Property Values and Water Quality: A Nationwide Meta-Analysis and the Implications for Benefit Transfer

By:

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Presentation for the

**USDA Sponsored workshop:**

**Applications and Potential of Ecosystem Services Valuation within USDA – Advancing the Science**

April 23-24, 2019; Washington, DC

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\(^2\) US EPA, Office of Research and Development

\(^3\) Abt Associates
The data/research described in this presentation has been funded in part by the U.S. Environmental Protection Agency (EPA) Contract No. EP-C-13-039 to Abt Associates. The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the US Environmental Protection Agency (EPA). Mention of trade names or commercial products does not constitute EPA endorsement or recommendations for use.
USDA Programs (e.g., CRP, CSP, EQIP)

Reduce pollutants into waterways (e.g., nutrients and sediment)

Improve aquatic ecosystems
Hedonic Property Value Methods

Estimate how local amenities (e.g., water quality) affect home values

Hedonic literature examining water quality goes back over 50 years (David, 1968)
Objective

➢ Summarize literature, and synthesize results using meta-analysis

➢ Estimate unit value and value functions of capitalization effects for purposes of benefit transfer
“Meta-analysis is the quantitative synthesis of multiple primary studies... allows [for] generalizations.”

(Nelson, 2013)

**Benefit Transfer** – practice of applying estimated values from studies of other regions or policies, to a policy/action of interest.
Meta-Dataset

65 studies identified

- Examine residential property values and water quality

Studies excluded if:

- Not a primary study
- Unpublished version of a later published study
- Not a study of surface water quality
- Outside of U.S.
- Only used subjective water quality ratings

36 studies included in meta-dataset
Lakes (25 studies*)

Estuaries (6 studies)

Rivers (3 studies*)

Small Rivers (3 studies)
Final dataset contains $n=665$ meta-observations

$n=598$ where we could infer a unique estimate of the price elasticity and corresponding standard error

Studies included in Meta-dataset
Price elasticity and semi-elasticity
- Study by study derivation based on initial functional form
- Standard errors inferred via Monte Carlo simulations (10,000 draws)

Common distances
- Waterfront and non-waterfront w/in 500 meters
Number of meta-observations by water quality measure

- Water Clarity: 260
- Fecal Coliform: 56
- Chlorophyll a: 36
- Nitrogen: 20
- pH: 19
- Phosphorous: 12

Number of meta-observations by water quality measure.
Meta-analysis

Unit Values
Value Functions
Cluster-adjusted Random Effect Size Weights

Random Effect Size (RES) Weights –
• Account for statistical precision of primary estimates

Clusters defined as unique housing markets
• Account for numerous estimates of same “true” elasticity for the same housing market and waters
Mean Elasticity Estimates

- Water Clarity: 0.105***
- Fecal Coliform: -1.30E-04***
- Chlorophyll a: -0.026***
- Nitrogen: 0.009***
- Phosphorous: -0.005

Waterfront
Non-waterfront w/in 500 m
Number of meta-observations by water quality measure

- Water Clarity: 260
- Fecal Coliform: 56
- Chlorophyll a: 36
- Nitrogen: 20
- pH: 19
- Phosphorous: 12
Meta-analysis

Unit Values

Value Functions
Meta-regression Model: Water clarity (Secchi disk depth)

$$\hat{e}_{idj} = \beta_0 + wf_{iaj}\beta_1 + estuary_{j}\beta_2 + WQ_{ij}\beta_2 + region_{j}\beta_3 + e_{idj}$$

1. Random Effects (RE) Panel Model
2. Mundlak Model
   (Mundlak, 1978; Boyle & Wooldridge, 2018)
Random Effects (RE) Panel Meta-regression Model
(dependent variable: predicted house price elasticity)

<table>
<thead>
<tr>
<th>VARIABLES</th>
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### Mundlak Meta-regression Model
(dependent variable: predicted house price elasticity)

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## Absolute Value of Transfer Error

<table>
<thead>
<tr>
<th>Out-of-sample transfer error</th>
<th>RES Mean Value Transfer</th>
<th>Meta-regression Model Function Transfer</th>
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<tr>
<td>RE Panel Meta-regression</td>
<td>0.13504</td>
<td>0.13502 0.13508 0.13262 0.14011 0.14563</td>
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<tr>
<td>Mundlak Meta-regression</td>
<td>0.13395</td>
<td>0.14074 0.13973 0.15739 0.16307</td>
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USDA Programs (e.g., CRP, CSP, EQIP)

Reduce pollutants into waterways (e.g., nutrients and sediment)

Improve aquatic ecosystems

Implications for Benefit-Transfer

If water quality models quantify change in:

- Water clarity
  → Function transfer using RE Panel model accounting for baseline clarity

- Fecal Coliform, Chlorophyll A, Nitrogen, pH, and Phosphorous
  → Value transfer

Combine with spatial data of waterbodies, housing, and housing values

→ BenSPLASH (Corona et al., 2019; session 6 today)
Conclusion

Meta-analysis provides tool for valuing improvements in water quality and aquatic ecosystem services

Plan to make meta-analysis and meta-dataset publicly available

Plan to periodically update meta-dataset
  • Other waterbody types
  • Other regions
  • More water quality measures
Thank you!

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