



Methodological and Ideological Options

Choosing a Functional Form for an International Benefit Transfer: Evidence from a Nine-country Valuation Experiment

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ARTICLE INFO

Article history:

Received 27 April 2016

Received in revised form 6 January 2017

Accepted 7 January 2017

Available online 21 January 2017

JEL Classification:

Q51

Q53

Q25

Keywords:

Benefit transfer

Functional forms

Explanatory variables

Transfer errors

Minimum tolerance levels

International

Contingent valuation

Water quality

ABSTRACT

This paper investigates the performance of common approaches in international benefit transfer using data from identical and simultaneous contingent valuation studies on marine water quality in nine European countries. The environmental good is shared by the study countries, but the countries differ substantially in their income levels and other characteristics. We compare the performance of value transfers (with or without income elasticity of willingness to pay adjustments) and function transfers that include only core variables supported by economic theory. Our results point to a new source of uncertainty associated with function transfer – choosing a particular functional form. Even if only theoretically relevant explanatory variables are used, the theory offers no insights with respect to a functional relationship of the dependence (e.g., linear, log-linear, exponential, polynomial). We show that while different functional forms may offer improvements in model fit, this does not necessarily translate to improvements in transfer errors or minimum tolerance levels. In our case, the value transfer with constant (unit) income elasticity adjustment, corresponding to the log-log functional relationship between willingness to pay and income, performs the best. Including additional explanatory variables or using other functional forms worsens the quality of transfers. Overall, our study questions the rationale for using more complicated function transfers in international benefit transfers, as the relationships observed within a country or a group of countries does not necessarily translate to dependencies between countries.

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1. Introduction

It is generally accepted that using benefit transfer (BT), which refers to the use of existing primary value estimates from a 'study' site to predict welfare estimates for an unstudied 'policy' site, is in many cases without alternatives. Often, resources for primary studies are lacking or value estimates are needed in a very short time span; BT is therefore the most frequently applied non-market valuation method, particularly for practical policy applications (Johnston et al., 2015a). Moreover, the prospects for future use look strong as demand for BT is likely to increase, particularly in the context of ecosystem service valuation (Richardson et al., 2015). How to improve the validity and reliability of BT is therefore one of the most important and under-researched questions of contemporary ecological economics.

While certain conditions under which BT is more reliable have been identified (see e.g., Kaul et al., 2013), a significant uncertainty remains with respect to how to ensure the accuracy of transferred value estimates in various conditions. In particular, a subject of an ongoing debate is whether it is useful to identify the characteristics influencing value estimates at the study site that could be used to predict values at the policy site (*function transfer*), or does the approach in which an overall value is transferred (*value transfer*) perform better.¹ After all, if the former offers a better opportunity to control for the differences in sociodemographic characteristics, why would it ever fail to perform better than the latter? While several explanations for this phenomenon have already been proposed in the literature, including cultural differences (Ready et al., 2004) or using ad hoc explanatory variables, rather than only those

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¹ It is worth noting that function transfer can be used for more than just socio-economic adjustments. Another primary purpose of using benefit function transfer in taking the scope or scale of environmental quality or quantity changes into account (Rolfe and Wang, 2011; Johnston et al., 2015a, Johnston et al., 2015b). In this paper, we focus on the ability to control for socio-demographic differences.

suggested by the general economic theoretic principles (Bateman et al., 2011), we focus on the importance of selecting an appropriate functional form for out-of-sample predictions.

Applying BT across countries causes specific problems (Ready and Navrud, 2006; Lindhjem and Navrud, 2008; Johnston and Rosenberger, 2010).² Navrud and Ready (2007) and Czajkowski and Ščasný (2010) argue for correctly considering income differences – one of the most important observable drivers of value estimates. Bateman et al. (2011) reason that transfer functions should incorporate only explanatory variables suggested by the general economic theoretic principles, rather than all variables, which may increase function fit but not necessarily accuracy of transfers. Hynes et al. (2013a) investigated the effect of adjusting for cultural differences on transfer errors (TE) in international BT but find that after controlling for the difference in incomes, the impact of cultural adjustments was small. Overall, however, as noted also by Johnston and Rosenberger (2010), the results of studies investigating international BT provide a mixed message, with some assessments finding that it passes convergent validity tests (e.g., Shrestha and Loomis, 2003; Czajkowski and Ščasný, 2010; Bateman et al., 2011), others observing significant differences (e.g., Muthke and Holm-Mueller, 2004; Brouwer and Bateman, 2005; Lindhjem and Navrud, 2008), and still other studies concluding that applying meta-analysis is promising (Johnston and Thomassin, 2010; Londoño and Johnston, 2012).

In this study, we provide evidence of the performance of international BT approaches by transferring values between nine European countries. Building on the suggestions of Bateman et al. (2011) and Czajkowski and Ščasný (2010), we compare the performance of different BT approaches through examining TE and the minimum tolerance levels (MTL).³ We compare both unit value transfers, using adjustments based on the assumption of a constant income elasticity of WTP, and function transfers with one or more explanatory variables reflecting the theoretic principles identified in the earlier literature (Bateman et al., 2011) also paying heed to the various options of functional relationships (linear, log-linear, exponential, polynomial).

The data come from an internationally coordinated contingent valuation (CV) study on the benefits of reaching good environmental status in the Baltic Sea – a policy target that includes eutrophication in marine waters. The survey was conducted simultaneously in all of the coastal states around the sea, resulting in >10,500 completed responses. The dataset includes a larger number of countries and observations than previous international BT tests and thus offers an opportunity for a more robust comparison. Moreover, the important characteristic of our study is that the valued good is identical⁴ for all respondents (“water quality in the Baltic Sea”). This eliminates, at least to some extent, differences across sites that are generally a concern for BT studies. This setting provides promising grounds for testing the performance of different approaches to international BT.

Overall, we find that while using more flexible functional forms or including additional theory-driven explanatory variables (Bateman et al., 2011) may offer improvements in model fit, it does not necessarily translate to improvements in TE or MTL. This is likely because observing a particular relationship within a country (or group of countries) does not readily translate to relationships between countries. In our case, the quick and easy value transfer with constant (unit) income elasticity adjustment, corresponding to the log-log functional relationship

between willingness to pay (WTP) and income,⁵ performed the best. In general, our results question the rationale for using more complicated function transfers in international BT, particularly because there is no theoretical guidance for selecting the functional form, and the approach based on maximizing the model fit does not necessarily result in the best performance of transfers.

2. Previous Benefit Transfer Studies Using the Same Survey Instrument

Previous studies on the performance of international BT that have used the same survey instrument are relatively rare.⁶ The available comparisons use data from two (Barton and Mourato, 2003; Muthke and Holm-Mueller, 2004; Rozan, 2004; Abou-Ali and Belhaj, 2005; Andreopoulos and Damigos, 2017), three (Kristofersson and Navrud, 2007; Brouwer et al., 2015; Kosenius and Ollikainen, 2015), four (Brouwer and Bateman, 2005) or five countries (Ready et al., 2004; Bateman et al., 2011) finding TE in the range of 20 to 400%, depending on the approach and the similarity of the countries. Rozan (2004) suggested using a BT approach only if TE of 30% or more is acceptable. Kristofersson and Navrud (2007) noted that the accuracy relies heavily on the similarity of the populations and improvement scenarios used in each country.

Many of the earlier BT studies found that accounting for socio-demographic differences, and income levels in particular, leads to the reduction of the observed TE. For example, Rosenberger (2015) summarizes 38 studies examining BT errors, and finds that median TE is lower in function transfer (36%) than in unit value transfer (45%). These results are consistent with the findings of Kaul et al. (2013) or Brouwer et al. (2015). However, transferring a function (which is theoretically able to account for many socio-demographic differences) does not *always* lead to better performance than simple value transfer (e.g., Ready et al., 2004; Brouwer and Bateman, 2005; Johnston and Duke, 2010), particularly when value transfers utilize the income elasticity correction approach (e.g., Barton, 2002; Muthke and Holm-Mueller, 2004; Andreopoulos and Damigos, 2017). This lack of improvement has been attributed to cultural differences (Ready et al., 2004; Hynes et al., 2013a) or including explanatory variables which are dictated by their statistical significance, rather than prior, theory-driven expectations (Bateman et al., 2011).⁷ We show that, perhaps in addition to these considerations, the performance of transfers greatly depends on the assumptions about the functional form of the relationships between WTP and explanatory variables.

The importance of the functional form assumptions has been suggested as one of the problematic issues of the BT before (e.g., Carson et al., 2015; Whitehead et al., 2015) and it is generally understood that BT results are sensitive to modeling assumptions (Johnston et al., 2015a). For this reason, good-quality studies often use different functional forms for sensitivity analysis (e.g., Lindhjem and Navrud, 2011; Skuras, 2016). The importance of the functional form can also be related to the suggestion that simple value transfers are preferred when transfers involve similar sites, but function transfers lead to better performance with dissimilar sites (Brouwer and Bateman, 2005; Bateman et al., 2011) – the failure of function transfer to provide even a modest improvement for similar sites could be a result of incorrect functional form specification (particularly with respect to income elasticity; Milligan et al., 2014).

² One of the unique challenges of international BT is the need to correct for differences in currencies (Navrud, 2004), which are typically made commensurate using either market-based (nominal) or purchasing power parity (PPP) corrected exchange rates (Ready et al., 2004).

³ The minimum tolerance level is the minimum difference that would result in the rejection of the null hypothesis of equivalence of two values. This measure is superior to simple transfer error because, in addition to looking at the difference in the values, it also considers the uncertainty with which they are known (Kristofersson and Navrud, 2005; Czajkowski and Ščasný, 2010).

⁴ Identical in terms of what the survey portrayed to the respondents.

⁵ This is equivalent to assuming that respondents are willing to spend a constant share of their income on the good that is valued.

⁶ As the present paper concerns an international BT based on data originating from using the same survey instrument, we confine this review to studies employing the same survey instrument in each country. Hence, studies that have used meta-analysis for international BT (e.g., Lindhjem and Navrud, 2008; Hynes et al., 2013b; Lindhjem and Navrud, 2015) are not explicitly considered here.

⁷ For the theoretical discussion of the ability of socio-demographic variables to account for WTP differences in BT and their importance for validity testing see Brouwer (2000) and Spash and Vatn (2006).

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