The transfer of benefit measures: the applicability conditions and the results

Giuseppe Stellin, Alice Candido[1]
DIMEG, University of Padua - Italy

Abstract

The benefit transfer refers to the use and adaptation of benefit measures obtained for a specific site (study site), to assess the benefits in another site (policy site), for which no original valuation is possible. Relying on relatively simplicity of application, and allowing saving time and money for the implementation, it represents a 'second best' solution and a valid alternative to the disregarding environmental economic values. The literature broadly agrees in considering two main approaches to benefit transfer: the transfer of a value or of a benefit function. The choice of the more suitable approach relies on the number of potential primary studies, the similarity degree between the study and the policy sites, on the purposes of the assessment and on the accuracy required. In this paper, the phases of conducting benefit transfer are outlined, highlighting the conditions for the transfer process and its limitations. Finally, the possible transfer errors related to incorrect transfer are reported and discussed.

Keywords: benefit measures, transfer, similarity conditions, validity tests, transfer error.

1. Introduction

In some valuation processes involving changes in the environment, such as in Cost-Benefit Analysis or regulatory policy, the need to have quickly responses about estimate values might not allow a time consuming and costly primary research.
The benefit transfer represents a 'second best' solution and a valid alternative to disregarding environmental values, saving time and money for the implementation (Rosenberger and Loomis, 2001). It refers to the use and adaptation of benefit measures obtained for a specific site – the study site – with primary research, to assess the benefits in another site – the policy site – (Desvousges et al., 1992). The flexibility represents one of the characteristic features of the transfer process, since it can be used both to estimate welfare measures when a primary research cannot be performed, and as a scoping study – a preliminary research to investigate weather a primary research is needed or not[2] (Pearce et al., 2004).
In the United States the rapid increase in the number of non-market valuation studies during the last years facilitated the widespread of benefit transfer even though the transfer process and its results are not completely defined. So far, univocal results on the accuracy of benefit transfer do not exist, and a need for guidelines is rising up due both to the high cost and the lead time involved in conducting primary research, and the future increase of demand of non-market valuation.

[1] Alice Candido is PhD in 'Real Estate Appraisal and Land Economics'; Giuseppe Stellin is Full Professor at the Faculty of Engineering at the University of Padua.
[2] As an inexpensive and relatively simple tool, the use of the benefit transfer approach has been recommended in the United States during the 1980s for the purpose of Cost-Benefit Analysis of environmental policies by several US government agencies, such as the U.S. Water Resources Council, the U.S. Forest Service, the U.S. Army Corps of Engineers, the Environmental Protection Agency. The National Oceanic and Atmospheric Administration allows the use of benefit transfer for Natural Resource Damage Assessment (NRDA) as a valuation method in determining the scale of projects required to compensate the public, on the same level of stated and revealed methods or a combination of them (NOAA, 1994). For a review of the use of benefit transfer in US and Canada see Desvousges et al. (1998) and Bergstrom and De Civita (1999 and 2001).

In the following sections, the benefit transfer approaches will be presented (Section 2), highlighting the conditions for and the limitations of their employment; furthermore, the steps to perform the transfer methods will be outlined. The results of validity tests available in literature will be presented in Section 3 and discussed in Sections 4, according to the transfer error.

2. The benefit transfer approach

Relying on the available primary research and the required conditions for the transfer, the literature considers two main approaches to the benefit transfer: the value transfer and the benefit function transfer. The value transfer approach entails the direct application of summary statistics from primary research to the policy context under restrictive conditions. Under less restrictive assumptions, it is possible to apply the benefit function approach, where the statistical function or model relating the summary statistics of primary studies to the specific context is adjusted and transferred to the policy context. The choice of the most suitable approach to adopt for each specific case relies on the purposes of the assessment and the accuracy required, on the characteristics of the study and the policy sites, and on available primary research.
Let's assume that a value V_S for the study site is available, broadly referred to a welfare measure. V_P represents the value needed at the policy site, for which no primary valuation is possible at the moment. When applied to the policy site, the study site value V_S becomes the transferred value V_T:

$$V_S \rightarrow V_T$$

Rarely the transferred value will be specific for the policy site without any type of adjustment; this will only be the case where study and policy sites are similar and thus the value measure V_S can be assumed to be equal to V_P. In all other circumstances, this unadjusted transfer results more inaccurate as the differences between sites arise. A further issue that arises when attempting benefit transfer is the stability of benefits over time. Benefit transfer presumes that such stability exists by assuming that preferences do not change in different time periods. However, when transferring a benefit estimate, the researcher has to consider that the temporality or stability of data and welfare measures might vary across time according to the type of good, its scarcity, and the system of preferences and tastes of individuals (Loomis, 1992).

2.1 The conditions for the transfer

The transferability of benefits has to be tested by verifying rigorous conditions. Indeed, differences in site features and their geographical size can affect population characteristics, preferences and the extent of market, especially when the transfer is performed throughout different countries (international transfer). The "Similarity Principle", that is similarity between study (S) and policy (P) sites about the valued good, site and population features and the extent of the market, involves the equality of welfare estimates and thus their transferability. In detail, the strict similarity refers to:
1) same public good, in terms of:
- resources and/or services;
- baseline level of quality or quantity of the good ($q_{0S} = q_{0P}$) and change[3] ($\Delta q_S = \Delta q_P$);
- site characteristics vectors ($s_S = s_P$);

2) same features of affected population:
- vector of characteristic ($z_S = z_P$), such as age and gender, and income ($y_P = y_P$);
- attitudes, tastes and perception of environmental issues;

3) same market:
- size and extent of the expected effects of the change;
- prices ($p_S = p_P$) and eventual substitute prices ($subp_S = subp_P$)

[3] Even though the change in environmental quality or quantity is the same between sites, the different baseline level could yield different relative changes perceived by respondents, above all in situation where international transfer is performed between countries (Kristoffersson and Navrud, 2001).

- goods supply;

4) same estimate value:
- type of welfare measure to be valued;
- components of the total economic value;

Only when those restrictive conditions are completely satisfied, the reasonable assumption is that the value for the policy site is equal to that of the study site and the benefit transfer is supposed to be valid. When it is not, as in the most real situations, the differences between sites have to be considered in the transfer process, and in case adjusted.

2.2 The limits

Due to those advantages and the relatively simplicity of application, the transfer process has been widely adopted in literature. However, the benefit transfer faces several limitations that can mine the validity and reliability of the results[4]. First, the transfer of a welfare measure can be as accurate as the original estimate; this involves the judgment about the quality of the original studies to transfer, since the transfer cannot provide more accurate estimates than the original ones. Second, the validity and reliability of the transfer are strictly connected to the researcher's judgement about the transferability conditions. On third, the employment of the benefit transfer requires the previous definition of the accuracy level needed for assessment purposes, which is linked to the acceptable uncertainty.

2.3 The phases

Several authors outline the general phases of conducting benefit transfer; broadly, the following five main steps are expected to be consistent with different approaches (Boyle and Bergstrom, 1992; Brouwer, 2000; Rosemberger and Loomis, 2003):

Step 1
Characterize the policy context, in case by collecting primary data about variables determining value individuals place on goods. In some cases, the use of secondary information or proxy variables, such as census average values for income, gender or age, can help in this step.

Step 2
Search for primary studies, that is collecting benefit measures obtained for similar sites to transfer. Unfortunately, the main issue in this step is that most of the published primary research is not conducted for benefit transfer purposes, and thus do not report the necessary information because of length constrains or publishing requirements.

Step 3
Screening of potential primary studies under the Similarity Principle. Knowledge of information about the policy site shall help in screening primary researches available in literature and, when possible, improve the transfer process.

Step 4
Select and perform the benefit transfer method. The choice between benefit transfer approaches is based both on information about policy and study sites and on the available literature.

Step 5
Once the estimate value for the policy site is obtained, it shall be extended to beneficiaries. Desvousges *et al.* (1998) identify three independent components of the relevant market which have to be identified for transfer purposes: the geographic extent, the affected individuals or subjects, and the availability of substitutes.

[4] The concepts of validity and reliability, though strictly connected, refer to specific issues. The validity of a transfer implies non-biases in measuring the 'true' benefits at the policy site by transferring benefit estimates from the study site. The reliability refers to the variance of replicated transfer estimates for a specific site, and is performed using confidence intervals around the predicted benefit estimates (Desvousges et al., 1992; Boyle and Bergstrom, 1992).

Obviously, those steps can be performed in a different order or simultaneously, with consistency requiring that the early steps be made knowing the later ones. The process is an iterative one involving a circle of preliminary assessments and hypotheses, which have to be revised and updated with new information.

2.4 The methods

The conditions, advantages and disadvantages of implementation of the methods are broadly discussed in this section. Throughout this discussion, we will assume that the primary studies are of high quality and that the estimates of the benefits that they produce are unbiased for the true values. Whenever an estimate value is used and transferred to another site, an implicit degree of judgment is required, starting from the choice of the primary studies, the definition of the similarities, the choice of the transfer method to perform and to the interpretation of results.
When the value transfer relies on the transfer of a benefit measure obtained for a single study, the *unit value transfer* is performed. Given the assessment needs for the policy site, this transfer method can be employed when all the similarity criteria are satisfied for a primary study. Thus, the study site estimate provides a statistically unbiased estimate of the policy site value (Boyle and Bergstrom, 1992):

$$\mu_S = \mu_P$$

where μ_S is the true average (mean or median) benefit at the study site given its characteristics, and μ_P is the true average benefit at the policy site.
The *average value transfer* method consists in using a measure of central tendency (such as mean value, median value or 95% confidence interval) of all or a subset of selected existing values for study sites to estimate benefit at the policy site, rather then using a range of unit value estimates (Rosenberger and Loomis, 2001). The conditions on similarity criteria have to be satisfied for all the primary studies as for unit value transfer. This method assumes that the average value from the study sites measures is unbiased for the benefits at the policy site. Formally:

$$\overline{\mu}_S = \mu_P$$

where $\overline{\mu}_S$ is a measure of central tendency for all or a subset of study site benefit measures reported in literature and expressed in common unit relevant to the policy site, and μ_P is the true value at the policy site. Due to the small number of study site estimates for a specific environmental good or commodity and the broad range of these estimates, the confidence interval can be very large (Rosenberger and Loomis, 2003).
The transfer of a simple unit value can face different problems, dealing with differences between sites, population or site characteristics. Some authors consider an adjustment of the unit value to transfer (*adjusted unit value*) accounting for distinction of the two sites, the change in environmental quality or quantity, different socio-economic characteristics of population, and/or different availability of substitute goods and services (Bergland *et al.*, 2002).
As example, let's consider the case where the change amount is different for the study and the policy site ($\Delta q_S \neq \Delta q_P$). Under constrain of all other criteria satisfaction and of small and localized changes, i.e. the benefit estimate can be considered constant across different levels of environmental quality or quantity, the adjusted unit value at the policy site would be expressed as:

$$\mu_S \cdot \frac{\Delta q_P}{\Delta q_S} = \mu_P$$

where Δq_S is the change in quality or quantity of environmental good at the study site and Δq_P is the change at the policy site. The implicit assumption is that the proportional adjustment for the proposed environmental quality at the study site is adequate.

When the transfer is performed between countries characterised by different income levels and standards of living, specific adjustments are necessary to convert welfare measures in common currency and to consider inflation[5].

Most of times the similarity degree among studies is relatively low, due not only to the wide range of different environmental good being valued and their quality or quantity level, but also to the differences between population characteristics and attitudes toward these goods, or the market in which they are placed. To overcome this issue, the entire benefit function estimated at the study site can be transferred to the policy site. By this way, the benefit function is adapted to the new context to fit the specifics of the policy site when population characteristics, level or change of the environmental good or market are different from those of the study site. A necessary condition for a valid benefit function transfer is that factors influencing preferences at different sites are accounted for in the benefit function and that the size of their impact coincide (Brower and Spaninks, 1999). These specifics involve more rigorous requirements for literature search, as only studies reporting the entire benefit function can be chosen.

Let suppose that only one potentially transferable primary study is found, in which the population shares the same tastes for income and environmental quality as in the policy context but is different in terms of observables, or reports differences in the environmental good or in site features. In this case, as in others in which dissimilarities between study and policy site are present and can be accounted for, using value transfer approach leads to insensitive or less robust transfer because of its invariance to differences between population and/or sites (Rosenberger and Loomis, 2001). The transfer of an appropriate benefit function is preferred to the transfer of unit values because effectively more information about the good, population or site characteristics can be transferred and yield more robust estimates (Pearce *et al.*, 1994). The implicit assumption in adopting the *demand function transfer* is that statistical relationships (regression coefficients) between the dependent variables at the study site are the same at the policy site[6].

A generic willingness to pay (WTP) function obtained by Contingent Valuation Method can be expressed as:

$$WTP = \hat{\mu} + \hat{\alpha} \cdot \Delta q + \hat{\beta} \cdot z + \hat{\gamma} \cdot y + \hat{\delta} \cdot s + \varepsilon$$

where Δq is the environmental change, z is the vector of population characteristics, y is the income level, s is the vector of site characteristics, $\hat{\mu}, \hat{\alpha}, \hat{\beta}, \hat{\gamma}, \hat{\delta}$ are the function parameters estimated for the study site, and ε is the random term expressing the preferences component known to the respondent but unknown to the observer.

The demand function transfer can however have disadvantages. The quality of the parameters estimates may vary across studies and many studies do not estimate all the necessary parameters; in most cases, in fact, some factors that could be important for the policy site may not have been considered in the study site and vice versa.

In performing demand transfer function, dissimilarities between sites, markets and population characteristics can be accounted for, given the same individual's tastes and attitudes, when the original benefit function includes those variables. However, in a single benefit function, the lack of variation in some independent variables implies their exclusion from the model. To overcome this issue, the choice of similar sites with reference to those variables is recommended.

Another solution is provided in case where different benefit functions are estimated for the same good or service, but referred to different sites. All the survey data referred to the sites can be pooled together and a new benefit function, demand or WTP function, can be estimated (*pooled model transfer*). Pooled models incorporate variations in site characteristics, yielding a common function to be

[5] In case of international transfer, some authors recommend the use of the purchasing power parity index (PPPI), i.e. the ratio of the weighted average price of a basket of goods between the two countries, instead of the exchange rate to account for space differences (Pattanayah et al., 2002; Ready et al., 2004).

[6] Several studies on reliability and validity tests however show that it may be false especially for international transfer, where differences in tastes and individual's perception are present (Rosenberger and Loomis, 2003; Rozan, 2004; Muthke and Holm-Mueller, 2004).

transferred to the policy site, considered as a linear combination of characteristics of existing sites (Loomis, 1992).
A generic benefit function obtained by pooling data can be expresses as:

$$WTP = \hat{\mu} + \hat{\alpha} \cdot \Delta q + \hat{\beta} \cdot z + \hat{\gamma} \cdot y + \hat{\delta} \cdot s + \hat{\varphi} \cdot q_P + \varepsilon$$

where $\hat{\varphi}$ is the function coefficient relative to the environmental quality level of the sites q_P, and the other parameters and variables are as previously defined.
If the model specification includes all the relevant explanatory variables in the correct functional form, than it can explain the variation in benefit. The adjustment of the variables contained in the pooled model enables the compensation for differences between the study and policy sites characteristics; this yields more robust function transfer model and less error, improving the transfer accuracy (Rosenberger and Loomis, 2003).
The need of considering variations in site, population characteristics and methodological specifications, constant within a single study but different across studies, can arise some issues in transferring a benefit function. The use of meta-analysis can help in this issue because it allows the identification of the individual effects those variables have on research outcomes (*meta-analysis function transfer*).
The generic meta-analysis function can be expresses as a linear function of the dependent variables (even though non linear model can be considered) like the one adopted for demand function or pooled model, but with added independent variables controlling the characteristics of each original study. In particular, the meta-analysis benefit equation relates the dependent variable, that is the primary summary statistic, to site, population characteristics and methodological specifications:

$$WTP = \hat{\mu} + \hat{\alpha} \cdot \Delta q + \hat{\beta} \cdot z + \hat{\gamma} \cdot y + \hat{\delta} \cdot s + \hat{\varphi} \cdot q_P + \hat{\vartheta} \cdot M + \varepsilon$$

where *M* is the variable considering methodological characteristic of the study, such as stated or revealed preferences, method, elicitation format, response rate variables included in the model, functional form, and others, and $\hat{\vartheta}$ is the related meta-analysis function coefficient; the other variables and parameters are as previously defined.
Meta-analysis can be employed in benefit transfer with some advantages (Shresta and Loomis, 2001). First, it utilizes information from a great number of studies with a common underlying distribution and thus provide more rigorous measures of central tendency. Second, it allows the control of methodological differences among primary studies. Finally, it potentially considers differences between the study and the policy site by setting the level of the independent variables specific to match the policy site. When this is not possible, the methodological variables and other variables of the meta-regression function unknown at the policy site can be set equal to the means of the respective meta-variables; the derived benefit value for the new policy site is thus consistent with the existing literature values or set equal to currently accepted best practice. However, there are also some limitations in employing meta-analysis for benefit transfer purposes. First, meta-analysis of primary studies can be as good as the quality of original studies, as for other transfer approaches. Second, a wide number of original studies are needed in order to make statistical inferences; this can origin the problem concerning the quantity rather than the quality of primary studies. Third, the original studies have to be combined and statistically analysed and a certain degree of similarity is thus necessary in content and context.

3. Validity tests and transfer error

In the United States, benefit transfer has been widely employed for several years in regulatory policies, Cost - Benefit Analysis and in natural resource damage assessment. As previously defined, however, the success of the transfer relies both on the demand of the analysis task, the quality and quantity of available information, on the level of complexity at which the information is transferred, and on the required level of accuracy needed. In order to improve the performance, the different transfer approaches have been of academic interest about their applicability for different uses. These studies focus on issues about the transferability conditions (degree of similarities between sites), the statistical similarity of function parameters and the range of transfer error.

Since the publication of a special issue of Water Resource Research (1992), a great number of validity and reliability study on benefit transfer were conducted. Rosenberger and Loomis (2003), Brouwer (2000) and Brouwer and Spaninks (1999) provide a literature review of some of those studies, and, according to Bergland *et al.* (1995), they all agree stating that no one of the studies unequivocally confirm the validity of benefit transfer.

The transfer errors ranges from 0% to 577% for unit value transfer, and from 0% to 475% for benefit transfer, involving the belief that the benefit transfer approach is not reliable at all. In those cases, however, the authors do not respect the similarity principle in choosing primary studies and performing the transfer, and they do not consider under which conditions the transfer is performed. A further cause of such an error is the lack of following the protocol when testing the validity of the transfer: the right way to perform validity tests is to conduct the same primary study for both study and policy sites under controlled conditions, and then compare their results. In detail, the validity of value and benefit function transfer has to be tested under specific working hypothesis concerning the equality of the benefit measure for policy and study sites (Bergland et al., 1995; Brouwer and Spaninks, 1999), even though Kristoffersson and Navrud (2005) argue using equivalence tests rather than equality tests. More precisely, the authors state that the non-rejection of the classical equality null hypotheses could not be sufficient for a valid benefit transfer, as it is strictly connected to the validity of the assumption of equality and testing methodologies. Given the dependence of WTP values from type, quantity and quality of environmental good, population characteristics, attitudes and tastes, prices of market and substitute goods, the most plausible null hypothesis being tested should concern the difference between WTP values in different contexts. Only when all the similarity criteria are completely satisfied, indeed, the equality of the WTP values at the study and policy sites is the most probable state of the world. The non-rejection of the classical equality null hypothesis could be due to poor or weak methodology of performed tests, such as involving small sample sizes or a great variance of WTP estimates. In equivalence tests, the introduction of a limit of tolerance Δ, representing the maximum difference between the true and the transferred WTP values that can be accepted, is necessary. Δ represents the defined error level that is considered negligible or policy insignificant when transferring a benefit measure, stating the equivalence between the two measures. Formally, the working hypothesis becomes the alternative hypothesis:

$$H_A: \left|\overline{WTP}_{SS} - \overline{WTP}_{PP}\right| < \Delta$$

The corresponding null hypothesis testing if the values are different (non equivalence) is:

$$H_0: \left|\overline{WTP}_{SS} - \overline{WTP}_{PP}\right| \geq \Delta$$

The rejection of the non equivalence null hypothesis involves the acceptance of the working hypothesis H_A and thus the equivalence of the two measures within the tolerance limit Δ. The non-rejection of the null hypothesis can only state that H_A has not been shown to be true; further classical equality tests could be carried out to test if the null hypothesis is not rejected because of the equality of values.

In the mostly accepted literature, the working hypotheses of equality tests define the null hypotheses (H_0) that have to be accepted for valid value transfer; thus, a rejection of the null hypothesis is interpreted as evidence against the validity of the transfer since it implies the statistical difference between the two benefit measures[7]. Empirical tests in the literature testing the validity of transfer can be grouped into two categories, even though French and Hitzhusen (2001) state they both are applications of meta-analysis process (Boyle and Bergstrom, 1992; Bergstrom, 1996; Desvousges *et al.*, 1998; Bergstrom and De Civita, 1999):

[7] However, when extremely poor survey conditions for the primary study (such as poor definition of the valuation scenario, large measurement error or small sample size) increase the variance of WTP and parameters estimates, the likelihood that the equality hypothesis will not be rejected will increase, although transfer error are substantial (Barton, 2002).

- *convergent validity tests* accounting for statistically similarities between estimates and parameters obtained by transferring information to the policy sites and those obtained at the policy site from primary studies. When the two sets of benefit estimates are statistically similar then the convergent validity of the transfer is presumed; on the other hand, when they are not, the extent and the direction of biases should be determined and, when possible, adjusted (Kirchhoff *et al.*, 1997);
- *value surface tests* consisting in valuation models based on available previous literature and obtained either by pooling raw data across sites, through meta-analysis or other aggregation models such as preference function calibration; the assumption underlying this test is that a valuation equation exists and determines valuation equations both for the study and the policy sites.

The transfer error is a measure of the accuracy of the benefit transfer estimates, and it is broadly expressed as absolute percent error:

$$\%\delta = \left(\frac{V_T - V_t}{V_t} \right) \cdot 100$$

where V_T is the transferred value, and V_t is the true value for the policy site. Here general terms V_T and V_t are used to account for different benefit transfer approaches, valuation methods and thus welfare measure tested. However, the adoption of a percentage error as an indicator of the performance of benefit transfer does not allow considering the variance of the primary estimates; moreover, in cases when the estimate value at the policy site is small, the likelihood that the error is large increases even though absolute differences are small (Engel, 2002). For this reason, Kirchhoff *et al.* (1997) suggest to check if the transferred value falls into appropriate confidence interval for the primary estimate.

4. Discussion and results

The results of validity tests available in literature, concerning the transfer of benefit measures obtained by Travel Cost (TC) and Contingent Valuation (CV) methods are reported in the following table. It highlights the transfer approach performed, and the transfer error related to the differences in terms of environmental good, population, site and adopted methodology. Even though some authors suggest the value transfer approach when little policy site information is available, this yields high transfer error. The value transfer approach implies knowledge of policy site characteristics, at least secondary data, in order to choose a primary study satisfying all similarity conditions. On the contrary, when knowledge of policy context is available and the sites are different, the transfer should account for those differences, yielding in most cases more accurate results (Barton, 2002). Benefit function transfer offers a better condition for valid transfer, even though in real benefit transfer many factors can affect the results. Information about explanatory variables could not be available for the study and the policy sites, as well as the coefficients for the primary research function. Even when a benefit function for the study site is available, it is necessary to test the conditions for transferability by verifying that the same explanatory variables influence the welfare measures at the policy site, and that adequate data can be collected.

The adoption of benefit function transfer, even though the null hypothesis is rejected in almost all cases, yields lower mean transfer error than the value transfer does. This is true when differences in population and site characteristics are controlled, given the same environmental good, with approximately the same baseline level and the same environmental change (Loomis, 1992; Bergland *et al.*, 1995; Brouwer and Spaninks, 1999; Muthke and Holm-Mueller, 2004). Excluding Downing and Otzuna (1996), Kirchhoff *et al.* (1997), and the international transfer of Muthke and Holm-Mueller (2004), the mean value transfer error is greater than the mean benefit function transfer error: for the value transfer it is lower than 35%, while for the benefit function transfer it is lower than 30%. An explanation of such a transfer error of about 30% is that important explanatory variables, which could yield high error in the transfer if neglected, were included in the specific WTP model. Environmental attitudes generally play an important role in respondents' WTP values in addition to socioeconomic characteristics, good and site characteristics (Jiang *et al.*, 2004). Bergland *et al.* (1995) consider differences in population attitudes, but the differences in the recreational uses of the two watercourses were not accounted for, yielding a mean benefit function transfer error of 30%. In general, benefit

function transfer tend to perform better when based on multi-site models than when using single-site models (Engel, 2002).
When analysing these results, however, an exception is highlighted in Muthke and Holm-Mueller study (2004). Testing the transfer of income adjusted WTP for Germany, according to Barton (2002) and giving opposite results with respect to theory expectations, they reject the hypothesis that benefit function transfer clearly outperforms value and income adjusted WTP transfer. Possible explanations for these results, the authors state, rely in the first case either on the relative small sample size or the impact of random answers, both preventing the inclusion of explanatory variables (Muthke and Holm-Mueller, 2004); in the second one in the erroneous assumption of a unitary income elasticity, grater than the actual observed one (Barton, 2002).
The reasons for the greater transfer error obtained in the remaining studies can be explained as follows. Downing and Otzuna (1996) report a mean value transfer error of 289% as a result of their simple benefit function, without considering site and population characteristics[8]; Kirchhoff *et al.* (1997), when differences in amenities, site characteristics and survey sample are not considered, report a mean value transfer error of 118 % and a benefit function transfer error of 156%.
Great attention should be paid when international benefit transfer is performed. On first, values have to be converted in common currency and consider inflation; on second, besides differences in observables of population and site characteristics, differences in preferences related to different culture and shared experience can provide high transfer error (Readly *et al.*, 2004). Muthke and Holm-Mueller state that international benefit transfer is not possible for unit value transfer, even though income adjustment can partially account for different economic conditions between countries. Rozan (2004) finds that, environmental good and its baseline level, income distribution and structure of the sample being similar, differences between European countries in population nationality, culture, sensitivity to the environment and attitudes led to a mean demand function transfer error of 23%. Ready *et al.* (2004) findings show that differences in preferences between European countries, non-related to measurable differences in the population characteristics and valuing the same good, yield mean transfer error of about 28%[9]. Moreover, the authors state that the value function transfer does not outperform value function transfer in their international benefit transfer exercise.
When performing international benefit transfer, however, the advices reported here are not followed very often in literature, yielding extremely high error values. As an example, Muthke and Holm-Mueller (2004) do not account for difference in population characteristics, environmental goods, baseline levels, and welfare measures, resulting in a mean international function transfer error of 561%.
Kristoffersson and Navrud (2001) tested the transferability of passive values versus use values by applying equality and equivalence analysis. Referring to CV studies to value recreational fishing and freshwater fish stock in Norway, their findings show that non-use values are more stable across countries than use values, and the transfer errors were found to be consistently smaller for the non-use values. This is due to the general preferences related to passive values and to the specificity of recreational fishing in the different countries. The authors, hence, supported Brouwer's hypothesis (2000) arguing that passive values can be considered more or less constant across countries since they reflect some kind of overall moral commitment to environmental causes. This is not in agreement with Morrison and Bennett's results (2004), since they found that the majority of implicit prices of river recreational activities are the same when comparing the out-of-catchment sample, while they were not for within-catchment samples. Their results indicate that the existence values tend to vary systematically across catchments, but values associated with recreation are relatively constant.
A general agreement about the transfer of passive and use values is not possible, since it is strictly connected to the type of resource and the value that individuals place on it. Anyway, some

[8] The estimated benefit function is a function only of the offered bid, and thus does not account for differences in site and population characteristics.
[9] In their study, Ready et al. (2004) perform international unit value, income adjusted value and benefit function transfer of the estimated WTP to avoid five ill health episodes. The authors found an average transfer error of about 38% in all cases; the average transfer error value of 28% reported here does not consider the ill episode that performed worse than the others.

considerations can be provided. The value of resources mainly reflecting use values can be transferred to similar sites, in which the same use values prevail, under the same site and population conditions. On the contrary, when dealing with resources or services with prevailing passive values, the researcher shall account for their strictly dependence to the system of preferences of individuals, and the resource stock and features. The transfer of their values is allowed throughout population expressing the same preferences, in case adjusting for differences. When it is not, passive values can not be transferred.
In a comparison of the relative performance of benefit function transfer and meta-regression analysis applied to recreational activities, Engel (2002) finds that the benefit function transfer performed better than meta-analysis in 14 out of the 20 cases examined; meta analysis was better in 6 cases and came close to the benefit function transfer twice. However, the method of comparison biased the results in favour of benefit function transfer for some reasons: a) the benefit function transfer was conducted under almost ideal conditions, within states and for very similar sites and activities; b) primary and transferred estimates came from the same study, conducted by the same analysts, and involving the same methodological choices.
Differences in site and population characteristics can be accounted for by transferring a Conjoint Choice Analysis (CCA) function. Morrison *et al.* (2002) performed validity test of a CCA function transfer of passive values both for the same population but across sites, and for the same site but with different populations. The null hypothesis of equality of the parameters had to be rejected in both cases, though for transfer across sites the difference between parameters appeared lower that the one for transfer across populations, confirming the high influence of population preferences. The null hypothesis of convergence of compensating surplus measures was tested and rejected, with a mean transfer error of 32%. The null hypothesis of equality of implicit prices was rejected only for two out of eight cases, one case in transfer across populations and one in transfer across sites, resulting, the authors state, in a general support of the use of implicit prices in benefit transfer. However, Jiang *et al.* (2004) suggest being cautious in the transfer of implicit prices, stating that the convergent validity could be due to the wide confidence interval related to prices themselves. Morison and Bennett (2004) also tested the transferability of implicit prices for New South Wales rivers, finding that it is valid only in case of transfer between similar rivers, while across different catchments it is not. Moreover, the authors found that the majority of implicit prices were the same when comparing the out-of-sample catchments, implying that gathering many of these samples is not necessary.

STUDY	VALUED GOOD	METHOD	DIFFERENCES IN COMPARED STUDIES Good	Population	Site	Methodology	TYPE OF TRANSFER APPROACH	TRANSFER ERROR[10]
Loomis (1992)	Sport ocean salmon fishing	TC		Differences in behaviour and attitudes	Nothing is said about site characteristics		Within state VT and BFT (multi-site equation)	VT: 4-39% (22%) BFT: 1-18% (10%)
Bergland *et al.* (1995)	Water quality improvement	CV			Differences in environmental characteristics of sites		VT BFT	VT: 25- 45% (35%) BFT: 18-41% (30%)
Downing and Otzuna (1996)	Recreational saltwater fishing	CV		Nothing is said about population characteristics	Nothing is said about site characteristics		Transfer across bays	VT: 0-577% (289%)
Kirchhoff *et al.* (1997)	Presence of species, habitats; and healthy ecosystems; Rafting trips	CV	Differences in valued amenity		Differences in site characteristics	Differences in survey sample frame	VT (direct and sample mean) BFT	VT: 35-69% (52%) VT: 6-229% (118%) BFT: 2-210% (156%)
Brouwer and Spaninks (1999)	Benefits of agricultural wildlife management on peat meadowland	CV			Different sizes of sites		VT BFT	VT: 27-36% (32%) BT: 22-28% (25%)
Muthke and Holm-Mueller (2004)	Water quality improvement	CV	Different goods and baseline levels	Different population	Different sizes	Different welfare measures	National-Germany VT National-Norway VT International VT National-Germany BFT National-Norway BFT International BFT	VT: 29-40% (35%) AVT: 12-14% (13%) VT: 25-33% (29%) VT: 459-946% (703%) AVT: 573-923% (748%) BFT: 0-27% (14%) BFT: 18-29% (24%) BFT: 264-858% (561%)
Rozan (2004)	Air quality improvement	CV		Population differences in culture, nationality and sensitivity to the environment			International BFT	BFT: 16-30% (23%)

[10] The reported range refers to the transfer performed in two directions, considering both sites as policy and study sites. The number between brackets refers to mean transfer error.

5. Conclusions and further research

In this paper, the benefit transfer approaches are presented and related to their applicability conditions and limits. The assumption underlying the transfer is the existence of unbiased estimates of the good of interest for the study site and knowledge of information about the policy site. The similarity between the study and the policy site about valued good, population, site characteristics and market then influences the transfer method to adopt. Indeed, when the similarity conditions are completely satisfied, the transfer of the value estimate to the policy site is supposed to be valid; when it is not the case, as in most real situations, the differences in good, site and population has to be considered by adjusting the benefit function. In limit situations, as in case of unique goods and situations, the transfer rarely can be performed, since its value is strictly connected to the specific site conditions and the system of preferences of individuals. In such cases, however, the transfer of welfare measures, adequately adjusted and controlled, can help in providing at least a reference range of values.

Of course, the validity and reliability of the transfer are strictly connected to the researcher's judgement about the transferability conditions. The quality of the transfer relies on the demand of the analysis task, the quality and quantity of available information, on the level of complexity at which the information is transferred, and on the required level of accuracy needed.

Besides considering the similarity between sites, a further issue arising when dealing with the transfer of welfare measures is the stability of welfare estimates over time; the transfer entails the assumption that such stability exists, by assuming that individual do not change their preferences and tastes towards the valued good. Actually, such stability has to be verified; if it is not, as in most cases, the transfer has to consider this discrepancy, and refer the estimate to the specific time period of assessment.

The different transfer approaches have been of academic interest about their applicability for different uses, focusing on issues about the transferability conditions (degree of similarities between sites), the statistical similarity of function parameters and the range of transfer error. So far, there are conflicting opinions about their results and the validity of the benefit transfer has not been unequivocally confirmed. The main issue when attempting validity tests is the control of the conditions under which the test is performed. Indeed, to conduct validity tests, *ad hoc* primary research for both the study and the policy sites are needed and their results have to be compared concerning the similarity degree between the two sites. However, this is not often the case; many validity tests and the calculation of relative transfer error have been conducted transgressing the similarity principle. Results obtained from original primary studies performed with different purposes were compared, and thus yield misleading results about both the validity and the accuracy of the transfer. According to Desvousges et al. (1998), many of these validity tests tested only specific transfer, but not the transfer method itself under its specific requirements. Thus, there is the need or further research to conduce validity tests by implementing primary research and controlling for differences between sites, in order to link similarity conditions and transfer error with regard to the transfer approach.

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