A meta-analysis regression of water quality valuation in the Nordic countries: A new tool for applied benefit function transfer

SB Olsen[1]*, M Zandersen[2], L Martinsen[2], KH Zemo[1], Toke Panduro[2], B Hasler[2]

[1] Department of Food and Resource Economics, University of Copenhagen, Denmark
[2] Department of Environmental Science, Aarhus University, Denmark
* Corresponding author e-mail address: sobo@ifro.ku.dk

Abstract: We conduct a meta-regression analysis based on primary valuation studies have been conducted for water quality improvements in the Nordic countries. The identified meta-regression function represents a significant contribution enabling more reliable benefit transfer when assessing costs and benefits of new policies and projects having impacts on water quality in the Nordic countries.

Keywords: Water quality; meta-regression analysis; economic valuation

The Water Framework Directive (WFD) (European Commission, 2000) requires that measures ensuring that all water bodies in the member states reach 'Good Ecological Status '(GES) should have been in place by 2015, but with opportunities for extension to 2027. Leakage of nutrients, particularly Nitrogen and Phosphorous, from agriculture and wastewater treatment plants other is the main source of pollution causing eutrophication of the aquatic environment. Nutrient load reductions are thus necessary to achieve GES of water ecosystems.

While achieving GES in all water bodies will be costly for the member states, it will also entail important benefits for society, including both use and non-use values, many of which are non-marketed. Use values include e.g. improved conditions for recreational activities and improved drinking water quality, while non-use values include existence values related to biodiversity and ecosystem health. An important performance measure for decision-makers considering new projects or policies aiming to improve water quality is the assessment of whether the societal benefits are actually higher than the societal costs. This requires economic valuation of the non-marketed benefits associated with improvements in water quality. However, conducting primary economic valuation studies is generally very costly, not only in terms of money, but also in terms of time. A cheaper and faster alternative is to use benefit transfer methods, which rely on transferring value estimates from a study site, where a primary valuation study has already been conducted to assess the value of a water quality improvement, to the policy site, where a new project or policy to improve water quality is being considered. Rather than simply transferring a value estimate from a single study site to the policy site of interest, it may be possible to construct value functions based on meta-regression analysis on values from a range of available study sites. Basing the benefit transfer on the transfer of such as meta-regression function is generally considered more reliable than the simple benefit transfer.

In this study, we conduct a meta-regression analysis based on the primary valuation studies that have been conducted for water quality improvements in the Nordic countries up until the year 2020. The main purpose is to develop a meta-regression function that can be used for practical and more precise benefit transfer than the simple unit value transfer approach that has previously been used when assessing welfare effects of new policies and projects affecting water quality in the Nordic countries.

We first review the literature to identify all primary valuation studies addressing water quality in the Nordic countries. From a gross list of about 50 potentially relevant studies, we identify 32 studies that not only provide estimates of WTP for changes in water quality, but also provide the sufficient level of detail necessary to populate our dataset. We then construct our dataset consisting

of about 100 variables for each of the 32 studies. Since some of the studies provide several WTP estimates, we have about 124 estimates of WTP for water quality improvements in the data set.

We then identify the best-fitting meta-regression model as a random effects linear regression model explaining the variation in the WTP estimates by a wide range or parameters in the dataset. The model explains more than 87% of the variation across the 124 WTP estimates. Specifically, we find that the larger the improvement in water quality, the larger the WTP. Also, the status quo water quality has a significant bearing on the WTP. For instance, a one-level improvement from 'moderate' to 'good' ecological status is more valuable than a one-level improvement from 'good' to 'high' ecological status. Besides that, a range of biophysical, sociodemographic as well as other study-specific variables significantly determine WTP. Finally, to assess the internal validity of the identified meta-regression function, we conduct a hold-one-out type of analysis, which suggests that use of the identified meta-regression model for benefit transfer will on average lead to a transfer error of 43%.

We conclude that the identified meta-regression function represents a useful approach for improving the validity and reliability of benefit transfer when used for assessing costs and benefits of new policies and projects having impacts on water quality in the Nordic countries.