Theoretical Framework Database Development

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Content

1. Introduction

The EU Water Framework Directive (WFD) (Directive 2000/60/EC) represents one of the major pieces of EU environmental regulation. It provides a regulatory framework for all water policies in Europe, and integrates several existing pieces of EC regulation, such as the Nitrates Directive (91/676/EEC), the Groundwater Directive (80/68/EEC) or Urban Waste Water Directive (91/271/EEC). The WFD introduced several innovations into European water management, including a stronger role of water economics in reaching the environmental WFD objectives. The WFD has been the first major environmental Directive in Europe that systematically includes economic approaches. Thus, throughout the implementation of the WFD, economic instruments (e.g. water pricing), methods (e.g. cost-effectiveness analysis) and principles (e.g. the polluter-pays-principle) are used to reach the Directive's objectives.

One of the most important challenges in WFD implementation is to demonstrate its socio-economic benefits. This is expected to play a crucial role in the assessment of disproportionate costs. The main objective of this short report is to provide the theoretical framework for the database in AquaMoney. An inventory will be made of existing economic valuation studies aiming to put a monetary value on the socio-economic benefits of water quality improvements. These values can be used for the purpose of benefits transfer. Benefits transfer is a technique in which the results of previous environmental valuation studies are applied to new policy or decision-making contexts. In the literature, benefits transfer is commonly defined as the transposition of monetary environmental values estimated at one site (study site) to another site (policy site). The study site refers to the site where the original study took place, while the policy site is a new site where information is needed about the monetary value of similar benefits. The most important reason for using previous research results in new policy contexts is that it saves a lot of time and money. Applying previous research findings to similar decision situations is a very attractive alternative to expensive and time consuming original research to inform decision-making. Especially in the context of the implementation of the WFD, no studies exist that specifically value the change from current water quality conditions to good ecological status (GES).

2. Analytical Framework

A number of criteria have been identified in the literature for benefits transfer to result in reliable estimates (e.g. Desvousges et al., 1992; Loomis et al., 1995). These are summarised in Brouwer (2000):

- sufficient good quality data
- similar populations of beneficiaries
- similar environmental goods and services
- similar sites where these goods and services are found
- similar market constructs
- similar market size (number of beneficiaries)
- similar number and quality of substitute sites where the environmental goods and services are found.

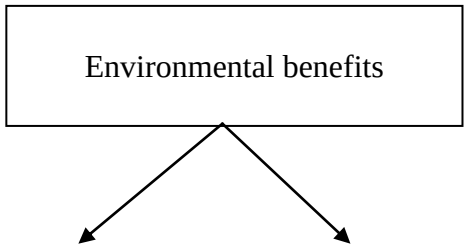
Study quality is an important criterion, which can be assessed in a number of ways. Above all, one can look at the internal validity of the study results, that is the extent to which findings correspond to what is theoretically expected. This internal validity has been extensively researched over the past three decades in valuation studies. Studies should contain sufficient information to assess the validity and reliability of their results. This refers, among others, to the adequate reporting of the estimated WTP function. The reporting of the estimation of the WTP function should also include an extensive reporting of statistical techniques used, definition of variables and manipulation of data.

In practice, several approaches to benefits transfer can be distinguished, which differ in the degree of complexity, the data requirements and the reliability of the results. In principle, these approaches are all related to the use of either average WTP values or WTP functions (Box 1). The first approach is most frequently applied, as it requires relatively little data or expertise, and is not very time consuming.

A first approach is where the unadjusted mean WTP point value is used from another study to predict the economic value of the benefits involved at the policy site. Ideally, this study focuses on the same environmental goods or services, but was carried out at a different location or at the same location at a different point in time.

A second approach is to use and average the unadjusted mean WTP estimates from more than one study, if available, instead of using the result from one study only. These are the two most frequently applied approaches to benefits transfer in practice. They are relatively data extensive and not very time consuming. However, although a quick and cheap alternative, especially compared to original valuation research, the results may be unreliable if circumstances and conditions in the new decision-making context in which they are used are very different from the ones prevailing in the original research.

A third approach is to use one or more mean WTP values adjusted for one or more factors which are, often based on *expert judgement*, expected to influence the value estimates at the policy site. For instance, mean WTP is sometimes adjusted for differences in income levels at the study and policy site, based on existing information about the income elasticity of WTP for the good or service in question, usually taken from the estimated WTP function in the original study.



1) Average WTP values

2) WTP functions

$$WTP = \alpha + \beta X + \gamma Y + \delta Z$$

where α, β, γ and δ are parameter estimates
X: good and site characteristics
Y: population characteristics
Z: study characteristics

Box 1: Benefits transfer

A fourth approach is to use the entire WTP function from an original study to predict mean WTP at the policy site. Whereas the three previous approaches are referred to in the literature as 'unit value' or 'point estimate' transfers, this fourth approach is usually called 'function transfer'. The estimated coefficients in the WTP function are multiplied by the average values of the explanatory factors in the new policy context to predict an adjusted average WTP value. It has been argued that the transfer of values based on estimated functions is more robust than the transfer of unadjusted average unit values, since effectively more information can be transferred (Pearce *et al*., 1994). However, this approach is usually more data intensive than the first three as information about all the relevant factors has to be ready available or collected.

A fifth approach is to use a WTP function, which has been estimated based on the results of various similar valuation studies. The difference between this approach and the fourth approach is that the WTP function is in this case estimated on the basis of either the summary statistics of more than one study or the individual data from these studies. In the literature, this approach is usually referred to as meta-analysis. Formally, meta-analysis is defined as the statistical analysis and evaluation of the results and findings of empirical studies (*e.g.* Wolf, 1986).

The fourth and fifth function approach assume that the estimated coefficients remain constant, through time, across groups of people and across locations. However, based on previous knowledge and *expert judgement*, for instance from previous research at similar study sites or previous research at the new policy site, one may find a reason to adjust coefficient estimates. For example, available information about increases in income level in an area and available information about previously estimated income elasticities of WTP at different income levels, the coefficient estimate in the value function can be modified to better fit the new situation. This approach is expected to become especially relevant when functions are used in benefits transfer exercises, which were estimated a long time ago. Obviously, preferences reflected in stated WTP change as a result of changing circumstances. The fifth approach can be referred to as an 'adjusted function' approach,

because a new WTP function is used, either based on the adjusted original function or a re-estimated function in a meta-analysis of multiple studies.

Thus, while benefit transfer provides a quick and cheap alternative to original valuation research, some conditions must be met if it should provide reliable results. Above all, the local circumstances and conditions in the new decision-making context need to be close enough to the ones prevailing in the original research. The risk of obtaining misleading results may be controlled and reduced by integrating more explaining variables into the transfer, however this also increases the data requirements and the complexity of the analysis. Also, the possibilities of conducting a sound and reliable benefits transfer hinge on the number, quality and diversity of valuation studies available – the larger, the better and the more diverse the existing set of studies is, the more likely will there be a primary study that is "close enough" to the policy site for results to be transferable.

3. Uncertainty and transfer errors

The extent to which non-market economic valuation methods are subject to uncertainties and produce estimation errors has not been subject to systematic analysis. In general, a distinction is made in the economic valuation literature between validity and reliability. Validity refers to the question to what extent a method measures what it is intended to measure. This is often called the 'true' economic value of the environmental goods or services involved. Since this true economic value is unknown (the reason why it is being measured through different valuation methods), the validity of economic valuation research is tested in practice by looking at the consistency of research findings compared to the theoretical starting points[1]. Reliability concerns the replicability of findings, for example with respect to the extent to which the method is able to produce the same outcomes at different sites across different groups of people at different points in time. Reliability is usually associated with the degree to which variability in contingent valuation (CV) responses can be attributed to random error.

According to Bateman and Turner (1993), reliability is related to two potential sources of variance: variance introduced by the sample and variance introduced by the method. The usual solution to the former is to use large samples. The general approach in the literature for examining the latter has been to assess the consistency of CV estimates over time in so-called 'test-retest' studies (e.g. Loomis, 1989; McConnell et al., 1998). To date test-retest studies have only considered relatively short periods, ranging from two weeks (Kealy et al., 1988 and 1990) to two years (Carson et al., 1997). These have supported the replicability of findings and stability of values across such modest periods[2]. In a recent test-retest study covering a time period which is more than double that considered in previous test-retest analyses (Brouwer and Bateman, 2005), average WTP values and WTP functions appear to be significantly different across this longer time

[1] In the CV literature a distinction is made between four different validity concepts (e.g. Mitchell and Carson, 1989): content validity, criterion validity, convergent validity and construct validity. It is mainly the last two validity concepts, which have been tested most in the existing literature. A number of studies have compared, for instance, the outcomes of contingent valuation studies with those from travel cost or hedonic pricing studies or other valuation studies (e.g. Smith et al., 1986; Carson et al., 1996) or the outcomes of different WTP elicitation formats in CV such as open ended or dichotomous choice WTP questions (e.g. Desvousges et al., 1983; Bateman et al., 1995).

[2] An overview of studies investigating the reliability of CV estimates is found in McConnell et al. (1998).

period for a number of reasons, including those expected from standard economic theory (changes in preferences and incomes).

Although benefits transfer is used extensively in practice, very little published evidence exists about its validity and reliability. Table 1 gives an overview of water related studies, which tested the reliability of the transfer of WTP values. Although not complete, Table 1 shows that most studies tested the reliability of transferring contingent valuation results. Three studies investigate the transferability of travel cost studies. The estimated benefits in these studies are related to different types of water use, such as recreational fishing, boating or other recreational water use (also the study by Bergland et al. (1995) and Parsons and Kealy (1994) look at water quality improvements for recreational use). The last column presents the range of transfer errors found in these studies, i.e. the absolute error when using the estimated economic value of a specific water use or water quality deterioration from another study in a new policy context. So, a transfer error of 50% means that the value from the previous study used in the new policy context is 50% higher or lower than the 'true' value in the new policy context. A range of transfer errors is presented as the reliability of benefits transfer was tested for at least two sites (transferring a WTP value from say site A to site B and the other way around) and for both WTP values and WTP value functions (see Brouwer (2000) for more details).

Study	**Valuation method**	**Estimated benefits**	**Transfer errors (%)**
Loomis (1992)	Travel cost	sport fishing benefits	5 – 40
Parsons and Kealy (1994)	Travel cost	water quality improvements	1 – 75
Loomis et al. (1995)	Travel cost	water based recreation	1 – 475
Bergland et al. (1995)	Contingent valuation	water quality improvements	18 – 45
Downing and Ozuna (1996)	Contingent valuation	saltwater fishing benefits	1 – 34
Kirchhoff et al. (1997)	Contingent valuation	white water rafting benefits	6 – 228
Brouwer and Bateman (2005)	Contingent valuation	flood control benefits	4 – 51

Source: Adapted from Brouwer (2000).

Table 1: Errors found in water related economic valuation studies testing benefits transfer

From Table 1, it is difficult to say how large the errors can be expected to be on average when using existing economic value estimates in new decision-making contexts. In some cases they can be very low, in other cases they can be as high as almost five times the value, which would have been found if original valuation research was carried out. No distinct differences can be found based on Table 1 when comparing transfer errors for contingent valuation and travel cost studies.

Another illustration of the accuracy underlying the use of existing economic estimates as proxies for environmental values is presented in Table 2. Table 2 presents an overview of the results of a meta-analysis of 30 CV studies of wetlands in temperate climate zones. The CV studies focus on different issues related to wetland conservation and were carried out at different points in time (in the 1980s and 1990s) in different

places (different countries in Europe and North America). A statistical meta-analysis of the findings of the different CV studies produced the summary statistics shown in Table 2.

	Mean WTP	Standard error	Min WTP	Max WTP
Wetland type				
Saltwater	84.3	40.8	28.5	205.5
Freshwater	88.4	9.2	1.5	400.5
Wetland function				
Flood water retention	138.9	36.6	36.0	265.5
Water recharge	32.3	10.2	4.5	88.5
Pollutant retention	78.8	8.9	13.5	261.0
Wildlife habitat	114.2	19.2	1.5	516.0
Wetland value				
Use value	102.2	12.6	13.5	516.0
Non-use value	53.3	7.2	18.0	117.0
Use and non-use	95.7	19.4	1.5	400.5
Continent				
North America	106.2	11.7	4.5	516.0
Europe	49.2	12.6	1.5	265.5

Source: Adapted from Brouwer et al. (1999).

Table 2: Break-down of average economic values found in the literature for wetlands in temperate climate zones in US$ per household per year (price level 1995)

The summary statistics (average WTP values) show a high degree of variability (measured through the minimum (Min) and maximum (Max) average WTP values found in individual studies). Standard errors, measures of the accuracy of the estimated average values, range between 10 and 50 percent of the summary statistic's average value (i.e. variation coefficient). The 95 percent confidence interval around these estimates is almost two times higher. For instance, the 95 percent confidence interval around the average economic value of freshwater wetlands is US$ 70.4 – 106.4, whereas the 95 percent confidence interval around the average economic value of saltwater wetlands is US$ 4.3 – 164.3. Together with the hydrological function water recharge, floodwater retention has the highest variation coefficient. The variation coefficient related to the economic value of the ecological function wildlife habitat provision is about half the size of that. However, the range of values found in the existing literature is highest for this latter ecological function, varying between one and five hundred US dollars per household per year.

The errors reported in Table 1 have to be considered in the light of the purpose the user wishes to use previous valuation results for. In some cases the user may find a transfer error of 50 percent too high, in other cases such an error may be acceptable. The extent to which the transfer errors reported in Table 1 are considered a problem depends upon the acceptability of these errors by the user (policy or decision maker) of the results. User acceptability of these errors will depend upon subjective judgement by the user self, but also on the purpose and nature of the cost-benefit evaluation and the phase of the policy or decision-making cycle in which the evaluation is carried out. The reliability (and corresponding errors) of pre-feasibility studies

carried out in an early stage of policy formulation to aid policy development is usually much lower (and errors larger) than the reliability of detailed cost-benefit studies which are looking at the practical implementation of concrete policy measures on the ground. In general, the further the policy or decision-making process has moved forward towards practical implementation, the higher the reliability of the evaluations based on increasing quantity and quality of information. Large errors and low reliability as a result of unresolved uncertainties and lack of information will become less and less acceptable the closer the project moves towards the practical implementation of policy measures on the ground.

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