and MSA data.

These are $T(M6T\ RSI+MSA)_{ij}$ and $T(non\text{-}M6T\ RSI+MSA)_{ij}$

Where it was not possible to calculate a proportional split because of lack of data in the sector-sector matrices then the proportion for similar length sector-sector movements was adopted.

Step 9 – based on the assumption that the M6T User matrices derived from the expanded M6 Toll and TAG data is 100% of the M6T users then the total numbers of non-M6T users can be estimated from:

$TF(non\text{-}M6T\ users)ij = TF(M6\ Toll\ User) * T(non\text{-}M6T\ RSI+MSA)_{ij} / T(M6T\ RSI+MSA)_{ij}$

Step 10 – calculate correction factors for sector-sector movements for non-M6T trips

$F(non\text{-}M6T) = TF(non\text{-}M6T\ users)_{ij} / T(non\text{-}M6T\ RSI+MSA)_{ij}$

Step 11 - amend non- M6 Toll user RP records expansion factors by applying above correction factors.

Step 12 – expand all RP data using the amended expansion factors and check the outturn totals for M6Toll and non-M6Toll users with exogenous evidence.

The above process resulted in a set of expansion factors for the RP records that took account of double counting, addressed the issue of partial observations of non-M6T users, and produced a typical weeks set of demands for M6Toll and non M6Toll for the trips in scope.

It should be noted that the above analyses was undertaken by broad purpose segmentations but there was a limit as to how far the data could be sub divided before the sector-to-sector records become too low for meaningful analyses to be undertaken.

Figure A16.1 Distribution of RP Data Origins and Destinations

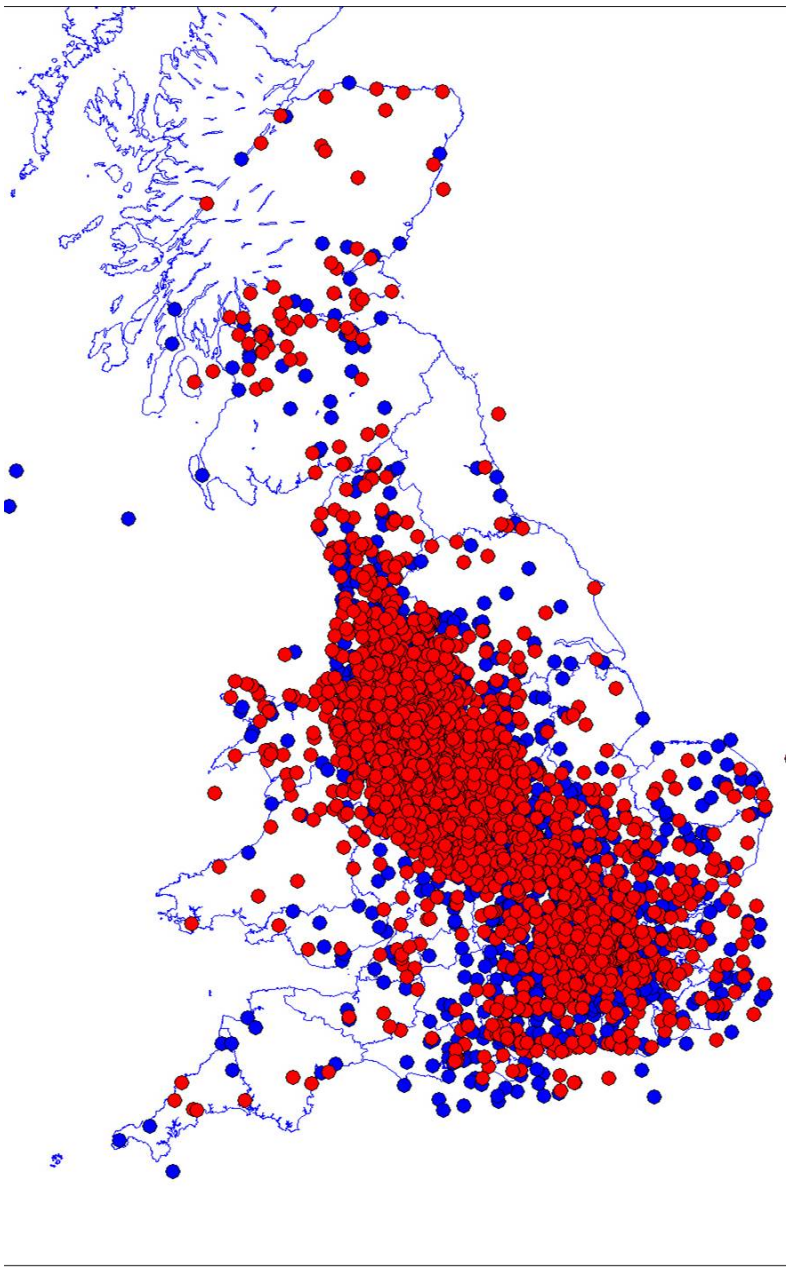


Figure A16.2 Primary Sector to Sector Movements

Table A16.1 RP Data Sector to Sector Movements (All Data)

	1	2	3	4	5	6	7	8	9	10	11	12
Scotland	0	0	0	0	0	0	0	15	0	2	32	6
North West	0	1	0	1	0	0	2	32	7	6	78	37
North East	0	0	1	0	0	5	0	4	1	0	4	1
M/Cr/Liv/Cheshire	2	1	0	12	1	3	5	178	9	52	309	120
W & S Yorks	0	0	0	0	0	5	0	9	0	0	3	2
Shropshire	2	1	3	1	17	2	2	94	3	59	58	34
Staffordshire	1	1	0	1	0	0	6	160	13	24	64	39
West Midlands	9	35	2	123	13	42	62	317	10	75	40	43
South West	3	8	0	8	4	0	6	3	2	14	1	2
East Midlands/Anglia	4	9	0	46	0	33	13	62	12	11	15	5
South East	24	80	1	212	1	20	22	32	3	8	11	0
Northants	8	45	1	81	2	15	21	31	2	2	0	6