Journal of Environmental Economics and Management 66 (2013) 90–104

Contents lists available at SciVerse ScienceDirect

Journal of Environmental Economics and Management

journal homepage: www.elsevier.com/locate/jeem

What can we learn from benefit transfer errors? Evidence from 20 years of research on convergent validity ☆

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ARTICLE INFO

Article history:
Received 30 September 2011
Available online 15 March 2013

Keywords:
Benefit transfer
Function transfer
Convergent validity
Meta-analysis

ABSTRACT

We develop a nonparametric approach to meta-analysis and use it to identify modeling decisions that affect benefit transfer errors. The meta-data describe the results from 31 empirical studies testing the convergent validity of benefit transfers. They evaluated numerous methodological procedures, collectively reporting 1071 transfer errors. Our meta-regressions identify several important findings, including: (1) the median absolute error is 39%; (2) function transfers outperform value transfers; (3) transfers describing environmental *quantity* generate lower transfer errors than transfers describing *quality* changes; (4) geographic site similarity is important for value transfers; (5) contingent valuation generates lower transfer errors than other valuation methods; and (6) combining data from multiple studies tends to reduce transfer errors.

1. Introduction

Benefit transfer is one of the most common methods for conducting benefit–cost analysis at the U.S. Environmental Protection Agency [36]. When it is too time-consuming or expensive to directly estimate the monetary benefits of a policy, a surrogate measure is produced from preexisting estimates. A benefit transfer takes preexisting values from a study case (or cases) to develop a customized benefit estimate for a new policy case.[1] A "value transfer" simply substitutes a point estimate from a previous study or, in some cases, the mean or median of several point estimates. A "function transfer" predicts benefits using a previously calibrated function describing how values vary with the characteristics of people and places [20].[2]

☆ We appreciate the helpful comments of V. Kerry Smith, JEEM editors Daniel J. Phaneuf and Christopher D. Timmins, and three anonymous referees. We also thank participants at several seminars for their comments. Courtney Mitchell provided excellent research assistance. This work was sponsored by EPA Grant no. RD-83345901-0.
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[1] We adopt the phrases *study case* and *policy case* from the U.S. EPA's 2010 *Guidelines for Preparing Economic Analyses* [36]. This is a change from the conventional terminology, *study site* and *policy site*. Benefits are not always transferred to new geographic sites. Some transfers occur at the same physical location, using past values to assess current situations or predict future outcomes. Thus, benefits may be transferred to a new policy case at the same study site or to a new policy case at a different site.
[2] Readers seeking background on concepts, terminology, and methods in the benefit transfer literature are directed to the surveys prepared by Bergstrom and Taylor [2], Boyle et al. [4], and Johnston and Rosenberger [16].

0095-0696/$ - see front matter
http://dx.doi.org/10.1016/j.jeem.2013.03.001

Since a 1992 issue of *Water Resources Research* (Vol. 28, 3) raised academic interest in benefit transfers among environmental economists, at least 40 studies have investigated the empirical accuracy of this method using tests of convergent validity, which considers the difference between two different estimates of the same theoretical construct. These tests are designed to measure benefit transfer error, defined as the difference between a benefit measure estimated using original data (i.e., the policy case) and a surrogate for that benefit measure based on preexisting estimates (i.e., the study cases). Two stylized facts have emerged. Function transfers generate lower transfer errors than value transfers, and greater similarity between the study and policy cases reduces transfer errors [4,16,17,29]. The apparent lack of consensus on other methodological features of the transfer process has made it difficult to define specific protocols for the conduct of benefit transfers and to develop a clear agenda for research. Johnston and Rosenberger [17] observe, the “complexity and relative disorganization of the (academic) literature may represent an obstacle to the use of updated (benefit-transfer) methods by practitioners.”

The purpose of this paper is to investigate if specific modeling decisions can be identified that affect benefit transfer errors, and this is done using a new statistical approach to meta-analysis. Our quantitative research design complements and extends previous qualitative assessments of the literature [29,30]. We begin by systematically reviewing empirical studies on the convergent validity of benefit transfers conducted over the past 20 years. These studies tested a tremendous variety of methodological procedures, collectively reporting *more than 1000* benefit transfer errors. Most of these observations come from studies conducted in the United States and Western Europe. The applications cover a wide variety of amenities. Examples include access to forest, park, and lake recreation; hunting; changes in the quantity and quality of water in lakes, rivers, and coastal areas; air quality; exposure to ultraviolet radiation; freshwater fishing in streams and rivers; proximity to various types of open space; farmland amenities; and measures of the overall ecological health of watersheds, wetlands, and rivers.

It is standard practice in meta-analyses to use linear meta-regressions with robust standard errors to distill the collective findings on important questions in the field of environmental economics [25]. However, we have some concerns about the credibility of a *linear* meta-regression in the context of our analysis. The modeling decisions that comprise a benefit transfer are represented by binary variables that can interact in complex ways to influence benefit transfer errors [3]. Any specific variable can have a unique effect on the outcome being investigated (meta-equation regressand) when combined with sets of other regressors. For example, similarity between study and policy cases may be crucial to the accuracy of a value transfer, but not as important for a function transfer that can be calibrated to policy case conditions. A statistical approach that allows for these interaction effects has the potential to provide richer insights about the literature being investigated. The typical linear meta-regression imposes separability of each of the regressors. Capturing all potential interaction effects would require adding an intractable number of regressors to the meta-equation. Therefore, we propose a new nonparametric approach to meta-analysis that does not impose the linearity and separability assumptions. We contrast the insights from our new approach with a conventional parametric approach.

Nonparametric meta-analysis is particularly useful for our application to benefit transfer because it avoids the need to impose a-priori restrictions on the functional relationship between benefit-transfer errors and the various modeling decisions that comprise the transfer process. The nonparametric approach generates response effects for the combination of regressors at every data point, which yields ranges of effects instead of the parametric point estimates of average impacts. This allows us to recognize that there are multiple possible effects for each transfer characteristic, with specific impacts depending on the empirical context defined by other methodological choices made by analysts in implementing a benefit transfer.

We follow Charles Manski's [21] “bottom-up” approach to data analysis where we start with the less restrictive nonparametric analysis and then move to a more restrictive parametric analysis. We use the nonparametric model to estimate the ranges of impacts for the benefit transfer characteristics that can be identified from variation in the meta-data. Then we add the linearity and separability restrictions that are commonly used in meta-regressions and repeat the estimation using weighted least squares. Following Manski's logic, we recognize that the credibility of inference based on our results is decreasing in the strength of the parametric restrictions that we impose on the meta-regression as findings may not be robust to relaxation of the imposed assumptions in the parametric analysis.

Our parametric and nonparametric models allow us to distill several important findings from the literature. First, our analysis confirms the stylized fact that function transfers outperform value transfers. Second, benefit transfers valuing changes in environmental *quality* (e.g. an increase in river clarity) almost always have larger errors than transfers describing *quantity* changes (e.g. an increase in the quantity of domestic water availability). Third, the geographic proximity of the study and policy locations tends to reduce transfer errors, especially for value transfers. Fourth, drawing on information from multiple preexisting studies (as opposed to a single study) also tends to reduce transfer errors, especially for function transfers. Lastly, for the stated-preference applications, contingent valuation generates lower transfer errors than choice modeling. For revealed preference applications, site demand models perform better than site choice models. Meta-analysis generates transfer errors that lie in between the stated and revealed preference models.

2. Conceptual framework

The process of benefit transfer begins by defining the relevant measure of benefits. Consider a public policy that is expected to change the quality of an environmental amenity from q^0 to q^1 at policy case j. A partial equilibrium Hicksian