Economic Value of Original Non-Market Valuation Research

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Short Abstract

We describe a method to determine the net economic gain from conducting original research to estimate non-market benefits of public policy and demonstrate an application of this method. We provide a step-wise method to allow policy practitioners to make informed decisions about when there are expected net benefits to conducting or contracting for original research to estimate the benefits of a policy decision.

Introduction

Federal Agencies are often required by statute or executive order to examine the costs and benefits of their decisions (Executive Order 12866; Toxic Substances Control Act, sec. 2506(c)(1) ; U.S. Water Resources Council). Quantifying the benefits of goods and services that are traded in markets can be relatively straightforward. Doing so where markets do not exist is more difficult; agencies use a variety of tools to estimate willingness-to-pay for non-market goods or services.

Generally, such values are estimated through original research using methods, such as the contingent valuation method (Mitchell and Carson) or the travel cost method, designed to examine either stated or revealed willingness-to-pay for the good or service in question. The increasingly rich literature of valuation studies, combined with theoretical innovations, created the opportunity for less resource intensive approaches to value estimation—a variety of techniques that can be described as benefit transfer (Loomis; McConnell; Desvousges, Johnson and Banzhaf).

Two general approaches have been taken to estimating benefit transfer values. The first, and simplest, involves taking a point estimate of value from a similar study site and adopting it as the transferred value for the current analysis. A slightly more complicated version of this approach involves averaging the estimates from several studies of similar sites and using that average value in the current analysis (for an example of both of these approaches and further discussion of them see Rosenberger and Loomis).

A second and more complicated approach, but one that may improve the accuracy of benefit transfer, is the use of benefit function transfer. Through this approach, a meta-analysis function is estimated from a database of original estimates of the class of goods or services under investigation. When an estimate is needed for a new situation, the variables in the meta-function are set to the appropriate levels and an estimate may be produced. Such meta-analysis functions exist for outdoor recreation (Rosenberger and Loomis; Walsh, Johnson and McKean; Smith and Kaoru), groundwater valuation (Boyle, Poe and Bergstrom), endangered species valuation (Loomis and White), air pollution and visibility (Smith and Osborne) and health effects of air pollution (Desvousges, Johnson and Banzhaf).

This paper develops an approach to calculating the benefits of original valuation research in terms of expected reduction in inaccuracy as an input to public policy decision-making. With such a benefit estimate available, along with knowledge of the cost of conducting or contracting for original valuation research, policy-makers can make informed decisions as to whether conducting an original study would yield positive economic returns compared to utilizing a benefit transfer approach. We will demonstrate exactly how the value we derive can be used for this sort of decision-making.

Two important notes are in order before we proceed to describe our theoretical approach. First, the willingness-to-pay estimate is only one component of the benefits estimation process. In most cases an incidence rate (such as visitor-days in recreation benefits or cases avoided for health benefits) will also be necessary. Our analysis focuses only on the valuation portion of benefits estimation and takes incidence level as given. Similar work on the accuracy of various approaches to incidence estimation could yield valuable insights. Second, the theoretical approach outlined below could be applied to either a benefit value transfer or benefit function transfer type approach. In our empirical example we focus on a benefit function transfer case, but the technique described could easily be used to assess benefit value transfer.

Theoretical Approach

The value of original research into non-market valuation has several components. The portion of the value considered directly in this article is the value in terms of avoided policy errors—or a more accurate benefits estimate as an input into policy decision-making. We will also assume that the research being contemplated has direct implications for only a single policy decision. Some types of research—such as willingness to pay for improved health or avoided health effects may well become factors in multiple decisions. In such a case each decision to which the research is expected to have direct relevance should be a term in the value function. It is important to consider that conducting original non-market valuation research has other values as well, values such as improving the dataset available for meta-analysis and thus benefit transfer, improving general knowledge about way people value non-market goods and services, and testing new approaches to improve the estimation of non-market values. If we consider the formal function:

Equation 1.

Value of Research = f(more accurate policy analysis input, meta-model input, general knowledge, technical improvements)

Our current analysis attempts to estimate only the first term in the value of non-market valuation research.

Estimating the differences in accuracy between original study estimates and benefit transfer approaches can best be done by directly comparing the estimate provided in an original study to the estimate provided by using a benefit transfer approach given the characteristics of the study good, techniques and population. We can apply this general approach to both benefit function transfer and benefit value transfer techniques. Once the expected additional accuracy of original research is known, the value of original non-market valuation research to policy analysis can be estimated as simply

Equation 2.

Value more accurate policy input = g(expected additional accuracy, size of policy decision)

We discuss this relationship in more detail later in this section, but first we will provide appropriate context by describing a technique to estimate the additional accuracy of original research.

In order to estimate the benefits of research, we will first assume that original study estimates are unbiased estimates of the value in question. This assumption allows us to calculate the benefits of research as the avoidance of errors, where the errors are calculated as the distance of the estimated value from an original study of the population for which the benefit transfer value is estimated. Therefore,

Equation 3.

$$\text{Error}_{\text{Benefit Transfer}} = |\text{Estimate}_{\text{Original}} - \text{Estimate}_{\text{Benefit Transfer}}|$$

Summing, averaging, or otherwise manipulating the results of a set of benefit transfer estimates would be problematic under this approach because the magnitudes of errors around high-value goods or services would overwhelm the errors in estimating the value of lower-value goods or services. For example, a fifty percent error in estimating a value of $100 appears, when computed as in equation three, significantly larger than a two hundred percent error in estimating a value of $1. In order to avoid this problem, we compute all of the errors analyzed in the remainder of this paper as proportions to their original study estimate as described in equation 4.

Equation 4.

$$\text{Error}_{\text{Benefit Transfer}} = |\text{Estimate}_{\text{Original}} - \text{Estimate}_{\text{Benefit Transfer}}|/\text{Estimate}_{\text{Original}}$$

Evaluating the benefit transfer as the entire distance given by equation four is problematic in its own right because it forces us to assume that not only are original studies unbiased, but that they are without uncertainty—that the point estimate of an original study is exactly truth. A better assumption is that an appropriate confidence interval around the original study's central estimate contains truth and that the appropriate measure of the benefit of original research is the avoided additional error of benefit transfer, as estimated from the extreme value of an appropriate confidence interval. We will use a 95 percent confidence interval as the appropriate level of uncertainty around the original estimate because such a confidence level is commonly used in discussions of uncertainty around a point-estimate. We calculate the proportional additional error of benefit transfer, considering uncertainty around the original estimate, as shown in equation 5.

Equation 5.

$$E_{BT} = \frac{\left|S_{BT} - S_{Orig}\right| - 1.96 * se_{orig}}{S_{Orig}}$$

Where E_{BT} is the percentage error of using benefit transfer, or the percentage improvement in accuracy from conducting original research

S_{BT} is the estimated value provided by benefit transfer

S_{Orig} is the estimated value from an original study

se_{orig} standard error of the estimated original study value.

Estimating the expected additional error of benefit transfer, or the expected additional accuracy gained by conducting original research, is relatively straightforward. First, a sample of studies of the appropriate non-market good or service is drawn. Then the benefit transfer method that is being tested (either a meta-analysis function for benefit function transfer or a simple estimated value for benefit value transfer) is used to estimate a benefit transfer value for the population, good, and analytical technique in each of the sampled studies. E_{BT} values may then be computed for each original study-benefit transfer pair.

Before the values provided for each comparison can be aggregated, it is necessary to set any values for which the estimated benefit transfer value is within the 95 percent confidence interval to zero. We do this because the mathematical outcome of negative expected error does not accurately reflect the real relationship between the original study estimate and the benefit transfer estimate. What an $E_{BT} \leq 0$ actually conveys is that the original study estimate in that case provides no more information, after considering uncertainty, than using benefit transfer would have.

Once the issue of negative values is accounted for, we can use the sample of E_{BT} values to compute some simple descriptive statistics of the difference in accuracy between original research and benefit transfer estimates. Of particular interest are the mean value and its standard error. The mean error from using benefit transfer calculated in this manner is the expected additional accuracy gained from conducting original non-market valuation research rather than relying on benefit transfer to estimate the value of a non-market good or service.

Possession of a measure of the expected additional accuracy from original research is useful, but to fully understand the value of that research in any particular case we need to move on to a method for deriving a monetized measure of the additional information in any particular case. The nature of our estimator—a percentage distance away from a range of values assumed to contain the true value—makes it easy to estimate a range of values in a post-hoc sense; if we have already conducted original research we may estimate the a range containing the value of that research by multiplying the value estimated in our research by the endpoints of the 95 percent confidence interval around the percentage expected error value calculated above.

A more powerful application, however, would be the ability to estimate the value of original non-market valuation research before that research is conducted. This application would allow us to begin to resolve the question posed in the introduction—when is it appropriate to use benefit transfer in estimating values for policy analysis and when would we expect there to be positive returns to conducting original research? We can use our expected additional accuracy estimate to approximate the value of this additional accuracy based on a "back of the envelope" estimate of the benefits of a particular policy. While valuation estimation is key to arriving at a accurate estimate of the benefits of a policy, an analyst will often understand the magnitude of the benefits before undertaking such estimation and can even leverage some common point estimates in a rough form of benefit value transfer to better approximate this value. With a rough, magnitude, estimate of the benefits of the policy in hand, we can draw a 95 percent confidence interval for the expected improvement in accuracy centered on the product of the expected percentage improvement in accuracy and the rough estimate of policy benefits.

This sort of distribution allows us to derive an additional interesting set of results when combined with some knowledge of the costs of original research. We can derive threshold values for the rough estimate of benefits, one value below which original research is unlikely to have positive economic returns and another above which original research is likely to generate returns. The area between these thresholds can be thought of as a zone of uncertainty—it is unclear whether or not original valuation research, when conducted for policy applications having rough benefits in this area, will yield positive economic returns. Given costs of a well-designed and conducted non-market valuation study between \$100 thousand and \$300 thousand (Loomis, personal communication), the threshold values can be calculated as shown in equation 6.

Equation 6.

$$L = \frac{100{,}000}{\overline{E} + 1.96 se_E}$$

$$H = \frac{300{,}000}{\overline{E} - 1.96 se_E}$$

Where L is the rough benefits level below which original research is unlikely to have positive returns

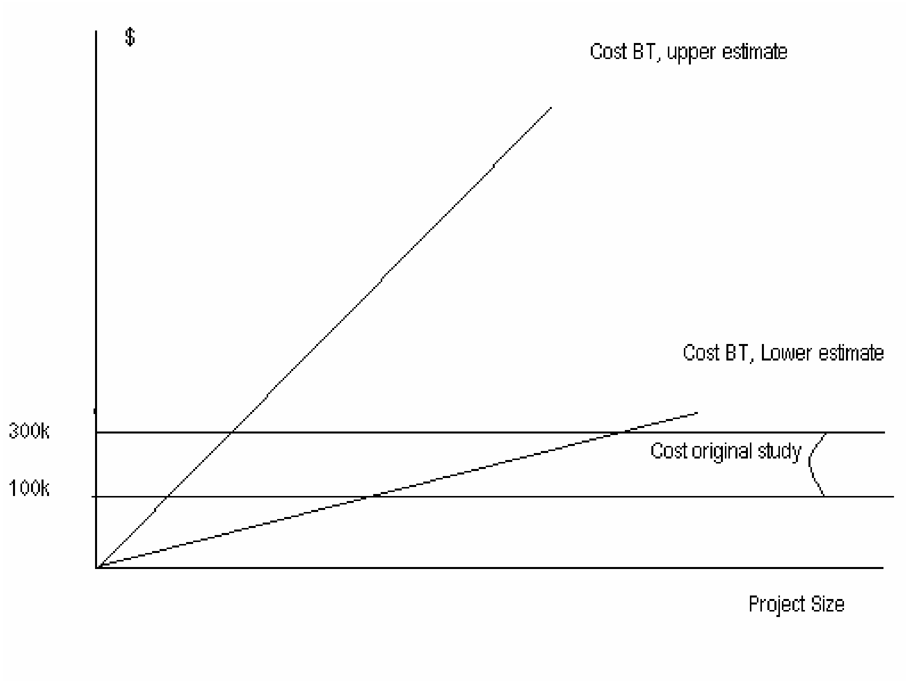
H is the rough benefits level above which original research is likely to have positive returns

$\overline{E}$ is the expected percentage error of benefit transfer, the calculation of which is described above

se_E is the standard error of the expected percentage error calculation

Expressed as a graph, the relationship described in equation 6 may appears as figure 2. This figure shows the marginal cost functions of original research (assumed to be constant, regardless of rough estimated benefits) and of benefits transfer (the marginal cost of which is a function of its inaccuracy and project size). Both functions have an area of uncertainty between the two boundary curves. The range of project sizes for which the benefit transfer surface is above the original research surface are those for which original research is expected to have positive economic returns. In the range in which the benefit transfer surface is below that of original research, we would expect benefit transfer to have negative economic returns. The overlap of the uncertainty regions is the region of uncertainty described previously.

Figure 2: Costs of Original Research and Benefit Transfer



E**mpirical Example**

In order to demonstrate the method described above, we examine a meta-analysis of recreation benefits constructed by Rosenberger and Loomis. We chose this particular benefit function transfer because it appears as a publication of the United States Department of Agriculture's Forest Service and is thus not only the sort of meta-analysis that could be used for benefit function transfer but also is a function disseminated by a federal agency for the specific purpose of benefit transfer.

The Rosenberger and Loomis analysis examined 701 estimates of per visitor-day willingness to pay estimates from recreation benefits surveys conducted from 1967 to 1996 (p. 19). The analysis creates a linear-form meta-model of the estimates, examining potential coefficients for characteristics of the study technique (contingent valuation or travel cost methods and the particular study characteristics within the chosen approach), site characteristics and activity characteristics. Their analysis produced the significant explanatory variables and coefficients reported in table 1 below.

Table 1. Significant Explanatory Variables and Their Coefficients from Rosenberger and Loomis (2001, p. 20)

Variable	Coefficient	White's Standard Error	Variable	Coefficient	White's Standard Error
Constant	81.273	15.97	R4	5.529	3.32
Method	-21.586	10.12	R6	-10.838	4.01
DCCVM	-36.981	10.44	R8	-5.128	2.53
OE	-51.762	11.01	Lake	-18.294	6.06
ItBid	-46.399	10.89	River	16.788	8.09
SpRp	-57.769	17.31	Forest	-9.165	4.98
PayCard	-83.192	17.85	Public	13.311	4.42
Conjoint	-74.028	14.44	Swim	-15.513	8.14
Phone	-15.253	4.28	OffRd	-17.366	12.23
Individ	-40.147	12.71	NoMtrbt	13.808	8.26
Zonal	-55.699	11.29	Bike	-14.306	8.54
RUM	-58.422	11.82	XSki	-5.937	3.72
Subs	-17.619	6.33	SnowMob	-20.919	9.31
Valunit	-9.072	3.92	BgHunt	15.387	3.72
Trend	0.980	0.47	WatFowl	9.894	4.29
FsAdmin	-17.822	3.70	Fish	7.057	4.31

R1	11.407	5.41	RockCl	62.027	17.66
Adjusted R^2	0.27	*F-stat*	*8.76*	*N*	701

Descriptions of the Meta-Analysis Variables are provided in Table 2. Unless otherwise noted, all variables are qualitative variables coded as '1' if the feature or activity applies and '0' otherwise.

Table 2. Explanation of the Rosenberger Meta-Analysis Variables (2001)

Variables	Description
Method	'1' if stated preference valuation approach was used, '0' if revealed preference approach
OE, ItBid, SpRP, PayCard, Conjoint	Features of the stated preference approach where OE is open ended elicitation, ItBid is iterative bidding, PayCard is payment card elicitation, SpRp is a study that combined stated and revealed preference methods and Conjoint is conjoint analysis.
Individ, Zonal, RUM, Subs	Features of the revealed preference study approach where Individ is an individual travel cost model, Zonal is a zonal travel cost model, RUM is a random utility model and subs indicates substitute sites included in the model.
Phone	Variable to indicate a telephone survey, a '0' value includes all other survey methods.
Valunit	'1' if consumer surplus was calculated per day in the original study,

	'0' otherwise
Trend	The year that the original estimate was recorded, codes as 1967=1, 1968=2…1996=30
FsAdmin	Variable for a site that is administered by the forest service.
R1, R4, R6, R8	Variables to indicate that the study site was located within a specific forest service region (geographic location of the site).
Lake, River, Forest	Variables for physical features of the site.
Public	Variable for sites located on public lands.
Offrd…RockCl	Variables for the relevant activity where Swim is swimming, OffRd is off-road driving, NoMtrbt is non-motorized boating, Bike is bicycling, Xski is cross-country skiing, SnowMob is snowmobiling, BgHunt is big-game hunting, WatFowl is waterfowl hunting, Fish is fishing and RockCl is rock climbing

From the original database of estimates used by Rosenberger and Loomis, we were able to use 58 that contained all of the information necessary to calculate our expected error statistic. In addition, we were able to find an additional 37 estimates from outside of the original meta-analysis sample. We therefore have a total of 95 data points from which to calculate our expected error of benefit transfer. The studies from which these data points were drawn are listed in Appendix A.

We calculated proportional errors of benefit transfer, as described in equation 5. The expected error of benefit function transfer in a setting where the values are from recreation activities and its standard error are presented in table 3 below.

Table 3. Expected error of benefit function transfer in a recreation setting

Statistic	Value
$\overline{E}_{BT}$	0.720
se_E	0.288

These values show us that the additional error created from using benefit transfer—or the value-added by original research—ranges from between 43.2 percent and 100.8 percent of the true benefits of the project being analyzed.

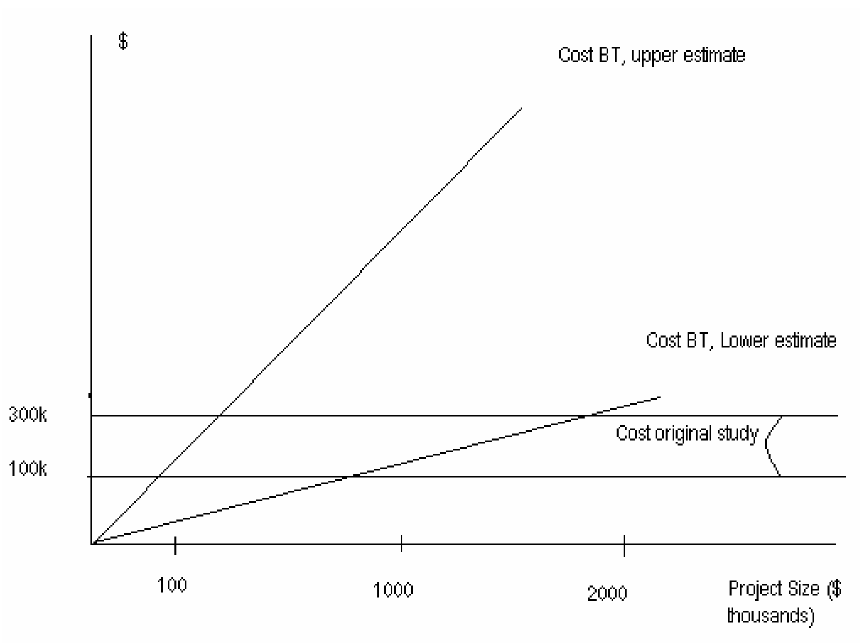
The next step in our analysis is to calculate the boundary project sizes above and below which original research is likely and unlikely (respectively) to return positive economic benefits. The reader will recall that these boundary sizes are based on an assumed cost of original research of between $100 thousand and $300 thousand and that between the two boundary values lies a range of project sizes for which we are uncertain of the sign of the economic benefits of original research. The calculation of the boundary project sizes is shown in equation 7 and then the results are shown graphically in figure 3.

Equation 7.

$$L = \frac{\$100{,}000}{0.720 + 1.96 * 0.288} = \$77{,}852.52$$

$$H = \frac{\$300{,}000}{0.720 - 1.96 * 0.288} = \$1{,}929{,}012.\ 34$$

Figure 3. Marginal Costs of Benefit Transfer and Original Research for Recreation Valuation



These results demonstrate that only small projects (those with rough benefits estimates of less than approximately $75 thousand) are unlikely to post positive economic benefits to original research. Even considering the uncertainty inherent in our method, we find it likely that positive economic returns will accrue to relatively small projects (those with rough benefits estimates of $2 million or more).

Conclusions

Benefit transfer techniques are becoming increasingly common as alternatives to original valuation research due to time and resource constraints. At the same time, it is generally understood that benefit transfer may not always be as accurate as original research in approximating the "true" value for a non-market good or service. There is therefore some need for an understanding of the additional value gained by doing original research and an ability to determine when such original research is likely to return positive economic benefits.

In this paper, we provided a technique for estimating the value of original research for a class of benefits, using this estimate to determine the expected returns in any particular case and determining for what sizes of projects such research is likely and unlikely to yield positive economic returns. We also provided a numerical example for recreation benefits estimate complete with the appropriate boundary values for project sizes for which original research is likely and unlikely to return positive benefits.

Future research extending our technique to other common benefits types and determining how the boundary project sizes vary across classes of benefits would be useful. Additionally, it would be interesting to apply the technique described here to benefit value transfer—a benefit transfer technique that may be more common than benefit function transfer.

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Appendix: Sources of estimates used in empirical example

Study	Number of Estimates
Adamowicz, Jennings and Coyne	2
Adams, et. al.	2
Baker	1
Balkan and Kahn	1
Barrick	1
Bergstrom and Cordell	1
Bergtsrom, et. al.	1
Bishop, Heberlein and Kealy	1
Bishop, et. al.	1
Duffield and Neher	3

Loomis and Feldman	3
Hay	43
McCollum and Miller	3
Moncur	1
Morey	1
Morey, Rowe and Watson	1
Mullen and Menz	1
Park, Loomis and Creel	1
Richards and Brown	1
Roberts, Thompson and Pawlyck	2
Rosenthal	1
Rosenthal and Walsh	1
Rowe, et. al.	1
Samples and Bishop	1
Shaw and Jakus	1
Siderelis, Brothers and Rea	3
Siderelis and Moore	2
SMS Research	1
Sorg, et. al.	1
Sorg and Nelson	1
Stoll and Johnson	2