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ANALYSIS

How reliable are meta-analyses for international benefit transfers?☆

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ABSTRACT

Meta-analysis has increasingly been used to synthesise the environmental valuation literature, but only a few test the use of these analyses for benefit transfer. These are typically based on national studies only. However, meta-analyses of valuation studies across countries are a potentially powerful tool for benefit transfer, especially for environmental goods where the domestic literature is scarce. We test the reliability of such international meta-analytic transfers, and find that even under conditions of homogeneity in valuation methods, cultural and institutional conditions across countries, and a meta-analysis with large explanatory power, the transfer errors could still be large. Further, international meta-analytic transfers do not on average perform better than simple value transfers averaging over domestic studies. Thus, we question whether the use of meta-analysis for practical benefit transfer achieves reliability gains justifying the increased effort. However, more meta-analytic benefit transfer tests should be performed for other environmental goods and other countries before discarding international meta-analysis as a tool for benefit transfer.

1. Introduction

Meta-analysis (MA) is now common in environmental economics and non-market valuation. Since Smith and Kaoru's (1990) seminal study of recreational benefits, MA has been conducted for a wide range of environmental goods, from wetlands (Woodward and Wui, 2001) to visibility (Smith and Osborne, 1996). Common to all of these studies is the focus on research synthesis and hypothesis testing, rather than on the more interesting policy question of how MA can be used to improve benefit transfer (BT) practices (Smith and Pattanayak, 2002). Meta-analytic benefit transfer (MA-BT) to unstudied sites ("policy sites") has only been cursory treated in the literature, typically a few pages add-ons at the end of lengthy MA papers, although authors emphasise its potential importance for future research and applications, for example in cost–benefit analysis (see the special issue on BT in Ecological Economics, 2006; Van Houtven et al., 2007). While there is some knowledge of how unit value and value function-based BT from single studies perform (Rosenberger and Phipps, 2007), Bergstrom and Taylor (2006, pp. 359) point out that "before widespread application of MA-BT models, there is a need for additional MA-BT validity tests across different types of natural resources and environmental commodities." Only a few studies have, to our knowledge, investigated the validity and reliability of

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MA-BT (Santos, 1998; Rosenberger and Loomis, 2000; Shrestha and Loomis, 2001, 2003; Santos, 2007; Shrestha et al., 2007). Four of the studies, however, are based on the same large dataset of use values for different recreational activities in the USA, and are unable to cover the breadth of issues involved in more typical MA-BT exercises, i.e. limited datasets, complex goods with significant non-use values, different level of methodological heterogeneity and mix of international studies to mention a few. Santos (2007) is the only study attempting a comprehensive comparison of two versions of a domestic MA-BT with simple BT techniques often used in practice. Further, all the above studies can be said to under-appreciate the potential impacts on the MA-BT performance of model specifications, values of methodological variables (Johnston et al., 2006) and other choices the meta-analyst needs to make (Hoehn, 2006)[1].

This paper aims to investigate the validity and reliability of international MA-BT of non-timber benefits based on a recently published MA of contingent valuation (CV) studies in Norway, Sweden and Finland (Lindhjem, 2007). Compared to previous research on MA-BT, our paper adds several new and interesting dimensions: (i) a more systematic and diverse testing of different MA-BT models, including comparisons with simple BT techniques, (ii) the good we investigate is complex and has substantial non-use values related to biodiversity (rather than mainly use values), (iii) data from three countries, which are similar culturally, economically, institutionally (e.g. people's right to walk in private forests), and in the way the good is perceived and used, and (iv) data are generally more homogenous methodologically since only CV studies are included. We investigate the transfer error (TE) of four different meta-regression model specifications, and use the best two models to compare MA-BT with simple unit value transfer techniques. A key question is whether MA-BT achieves reliability gains justifying the increased effort. As pointed out by Navrud and Ready (2007a, pp. 288): "Simple approaches should not be cast aside until we are confident that more complex approaches do perform better".

2. Validity and reliability of meta-analytic benefit transfer

2.1. *Underlying theory of MA-BT*

The simple underlying indirect utility function for a change from Q_0 to Q_1 in the quality/quantity vector describing an environmental good available to individual i is:

$$V_i(p_i, I_i, Q_0) = V_i(p_i, I_i - \text{WTP}, Q_1) \quad (1)$$

where P_i, I_i are a market price vector and income, respectively, and WTP is Willingness-to-Pay. Eq. (1) solved for WTP, yields the bid-function that forms the (often implicit) basis for any MA-BT exercise. Following Bergstrom and Taylor (2006), we further assume what they call a "weak structural utility theoretic" approach[2], i.e. that the underlying variables in the bid-function is assumed to be derivable from some unknown utility function, but that flexibility is maintained to introduce explanatory variables, such as study characteristics, into the WTP model that do not necessarily follow from (1). This is the approach used in most previous MA-BT exercises (for example Rosenberger and Loomis 2000, Shrestha and Loomis 2003). We specify a meta-model that captures j site characteristics X, k study or methodological characteristics M, l programme characteristics P, and q socio-economic characteristics S. Mean WTP estimate (long term, per household in Norwegian Kroner 2005) m from study s, WTP_{ms}, can then be defined as:

$$\text{WTP}_{ms} = \beta_0 + \beta_X X^j_{ms} + \beta_M M^k_{ms} + \beta_P P^1_{ms} + \beta_S S^q_{ms} + e_{ms} + u_s. \quad (2)$$

Where, β_0, β are constant term and parameter vectors for the explanatory variables, and e_{ms} and u_s are random error terms for the measurement and study levels, respectively. MA-BT involves estimating (2) based on previous studies, inserting values for X, P and S for the policy site under investigation, and choosing values for M (typically average of the meta-data, "best-practice" values or sample from a distribution — see e.g. Johnston et al. (2006)). The meta-model has several potential advantages for BT, compared to unit value transfer or function transfer based on a single study[3]. MA utilizes information from several studies providing more rigorous measures of central tendency that are sensitive to the underlying distribution of the study values (Rosenberger and Loomis 2000). Further, as specified in the model above, MA can control for study-specific choices of methodology, and finally it is possible to account for differences in site and programme characteristics between the policy site and the study sites in the meta-data, by setting these variable values equal to the policy site.

2.2. *Validity and reliability of BT*

Validity and reliability of BT can be explained using the concept of transfer error (TE), defined as:

$$\text{TE} = \frac{|\text{WTP}_T - \text{WTP}_B|}{\text{WTP}_B}, \quad (3)$$

where T = transferred (predicted) value from study site(s), B = estimated true value ("benchmark") at policy site. Validity[4] has traditionally required "that the values, or the value functions generated from the study site, be statistically identical to those estimated at the policy site" (Navrud and Ready, 2007b, pp. 7), i.e. that TE is statistically indistinguishable from zero. Most of the studies testing BT validity have used the same valuation methodology for similar goods nationally or internationally often resulting in high TE levels and rejection of the hypothesis of TE = 0 (see Rosenberger and Phipps (2007, Table 1) for an overview of results). For MA-BT, such tests are scarce. Rosenberger and Loomis (2000) use raw

[1] An alternative to the classical MA approach, not considered here, uses Bayesian modelling techniques to address some of these challenges (Moeltner et al., 2007).

[2] Bergstrom and Taylor (2006) categorise three main utility theoretic MA-BT approaches (of which only the first two are recommended): Strong, weak, and non-structural.

[3] The BT function from a single study, for individual i, is often specified as $\text{WTP}_i = a + bX_{ij} + cY_{ik} + e_i$, where X is site/good characteristics (j), Y respondent characteristics (k), e_j random error, and the number of observations is equal to the number of respondents (Brouwer, 2000).

[4] In the BT literature the term "convergent validity" is sometimes used.