UNIVERSITY OF WAIKATO

Hamilton

New Zealand

Testing the stability of the Benefit Transfer Function for Discrete Choice Contingent Valuation Data

David I. Matthews

W. George Hutchinson

Riccardo Scarpa

Department of Economics

Working Paper in Economics 8/07

May 2007

David I. Matthews
Biometrics Branch, Agri-Food and Biosciences Institute (AFBI), Newforge Lane, Belfast BT9 5PX.
Email : dave.matthews@afbini.gov.uk

W. George Hutchinson
Gibson Institute for Land Food and Environment
Queen's University Belfast
BT9 5AG, U.K.
Tel: +44 (0) 28 9097 5562
Fax: +44 (0) 28 9097 5457
Emails: g.hutchinson@qub.ac.uk
Web: http://www.qub.ac.uk/gibsoninstitute

Riccardo Scarpa
Economics Department
University of Waikato
Private Bag 3105
Hamilton, New Zealand
Tel: +64 (0) 7-838-4045
Fax: +64 (0) 7-838-4331
Email: rscarpa@waikato.ac.nz
Web: http://www.mngt.waikato.ac.nz

Abstract

We examine the stability of the benefit transfer function across 42 recreational forests in the British Isles. A working definition of reliable function transfer is put forward, and a suitable statistical test is provided. The test is based on the sensitivity of the model log-likelihood to removal of individual forest recreation sites. We apply the proposed methodology on discrete choice contingent valuation data and find that a stable function improves our measure of transfer reliability, but not by much. We conclude that, in empirical studies on transferability, function stability considerations are secondary to the availability and quality of site attribute data. Modellers' can study the advantages of transfer function stability vis-à-vis the value of additional information on recreation site attributes.

Keywords

Benefit function transfer

Function stability tests

Transfer reliability

Forest recreation values

Contingent Valuation

Split sample

JEL Classification

Q26, H41, C25

1. Introduction

The objective of this paper is to report results on the reliability of the practice of benefit function transfer. We focus on the stability of the transfer function estimates to the inclusion and exclusion of data from a selection of the overall available sites. Benefit transfer techniques are used to estimate benefit values for natural resource sites for which on-site data on benefits are unavailable (the policy sites). This is done by transferring (i.e. predicting) benefit estimates on the basis of benefit transfer functions estimated on data concerning other similar sites (the study sites). The technique is used to estimate non market values for cost benefit analyses in situations where either the estimation of benefits using other techniques would be prohibitively expensive, or when the available time is insufficient to allow new data collection for the policy site. The method has become widely used because of its inexpensive nature. Resources such as the International Environmental Valuation Reference Inventory website (EVRI) have been set-up to help policy-makers identify suitable studies to use for benefit estimation covering a wide range of environmental goods.

Benefit transfers in practice can take place with various degrees of sophistication. Two broad categories can be identified: the site-unadjusted value transfer, and the site-adjusted value transfer. In the first case the transfer is quite crude, as the value of the unit of recreation (say the single day-out forest visit) is transferred from a study site for which original survey data exist, to the policy site *without* adjusting for the differences in recreational attributes between the two sites. Such differences, of course, can systematically affect the magnitude of the benefits enjoyed by recreationists. In the case of site-adjusted value transfer, the transfer takes place after an adjustment, which accounts for differences between attributes relevant for recreation across the two sites. Adjustment techniques may also vary in their degree of sophistication. A more sophisticated approach employs the method of benefit *function* transfer, which is the focus of this study. With this method, the researcher believes there is a given mathematical relationship between some site-specific attributes (e.g. parking space, forest composition, extension of paths etc.) and the measure of benefit of interest. Such an approach is commonly called “benefit function transfer" and has been championed by a number of authors as preferable to the unadjusted value transfer approach (Loomis 1992, Opaluch and Mazzotta1992).

More specifically, the benefit transfer function approach attempts to explain variation in willingness to pay (WTP) for access to the forest site on the basis of variation of forest attributes relevant to recreational activities. This is done from data obtained from a pool of sites where surveys have been conducted. It is an estimate of a behaviourally-based mathematical relationship between WTP and site attributes. As such, it requires data collection across a sufficiently large number of recreational sites, to systematically explain the response of benefits to changes in site attributes. For example, in the forest recreation context, WTP may plausibly be related to measures of site quality, size of site and other attributes, such as the percent of the woodland area covered by broadleaf trees.[1]

Using the benefit transfer function obtained from the pooled data, an estimate of the WTP can be predicted for a policy site by substituting the known forest attributes into the benefit transfer function. A recent example of an application using this method is a study of the *Recreation Value of Woodland* for the Forestry Commission (Scarpa 2003) were site-specific benefit estimates for policy sites were obtained from an estimated function of this type. This was part of a much larger study (Willis et al. 2003) with the goal of producing an estimate of the total non-timber value of woodland in the U.K. In Scarpa (2003) the objective was to validate and extend to England and Wales the validity of the benefit function used to predict the recreational value of a woodland visit and derived from the 1992 Queens University CAMAR contingent valuation study, which was—instead—limited to Ireland and Scotland. This would have produced a benefit function for recreational values valid for the entire British Isles.

---

[1] Empirically speaking here lies the main limitation of benefit transfer studies so far. In fact, there have been very few data collection exercises that allow the researcher to comfortably pool benefit data across a sufficiently large number of sites to safely establish such a mathematical relationship. The present study is based on data largely immune to critiques of this kind as it was collected using the same survey format and in very short time interval at all forest sites.

One little explored issue is the degree of stability of the benefit function to the inclusion or exclusion of individual sites (see Leon-Gonzalez and Scarpa 2007 for a treatment of this issue using Bayesian Average Modelling). It is in fact plausible that the estimated benefit transfer function will be suitable for only a subset of the pooled sites, rather than fitting equally well across all sites.

However, the testing of the hypothesis of whether data from a given site share the same benefit transfer function as the remainder of the pooled data poses some challenges. We propose an econometric test drawn from testing the independence of irrelevant alternative in the multinomial choice literature (Small and Hsiao,1985) and apply it to our data to identify the sites whose exclusion or inclusion results in a statistically significantly difference in the parameters of the benefit transfer function as measured by a likelihood ratio test.

This paper provides a large scale test of this technique using the Queen's University, CAMAR forest recreation dataset, which includes contingent valuation data on discrete choice responses to WTP questions related to forest access and collected at 42 forest sites in three regions of the British Isles (Republic of Ireland, Northern Ireland and Scotland). A quite extraordinary and advantageous feature of this large scale study is that data were collected for the same period and with an identical survey instrument. This allows us to overcome common criticisms based on temporal instability of preferences. Scarpa et al. (2000a, 2007) used the Irish portion of this data, for 27 forest recreation sites, to assess transferability of *value estimates*, while in this paper we focus on stability of the *transfer function* and we use a larger dataset, which includes the Scottish forests. More specifically, in this study each site acts in turn as one of the "the survey sites" from which the function transfer is estimated and then it is also used as benchmark to test the accuracy of the transferred estimates, thus acting as individual policy sites. The on-site estimates of willingness to pay are denoted by WTP_{os} and derived using the single site survey data. These represent better quality estimates of course, and mimic the quality estimates one would like to have available, but instead need to substitute by predicting them with the transfer function estimated on the other sites (See Table 2). The on-site WTP_{os} estimates are used for bench-marking the predicted estimates from the transfer function. In this study the differences between benefit transfer function estimates are less likely to be due to external procedural factors because the questionnaire, sampling method and time period of the survey are the same across all sites, thereby ensuring a form of procedural invariance that many other nonmarket valuation data collated from visitation surveys do not share.

2. Method

The same Contingent Valuation survey was administered at 42 forest sites in Northern Ireland, Republic of Ireland and Scotland. The survey objective was to elicit respondents WTP for access to forest grounds for the purpose of outdoor recreation. The referendum method was used where respondents were asked a take-it-or-leave-it question on whether they were WTP a predefined amount for accessing the forest site rather than foregoing the recreational experience of the forest site. Each respondent was then asked a follow up referendum question to ascertain his or her willingness to pay a related bid amount.

Site-specific estimates were obtained for each site using both single and double bounded probit models (Hanneman, 1991) using bids amounts and no other covariates. For each recreation site, estimates of measures of central tendency for respondent benefits were obtained, such as the median WTP from the population of visitors. Information on forest attributes of each site were obtained from the databases of the forest management agencies. Forest attributes which had been previously demonstrated (e.g. Scarpa et al. 2000b, 2000c) to affect individual WTP where included in the study. Site quality and percentage of broadleaf woodland had a positive effect on WTP. Percentage of conifer woodland, length of trails, site quality and availability of specified visitor attractions such as nature reserves and on-site cafes where also included. A single descriptor was used to describe the wealth of forest visitors at a single site, and this was the median income level of visitors sampled at that site. This allowed the model to account for differences in income levels across sites. The number of users per available parking spaces was also included to measures perceived congestion at the site.

3. Stability of Benefit Transfer Function

Benefit transfer functions are derived by pooling the survey data across sites and are then used to estimate the site-specific median WTP_s (WTP for use of recreational site s). A Double Bounded Dichotomous Choice specification is used, with the utility difference specified as a linear index as follows:

$$\Delta v = \alpha + \beta_{bid}\log(t) + \Sigma_j \beta_j A_{fj} \quad (1)$$

Where β_{bid} denotes the coefficient of the log of the bid *t* offered to respondents, β_j denotes the generic coefficient related to attribute X_{fj} which varies by forest. Coefficients were estimated using maximum likelihood using the approach outlined in Hanemann et al. (1991).

The resulting benefit transfer function may be used to predict the benefit transfer value for a policy site *s*, in our case we focussed on Median $MWTP_s$, which, given our specification is:

$$MWTP_s = \exp(-\Sigma_j \beta_j X_{sj}/\beta_{bid}) \quad (2)$$

Note that we condition on X_{sj} which denotes the generic j^{th} attribute for policy site *s*, while the values of β are those estimated for the parameters from data which exclude the policy site *s*. The problem is to examine the reliability of the benefit transfer function and to identify problems with individual sites, which contribute poorly to the stability of the estimates of the benefit transfer coefficients.

To test the stability of the benefit transfer function its parameters are estimated by dropping each site in turn, so as to examine the sensitivity of the benefit transfer function to site inclusion. The method involves testing the effect of removing each recreation site in turn on the coefficients of the benefit function. In this way we identify those sites whose removal significantly lowers the value of the log-likelihood function at a maximum. To test this effect it is necessary to test the restricted model against the unrestricted complete model for each site removal.

$$H_o\colon \beta_{full} = \beta_{full-ss}$$

Where β_{full} is the vector of coefficients for the benefit transfer function which includes *all* study sites and $\beta_{full-ss}$ are the coefficient values estimated on the data after removal of the study site ss.

This test is straightforward when models include the same number of responses since the null associated with the restriction can be tested using the standard specification tests (Likelihood Ratio, Wald or Lagrange Multiplier tests) so as to determine the effect of this restriction. However, in our case we do not have the same number of responses in the two models because the restricted model is estimated on a reduced dataset. We hence adopt the Small and Hsiao 1985 split sample method suggested to overcome this very problem in multinomial choice tests. The inadequacy of standard tests is due to the non-independence of the samples used in estimating the two log-likelihoods. The Small and Hsiao method that avoids this problem is outlined below:

1. Systematically split the sample into two representative samples of approximately equal size.
   Denote the sample sizes for sub-samples A and B as N_A and N_B;

2. Estimate the maximum of the likelihood function for the two sub-samples A and B obtaining coefficient estimates $\beta^A{}_0$ and $\beta^B{}_0$;

3. Compute $\beta^{AB}{}_0 = (1/\surd 2)\,\beta^A{}_0 + (1-(1/\surd 2))\,\beta^B{}_0$;

4. From sub-sample B a recreation sites is removed, the value of the maximum of the restricted likelihood function $L^B{}_1(\beta^B{}_1)$ is estimated on sub-sample B;

5. Estimate the unrestricted likelihood $L^B{}_1(\beta^{AB}{}_0)$ for sub-sample B;

6. Evaluate $\Delta = -2[\, L^B{}_1(\beta^{AB}{}_0) - L^B{}_1(\beta^B{}_1)\,]$

Δ is distributed as χ^2 with degree of freedom = number of coefficients estimated.

Using the above method a benefit transfer function is computed estimating the coefficients β_{full} using the complete set of 42 forests sites. Each constituent site making up the benefit transfer function is individually tested to see if the exclusion will significantly change the values of coefficients of the benefit transfer function. Those sites, which do, can be isolated as not belonging to the same benefit generating function (not poolable sites). This indicates that these sites have recreation values and characteristics which are significantly different from other sites in the pool. In this study sites are rejected when $Prob(H_o) < 10\%$. The remaining pool of sites is then used to calculate a new benefit transfer function estimating a new set of coefficients $\beta_{reduced}$. Each of the sites are then used as policy sites and estimates of median benefit function values $MWTP_{\beta full}$, $MWTP_{\beta reduced}$ are obtained for each of the sites using both β_{full} and $\beta_{reduced}$ estimates are compared to on site welfare estimates.

Benefit transfer errors $MWTP_{os} - MWTP_{\beta reduced}$ are calculated for each policy site. Benefit transfer functions are tested using Mean square errors on the transferred benefits calculated for the stable set of sites for both the full:

$$MSE_{full} = 1/n_{stable} \Sigma[MWTP_{\beta full} - MWTP_{os}]^2 \qquad (3)$$

and the reduced:

$$MSE_{reduced} = 1/n_{stable} \Sigma[MWTP_{\beta reduced} - MWTP_{os}]^2 \qquad (4)$$

where n_{stable} is the number of sites which are not rejected. The MSE expresses the square of the average amount of the difference between the on site measures and transferred values for all policy sites in the study.

For comparison a simple measure of benefit value transfer is also considered. The average on-site MWTP is used as a measure of value transfer for each policy site with no adjustment for site attributes. This method is evaluated using a MSE calculation.

$$MSE_{average} = 1/n_{stable} \Sigma[MWTP_{\beta stable} - MWTP_{average}]^2 \qquad (5)$$

Criteria for Stability

If the benefit transfer function performs better when estimated from the reduced pool of sites, then this indicates that the Benefit Transfer function is stable. The criterion used to evaluate stability is: *Iff* $MSE_{reduced} < MSE_{full}$ then Benefit transfer function is stable. This suggests that a smaller pool of well chosen sites can be used to facilitate benefit transfer.

4. Results

Sites rejected

Table 1 shows the on-site estimates for all survey sites. A total of 5 problem sites from the pool of 42 are identified as each significantly affecting the benefit transfer function: four sites at prob. <0.05 and one site at prob. <0.1. This is a relatively small number of sites (only 12%) and indicates high initial stability.

The problem sites identified are a mixture of both low value sites and sites where access fees were not in use at the moment of the survey, with users making many frequent visits. The benefit value at these sites may be biased if estimated using the transfer method. Examples of these include the Northern Ireland site Crawfordsburn which has many repeat visits and, although it has above average site quality, it had no access fees. Another Northern Ireland site, Belvoir is a low quality urban, no-fee site with many repeat visits and many users entering the site on foot, from nearby housing.

The Irish site John F. Kennedy is a high value site with on-site estimate of over £2 per visit. Unlike most of the other problem sites the transfer estimate for this site is less than the on-site estimate and may arise from the lower than average site quality assessment attribute.

Performance of Benefit transfer functions

Table 4 shows a summary of the performance of the benefit transfer methods. Three transfer methods are assessed. The reduced pool benefit transfer model performs best with a MSE error of 9p, which corresponds to an average error of 30p per site. This is slightly better than the model using the full pool of 42 sites, which has an average error of 31p.

The mean value transfer uses the mean value of on-site WTP as £1.22. This overall mean value transfer performs worst, average error of 39p, indicating the success of benefit transfer function method in adjusting the transferred values. However, the maximum percentage error for the unadjusted value transfer method is the smallest 73%. Fig 1 shows the distribution of benefit transfer error. In the best performing transfer function some estimates can be very inaccurate, 64% of sites estimated the transfer value within 20% of the on-site value while 12% of sites have errors more than 70%.

5. Discussion and conclusions

The benefit transfer function is found to be stable in this study after dropping 5 problem sites. Table 4 shows the comparison of the proposed benefit transfer method. The mean squared error derived from the benefit function estimates from the reduced pool of 37 sites (MSE_{37}) is 9p and it is a little lower than the 10p value derived from the full pool of 42 sites (MSE_{42}). This corresponds to average absolute differences of 31p and 30p.

Fig 2 shows a radar plot describing the distribution of transfer errors. The figure orders the sites clockwise with decreasing value of on-site WTP. The line shows the percentage difference between the on-site value and the transferred value of each site. The sites that perform particularly badly occur at the low value area of the radar plot indicating problems with low value sites. Although these sites are not rejected from the pool they are clearly different and suggest that these sites should not have been included within the pool. Two possible approaches are suggested for these sites. A separate benefit functions could be estimated from the pool of low quality urban sites, or alternatively, an extra dummy variable can be used in the benefit transfer function to help improve transfer estimates.

Stability issues.

When the stability criteria are satisfied as in this study this suggests that a further reduced pool of adequately selected sites can be used to conduct benefit transfer. The questions is how many sites could be chosen and how would the benefit estimates be affected?

The fact that MSE is smaller does not guarantee improvements in all the benefit estimates. In many sites in the study the benefit transfer estimates of the reduced pool are worse than the estimates made with the larger pool.

How good is the benefit transfer function? For a benefit function to perform well the function must capture differences in welfare value between sites. In statistical terms variation between sites must be captured in the choice of site attributes used in model estimation. If the site attributes are poorly chosen, or the benefit transfer function is poor, then the pool of sites needs to be large enough to incorporate the range of available sites. The pool of Survey Sites should ideally be selected so that the matrix of attribute values provides the largest information. So, similarly to other studies (e.g. see discussion in the context of choice experiments by Ferrini and Scarpa 2007) this leads to a selection rule dominated by lowest estimator variance.

Benefit transfer will usually be a low cost alternative to carrying out a full study. In many cases the benefit values maybe acceptable even though individual policy site transferred estimates maybe quite far out. Policy makers embarking on these studies need to decide on a level of acceptable error in value estimation (Kristofersson, D. and Navrud, 2005).

The estimate of on-site WTP depends not only on the characteristics of the site but also on the characteristics and distribution of site users. Sites that have the same attributes can have different visitor profiles. The urban sites in the study tend to have lower WTP because they have many repeat visitors with low average WTP because their cumulative payments would otherwise be quite high. Many sites did not have any access fee at the time of the survey. Here respondents might have answered prompted by a feeling of protest motivated by the unwelcome prospect of having to pay for something that they habitually use for free and feel they are entitled to.

Overall we feel that the issue of stability of the benefit transfer function is secondary to several other considerations such as the choice of a well chosen set of attributes which predict the welfare measure and the study survey methodology. Measurement of these forest site attributes must be available for all study and policy sites so as to implement the methodology with success. An operationally salient question for future research is what set of forest site attributes should one focus on for the purpose of benefit transfer function estimation.

6. References

EVRI. Environmental Valuation Reference Inventory website, http://www.evri.ca .

Ferrini, S. and Scarpa, R., 2007. Designs with a-priori information for nonmarket valuation with choice-experiments: a Monte Carlo study, *Journal of Environmental Economics and Management*, 53(3).

Hanneman, M., Loomis, J. and Kanninen, B. 1991. Statistical Efficiency of Double Bounded Dichotomous Contingent Choice Contingent Valuation, *American Journal of Agricultural Economics*, 73:1255-1263.

Kristofersson, D. and Navrud, S. 2005. Validity Tests of Benefit Transfer -- Are We Performing the Wrong Tests? *Environmental and Resource Economics*, 30:279-286

Leon-Gonzalez, R. and Scarpa, R. 2007. *Robust Benefit Function Transfer: A Bayesian Model Averaging Approach*. Working Paper No. 07/01, University of Leicester, Dpt. of Economics.

Loomis, J. 1992. The evolution of a more rigorous approach to benefit transfer: benefit function transfer, *Water Resources Research*, 28, 701-705.

Opaluch, J. J. and Mazzotta M. J. 1992. Fundamental issues in benefit transfer and natural resource damage assessment, in Benefit transfer: procedures, problems and research needs. Workshop proceedings, AERE, Snowbird, UT, June.

Scarpa, R., Hutchinson W. G. and Chilton S.M. 2000a. Benefits From Forest Recreation: Flexible Functional Forms For WTP Distributions. *Journal of Forest Economics*, 6(1): 41-54.

Scarpa, R., Chilton S.M, Hutchinson W.G. and J. Buongiorno. 2000b. Valuing the Recreational Benefits from the Creation of Nature Reserves in Irish Forests. *Ecological Economics*. April, 33(2):237-250.

Scarpa, R., W. G. Hutchinson, S. M. Chilton and J. Buongiorno. 2000c. Importance of Forest Attributes in the Willingness To Pay for Recreation: A Contingent Valuation Study of Irish Forests. *Forest Policy and Economics*. December, 1(3-4):315-329

Scarpa, R. 2003. "*The Recreational Value of Woodland In Great Britain*" Report to The Forestry Commission, Edinburgh, by Centre for Research in Environmental Appraisal & Management, University of Newcastle.

Scarpa, R., Hutchinson, W.G., Chilton, S. and Buongiorno, J. 2007. Reliability of Benefit Value Transfers from Contingent Valuation Data with Forest-Specific Attributes. Chapter 10 in *Environmental value transfer: issues and methods*. Edited by Ståle Navrud and Richard Ready, Springer Publisher.

Small, A., Hsiao C. 1985. Multinomial Logit Specification Tests, *International Economic Review*, 26(3):619-627.

Willis, K. G., G. Garrod, R. Scarpa, N. Powe, N. Hanley, D. C. Macmillan, A. Lovett, and I. Bateman. 2003. "*The Social And Environmental Benefits Of Forests In Great Britain*" Report to The Forestry Commission, Edinburgh, by Centre for Research in Environmental Appraisal & Management, University of Newcastle.

Table 1 On-site estimates of $MWTP_{os}$ for all forest recreation sites (not using a Benefit transfer function).

Region	Forest site	$MWTP_{os}$	Std.Err.
N.Ireland	Tollymore	£1.50	0.06
	Castlewellen	£1.36	0.05
	Hillsborough	£0.78	0.04
	Belvoir[5]	**£0.76**	**0.04**
	Gosford	£1.34	0.04
	Drum manor	£1.05	0.05
	Gortin glen	£1.33	0.05
	Glenariff	£1.74	0.06
	Ballypatrick	£1.13	0.08
	Somerset	£0.47	0.06
	Florencecourt	£0.97	0.09
	Lough Navar	£1.39	0.08
	Castle Archdale	£1.31	0.05
	Crawfordsburn	£0.80	0.04
Scotland	Loch Trool	£1.49	0.08
	Culzean	£2.45	0.10
	Calderglen	£0.69	0.05
	Vogrie	£0.85	0.04
	Almondell & Calderwood	£0.77	0.04
	Beecraigs	**£0.49**	**0.04**
	Kinnoul Hill	£0.67	0.07
	Tentsmuir	£0.91	0.04
	Hermitage	£1.68	0.20
	Glenmore	£1.38	0.11
	Strathyre	£0.87	0.07
	Queen Elizabeth /David Marshall	£1.21	0.07
	Rowardeenan	£1.06	0.06
	Aden	£1.24	0.05
	Killiecrankie	£1.71	0.11
Republic of Ireland	Lough Key	£1.77	0.06
	Hazelwood	**£0.86**	**0.04**
	Dun a Dee	£1.08	0.07
	John F Kennedy	**£2.23**	**0.08**
	Dun a Ree	£1.40	0.07
	Currachase	£1.45	0.05
	Cratloe	£0.65	0.05
	Douneraile	£1.25	0.05
	Farran	£1.18	0.05
	Guaghan Barra	£1.50	0.13
	Avondale	£1.31	0.05
	Killykeen	£1.22	0.09
	Glendalough	£1.88	0.10
All sites	Mean($MWTP_{os}$)	£1.22	

[5] Sites shown in bold are survey sites which have been excluded from the pool of survey sites making up the stable pool.

Table 2 Comparison of transferred estimates using Benefit Transfer functions.

Region	Forest site	$MWTP_{os}$	$MWTP_{\beta 42}$	$MWTP_{\beta 37}$
N.Ireland	Tollymore	£1.50	£1.32	£1.39
	Castlewellan	£1.36	£1.31	£1.31
	Hillsborough	£0.78	£0.65	£0.72
	Belvoir	£0.76	£0.69	£0.64
	Gosford	£1.34	£1.15	£1.12
	Drum manor	£1.05	£1.08	£1.15
	Gortin glen	£1.33	£1.08	£1.11
	Glenariff	£1.74	£1.54	£1.52
	Ballypatrick	£1.13	£0.93	£0.88
	Somerset	£0.47	£1.01	£0.92
	Florencecourt	£0.97	£1.59	£1.63
	Lough Navar	£1.39	£1.49	£1.46
	Castle Archdale	£1.31	£1.33	£1.29
	Crawfordsburn	£0.80	£1.09	£1.38
Scotland	Loch Trool	£1.49	£1.14	£1.13
	Culzean	£2.45	£1.85	£1.95
	Calderglen	£0.69	£1.19	£1.38
	Vogrie	£0.85	£0.77	£0.86
	Almondell & Calderwood	£0.77	£0.93	£0.87
	Beecraigs	£0.49	£0.91	£0.96
	Kinnoul Hill	£0.67	£1.32	£1.51
	Tentsmuir	£0.91	£1.15	£1.11
	Hermitage	£1.68	£1.08	£1.28
	Glenmore	£1.38	£1.36	£1.48
	Strathyre	£0.87	£0.96	£0.96
	Queen Elizabeth / David Marshall	£1.21	£1.39	£1.57
	Rowardeenan	£1.06	£1.63	£1.50
	Aden	£1.24	£1.12	£1.20
	Killiecrankie	£1.71	£1.42	£1.54
Republic of Ireland	Lough Key	£1.77	£1.35	£1.56
	Hazelwood	£0.86	£1.44	£1.45
	Dun a Dee	£1.08	£1.16	£1.14
	John F Kennedy	£2.23	£1.43	£1.29
	Dun a Ree	£1.40	£1.28	£1.35
	Currachase	£1.45	£1.64	£1.45
	Cratloe	£0.65	£1.15	£0.93
	Douneraile	£1.25	£1.31	£1.47
	Farran	£1.18	£1.16	£1.12
	Guaghan Barra	£1.50	£1.40	£1.33
	Avondale	£1.31	£1.18	£1.11
	Killykeen	£1.22	£0.96	£1.00
	Glendalough	£1.88	£1.74	£1.76
	All sites	**£1.22**	**£1.23**	**£1.26**

Table 3 DBDC Probit coefficient estimates for models using all sites and reduced pool of 37 sites.

	β_{42}		β_{37}	
Variable	Coef.	|t-value|	Coef.	|t-value|
Constant	-0.4973	7.1	-0.6879	9.4
Log(bid)	-1.2932	73.8	-1.3295	71.4
Squality	0.0036	8.7	0.0055	12.1
Bdleaf	0.0068	10.3	0.0048	5.3
Larch	0.0065	3.7	-0.0009	0.5
Pre1940	-0.0044	5.4	-0.0011	1.0
NatRes	0.1437	4.1	0.0150	0.4
Congest	-0.0204	14.1	-0.0144	7.7
Hseinc	0.0510	6.5	0.0550	6.3

Descriptions of explanatory variables

Log(Bid)	Log of the bid values for individual respondents
Squality	Site quality assessment (normal value 100)
Bdleaf	Percentage of broadleaf woodland
Larch	Percentage of Larch woodland
Pre1940	Percentage of woodland planted before 1940
NatRes	1 Nature reserve on site (0) otherwise
Congest	Site congestion (Number of visitors per car parking space)
Hseinc	Ordinal measure of average household income of visitor (1 to 5)

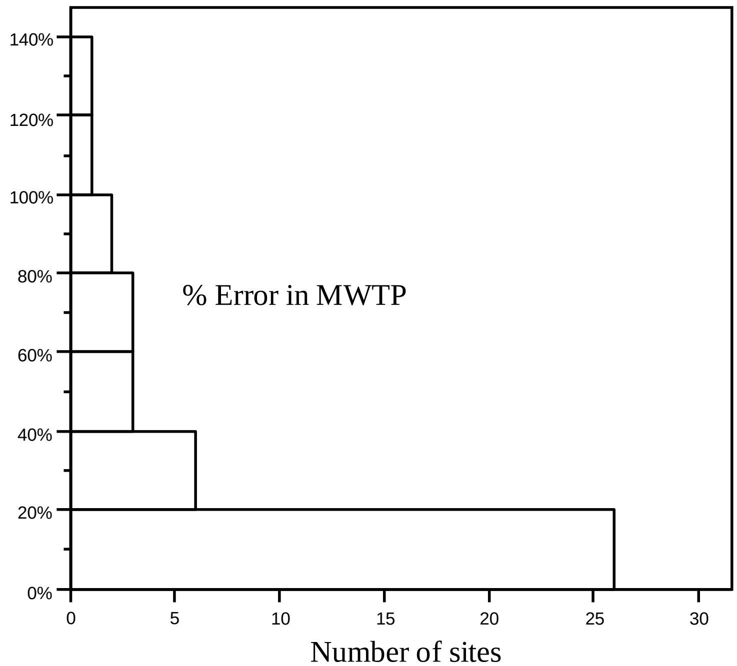
Table 4 Summary of the Benefit Transfer model performances.

Statistic	β_{42}	β_{37}	Mean Value Transfer
MSE	10p	9p	16p
Mean Absolute difference	31p	30p	39p
Maximum difference	60p	84p	63p
Maximum Prop Difference	116%	120%	73%

Table 5 Site attributes for all 42 sites.

Region	Forest site	Site quality	% conifers	% broadleaf	% larch	% pre1940	Nature reserve	Conjestion	Average income	n
N. Ireland	Tollymore	167	57	5	21	26	0	2.68	5.03	498
	Castlewellan	144	44	7	17	12	0	1.38	4.81	496
	Hillsborough	92	57	12	17	6	0	40.00	5.06	491
	Belvoir	82	24	6	27	0	1	44.00	4.73	476
	Gosford	89	40	21	0	2	0	1.39	4.48	489
	Drum manor	116	20	9	0	11	0	1.40	4.41	370
	Gortin glen	112	70	2	3	3	0	1.17	4.54	341
	Glenariff	181	67	1	7	2	1	1.75	4.97	480
	Ballypatrick	56	81	0	3	0	0	0.85	4.25	90
	Somerset	50	59	14	6	3	0	2.00	4.97	243
	Florencecourt	190	32	5	0	1	1	0.50	4.89	167
	Lough Navar	158	68	1	1	0	1	0.77	4.85	265
	Castle Archdale	147	54	3	4	1	1	4.75	4.46	465
	Crawfordsburn	164	5	40	1	50	0	14.29	4.71	498
Scotland	Loch Trool	111	37	1	8	0	0	2.11	5.10	280
	Culzean	216	12	35	0	8	1	3.89	4.98	429
	Calderglen	168	10	20	1	5	0	12.50	5.08	269
	Vogrie	85	12	40	1	11	0	30.77	4.79	422
	Almondell & Calderwood	54	23	41	9	58	1	13.33	4.81	248
	Beecraigs	93	62	2	8	25	0	8.37	4.94	458
	Kinnoul Hill	161	46	20	4	30	0	2.74	5.15	182
	Tentsmuir	96	93	3	1	27	1	1.00	5.46	483
	Hermitage	136	66	17	5	50	0	5.88	5.50	95
	Glenmore	170	61	0	1	33	1	1.47	5.27	341
	Strathyre	78	53	3	6	10	0	5.00	4.62	220
	Queen Elizabeth /David Marshall	177	69	6	4	5	0	2.88	5.20	397
	Rowardeenan	172	57	18	16	11	1	3.13	5.06	499
	Aden	121	20	26	1	9	0	9.36	4.48	500
	Killiecrankie	124	0	93	0	50	0	10.00	5.52	225
Republic of Ireland	Lough Key	136	22	78	0	73	0	3.00	4.70	483
	Hazelwood	125	7	93	0	0	0	20.00	5.67	493
	Dun a Dee	74	51	48	1	26	0	5.00	5.49	196
	John F Kennedy	90	35	60	5	4	0	1.70	5.09	498
	Dun a Ree	119	64	36	0	22	0	3.00	5.67	249
	Currachase	118	20	68	12	3	0	3.30	5.21	498
	Cratloe	70	56	3	41	21	0	3.80	5.50	160
	Douneraile	120	4	96	0	81	0	4.00	4.15	273
	Farran	96	83	7	10	9	0	1.70	5.31	491
	Guaghan Barra	156	46	12	42	42	0	5.00	5.27	136
	Avondale	102	30	10	4	24	1	1.80	5.10	318
	Killykeen	79	90	8	2	27	0	2.00	4.92	199
	Glendalough	216	42	7	27	43	1	2.00	5.70	496
	All sites (mean)	124	44	23	8	20	0	7	5	355

Fig 1 : Site distribution of benefit transfer errors using benefit transfer coefficents β_{37}



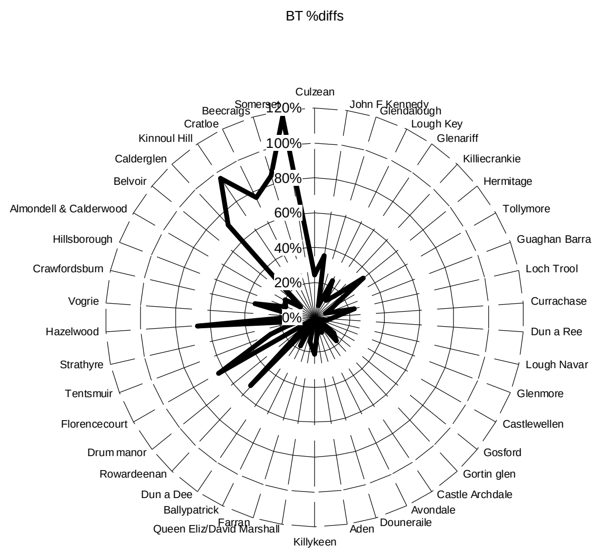


Fig 2 : Function transfer error % for each site ordered by on-site MWTP