3

Recreation: predicting values

Introduction

While typically unpriced, recreational time is often the most valuable part of any day (Broadhurst, 2001). This chapter discusses applications of the CV and TC methods to the valuation of unpriced, open-access recreation in UK woodlands. The following section presents a review of the existing literature, after which we describe analyses undertaken as part of this research. We conducted three separate woodland recreation valuation studies, all in the UK: two in Thetford Forest, East Anglia, and one in and around Wantage, Oxfordshire. These are subsequently referred to as the Thetford 1, Thetford 2 and Wantage studies. The design of these studies reflected both the previous findings and research objectives set out in Chapter 2 (i.e. to investigate the validity and sensitivity of measures) and the desire to obtain values which were of use within our wider CBA. In Chapter 4 we consider the transferability of these findings to our wider study area of Wales.

Review of the literature

In the UK there have been more applications of the CV and TC methods to the evaluation of woodland recreation than of any other open-access recreational good.[1] A review of the literature identified over forty relevant papers containing over a hundred monetary evaluation estimates (see details in Bateman, 1996). These included studies calculating national-level values, estimates based on household once-and-for-all payments and various other measures which were of little use in our wider study. However, a smaller number of studies provided per person per visit values which can be readily utilised in valuing the woodland visit numbers

[1] We have excluded non-UK studies as we believe that the uncertainties surrounding relevant cultural and socio-economic differences between countries such as the USA (where the majority of evaluation work has been conducted) and the UK make such extrapolations of highly dubious value. Loomis (1996) provides a review of non-UK evaluations of forestry preservation benefits conducted using the CV method.

estimated in Chapter 4. Our review of previous studies is categorised according to the various valuation methods employed (ITC, ZTC and CV).

ITC studies

Prior to the present research, the work of Willis and Garrod (1991b) was the only ITC study giving per person per visit estimates of UK woodland recreation benefits. This study provided estimates for six sites across the UK. However, problems concerning sample size and functional form (detailed in Bateman, 1996) mean that we have reservations about the transferability of these particular results to a wider context and prefer our own ITC measures discussed later in this chapter.

ZTC studies

Table 3.1 presents results from three separate ZTC studies[2] but is dominated by the multisite analysis of Benson and Willis (1992). The figures reported for this particular study are from their 'Standard Model' where travel expenditure is calculated using full costs of 33p per mile and travel time is valued at 43% of wage rate (see the discussion of travel cost definitions in Chapter 2). Consumer surplus values are given for both the study year and as a 1990 equivalent, the latter being the base year for our wider CBA study.

The utility of these findings for estimating recreation benefits at other sites is discussed later in this chapter.

CV studies

The majority of potentially useful UK woodland recreation studies have been conducted using the CV method. All of the results summarised in Table 3.2 were derived from WTP questions concerning per person per visit recreation values. These studies all employed an entrance fee payment vehicle, although a variety of elicitation methods were used as were both direct 'use' and 'use + option' value formats (see Chapter 1), as indicated.

Benefits transfer

To what extent can the results summarised above (and indeed those from our own studies) be applied to other woodland areas? This issue of transferring benefit

[2] The study by Christensen (1985) is reviewed in Bateman (1996) but is not included here because of problems, highlighted by Christensen, regarding the quality of data employed.

Table 3.1. *Forest users' per person per visit recreation values from ZTC studies*

Forest	Study-year value (£)	Study year	1990 value (£)
Benson and Willis (1992)			
New Forest	1.43	1988	1.69
Cheshire	1.91	1988	2.26
Loch Awe	3.31	1988	3.91
Brecon	2.60	1988	3.07
Buchan	2.26	1988	2.67
Durham	1.64	1988	1.94
North Yorkshire Moors	1.93	1988	2.28
Aberfoyle	2.72	1988	3.21
South Lakes	1.34	1988	1.58
Newton Stewart	1.61	1988	1.90
Lorne	1.44	1988	1.70
Castle Douglas	2.41	1988	2.85
Ruthin	2.52	1988	2.98
Forest of Dean	2.34	1988	2.76
Thetford	2.66	1988	3.14
mean (all forests)	1.98	1988	2.34
Hanley (1989)			
Aberfoyle	1.70	1987	2.14
Everett (1979)			
Dalby	0.41	1976	1.30

estimates has in recent years developed into a major area of research.[3] The advantages of a rigorous approach to benefits transfer are clear. The costs, both financial and temporal, of conducting individual valuation exercises at each site involved in a policy decision would be prohibitive. Consequently the US Environmental Protection Agency and, more recently, several UK government organisations, including the Department of the Environment, Food and Regional Affairs and the Environment Agency, have shown considerable interest in this avenue of research. However, as several eminent researchers acknowledge, the problems involved in formulating and conducting a successful benefits transfer are numerous and formidable (Desvousges *et al*., 1992, 1998; Atkinson *et al*., 1992; McConnell, 1992b; Smith, 1992; Downing and Ozuna, 1996; Kirchhoff *et al*., 1997; van den Bergh *et al*., 1997; Brouwer and Spaninks, 1999).

We can identify two basic approaches to benefits transfer: unit value transfer and function transfer (discussed subsequently). At the extreme, unit value transfer may simply involve assuming that, say, a per visit value estimated at one 'source' site

[3] Loomis (1992) actually traces research into benefits transfer back to 1962. However, it was only in the late 1980s that this became a major focus of research. See the review by Bateman *et al*. (2001d).

Table 3.2. *Forest users' per person per visit recreation values from CV studies*

Forest	Value type[1]	Elicit. method[2]	Study-year value (£)	Study year	1990 value (£)
Whiteman and Sinclair (1994)					
Mercia	use	OE	1.00	1992	0.93
Thames Chase	use	OE	0.71	1992	0.66
Great Northern	use	OE	0.81	1992	0.75
Hanley and Ruffell (1992)					
various	use	OE	0.93	1991	0.88
Hanley and Ruffell (1991)					
Aberfoyle	use	OE	0.90	1991	0.85
Aberfoyle	use	IB	1.21	1991	1.14
Aberfoyle	use	PC	1.39	1991	1.31
Aberfoyle	use	DC	1.49	1991	1.41
Bishop (1992)					
Derwent Walk	use	OE	0.42	1989	0.46
Derwent Walk	use+option	OE	0.97	1989	1.06
Whippendell	use	OE	0.54	1989	0.59
Whippendell	use+option	OE	1.34	1989	1.46
Willis and Benson (1989)					
New Forest	use	OE	0.43	1988	0.47
Cheshire	use	OE	0.47	1988	0.51
Loch Awe	use	OE	0.50	1988	0.55
Brecon	use	OE	0.46	1988	0.50
Buchan	use	OE	0.57	1988	0.62
Newton Stewart	use	OE	0.73	1988	0.80
Lorne	use	OE	0.72	1988	0.79
Ruthin	use	OE	0.44	1988	0.48
mean	use	OE	0.53	1988	0.58
New Forest	use+option	OE	0.88	1988	0.96
Cheshire	use+option	OE	0.72	1988	0.79
Loch Awe	use+option	OE	0.76	1988	0.83
Brecon	use+option	OE	0.66	1988	0.72
Buchan	use+option	OE	0.79	1988	0.86
Newton Stewart	use+option	OE	1.18	1988	1.29
Lorne	use+option	OE	1.02	1988	1.12
Ruthin	use+option	OE	0.63	1988	0.69
mean	use+option	OE	0.82	1988	0.90
Hanley (1989)					
Aberfoyle	use	OE	1.24	1987	1.53
Aberfoyle	use	PC	1.25	1987	1.55
Willis et al. *(1988)*					
Castle Douglas	use	OE	0.37	1987	0.46

Table 3.2. (*cont.*)

Forest	Value type[1]	Elicit. method[2]	Study-year value (£)	Study year	1990 value (£)
South Lakes	use	OE	0.39	1987	0.48
North Yorkshire Moors	use	OE	0.53	1987	0.66
Durham	use	OE	0.31	1987	0.38
Thetford	use	OE	0.23	1987	0.28
Dean	use	OE	0.28	1987	0.35
Castle Douglas	use+option	OE	0.80	1987	0.99
South Lakes	use+option	OE	0.86	1987	1.06
North Yorkshire Moors	use+option	OE	1.03	1987	1.27
Durham	use+option	OE	0.56	1987	0.69
Thetford	use+option	OE	0.41	1987	0.51
Dean	use+option	OE	0.63	1987	0.78

Notes: [1] Valuation categories investigated are as follows: use = use value; option = option value (the extra WTP to ensure conservation of the site for future use).
[2] Elicitation methods are: OE = open-ended; IB = iterative bidding; PC = payment card; DC = dichotomous choice.

can be applied to the 'target' or 'policy' site for which values are required. This is clearly very crude and so a considerable literature has developed applying the principles of 'meta-analysis' to benefit estimates.[4] Here researchers have related measures such as the mean benefit value reported in each of a set of source site studies to a series of simple (usually binary) explanatory variables detailing, for example, the evaluation method employed, the type of resource studied, the measurement unit and the elicitation method used (see, for example, Smith and Kaoru, 1990; Walsh *et al.*, 1992; Rosenberger and Loomis, 2000). Our benefit transfer study of reviewed articles derives directly from such a meta-analysis approach. Given that we are only considering woodland recreation studies, we do not need to define variables detailing the type of good evaluated,[5] and other explanatory factors are incorporated by defining relevant binary variables as in the studies cited above.

Before considering results from our meta-analysis we need to consider the alternative benefit function transfer approach, which in many ways is more theoretically appealing. Here, as before, a set of source site studies are gathered together, but

[4] For an introduction to the principles of meta-analysis, see Glass *et al.* (1981) and Wolf (1986). Note that these sources show that the form of analysis found in the benefit valuation literature and in this volume is, strictly speaking, only a partial meta-analysis dictated by the constraint of studies which were not designed with such cross-study analyses in mind (e.g. definitions of variables typically vary between benefit studies). Guidelines for a common standard of design and reporting for future studies to facilitate such meta-analyses are set out in Bateman *et al.* (2002).

[5] In a separate study we present a simple analysis of valuations across differing recreational experiences, noting that the results were logically related to both the substitutability of the environmental resource concerned and the magnitude of the change in provision considered (Bateman *et al.*, 1994).

rather than using summary results, such as mean values, the raw data are used to estimate a general benefit value function. This is then used to estimate values for the target site by holding the estimated coefficients of the function constant and changing the explanatory variable values in line with the characteristics of the target site. So, for example, if the benefit transfer function estimated from source sites included a coefficient linking recreational values to the size of a site, then one of the elements in predicting values for the target site would be to multiply its size by the estimated coefficient in the transfer function. Undertaking this operation for all the explanatory variables in the transfer function provides the overall estimate of values for the target site.

This approach need not be confined solely to the estimation of values, and in Chapter 4 we apply it to the estimation of visitor numbers, showing that the method works quite acceptably in such an application. However, in empirical trials, the function transfer approach does not fare so well in the estimation of values for target sites (Loomis, 1992; Bergland *et al*., 1995; Downing and Ozuna, 1996; Brouwer and Spaninks, 1999). In a study combining data from a single survey questionnaire applied at source sites in five countries, Brouwer and Bateman (2000) find that the function transfer approach yields higher benefit value estimation errors for target sites than does a simpler, meta-analysis style, unit value transfer. One possible cause of such findings is that benefit value functions differ more substantially between sites than do functions predicting arrival numbers (which the results presented in Chapter 4, as well as ongoing research, suggest are comparatively simple).[6] Value functions may differ in terms of which explanatory variables are pertinent and/or in coefficient estimates for those variables (i.e. what influences benefit values, and how, varies across sites). While these effects may not be that profound when viewed as a whole (making simpler unit benefit value transfers reasonably valid), the function transfer approach may give undue weight to these differences, leading to unreliable value estimates.

Given the above, we adopt a function transfer approach for estimating the number of arrivals to target sites (see Chapter 4), but a simpler meta-analysis transfer approach to the estimation of values. Consideration of the ZTC studies reviewed above (ITC studies being discarded for the reasons given) indicated that these results were not suitable for entry in such a meta-analysis both because of a lack of observations and because our own TC work (see discussion of the Thetford 2 study later in this chapter) suggested that the travel expenditure and travel time cost assumptions used in the Benson and Willis (1992) 'Standard Model' were liable to produce overestimates of benefit values. Given our desire to emphasise defensible lower-bound values, the estimates given in Table 3.1 were not used for further

[6] This work has been carried out at a variety of woodland and non-woodland sites (e.g. waterways, beaches, built attractions, etc.) and is funded by the Forestry Commission, British Waterways and others.

analysis.[7] Thus we argue that only the CV studies detailed in Table 3.2 provide a suitable concentration of observations for further cross-study analysis.

A meta-analysis of previous CV studies

Our meta-analysis of previous UK CV studies yielding per person per visit values for woodland recreation follows the approach of Smith and Kaoru (1990), Walsh *et al*. (1992) and Rosenberger and Loomis (2000). Table 3.2 lists seven studies yielding forty-four estimates. To this we have added one compatible value from the Thetford 2 study discussed later in this chapter.[8] While this list represents the largest set of estimates for any UK natural resource, it is still considerably smaller than those used by Smith and Kaoru (77 studies of which 35 were used to yield some 400 estimates) and Walsh *et al*. (120 studies yielding 287 estimates of which 129 were obtained using the CV method) in their meta-analyses of US resources. This underlines the difference in available, comparable studies in the US and UK and reinforces our opinion that the major barrier to successful benefit transfer in the UK is the lack of sufficient, high-quality valuation studies. The analysis we conducted here was therefore intended to be illustrative rather than definitive.

Our database of valuation estimates yielded the following simple explanatory variables:

WTP = study mean willingness to pay (£/person/visit)
OPTION = 1 if the study asked WTP for use plus option value; 0 if the study asked WTP for use value alone
ELICITAT = elicitation method (categorical variable): 1 = open-ended; 2 = iterative bidding; 3 = payment card; 4 = dichotomous choice
OE = 1 if open-ended elicitation method; 0 if other elicitation method
AUTHOR = authorship (categorical variable)

Following Glass *et al*. (1981) an early concern was to ensure the comparability of studies. A number of reviewed studies were excluded from Table 3.2 due to design, implementation or gross reporting problems (see Bateman, 1996). To some extent, further design effects are incorporated within analysis of the AUTHOR variable, which identified individual study designs. Although a generalised linear model[9] (Aitken *et al*., 1989) analysis did reveal some differences, these were highly correlated with the OPTION and OE variables and the AUTHOR variable had to

[7] Such analysis is given in Bateman (1996) which concludes that these results are upper-bound values for woodland recreation.
[8] This value is obtained from the sample in the Thetford 2 study who faced an entrance fee question not preceded by budget or tax questions. This sample is comparable with the other studies examined in Table 3.2.
[9] The estimated model was specified so as to explicitly permit the use of categorical variables such as AUTHOR within linear regression models with each level of the variable being treated in a manner analogous to the use of individual dummy variables.

be omitted from further analysis. Analysis of unusual design effects was therefore conducted by identifying statistical outliers (as discussed below).

Clearly the variables ELICITAT and OE cannot be included within the same model, as one is derived from the other. Analyses of variance showed that the numbers in categories 2, 3 and 4 of the ELICITAT variable were too small to allow for meaningful individual treatment. However, when these categories were amalgamated to form the OE variable, a significant difference (at the 5 per cent significance level) between results from these and the open-ended studies was observed. Following these preliminary analyses we concluded that the most conservative approach was to investigate a simple model of WTP, relating it to just the OPTION and OE variables.

Estimation of this model identified two statistical outliers, which may indicate the presence of unusual design effects.[10] These observations were excluded and the final model was:

$$\begin{aligned} \text{WTP} = {} & \underset{(14.04)}{1.3525} - \underset{(-7.28)}{0.7571}\ \text{OE} + \underset{(5.02)}{0.3120}\ \text{OPTION} \qquad (3.1)\\ & R^2 = 61.1\% \quad R^2(\text{adj.}) = 59.2\% \quad n = 43 \end{aligned}$$

Figures in brackets are t-statistics

A number of interesting observations arise from Equation (3.1). The overall fit of the model is good (given that we are dealing with socio-economic data) with about 60 per cent of total variation explained. However, the strongest explanatory variable is the constant, a finding which may reflect a common perception among respondents regarding an appropriate response to a per visit WTP question. Responses may be reflecting a mixture of respondents' notions of a socially fair level of WTP and prior experience of payments for comparable goods (entrance fees, car parking fees, etc.). Such motivations move bids away from the underlying value they are intended to measure. In effect, such measures may be more akin to prices than values.

The sign and significance of both of the explanatory variables is as anticipated. Relative to other approaches the use of an OE elicitation technique results in lower-bound WTP sums, while asking respondents to assess both their use and option value produces higher bids than when use values alone are considered. By combining these two factors we can use the coefficients of Equation (3.1) to predict cross-study estimates for the four types of per person per visit values shown in Table 3.3. Furthermore, by referring to information regarding the number of persons in an average visitor party we can infer the various per party per visit values also shown

[10] The Bishop (1992) OE use + option value for Whippendell Wood and the Hanley (1989) OE use value for Aberfoyle. For further details, see Bateman (1996).

Table 3.3. *Woodland recreation values from a cross-study analysis of CV estimates*

	Per person per visit values (£, 1990)		Per party per visit values[1] (£, 1990)	
Value type	OE elicitation method	Other elicitation method	OE elicitation method	Other elicitation method
Use value	0.60	1.35	1.82	4.12
Use + option value	0.91	1.66	2.78	5.06

Note: [1] Assuming a mean party size (from Thetford 2 study) of 3.05 persons per party.

in the table (sensitivity analysis on these estimates is given in the summary at the end of this chapter).

Conclusions

Our review of UK monetary evaluations of woodland recreation suggests that, while the literature is developing fast, the body of consistent, high-quality papers necessary for advanced benefit transfer does not exist to date (although it is arguable whether this is even true of the more advanced US literature). Consequently we have conducted a fairly simple cross-study meta-analysis concentrating on results from just one valuation method, the CV approach. While this is sufficient to demonstrate our wider methodology, it does mean that the results should be treated with some caution. We attempt to remedy this in the following sections, which examine a number of methodological and theoretical issues across both chosen valuation methods, as well as providing further benefit estimates for the wider study.

The first Thetford CV/TC study

Our initial woodland recreation study was conducted in Thetford Forest, East Anglia (providing the user sample) and the city of Norwich (about twenty-five miles distant; providing the non-user sample) in the summer of 1990 (hereafter referred to as the Thetford 1 study). The research consisted of both CV and TC analyses. The CV study involved a split-sample design examining payment vehicle and elicitation effects across both users and non-users, while the TC study (which used the ITC variant) concentrated on visit cost assumptions and the impacts of varying functional form. On account of space constraints, only principal results are presented here, with full details being given in Bateman (1996).

The Thetford 1 CV study: elicitation, payment vehicle and user versus non-user effects

The CV study asked respondents for their WTP for the recreational services and facilities available at Lynford Stag, a major woodland recreation site within Thetford Forest. In total seven subsamples were gathered. These can be divided into two groups:

(i) whether respondents were users or non-users
(ii) whether an annual tax or per visit payment vehicle was used.

In all the annual tax payment (but not entrance fee) treatments it was decided to inform respondents, prior to any WTP question, of the current average level of annual per household payments to support the Forestry Commission, which was estimated at approximately £2.60 per annum.[11] This approach followed contemporary practice in UK CV studies, particularly as pioneered in the work of Turner and Brooke (1988), a study which had recently been approved (as part of a wider CBA) by H.M. Treasury. However, subsequent studies, such as that reported by Baron and Maxwell (1996), indicate that cost information provided to CV respondents may be construed as indicating the value of the good in question (see subsequent results regarding payment card effects and the discussion of starting point bias in Chapter 2). This suggests that in the Thetford 1 study, cost information may have anchored WTP responses towards this sum. Consequently we must treat the absolute level of WTP results from this experiment with some caution although relative differences remain of interest (the subsequent study in Wantage abandoned this approach and so provides some evidence of the magnitude of the anchoring effect). Table 3.4 details WTP results across the three annual tax format samples.

Per annum WTP responses were elicited using an OE question while per visit responses were obtained using a payment card. While this precludes strict comparability across samples (study resource constraints meant that further subsamples could not be gathered at that time), such an approach was chosen to facilitate further testing of design effects as follows:

(i) For the tax format, while both users and non-users were presented with a general tax payment vehicle, a further subsample of non-users was presented with a community charge (poll tax) vehicle. At the time of the study the imposition of a poll tax was the major political issue of the day and this vehicle was deliberately chosen to examine the potential magnitude of payment vehicle effects. Non-users were identified as the group who might have the most ill-defined preferences and so provide the most extreme responses to such effects.

[11] Based upon Forestry Commission (1985a).

Table 3.4. *Summary WTP responses for the Thetford 1 CV study*

Payment period	Payment vehicle	Sample	Elicitation method[1]	Mean WTP (£)	95% C.I. (£)	Median (£)
Per annum	General tax	Users	OE	5.14	1.48–8.81	2.00
Per annum	General tax	Non-users	OE	3.51	1.13–5.88	0.70
Per annum	Poll tax	Non-users	OE	7.09	2.68–11.50	0.00
Per visit	Entrance fee	Users	PCL	1.21	0.99–1.43	1.00
Per visit	Entrance fee	Users	PCH	1.55	1.19–1.92	1.25
Per visit	Entrance fee	Non-users	PCL	1.45	1.15–1.75	1.25
Per visit	Entrance fee	Non-users	PCH	2.37	1.98–2.76	2.00

Note: [1] OE = open-ended; PCL = payment card (low range); PCH = payment card (high range).

(ii) For the per visit format two payment cards were used, the first showing a payment range from £0 to £3 in increments of 50p and the second ranging from £2 to £5 using the same increments. Both cards also explicitly stated that respondents were free to select any other amount.

All samples were collected using face-to-face interviewing of randomly selected respondents.[12] Sample size was fifty for most subsamples falling to a minimum of forty-six. While not large, the continuous nature of the valuation responses meant that these samples were generally sufficient to perform rudimentary statistical and validity analyses. Summary WTP statistics are reported in Table 3.4.

Because of the differences in elicitation method (and the use of existing payment information in the per annum questions) we cannot meaningfully compare per annum with per visit results and must confine ourselves to comparisons within these subgroups. Considering the per annum results we can see that, as expected, when all other factors are held constant (i.e. when a general tax vehicle is used), both mean and median WTP is higher for users than for non-users (although the high response variability typical of OE studies combined with relatively small sample size means that these differences are not statistically significant in this case). Analysis shows that, although all non-user samples are socio-economically similar, the user group enjoys significantly higher income levels, a finding which somewhat complicates the interpretation of this result. However, comparison of these findings with results obtained using the poll tax vehicle shows that the latter has a clear and strong effect on univariate WTP measures. The first point to note is that while refusal to pay rates are similar across the two general tax subgroups (both about 15 per cent), just over 50 per cent of those faced with a poll tax vehicle refuse to pay. Just as interesting are

[12] The authors wish to thank Joanne Wall (formerly of the University of East Anglia) for managing the survey.

the findings that, despite this, the poll tax sample recorded the highest mean WTP amount. In effect, while most respondents reject the use of poll tax as a suitable vehicle for funding the public good under evaluation, a minority are strongly in favour of such an approach and state comparatively large WTP sums, resulting in a relatively high mean.

Consideration of the per visit values detailed in Table 3.4 shows that for both user and non-user samples the higher-range payment card results in higher mean and median WTP sums (although these differences are not statistically significant in the present samples). Both the non-user samples record higher WTP sums than their user group counterparts. One plausible explanation of this finding is that non-users see the use of entrance fees as a method of moving funding costs away from themselves and onto users; we therefore have to discount the validity of such responses as indicators of underlying values.

A number of socio-economic variables were collected in all surveys so as to facilitate regression analysis of underlying bid functions (full results are reported in Bateman, 1996).[13] These functions[14] suggested that a consistent set of factors underpinned valuation responses across formats, with higher WTP values being associated with higher incomes,[15] clear knowledge of, or living near, the area under evaluation. For those facing per annum questions, WTP was positively associated with the number of visits made to Thetford annually, while for those facing per visit questions, regular visitors stated relatively lower amounts. However, for this latter group, when the number of annual visits is considered, this equated to a higher than average total WTP. These findings conform to prior expectations. However, it was noticed that bid functions for all the per visit subsamples were dominated by a highly significant intercept term, suggesting that responses were subject to some prior notion of a 'correct' (or 'social norm') answer, most probably influenced by experience of entrance fees at comparable attractions (for example, car parking fees at National Trust sites). While this again conforms to prior expectations, it undermines the validity of these particular answers as a source of valid valuations.

In conclusion, while the CV exercise carried out as part of the Thetford 1 study produces a number of results which conform to prior expectations, its major findings highlight the potential impact of design effects, so providing valuable pointers

[13] In the case of the on-site interviews with forest users, variables collected included: home address; sex; age; employment; whether the interviewee was a pensioner; income; precise interview location; preference for natural or urban recreation; history and frequency of visits to the specific site and forest entirety; time spent on site; and use-value WTP. Similar variables were elicited from the non-user samples with the addition of questions regarding respondents' knowledge of the forest and integral visitor sites.

[14] In each case a log (dependent) functional form satisfied an n-scores normal distribution test. All functions fitted the data to an acceptable degree, with R^2 values ranging from 0.15 to 0.50.

[15] This relationship was proxied in some cases by a negative association between reported WTP and the respondent being a pensioner.

towards improved study design. In particular, the highly significant impact of changing the payment vehicle indicates that considerable care is needed if future studies are to elicit usable estimates of recreation value (rather than estimates of how respondents perceived the payment vehicles themselves). Furthermore, results from the entrance fee experiment suggest that payment cards have the potential to impact upon stated values. The possibility of entrance fees themselves causing respondents to resort to simple heuristics rather than to preferences in determining values also arose but could not be adequately assessed and so was made an objective of subsequent work.

We now turn to consider the ITC analysis carried out as part of the Thetford 1 study.

The Thetford 1 TC study: functional form effects

Responses from the 129 parties of visitors (comprising almost 400 individuals) interviewed at Thetford Forest were used to undertake an ITC study of recreational values. In addition to the variables discussed previously, data regarding the distance, cost and duration of visits, substitutes and further socio-economic variables which might explain visits were collected. OLS estimation techniques were employed (a comparison with maximum likelihood techniques was conducted as part of the Thetford 2 study described subsequently) and initial analysis considered the correct specification of the dependent variable for our trip generation function (TGF). A series of correlation and regression tests confirmed that a log dependent variable was clearly superior. This decision was not so clear-cut when specification of the cost variable was considered. Following the discussion in Chapter 2, three definitions of travel expenditure cost (marginal (petrol only); petrol plus insurance; full running costs) and three definitions of travel time cost (zero (respondents enjoy travelling); the Department of Transport (DoT) wage rate; full wage rate) were investigated. All linear and logarithmic permutations of these costs were considered in defining total travel costs, and statistical tests indicated that a cost function using the full running cost estimate of travel expenditures and a zero travel time cost assumption provided the most significant travel cost variable. A considerable advantage of using a cost function which is not (via time costs) linked to wage rates is that the visitor's income may be entered as a separate explanatory variable without inducing collinearity problems.

Further explanatory variables were investigated through stepwise regression analysis of the full range of socio-economic variables collected in the survey. Of these, only the respondents' household income proved significant. This finding again echoes the results of earlier UK TC studies (Willis and Benson, 1988, 1989) which report TGFs relating visits to cost and some indicator of socio-economic status.

Table 3.5. *Thetford 1 TC study: consumer surplus estimates for three functional forms*

Functional form	R^2 adj. (%)	Travel cost coefficient. (t-ratio)	CS per party per visit (£, 1990)	CS per person per visit (£, 1990) 1 child = 1 adult	1 child = 0.5 adult	children omitted
Double-log	44.2	−0.9422 (−8.41)	3.37	1.07	1.19	1.34
Semi-log (dep.)	39.9	−0.0009490 (−7.42)	7.40	2.40	2.67	3.00
Linear	21.0	−0.026719 (−3.96)	27.42	8.88	9.87	11.10

The impact of changing the functional form was investigated[16] and Table 3.5 reports summary findings and consumer surplus estimates per party visit and per individual visit. The latter results are subdivided to consider different treatments of child visitors.

Inspection of Table 3.5 shows the double-log functional form gives the best fit to the data[17] and resultant valuation estimates accord well with prior expectations. Clearly misspecification of functional form leads to substantial error in consumer surplus estimates (e.g. adopting a linear form very substantially overestimates recreation values). The final four columns of Table 3.5 consider the issue of whether to report per party or per person values. These are highly responsive to the treatment of children within the sample. Our proposed solution, which we adopt in subsequent work, is to concentrate upon the party as the basic unit of valuation, thereby avoiding subjective decisions regarding individual level values.

In conclusion, this study was generally satisfactory and provided useful guidelines for our future TC studies. At first glance it also generated a defensible valuation of woodland recreation benefits. However, during the course of this analysis we became increasingly conscious of the theoretical problems associated with applying OLS estimation techniques to ITC data and therefore made an analysis of potential estimation effects a feature of our subsequent TC work, reported in the Thetford 2 study.

[16] These are all parametric functional forms and so impose corresponding assumptions upon our analysis. Cooper (2000) considers non-parametric and semi-parametric approaches to TC analysis.

[17] This function yields higher explanatory power than both those reported in the Willis and Garrod (1991b) ITC studies of UK woodland recreation and higher than all but two of the twenty-two comparable OLS estimated functions reported by Smith and Desvousges (1986) in their ITC studies of water-based recreation in the United States.

The Wantage CV study: households' WTP and farmers' WTA compensation for a community woodland

This project consisted of two CV surveys examining issues related to the provision of open-access, recreational woodlands on land currently used for farming.[18] Two specific aims were to determine:

(i) the willingness of the local community to pay for the provision of such a woodland
(ii) the willingness of local farmers on whose land the proposed woodland could feasibly be located to accept compensation.

The study was motivated by the introduction of the Forestry Commission's (FC) Community Woodland Scheme (CWS), a policy intended to promote open-access woodlands 'within 5 miles of the edge of a town or city and in [areas] where the opportunities for woodland recreation are limited' (Forestry Commission, 1991). Results from the research permitted cost-benefit assessment of the CWS. The study examined valuations of a proposed (hypothetical) community woodland scheme near Wantage, Oxfordshire. Full details of this study are presented in Bateman *et al*. (1996b).

Household WTP survey

Study design

Benefits from the proposed community woodland were assessed through a face-to-face CV survey of 325 randomly selected households in and around Wantage. A number of questions were designed to elicit information which might explain differences in valuations, although the main focus of the survey concerned WTP issues. The survey interview opened with a 'constant information statement' which informed households about the size (100 acres) and facilities (recreational walks and car parking) of the proposed wood and its open-access nature. Respondents were then asked whether or not they would be prepared to pay towards provision of the wood. Such a 'payment principle' question was included mainly as a way of validating zero bids as it was felt that directly presenting respondents with a WTP question might intimidate those who held zero values (Harris *et al*., 1989). Respondents who answered 'no' to this question were asked to state their reasons for such a response whilst those who answered positively were asked the WTP questions.

Two WTP questions were used in the study. First, respondents were asked how much they were WTP per household per annum in extra taxes (referred to subsequently as the 'per annum question'). Second, respondents were asked how much

[18] Further details regarding this study are given in Bateman *et al.* (1996b).

Table 3.6. *Summary WTP results: per annum (WTPpa) and per visit (WTPfee) formats*

Format	n	Mean (£)	95% C.I.[1]	Truncated mean[2](£)	Median (£)	Lower quartile (£)	Upper quartile (£)
WTPpa	325	9.94	8.92–11.14	8.85	10.00	2.00	15.00
WTPfee	325	0.82	0.75–0.89	0.68	0.75	0.05	1.00

Notes: [1] Bootstrapped confidence intervals calculated by the BCa percentile method (Efron and Tibshirani, 1993). See text for definition.
[2] Omits potential warm-glow bids. See text for definition.
All values in 1991 prices.
Minimum bid is zero for both formats (included in calculation of mean, median, etc.).

they would be WTP per adult per visit as a car parking fee (referred to subsequently as the 'per visit question'). Therefore all respondents who were WTP some amount were presented with, in turn, both the per annum and per visit format questions.[19] In all cases an OE elicitation format was used in line with our previous findings (and a desire to produce defensible, lower-bound values) and the entire design was successfully tested using a pilot sample of thirty respondents.

WTP results

Considering first the payment principle question, just under 25 per cent of respondents stated that they were unwilling in principle to pay for the proposed recreational woodland. This rate is very similar to that obtained for almost identical services in the Thetford 2 study discussed subsequently, and somewhat higher than that recorded for larger, high-profile environmental resources such as National Parks (Willis and Garrod, 1993; Bateman *et al.*, 1994). When asked, well over three-quarters of those refusing the payment principle cited income or related economic constraints as the main factor underlying their answers and none said that they were objecting to the principle of valuation *per se*. Such responses give us no cause for rejecting the application of CV techniques to this issue.

Table 3.6 gives summary WTP statistics for responses to the two formats used in this study. To guard against the potential non-normality of the response distributions we report bootstrapped 95 per cent confidence intervals, calculated via the BCa percentile method (Efron and Tibshirani, 1993) using 999 simulations. This method is based on a refined normal approximation which corrects for bias and skewness in the distribution of mean WTP and is hence an improvement over the basic

[19] Ideally we would want to either use separate samples for each format or vary the order in which questions are presented so that any ordering or anchoring effects might be assessed. Such an analysis is undertaken as part of our second Thetford CV study, reported subsequently.

non-parametric bootstrap. This is of importance with the samples of WTP values considered, which are skewed and truncated at zero.

A within-format comparison with over thirty on-site (user) CV studies of a variety of outdoor recreation resources (ranging across woodlands, wetlands, National Parks, etc.) using per annum WTP measures (Bateman *et al.*, 1994) showed that estimates obtained from the Wantage survey were logically related to the characteristics, substitutability, uniqueness and provision-change factors inherent in the contingent market presented to respondents. Given this result it is interesting to note that the Wantage WTP per annum (WTPpa) measure lies considerably above that estimated for the Thetford 1 samples, suggesting that the inclusion of information on average annual tax support for the Forestry Commission (£2.60) in the latter study had downwardly biased WTP bids. Similarly, while the Wantage WTP per visit (WTPfee) amount falls within one standard deviation of the mean of all other comparable UK studies (as reviewed at the start of this chapter), it lies well below the per visit measures recorded in the Thetford 1 study (Table 3.4), indicating that the latter were upwardly biased by the use of payment cards. On both these counts therefore, results from the Wantage study appear more valid and generally applicable than those from the Thetford 1 study.

The Wantage WTP responses were investigated for evidence of a number of the biases identified in Chapter 2 including warm-glow bids, free-riding and strategic overbidding (see Bateman *et al.*, 1996b, for details). No conclusive evidence of free-riding or strategic overbidding was found; however, limited indications of warm-glow effects were detected. Warm-glow giving (Kahneman and Knetsch, 1992) occurs where respondents purchase moral satisfaction rather than the good on offer in the contingent market (i.e. they see the CV market as a donation to a good cause and offer some, typically small, amount which is not related to the specific characteristics of the good and therefore contravenes the assumptions of the CV method). In order to investigate the sensitivity of welfare measures to such a bias the distributions of bids under both formats were examined for evidence of any appropriate amounts which respondents might choose to give under warm-glow bidding. For the annual format, a strong assumption was made that the relevant bid threshold was £5 per annum whilst for the per visit question, a threshold of £0.50 was assumed. Mean WTP was then recalculated by setting all bids up to and including these thresholds to zero to yield the truncated means listed in Table 3.6. Inspection of these truncated means indicates that, for both formats, even under such strong assumptions, warm-glow bidding makes relatively little difference to the estimated mean, which declines 11 per cent for the annual payment format and 17 per cent for the per visit format (medians remain constant throughout). We would suggest that such assumptions are too strong as they omit some genuine, low-value bids. We conclude then that although warm-glow bidding may be a feature of this

Table 3.7. *Stepwise regression of lnWTPpa on significant predictors*

Step	1	2	3	4	5	6
Constant	−5.397	−5.335	−5.096	−4.418	−4.214	−4.374
lnINCOME	0.755	0.726	0.683	0.683	0.647	0.630
	(9.79)	(9.56)	(9.06)	(9.16)	(8.54)	(8.33)
lnRURVIS		0.165	0.160	0.140	0.156	0.131
		(3.78)	(3.74)	(3.25)	(3.61)	(2.98)
lnPKVIS			0.246	0.227	0.239	0.235
			(3.69)	(3.43)	(3.62)	(3.59)
PREFTOWN				−0.590	−0.560	−0.520
				(−2.90)	(−2.75)	(−2.58)
AGE17–25					0.167	0.173
					(2.32)	(2.42)
lnVISWOOD						0.140
						(2.34)
R^2	0.288	0.261	0.292	0.310	0.321	0.333

lnWTPpa = natural logarithm of household's annual WTP (£)
lnINCOME = natural logarithm of household's gross annual income. Income was recorded on an eight-point scale (see Bateman *et al*., 1996b, for details).
lnRURVIS = natural logarithm of number of visits made by household to rural sites per annum
lnPKVIS = natural logarithm of number of visits made to parks
PREFTOWN = 1 if prefers town-based recreation; = 0 otherwise
AGE17–25 = number of persons in household aged 17–25 years
lnVISWOOD = natural logarithm of household's predicted visits to proposed wood per annum
Figures in brackets are *t*-statistics.

and other CV surveys, with regard to this study the impact of any such tendency is not severe.

Validation: bid curve analysis

Responses to both WTP formats were subjected to theoretical validity testing via bid curve analysis. For the WTPpa bids, analysis showed that a log-linear functional form provided the best fit to the data. Table 3.7 reports results from a forward-entry stepwise regression analysis relating the log-linear dependent variable, lnWTPpa, to significant explanatory variables. These models provide a good degree of explanation (easily satisfying the fit criteria discussed in Chapter 2) with bids being linked in the expected manner to a number of explanatory variables. In essence the models show that higher WTP bids were associated with richer households, containing young people, which enjoyed outdoor rather than urban-based recreation. Tests for multicollinearity suggested that the variables lnRURVIS and lnVISWOOD should probably not be included in the same model and so we identify the model given at step 5 of Table 3.7 as providing the best explanation of per annum WTP responses.

Unlike the per annum bids, analysis of responses to the per visit WTP question showed them to be much less firmly linked to standard explanatory variables. While a log-linear dependent variable provided the best fit of the data, the resulting bid curve model, detailed in Equation (3.2), achieved only a low degree of overall explanatory power ($R^2 = 5\%$) and failed to satisfy the fit criteria discussed previously.

$$\begin{array}{llll} \text{lnWTPfee} = & 0.595 & -\ 0.135\ \text{PENSION} & -\ 0.00175\ \text{VISWOOD} \\ & (25.33) & (-3.94) & (-2.26) \end{array} \qquad (3.2)$$

where:

lnWTPfee = natural logarithm of stated WTP per visit
PENSION = number in household aged 65 years or over
VISWOOD = predicted number of household visits to the proposed wood per annum

Figures in brackets are *t*-statistics.

Comparison of Equation (3.2) with those obtained from the Thetford 1 per visit format (detailed in Bateman, 1996) showed that all were dominated by the intercept term. This observation, we suggest, may be reflecting the 'social norm' concept discussed with respect to our cross-study analysis of the UK CV literature.

Aggregation

The procedure used to calculate aggregate WTP varied according to the question format used. The per annum format question elicited a mean WTP (including those who refused to pay as zeros) of £9.94 per household. At the time of the study the town of Wantage had an adult population of about 11,500. Therefore, even if we take an extreme upper-bound estimate on household size (so as to derive a lower-bound estimate on household WTP) of 2.57 (Central Statistical Office, 1991)[20] this would give an estimate of some 4,473 households in Wantage which would, in turn, imply an aggregate WTP of £44,450 per annum for the woodland.

For the per visit measure we elicited a WTP of £0.82 per adult visit (again including those who refused to pay as zeros). The mean estimated number of visits (including those who would not visit) was just under fifteen per annum, implying a total annual entrance fee expenditure of £12.29 per adult. Grossing up across all adults[21] implies a total annual willingness to pay entrance fees of £141,252.

[20] This figure refers to average UK total household size (including adults and children) rather than the average number of adults per household. If the latter were used this would increase our estimate of household WTP, i.e. we have employed a conservative, lower-bound assumption.

[21] Note that we have already accounted for non-visitors in the annual per adult visit rate.

Table 3.8. *Farm characteristics and farmers' willingness to accept compensation for transferring from present output to woodland*

Farm	Land use	Tenure	Profit/acre (£)	WTA/acre (£)	Allocation (acres)	Reason for non-allocation
1	Mainly arable	Owned	100	250	0	Land should be used to produce food
2	Mainly arable	Owned	—	20,000	0	Does not like government policy
3	Mainly arable	Owned	125	300	0	Does not want public access to the farm
4	Arable	Owned	30	200	5	—
5	Arable	Owned	105	250	30	—
6	Arable	Owned	45	150	2	—
7	Mainly arable	Owned	130	—	0	Does not want public access to the farm
8	Arable	Owned	—	—	0	Land not suitable to grow trees upon
9	Dairy	Rented	85	—	0	Does not want public access to the farm
10	Arable	Owned	116	300	0	Farm too small for the scheme
11	Mainly arable	Owned	100	—	0	Does not want public access to the farm
12	Mainly arable	Owned	186	100	125	—
13	Mainly arable	Owned	186	200	100	—
14	Mainly arable	Owned	163	250	20	—
15	Mainly arable	Rented	150	250	0	Does not want public access to the farm
16	Arable	Owned	280	600	3	—
17	Arable	Owned	145	150	0	Farm too small for scheme
18	Mainly arable	Owned	140	—	0	Farmer too old to undertake long-term project
19	Set-aside	Owned	—	250	0	Unwilling to undertake alternative to set-aside
Mean[1]	—	—	130	250	15	—

Note: [1] Excludes Farm 2.

However, we are sceptical that respondents would actually visit as often as stated (stated visitation rates considerably exceed the actual rates which we have observed at other woodland sites; see Bateman, *et al*., 1999c and Chapter 4) and so regard this as an overestimate of the likely annual value of such a site. Further comment on these findings is given in our conclusions to this study.

Farmers' WTA survey

Design

Farmers around Wantage were interviewed in order to obtain information concerning likely participation in the Community Woodland Scheme (CWS) and associated compensation requirements. Data on a variety of factors which might determine WTA levels were collected. Table 3.8 lists several of these factors, together with stated WTA sums and the amount of land farmers were willing to allocate to the CWS, for the nineteen survey participants.

WTA results

Twelve farmers (63 per cent) initially stated that they were unwilling to allocate land for public access recreational woodland.[22] Amongst these the most commonly stated reason for refusal was that the farmer did not want to allow public access to the farm (five farms, or 42 per cent of those refusing to enter the scheme). Such concerns may be well founded, as repeated public use of footpaths within a wood may lead to their classification as public rights of way. Furthermore, subsequent interviews with senior Forestry Commission staff revealed that land-owners would not be granted felling licences unless equivalent areas of replanting were agreed.[23] In other words, the decision to allocate a certain area of agricultural land to recreational forestry may, in practice, be difficult to reverse. Such irreversibility may, perversely, prove to be a considerable block to the extension of farm-forestry although the small sample size precludes any firm conclusion being drawn.

Seven farmers (37 per cent) were initially willing to allocate land to the recreational woodland scheme, the mean allocation being just over 40 acres per participating farm. Uptake among participating farms appeared to be bimodally distributed, with two farms willing to allocate 100 acres or more to woodland and the remainder only willing to undertake small-scale afforestation projects. Whilst grant aid is available for small-scale schemes, if the objective is to provide a viable, discrete recreational area then such small pockets (unless they can be combined) may not be suitable. Nevertheless the willingness to undertake large-scale planting

[22] This general unwillingness to participate in such schemes is also reported in a similar study in France by Noel *et al*. (2000).

[23] Interview with Chief Forester, Santon Downham, Thetford Forest. See also Chapter 5, this volume.

by two farmers is encouraging, particularly where the objective (as under the CWS) is simply to ensure that the local community has access to a nearby woodland recreation site.

The majority of interviewees (fourteen farms; 74 per cent) stated a sum which they would be willing to accept in annual compensation for allocating land out of agriculture and into public access woodland (WTApa). This included seven (58 per cent) of the farmers who initially rejected the principle of such allocation. This latter result seems to indicate that, if the price was right, such farms would consider a move out of conventional agriculture. However, there was one very noticeable 'protest bid'[24] amongst this subsample which, at £20,000/acre, was not only more than 150 standard deviations above the mean of the remaining sample and more than thirty times larger than the next highest bid, but also of approximately equal magnitude to the entire annual net farm income. It is possible that this respondent had in mind a discounted total net present value sum for the entirety of the project, in which case such a response would be reasonable. However, given that no other respondent gave an answer within the same order of magnitude, we feel that such an explanation is unlikely and a protest strategy seems much more probable.

Excluding this one outlier, the mean stated WTApa was £250/acre. Almost all farms required higher annual subsidy compensation rates than they currently achieved under agriculture. This seems reasonable given that woodland is an unknown quantity to most farmers, who consequently require a risk premium compared to standard activities.

Validation: bid curve analysis

Analysis of responses showed that stated compensation levels were strongly related to both existing profit levels and the overall size of the farm. No further significant explanatory variables were identified and the best-fitting regression model for WTApa is:[25]

$$\begin{array}{llll} \text{WTApa} = 94.04 & +\ 1.48\ \text{PROFIT} & -\ 1.93\ \text{ACRES} \\ \qquad\quad\ (1.81) & \quad (4.04) & \quad (-3.37) \end{array} \tag{3.3}$$

where:

WTApa = Farmers' required compensation (£/acre) for entering the woodland scheme

PROFIT = Level of profit under existing agriculture (£/acre)

ACRES = Area in acres which the farm is prepared to allocate into the woodland scheme

Figures in brackets are *t*-statistics.

[24] The authors dislike the general application of this term to anyone who does not give an expected answer to a bidding (WTP or WTA) question. However, this particular respondent seemed to satisfy all relevant requirements of an archetypal 'protester'.

[25] The previously identified outlier was excluded from this analysis.

The model presented in Equation (3.3) fits the data well (although sample size is clearly a problem), satisfying fit criteria ($R^2 = 70\%$) and indicating logical relationships between the dependent and explanatory variables. Farmers with higher profit levels from existing activities demanded higher levels of compensation for entering the woodland scheme. Furthermore, those who were only willing to consider small-scale planting required higher per acre payments. This implies, logically, that large-scale plantations, which presumably will benefit from economies of scale, are considered viable alternatives at relatively lower per acre subsidy rates than small-scale woodlands.

Aggregation

To allow comparability with our household WTP survey, aggregate farm WTA needed to be calculated for a similar 100 acre site. Using the mean stated WTApa of £250/acre produced a total compensation requirement for such a woodland of £25,000 per annum.

Comparison of household WTP and farm WTA measures

Both measures of aggregate household WTP exceeded our estimate of aggregate farm WTA to a considerable degree. In the case of the annual format we have a simple[26] benefit/cost ratio of 1.78 whilst the entrance fee format yields a ratio of 5.65. Such results point strongly in favour of the establishment of Community Woodland Schemes. However, we prefer to retain a cautious approach to the WTP sums. Another way of examining these is to consider the minimum number of payments needed to meet the required aggregate compensation level. Using the per annum format and our estimated household size implies that some 2,515 households (i.e. 56 per cent of all those in Wantage) would need to pay the £9.94 mean WTPpa for the scheme to break even. Alternatively, all the households in Wantage would have to pay £5.59 per annum for the scheme to again break even.[27] Using the per visit mean WTP of £0.82 implies that 30,487 individual visits per annum would be required to pay for the forest, i.e. each individual in Wantage would need to make 2.65 paying visits per annum for the site to break even.

The Wantage study: conclusions

The Wantage study provides a number of findings which are of use to our overall research objectives. First, it gives a number of recreation benefit estimates which, compared to our earlier Thetford 1 study, appear relatively unbiased. Second, the

[26] The term ‘simple’ refers here to the fact that this study represents only a partial cost-benefit analysis of such a scheme.

[27] Note that this is considerably less than the mean WTP excluding suspected strategic overbidders detailed in Table 3.6.

WTA experiment suggests that, given appropriate compensation, sufficient farmers are prepared to countenance entry into the CWS to make the scheme viable. The strong bid function estimated from WTA responses implies that familiarity with the concept of compensation makes farmers adept at determining appropriate threshold compensation levels, these levels being linked to current profitability and postulated involvement with the scheme. Third, aggregate benefit sums considerably exceed estimates of farmers' compensation requirements suggesting that the implementation of such projects could result in the creation of substantial net public benefits. The magnitude of the implicit benefit-cost ratio is also sufficient to overcome any residual concerns regarding the precise value of estimated welfare measures.

The second Thetford CV/TC study

This study consisted of a joint CV/TC on-site survey of recreational visitors to Lynford Stag, the site previously used in the Thetford 1 study. The overarching objective was to examine how responsive benefit estimates were to changes in study design and analytic methods. We will discuss the CV study first (further details can be found in Bateman and Langford, 1997a).

The Thetford 2 CV study: budget constraint and question-order effects

The CV study used a split-sample design to address two principal issues arising from the literature review presented in Chapter 2:

(i) the impact of explicitly asking respondents to consider their budget constraints prior to stating WTP
(ii) question-ordering effects.

In addition to these effects, payment vehicle impacts were again investigated through use of both per annum taxes and per visit entrance fees.

Study design

The study objective required a split-sample design in which respondents were divided into two groups, each of which was further divided into two subgroups as follows:

Group B: Prior to any WTP question, respondents were asked to calculate and state their annual recreational budget.
Group NB: No budget question was asked prior to any WTP response.
Subgroup 1: WTP per annum (tax payment vehicle) was asked prior to WTP per visit (entrance fee payment vehicle) question.
Subgroup 2: WTP per visit (fee) was asked prior to WTP per annum (tax) question.

The above design gave us four subsamples (B1, B2, NB1 and NB2), each of which provided both per annum (tax) and per visit (fee) WTP responses for which we defined a series of testable hypotheses concerning the effects under investigation. Testing used various approaches. Simple comparisons of means and standard (normal) confidence intervals were undertaken. However, while of interest, such statistics are potentially biased by necessary distributional assumptions. To combat this, non-parametric confidence intervals for mean WTP were calculated via the BCa percentile bootstrap method (Efron and Tibshirani, 1993) as discussed previously.

In line with preceding studies an OE elicitation format was used throughout. In addition to the valuation responses the survey also elicited information regarding relevant visit, socio-economic and interview condition variables necessary for subsequent validity analyses. The questionnaire was tested with a pilot survey of thirty-two respondents. This resulted in marginal changes to the questionnaire which was then applied to the main survey from which a sample of 351 respondents was collected.

WTP results

As in previous designs, prior to the budget and WTP questions, respondents were asked a 'payment principle' question enquiring whether or not they were willing to pay anything at all. Some 96 respondents (27.6 per cent of all respondents;[28] a rate in line with previous results)[29] stated that they were not prepared to pay at least some amount for the recreational facilities provided at the site, leaving 255 respondents to answer the budget and WTP questions. To prevent overstating sample WTP (and avoid problems caused by somewhat uneven numbers in each subsample accepting the payment principle), in later calculations these refusals were allocated evenly between the four subsamples and treated as zeros.[30]

Those who agreed to the payment principle were (unbeknown to themselves) then randomly allocated to one of the four groups defined above and asked the relevant WTP questions, results from which are described below.

WTP per annum (tax) responses

Table 3.9 presents mean WTP per annum (via taxes) for each of our four subsamples. For notational simplicity we can refer to the subsamples described in the upper row as $NB1_a$ and $NB2_a$ (left- and right-hand cells respectively; subscript *a* indicates per annum (tax) response) and those on the lower row as $B1_a$ and $B2_a$. Below each mean (in rounded brackets) we report 95 per cent confidence intervals calculated

[28] Reasons for refusing to pay were mainly related to economic factors and are analysed further in Bateman and Langford (1997a). At most only 2 per cent of the sample gave refusal reasons which can be interpreted as in some way protesting against the valuation process.

[29] See, for example, Bateman *et al.* (1995a).

[30] The inclusion of such zeros reinforces the need to conduct non-parametric testing.

Table 3.9. *Mean WTP (tax) per annum and 95 per cent confidence intervals for each subsample (including payment principle refusals as zeros)*

	Payment ordering scenario	
Budget question	1 (tax then fee) (£)	2 (fee then tax) (£)
NB (not asked)	12.55 (8.94–18.47) [8.11–16.99]	7.62 (4.36–15.77) [2.87–12.37]
B (asked)	32.60 (23.18–45.89) [21.76–43.43]	16.37 (11.78–22.12) [11.19–21.55]

Note: Figures in round brackets are 95% C.I.s calculated by the BCa percentile method, as discussed previously, while figures in square brackets are conventional 95% C.I.s.

via the BCa percentile bootstrap method, while below these (in square brackets) we report standard normal 95 per cent confidence intervals for comparison.

Table 3.9 indicates that the inclusion or exclusion of the recreational budget question, and/or changes in the ordering of payment vehicle presentation, results in apparently consistent and major impacts upon stated WTP. For ordering scenario 1 (tax then fee), the inclusion of the budget question (i.e. moving from cell $NB1_a$ to cell $B1_a$) raised mean annual WTP (tax) by a factor of 2.60, while for ordering scenario 2 (fee then tax) inclusion of the budget question (i.e. moving from cell $NB2_a$ to cell $B2_a$) raised mean annual WTP (tax) by a factor of 2.15. However, examination of BCa confidence intervals shows that only the first of these differences is clearly significant (i.e. the 95 per cent BCa confidence intervals do not overlap).

Considering the impact of changing the order of payment questions upon per annum responses, in those subsamples not given the prior budget question, asking for per visit WTP before the per annum question (cell $NB2_a$) lowered the latter to just 60.7 per cent of stated annual WTP when not preceded by a per visit question (cell $NB1_a$). For those subsamples which were given a prior budget question, this disparity increased so that annual WTP preceded by a per visit question (cell $B2_a$) was just 50.2 per cent of the annual WTP otherwise (cell $B1_a$). Again, the BCa confidence intervals indicate that only one of these differences (the latter) is significant, suggesting in this case that the prior per visit question substantially reduced the subsequent stated per annum WTP.

Consideration of the diagonals in Table 3.9 shows that where the apparently negative effect of including a prior per visit WTP question is combined with the

Table 3.10. *Mean WTP (fee) per visit and 95 per cent confidence intervals for each subsample (including payment principle refusals as zeros)*

	Payment ordering scenario	
Budget question	1 (tax then fee) (£)	2 (fee then tax) (£)
NB (not asked)	0.45	0.20
	(0.35–0.57)	(0.12–0.32)
	[0.35–0.55]	[0.11–0.29]
B (asked)	0.78	0.46
	(0.57–1.09)	(0.33–0.66)
	[0.53–1.03]	[0.30–0.62]

Note: Figures in round brackets are 95% C.I.s calculated by the BCa percentile method, as discussed previously, while figures in square brackets are conventional 95% C.I.s.

positive impact of a prior budget question (cell $B2_a$), then the resultant per annum WTP statement is not significantly different from that elicited in the absence of both preceding questions (cell $NB1_a$). However, comparison of stated per annum WTP when preceded solely by the apparently negative effect of a prior per visit question (cell $NB2_a$) with annual WTP preceded solely by the positive impact of a prior budget question (cell $B1_a$) shows a highly significant difference in WTP responses.

Comparison of the BCa and standard (normal) confidence intervals is also interesting. The distributional assumption underlying the latter does not prevent negative WTP values and the presence of significant numbers of zeros (payment principle refusals), alongside a distribution of non-zero responses containing some relatively high values, results in unreliable confidence intervals. These problems are corrected for in the BCa approach by using empirically derived estimates of bias and skewness which are calculated for each subsample. Upper and lower percentile points are then calculated accordingly. Here we can see that reliance upon conventional (normal) confidence intervals would overemphasise the significance of differences between subsamples.

WTP per visit (fee) responses

Table 3.10 presents mean WTP per visit (via fees) for each subsample and 95 per cent confidence intervals (as previously described). In the subsequent discussion, subsample notation is similar to that used above, with the subscript v indicating per visit (fee) responses.

Considering Table 3.10 we can see that the design effects detected in the per annum experiments have been repeated in the per visit studies. Again the inclusion of a prior question regarding recreation budgets seems to lead to increases in subsequent per visit WTP responses which are significant in both cases. Table 3.10 also shows that the prefixing of per visit WTP questions by per annum questions apparently increases per visit WTP bids. However, examination of the BCa confidence intervals indicates that only one of these two differences is statistically significant.

Consideration of the diagonals in Table 3.10 again tells a consistent story regarding the interplay of budget and ordering effects. Where these tend to shift responses in the same direction (i.e. comparing influences which are both negative in cell $NB2_v$ with influences which are both positive in cell $B1_v$), confidence intervals indicate highly significant differences, but where they work in opposition (comparing cell $NB1_v$ with cell $B2_v$), equality cannot be rejected. Finally, as before, reliance upon normal confidence intervals would generally lead us to overestimate the significance of these results.

Validation

Validation of survey results was carried out in accordance with the criteria set by Mitchell and Carson (1989). A central notion here is the concept of construct validity which is in turn composed of convergent and theoretical validation. In practice, convergent validity testing has generally been achieved by comparing benefits with those of other studies, while theoretical validity has been examined through the estimation of bid functions and analysis of their consistency with theoretical expectations.

Two types of convergent validity test were undertaken. In the first, results from the NB subgroups of this study were compared with the other estimates of UK woodland recreation value discussed earlier in this chapter (there were no studies comparable with the B format subgroups). Tests showed that the results obtained in the present study strongly conformed to expectations from prior research (details are given in Bateman and Langford, 1997a). A second test compared results from the NB subgroups with those from a selection of studies in a similar format of different resources (e.g. wetlands, reservoirs, etc.). It was found that results across these studies were logically related to both substitute availability and the change in provision presented in the contingent market and that the findings of the present study were consistent with these expectations (details are given in Bateman and Langford, 1997b).

Theoretical validation of our results was carried out via statistical investigation of the bid functions underlying WTP responses. A semi-log (dependent) functional form provided the best fit for the per annum data:

$$
\begin{aligned}
\text{lnWTPtax} = {} & \underset{(10.6)}{1.20} + \underset{(11.17)}{1.50}\ \text{BUDGET} - \underset{(4.76)}{0.633}\ \text{ORDER} \\
& + \underset{(1.66)}{0.390}\ \text{GREEN} + \underset{(3.35)}{1.08}\ \text{NONCAR} + \underset{(2.88)}{0.574}\ \text{SUPERB}
\end{aligned}
\tag{3.4}
$$

where:

lnWTPtax = natural logarithm of WTP per annum (tax vehicle)
BUDGET = 1 if respondent had been asked to state annual recreational budget prior to WTP questions; = 0 otherwise
ORDER = 1 if respondent faced a prior per visit WTP question (ordering scenario 2); = 0 otherwise
GREEN = 1 if respondent was a member of at least one of various countryside/wildlife organisations; = 0 otherwise
NONCAR = 1 if the respondent did not travel to the site by car; = 0 otherwise
SUPERB = 1 if the respondent rated scenery at the site on the top of a four-point scale; = 0 otherwise.

Figures in brackets are *t*-statistics.

Equation (3.4) fits the data well (adjusted $R^2 = 33.7\%$), easily satisfying the criteria for theoretical validity discussed previously. The model again indicates the significant influence of budget constraint and question ordering on per annum responses. This finding is repeated in the per visit bid function shown in Equation (3.5), which again satisfies the Mitchell and Carson (1989) criteria regarding the degree of explanation (adjusted $R^2 = 26.4\%$) although the strength of the constant in this model recalls our earlier comments regarding the influence of social norms upon entrance fee WTP responses. Here a linear form fitted the data best, reflecting the clumping of bids around two round-figure amounts (50p and £1).

$$
\begin{aligned}
\text{WTPfee} = {} & \underset{(8.12)}{0.618} + \underset{(2.48)}{0.167}\ \text{BUDGET} - \underset{(1.94)}{0.167}\ \text{ORDER} \\
& - \underset{(3.05)}{0.299}\ \text{GREEN} + \underset{(3.16)}{0.397}\ \text{CAMP}
\end{aligned}
\tag{3.5}
$$

where:

WTPfee = WTP per visit (entrance fee vehicle)
CAMP = 1 if the respondent often camps in the area; = 0 otherwise
Other variables as defined above.
Figures in brackets are *t*-statistics.

In general the above findings are unremarkable with one exception: the dramatic change in the influence of the explanatory variable GREEN which is positively related to per annum bids (although only significant at the 10 per cent level), but negatively associated with per visit bids (significant at the 1 per cent level). We consider this and other findings below.

Discussion

Budget constraint effects

In both our per visit and per annum responses the inclusion of a prior budget constraint question resulted in a very substantial increase in subsequent stated WTP. Three of the four comparisons which make up this analysis indicated that this difference was statistically significant, a result of some importance for CV research.

The direction of impact is also interesting. Most commentators (Mitchell and Carson, 1989; Willis and Garrod, 1993) discuss cases in which, *a priori*, we would expect that respondents' consideration of annual expenditure upon recreation and consequent budget constraints would lead to a reduction in stated WTP compared to statements made without such consideration. However, here we observed a strong opposite effect whereby respondents who were asked to calculate their present annual expenditure stated significantly higher WTP sums than those not asked the prior budget question.

Why has this effect occurred? It seems to us that two interpretations are possible, one generally supportive of CV and the other critical. The former argues that respondents forced to overtly consider their annual recreational budget find that, on average, this accounts for a significant portion of their total annual expenditure, perhaps more than they realised without such consideration. Certainly, stated annual recreational budgets were not insignificant. The mean budget (£227.30) was considerably affected by the skewed nature of this distribution. Nevertheless, the median value of £120 shows that most respondents had considerable annual recreation budgets. Following this argument then, after considering the apparent importance of recreation in their preference sets, such respondents gave higher WTP sums than would otherwise have been stated. If we accept such a line of reasoning then a supplementary question arises as to which WTP measure (with, or without, the prior budget question) is correct. The argument would seem to suggest that answers formulated following the consideration of available budgets will be less susceptible to mental accounting problems and therefore preferable.

A more critical interpretation of our findings, however, argues that the calculation of the annual budget (which is relatively high compared to WTP) acts as an anchor for subsequent WTP statements. Kahneman *et al*. (1982) suggest that such an effect is most likely to occur where individuals are inexperienced and face considerable uncertainty in forming their response. Here, then, our use of an open-ended WTP elicitation approach may have exacerbated such an effect, as individuals do not have as much experience of setting prices as reacting to them.

Clearly such findings give us pause for thought regarding the degree to which WTP responses may be manipulated by small and apparently defensible changes in questionnaire design. The responsiveness of stated WTP to the inclusion of the budget question is remarkable and a matter of significant concern for CV studies.

Ordering effects

Irrespective of whether or not a budget constraint question was asked, stated WTP per annum amounts were higher when given as an individual's first WTP response than when given after a response to the per visit WTP question (although this effect is only significant in one treatment). A first point to note regarding such ordering effects is that, as indicated in our literature review, these results are not necessarily inconsistent with economic theory. Indeed the work of Carson *et al*. (1992, 1998) and Randall and Hoehn (1992) would lead to such an expectation. However, there are further (although not necessarily contradictory) explanations of these results. A somewhat simplistic interpretation of such findings might be that such respondents were taking prior per visit payments and extrapolating them to produce a per annum sum.[31] However, this would imply that per annum responses made prior to per visit bids were in error.

An alternative explanation of the apparent ordering effect is suggested by our observation that membership of 'green' groups was positively correlated with WTP per annum but negatively related to WTP per visit. We suggest that this apparent disparity arises from a change, induced by the switch in payment vehicle, in the perceived nature of the good under evaluation. When presented with a non-preceded WTP per annum question (ordering scenario 1), respondents recognise a typical payment mechanism for funding public goods in the UK. Individuals understand the redistributive nature of most UK taxes and that such a payment would preserve the common-property, public-good, nature of recreation within Forestry Commission woodlands. Here, then, payments ensure provision for both the payee and other members of society, both types of provision being likely to be valued by the respondent. However, respondents facing ordering scenario 2 are initially presented with a WTP per visit (entrance fee) question. Such payments only ensure access for the payee and imply the exclusion of non-payers. The payment vehicle thus describes a private, rather than a public, good. This perception is liable to be retained when, subsequently, respondents are presented with the per annum WTP question. We

[31] Factors such as discounting, uncertainty and risk mean that we would not expect a simple relationship between per visit and per annum WTP.

can therefore view the apparent ordering effect in per annum responses as arising out of a category shift in perceptions, induced by the payment vehicle, regarding the nature of the good under evaluation. The observed relationship of responses conforms to the perceived loss of services between ordering scenarios 1 (recreation seen as a public good) and 2 (recreation seen as a private good).

If the difference in WTP statements is derived purely from the additional value aspects which respondents feel they obtain from woodland as a public good (bequest, altruism, etc.) rather than as a private good, then, while complicating the matter, this may be viewed as simply reflecting preferences. However, a number of commentators have argued that the evaluation of the same asset as either a public or private good may alter the underlying motivations upon which individual preferences lie. Schkade and Payne (1994) and Blamey (1998) note that evaluations of public goods appear in part to reflect norms regarding civic duty and fairness. Furthermore, Brennan and Buchanan (1984) argue that such valuations may also be influenced by a self-image or expressive value, derived from contributions towards goods which benefit not just the individual but also others in society.

In support of such an argument it is important to emphasise that the study was conducted midway through a high-profile, year-long public debate concerning (and generally opposing) proposals by the then UK government to privatise the Forestry Commission estate, a resource which provides the largest area of open-access recreational land in the UK. Countryside groups and their members were vociferous in their opposition to privatisation, as evidenced in the remarkable swing from positive to negative correlations with WTP as payment vehicles switch from those of a public to a private good. If normative and expressive values do underpin these differences, then, as Sugden (1999b) argues, CV estimates must be considered as being context-specific rather than as absolute valuations of the assets concerned.

A contrary and more critical explanation of the observed ordering effect follows Kahneman *et al*. (1982) in arguing that relatively small prior per visit WTP responses have here downwardly anchored subsequent per annum bids. In the context of our particular experiment, with one WTP response directly preceding another, such an effect is similar to the widely observed phenomenon of starting point bias (Boyle *et al.*, 1985). However, the remarkable and highly significant reversal in WTP correlation signs for members of green groups described above, makes us feel that the public/private goods argument cannot be ignored here. This does not preclude the possibility that the observed ordering effect has been heightened by anchoring/starting point bias, with consequent questions being raised regarding the validity of such results.

Each of the theoretical expectation, public/private goods and anchoring arguments can also be applied as explanations of the observed ordering effects in per visit WTP responses. Here the direction of causation is reversed in that the introduction of a prior per annum WTP question raises per visit WTP (although again only one of these effects is statistically significant). This could be following theoretical expectations, perhaps enhanced by the per annum approach inducing respondents to think of this as being a public as opposed to a private good. Alternatively it may be that the relatively high prior per annum response upwardly anchors subsequent per visit responses, or a mixture of both.

Conclusions

The analysis applied a split-sample approach to the investigation of budget constraint, temporal and ordering effects in CV studies. In three out of four tests significant budget constraint effects were detected. Interpretation of such results is not straightforward as they may be viewed either as the expected consequence of respondents revising bids in the light of further reflection, or as evidence of an anchoring bias. While both explanations may have some validity their implications for future studies are in direct conflict. If budget constraint questions induce respondents to consider more fully their personal circumstances, then, following the recommendations of Arrow *et al*. (1993), some variant of these questions should be included prior to WTP questions. Conversely, if the responses to budget constraint questions anchor subsequent WTP bids, then this suggests that they should be avoided.

Two of the four tests of ordering effects indicated that significant differences were observed. Again, at least two explanations of these results can be proposed. Following Carson *et al*. (1992, 1998), economic theory allows for divergence between measures of the same good elicited at different points in a valuation sequence. Such differences are likely to be exacerbated if the sequence itself induces differing subsamples to view the resource under evaluation as either a public or a private good. Following such an explanation, the divergence in valuations can be seen either as reflecting the differing attributes of such goods, or as arising from a consequent change in the motivations underlying the preferences expressed. However, as with our budget constraint experiment, these divergences can also be interpreted as evidence of prior responses anchoring subsequent bids.

In conclusion, these findings can be viewed either as demonstrating the susceptibility of CV results to design effects or as quantifying the limits of such effects. For the purposes of our subsequent work we adopt the latter position, stressing that the valuation of environmental preferences remains more of an art than a science, but that such values, if treated with due caution, can improve decision-making substantially when compared with standard approaches in which such preferences are implicitly ignored.

The Thetford 2 TC study: a GIS-based investigation of measurement and estimation effects[32]

The analysis of revealed visitation behaviour derived from the TC data gathered in the Thetford 2 survey involved the first application of geographical information system (GIS) techniques to be presented in this volume. The GIS was used to provide estimates of travel time and distance from outset locations to the site. The spatial analytic capabilities of the GIS were then used to perform a sensitivity analysis of common measurement assumptions in TC studies. As we shall see in Chapter 4, the GIS was also used to manipulate TC data so as to generate a transferable arrivals function, capable of estimating the number of visitors both to this surveyed site and to other unsurveyed sites in our wider study area of Wales.

The Thetford 2 TC study was also used to conduct a full sensitivity analysis across a range of unit-value assumptions regarding travel expenditure and time cost and to assess how effects vary between differing estimation procedures, namely ordinary least squares (OLS) and maximum likelihood (ML) techniques. Survey details are as for the Thetford 2 CV study (the questionnaire was designed to facilitate both CV and TC analysis), although here we stress the importance of questions concerning the recreational trip. Respondents were asked to state:

(i) home address, and trip origin if different to this (e.g. if on holiday away from home)
(ii) how they travelled to the site
(iii) the perceived travel time and cost
(iv) the number of other sites visited during the day's trip
(v) the proportions of the whole day's enjoyment attributable to time spent travelling, time spent at the survey site and time spent at other sites.

Applying GIS to the TC method

One of the most obvious advantages of using GIS techniques in TC studies is to standardise and improve the accuracy in the derivation of travel distance and duration variables. Given that these are the basic elements underpinning estimates of individuals' travel expenditure, travel time and hence travel cost, the potential benefits are clearly considerable. This section describes the procedure by which the GIS was used to calculate travel times and distances.

Using the data collected from the visitor survey, the 1km National Grid reference of trip origin was located by consulting the Ordnance Survey's *Gazetteer of Great Britain* (Ordnance Survey, 1987). Digital road network details were extracted from the Bartholomew 1:250,000-scale database for the UK. This source provides information on road classes, distinguishing fifteen separate categories from minor, single-track country lanes to motorways. Computing constraints made

[32] Further details of this study are given in Bateman (1996) and Bateman *et al*. (1996a)

Table 3.11. *Average road speed estimates*

Road type	DoT estimates Rural (1) (m.p.h.)	DoT estimates Urban (2) (m.p.h.)	Adjusted speeds Rural (3) (m.p.h.)	Adjusted speeds Urban (4) (m.p.h.)
Motorway	70	50	63	35
A-road primary, dual carriageway	60	40	54	28
A-road other, dual carriageway	55	35	50	25
A-road primary, single carriageway	50	35	45	25
A-road other, single carriageway	40	25	32	18
B-road, dual carriageway	40	25	36	18
B-road, single carriageway	30	17	24	12
Minor road	20	15	14	11

Source: Columns (1) and (2) from Department of Transport (1992, 1993).

it impractical to assemble a detailed road network for the entire area covering origins of Thetford visitors (this ranged from near Newcastle upon Tyne in the north to Hampshire in the south). We therefore defined a study area to include the counties of Norfolk, Suffolk and Cambridgeshire, together with adjoining districts in Lincolnshire and Essex. This encompassed over 92 per cent of the visitor origins.

Typical speeds can be assigned to the different classes of road defined in the Bartholomew's database so enabling travel times to be calculated for discrete sections of road. From these, travel times can be calculated for routes across the whole network. Data on average travel speeds for differing categories of road were obtained from a variety of sources. This exercise revealed both the paucity of such data and some significant differences in estimates. An initial investigation was undertaken using road speeds given in Department of Transport (DoT) sources as detailed in columns (1) and (2) of Table 3.11.

Travel times from each road segment in the network were calculated as:

$$\text{travel time} = \frac{\text{length of road segment (in miles)}}{\text{speed (miles per hour)}} \tag{3.6}$$

Minimum travel time can be calculated by specifying the time from Equation (3.6) as the impedance associated with a particular road segment in the digital network. An algorithm is then used to identify the route between the trip origin and forest site which minimises the cumulative impedance, thereby also deriving the minimum travel time (see Lupien *et al.*, 1987). Utilising the DoT road speeds in Table 3.11, a series of travel times were calculated for a variety of routes between a sample of towns and villages in the area. These were then compared with those generated using the alternative road speeds given in Gatrell and Naumann

(1992) and the Automobile Association's Autoroute route planning software package. Further calibration was achieved by calculation of travel times for a number of routes well known to the authors and their colleagues. These assessments consistently pointed to the conclusion that the DoT road speeds given in Table 3.11 were overestimates of those realistically attainable in the study area. Such a finding reflects the fact that these official road speed estimates are based on limited information regarding the impact of road junctions and other sources of traffic congestion. Although it was feasible to consult Ordnance Survey maps regarding the topology of motorway junctions it was not practicable to conduct a systematic assessment of all junctions (or other traffic constraints) throughout the road network. Accordingly, a sensitivity analysis was undertaken to obtain appropriate adjustment factors by comparing calculated travel times with those regarded as more realistic.[33] Best-fit adjusted road speeds are presented in columns (3) and (4) of Table 3.11.

The calculation of individuals' travel times and distances using the GIS involved three steps. First, the survey site was identified on the road network and an algorithm in the GIS software (Arc/Info) was used to calculate the minimum sum impedance[34] between the destination and each unique segment of road. This produces the minimum cumulative time (in minutes) that it takes to reach the start-point and end-point of each road segment. These times are then stored in an output table (Environmental Systems Research Institute, 1994).

The second step involved finding the nearest point on the road network for each individual visit origin. Travel times from this point to the site were then extracted using both the prepared output table and interpolation between the two end-points of each road segment. Finally, the distance travelled by each visitor along these minimum impedance routes was calculated using further GIS facilities (*ibid*.).

As a test of the validity of these GIS-defined measures, respondents' estimated travel times and distances were compared with their GIS equivalents.[35] Travel time distributions were found to be very similar (a two-sample t-test for difference gave a t-statistic of 0.09 for which $p = 0.88$). A similar result was obtained regarding travel distances. However, the values highlighted some potential advantages of the GIS approach. These are illustrated in Figure 3.1 which graphs the ratio of stated to GIS-calculated distance against the absolute value of the latter.

Examining Figure 3.1 shows that, on average, the distance measures coincide reasonably well. Most observations have a ratio value of about 1 (i.e. stated =

[33] Further details are given in Bateman *et al.* (1999c).

[34] The algorithm used works recursively through the entire road network, keeping information about the minimum impedance route found so far, until all possible route permutations are exhausted.

[35] A similar analysis is reported by Liston-Heyes (1999).

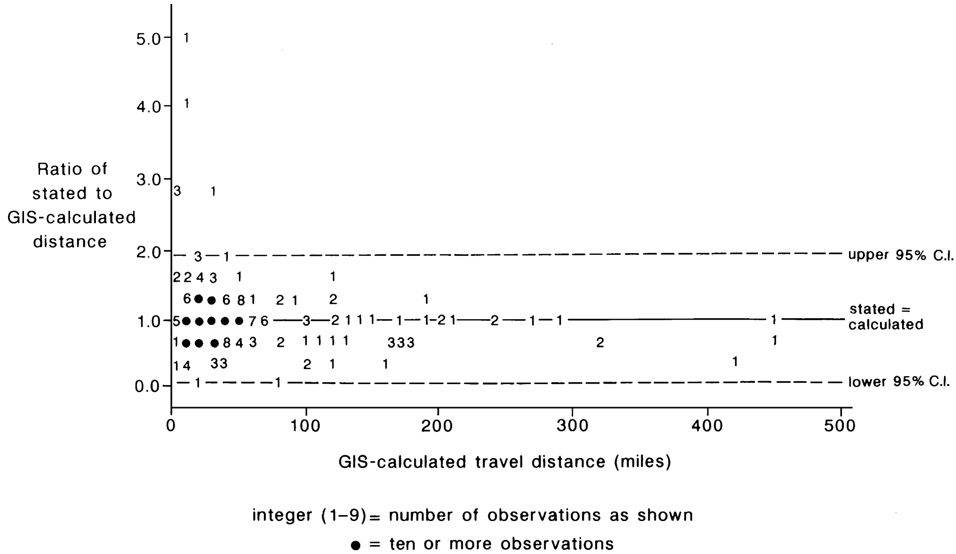

Figure 3.1. Graph of the ratio of stated to GIS-calculated distance against calculated distance. (*Source:* Adapted from Bateman *et al*., 1996b.)

GIS-calculated values) and there are approximately as many observations below 1 as above. However, given that the GIS distance is based on a minimum impedance algorithm (minimum possible travel time), those respondent estimates below the unity line are likely to be subject to some form of error, a situation which we suspect is due to respondents rounding their stated travel time estimates, e.g. a true travel time of twelve minutes is reported as being ten minutes. Support for such an argument comes from noting that, with a few exceptions (discussed below), a similar distribution of upward rounding errors can be seen lying above the unity line, e.g. a true travel time of eight minutes being reported as ten minutes.

Such results indicate that GIS measures are, for the majority of visitors, good estimates of true travel distance and duration. However, Figure 3.1 shows that for a small minority such a conclusion does not hold. Six respondents (i.e. about 2 per cent of the sample) lie above the upper 95 per cent confidence interval around the unity line. Cross-checking against responses from these parties shows them to be 'meanderers' (see Chapter 2), whose main objective is enjoyment of the journey rather than time spent on site. The relatively low importance of the on-site recreational experience to such respondents will be reflected in their responses to question (v) above which are used as utility weights on travel costs in the TC model. Such a procedure ensures that we only use that portion of travel costs which is due to the on-site recreational experience in calculating the benefit values of that site. Coincidentally, this same procedure drastically reduces the influence of any error due to the use of GIS-based measures for such meanderers. Given this, and the advantages of such measures with respect to rounding errors, we consider that GIS-calculated travel distance and duration provide a good basis for TC studies, an assumption which we test subsequently in this study.

Sensitivity analysis 1: unit-value assumptions and estimation techniques

In Chapter 2 we discussed the various definitions of travel expenditure and time cost which underpin travel costs. Here we test various combinations of each, defining travel expenditure as marginal (petrol only) or total running costs (8p and 23p per mile respectively)[36] and time costs at the following wage rates: 100 per cent (assuming that leisure time is valued at the full wage rate); 43 per cent (the DoT appraisal rate); 0 per cent (assuming that there is no opportunity cost of non-work time); and a best-fit rate (that rate which maximises the model's fit to the data).[37] These combinations defined a series of alternative travel cost (expenditure plus time) variables which were then used as the basis of a number of models to predict visits to the site at Thetford Forest. Other explanatory variables were derived from survey data and are discussed subsequently.

A further issue which our theoretical appraisal highlighted was the impact of varying the estimation procedure employed. In particular, it was noted that the use of ordinary least squares (OLS) techniques failed to allow for the truncation of non-positive visits (i.e. it does not take into account the fact that any on-site survey respondents cannot make less than one visit to the site). This issue can be addressed by the use of maximum likelihood (ML) methods where the underlying likelihood function can be defined to allow for this truncation (for details regarding the present study, see Bateman *et al.*, 1996b). For comparative purposes both OLS and ML estimation methods were applied to the various unit-value permutations described above. Goodness-of-fit measures were given by R^2 statistics for OLS regressions and log likelihood values for ML analyses.

Results

Tests across a variety of functional forms indicated that in all cases the natural log of the number of visits made by a party to the site (lnVISIT) gave the best definition of the dependent variable. To enhance comparability across models a consistent set of explanatory variables was used in all sensitivity analysis models as follows:[38]

[36] Automobile Association estimates given in Benson and Willis (1992).
[37] Further permutations, including the use of measures based on respondents' perceived travel costs, are presented in Bateman (1996) and Bateman *et al*. (1996a).
[38] Other variables considered but rejected from the comparative models include: party size; age<25; age>65; membership of any environmental organisation; membership of separate organisations; other main activity dummies.

TC	=	travel cost (travel expenditure + travel time); various permutations as discussed previously
HSIZE	=	household size
HOLS	=	1 if respondent was on holiday at time of interview; = 0 otherwise
WORK	=	1 if respondent was working at time of interview; = 0 otherwise
LIVE	=	1 if respondent lives near site; = 0 otherwise
RATING	=	respondent's rating of scenery at the site (from 1 = poor to 4 = superb)
NT	=	1 if respondent was a member of the National Trust; = 0 otherwise
TAX	=	1 if respondent was a taxpayer; = 0 otherwise
MDOG	=	1 if respondent's main reason for visit was dog walking; = 0 otherwise

Table 3.12 presents the travel cost coefficient (full functions given in Bateman, 1996) and three consumer surplus (CS) values from ML-estimated models for the various definitions of travel cost considered in the sensitivity analysis.

Given the strong correlations among the various definitions of travel cost, and that the set of other predictors remains constant across models, goodness-of-fit statistics were similar for all the models detailed in Table 3.12 (see details in Bateman, 1996). However, the marginal cost (8p per mile) travel expenditure model using a best-fit (2.5 per cent) travel time assumption provided an overall optimal fit to the data and is therefore our preferred model from the ML analyses (shown in italics in Table 3.12). This is an interesting result as it suggests that time costs, although highly significant in determining trips (see Chapter 4), can be substantially overstated in absolute terms, resulting in large overestimates of consumer surplus (e.g. benefit estimates are nearly 2.5 times higher if the DoT wage rate is used rather than our best-fit rate). A similar degree of benefit overestimation occurs where the poorer-fitting full travel expenditure assumption is employed.

Comparison of benefit estimates from our preferred model with those obtained from the other studies considered in this chapter strongly reinforces the findings of our review of previous research, in that the values obtained from our TC studies are consistently above those derived from CV analyses, the magnitude of this difference being similar across studies. Reasons for this disparity are discussed in the conclusions to this chapter.

In the TC method as shown in Chapter 2, welfare estimates are obtained by integration under the demand curve which is in turn derived from the trip generation

Table 3.12. *Sensitivity analysis: ML models (best-fitting model shown in italics)*

Travel expenditure cost	Travel time cost (wage rate)	Travel cost coefficient (t-statistic)	CS per household per annum (£)[1]	CS per household per visit (£)[1,2]	CS per person per visit (£)[1,3]
Marginal (8p/mile)	Zero (0%)	−0.084758 (−3.32)	140.39 (127.55)	3.62 (3.29)	1.21 (1.10)
Marginal (8p/mile)	DoT (43%)	−0.031808 (−2.92)	374.10 (339.87)	9.65 (8.77)	3.22 (2.92)
Marginal (8p/mile)	Full (100%)	−0.016002 (−2.72)	743.61 (675.57)	19.18 (17.42)	6.39 (5.81)
Marginal (8p/mile)	*Best fit (2.5%)*	*−0.077656 (−3.24)*	*153.23 (139.21)*	*3.95 (3.59)*	*1.32 (1.20)*
Full (23p/mile)	Zero (0%)	−0.031207 (−3.32)	381.31 (346.42)	9.83 (8.93)	3.28 (2.98)
Full (23p/mile)	DoT (43%)	−0.020856 (−3.02)	570.56 (518.36)	14.71 (13.36)	4.90 (4.45)
Full (23p/mile)	Full (100%)	−0.013251 (−3.00)	898.02 (815.85)	23.16 (21.04)	7.72 (7.01)
Full (23p/mile)	Best fit (6%)	−0.029540 (−3.32)	402.83 (365.97)	10.39 (9.44)	3.46 (3.15)

Notes: [1] values in each cell are at 1993 prices; lower values (in brackets) are at 1990 prices (for comparison with subsequent chapters). Deflator from Central Statistical Office (1993a).
[2] On average, households visited Thetford Forest nearly fifteen times per annum.
[3] Calculated using median party composition figures of three persons (two of whom were >16 years). Mean party size was considerably skewed by a few large parties and was not thought to provide an appropriate measure. Note that this assumption treats adults and children equally.

function. This function itself also provides a degree of theoretical validation of the study through inspection of the various relationships found to be statistically significant predictors of visits. Equation (3.7) details the trip generation function for our best-fitting ML model.

$$
\begin{aligned}
\ln\text{VISIT} = {} & \underset{(-0.819)}{-0.4853} - \underset{(-3.235)}{0.0776\ \text{TC}} + \underset{(1.326)}{0.0718\ \text{HSIZE}} - \underset{(-2.762)}{1.4728\ \text{HOLS}} \\
& + \underset{(3.840)}{1.7408\ \text{WORK}} + \underset{(5.771)}{2.2770\ \text{LIVE}} + \underset{(3.198)}{0.5050\ \text{RATING}} - \underset{(-1.915)}{0.4629\ \text{NT}} \\
& + \underset{(1.863)}{0.4416\ \text{TAX}} + \underset{(2.461)}{0.6066\ \text{MDOG}} \qquad (3.7)
\end{aligned}
$$

Log likelihood value = − 454.59 Sigma = 1.18 (16.79)
Variables as previously defined. Figures in brackets are *t*-statistics.

The model given in Equation (3.7) has expected signs and significance on all explanatory variables (of our standard set of predictors only HSIZE proved to be statistically insignificant). The travel cost variable is highly significant, easily passing a 1 per cent test, and indicating that visits are inversely related to the sum of journey and time costs. More visits are made by those who live or work near the site, who rate the scenery highly, use the location for dog walking (these respondents made a relatively large number of visits) and were taxpayers. Those making less frequent visits included respondents who were on holiday at the time of the survey (most of whom did not live locally) and those who were members of the National Trust, a factor which may either be linked to a wider recreational opportunity set or to an interesting inverse link with income (which we explore in Chapter 4).

Given the findings of our ML analyses, only zero and 43 per cent wage rate time costs were used in the OLS sensitivity analysis, the results of which are presented in Table 3.13. These results confirm our prior ML findings that models using marginal journey costs (8p/mile) and very low (here zero) time costs fit the data best. However, in other respects our OLS-based models do not compare favourably with their ML counterparts. Although comparison of overall goodness-of-fit statistics (log likelihood values versus R^2) is problematic, explanatory variable *t*-values in directly comparable models were generally higher in ML than OLS models, and invariably so with regard to the travel cost variable. Perhaps more importantly from a practical point of view, these results fail both convergent validity (Mitchell and Carson, 1989) and plausibility tests, in that the benefit estimates derived are over five times larger than those obtained from our ML models (which were themselves in line with results elsewhere in the literature). Given this, we can conclude that the theoretical problems inherent in the application of OLS techniques to individual TC valuations

Table 3.13. *Sensitivity analysis: OLS models (best-fitting model shown in italics)*

Travel expenditure cost	Travel time cost (wage rate)	Travel cost coefficient (*t*-statistic)	CS per household per annum (£)[1]	CS per household per visit (£)[1,2]	CS per person per visit (£)[1,3]
Marginal (8p/mile)	*Zero (0%)*	*−0.046776*	*313.19*	*21.38*	*7.13*
		(−2.93)	*(284.53)*	*(19.42)*	*(6.47)*
Marginal (8p/mile)	DoT (43%)	−0.011519	1271.82	86.81	28.94
		(−2.12)	(1155.45)	(78.87)	(26.29)
Full (23p/mile)	Zero (0%)	−0.016801	871.97	59.52	19.84
		(−2.90)	(792.19)	(54.07)	(18.02)
Full (23p/mile)	DoT (43%)	−0.008904	1645.33	112.13	37.38
		(−2.51)	(1494.78)	(101.87)	(33.96)

Notes: [1] values in each cell are at 1993 prices, lower values (in brackets) are at 1990 prices (for comparison with subsequent chapters). Deflator from Central Statistical Office (1993a).

[2] On average households visited Thetford Forest nearly fifteen times per annum.

[3] Calculated using median party composition figures of three persons (two of whom were >16 years). Mean party size was considerably skewed by a few large parties and was not thought to provide an appropriate measure. Note that this assumption treats adults and children equally.

are matched by empirical problems, and that consequently results obtained from such analyses should not be used for decision-making purposes.

Sensitivity analysis 2: measurement issues[39]

In Chapter 2 we noted that certain common simplifying assumptions regarding the measurement of travel time and distance might have the potential to produce biased estimates of consumer surplus. In particular we highlighted the use of centroid rather than actual outset origins and various simplifying assumptions regarding journey routing, notably the use of straight-line distance or constant travel speeds. The use of a GIS allows us to investigate the potential impact of these measurement assumptions by permitting the analyst the following types of flexibility:

(i) Relatively precise journey origins (accurate, in this study, to 1 km) may be specified;
(ii) Alternatively, centroid journey origins may be defined using a variety of administrative areas;
(iii) Travel distance and travel time may be calculated either using straight lines or by reference to a digital road network. Where the latter approach is used, information on road quality and corresponding speeds can also be incorporated to provide more accurate measures of travel distance and time.

In order to investigate the centroid issue, three types of outset origin were specified: (i) the 1 km resolution outset location used previously; (ii) the geographical centroid defined by UK district boundaries; and (iii) the geographical centroid defined by UK county boundaries.[40] In order to ensure sufficient variation at the county level, the road network had to be extended to cover the entire sample of survey respondents. This was achieved by defining a simpler skeleton digital road network beyond the previously defined area, concentrating upon the main roads. This simplification was considered reasonable given that visitors travelling from a considerable distance were unlikely to make much use of minor roads until they were near to the site.

For each origin at the three resolutions the travel distance and duration measures underpinning travel costs were calculated first by using the minimum impedance algorithm in conjunction with the digital road network (i.e. routing visitors along the least-cost path as described previously) and secondly by using straight-line distances.

The various travel cost measures obtained from all these permutations were then entered into a series of trip generation functions. Statistical tests again indicated

[39] Further details of this analysis are given in Bateman *et al*. (1999a).
[40] UK districts and counties roughly correspond to the smallest and largest US counties used as centroids in the TC-based study by Loomis *et al*. (1995).

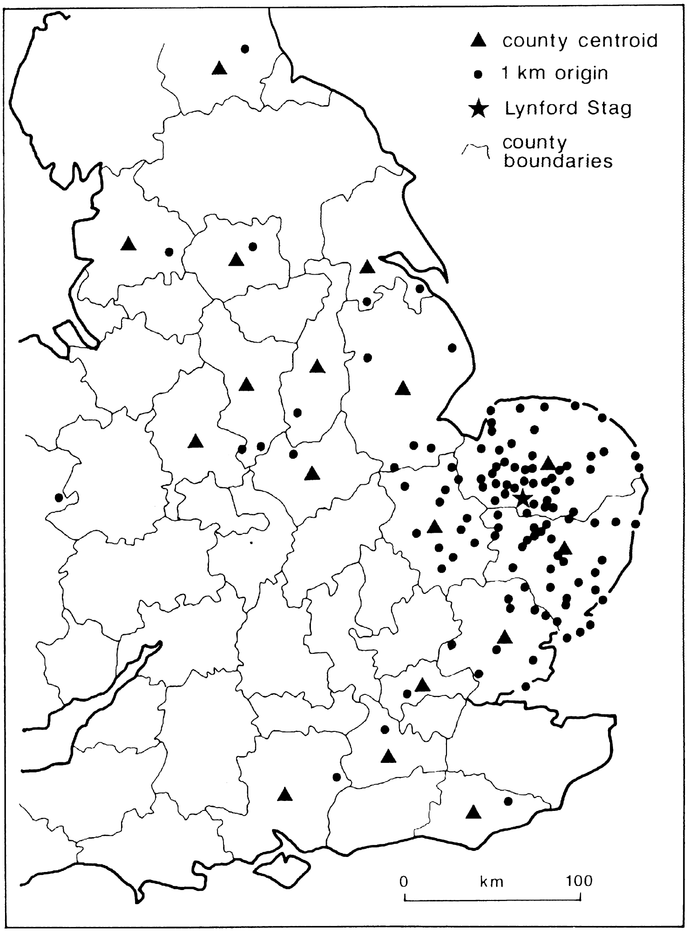

Figure 3.2. Comparison of 1 km grid reference with county centroid trip origins. (*Source:* Bateman *et al*., 1999a.)

that a semi-log (dependent) functional form provided the best fit to the data. Given our previous findings, ML estimation techniques were employed throughout.

Results

Figure 3.2 illustrates some of the graphical output which can be produced by a GIS and demonstrates the impact of adopting large catchment areas. Here the 1 km outset origins derived from visitors' responses are compared to the county centroids. Inspection of those counties in the vicinity of the site clearly shows that the majority of visitors set out from origins which are closer to the site than the centroids for their corresponding areas. This is likely to be the case irrespective of the size or location of the area. However, the relative error caused by this effect is much greater for areas close to the site than for more distant ones. This

Table 3.14. *Sensitivity analysis: effects of varying outset origin on TC benefit estimates*

Outset origin	Source of distance and duration measures	CS per household per annum (£)	CS per household per visit (£)	CS per person per visit (£)
1 km grid	Digital road network	173.25	4.47	1.49
reference	Straight line	141.97	3.66	1.22
District	Digital road network	206.40	5.32	1.78
centroid	Straight line	173.71	4.48	1.49
County	Digital road network	364.73	9.40	3.14
centroid	Straight line	338.29	8.72	2.91

systematic bias will result in an overestimate of consumer surplus as discussed previously.

Full results from our analysis are presented in Table 3.14. Here, following the findings of our previous sensitivity analysis, marginal travel expenditure (8p/mile) and best-fit travel time costs (2.5 per cent of wage rate) are used throughout to define travel costs.

Examining Table 3.14 reveals that using straight-line as opposed to road-based measures of travel cost consistently produces lower estimates of consumer surplus. This is as expected and reflects the underestimate of true travel cost produced by straight-line approximations. The resultant underestimation ranges up to 20 per cent; however, this is small compared to the error induced by using large-area centroids as opposed to more accurate estimates of outset origin. While the increase induced by moving from 1 km origins to district centroids is similar to that of changing from road network to straight-line measures, a very substantial impact occurs where we move from 1 km to county centroid origins with benefit estimates more than doubling.

These findings lead us to conclude that the benefit estimates produced by studies adopting large-area centroid origins and/or straight-line-based measures of travel cost should be treated with caution. By contrast, the GIS-based measures derived from the higher resolution origins utilised in the present study seem to offer a substantial improvement in the robustness of benefit estimates.

Thetford 2 TC study: conclusions

Perhaps the primary objective of the Thetford 2 TC study was to show how GIS techniques can enhance the application and validity of the method. These techniques were applied to the fundamental tasks of calculating the travel distance and duration data and have been shown to have a number of advantages over more conventional

Table 3.15. *Valuing recreational visits to woodland: a synthesis of studies*

Study	Method	£ per person per visit[1]	£ per party per visit[2]: Mean party size (3.05)	Upper 95% C.I. party size (3.27)	Lower 95% C.I. party size (2.85)
Cross-study analysis (OE WTP use value)	CV	0.60	1.82	1.95	1.69
Wantage (OE WTP/visit study)	CV	0.82	2.50	2.68	2.33
Thetford 2 (ML model)	ITC	1.20	3.59	3.85	3.35

Notes: [1] Figures are best-estimate means (1990 prices). Bateman (1996) also reports 95% C.I.s and alternative estimates based on WTP per annum studies.
[2] The sensitivity analysis on party size treats adults and children equally as party members. Note that the per person per visit value used is kept constant within each row.

approaches. The advantages are perhaps best demonstrated in our second sensitivity analysis which uses the flexibility of GIS to indicate how a number of common measurement assumptions can lead to substantial biases within benefit estimates and, more importantly, how they can be avoided.

The study has also revisited a number of areas of controversy in the existing literature by conducting a sensitivity analysis across a number of common unit-value assumptions and estimation techniques. This analysis quantified the magnitude of potential welfare measure variance as well as yielding some defensible values for use in our subsequent research.

Summary and conclusions

This chapter has presented a considerable number of results regarding the valuation of woodland recreation benefits. From our review of the existing literature we identified a number of CV analyses which provided the basis for a cross-study meta-analysis of values. This work showed that WTP responses were logically linked to the values individuals were asked to assess and to the elicitation method employed. From the various values which can be derived from our cross-study model we emphasise the estimate of use value derived using an OE elicitation method, the latter being conducive to the estimation of the lower-bound values we have emphasised throughout. This result is reproduced in the top row of Table 3.15 which summarises the more robust valuations presented here.

The remaining rows of Table 3.15 summarise selected results from our own valuation work. Reviewing the various research objectives we set ourselves in

Chapter 2 with respect to the CV method, we have seen through the Thetford 1 study the substantial variation in WTP values reported by woodland users as opposed to non-users of woodland recreation, while the Wantage study has contrasted these with the WTA compensation levels demanded by farmers for providing woodland recreation opportunities on their land. Taken together, the three CV studies presented in this chapter also provide evidence of the considerable variation in values induced by choice of elicitation method and payment vehicle. While these effects are, arguably, consistent with theoretical expectations, of greater concern are the substantial impacts induced by adding budget constraint questions and testing question ordering in the Thetford 2 CV study. While we would not contend that these studies are beyond criticism, such findings suggest that values should be treated with some caution and that the conservative approach advocated by H.M. Treasury may be justified.

Turning to consider the objectives for our TC studies set out at the end of Chapter 2, in the Thetford 2 study we have used GIS techniques to investigate the impact of different strategies for measuring travel time and travel distance upon resultant consumer surplus estimates. The GIS has permitted a substantial improvement in defining the journey outset location, modelling journey routing and conducting sensitivity analyses on consumer surplus estimates. We have also examined the impact of various statistical modelling procedures and functional forms upon those estimates. Again we have seen that benefit estimates are highly sensitive to a range of methodological issues, reinforcing the need to exercise care when incorporating benefit estimates in CBAs.

Given these concerns we have omitted the Thetford 1 studies from Table 3.15 as these were principally methodological tests and the values produced have to be treated with considerable caution. We have fewer reservations regarding the validity of CV estimates obtained from the Wantage study. However, as the benefit transfer methods employed in the following chapter require per visit values we do not make any further use of the WTP per annum results obtained from this or the Thetford 2 CV study. The per visit estimates obtained from the latter study are also difficult to apply to a wider context as they are strongly influenced by the various designs used in each sample (and the one readily comparable estimate is included within our cross-study meta-analysis). However, the value obtained from our preferred model in the Thetford 2 ITC study does appear to have reasonable claims to validity and forms the final row of Table 3.15.

Examination of the various values presented in Table 3.15 indicates that they conform well to prior theoretical and empirical expectations in that per party per visit values obtained from our CV studies are similar to, but somewhat smaller than, our TC estimates. Such a finding conforms to the large-sample cross-study comparison of TC and CV studies reported by Carson *et al*. (1996) as well as satisfying a plausibility test.

Given that conservative measures have been emphasised throughout, we use the lower of the two CV values shown (i.e. £1.82 per party per visit) for our subsequent benefit transfer work, both because it gives a more defensible estimate of recreation values and because it is based on a large number of studies. This claim cannot be made for our ITC value. However, the study underpinning this particular value appears robust and has considerable advantages over others in the literature. Given this outcome we also use this value as an upper-bound contrast with the cross-study CV measure within the benefit transfer work discussed in the following chapter.

Finally, although all of the values discussed above have been adjusted in real terms to our 1990 study period, is there any evidence that these values may have changed over time up to the present day? This question is considered in a recent re-examination and extension of our meta-analysis work presented in Bateman *et al*. (2001d). Here, we combine the various CV and TC estimates of woodland per person per visit recreational values into one meta-model. This study utilises multilevel modelling techniques (Goldstein, 1995) to control for intra-unit correlation (IUC) between value estimates produced by each study author and within each forest (i.e. the possibility that estimates produced by a given author are more similar than those produced by taking a random sample from all estimates). The study finds no significant evidence of IUC effects either within authors or within forests. Furthermore, conclusions regarding valuation estimates remain broadly the same as reported here and so are not repeated. However, the expansion of estimates permitted by combining results from all CV and TC studies permitted investigation of whether, controlling for all other significant factors, any time trend in the real value of woodland recreation could be observed. Findings suggest that a small increase in real values was statistically significant across the time series (of seventeen years) considered. While we consider a number of possible reasons for this result we cannot reject the hypothesis that this reflects an underlying real increase in the perceived recreational value of woodland over time. This result is reminiscent of that postulated by Krutilla and Fisher (1975) in their discussion of the value of natural environments over time. Certainly, there seems little reason to suppose that recreation values will decline in real terms over time; rather they should be stable or increase. In Chapter 9 we consider the implications of such trends for our cost-benefit results.