A Conditioned Model for Choice of Mode Under Information

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ABSTRACT

This paper examines the influence of time and cost information obtained from different sources on choice of mode of Leeds' long distance travellers. The choice of mode was investigated through modal attributes provided by at least two different information sources which might provide contrary or corroborating information rather than on actual attributes. The experiment included telephone-administered questionnaire including RP (Revealed Preference) questions and an SP (Stated Preference) exercise dealing with the choice of modes conditioned by the information received from various sources. Information on travel time and cost was provided from two different information sources for each mode to facilitate the conditioning of mode choice on corroborating/contradictory information. The research employs a wide range of modelling methodologies and examines a range of traditional and newly developed calibration and estimation procedures including Mixed Logit models with individual specific parameters and the newly developed RRM (Random Regret Minimisation) framework. The study confirms that the market share of the modes increases when information sources show decreased travel time and cost values and shows that the maximum shares are achieved when different information sources give the same information to the travellers. The study found that pre-trip time information has more influence on mode choice when derived from websites than when derived from other sources. Pre-trip information on costs was, however, less influential when derived from websites than when derived from other sources.

Key Words: **Choice Modelling, Travel Information, Mixed Logit, Random Regret Model, Mode Choice.**

1. INTRODUCTION

Traveller information has long been used to improve traffic and network conditions. Many types of information services and products are already in the market and developments continue with new generations of these systems using portable personal communication devices. It has been widely acknowledged that providing travellers the information about their travel choices influences their behaviour in ways that are beneficial for the efficiency and use of the transport system [1-2]. In order to understand behaviour with information it is desirable to first discuss what type of information is required, who wants information, and what should be the information content. The following paragraphs briefly explore these questions.

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Literature on the travel information need and type suggests that, in most cases, people require information about travel time and travel cost for different modes [3]. The literature also suggests that age, sex, income level and education are the key factors that influence the use of traveller information [4-11]. Trip purpose also has an influence; various studies report that different trip purposes produce different responses towards traffic information. For example, Hato, et. al. [12] found that commuters were less likely to divert to alternative routes under information as compared to other trip purposes. Literature suggests that a combination of prescriptive and quantitative information influences travellers more than prescriptive or qualitative information alone [6-7,9,11,13-16]. The credibility of the information source is found to be an important determinant which influences the travellers' decisions. Bonsall and Parry [13] found that travellers tend to give less credence to information than to what they actually observe with their own eyes. Bonsall, et. al. [14] also found that travellers prefer to test the credibility of the information source before relying on it. Bonsall [4] reported that the influence of traffic information on route choice depended on whether the information was credible, relevant and clear. He also reported that the credibility of the information source heavily influences user compliance. The information search process can be explained under different theories of decision making including maximising decision strategy [17], satisficing behaviour [18] and regret minimisation [19]. Several notions of microeconomic search theory can be found in travel demand studies [20-27]. Applying the insights gained from the review to the question of travellers' search for information, it can be argued that travellers behave differently in different travel situations. For Instance, if they are planning a one-off long distance trip, they would tend to maximise their choices, and in doing so they might spend sufficient resources to achieve the best available alternative. On the other hand, while planning a frequent day to day journey e.g. commuting, they tend to follow satisficing or habitual behaviour. Here the search process ends when an alternative is good enough to meet the aspiration levels of the traveller. The current research focuses on one-off travel decisions and the maximising principle will be generally assumed to prevail not least because of its compatibility with a range of theories in a wide range of disciplines. Furthermore, utility maximisation theory is easier to implement in the current context as other methods would further complicate an already complicated model structure. Utility maximisation provides a way by which choice probabilities can be estimated relatively easily. The regret minimising approach also seems plausible in the current situation. A traveller may also try to minimise the regret associated with the forgone alternatives. Hence in this study, additional models will be estimated on the basis of regret minimisation principles to check their robustness. The aim of the study is to investigate the effects of various information sources on mode choice for travellers who use public transport at least occasionally. This research focuses on the role and use of information sources in long distance journeys made at relatively short notice. It was anticipated that the cost implications of making a trip at short notice would not make some modes unattractive because the cost levels were specified without customisation. The pilot surveys also confirmed that there was sufficient trading between the modes at the specified attribute levels. We note, however, that non-observed attributes (such as effort required to prepare for a trip by a given mode) might be affected by the short notice but this would affect all the modes and would not make any single mode unattractive.

2. SCOPE AND STRUCTURE OF THE PAPER

Following the introduction, Section 3 briefly discusses the design of the questionnaire and includes the details of the SP experimental design and explains the choice of SP scenario, attributes, and levels for the selected variables for mode choice experiments used to model mode choice decisions. Section 3 also describes the selection of the CATI (Computer Assisted Telephonic Interview) technique and the use of simulation and pilot studies in the development of the final SP exercise. Section 4 details the calibration and estimation of separate models for mode choice based on RP and SP data and then estimates models using both RP and SP data. Four alternative model specifications are calibrated from the collected data. The four model specifications include the multinomial logit, the nested logit, the mixed logit and the random regret minimisation models. The Jack-knife method was applied to correct the SP MNL (Multinomial Logit) models for repeated measurement bias and a specification with random individual-specific taste variation was applied to the mixed logit models. In Section 5, the disaggregate choice models developed in Section 4 are applied to generate mode choice forecasts. The forecasts are made on both the estimation sample and the expanded sample taking account of the NTS (National Travel Survey) 2006 long distance travellers' demographics. Finally Section 6 provides the summary of the achievements of this work and identifies areas that would benefit from further research.

3. DATA COLLECTION

The questionnaire developed in this study has four parts. The first part gathers RP data for the last long journey (over 50 miles) made by the respondents who use public transport (regularly/occasionally) for their journeys and are residents of Leeds. The second part includes SP survey questions to investigate their mode choice under information when making long journeys (the survey also included another SP experiment that dealt with the choice of information source, but this is not discussed in the present paper). The third part includes general questions about their attitudes towards different sources of information and on their normal search patterns. The final part contains questions about the travellers' characteristics.

The questionnaire could not be paper based because complex branching/routing is required depending on the respondent's characteristics and recent behaviour. In order to better comprehend the choice behaviour, the questionnaire needs to be interactive such that the appearance of a question sometimes depends on the previous response of the respondent. Hence it was decided to use a computer based questionnaire. It was hoped that it could be based on CAPIs (Computer Assisted Personal Interviews) at relevant locations (bus or train stations), but the pilot survey revealed that the questionnaire had typically taken about 25 minutes to complete too long for completion of an at station interview. Interviewing the respondents via CAPI at their homes or workplaces had to be ruled out because of resource constraints. The decision was therefore made to recruit people at stations and arrange to interview them by telephone using CATI software to facilitate branching & routing. Another method which was considered was online or internet based surveys but that method was not suitable in the current context because it could include only those respondents who are already familiar with the internet and so would result in a biased sample. Furthermore, in online surveys, respondents may find it difficult to understand complicated questionnaires of the type we were envisaging (in CATI, the interviewer can help avoid errors and the chance of the loss of a valuable respondent is reduced). Commercially available software was used to create questionnaires.

3.1 Non SP Content

In the RP part of the questionnaire the data was gathered for the last long journey (over 50 miles) made by the respondent. An account of the journey was obtained by asking numerous questions including their frequency of travel to those destinations, purpose of visits and the chosen mode. In order to reconstruct the choice set, questions were asked regarding respondents' perception of attributes of different modes available to them when they were taking the travel decisions. The questionnaire also included questions regarding the external circumstances of the journey and about the use and effect of any information source used while taking travel decisions about that journey. The main reason for including these questions before the SP data was to explore the respondents' current travel behaviour and use of travel information. Moreover RP questions, being based on real travel decisions, avoided the obvious biases inherent in SP data. Other non SP questions explored respondents' attitudes towards different sources of information, their normal information search patterns and their personal characteristics.

3.2. SP Content

The SP exercise dealt with the choice of mode by users and non-users of the information sources. A number of alternative scenarios varying the trip destination, purpose and accompanying individuals were tested in the pilot surveys. The most influential scenario(s) were selected. A fractional factorial design was used with the fraction selected to avoid dominance (combinations in which the respondent is better off or worse off on every dimension). However, since dominated options can be used to identify non-logical responses, each SP exercise included one dominated option to check the consistency of responses. In the interests of simplicity, it was decided to present a binary choice regarding choice of information source. D-efficient designs are promising, but only when based on accurate prior parameter values. As this study is novel, good quality priori information of coefficients is lacking and the use of conventional fractional factorial designs is considered more appropriate. Three modes were identified as relevant; car, train and coach. This yields three binary choices; car and train, car and coach, or coach and train. However, simulation results for the car-coach choice indicated that trading would only occur at implausible cost and time values and so it was decided to concentrate on the other two choices. Each individual saw 5 choices between car and train and 4 choices between coach and train. The SP questionnaire was customised to reflect characteristics of the respondent such as their car availability (i.e. if car is unavailable to them, the questionnaire would show choices between coach and train only).

3.2.1 Representation of the Scenarios

In this research the scenario was a long journey between cities. Although it would have been easy to present respondents with a hypothetical journey without mentioning the destination however, if the use of information sources is unrealistic, the respondents would be unable to conceptualise proper need for specific information. One option was to offer a journey from Leeds to London since this is a long journey and requires acquisition of information for a variety of conditions. However, specifying London as the destination would have brought two problems; firstly, the car mode is relatively unattractive for single travellers and secondly a large proportion of our sample were likely to have recently made a trip to London and so the choice of mode and information source would be highly influenced by the experience of previous journeys and information sources. A journey from Leeds to Cardiff was selected on the grounds that it avoids all of the above mentioned problems; Cardiff is distant from Leeds (about 250 km), can be reached from Leeds by car, coach or train (with no mode being unattractive), and, although offering numerous potential sub destinations for business and leisure trips, is a relatively rare destination for Leeds residents.

Two scenarios were selected for the SP exercise, one was a trip for personal business and the other was a leisure trip. The first scenario asked respondents to "imagine that you need to travel from Leeds to Cardiff in 3 days time on personal business with an appointment from 1130 till 1230 in Cardiff city hall". The scenario is not varied within one SP design, rather the scenario attributes are explored by adding questions in the RP part of the questionnaire. The reason for keeping the scenario constant within a single SP game is that variation would complicate an already complicated SP design and questionnaire. It would also tend to make the experiments and questionnaire lengthy and it would be difficult to keep the respondents' interest intact throughout the interview. The other scenario for a separate set of respondents asked the respondents to "imagine that you need to travel from Leeds to Cardiff in 3 days time on a leisure trip with two of your friends and you need to arrive there at 1130". The sample size for the leisure trip obtained after the survey was inadequate to support the estimation and hence the current paper only reports models for the personal business (solo) trip.

3.2.2 Attributes and Levels of SP Design

The attributes of the SP design were selected considering those used and found significant in the relevant previous studies [6-7,9,11,28-30]. Travel times, levels of extra delay, levels of costs, and the available sources of information are selected to represent the respondent's choice situation. The sources of information were the same as mentioned in the RP part and different combinations were used with each alternative. The potential "full" set of the information sources was pruned to make it more manageable and easier to design the SP exercise. The pruning was based on the results of the RP. It can, of course, be argued that by doing so the information source could be correlated to the mode, but we will see in the following sections that this correlation did not prevent us from estimating a model. In addition to this, at least two information sources were used for each mode in order to overcome any credibility bias affecting the subsequent choices (after selecting an option on the first screen respondents would tend to choose the same selection for the rest of screens). Each mode had at least two sources and time and cost attributes. It would clearly have been desirable to include a fuller range of variables and attributes of modes- but as mentioned earlier this would have made SP exercise very long and difficult and would in turn have required a bigger dataset than was likely to be possible given the budgetary constraints. The absence of the full range of variables is, of course, the norm in SP exercises and always introduces risk of "distortion" and misinterpretation. It was assumed that, in the absence of those variables, their effects would be captured partly by the alternative specific constants and partly by time and cost coefficients.

The base levels of the chosen variables were representative of the travel time and costs values prevalent in summer 2007 for all the three modes as described by information sources during normal conditions. The other values were 20% deviation from these average values. This design implies 2 variables with 3 levels for each of the mode. A full factorial design thus requires 9 combinations of attribute levels for each alternative, which is what was used.

3.3 Development of the Main Questionnaire

3.3.1 Outline of the Process

Before conducting the survey, in line with the advice of Fowkes and Wardman [31], simulation testing was carried out to test whether the SP design was capable of recovering specified values of key variables. A pilot survey was conducted among friends and colleagues to check the ecological design of the survey. The pilot survey also included general questions about the legibility and clarity of the questionnaire, appropriateness of the attribute levels, presentation of the SP experiments and whether it was realistic or not. Logit models estimated from the results of the pilot survey and the calibrated models were checked statistically. The estimated parameters were checked to have the correct sign and acceptable t-stats to the extent that this is possible in a pilot exercise.

Following the pilot survey, various improvements were made to the presentation and to the design of different levels of the attributes (to avoid dominance in the choices of different alternatives while maintaining realistic values for the attributes). In addition to this, the most appropriate scenarios (including destination, trip purpose and accompanying passengers) was selected from among those tested in the pilot survey. The simulation test was repeated after improvement in the design following the pilot survey and confirmed that the revised design was capable of recovering the specified values.

3.3.2 Main Survey

Respondents were recruited at the main long distance transport interchanges in Leeds - the Leeds Coach Station and the Leeds Train Station (prior to the decision to limit the study to people who sometimes use public transport, it had been hoped that recruitment would also be possible at locations likely to be frequented by long distance drivers but this proved unpractical). The recruitment interview conducted at the rail and coach station (150 to be recruited at each location) was brief and sought only the potential respondent's willingness to participate, whether they were residents of Leeds, whether they make journeys over 50 miles for leisure or personal business, a telephone number and time at which it would be convenient to conduct the telephone interviews. A set of cards to represent the SP options was distributed at the time of recruitment. The cards included the sets of SP questions for the respondent to consult while answering the questions on the telephone. Every respondent was given four sets of SP cards from which he would use only one. In these four cards one was for those respondents who can use all the three modes (i.e. car. coach and train) whereas the other was for respondents whose choice of modes was limited for some reason. Recruits were subsequently interviewed by CATI at a mutually convenient time.

The response rate in the first few weeks was lower than expected and so other Ph.D. students were employed to help with recruitment. About 950 members of the public were recruited to achieve the target sample of 300 completed interviews .As mentioned earlier, the SP exercise contained one dominated option to check the consistency of the responses. The dominated options were chosen by 18 respondents; data from those 18 respondents were omitted from the model estimation. The sample size gathered after the survey was smaller than what was proposed in the beginning due to the above mentioned problems in addition to budget and time constraints.

The demographics of the sample can be compared with the population distribution for Leeds residents (as summarised in the 2001 Census - HMSO 2001) and for long distance travellers by all modes (as summarised in the National Travel Survey data for long distance travellers in 2006).

About 61% of respondents were males. This compares with a figure of 48%for Leeds residents. This difference is not unexpected because the target population of the research was long distance travellers not residents. On the other hand, as expected the figure matches with a figure of 61%for long distance travellers. About 30% of the respondents were under 30 (compared to 40% for Leeds residents) and about 63% of the respondents had ages between 30 and 50 (compared to 40% for Leeds residents). Our sample has fewer people aged under 20 and over 50 than is the case for Leeds residents - presumably because these age groups make fewer long distance trips. About 76% of the respondents had at least one car (compared to 66% for Leeds residents and 92% for long distance travellers). The fact that the sample had a lower proportion of car owners than is found among long distance travellers is clearly due to our focus on travellers who sometimes use public transport. Sixty-three percent of the respondents were full time employed as compared to 59% for Leeds residents and 66% for long distance travellers. Twenty-eight percent of the respondents were students as compared to 11% for Leeds residents and 3% for long distance travellers (Leeds has a high proportion of students because it has two big universities). The over representation of students in our sample (compared to the Leeds population) may reflect the higher tendency of students to make long trips by coach or train 66% of respondents had income more than £20,000 this is less than is the 82% for long distance travellers recorded in NTS and probably reflects the fact that our sample is focussed on people who sometimes use public transport.

4. MODELLING CHOICE OF MODE CONDITIONED BY INFORMATION SOURCE

Previous sections discussed the important issues that should be considered in any study of travel information acquisition and travel decisions. In particular, Section 3 discussed the underlying theories of the information search process. The inclusion of the full range of travel choices (mode, route, timing, frequency....) in a single study was not a practical proposition and the current study focuses only on the choice of mode as conditioned by different information sources. The selection of the determinants for these choices is also simplified and only the most relevant attributes are selected. Fig. 1 presents the simplified modelling framework conducted in this study.

The choice here is the selection of mode for the trip after acquiring information from one or more sources. As in Fig. 1, the determinants of this choice are classified in three categories: (1) Personal Characteristics and Attitudes including experience of sources; (2) Journey Characteristics as specified by the respondents (in the RP case) or in the scenario statements (in the SP case); and (3) Modal attributes namely cost and time as described by the different information sources. The restriction to only two attributes, cost and time, was adopted in order to simplify the SP exercise for the respondent - the number of SP combinations would otherwise have been impractical. Various information sources were included in the questionnaire survey but only the predominant sources were used in the choice set. Similarly only three modes, car coach and train, were included in the mode choice exercise.

4.1 RP Model for Mode Choice

Multinomial models of mode choice were calibrated using the RP data. As mentioned earlier the data consists of respondents' past behaviour for the last long journey (over 50 miles). Variables used in the model were selected as discussed in Section 4 and were added to the model incrementally (from simpler to more complex). Statistical tests were used to verify the model and to reformulate the utility function. The focus was on finding a more precise model that performs better statistically and is consistent with priori expectations in terms of signs and magnitudes. The coefficients of the utility function were estimated by Alogit. "The t-stat values of all variables, r2, log likelihood with zero coefficients, and log likelihood at convergence were obtained from the package". A MNL Model is constructed with the dependent variable being the choice among car, coach and train. The base case for this model is travelling by car. The choice set C_n of each individual thus consists of three alternatives. The utility functions are given by, (with the variables in italics and details of the variables and associated coefficients used in all models defined in Annexure-1):

$$U_{(Car)} = \text{Time}*\mathit{Time}_1 + \text{Cost}*\mathit{Cost}_1 \quad (1)$$

$$U_{(Coach)} = \text{Time}*\mathit{Time}_2 + \text{Cost}*\mathit{Cost}_2 + \text{BPur}_2*\mathit{DBPur}_2 + \text{LFreq}_2*\mathit{DLFreq}_2 + \text{GWeather}_2*\mathit{DGWeather}_2 + \text{PeakP}_2*\mathit{DPeakP}_2 + \text{ASC}_2 \quad (2)$$

$$U_{(Train)} = \text{Time}*\mathit{Time}_3 + \text{Cost}*\mathit{Cost}_3 + \text{BPur}_3*\mathit{DBPur}_3 + \text{LFreq}_3*\mathit{DLFreq}_3 + \text{GWeather}_3*\mathit{DGWeather}_3 + \text{PeakP}_3*\mathit{DPeakP}_3 + \text{ASC}_3 \quad (3)$$

Model estimates are shown in Table 1. It is clear that the value of time implied by the model is similar to the long distance traveller's value of time as calculated by similar studies (33 £/hour for long distance travel for business, Dargay, 2010). This show the values of time are within acceptable limits. The t-statistic values of some variables were not satisfactory.

The following results are also worthy of note: The negative sign for coach implies a natural aversion to go by coach

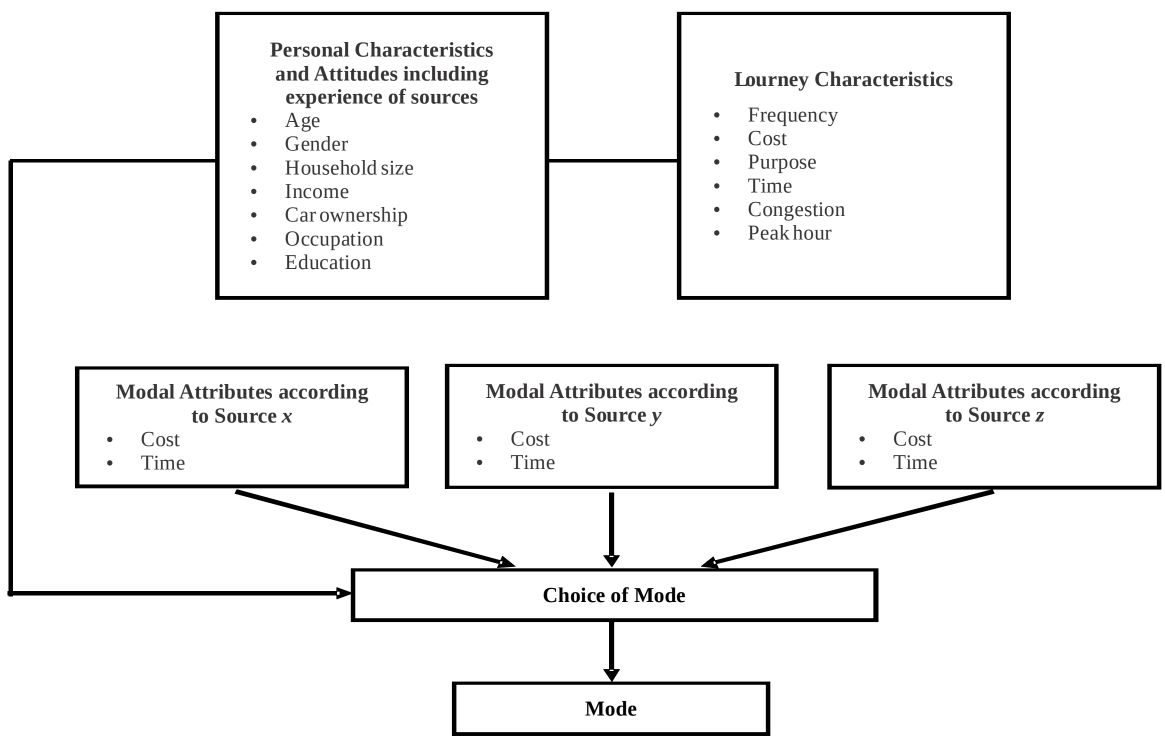

FIG. 1. FRAMEWORK FOR MODELLING CONDUCTED IN THIS RESEARCH

(all else being equal). This is intuitively reasonable as, in long intercity journeys, coach has longer travel time than car or train and is less convenient than car for most the travellers. The alternative specific constant for train was not significant. Taken with the negative result for coach, this suggests that users exhibit an inclination to travel by car in long distance journeys. This is particularly interesting given that our sample underrepresented habitual car users. As expected, travel time is negative in all models, which shows that travellers prefer to select the alternative which offers the lowest travel time. The cost is also negative but becomes insignificant with more complicated models. The Peak period travel by both coach and train is not statistically significant whereas travelling in good weather was significant for train, this shows if all being equal the travellers in good weather try to travel by car as in good weather driving is more enjoyable. If the frequency of the travel is lower, the people are more likely to travel by train and coach. This seems plausible as, in high frequency travel, people know all the routes and try to travel by car.

TABLE 1. ESTIMATES OF RP MODE MODEL (T-RATIOS IN BRACKETS)

Coefficients	RP Mode Model (Bold Values Show 10% Significance)
Time	**-0.0140(-3.3)**
Cost	**-2.5e-4(-1.9)**
$BPur_2$	1.18(1.6)
$LFreq_2$	**1.91(2.3)**
$BPur_3$	-0.111(-0.2)
$LFreq_3$	**1.12(2.1)**
ASC_2	**-2.92(-1.8)**
ASC_3	1.04(1.1)
$GWeather_2$	0.373(0.3)
$PeakP_2$	-0.260(-0.4)
$GWeather_3$	**-2.20(-3.2)**
$PeakP_3$	0.339(0.7)
Observations	**243**
Final Log (L)	**-97.7**
Rho²(c)	**0.194**
VOT (£/h)	**34**

4.2 SP Model for Mode Choice

Multinomial models of mode choice were calibrated using the SP data. As mentioned earlier the data consists of respondent's stated choice between the three mode alternatives under the influence of information. As above, variables used in the model were selected and added in the model incrementally.

4.2.1 The Multinomial Logit Model

A MNL was constructed with the dependent variable being the choice among car, coach and train. The base case for this model is travelling by coach. The choice set Cn of each individual thus consists of three alternatives. The utility functions are given by:

$$U_{(car)} = \text{Carfrit}_1 * Carfrit_1 + \text{Carmult}_1 * Carmult_1 + \text{Carfric}_1 * Carfric_1 + \text{Carmulc}_1 * Carmulc_1 + \text{Male}_1 * DMale_1 + \text{FEmp}_1 * DFEmp_1 + \text{Inc}_1 * DInc_1 + \text{Age}_1 * DAge_1 \quad (4)$$

$$U_{(coach)} = \text{Coawt}_2 * Coawt_2 + \text{Coamult}_2 * Coamult_2 + \text{Coawc}_2 * Coawc_2 + \text{Coamulc}_2 * Coamulc_2 \quad (5)$$

$$U_{(train)} = \text{Trainwt}_3 * Trainwt_3 + \text{Trainext}_3 * Trainext_3 + \text{Trainwc}_3 * Trainwc_3 + \text{Trainexc}_3 * Trainexc_3 + \text{Male}_3 * DMale_3 + \text{FEmp}_3 * DFEmp_3 + \text{Inc}_3 * DInc_3 + \text{Age}_3 * DAge_3 \quad (6)$$

Model estimates are shown in Table 2. The following results are worthy of note: As expected, travel time, and cost by different information sources for all the models were negative, which shows travellers will prefer any alternative which offers the lowest expected travel time and cost. The t-stats ratio for the time and cost for the initial models were not significant but when the coefficients for each information source were constrained to be same for all modes, the model's t stats improved. The value of time for the Model are 24, 18 and 10 £/hour for car, train and coach respectively. The values are similar to those found in other long distance journey studies (corresponding values found by Dargay, 2010 were 24, 28 and 10 respectively for long distance journey of more than 150 miles).Being male, in full time employment, and with higher income increased the propensity to travel by car and train all else being equal. This is in line with the expectation that coach is inconvenient for longer journeys. Age on the other hand was negative which means that the younger people have higher probability to travel by coach, this is again as expected because coach, being relatively cheaper in cost, is attractive to younger people and students.

TABLE 2. COMPARISON OF ESTIMATES BETWEEN MNL, LACK-KNIFE METHOD AND MIXED LOGIT MODE CHOICE MODEL (T-RATIOS IN BRACKETS AND BOLD VALUES SHOW 10% SIGNIFICANCE)

Coefficients	SP Mode MNL	Jack-Knifed	MMNL	Panel MMNL
$Carfrit_1$	-0.0070(-1.7)	**-0.0072(-1.8)**	**-0.0074(-1.8)**	-0.0030(-0.5)
$Carmult_1$	**-0.0047(-2.5)**	**-0.0046(-2.6)**		
Mean of $Carmult_1$			**-0.0050(-2.6)**	-0.0022(-0.4)
SD of $Carmult_1$			1.9e-4(0.4)	-0.0012(-0.0)
$Carfric_1$	**-2.8e-4(-2.0)**	**-2.9e-4(-1.8)**	**-2.9e-4(-1.9)**	**-3.9e-4(-2.5)**
$Carmulc_1$	**-1.2e-4(-1.8)**	-1.2e-4(-1.5)		
Mean of $Carmulc_1$			**-1.2e-4(-1.8)**	-6.5e-5(-0.6)
SD of $Carmulc_1$			-3.1e-6(-0.1)	**-1.0e-4(-2.5)**
$Male_1$	**1.38(3.8)**	**1.39(3.9)**	**1.38(3.5)**	1.8e-4(0.0)
$FEmp_1$	**1.22(3.5)**	**1.21(3.1)**	**1.28(3.6)**	8.8e-5(0.0)
Inc_1	**1.04(2.6)**	**1.02(2.0)**	**1.00(2.3)**	-9.1e-5(-0.0)
Age_1	-1.13(-1.5)	-0.900(-1.1)	-1.13(-1.5)	-5.2e-6(-0.0)
$Trainext_3$	-0.0049(-0.8)	-0.0055(-0.8)	-0.0053(-0.9)	0.0014(0.1)
$Trainwc_3$	**-1.9e-4(-3.5)**	**-1.9e-4(-3.8)**		
Mean of $Trainwc_3$			**-1.9e-4(-3.5)**	**-3.0e-4(-4.5)**
SD of $Trainwc_3$			-2.8e-5(-1.4)	**1.4e-4(7.4)**
$Trainexc_3$	**-1.2e-4(-1.8)**	**-1.2e-4(-1.8)**	**-1.3e-4(-1.8)**	-2.2e-4(-1.7)
$Male_3$	0.192(0.6)	0.198(0.6)	0.177(0.5)	-1.8e-4(-0.0)
$FEmp_3$	**0.584(2.1)**	**0.575(2.0)**	**0.603(2.2)**	-8.8e-5(-0.0)
Inc_3	**2.01(6.2)**	**2.00(4.9)**	**2.02(5.7)**	9.1e-5(0.0)
Age_3	-1.06(-1.5)	-0.816(-1.1)	-1.10(-1.6)	5.2e-6(0.0)
$Coawt_2$	**-0.0056(-2.3)**	**-0.0054(-2.1)**		
Mean of $Coawt_2$			**-0.0059(-2.3)**	0.0016(0.1)
SD of $Coawt_2$			-5.6e-4(-0.7)	-5.6e-4(-0.2)
$Coawc_2$	**-3.5e-4(-2.1)**	**-3.4e-4(-1.9)**	**-3.5e-4(-2.1)**	0(0.0)
Observations	2286	2286	2286	2286
Final Log (L)	-534.8	-534.8	-533.1	-534.3
$Rho^2(0)$	0.325	0.325	0.439	0.495
$Rho^2(c)$	0.198	0.198	0.327	0.161

4.2.2 Correction for Repeated Measurements

Six models were estimated each with a different number of randomly chosen sub-samples; 5, 10, 20, 30, 40, 60 and 90. The selected SP Mode model was taken for correction. The Jack-knife estimates reported in Table 2 show that the estimates are close to the MNL model, regardless of the number of sub-samples. These results show that the coefficients of the uncorrected model estimate were rather accurate despite the repeated measurement problem. With repeated measurements, one would expect that t-statistics should decrease considerably post jack-knifing which is not the case here. There are several studies where the application of jack-knife or bootstrap methods did not consistently reduce all t-ratios by a factor two or so (but sometimes by a smaller factor, and even increasing t-ratios). Please refer [32-33] among others.

4.2.3 Mixed Logit Model

The SP data was now used to calibrate a MMNL (Mixed Logit Model). This model has similar specification to the MNL but with following differences. Firstly (MMNL in Table 2), four normally distributed coefficients were specified for multimodal website time, multimodal website cost, mode specific website time and train website cost. Random components for other normally distributed coefficients for coach website cost, friend time, friend cost, train experience cost and previous experience time were also tried but were found insignificant and were subsequently dropped. Secondly, in another model (Panel MMNL in Table 2), the above mentioned coefficients were found to vary only across individuals to cope with repeated measurement problem. The utility functions are as follows:

$$U_{(car)} = \mathrm{Carfrit}_1 * \mathit{Carfrit}_1 + \mathrm{Carmult}_1 * \mathit{Carmult}_1[\mathrm{Sigma}_1] + \mathrm{Carfric}_1 * \mathit{Carfric}_1 + \mathrm{Carmulc}_1 * \mathit{Carmulc}_1[\mathrm{Sigma}_2] + \mathrm{Male}_1 * \mathit{DMale}_1 + \mathrm{FEmp}_1 * \mathit{DFEmp}_1 + \mathrm{Inc}_1 * \mathit{DInc}_1 + \mathrm{Age}_1 * \mathit{DAge}_1 \quad (7)$$

$$U_{(coach)} = \mathrm{Coawt}_2 * \mathit{Coawt}_2[\mathrm{Sigma}_3] + \mathrm{Carmult}_1 * \mathit{Coamult}_2[\mathrm{Sigma}_1] + \mathrm{Coawc}_2 * \mathit{Coawc}_2 + \mathrm{Carmulc}_1 * \mathit{Coamulc}_2\ [\mathrm{Sigma}_2] \quad (8)$$

$$U_{(train)} = \mathrm{Coawt}_2 * \mathit{Trainwt}_3[\mathrm{Sigma}_3] + \mathrm{Trainext}_3 * \mathit{Trainext}_3 + \mathrm{Trainwc}_3 * \mathit{Trainwc}_3[\mathrm{Sigma}_4] + \mathrm{Trainexc}_3 * \mathit{Trainexc}_3 + \mathrm{Male}_3 * \mathit{DMale}_3 + \mathrm{FEmp}_3 * \mathit{DFEmp}_3 + \mathrm{Inc}_3 * \mathit{DInc}_3 + \mathrm{Age}_3 * \mathit{DAge}_3 \quad (9)$$

The results of the MMNL model suggest that there is no significant improvement in the models. The estimates of the standard deviations of the normally distributed terms were not significant (or if they are significant, as happens sometimes in the panel specification, this takes place at the expense of the precision of coefficients of other attributes, without significant gains in the overall Loglikelihood value). This all means that the MNL model reflects the characteristics of the population satisfactorily.

4.2.4 Application of Regret Minimization on SP Model of Mode Choice

The SP data was now used to calibrate a RRM (Random Regret Minimization) model (see Section 3 for a general introduction) of mode choice. Two models were estimated, one with all the cost and time variables inside the regret function, the other with Information from friend and Previous experience kept outside the regret function. The dummies were outside the regret function for both the models. The utility function for car is as follows (with regret functions for coach and train formulated in a similar way):

$$R_{(car)} = \ln(1+e^{\mathrm{Carfrit1}*(Coawt2-Carfrit1)}) + \ln(1+e^{\mathrm{Carfrit1}*(Coamult2-Carfrit1)}) + \ln(1+e^{\mathrm{Carfrit1}*(Trainwt3-Carfrit1)}) + \ln(1+e^{\mathrm{Carfrit1}*(Trainext3-Carfrit1)}) + \ln(1+e^{\mathrm{Carmult1}*(Coawt2-Carmult1)}) + \ln(1+e^{\mathrm{Carmult1}*(Coamult2-Carmult1)}) + \ln(1+e^{\mathrm{Carmult1}*(Trainwt3-Carmult1)}) + \ln(1+e^{\mathrm{Carmult1}*(Trainext3-Carmult1)}) + \ln(1+e^{\mathrm{Carfric1}*(Coawc2-Carfric1)}) + \ln(1+e^{\mathrm{Carfric1}*(Coamulc2-Carfric1)}) + \ln(1+e^{\mathrm{Carfric1}*(Trainwc3-Carfric1)}) + \ln(1+e^{\mathrm{Carfric1}*(Trainexc3-Carfric1)}) + \ln(1+e^{\mathrm{Carmulc1}*(Coawc2-Carmulc1)}) + \ln(1+e^{\mathrm{Carmulc1}*(Coamulc2-Carmulc1)}) + \ln(1+e^{\mathrm{Carmulc1}*(Trainwc3-Carmulc1)}) + \ln(1+e^{\mathrm{Carmulc1}*(Trainexc3-Carmulc1)}) + \mathrm{Male}_1 * \mathit{DMale}_1 + \mathrm{FEmp}_1 * \mathit{DFEmp}_1 + \mathrm{Inc}_1 * \mathit{DInc}_1 + \mathrm{Age}_1 * \mathit{DAge}_1 \quad (10)$$

The results, shown in Table 3, suggest that all the significant parameters in both the RRM models have the expected signs thus supporting the regret paradigms of the models. Some of the variables had reverse signs but they were not significant. In terms of comparison between RRM and MNL models, it appears that the MNL model fits the data slightly better than its RRM counterpart. The significance levels of some of the parameter were increased in RRM. RRM estimates of the parameters were about half of their MNL counterparts. This suggests that the respondents had lower anticipated regret of the foregone alternatives.

4.3 Combined RP and SP Model for Mode Choice

As discussed in Section 4, there were two data sets in this study. The first was RP data which explored previous behaviours and choices of the travellers when choosing information sources in travelling. The second data set included an SP exercise which explored the choice of modes under the influence of different information sources. A combination of both datasets was considered in order to capture their respective advantages. Although the SP experiments were hypothetical in nature and involved

TABLE 3. COMPARISON OF ESTIMATES BETWEEN UNCORRECTED METHOD, LACK-KNIFED AND REGRET MODE CHOICE MODELS (T-RATIOS IN BRACKETS AND BOLD VALUES SHOW 10% SIGNIFICANCE)

Coefficients	SP Mode MNL	Jack-Knifed	$Regret_1$(All)	Regret (Without Friend & Experience)
$Carfrit_1$	-0.0070(-1.7)	**-0.0072(-1.8)**	-0.0026(-1.2)	**-0.0032(-2.3)**
$Carmult_1$	**-0.0047(-2.5)**	**-0.0046(-2.6)**	-4.4e-4(-0.3)	4.6e-4(0.4)
$Carfric_1$	**-2.8e-4(-2.0)**	**-2.9e-4(-1.8)**	-1.4e-4(-1.6)	1.8e-5(1.5)
$Carmulc_1$	**-1.2e-4(-1.8)**	-1.2e-4(-1.5)	-6.5e-5(-1.6)	**-6.6e-5(-1.9)**
$Male_1$	**1.38(3.8)**	**1.39(3.9)**	**-1.39(-3.6)**	**-1.40(-3.9)**
$FEmp_1$	**1.22(3.5)**	**1.21(3.1)**	**-1.23(-3.6)**	**-1.21(-3.5)**
Inc_1	**1.04(2.6)**	**1.02(2.0)**	**-1.05(-2.5)**	**1.06(-3.0)**
Age_1	-1.13(-1.5)	-0.900(-1.1)	0.914(1.2)	**0.900(1.8)**
$Trainext_1$	-0.0049(-0.8)	-0.0055(-0.8)	-0.0045(-1.1)	-0.059(-1.2)
$Trainwc_1$	**-1.9e-4(-3.5)**	**-1.9e-4(-3.8)**	-2.1e-5(-0.5)	**-2.2e-4(-2.0)**
$Trainexc_1$	**-1.2e-4(-1.8)**	**-1.2e-4(-1.8)**	2.0e-5(0.6)	-2.6e-5(-0.9)
$Male_2$	0.192(0.6)	0.198(0.6)	-0.206(-0.6)	-0.219(-0.9)
$FEmp_2$	**0.584(2.1)**	**0.575(2.0)**	**-0.595(-2.2)**	**-0.591(-2.2)**
Inc_2	**2.01(6.2)**	**2.00(4.9)**	**-2.02(-5.8)**	**-2.16(-6.0)**
Age_2	-1.06(-1.5)	-0.816(-1.1)	0.847(1.3)	0.943(1.1)
$CoaWT_1$	**-0.0056(-2.3)**	**-0.0054(-2.1)**	-0.0019(-0.8)	**-0.0027(-2.8)**
$Coawc_1$	**-3.5e-4(-2.1)**	**-3.4e-4(-1.9)**	**-2.0e-4(-2.1)**	**-2.4e-5(-1.9)**
Observations	2286	2286	2286	2286
Final Log (L)	-534.8	-534.8	-534.8	-534.7
$Rho^2(0)$	0.325	0.325	0.437	0.434
$Rho^2(c)$	0.198	0.198	0.325	0.325

similar tasks for the respondent under similar conditions, it is important to examine the data to test for any systematic differences in the scale of the utility functions. The potential differences in error between the datasets can be removed by multiplying the parameters of SP by the scale parameter. In order to develop a single choice model, data from the RP questions and from the mode choice SP, an artificial tree structure was used. It is important to note that the RP data relates to any long distance trip (intercepted in Leeds) in the UK whereas the SP relates to one OD (i.e. Leeds to Cardiff) and this could have implications for the coefficients (and might have reduced the VoT variance). However, this problem could be dealt with by the scaling process which would scale this variance of one dataset to the other.

The utility functions of the RP model are given as:

$$U_{(carweb)} = Time_1 * Time_1 + Cost_1 * Cost_1 \quad (11)$$

$$U_{(carfrweb)} = Time_1 * Time_2 + Cost_1 * Cost_2 \quad (12)$$

$$U_{(carmpweb)} = Time_1 * Time_3 + Cost_1 * Cost_3 \quad (13)$$

$$U_{(carmfweb)} = Time_1 * Time_4 + Cost_1 * Cost_4 \quad (14)$$

$$U_{(carmap)} = Time_1 * Time_5 + Cost_1 * Cost_5 \quad (15)$$

$$U_{(busweb)} = Time_1 * Time_6 + Cost_1 * Cost_6 \quad (16)$$

$$U_{(busfrweb)} = Time_1 * Time_7 + Cost_1 * Cost_7 \quad (17)$$

$$U_{(traweb)} = Time_1 * Time_8 + Cost_1 * Cost_8 \quad (18)$$

$$U_{(trafrweb)} = Time_1 * Time_9 + Cost_1 * Cost_9 \quad (19)$$

The SP experiment had following utility functions:

$$U_{(car)} = Time_1 * Carfrit_1 + Timeweb_1 * Carmult_1 + Cost_1 * Carfric_1 + Costweb_1 * Carmulc_1 \quad (20)$$

$$U_{(coach)} = Timeweb_1 * Coawt_2 + Timeweb_1 * Coamult_2 + Cost_1 * Coawc_2 + Cost_1 * Coamulc_2 \quad (21)$$

$$U_{(train)} = Timeweb_1 * Trainwt_3 + Time_1 * Trainext_3 + Costweb_1 * Trainwc_3 + Cost_1 * Trainexc_3 \quad (22)$$

Table 4 presents t he results of the combined RP-SP model.

The important properties of the estimated coefficients in this combined model are: Travel time information provided by websites has a more influence on travel decisions than does generic time. Table 4 shows that when comparing time coefficients, model $Sprpjointn_2$ (Combined RP-SP Model 2) depicts that Timeweb (travel time as provided by a website) is more influential as compared to generic time. Model $Sprpjointn_3$ (Combined RP-SP Model 3) also

TABLE 4. ESTIMATES FOR RP-SP MODEL FOR MODE (T-RATIOS IN BRACKETS AND BOLD VALUES SHOW 10% SIGNIFICANCE)

Coefficients	$Sprpjointn_1$	$Sprpjointn_2$	$Sprpjointn_3$
Time	-0.0024(-1.3)	-0.0030(-1.5)	-0.0026(-1.3)
Cost	-4.5e-5(-1.2)	**-2.8e-4(-3.8)**	**-2.8e-4(-3.8)**
Scale2	3.00(1.3)	**0.296 (3.2)**	**0.228(2.2)**
Timeweb		**-0.0145(-3.6)**	**-0.0207(-1.9)**
Costweb			-4.9e-4(-1.4)
Value of Time (Cost/Time) (£/hr.)	32	6.5	5.5
Value of Time (Cost/Timeweb)		31	44
Value of Time (Costweb/Timeweb)			25
Observations	2529	2529	2529
Final Log (L)	-1113.6	-1105.6	-1105.3
$Rho^2(0)$	0.136	0.142	0.142
$Rho^2(c)$	0.012	0.019	0.020

shows the same trend. However, model $Sprpjointn_3$ shows that after allowing the scale factor Costweb (travel cost as provided by a website) is less influential than generic cost. The reason for this might be because websites sometimes don't include cost for car mode and even when they do show, people don't believe this cost information (there are always hidden costs which generally travellers don't consider). Hence in the overall mode choice, cost from the website is less influential than other sources. The value of time is significantly reduced with the introduction of web time as a variable. This shows that travellers consider information from websites at least four times more important than the normal travel time.

5. FORECASTING

The combined RP SP model developed in Section 5 was used to predict the choice probabilities for the mode forecasts. This model was preferred because it had been developed on the aggregation of both data sets (RP and SP), instead of SP data only, which may have a scale that differs from a model on observed choices.

The forecasts of mode choice are based on specified time and cost attributes coming from the different information sources. For each respondent in the sample, a forecast is made of the probability that they will choose car, coach or train. Table 5 shows the resulting market share of the modes under different values of time and cost provided by the information sources. First the lowest levels of the SP design were tested for each information source. Then the values of time and cost were reduced by 20% from the SP design lowest level for each source and mode. Later both time and cost were reduced together for each of the source. Finally, the time and cost were reduced for one source and it was made worse (up as far as the highest value used in the SP experiment) for other modes and sources. Results in normal font relate to the estimation sample while those in italics relate to an expanded sample which reflects the demographics of the long distance travellers as revealed by the NTS. The table reveals that, for the estimation sample, information provided by a multimodal website is more influential than information provided by friends for car users. On the other hand previous experience of a travel with a mode has more influences if it is also validated by other sources. Table 5 also reveals that if a person gets information from both sources, the market share increases even more.

The italicised figures in Table 5 show that market share of the modes increase when information sources show

TABLE 5.RPSP MODEL PREDICTIONS OF MODE SHARES UNDER DIFFERENT TIME AND COST LEVELS ACCORDING TO THE SPECIFIED INFORMATION SOURCE (ESTIMATION SAMPLE AND EXPANDED SAMPLE)

Mode / Time and Cost Values	Car				Train				Coach			
	Friend		Multimodal Website		Train Website		Previous Experience		Coach Website		Multimodal Website	
Average of SP	52	*64*	52	*64*	30	*20*	30	*20*	17	*16*	17	*16*
Lowest Value of SP	54	*67*	56	*70*	34	*24*	34	*23*	19	*18*	19	*18*
Time (-20%)[1]	57	*70*	59	*73*	35	*24*	35	*24*	21	*19*	22	*20*
Cost (-20%)[2]	54	*67*	56	*69*	37	*26*	37	*26*	19	*17*	19	*17*
Both (-20%)	59	*73*	62	*77*	41	*31*	42	*31*	22	*21*	23	*21*
From Both Sources	69		*85*		52		*43*		28		*26*	

[1] The 20% reduced time for car, train and coach was calculated to be 200, 170 and 300 minutes respectively.
[2] The 20% reduced cost for car, train and coach was calculated to be 4000, 6000 and 3500 pence respectively.

decreased travel time and cost values. This shows that information sources could be used as a policy measure to distribute the travel miles among the modes. And the maximum results are achieved when different information sources give the same information to the travellers. This shows the effect of credibility on the sources as travellers tend to believe more when they observe same information about the journey from multiple sources.

6. CONCLUSIONS

This paper has described the development of a range of models to explain influence of information sources on the subsequent mode choice. The models are calibrated to data from a CATI questionnaire survey conducted at the main transport interchanges in Leeds. The range of models developed includes multinomial

ANNEXURE-1 VARIABLES AND ASSOCIATED COEFFICIENTS USED IN THE MODELS

Variables	Coefficients	Definition
$Time_n$	Time	(Generic, in Minutes)
$Cost_n$	Cost	(Generic, in Pence)
$DBPur_n$	BPurn	(Dummy, Business Purpose = 1, otherwise = 0)
$DLFreq_n$	LFreqn	(Dummy, Trip Frequency less than 13/year =1, otherwise = 0)
$DGWeather_n$	$GWeather_n$	(Dummy, Good Weather =1, Otherwise = 0)
$DPeakP_n$	$PeakP_n$	(Dummy, Travelled in the Peak Period = 1, Otherwise = 0)
$DMale_n$	$Male_n$	(Dummy, If Male = 1, Otherwise = 0)
$DEduc_n$	$Educ_n$	(Dummy, Left Full Time Education at or after 20 = 1, Otherwise = 0)
$DFEmpl_n$	$FEmpl_n$	(Dummy, Full Time Employed =1, Otherwise = 0)
$DInc_n$	Inc_n	(Dummy, If Income Over £30,000 =1, Otherwise = 0)
$DAge_n$	Age_n	(Dummy, If Age Less than 50 =1, Otherwise = 0)
$Carfrit_n$	$Carfrit_n$	(Time by Car Information by Friend, in Minutes)
$Carmult_n$	$Carmult_n$	(Time by Car Information by Multimodal Website, in Pence)
$Carfric_n$	$Carfric_n$	(Cost by Car Information by Friend, in Minutes)
$Carmultc_n$	$Carmultc_n$	(Cost by Car Information by Multimodal Website, in Pence)
$Trainwt_n$	$Trainwt_n$	(Time by Train Information by Train Website, in Minutes)
$Trainext_n$	$Trainext_n$	(Time by Train Information by Past Experience, in Minutes)
$Trainwc_n$	$Trainwc_n$	(Cost by Train Information by Train Website, in Pence)
$Trainexc_n$	$Trainexc_n$	(Cost by Train Information by Past Experience, in Pences)
$Coawt_n$	$Coawt_n$	(Time by Coach Information by Coach Website, in Minutes)
$Coawc_n$	$Coawc_n$	(Cost by Coach Information by Coach Website, in Pences)
$Coamult_n$	$Coamult_n$	(Time by Coach Information by Multimodal Website, in Minutes)
$Coamulc_n$	$Coamulc_n$	(Cost by Coach Information by Multimodal Website, in Pence)
$DComAd_n$:	$ComAd_n$:	(Dummy that Equals 1 if Commercial Ads No Sub; Otherwise 0)
$Timeweb_n$	Timeweb	(Time by Modal Web/Multimodal Website, Generic, in Minutes)
$Costweb_n$	Costweb	(Cost by Modal Web/Multimodal Website, Generic, in Pence)
	ASC_n	(Alternative Specific Constant)

logit, nested logit, mixed logit to account for the correlations between choice alternatives and random regret minimisation model to study the concept of newly developed regret minimisation framework. The paper has also performed a comparison of traditional GEV (Generalised Extreme Value) modelling techniques with mixed logit modelling and random regret minimisation framework. The results from the RP and SP (MNL) mode choice models establish the fact that Leeds travellers have higher tendencies to prefer any alternative which offers the lowest expected travel time and cost. It also suggests that males, in full time employment, and with higher income are more likely to use car and train whereas coach is inconvenient for longer journeys. Moreover, UK younger people have higher probability of travelling by coach. The Combined RP-SP model indicated that information of journey time from websites is a very important attribute and travellers consider it more important than time and cost actually spent on travelling. The apparent value of travel time is reduced significantly with the introduction of web time as a variable (travel time provided by website). This suggests that the information from websites influence travel behaviour significantly and travellers consider it 4 times more important than the normal travel time and this is higher than the multiplier on waiting times on stops in the normal mode choice models. The Jack-knife estimates of the SP model of Mode choice model show that the estimates are close to the MNL model, regardless of the number of sub-samples. The Model is then taken for the calibration of mixed logit model for SP mode choice. The results of the model also suggest that there is no significant difference in the models. The same model was then used to estimate a RRM model. The results suggest that all the significant parameters in RRM models have the expected signs which support the regret paradigms of the models. Comparison between RRM and MNL models, suggests that the MNL model fits the data slightly better than its RRM counterpart. The significance levels of some of the parameters were increased and the RRM estimates of the parameters were about half of their MNL counterparts. This suggests that the respondents had lower anticipated regret of the foregone alternatives.

The study gave detailed insights on the effect of different types of information sources on the mode choice decisions of the UK long distance travellers. It was found that there is a lot of difference between the impact of a multimodal website and a mono-modal website on mode choice. It was found that the effect of information, provided by multimodal websites, is even more important than the advice from friends. This is a very interesting finding as this shows the effect of websites on the decisions of travellers. It was found that even the previous experience of a traveller has the same impact on her travel decisions as of any website. This is also a very interesting result. This also shows the usability and influence of websites. On the other hand, previous experience of a mode influences the choice more if it is also validated by other sources; if a person gets information from both sources, the market share increases even more. It was found that the market share of the modes increase when information sources show decreased travel time and cost values. At least this suggests that information sources could be used as a policy measure to distribute the travel miles among the modes, previous work on the credibility of information sources indicates that deliberate distortion of true values would not be a viable policy. Maximum results are achieved when different information sources give the same information to the travellers. This shows the effect of credibility on the sources as travellers tend to believe more when they observe the same information about the journey from multiple sources. It is however acknowledged that the bigger dataset would have given more understandings of the choice behaviour. Furthermore the absence of fuller set of attributes for different modes and information sources would have given even further insights of the underlying effects of information on mode choice. Nonetheless, this study has tried to understand some of those insights and will be an interesting addition to the literature of information and mode choice.

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REFERENCES

[1] Koppelman, F.S., and Pas, E.I., "Travel Choice Behaviour: Models of Perceptions, Feelings, Preference, and Choice", Transportation Research Record, Volume 765, pp. 26-33, 1980.

[2] Kanninen, B.J., "Intelligent Transportation Systems: An Economic and Environmental Policy Assessment", Transportation Research, Volume 30A, pp. 1-10, 1996.

[3] Hague Consulting Group, "Factors Influencing Mode Choice", Final Report, Hague, 1991.

[4] Bonsall, P.W., "The Influence of Route Guidance Advice on Route Choice in Urban Networks", Transportation, Volume 19, No. 1, pp. 1-23, 1992.

[5] Bonsall, P.W., "Assessing the Impacts and Benefits of in Car Route Guidance Advice via Field Trials", IEEE-IEE Vehicle Navigation and Information Systems Conference, Volume 93, Ottawa, 1993.

[6] Khattak, A.J., Koppelman, F.S., and Schofer, J.L., "Stated Preference for Investigating Commuters' Diversion Propensities", Transportation, Volume 20, pp. 107-127, 1993.

[7] Khattak, A.J., Schofer, J.L., and Koppelman, F.S., "Commuters' En-Route Diversion and Return Decisions: Analysis and Implications for Advances Traveller Information Systems", Transportation Research, Volume 27A, No. 2, 1993.

[8] Mannering, F., Kim, S.G., Barfield, W., and Ng, L., "Statistical Analysis of Commuters' Route, Mode, and Departure Time Flexibility", Transportation Research, Volume 2C, pp. 35-47, 1994.

[9] Bonsall, P.W., "Analyzing and Modelling the Influence of Roadside Variable Message Displays on Drivers' Route Choice", 7th World Conference on Transportation Research, pp. 16-21, Sydney, 1995.

[10] Emmerink, R., Nijkamp, P., Rietveld, P., and Van Ommeren, J.N., "Variable Message Signs and Radio Traffic Information: An Integrated Empirical Analysis of Drivers' Route Choice Behaviour", Transportation Research, Volume 30A, pp. 135-153, 1996.

[11] Wardman, M., Bonsall, P.W., and Shires, J.D., "Driver Response to Variable Message Signs: A Stated Preference Investigation", Transportation Research, Volume 5C, pp. 389-405, 1997.

[12] Hato, E., Taniguchi, M., and Sugie, Y., "Influence of Traffic Information on Drivers; Route Choice", Paper Presented at WCTR, 1995.

[13] Bonsall, P.W., and Parry, T., "Using an Interactive Route-Choice Simulator to Investigate Drivers' Compliance with Route Guidance Advice", Transportation Research Record, 1306, National Research Council, pp. 59-68, Washington DC, 1991.

[14] Bonsall, P.W., Pickup, L., and Stathopoulos, A., "Measuring Behavioural Responses to Road Transport Informatics", Proceedings of Drive Conference on Advanced Telematics in Road Transport, Volume 2, pp. 1457-1487, Brussels, 1991.

[15] Khattak, A., Schofer, J., and Koppelman, F., |Factors Influencing Commuters' En-Route Diversion Behaviour in Response to Delay", Transportation Research Record 1318, National Research Council, pp. 125-136, Washington, DC, 1991.

[16] Polak, J., and Jones, P., 'The Acquisition of Pre-Trip Information: a Stated Preference Approach", Transportation, Volume 20, pp. 179-198, 1993.

[17] Samuelson, P.A., "Foundations of Economic Analysis", Harvard University Press, Cambridge, Massachusetts, 1947.

[18] Simon, H.A., "A Behavioural Model of Rational Choice", Quarterly Journal of Economics, Volume 69, pp. 99-118, 1955.

[19] Chorus, C.G., Arentze, T.A., and Timmermans, H.J.P. "Spatial Choice: A Matter of Utility or Regret?", Environment and Planning Part-B, Volume 36, No. 3, pp. 538-551, 2009.

[20] Williams, H.C.W.L., and Ortuzar, J.D., "Behavioural Theories of Dispersion and the Miss-Specification of Travel Demand Models", Transportation Research, Volume 16B, pp. 167-219, 1982.

[21] Richardson, A., "Search Models and Choice Set Generation", Transportation Research, Volume 16A, pp. 403-419, 1982.

[22] Lerman, S.R., and Mahmassani, H.S., "The Econometrics of Search", Environmental and Planning, Volume 17A, pp. 1009-1024, 1985.

[23] Swait, J., and Ben-Akiva, M., "Incorporating Random Constraints in Discrete Models of Choice Set Generation", Transportation Research, Volume 21B, pp. 91-102, 1987.

[24] Polak, J., and Jones, P., "The Acquisition of Pre-Trip Information: A Stated Preference Approach", Transportation, Volume 20, pp. 179-198, 1993.

[25] Ben-Akiva, M., and Boccara, B., "Discrete Choice Models with Latent Choice Sets", International Journal of Marketing, Volume 12, pp. 9-24, 1995.

[26] Arentze, T.A., and Timmermans, H.J.P., "Representing Mental Maps and Cognitive Learning in Microsimulation Models of Activity-Travel Choice Dynamics", Transportation, Volume 32, pp. 321-341, 2005.

[27] Arentze, T.A., and Timmermans, H.J.P., "Information Gain, Novelty Seeking and Travel: A Model of Dynamic Activity Travel Behaviour Under Conditions on Uncertainty", Transportation Research, Volume 39A, pp. 125-145, 2005.

[28] Bonsall, P.W., and Joint, M., "Driver Compliance with Route Guidance Advice: The Evidence and its Implications", Proceedings of Vehicle Navigation and Information Systems Conference Proceedings, pp. 47-59, Dearborn Michighan, USA October, 1991.

[29] Bonsall, P.W., and Merall, A., "Analyzing and Modelling the Influence of Roadside Variable Message Displays on Drivers' Route Choice", Presented at WCTR, Sydney, July, 1995.

[30] Bonsall, P.W., and Whelan, G.A., "Using Stated Preference Techniques to Assess the Impact of VMS Information on Drivers' Propensity to Divert to Park-and-Ride", ITS, University of Leeds, 1995.

[31] Fowkes, A.S., and Wardman, M., "Disaggregate Methods", Chapter-4, Fowkes, A.S., and Nash, C.A., "Analyzing Demand for Rail Travel, Avebury, 1991.

[32] Jong, G.C. de, A.J., Daly, M., Pieters, S., Miller, R.P., and Hofman, F,. "Uncertainty in Traffic Forecasts: Literature Review and New Results for The Netherlands", Transportation, Volume 34, pp. 375-395, 2007.

[33] RAND Europe, SEO en Veldkamp/NIPO Hoofdonderzoek naar de Reistijdwaardering in Het Hoederenvervoer (Main Survey into the Value of Transport Time in Freight Transport), Report TR-154-AVV for AVV, RAND Europe, Leiden. 2004.