OPTION AND NON-USE VALUES IN BUS NETWORKS

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ABSTRACT

This paper presents results from new research demonstrating the existence of significant option and non-use values in bus networks. In appraisal terms option and non-use values are a monetisation of the accessibility criterion in STAG. Their inclusion in the cost benefit analysis (i.e. the TEE element of STAG) ensures that the TEE is as broad as possible when assessing social inclusion type projects. The current economic climate means that bus service subsidies are being reduced, and the full costs of such service reductions should be evaluated. Additionally the research implies a case for expanding the scope of the TEE element in STAG. The paper presents three distinct strands of research: an online national urban survey of 2,500 respondents and two smaller household surveys in different areas of Leeds, one affluent and one poor. In the affluent area the option and non-use values of better bus infrastructure (guided bus) were examined, whilst in the poor area the option and non-use value of evening and Sunday services were examined. The national survey examined the option and non-use value of existing bus services across Britain. We find evidence that households are using bus services for making unexpected trips – one of the motives to option values – and we estimate that the option and non-use value of the national urban bus network is £490 million per annum. We also find evidence of great variation in values with low income households holding high option and non-use values for evening and Sunday bus services, whilst at the other end of the spectrum, high income households holding low or zero values for improving bus infrastructure. We illustrate the policy implications of our results with a case study of evening and Sunday bus services. Our research also identifies a number of methodological challenges when surveying option and non-use values.

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1 INTRODUCTION

The economic context of the last years has resulted in cuts to government funding. Levels of public transport subsidy have therefore been called into question, with cuts to bus services occurring in places. Economic stimulus packages including construction of transport infrastructure have also been advocated. Against such a background it is important that a full economic appraisal is undertaken. Where step-changes in bus service level provision are advocated (e.g. service withdrawal or contrastingly new dedicated public transport infrastructure) option and non-use values may potentially be relevant – see Laird et al., 2009, for an example of relevance to rail policy. These benefits reflect the values that people who are not actually using a bus service attribute to that service. A barrier to their inclusion however remains a lack of evidence on their size and how they may vary with differing qualities of bus service. In a STAG appraisal context option and non-use values are a monetisation of the STAG accessibility criterion.

The initial ideas of option and non-use values were introduced in the 1960s by Weisbrod (1964) and Krutilla (1967) respectively. The focus was on environmental economics and in the following years, the 1970s and 1980s, the concern was to strength the theoretical framework of both concepts. It is in the last two decades when the first quantitative studies focused in the transport sector have appeared: Bristow et al. (1991); Crockett (1992); Humphreys and Fowkes (2006) and Jackson (2010) made studies in the British context whilst Painter et al. (2002); Geurs et al. (2006); Chang et al (2012) and Wallis and Wignal (2012) did the same in other countries.

Bristow et al. (1991) were the first in developing a methodology in order to obtain option and non-use values. The authors analysed the impact of the withdrawal of bus services in two areas of Leeds. Crocket (1992) investigated the case of the withdrawal of a Settle-Carlisle rail service. Humphreys and Fowkes (2006) were the first in disaggregating and estimating empirically the components of the total economic value in the Edinburgh-North Berwick rail line. The novelty was the use of a choice experiment in addition to the already used contingent valuation method. Geurs et al. (2006) used choice experiments only in their analysis of two rail services in low and high density areas in Netherlands with the context of changes in frequency and withdrawal of the service.

Jackson (2010) also estimated option and non-use values in three rail lines in the north of England presenting a different approach to disaggregate the total economic value. In addition, the author demonstrated that self-completion surveys can be useful in certain contexts. Chang et al. (2012) focused their analysis in bus services to and from Seoul metropolitan area with the context of change in level of service and withdrawal of it. Wallis and Wignal (2012) investigated option and non-use values in bus and rail services in four semi-rural/peri-urban communities in New Zealand. The context of their analysis was the withdrawal of the existing service or the introduction of a new one.

Despite these studies, the evidence on option and non-use values is still limited for transport appraisal applications. Aside from service withdrawal it is uncertain what values are relevant for other contexts of transport service provision, and for differing degrees of accessibility to opportunities of employment or services. Other evidence gaps relate to catchment areas of stations, the impact of a combined use of modes (i.e. bus and train), new railway links (i.e. high speed rail) and how much of the non-use value double counts use benefits (Laird et al, 2009). In addition to these evidence gaps the only evidence related to UK bus services is more than 20 years old and derives from a small exploratory study (Bristow et al., 1991).

In that sense, the objective of this paper is to determine if option and non-use values vary in bus networks by type of service (e.g. weekdays, evenings and Sundays), by the quality of the supporting bus infrastructure, and by household attributes (e.g. income and car ownership). To do this, the paper reports the empirical findings of three studies: a national internet survey and two household surveys in different parts of Leeds – a high income suburb and a low income suburb. Following this introductory section Part 2 details the location, data collection method and analysis approach adopted. Part 3 and Part 4 present our empirical results. Part 5 explains the implications of these results to transport policy and, finally, Part 6 provides some conclusions.

2 DATA

The data presented in this paper derive from three distinct surveys of bus users and non-users. One was a large national internet survey whilst the other two were bespoke household mail out surveys in different areas of Leeds. These latter surveys had much smaller sample sizes.

2.1 National survey

The national internet survey was conducted for a study on the wider benefits of bus use (Mackie, Laird and Johnson, 2012). The survey questionnaire contained a number of sections collecting background information about the respondent, their household, access to work and/or education, retail and leisure trips by bus and most importantly from our perspective questions designed to elicit willingness to pay to maintain existing bus services. Respondents were recruited from an internet market research panel held by Research Now – a market research company. Participants were invited to participate in the survey by email and were then presented with a set of screening questions to ensure that they were within sample. Quotas were set for bus users, bus non-users, those who use bus for commuting and by income group - the latter to ensure that the natural bias in internet surveys towards high income groups was corrected. The survey was also restricted to those 18 years or over living in settlements greater than 3,000 people (i.e. excluded those in rural areas). It was intended to receive 2,000 responses randomly from across Britain and a further 500 from four top-up areas: Brighton, West Yorkshire, Kent and Nottingham. The online questionnaire was hosted in the Survey Monkey software. The questionnaire was piloted by the project team, colleagues and Research Now. This led to only subtle changes in the wording of some of the questions.

In terms of the willingness to pay questions: respondents were presented with a scenario in which their household's bus services were under threat from local government cuts and were asked if their household would be willing to pay £1 extra in Council Tax to preserve their bus services. This is a form of dichotomous choice contingent valuation question. If they answered yes they were then asked how much they would be willing to pay in extra in Council Tax per month – a form of direct elicitation contingent valuation question. Follow-up certainty questions were asked of all respondents to reduce/eliminate hypothetical bias. Follow-up questions were also asked to those who stated a zero willingness to pay, to try and identify if their willingness to pay was truly zero.

The survey was undertaken between the 23rd March and the 19th April 2012. In total 2,512 complete responses were received from 17,841 invites distributed. This represents a completion rate of 14.1%. This was considered acceptable for this type of survey and the difficulty faced in reaching the target audience.

2.2 Leeds Case Studies

2.2.1 Study areas

The two Leeds case studies used similar methodologies to examine the option and non-use value of evening and weekend services and the option and non-use value of high quality bus infrastructure (guided bus routes). The study area for the evening and weekend service case study was Middleton and Belle Isle, a low income and low car ownership neighbourhood of Leeds (see Figure 1). It is located about 3 to 4 miles south of Leeds city centre and is relatively isolated from the city centre, partially due to the presence of the M621 to the north and east. It suffers from multiple deprivation as 89% of its houses are in the lowest-rated Council Tax bands A and B (WYO, 2012) and 49% of the local households do not have access to a car (WYO, n.d.). In contrast the study area for the high quality infrastructure case study was Alwoodley a high income suburb in north Leeds 5 miles north of the city centre.

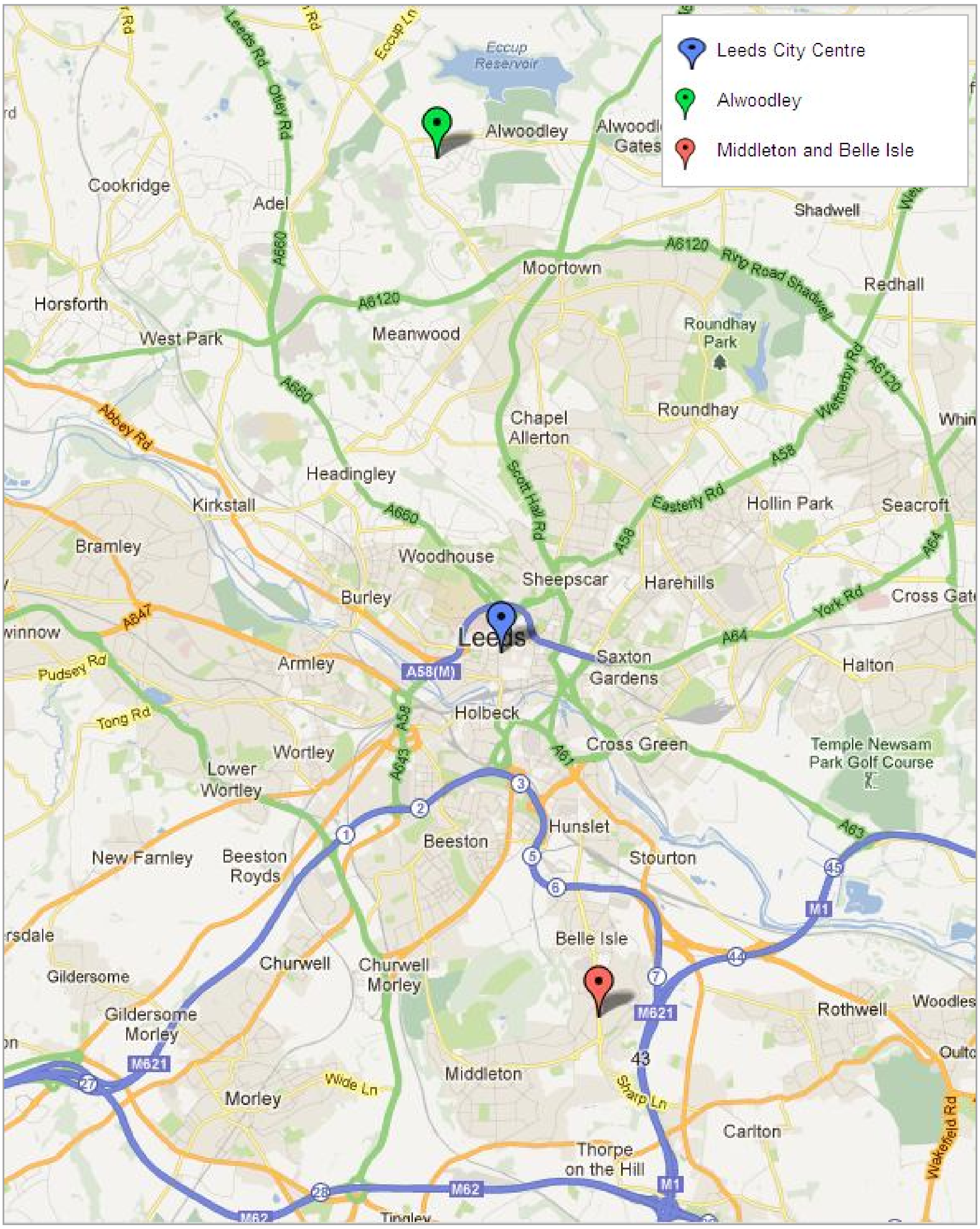

Figure 1: Study Areas Location

2.2.2 Survey design

The self-completion survey questionnaires included a number of background social and demographic questions as well as questions to attain information about how frequently and with what purpose the respondents use bus services. The core part of the questionnaires was the stated choice and contingent valuation questions to estimate residents' willingness to pay to maintain evening and weekend bus services.

The exercises used Council Tax as the payment mechanism and asked for collective household valuations rather than individuals' willingness to pay. The stated choice questions were designed using software Ngene v 1.0 (ChoiceMetrics Pty Ltd) utilising the Bayesian efficient design technique. Pilot surveys were carried out in both study areas and indicated a significant level of non-trading behaviour, which led to a re-design of the scenarios to alter the range of attribute levels considered. The final stated choice experiments were then derived from an interactive simulation process which evaluates modelled parameter values against the priors set and comprised the attributes and levels summarised in Table 2.

The contingent valuation exercise included in the questionnaires varied. For the quality infrastructure study all the questionnaires used open-ended willingness to pay questions, whilst for the evening and weekend study half of the questionnaires had an open-ended willingness to pay question and the other half used a payment ladder question.

Following Jackson (2010) the monetary valuations derived from the expressed preference exercises were disaggregated into the different economic value categories, so the elements of option and non-use value can be defined, by asking respondents were asked to rate the significance of different items when they were answering the stated preference exercises. Table 1 indicates how each of these proxies relates to the different economic value categories.

Table 1: Proxies for Economic Value Elements

Proxy	Economic Value Element
- Your current use of the service	Actual Use
- Your possible future use of the service - Insurance in case your car is unavailable	Option Value
- Concern for future generations - Benefit to your family and friends - Benefit to others in the community (i.e. elderly)	Non-Use Value, altruism
- Concerns about the environment - Concerns about road congestion	Non-Use Value, indirect user benefits (double counting)

Table 2: Stated choice attributes and levels – Leeds case studies

Attribute	Levels		
	Evening and Sunday services case study - South Leeds		Quality bus infrastructure study - North Leeds
	Weekday evenings stated choice experiment	Sundays	
Bus service frequency/headway	Service withdrawal, every hour, 30 mins, 15 mins	Service withdrawal, every hour, 30 mins, 15 mins	Guided bus: every 5 mins, 10 mins (existing), 15mins Normal bus: every 10 mins (existing)
Travel time	n/a	n/a	Guided bus: 30 mins, 35 mins (existing), 38 mins Normal bus: 44 mins, 46 mins, 48 mins
Council tax change	+£12, +£5, no change, -£4 per month	+£10, +£4, no change, -£3 per month	Guided bus: +£60, no change, -£30 per month Normal bus: +£40, no change, -£40 per month

A total of 1,200 questionnaires were distributed by letter box drop in South Leeds and 1,000 in North Leeds in July 2012. Respondents were given a postage paid return envelope and were also entered into a prize draw if they returned their questionnaire. For South Leeds 145 completed surveys were received and 175 in North Leeds, representing response rates of 12% and 17.5% respectively. These were considered acceptable given that mail out self completion surveys typically get a 10% response rate.

2.3 Data cleaning

A number of logic checks were undertaken on each of the data samples collected. These are reported in Table 3 and Table 4. The broader breadth of data collected in the national internet survey (in terms of its study objectives) meant that more checks were made on its data relative to that to the Leeds case studies. For the national internet survey 186 cases were excluded (7.4%), whilst more cases were excluded from the Leeds case study experiments – just under 20% if lexicographic and non-trader responses are retained and in the region of 40% if they are excluded.

Table 3: Reasons for excluding cases from analysis – national internet survey

	Frequency	Percent	Valid Percent	Cumulative Percent
1. Cannot identify Government Office Region(GOR)	59	2.3	2.3	2.3
2. Inconsistent data provided on trip making frequency by bus	41	1.6	1.6	4.0
3. Personal income data withheld	1	0.0	0.0	4.0
5. Bus trips exceed 29 single trips per week	54	2.1	2.1	6.2
6. Average single journey costs £6.50 or more	18	0.7	0.7	6.9
7. Fares form more than 30% of household income	1	0.0	0.0	6.9
8. Willingness to pay to maintain existing bus services is 30% or more of household income	11	0.4	0.4	7.4
9. Household is located in a rural area	1	0.0	0.0	7.4
10. Clean cases	2,326	92.6	92.6	100.0
Total	2,512	100.0	100.0	

Table 4: Reasons for excluding cases from analysis – stated choice experiments Leeds case studies

	No. of Surveys (% of returned surveys)					
	Evening experiment		Sunday experiment		High quality bus experiment	
Returned questionnaires	145		145		175	
Reason for exclusion						
Not responded to any of the stated choice scenarios	16	11%	20	14%	21	12%
Inconsistence or irrational behaviour	5	3%	3	2%	16	9%
Lexicographic/Non-Traders	32	22%	35	24%	42	24%
Total excluded surveys	53	37%	58	40%	79	45%

Note: respondents who always choose the same mode, the lowest/highest cost, etc. alternative can either be exhibiting lexicographic or non-trading behaviour.

3 OPTION USE OF BUS SERVICES

Our surveys identified evidence that households use bus services in an option use capacity. Option bus use occurs when a bus trip is not planned or anticipated – for example it could occur due to a regular travel choice not being available, due to a sudden temporary change in circumstances, or a more permanent but unexpected change in circumstance (e.g. loss of job and having to commute to a new location for work).

In Alwoodley, north Leeds households report making occasional and unexpected/unanticipated trips by bus. In this high income sample it can be seen that the majority (81) of households are using the bus to perform an occasional or unexpected trip (see Table 5).

Similarly we found evidence of option use in our national survey. In that sample 1,125 respondents are in paid employment and of these that 251 people use the bus in an option use capacity – as a back-up mode for the journey to work (see Table 6). That is for every 7 regular bus commuters there are 3 people who use the bus in an option use capacity for the journey to work. As those who usually travel to work by bus form 8.5% of those in work (Mackie, Laird and Johnson, 2012 Appendix 1 Table 2.9), this implies that 3.65% of all workers are using the bus in an option use capacity.

Table 5. Number of households making regular and unexpected trips (Alwoodley, North Leeds)

Frequency of use	Type of trip			
	Regular	Occasional/ Unexpected	Never use the bus	Total
Daily to monthly	30	28	-	58
Monthly to 6 monthly	3	24	-	27
Six monthly to yearly	3	24	-	27
Not in the last year	2	5	19	26
Total	38	81	19	138

-If the household performs at least one activity in a regular basis, it is labelled as "Regular"
-Households that never use a bus service are included in the "Not in the last year" for simplicity.

Table 6: Option use of bus for the journey to work (National Internet Survey)

	Frequency	Percent
Normally or reasonably often travel by bus as part of journey to work	585	52.0%
Use bus as a back-up mode for journey to work	251	22.3%
Never use it	289	25.7%
Total	1,125	100.0%

Source: National survey –those in employment only.

It is of interest to understand who these option users are and how they differ from pure 'non-users' of bus services. Looking closely at the differences between option users (for commuting) and those who never use the bus for commuting we regressed a binary variable representing this choice against variables describing bus service quality, settlement type, person characteristics (age, gender, driving licence), household location (within walking distance of the city centre or local amenities), personal earned income, household income, household car ownership and car availability to the respondent. The final model is presented in Table 7. This model was estimated by estimating a model using all the exogenous variables and then in a stepped process removing those that were not significant at the 5% level. It used the automated procedure in SPSS. As can be seen from this table car availability is critical as is bus service quality (journey times and frequency) and urban area. Interestingly income, age and gender to not play a part in determining whether a respondent never uses the bus for the commute or is an option user. This is interesting as typically we find that bus use varies systematically with income, age and gender (Mackie, Laird and Johnson, 2012). This evidence on the other hand suggests that in contrast option use is more a function of travel specific variables rather than person specific variables.

Table 7: Model estimation describing choice between non-user and option user of bus services for the commute

	Coefficient	Std error	T- stat	Significance
Car availability block (against no car/van available)				0.00
Car/van always available	-0.27	0.30	-0.90	0.37
Car/van almost always available	0.77	0.36	2.12	0.03
Car/van only available infrequently (e.g. in evenings)	0.52	0.40	1.29	0.20
Doesn't hold driving licence	-0.53	0.29	-1.80	0.07
Doesn't hold a free bus pass	1.13	0.42	2.70	0.01
Bus frequency: 1 or more every 15mins	1.07	0.40	2.65	0.01
Bus journey times are fair or better compared to car	0.82	0.28	2.91	0.00
Bus journey times are good or better compared to car	0.75	0.27	2.78	0.01
Urban area type block (base: settlements of 3,000 to 10,000)				0.06
A London Borough	1.08	0.41	2.61	0.01
One of the seven metropolitan areas	0.45	0.33	1.36	0.17
City over 1 million	1.31	0.59	2.21	0.03
City/large town ver 250,000 to 1 million people	0.42	0.35	1.21	0.23
City/large town over 25,000 up to 250,000	0.80	0.31	2.63	0.01
City/town over 10,000 up to 25,000 people	0.70	0.35	2.02	0.04
Constant	-3.25	0.69	-4.72	0.00

Notes: Dependent variable is binary variable indicator if the respondents is a option user of bus services for commuting (1) or a never uses bus services for commuting (0). Estimated using logistic regression in SPSS v19.

4 WILLINGNESS TO PAY FOR OPTION AND NON-USE OF BUS SERVICES

4.1 National survey

We estimate option and non-use values from the contingent valuation data in the national internet sample by following the environmental economic literature and the approach adopted by (Geurs et al., 2006) and splitting the sample into non-users, option users and users. As users hold option values and non-use values, and option users hold option values and non-use values the mean use values, option values and non-use values can be estimated from a simple computation using the mean willingness to pay of each group. For example the option value can be estimated by subtracting the mean willingness to pay for non-users from that of option users.

Table 8 presents the results of this analysis. In the first row of the table the results for all the clean data are presented. A lot of respondents had indicated or implied by answering other questions in a certain way a willingness to pay of zero. We are however of the view that not all of these responses are realistic. This is because users of bus services can tolerate fare increases, implying that they hold some consumer surplus for existing bus trips. The second row of the table therefore excludes respondents (i.e. users of bus services) who report a zero willingness to pay. To test for hypothetical bias we also exclude respondents who are not very certain they would pay the stated willingness to pay. This result is reported in the third row. Statistically we find a large standard error associated with the estimates which control for hypothetical bias which make them statistically equivalent to the results for which no control has been made (i.e. the second row). We therefore reject the hypothesis that our results exhibit hypothetical response bias and in the remainder of this discussion focus on the results presented in the second row. We therefore find that average consumer surplus of bus users is £21.51, average option values of bus users and potential users is £36.89 and average non-use values across the whole population is £1.20. It is possible that with these values that the option value is overestimated and the consumer surplus is underestimated due to hypothetical bias.

Table 8: National internet survey – total willingness to pay, consumer surplus, option value and non-use value

	No. of cases	Total willingness to pay	Willingness to pay components		
			Consumer surplus	Option Value	Non-use value
All ' clean' data	2,326	£32.86	£16.40	£15.26	£1.20
As above but excluding cases where households report zero WTP but use the bus	1,272	£59.60	£21.51	£36.89	£1.20
As above but only including 'certain' WTP values	511	£66.98	£51.64	£14.51	£0.83

For our sample total willingness to pay in addition to fares for existing bus services is £132,600. This comprises, we estimate, of 2,326 households willing to pay a sum of £2,800 for non-use benefits, 2,296 households willing to pay a sum of £84,700 for option use benefits and 2,097 households willing to pay £45,100 for use benefits. Due to the survey methodology employed we consider this figure to be a conservative estimate.

Using NTS data on proportions on frequency of bus use of individuals (see Mackie, Laird and Johnson, 2012, Table 2.3) and the number of households in Great Britain we estimate that the total willingness to pay for the existing bus network is therefore £730 million. Broadly speaking this disaggregates as £28 million as non-use value, £490 million as option value and £210 million as consumer surplus.

We have also regressed respondent characteristics on their willingness to pay bids to gain an understanding as to what household attributes lead to them holding a positive willingness to pay for option and non-use values. A Tweedie regression has been used as it is a mixed distribution model that comprises a gamma distribution with a mass point at zero and is appropriate for continuous data with zero values. The model was estimated by including all household characteristics and then excluding those that were not significant at the 5% level. The final model is presented in Table 8. Car availability is clearly important as with a car available the bus is only sometimes needed for 'unexpected' trips. In terms of bus quality frequency is important, some effects for journey times were also found but these were not significant at the 5% level. Having a worker in the house who uses the bus in a back up for accessing work is also important. It's unclear why households with free bus passes would be willing to pay less than those who have to pay fares, as clearly the bus is more of an option for them. Possibly the negative sign on the coefficient reflects the fact that they are typically elderly, not at work and do not need the bus service in quite the same way that a non-elderly household does (e.g. to access work). Income did not appear to influence willingness to pay, nor did household size.

Table 9: The main determinant to willingness to pay for option users

	Coefficient	Std error	T-stat	Significance
Constant	2.99	0.43	7.01	0.00
Car available sometimes, infrequently or never	0.54	0.25	2.15	0.03
Bus frequency: 1 or more every 15mins	1.05	0.36	2.90	0.00
Household contains a worker who uses bus as a back-up moden	0.82	0.34	2.41	0.02
Household contains someone with a free bus pass	-0.81	0.30	-2.69	0.01
(Scale)	7.49	0.82		

Notes: Tweedie regression with dependent variable annual willingness to pay bids for option users. Estimated using SPSS v19.
Source: National internet survey

4.2 Leeds Case Studies

In this section we present the empirical results from the Leeds case study surveys. In the first sub-section below we estimate the total willingness to pay above fares for the bus services in question, and then in the second sub-section we disaggregate that value using the method employed by Jackson (2010) into consumers surplus, option value and non-use value.

4.2.1 Willingness to pay for bus services in Leeds Case Studies

Evening and Sunday services

The willingness to pay results for this case study were estimated by fitting a model with the following simple linear specification to the stated choice data:

$$U_j = \beta_{FQ1} FQ_{1j} + \beta_{FQ2} FQ_{2j} + \beta_{FQ4} FQ_{4j} + \beta_{CT}\, CT_j$$

Where U_j is the utility from choice scenario *j*, with FQ_n representing a dummy variable capturing the level of frequency as *n* services per hour, with FQ_0 the omitted base variable representing no service (note: $FQ_0+FQ_1+FQ_2+FQ_4=1$), so that all resulting frequency valuations are relative to no service.

The model was estimated in BIOGEME and the results are presented in Table 10.

Table 10: Value of the coefficients of the utility function for Evening and Sunday Services

	Evening Experiment				Sunday Experiment			
	All sample		Full CT Payers		All sample		Full CT Payers	
Households	93		62		88		54	
Obs	648		447		621		390	
Adjusted rho-square	0.21		0.24		0.24		0.24	
Parameters	Estimate	t-test ratio	Estimate	t-test ratio	Estimate	t-test ratio	Estimate	t-test ratio
βCT	-0.13	-9.05	-0.153	-8.11	-0.155	-10.57	-0.18	-9.41
β_{FQ1}	1.45	8.5	1.21	5.73	1.88	10.46	1.55	6.88
$\beta FQ2$	1.56	4.8	1.52	3.67	2.32	8.58	2.26	6.34
$\beta FQ4$	1.37	6.99	1.31	5.63	2.13	9.39	2.04	7.39

Note: excludes non-trading/lexicographic households

The resulting strong t-test ratios and the adjusted rho-square values obtained with this model indicate that all the parameters are significant with a 95% confidence level and suggest that the model is functioning well and producing robust parameters estimates. The relative simplicity of the adopted utility function and model specification is proven necessary due to the limited sample size obtained, with smaller subsets of the data reducing the reliability of the results.

The estimated monetary values, calculated in pounds per month as the ratio between the bus service level and the change in council tax coefficients, are presented in Table 11. These willingness to pay results represent the sum of consumers surplus, option and non-use values – and if added to expenditure on fares would give an estimate of the Total Economic Value of the bus services at those times of the day/week.

Table 11: Stated Choice – Calculated WTP (£)

	WTP for Evening Bus Services (per household)				WTP for Sunday Bus Services (per household)			
	All Households		Households paying full council tax		All Households		Households paying full council tax	
	Monthly	Yearly	Monthly	Yearly	Monthly	Yearly	Monthly	Yearly
Hourly service	11	134	8	95	12	146	9	103
Half hourly	12	144	10	119	15	180	13	151
4 buses per hour	11	126	9	103	14	165	11	136

Overall, the table indicates that respondents hold a strong valuation of the existing services and are willing to pay significant amounts to avoid the withdrawal of local bus services. It reveals that the households that receive some sort of council tax discount value the bus services more than the households that pay the full council tax values. Contrary to initial assumptions, the results also indicate higher WTP for Sunday services compared to weekday evening services. This may reflect individuals' perception of greater bus use opportunities on Sundays than weekday evenings.

Although council tax discounts are conceded for a range of different reasons, including for single occupancy households despite income, it is considered that a significant proportion of the respondents that indicated they receive discounts are within lower income groups. This group of respondents is therefore likely to be relatively more dependent on bus services and less able to afford the available alternative model (e.g. taxi). They are thus expected to hold a greater WTP to maintain the services. However, it is also possible that this group of users did not fully understand that the implied Council Tax increase would have to be paid by them even if they currently received either a full rebate or a partial discount. Given this concern we have decided to focus in the remainder of our analysis on those households who pay the full council tax.

High quality bus services

The general notation of the utility functions used to estimate total willingness to pay above fares for the estimation of the model to the data on normal and segregated bus services are presented below.

$$U_1 = \beta_{CT}CT_1 + \beta_{HEADWAY}HEAD_1 + \beta_{TIME}TIME_1$$

$$U_2 = \text{ASC} + \beta_{CT}CT_2 + \beta_{HEADWAY}HEAD_2 + \beta_{TIME}TIME_2$$

where:
U_1: utility from choice alternative 1 (normal bus service)
U_2: utility from choice alternative 2 (segregated service)
CT_i: council tax change (pounds per year) associated with alternative *i*
$HEAD_i$: average interval (in minutes) between buses associated with alternative *i*
$TIME_i$: journey time (in minutes) between the city centre and the zone of study associated with alternative *i*.
ASC: the alternative specific constant, an unobserved component of the utility (in this case captures the preference for the segregated service over the normal service)

The analysis of the choice model was done using the software BIOGEME. The results are presented in Table 12 for two groups of observations: 138 questionnaires that included lexicographic and non-trading bias and 96 questionnaires that do not exhibit these characteristics. For both groups, the coefficients of the attributes council tax, journey time and headway (COST, TIME and HEAD respectively) have the expected sign. The alternative specific constant sign is positive and significant which indicates a positive preference for the segregated option. In addition, the ratio ASC/COST, which measures the WTP for the segregated option in the context of variation of attributes of headway and time, is presented.

Table 12: Value of the coefficients of the utility function for high quality bus services

	Value [1]		Robust t-test [1]	
Coefficient	Including lexicographic/ non-traders	Excluding lexicographic/ non-traders)	Including lexicographic / non-traders	Excluding lexicographic / non-traders)
ASC	1.400	1.410	5.44	4.86
COST	-0.030	-0.032	-8.40	-7.48
HEAD	-0.061	-0.138	-2.92	-5.58
TIME	-0.003	-0.019	-0.15	-1.00
Households	138	96		
Rho-squared	0.278	0.245		
ASC/COST	-47.30	-44.06		
Std. Error[3]	9.10	9.92		
t-test[3]	-5.20	-4.73		
HEAD/COST	2.05	4.31		
Std. Error[3]	0.52	0.25		
t-test[3]	3.94	17.25		

(1) The values, robust t-test and rho-squared were obtained using BIOGEME
(2) The std error and t-test of the ratios were obtained using the spreadsheet tool developed by Prof Stephane Hess http://www.stephanehess.me.uk/

The WTP to choose the segregated option is £47.3 ± £1.96x9.1 per year (with 95% confidence interval). However, if lexicographic bias is not included, the result does not change drastically (£44.1 ± £1.96x9.3). Statistically, both are similar.

Another relevant result is the value of the attribute TIME which is almost zero (-0.003), not significant statistically. This implies that the respondents in the sample of this survey do not consider time as an attribute in their choice of the alternatives proposed.

4.2.2 Comparing Contingent Valuation and Stated Choice results for the Leeds Case Study Areas

Contingent valuation questions were offered in the questionnaires in order to give a comparison to the stated preference results.

Contingent valuation results for total willingness to pay

As in the national internet survey it was necessary to eliminate those respondents who indicated a zero willingness to pay (WTP) but for whom this was regarded as a protest vote. Table 13 present the contingent valuation results from the evening and weekend services survey and the high quality bus survey.

Table 13: Contingent Valuation Analysis Results

	Evening		Sunday		High Quality Services	
	Open Ended WTP	Payment Ladder	Open Ended WTP	Payment Ladder	Including zero WTP protest votes	Excluding zero WTP protest votes
Mean WTP (£/year)	104.16	80.16	98.52	97.92	30.22	45.61
Median WTP (£/year)	60.00	60.00	60.00	60.00	20.00	40.00
Total observations	22	28	22	25	160	106

Table 13 indicates that the open-ended and the payment ladder questions resulted in similar estimated median WTP for evening services (although the range of WTP values was higher for the payment ladder experiments). For the Sunday services, the calculated WTP is approximately 20% lower for the open-ended experiment. As can be seen from the table, WTP values for the sample excluding zero WTPs were 50% higher than those where the zero WTP protest votes were included.

Contingent Valuation compared to Stated Preference

Table 14 presents a comparison of the results obtained via the stated choice experiment and the contingent valuation questions. It indicates that the stated choice resulted in monetary valuations in the order of twice the value of the contingent valuation estimations, which supports the findings of other research suggesting greater valuations using stated choice in comparison to contingent valuation (Christie and Azevedo, 2009; Boxall et al., 1996). Whilst these results may support assumptions that contingent valuation methods may not fully capture non-use values (Boxall et al., 1996), it should be noted that the limited sample sizes for the contingent valuation experiments may have skewed the its results. In light of the above comments the following analyses considers the stated choice results only.

Table 14: Stated Choice and Contingent Valuation WTP Results compared (£ per year per household)

	Stated Preference		Contingent Valuation
	Low freq.	High freq.	
Evening Bus Services	95	119	104
Sunday Bus Services	103	151	98
High Quality Bus Services	44-47		30-46

All models suggest the SP values are higher than the CV values (up to around 50%). The case of the high quality services is more complex as the CV question involved valued the complete removal of the existing high quality service, whereas the SP analysis valued the enhanced infrastructure – and one would expect that full service withdrawal would be valued more highly than an incremental service enhancement.

4.2.3 Disaggregation of Total Willingness To Pay to Option and Non-Use Values for the Leeds Case Studies

The monetary valuations derived from the stated choice modelling process need to be disaggregated into the different TEV categories so the elements of option and non-use value can be defined. To allow for this disaggregation, respondents were asked to rate the significance of different items when they were answering the stated preference exercises as indicated in Table 1. Table 15 shows the weighting of the TEV Elements. Table 16 reports the disaggregated values.

Table 15: Weighting of TEV Elements

	Eve-nings	Sun-days	High Qual (1)	High Qual(2)	TEV Element	Eve-nings	Sun-days	High Qual (1)	High Qual (2)
Current use	4.66	4.08	6.60	6.14	Actual Use	11	10	16	15
Possible future use	5.54	5.00	6.78	6.56	Option Value				
Insurance mode	4.73	4.88	3.44	3.59		24	25	24	24
Future generations	5.41	5.34	5.04	5.07					
Family and friends	5.42	5.59	5.16	5.07	Non-Use Value	42	44	37	37
Others in community	6.7	6.9	5.55	5.41					
Environ-ment	4.71	4.26	4.64	4.73	Indirect user benefit	23	21	23	25
Congestion	4.8	4.24	5.35	5.64					

(1) Including lexicographic and non-trading bias; (2) not including.

Table 16: Disaggregated Monetary Values (yearly, per household)

WTP for Evening Services	WTP for Evening Services		WTP for Sunday Services			
	Lower	Upper	Lower	Upper	High Quality (1)	High Quality(2)
Aggregated WTP	£94.90	£119.22	£103.33	£150.67	47.3	44.1
Actual Use	£10.54	£13.24	£10.46	£15.26	7.3	6.4
Option Value	£23.22	£29.17	£25.34	£36.95	11.4	10.6
Non-Use Value	£39.64	£49.79	£45.73	£66.68	17.5	16.2
Indirect user benefits	£21.50	£27.01	£21.80	£31.79	11.1	10.8

(2) Including lexicographic and non-trading bias; (2) not including.

The disaggregated values reported in Table 16 indicate that the households hold significant option and non-use values to maintain evening and Sunday bus services, which respectively account for £63-79 and £71-104 per household per year depending on frequency. Option and non-use values for the High Quality service areas are more than 50% lower than those for evening and Sunday services..

The table also indicates that the estimated option values are lower than the disaggregated non-use value, which suggests that respondents value their own future possible use of the services lower than the current and future use of others. Finally, this disaggregation exercise revealed that over 30% of the aggregated WTP was related to actual use or other TEV elements that are already accounted for in the standard CAB approach, which stresses the importance of segregating these values.

4.3 Estimation and data collection issues

A comparison of the valuations obtained through the three surveys is presented in Table 17. The comparison shows that option and non-use values are very much dependent on the context of the services affected, as well as the nature of the study area. What is very interesting is that the average value for the national survey (for a full service withdrawal) is lower than the partial withdrawal of services in the poor area of South Leeds (sum of evening and Sunday service withdrawal) and higher than the incremental improvement to services in North Leeds. Car availability plays a strong role in this (see e.g. Table 9). We also conjecture that whilst the improved quality of the bus service in North Leeds made the service more convenient for users, it did not really open up that many more opportunities (relative to losing a bus service for part of a day or a whole day in the case of the Sunday services).

Table 17: Comparison of Bus Service Valuations (yearly per household)

	Option and Non-Use Values	Option Value only
National internet survey	£38	£37
Evening bus services	£63-79	£23-29
Sunday bus services	£71-104	£25-37
High quality bus services	£27-29	£11

Differences in the survey results could also have arisen due to the difference methodologies employed. The national internet survey employed a contingent valuation method which appears to give lower results than the stated choice methods that formed the centre piece of the Leeds case studies.

We also experienced some difficulties with the stated choice experiments. We found that high frequency services of 4 per hour in the Sunday and evening survey were valued (insignificantly) lower than 3 per hour. Perhaps this reflects disbelief on behalf of the respondents or some residual concern that they might have to pay more for these services. Whilst we found significant values for the infrastructure in the high quality services study, we found no significant journey time effect on individuals' choices. This could be related to survey design - due to the high correlation (0.869) between the attributes TIME and ASC, the ASC appears to be measuring more than the 'pure' preference of one mode. The construction of a segregated option is linked with an improvement of journey time. The option and non-use value in Table 17 must therefore be interpreted as the value associated with both an infrastructure upgrade and a simultaneous time saving.

Regarding the disaggregation method of the TEV for appraisal purposes, the process could have elements of error which may have led to higher values for option and non-use values. The fact that the non-use and option value proxy categories contained multiple components with only one component in the use category, coupled with the observation that people rarely use the whole scale they are offered means the relative weight of option and non-use could be higher than the user value.

It seems that self-completion questionnaires can be potentially useful in the case of certain constraints. The rate of response in the present survey (17.5% and 12% respectively for the high quality and evening & Sunday services respectively) was above the average for these type of surveys and the possible reason could be a combination of the design, presentation and incentive of the survey. Thus, this work has proved that a self-completion questionnaire can obtain good results. However, we lost over a quarter of our initial sample of observations in the evening and Sunday experiment from non-trading behaviour and 11% who didn't attempt the SP experiment. Our favoured results were based on full council tax payers which meant further discounting of around 20% of the collected sample. In the high quality bus service experiment, of the 175 questionnaires returned, over 20% were not completed or showed inconsistent behaviour. A further 24% showed non-trading behaviour.

Regarding the Contingent Valuation questions, it seems people found it hard to understand the experiment in all three applications. We lost around 2/3rd of our evening and Sunday sample when we took the step of dropping non-responses and those with zero WTP values. For the high quality services CV question those with zero WTP represented 31% of the sample and a further 10% were lost as they didn't respond to the CV. In the national survey we lost 55% of the sample from excluding the zero WTP responses. Even when excluding 'protest' zeros from the data we find that CV results are consistently lower than results derived from SP.

5 POLICY IMPLICATIONS

To understand the value of our research to transport policy we have considered the case of the withdrawal of evening and Sunday services to our case study area in South Leeds: Middleton and Bell Isle.

Whilst it is acknowledged that the potential withdrawal of bus services between the study area and the city centre would affect other communities along the bus routes, aiming for a conservative estimate, the calculation of the total monetary valuation of option and non-use values for the area was based on the assumptions that:

- Half of the ward households are along the bus corridors considered in the surveys; and
- That these are the only households that hold bus option and non-use values.

Table 18 presents the estimation of the total monetary valuation of option and non-use values for the area and suggests a strong valuation of over £350k per year even with a relatively limited population being included in the calculation.

Table 18: Total Monetary Valuation of Option and Non-Use Values (per year)

	Evening Bus Services	**Sunday Bus Services**
Total households in the area	5,807	5,807
Option Values (per household)	£23-29	£25-37
Total Annual Option Values	£134k-168k	£145k-215k
Non-Use Values (per household)	£40-50	£46-67
Total Annual Non-Use Values	£232k-290k	£267k-389k
Total Option and Non-Use Values	**£366k-459k**	**£412k-604k**

Assuming subsidy costs of £1.75 per mile, Table 19 presents an estimate of subsidy costs for the evening and bus services linking the study area and Leeds City Centre.

Table 19: Bus Services Subsidy Costs (per year)

	Evening Bus Services	**Sunday Bus Services**
No. of buses in both directions per day	62	200
Annualisation factor	253	60
Subsidy per mile	£1.75	£1.75
Trip distance in miles	4.5	4.5
Annual subsidy costs	**£124k**	**£95k**

A comparison of the benefits derived in Table 18 and the subsidy costs estimated in Table 19 indicates that the costs associated with subsidising evening and Sunday bus services are more than covered by the residents' valuation of option and non-use values. The calculations suggest that the additional monetary valuation is over 3 times greater than the subsidy costs for the evening bus services and over 4 times the subsidy costs for the Sunday bus services, even under conservative assumptions that 100% of the services are subsidised and considering a limited population affected. This analysis supports recommendations for the inclusion of option and non-use values in the appraisal of bus provision and other transport interventions with the potential of significantly improving benefit cost ratios.

6 CONCLUSIONS

Option and non-use values can be viewed as a monetisation of the accessibility appraisal presented within the Scottish Transport Appraisal Guidance (STAG), although such a valuation is at present not required in STAG appraisals. The results from the three studies presented suggest that the conventional appraisal of bus service provision is incomplete and may lead to deceptive cost benefit analysis conclusions if option and non-use values are unaccounted for.

For the commute to work we found that for every 2 regular bus commuters there is almost one other that uses the person in an option use capacity, thus demonstrating the importance of bus networks in supporting accessibility to work. The use of the bus as a back-up option for the journey to work seems to depend more on travel characteristics faced by individuals rather than personal characteristics – which is in contrast to the key determinates of bus use.

We also find significant variation in values between a 'national average' and those specific to certain services. Importantly we find that services that are out of standard office hours can hold option and non-use values. This possibly arises due to the fact that many workers no longer work 'standard' hours. Services pertaining to periods of a day (evenings) or a day of the week (Sundays) are valued much more highly than an across the board improvement in quality. Car availability and prior use of the bus in an option use capacity appear to be strong determinants in households willingness to pay for option values. Extrapolating our results to a GB level would suggest that the willingness to pay of the population above fares to maintain the existing bus network is £730 million. Broadly speaking this disaggregates as £28 million as non-use value, £490 million as option value and £210 million as consumer surplus.

From a policy perspective our results would suggest that if service withdrawals must be considered then reductions in frequency are preferred from a social perspective to reductions in hours (e.g. evenings) or days (e.g. Sundays) of coverage. Similarly increases in journey time would be preferred to loss of service.

We identified a number of methodological issues that would be worthy of further research: differences between stated choice and stated preference in the context of option and non-use values and the most appropriate way to disaggregate the willingness to pay results between consumer surplus, option use and non-use values.

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