CORRESPONDENCE AND EFFICIENCY IN FORECASTS OF ECOSYSTEM SERVICE BENEFITS

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Introduction

As societies have increasingly ranked and identified the benefits that humans experience due to the services of nature, the numerous trade-offs associated with land use changes and ongoing ecological system changes have become an important set of questions. Contributions to human well-being, ecosystem services are estimated to be valued in the United States alone, it is important to determine the role of wetlands in regulating water and due to the extensive conversions of wetlands to uplands, open water, and marline environments. A result of the difficulty and expense associated with gathering and analyzing data for primary economic valuation studies is the availability of data that can predict ecosystem services value has gained increased attention. Benefit transfer (BT) is the most common term for the practice of making valuation predictions or forecasts with existing valuation data.

The correspondence has been mentioned a number of times in the ecosystem service valuation literature. Correspondence is relevant to benefit transfers from study sites with primary data based valuation estimates to policy sites lacking data. Recently in a Land Economics article, Runenberg and Johnson (2009) theorized that, “Transfer error is often inversely related to the correspondence between a study site and a policy site among various dimensions.” We suggest that correspondence not only to characteristics of the sites involved, but also to the local population and the valuation method employed.

The ecosystem service valuation studies, multiple primary valuation estimates are typically summarized with statistical models or aggregated to a single regression. Meta-analysis benefit (MBAT) [57] where such a statistical summary is used for forecasting ecosystem services. Meta-analysis is a multidisciplinary method that transfer desire high correspondence, an independent citation of the literature (often written down to a small sub-set that can be argued to not suffer from extensive transfer error or poor correspondence (e.g., Moertl et al., 2007; Moertl and Woodward 2009; Smith and Wukasch 2009). The alternative to subjectively assigning one’s data to enhance correspondence is to estimate a broader model that uses the method that controls for variance in [57] that might increase transfer error. A sequence of four meta-analyses of wetland ecosystem service valuation studies can be found in the literature that employs this broader modeling approach (Woodward and Wu 2001; Brandt, et al., 2006; Ghennadi et al., 2010; and Brandt et al., 2013). Interestingly in Figure 2, we are able to estimate distance correspondence with the direction equation for sites that lack primary valuation estimates. Multiple primary (NWRS). The magenta color indicates greater correspondence while cyan indicates an observation that has relatively poor correspondence and high correspondence, and a red band indicates a location that has been appropriately downweighted to enhance forecast efficiency for the centered policy site. Figure 1 contains a diagram demonstrating the hypothesized benefits of an approach to MBAT that attains both efficiency and a systematic approach. Figure 1 can be read as if it represented preferences (a well- intentioned modeler), and the concave lines represent indifference curves. We expect that movements away from the origin will lead to lesser gains of welfare due to the use of inaccurate BT estimates.

Objectives and Method Overview

In order to better understand the values associated with storm control/flood protection and water quality provisioning services we advanced two general frameworks: the one centered on National Wildlife Refuges (NWRS), we implement a novel meta-analysis method. Our objective is to develop an estimator that accommodates the biases in transfer estimation of ecosystem services that have poor correspondence with a hypothetical valuation study (e.g., a contingent valuation study of a policy site of interest, without a need for ad hoc analysis resembling the estimator). The estimated parameter is subjectively weakly estimated, and the parametric models are the regression equation that centered on observations with good correspondence. Our new estimator is developed to examine the performance of the estimator relative to a conventional OLS estimator that is typically unbiased due to assumed moments.

The Parametric Locality Weighed Least Squares (LWLS) estimator is employed in an optimization routine that takes as its arguments a function of logit errors in centered regression model, where i is the sample size. Each of the centered regression models is intended for a particular observation (the centered observation as a function of the present in the centered regression models is the weights that are obtained from the centered equation. Below, we discuss how an observation and the regression tailored to that observation, we refer to the observation as being centered and refer to the centered regression equation for centered observation i as the jth regression equation. We index observations i, j, in both i and j. We define a set of h0=1,...,h0 corresponding to each observation, such that the P (or the jth) observation has attributed weight inversely proportional to the omni-regressors. For the ith centered regression equation, we are interested in the ith centered regression equation for the ith observation, we specify an exponential functional such that, where wi = 1/[1 + e−(β0+β1x1+...+βixi)], which is the weight applied to the jth observation in the centered regression equation for observation i. The exponential function ensures that there is a higher weight to the centered observation(s) which are both close to the decision boundary (positive and negative) and that the equation is always monotonic increasing. The correspondence equation will equal 1.0 when observations are nearly identical. We can then say that all correspondence attributes are equal to those two observations. Our specification ensures the following relationship: 

where 0 < d < 1

or that decreased correspondence between observations decreases the weight attributed to those observations by one another due to smaller generalized least squares (GLS) regression weights.

We specify an exponential function for the estimation parameters, δ0,δ1, which are the only global parameters or coefficients across all in centered regression equations. The specification of the correspondence equation imply that information contained in between observations is symmetric. For example with the first 2 observations in the data set, the information that observation 1 provides about observation 2 is the same as observation 2 provides about observation 1 in the equation for i = j.

The function relies on re-estimating an OLS from GLS estimators that the square root of an observation’s population error variance could be used to rescale that observation such that the resulting error variance is unity, leading to an estimated regression parameter with a lower variance than can be provided by Ordinary Least Squares (OLS). The left panel of Figure 3 contains the results of the PWLS estimator jackknife simulations. In general, the jackknife efficiency is noticeably improved in all cases. Additionally, for the small sample and the fourth pair of transfer, the relative magnitudes of the two statistic improve the flexibility of the PWLS model. The right panel of Figure 3 contains an additional specification of the PWLS estimator that retains all features less the objective function specified above. For the left panel, correspondence parameters were chosen to simply minimize squared transfer error, using one observation from each centered regression model. This intuitively appealing estimator does poorly in this sample. Diagnostics indicate the approach drastically overfits the in sample forecasts.

The PWLS approach appears promising based on our initial analysis. Yet lacking analytical variance formulas or statistics to test this model, some degree of skepticism over formal properties is reasonable. Our results, however indicate that forecast bias is small as the error variance. Future research is needed to validate the PWLS approach and develop useful post-estimation strategies for identifying under-studied ecosystem services and situations in which benefit transfers are expected to be especially accurate due to high correspondence in the sample.

References


The correspondence equation is then specified to be a single squared regression equation, with δ0,δ1,...,δH centered in the model for centered observation i. Accordingly, we fit the correspondence equation to the inverse of the sample variance as can be seen from the following equation,

where is the sample residual for observation i from the GLS regression equation centered on observation i. The GLS weights for each of the j observations in the equation for centered observation i are determined by the correspondence equation, mentioned above. In the present equation, the weight outside the bracket serves as a 270- style weight. We apply this additional weighting based on the idea that we want to preserve more information about the error in the variance prediction when between observations i and j is high.

Empirical Application

We construct a novel dataset of 26 primary valuation studies, that yield 26 grassland dependent wellbeing observations of willingness to pay (WTP). Included valuation methodologies are, the Travel Cost Method, the Contingent Valuation Method, the Hedonic Price Method, the Random Parameters Model, and Replacement Cost Methods. Because we are interested in domestic wetlands, all observations are domestic, sites, and all values are attributed by the authors entirely to wetland ecosystems.

We apply the LWLS valuation estimation so that we can examine the magnitude of the parameters estimated correspondence attributes (i.e., αj), that indicate which method is used to derive the value of a service. The source of error in MBAT models has been identified in the literature as dominating all other sources, and therefore we approach this problem in a new way. We are agnostic about exclusions beyond the initial requirements for our sample (domestic wetland studies that can be georeferenced).

Results and Discussion

We find that the PWLS estimator produces fairly comparable value estimates relative to the OLS estimator and an alternative algorithmic specification (not shown). Figure 3 contains a comparison of the jackknife simulated forecast efficiency for water quality provisioning and flood control/storm protection. Our results are based on four case study NRMs. The vertical axis is estimated WTP/1000people/1000acres and the horizontal axis contains paired observations for water quality and then flood control/storm protection. The PWLS method demonstrates the approximate sampling variability of OLS. Because the single equation used in OLS models, one can see that the OLS estimator underestimates the value of water quality provisioning is always expected to be more highly valued than flood control/storm protection.