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THE TRANSFERABILITY OF ENVIRONMENTAL BENEFITS: A REVIEW OF RECENT RESEARCH IN WATER RESOURCES MANAGEMENT

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Abstract

Recently, interest has been increasing with regard to the possibility of transferring the monetary benefits estimated for one non-market good to another similar good. Both practitioners and policy-makers have seen the advantages which could accrue if existing benefit estimates could be applied to secondary decision-making scenarios. However, there are a number of conceptual and empirical problems underlying such benefit transfers, which mean that they cannot to be undertaken without considerable care. This paper reviews recent research in the field of benefit transfers, with special regard to the issue of water resources management, and makes a number of recommendations which may be important for the future conduct of benefit-transfer studies in the UK.

Introduction

In the first few years of the 1990s increasing interest has been shown regarding the possibility of transferring the monetary benefits estimated for one non-market good to another similar good. Practitioners and policy-makers alike, have seen the potential advantages inherent in any procedure which allows existing estimates to be applied systematically to secondary decision-making scenarios. However, there are a number of conceptual and empirical issues surrounding such benefit transfers which mean that they cannot to be undertaken lightly.

Historically, the transfer of benefit estimates has been a common practice since the 1960s. In those days it was usual to adopt standard unit-day estimates based upon some form of expert opinion (see Brookshire and Neill, 1992). Other transfer estimates were based on proxy values, for example assigning a value to deer using beef prices.[1] These rather crude estimates were later superseded by ones based upon observed behaviour, for example by per visit consumer-surplus estimates from a travel-cost model. More recently benefit transfers have been achieved in a rather more sophisticated manner using estimates based on revealed preference techniques.

For the purposes of this paper, benefit transfers may be regarded as the use of existing non-market valuation estimates, say for water quality, at a site other than that for which they have been estimated, in order to allow the approximation of water-quality benefits at that site without the need for extensive empirical work. Such transfers have the advantages of being both considerably cheaper and quicker than conventional valuation studies, which usually require some form of survey and subsequent time-consuming analysis of the resulting empirical data. The disadvantages of such a procedure are also apparent. Clearly, a data set developed for a specific site may not be ideal for use at a different site, and benefit estimates may have to be adjusted to take account of this. There is also an issue regarding the desirability of using non-market valuation estimates, the accuracy of which are by no means universally agreed upon, in another, less appropriate context.

[1] This happened in a court case: Lac Courte Oreilles Band of Lake Superior Chippewa Indians versus State of Wisconsin (1988). US District Court no. 686 F. Supp. 226, W.D., Wi.

In this paper the issue of benefit transfer will reviewed chiefly in the context of contingent valuation studies addressing issues regarding water quality or water-based recreation. First, a particularly promising approach to benefit transfer is summarised, followed by a review of a number of recent empirical benefit-transfer studies in the field of water research. Next, the role of meta-analysis in the transfer of benefits is discussed, and finally, some general conclusions are made regarding the conduct of benefit-transfer studies in the UK.

The Boyle and Bergstrom Approach

One of the most promising approaches to benefit transfer in environmental benefit assessment was put forward by Boyle and Bergstrom (1992). They recognised the lack of any methodical approach for the critical assessment of benefit-transfer estimates, and proposed a 'systematic, conceptual foundation for conducting benefit transfer studies', suggesting a programme of research to identify conditions under which credible benefit-transfer estimates may be derived.

Their approach was motivated by the recognition that with the increasing volume of valuation studies providing improved information for benefit-transfer applications, such analyses would become increasingly common and would require stringent examination. Boyle and Bergstrom devised a conceptual framework for benefit transfer based on the consideration of various philosophical orientations toward the subject. This led them to attempt to formulate an idealistic approach to benefit transfers, where estimates must be unbiased and replicable, and to investigate the extent to which such ideals can be met in practice. This approach should prove helpful in facilitating the development of practical boundaries for the application of benefit-transfer studies in the future.

The case study example used by Boyle and Bergstrom to illustrate their discussion centred on the valuation of various flow levels of the Kennebec River in Maine. Flow levels could be altered by hydro-electric power generation on the river, and trades-offs were sought between this function and the recreational value of the river to white-water rafters. The Kennebec River was defined as the 'policy site', while any other sites from which existing estimates of non-market values were used, were referred to as the 'study sites'. The first step recommended by Boyle and Bergstrom was to formally define the focus of interest at the policy site. In their case study, this was done by specifying the following indirect utility function for white-water rafting:

$$V(P_W, P, Y \mid A, S) = \max_{T,X} U(T, X \mid A, S) \quad \text{subject to: } P_W T + PX = Y$$

where P_W was the cost of a white-water raft trip; P a vector of other goods and services; Y is income; A vector of exogenous attributes of a trip, including flow level; S a vector of the socio-economic characteristics of the participants, T the number of trips made; and X the quantity of all other goods and services consumed. This was then used to define the following Hicksian compensating willingness to pay (WTP) measure:

$$V(P_W, P, Y - WTP_{f^*}; A_f, S) = V(P^x{}_W, P, Y; A_{f^*}, S)$$

where WTP_{f^*} is the value to be estimated for the fixed water flow f^* and $P^x{}_W$ is the choke price where an individual would not make any further trips.

These theoretical measures allow the practitioner to identify certain key aspects of the benefit-transfer exchange. Particularly important are the vectors of site attributes and socio-economic characteristics, which will help to determine the similarities and differences which exist between the policy site and the study sites. If a comparison of the vectors between study and policy sites shows that there were no differences in terms of site attributes and the user group, then benefit-transfers would be relatively straightforward. If however, as is likely to be the case, differences exist and their magnitude is known, it may still be possible to manipulate the values in a way which will provide valid benefit-transfer estimates.

Following the theoretical specification of the value to be estimated, Boyle and Bergstrom's next step is to review the valuation literature for possible study sites. In the US this step mainly depends on a practitioner's ability to trawl through the large quantity of valuation studies carried out by academics, government agencies and private firms. As the authors point out, this is not necessarily an easy task even in the US, particularly for goods or issues which rarely catch the attention of the valuation profession. In the

UK, where the tradition of environmental valuation is much shorter, this search procedure may founder much more rapidly due to the sheer lack of relevant material. While a number of useful listing of US valuation studies exist in the literature, UK practitioners have to rely on sources such as Bateman *et al.* (1993), where the authors list over 30 recreation based contingent valuation studies in the UK.

Eventually, Boyle and Bergstrom arrived at five potential study sites which then had to be assessed in terms of their suitability for use in benefit transfers. The authors then set out three objective technical criteria for the assessment of the suitability of a study site for this kind of analysis:

i. the non-market good to be valued at the policy site must be identical to that already valued at the study site;

ii. the populations affected by the non-market goods must be identical at each site;

iii. the same welfare measure should be theoretically appropriate at each site, e.g. property rights existing at each site should imply the use of either WTP or WTA measures.

The use of the word 'identical' satisfies the idealistic orientation presented by Boyle and Bergstrom in their introduction to benefit transfers. However, the pragmatist, who they also deal with, would be satisfied with the looser specification of 'similar', possibly in the sense of no statistically significant differences between mean values at some agreed significance level.

Using these criteria as guidelines all five potential study sites were rejected by the authors for a variety of reasons, including differences in observed flow levels between study sites and policy site, and the way in which these levels were measured. It is clear from the reasons given for rejecting each study site, that even a more pragmatic set of criteria would not have permitted benefit transfers to be undertaken in this case.

Boyle and Bergstrom did not allow their failure to identify suitable study sites to deflect them from their objective, and go on to set out an agenda for assessing the quality of benefit transfers both at an intersite and an intrasite level. The first step required a critical assessment of the valuation estimates derived at the study sites, and in particular seeks to establish the unbiasedness of those estimates. This practice is similar to the validation procedure which is undertaken in many non-market valuation studies, and requires the assessment of the validity of the study under several headings:

i. **content validity:** a subjective judgement about the soundness of procedures and assumptions underlying the valuation exercise. For example in a study using the contingent valuation method (CVM), is the scenario theoretically accurate? Policy relevant? Understandable by the respondent as intended? Plausible to the respondent? Meaningful to the respondent? Has the good to be valued been successfully described? Can the good as described be delivered? Do respondents believe others could free ride and hence bias their WTP? Have any avoidable biases been introduced through the framing and wording of the questionnaire, or from the elicitation method or payment vehicle used? Has the questionnaire introduced or modified uncertainty about ecological supply and hence biased WTP?

Content validity can only be judged from a thorough working knowledge of the valuation literature, and requires that the results from the study sites have been reported exhaustively and accurately.

ii. **theoretical validity:** this involves assessing the extent to which the empirical findings of the study are consistent with theoretical expectations. In a theoretical validity test, interest focuses on the determinants of the demand or WTP model, and on whether they behave in a way consistent with theoretical expectations. Again, any such procedure is dependent on the honesty and thoroughness of the investigators at the study sites.

Boyle and Bergstrom do not rule out the possible usefulness of biased estimates, but suggest that any such problems may have potentially serious implications for the transferability of estimates. Indeed, as they point out, all non-market valuation studies are subject to some degree of error which must be taken account of in any benefit-transfer study, and the inclusion of small biases may in fact turn out to be permissible under certain circumstances.

Allowing for the presence of errors even in unbiased estimates, and for the fact that sites will rarely be identical in their attributes, user population characteristics, and property-right structures, Boyle and Bergstrom went on to propose a more pragmatic approach to the implementation of the technical benefit-transfer criteria. Their more pragmatic rule is that study site values can be used in benefit transfers if they provide 'a statistically unbiased estimate of the policy site value'. If this criterion is not met then the authors list the remaining three possibilities: (1) abandoning the benefit-transfer exercise; (2) using the biased estimate if the bias is within an acceptable range of error for the policy site application; and (3) systematically adjusting the study site value to remove the bias.

The third course is clearly preferable, it only remains to suggest how it can be implemented. The approach favoured by Boyle and Bergstrom is similar to meta-analysis (see Smith and Karou, 1990), and requires a knowledge about the effect of key attribute and socio-economic variables on the valuation estimates obtained at the study site.

So, as a result of this study what conclusions do Boyle and Bergstrom come to which may be useful to the establishment of a successful procedure for implementing benefit transfers in the field of environmental valuation? First, there are several useful practical points. A national library of valuation studies should be set up including detailed reports of results and possibly even data sets. This would be invaluable in the UK as a means of co-ordinating the limited resources in terms of available valuation studies. In addition future empirical studies should be carried out with the possibilities of their use in future benefit transfers in mind, and the results of these studies should be reported in full, facilitating the content and theoretical validation procedures outlined earlier.

Second, there are the technical conclusions. Boyle and Bergstrom suggested that benefit transfers may be improved by additional primary data collection. This might require detailed interviews with the investigators at the study sites, collection of technical data about all sites involved, and possibly re-estimation of existing estimates in line with new developments in valuation methodology. Also suggested were preliminary surveys of policy sites to identify items, possibly the key characteristics of the user group, which could be useful for assessing the suitability of potential study sites, and for any adjustments which may need to be made to estimates.

Third, there are several suggestions for further research. These include simultaneous estimation of non-market values at both the study and policy site using primary data, followed by the comparison of benefit transfer values from the study site with values estimated from the policy site. If the two estimates are not statistically different then convergent validity will be confirmed, and some evidence will have been provided about the conditions under which transferability works. More interestingly, if biases exist in the study site estimates, then this technique allows for a comparison of the magnitude and effect of these biases, and also permits an investigation of the adjustments which need to be made before benefit transfers can be justifiably made.

Some Recent Case Studies in Benefit Transfer

Loomis (1992) investigated benefit-transfers derived from the use of travel-cost demand equations. This practice arose in the 1970s as an antidote to the use of unit-day values to estimate the recreational benefits of new or unstudied sites. These values were initially derived from an 'administratively approved table' and were later replaced by mean net WTP values taken from other recreational demand studies. Rather than use these mean WTP values it was soon suggested that transferring the whole demand equation across studies was conceptually more acceptable. Having summarized the historical basis of this approach, Loomis goes on to suggest why using this method to estimate recreational benefits at a policy site is preferable to using the simple per day estimates of benefit. In brief, the main benefits generated by transferring the demand equation originate from the fact that this approach permits the investigator to account directly for the characteristics of both the policy site and its user group. This derives from the use of complex demand functions in travel-cost method (TCM) studies (or WTP functions in contingent valuation applications) which allow these characteristics to be taken into account when estimating benefits. Therefore, in theory the benefit estimate for the policy site could be calculated using the values of its characteristics, and the associated benefit estimates implicit in the coefficient values for the same characteristics in the TCM model derived for the study site.

The simplicity of such an approach is appealing, but Loomis goes on to investigate how useful this benefit-transfer methodology is in practice. He does this by adopting a similar criterion of convergent validity to his benefit-transfer estimators as that suggested by Boyle and Bergstrom (1992). Loomis' case studies involved recreational fishing in the North-Western United States, and in particular ocean salmon fishing in Oregon and Washington, and freshwater steelhead fishing in Oregon and Idaho. The method of benefit estimation used was the zonal travel-cost method (ZTCM), favoured by Loomis because of the relative ease with which it can be used to make benefit transfers. The zonal nature of the analysis means that the ZTCM explicitly accounts for spatial variations around the site, while the use of per capita visit levels reflects both the probability that an individual will make a trip to the site, and the quantity of visits he or she will make.

Using data from a variety of sources, Loomis estimated the following two pairs of zonal travel-cost method (ZTCM) demand models for recreational fishing:

A - i. ocean salmon fishing: Oregon

$$\ln (T_{ij}/POP_i) = -2.1285 - 1.07 (\ln DIST_{ij}) - 0.401 (\ln FISH_j)$$
$R^2 = 0.62$

A - ii. ocean salmon fishing: Washington

$$\ln (T_{ij}/POP_i) = -5.643 - 0.94 (\ln DIST_{ij}) - 0.592 (\ln FISH_j)$$
$R^2 = 0.53$

B - i. freshwater steelhead fishing: Oregon

$$\ln (T_{ij}/POP_i) = -3.9 - 0.828 (\ln DIST_{ij}) - 0.524 (\ln FISH_j) - 0.077(\ln SUBS)$$
$R^2 = 0.48$

B - ii. freshwater steelhead fishing: Idaho

$$\ln (T_{ij}/POP_i) = -0.422 - 1.2377 (\ln DIST_{ij}) - 0.317 (\ln FISH_j) - 0.1269 (\ln SUBS)$$
$R^2 = 0.50$

where T_{ij}/POP_i is per capita visits to site j from zone i, $DIST_{ij}$ is the round-trip distance from zone i to site j, $FISH_j$ is the total sport catch of fish at site j, and SUBS is an index of the ratio of fishing quality to distance for substitute sites with respect to zone i.

For each pair of equations the hypothesis of the equality of each of the individual paired coefficients was tested using a Chow-type test.

i.e. test whether: $A_0 = B_0$ and $A_1 = B_1$ and $A_2 = B_2$ and . . . $B_n = B_n$

where $\forall$ i = 0, 1, 2, ... , n the A_i and B_i refer to the coefficients of the first and second recreational fishing models respectively in each pair.

For the ocean salmon pairing the coefficient equality hypothesis was rejected at the 0.01 level. However, for the steelhead pairing, while the hypothesis was rejected at the 0.05 significance level, there was no evidence to reject it at the 0.01 level. This led Loomis to conclude that while inaccurate estimates would be derived from using the demand models for salmon fishing at Oregon to estimate total recreational benefits from Washington, and vice versa, that the benefit-transfer procedure would not lead to such poor estimates in the steelhead fishing case.

Loomis goes on to examine why this experiment failed. Importantly, the data from which the equations were derived were taken from different sources and generated at different times. This time difference was especially important as it was associated with changes in use levels between sites. In other ways too, it is not surprising that these demand equations were dissimilar. Few of the important pre-analysis comparisons suggested by Boyle and Bergstrom (1992) had been carried out, and there was little evidence to suggest that site attributes or user groups were similar. While this experiment is not encouraging with regard to the feasibility of benefit transfers, a more valuable (and more costly) approach would have been to collect primary data from each site and then derive ZTCM demand equations, bearing in mind their implications for benefit transfers. A hypothesis test comparing the coefficients from these models would have been more interesting, as observed differences could not have been explained by data limitations alone.

Loomis goes on to examine within-state transfer of demand equations for recreational fishing for ten steelhead rivers in Oregon. This was done by estimating ten multi-site TCM demand equations, one for each subset of nine of the ten rivers, and using this reduced model to predict the demand equation for the tenth, omitted river. The benefit estimates from this 'transfer model' were then compared with the estimates derived from a full model incorporating all ten rivers. The difference in total estimated recreational benefits for the missing river between full and transfer models was found to be as high as 17 per cent, though in most cases the differences were only half this. However, even larger percentage differences were observed when comparing estimated benefits from the full model with a 'ten-river average benefits per trip' figure which was also estimated. Overall, transferring the demand equation from the transfer model to the missing river gave estimates of total recreational benefit which were closest to those derived from the full model.

The shortcomings of this study mean that it is of relatively little use in assessing the feasibility of benefit transfers in general. It does, however, illustrate the need for good, contemporary data at the study site, and careful comparison between it and the policy site before implementation of benefit transfers.

Luken *et al.* (1992) report a benefit-transfer case study which estimates the benefits of local improvements in water quality, originating from controls on the release of effluents from 68 pulp and paper mills in the United States. These controls were enforced under the Clean Water Act (CWA) which imposes uniform standards on water quality which are applied regardless of cost, existing water quality, recreational potential and other factors. Luken *et al.* point out that the lack of discrimination in the application of CWA regulations lead to wide variations in the costs and benefits between different rivers, variations which motivate their investigation into the policy.

Problems in identifying the sources of river pollution in some areas, led to a concentration on 68 mills on stretches of river where pulp and paper mills could be identified as the major sources of effluent discharge. This sample was found not to be wholly representative of the population of pulp and paper mills, with discharges on average likely to have a greater effect than for the industry as a whole: this meant that benefits from reducing discharges would be proportionately higher in the sample than those which would be expected on a national basis.

Luken *et al.* categorised the following benefits which arise from reducing effluent discharges from pulp and paper mills:

i. reduced human health risks;
ii. reduced costs of treatment for contaminated water supplies;
iii. improved water-based recreation;
iv. non-use benefits
v. ecological benefits

The fact that few of the mills were upstream of drinking water intakes, coupled with the lack of a suitable methodology to quantify ecological benefits, led the authors to concentrate on the recreational and non-use benefits of reducing effluent loading. Focusing on these areas meant that suitable benefit estimates could be derived by investigating the WTP of various groups for improvements in water quality. Because no studies existed which specifically took account of the stretches of river affected by the mill sample, Luken *et al.* were obliged to look elsewhere for benefit estimates. A total of eight water quality benefit studies were located and their suitability for benefit transfer was investigated. Five studies were rejected due to a concentration on aggregate national effects, or on rivers too dissimilar to those under consideration: the remainder concentrated on three studies based on two warm-water rivers, each including recreational benefit estimates (Gramlich, 1977; Desvousges *et al.,* 1983; Smith *et al.,* 1984).

Luken *et al.* admitted that these rivers were not particularly well suited to their intentions, differing in character from the pulp and paper reaches and experiencing different levels of quality changes. Recognizing these and other limitations, the authors devised a schedule of upper and lower bounds of WTP for a table of water quality improvements constructed using the results from both a TCM study and a contingent valuation study of the Monongahela River (Desvousges *et al.,* 1983; and Smith *et al.,* 1984). This permitted a range of estimates to be generated for a particular quality improvement, say a change from being suitable for rough fishing, to being suitable for game fishing and swimming.

The benefits of water quality improvements under the CWA were estimated for each of the 68 mills in the following way. First, the improvement resulting from the regulation was estimated for each site using a simulation model, and placed within one of five increasing categories of water quality improvement: unusable; boatable; suitable for rough fishing; suitable for game fishing and swimming; and suitable for superior game fishing and swimming. The schedule of water quality improvement values constructed from the Monongahela River studies, was based on the range of benefits associated with moving into a higher quality category. If the improvement failed to move water quality into a higher category a weighting coefficient was used to indicate the level of improvement relative to that category, e.g. if water quality remained merely boatable and did not move up to the next category, i.e. suitable for rough fishing, the improvement was assigned a fraction of the value of that next category, say 50 per cent, to indicate the level of improvement which had taken place. Second, the potential recreation market was estimated as the number of household living within a 48km radius of the site. Third, a rough index of available substitute sites was calculated, and used to determine estimated maximum visit rates: few substitutes meant that a maximum of 50 per cent of the potential recreation market would visit; a moderate amount of substitutes implied a maximum 30 per cent visit rate; while many substitutes being available signified a maximum visit rate of only 10 per cent. Finally, these estimates were combined to give upper and lower bounds to annual benefits. Lower bounds reflected only user values, while upper bounds included non-use benefits as well, though quite how this was achieved is not clear.

Luken *et al.* made some efforts to enumerate the possible sources of bias in their benefit calculations. These included: using simulations to determine water quality improvements; using an unrepresentative sample of mill reaches; substantially over-estimating visit rates; using crude estimates of the user population; taking inadequate account of non-users; and inferring benefits from a single river, the attributes and user characteristics of which may not have been directly comparable to the rivers being studied. The authors suggested that the overall effect of these biases would be to over-estimate the benefits of water quality improvements to users, and this has important consequences for the analysis. In spite of these over-estimates, the majority of mills in the sample incurred pollution-control costs considerably greater than the estimated upper-bound benefits associated with the reduction in effluent: in fact only 15 of the 68 sites had upper bound benefits which exceeded estimated costs, and of these only seven had benefits which were substantially higher than the associated costs.

Thus, despite the relative crudity of the benefit transfers implemented, the study was able to reach some policy-relevant conclusions with regard to the CWA. These reflected the potential waste of resources involved in the uniform imposition of the CWA regulations regardless of cost, on sites where the environmental benefits were unlikely to be significant. However, Luken *et al.'s* analysis did not cover the full range of benefits associated with effluent control, and did not tell the full story in terms of benefits generated by the controls. From the point of view of benefit-transfer methodology, this study is useful in demonstrating that even quite unsophisticated applications can have some policy relevance, though if the benefit-cost ratios had been less unambiguous, any conclusions that could have been drawn from the study would have been less clear.

Desvousges *et al.* (1992) also attempted to use transfer techniques to measure the benefits of water quality improvements arising from proposed regulation on the pulp and paper industry. Their study was originally undertaken for the US Environmental Protection Agency (EPA), but was reported to illustrate the potential utility of benefit-transfer techniques for policy evaluation, permitting the authors to examine their work more critically than might otherwise have been possible. Their use of benefit-transfer techniques was originally motivated by the EPA's need to produce estimates of the benefits generated from anti-pollution regulations implemented on 21 pulp and paper mills in the US. This evaluation process had to be completed within a six month period with the usual constraints over the funds available for the work.

Desvousges *et al.* treated this as a constrained optimisation problem, and evaluated it in terms of the minimization of the mean squared error (MSE) in the benefit estimates. This followed their specification of the goal of benefit-transfer studies as being to use existing studies to produce the best possible predictor for estimating the benefits of environmental improvements at policy sites. Like Boyle and Bergstrom (1992) Desvousges *et al.* set out five criteria for assessing which studies to use for benefit transfers, these are summarized below.

i. The study must be technically and theoretically sound, that is it should use adequate data, correct theory and appropriate techniques.

ii. The quality changes at the study site should be similar to those expected at the policy site.

iii. The study must report a model of WTP, with independent variables which include socio-economic characteristics.

iv. Study and policy sites should be similar in terms of their physical characteristics and their user populations. Alternatively, the WTP model should include site characteristics as independent variables, allowing the necessary adjustments to be made within the transfer model.

v. The markets for the study and policy sites should be similar.

These criteria were applied to the sites under consideration for the EPA benefit-transfer study. Because of the negligible effects of the proposed regulation on nine of the rivers, the benefits accruing to these could be set at zero. This left 12 sites for which to find suitable estimates of the benefits of improved water quality. For each of these Desvousges *et al.* presented estimates of the expected percentage decrease in pollution loading as measured from two factor: biological oxygen demand (BOD); and total suspended solids (TSS). Also given was the length of river affected by the improvements, and a qualitative assessment of the per-family benefits due to reduction. This ranked the effect on sites as moderate, low/moderate or low, and reflected both the potential for water quality improvements and the adequacy of access to the site.

Eight studies were found which provided estimates of water quality improvements based on sound methodology. Of these, five were contingent valuation based, two were travel-cost studies and the other was a participation study. Five studies were eliminated immediately because they did not meet Desvousges *et al.'s* fourth criterion, displaying either very different characteristics to the policy sites, or estimating a single value over a number of rivers which could not be meaningfully disaggregated to an individual level. The three remaining studies were, coincidentally, the same three which Luken *et al.* (1992) were left with after their selection process, and consisted of one travel-cost study and two contingent valuation studies. This convergence between transfer studies is encouraging, suggesting some measure of consistency in application even at this early stage.

Desvousges *et al.* compared the attributes of the two rivers investigated in these three studies, with those belonging to the 12 policy sites. All of the policy sites were in the Eastern US, and all attracted primarily local users and had many substitutes. However, the two study sites were somewhat more urban, and served larger, wealthier and better educated populations than the policy sites. In addition, recreational usage varied across all sites. Having compared the site attributes, the authors went on to examine the quality of the transfer studies, noting that while each was adequate, various errors and problems existed within them.

Five major problems in implementing the transfer process were noted by Desvousges *et al.* for this case. These problems, and the ways in which they were resolved, are described below, along with the direction of any biases which these solutions might have introduced.

i. ***The definition of market size.*** The authors assumed that the policy sites were used mainly by local people, and that it was only this local population which might have non-use values. This probably introduced some downward biases in the transfer estimates by under-estimating the magnitude of non-use values.

ii ***WTP for small increments in quality at the policy site must be associated with the WTP for broader qualitative changes which were given for the study sites.*** In the absence of any broad estimates of quality changes at the policy sites, Desvousges *et al.* were forced to accept the benefit estimates for changes in the broad increments used at the study sites. This extrapolation of what were often small changes at the policy sites to the larger changes which had been observed at the study sites introduced an upward bias to some estimates.

iii. ***None of the potential transfer studies linked site characteristics and the value of water quality improvements.*** This was solved by choosing study sites that were as similar as possible to the policy sites. However, differences in access and better recreational opportunities at the study sites meant that using them probably introduced an upward bias.

iv. ***There were no usable estimates for substitute prices to define the relationship between the policy sites and any substitutes.*** Desvousges *et al.* used the relationship between distance from the site and WTP as a proxy for own price, and tried to minimize differences in substitute prices by choosing study sites with a similar amount of substitutes to the policy sites. The direction of bias depended on the attributes of the various substitutes available to each site.

v. ***The studies estimated benefits for different categories of user and non-users.*** Desvousges *et al.* adjusted the estimates of use values in order to make them comparable. The effect of these correction procedures was unclear, though the authors suggested that a downward bias might be introduced because they only attempted to measure use and non-use option values, ignoring existence values.

Bearing the above problems in mind, Desvousges *et al.* first defined the market areas for the policy sites to be coincident with the county boundaries of those counties bordering the affected rivers. This was consistent with the assumption of primarily local user groups, and had the added advantage that it enabled the study to use population and socio-economic data from the census. For larger counties, where this definition meant that the markets extended as far away as 177 km, possible biases were minimized because the transfer process assumed a negative relationship between distance and benefits. Second, average benefit estimates were calculated for 'representative households' in each market area. In order to do this, a number of assumptions were required. Market areas were arbitrarily divided into inner and outer zones, beyond which benefit values were zero. In each zone representative households were defined as possessing zonal average population characteristics, and as being located at the zonal average distance from the policy site. This approach permitted the use of population mean census data, while at the same time allowing an adjustment for the relationship between distance and the level of benefits. Each of the three studies which were used to transfer benefits to the policy sites was different, therefore the approach to benefit transfer had to be adjusted to fit their particular characteristics. For example, the water quality improvements at the policy sites had to be measured in ways which were consistent with those used in each of the transfer studies. In one of the three transfer studies, where no significant relationship was found between distance away from the site and the benefits of water-quality improvements, a single representative household was used to represent both zones.

Aggregate benefits for each market were estimated by multiplying representative household benefits by the number of households in the relevant zone and summing the results. This gave estimates of the overall benefits of the proposed water quality regulation which ranged between $11 million and $26 million per year, with the benefits derived from the travel-cost approach giving the lowest aggregate values.

Recognizing the limitations of their approach Desvousges *et al.* offered four recommendations for the design of future valuation studies which should alleviate some of the problems which they encountered when attempting to transfer benefits. Their first recommendation was to use multi-site models in these studies in order to investigate how individuals' preferences vary with changes in site attributes and location. This would also have the advantage of allowing market size and its relationship with site characteristics and possible substitutes to be deduced more readily. This approach is often used in travel-cost models, though is somewhat harder to incorporate into contingent valuation studies. Second, it was recommended that these transfer models be compared with similar multi-site models estimated in other areas in order that some tests of comparative validity could be carried out. This idea was similar to that put forward by Boyle and Bergstrom (1992), and would allow an investigation of how differences in site attributes might be dealt with in benefit-transfer applications, and would help to identify any attributes which are particularly influential in generating transfer estimates. Thirdly, the authors suggested that variables measuring environmental change used in transfer studies should be policy-relevant, thus making those studies more useful for any subsequent benefit-transfers where quality changes would be measured in a similar way. Finally, it was recommended that as well as a site-specific model, valuation studies include a transfer model which would concentrate only on those explanatory variables which are available at the majority of sites of that type. This additional model would allow benefit-transfers to be carried out without adjustments having to be made for variables in the transfer model which are not appropriate for the study site.

The similarities between the previous two studies inspired Smith (1992) to compare them in order to illustrate how differences in the implementation of benefit-transfer studies can alter the eventual outcomes. This comparison was helped by the discovery that both studies were concerned with the Hudson River, and that the plants considered in the Luken *et al.* (1992) paper were on a stretch of the river examined by Desvousges *et al.* (1992). Looking at the results for this stretch of the Hudson, Smith concluded that the differences in the assumptions made in each of the benefit-transfer studies would lead to conflicting conclusions with respect to the reduction of effluent outflows from the pulp and paper mills located there. Smith found that differences in the characterisation of water quality along the reaches of the Hudson considered in these studies were particularly influential in achieving these contrasting results. He concluded that this phenomenon of conflicting results was caused by an absence of 'a systematic protocol for benefit transfer analysis.'

The Role of Meta Analysis in Benefit Transfer

Meta analysis has been used for some years in disciplines such as education and health science, where the results from controlled experiments have been aggregated for the process of review and summary (Smith and Kaoru, 1990). Meta analysis provides a means of synthesising the results from a number of studies in order to gain a better understanding of the consequences of the underlying modelling process (Cooper, 1984). The synthesis may ultimately prove useful for indirectly estimating benefits at a policy site, or for evaluating other such benefit transfers, it may also provide an insight into how benefit estimates should be adjusted to compensate for variations in methodology between studies.

Since the majority of studies of economic benefits are not based on controlled experiments, the results of these studies cannot be investigated through the aggregation of independent observations taken from the experimental findings of a number of studies (Cordray, 1987). Thus, as

Smith and Kaoru (1990) point out, the results of empirical economic research cannot be treated in quite the same way as in more scientific disciplines, and meta analysis must take into account both the modelling judgements used in such analyses and the interdependent panel nature of the sample of research results.

Smith and Kaoru (1990) used meta analysis to summarise the benefit estimates derived from 77 TCMs estimated in the US between 1970 and 1986. These studies were chosen from a set of over 200 similar studies because they all yielded comparable benefit estimates, that is estimated consumer surplus per unit of use (CS/v). This decision was made because it was both consistent with the usual desire in benefit-transfer studies to develop unit benefit estimates, and with the need to adjust for the levels of accessibility between recreation sites.

Five factors which may influence the estimation of CS/v in travel-cost studies were identified by Smith and Kaoru:

i. the type of recreation site;
ii. the definition of the recreation site, site quality and usage;
iii. the way in which the opportunity cost of time is modelled;
iv. the incorporation of the role of substitute sites in defining recreation service flows;
v. the specification of the demand model and how it is linked to an underlying behavioural model.

The recognition of these factors allowed Smith and Kaoru to define a number of variables for use in the empirical analysis. These included three recreation activity variables (water-based recreation, hunting and recreational hiking), five recreation site variables (lake, forest/mountain, river, state park, national park), as well as a number of variables indicating modelling assumptions (e.g. use of a substitute price term, use of average or income-based wage rate for the calculation of time cost, and whether a state or regional TCM was used). In addition model specification variables were defined to indicate the use of a variety of functional forms, and estimator variables were specified to denote whether ordinary least-squares, generalised least-squares or maximum-likelihood (adjusted for sample truncation) estimators were used. Finally, a variable giving the year in which the particular study was undertaken was specified to investigate the existence of any time trend effects.

Variation in specification and estimation procedures meant that 77 individual studies examined by Smith and Kaoru yielded over 400 usable benefit estimates, along with the variables needed for the empirical analysis. The hypothesis underlying the analysis was that these benefit estimates varied because of differences in the theory underlying the demand equation as well as differences in the way in which the analysis was implemented. These differences were explained through the use of the variables summarised above.

Empirical models based on various combinations of independent variables were estimated using OLS regression. From these the effects of the various specifications and modelling assumptions could be inferred. Thus, measures such as the inclusion of a substitute price or the opportunity cost of travel time were found to have a statistically significant effect on CS/v. Furthermore functional specification and method of estimation were also found to significantly effect benefit estimates, while more fundamentally, type of recreation site and the primary activities promoted at sites were also found to have a significant effect on CS/v. In general, all of these findings were consistent with various empirical issues identified by researchers seeking to investigate the influence of various factors on travel-cost benefit estimates.

Overall, the Smith and Kaoru attempt at meta analysis suggested that econometric methods could indeed summarise the results from a large number of empirical studies. Furthermore, it gave some insights into the empirical consequences of some of the practices and modelling assumptions which are commonly used in travel-cost applications. However, the authors are at pains not to commit themselves with regard to the usefulness of meta analysis for predicting benefit estimates for policy analysis. Instead they suggest that in the absence of further research, meta analysis should be used as a consistency check for the processes used in benefit-transfer analysis.

Walsh *et al.* (1989; 1992) were rather less coy when it came to making claims about the efficacy of meta analysis in performing benefit transfers; however, they were also firm about the need for further research before the complexities involved could be fully understood. Even so, their application of meta analysis was considerably more ambitious than that of Smith and Kaoru, incorporating on-site recreational benefits estimated by both the travel-cost method and contingent valuation applications. To begin with the authors implemented a systematic review of the literature on recreation demand studies prior to 1989, gathering all available estimates of recreational use values. In all a total of 120 studies were used to derive 287 estimates of net economic value per activity day[2] for use in the subsequent analysis. Benefit estimates arising from hypothetical quality changes were adjusted to the base value of current site quality, and all estimates were adjusted to 1987 dollar values. Before any modelling was attempted a comparison was made between the magnitude of benefits yielded by a range of different recreational activities: this revealed that salt-water fishing gave the highest mean per day value ($72.49), picnicking the lowest ($17.33). While the results of this comparison seemed plausible, an examination of the range of values in each activity category was interesting. For each category examination revealed a large variation in benefit estimates: this begged the question of which factors were responsible for these large variations - the benefit-estimation methodology, site quality, user characteristics or some combination of these?

Walsh *et al's* models were based on standard applied microeconomic theory, and sought to explain variation in net economic benefits per activity day in terms of a range of variables describing these factors. Site variables included a crude rating of site quality (1 = high quality; 0 = medium or low quality), indicators of the recreational activities undertaken there and whether the site was administered by the Forest Service. Methodological variables included indicators of methodology (contingent valuation or other), household or on-site survey, the use of time costs or individual observations in TCM studies, the use of open-ended or dichotomous choice questions in CVM studies, and whether or not the sample included out-of-state residents. A series of qualitative locational variables was used as a proxy for the socio-economic characteristics of the user populations.

Three models of recreational benefits were reported: one for all estimates (287 obs), and one each for those estimates generated respectively by TCM

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[2] An activity day was defined as one person on site for any part of a day. Values reported in an alternative form were adjusted to a per activity day basis.

(156 obs) and CVM studies (129 obs). In all around two thirds of the explanatory variables were statistically significant at the 0.01 level, and adjusted R^2 values indicated that between 36 and 44 per cent of the variation in the dependent variable had been explained by the model. The models proved to be of considerable interest from the point of view of benefit transfers. First, the model based on TCM estimates indicated that omitting the cost of travel time in TCM studies reduced benefit estimates by 34 per cent, while omitting an effective cross-price term for substitution raised estimates by 30 per cent. Second, the model suggested that if the TCM was the accepted standard for benefit estimation then CVM estimates would have to be adjusted upwards, by around 10 to 15 per cent for studies using a DC format or 20 to 30 per cent for studies using an OE question format. Other significant explanatory variables included site quality, four of the nine locational variables and three activity variables (salt water and anadromous fishing; big game hunting; and waterfowl hunting).

Walsh *et al.* documented the limitations of their approach with regard to multicollinearity and omitted variable bias, but nevertheless their results seemed encouraging both for future meta-analyses and for the systematic adjustment of benefit estimates in transfer studies.

Conclusions and Discussion

Over the last two decades many studies in the UK have sought to estimate the benefits associated with the provision of a variety of non-priced environmental goods. These goods have varied considerably in type, location and importance, and may have been valued in relation to either an increase or a decrease in their current provision. In addition these studies have used a number of methodologies and a wide range of specific modelling assumptions in order to generate benefit estimates.

Such a history does not bode well for future benefit-transfer studies. These valuation exercises were not designed with future transfer studies in mind, but were developed to explore the limits of new methodologies, to test specific hypotheses and to explore the implication of various approaches to survey design and data modelling. Thus, if they are to be useful in a benefit-transfer context they must be carefully modified and any transfer estimates they yield must be subject to detailed scrutiny. Even then, judging by the studies reviewed in this paper, it is doubtful whether such modifications would yield transfer estimates which were reliable and robust enough to be used with confidence in policy applications.

Techniques such as meta analysis may provide some beneficial insights into the effects of various modelling and site selection decisions, and how benefit estimates may be adjusted to take account of variations in methodology. However, much more work needs to be done in this field before this type of model could be recommended for use in generating transfer estimates. A more feasible first step for the UK would be to undertake a series of empirical studies specifically designed to test the feasibility of benefit transfer. This would require experiments of the sort proposed by Boyle and Bergstrom (1992), where the non-market values at both the study and policy sites are simultaneously estimated using primary data. This would be followed by a comparison of benefit-transfer values from the study site with the actual estimated benefit values estimated from the policy site. Alternative benefit-transfer values could be estimated for the study site using various techniques and the merits of each could be investigated through comparison with the policy site values. If biases exist in the study site estimates, then this allows for a comparison of the magnitude and effect of these biases, and permits an investigation of the adjustments which need to be made before benefit transfers can be justifiably made.

Additional recommendations relevant to the UK context include the construction of a database consisting of all environmental benefit estimates, plus details of the modelling procedures used, and all relevant assumptions. In addition full descriptions of the site and of the user group would also be required so that a detailed comparison with potential transfer sites could be made in order to assess the suitability of the study site. Furthermore, researchers should be encouraged to bear the requirements of benefit transfer studies in mind when undertaking valuation studies. To facilitate this a broad code of practice for the conduct of benefit studies should be drawn up, which would ensure that the outputs from valuation studies would be usable in future benefit transfers. To ensure the success of such a code of practice government departments and other agencies funding research should make adherence to it a condition for all benefit-estimation work they commission.

One recommendation that should be included in any code of practice is Desvousges *et al's* suggestion that as well as a site-specific model, valuation studies include a transfer model which would concentrate only on those explanatory variables which are available at the majority of sites of that type. This additional model would allow benefit-transfers to be carried out without adjustments having to be made for variables in the transfer model which are not appropriate for the study site.

With government departments and the various other organisations responsible for commissioning valuation studies jumping onto the transferability bandwagon, the demand for benefit transfer applications is likely to increase over the next few years. Practitioners must be careful not to get carried away on the tide of these demands, and to use benefit-transfer estimates only in those situations where they can be justified on both practical and methodological grounds, or in extreme cases where there is no time for conventional analysis. Poorly conducted benefit-transfer studies, giving unreliable estimates, will only serve to discredit both non-market valuation and the people who undertake it, while at the same time providing policy makers with poor information which may lead to incorrect and damaging decisions being made.

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