Benefit Transfer and Commodity Measurement Scales: Consequences for Validity and Reliability

Robert J. Johnston
Clark University

and

Ewa Zawojska
University of Warsaw

ewa.zawojska@uw.edu.pl

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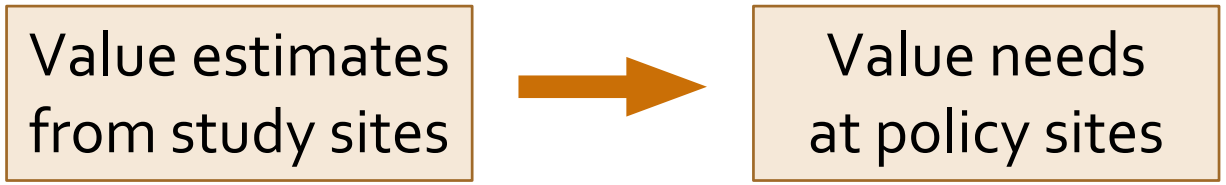
Benefit transfer



- A method to estimate economic value of non-market goods, including public goods
- Existing value estimates from primary studies at one or more sites (study sites) are used to estimate the value at other, typically unstudied sites (policy sites)
- Many constraints (e.g., in terms of time or funding) can prevent primary valuation studies when and where they are needed
- Thus, benefit transfer is often the only feasible means to estimate values
- Benefit transfer is a central component of nearly all large-scale benefit-cost analyses in the EU, US and elsewhere

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Commodity measurement scales

- Most non-market goods can be measured in cardinal or relative units
  - Cardinal – an absolute quantity
  - Relative – a percentage
- Example: 200-acre marsh, of which 20 acres is affected by a policy
  - In cardinal units – 20 acres
  - In relative units – 10% of the marsh
- Such transformations are inconsequential for single-site econometric analysis: ex-post linear rescaling of variables (e.g., between cardinal and relative units) has no impact on site-specific value estimates
- But these seemingly inconsequential transformations can lead to significant consequences for benefit transfer across different sites

Unacknowledged in the literature

Potentially important effects of measurement conventions in benefit transfer

In benefit transfer, cardinal versus relative rescaling remains inconsequential only when baseline levels (from which relative quantities are calculated) are the same.

Simple example: A program of restoring 20 acres of marsh

- Study Site A with 200 marsh acres and Policy Site B with 100 marsh acres
- A 20-acre restored area is: 10% of the marsh at Site A and 20% of the marsh at Site B
- A primary study at Site A estimates $20 value per household for the 20-acre restoration: $1 per acre or $2 per percentage point of marsh restored
- Value transfers to Site B:
  - Cardinal, per acre → $1*20 = $20 per household for the 20-acre restoration
  - Relative, per percentage-point → $2*20 = $40 per household for the same restoration

Cardinal versus relative scaling may have significant consequences for benefit transfers

Cardinal versus relative scaling may have significant consequences for benefit transfers

- How important are these effects in actual, or potential, transfer contexts?
- Does theory or empirical evidence provide guidance as to whether cardinal or relative benefit transfers are likely to be more valid and reliable?
- Under what conditions could one of them be more valid and reliable than the other?
- Many benefit transfers can be conducted over either relative or cardinal units. **Which one should we use?**

Our research is the first one to address these questions

Theoretical approach

BOTTOM LINE

- Conducting transfers in cardinal versus relative units implies different assumptions about utility
- The degree to which these assumptions hold will influence the validity of the transfers
- Cardinal transfers assumes constant marginal utility per cardinal unit across sites, regardless of differences in baselines
- Relative transfers imply a specific mathematical form of diminishing marginal utility per cardinal unit
- Which of these assumptions is closer to actual conditions?
- It is unknown, but often one may wish to allow for diminishing marginal utility in cardinal units if baselines differ across sites

⇒ relative transfers potentially better

Methods and Effects of Protection	Result in 2020s with NO NEW ACTION	Result in 2020s with PROTECTION OPTION A	Result in 2020s with PROTECTION OPTION B
	No Change in Existing Defenses	SIMILAR Emphasis on Hard and Soft Defenses	More Emphasis on SOFT Defenses
Homes Flooded	7% 566 of 8,460 homes expected to flood in a Category 3 storm	7% 566 of 8,460 homes expected to flood in a Category 3 storm	7% 566 of 8,460 homes expected to flood in a Category 3 storm
Wetlands Lost	12% 9 of 77 wetland acres expected to be lost	12% 9 of 77 wetland acres expected to be lost	5% 4 of 77 wetland acres expected to be lost
Beaches and Dunes Lost	10% 4 of 36 beach acres expected to be lost	4% 1 of 36 beach acres expected to be lost	4% 1 of 36 beach acres expected to be lost
Seawalls and Coastal Armoring	50% 13 of 26 miles of coast armored	50% 13 of 26 miles of coast armored	40% 10 of 26 miles of coast armored
$ Cost to Your Household per Year	$0 Increase in annual taxes or fees	$95 Increase in annual taxes or fees	$125 Increase in annual taxes or fees
HOW WOULD YOU VOTE? (CHOOSE ONLY ONE) I vote for	☐ I vote for NO NEW ACTION	☐ I vote for PROTECTION OPTION A	☐ I vote for PROTECTION OPTION B

Empirical approach

- Stated preference discrete choice experiments (DCEs) on options for coastal flood adaptation
- In two Connecticut (USA) communities: Old Saybrook and Waterford
- The communities differ in endowments of assets considered in the DCE
- The DCEs in the communities are identical beyond differences in quantitative attribute levels and baselines
- Three choice tasks per person
- Pen-and-paper surveys, distributed via mail, from May to June 2014

Data analysis

- A **mixed (random parameter) logit model** in willingness-to-pay (WTP) space
  - Pooled data for two communities, with a shifter (interaction) for Waterford
  - Non-monetary attributes distributed normally
  - Monetary attribute distributed log-normally
- **Validity assessment** of benefit transfer:
  We calculate WTP values for attributes in cardinal and relative units, and compare which transfer type more often generates statistically valid WTP values
- **Reliability assessment** of benefit transfer:
  Based on absolute value percent transfer error (TE)

$$TE = \frac{|V_S - V_P|}{V_P} \cdot 100$$

V_S – a value from the assumed study site, V_P – a value for the assumed policy site

	Mean: Main effect	Mean: Shifter for Waterford	Standard deviation
Status quo	-1.3912***	-0.3245***	3.4463***
	(0.0548)	(0.0836)	(0.2214)
Homes	-0.9295***	0.9398***	0.8919***
	(0.0487)	(0.1276)	(0.0551)
Wetlands	-0.9951***	-0.4027***	0.9129***
	(0.1134)	(0.1052)	(0.0713)
Beaches	-0.8129***	-0.0351	1.0404***
	(0.0946)	(0.0888)	(0.0662)
Seawalls	-0.0084	0.1885***	0.6993***
	(0.0824)	(0.0606)	(0.0775)
Emphasis on *Hard* defenses	-0.4568***	0.3023***	1.1610***
	(0.0946)	(0.0900)	(0.0839)
Emphasis on *Soft* defenses	0.1438	-0.6011***	1.3347***
	(0.1316)	(0.1795)	(0.0908)
Cost	2.8707***	-1.1047	2.9222***
	(0.9895)	(0.6932)	(0.6327)
Log-likelihood	-686.20		
Log-likelihood with constants only	-893.49		
McFadden pseudo-R^2	0.2320		
Ben-Akiva-Lerman pseudo-R^2	0.4555		
Number of observations	815		

Mixed logit model in WTP-space

Validity assessment

Attributes defined as discrete variables

	WTP_{OS}	WTP_{W}	$WTP_{OS} \neq WTP_{W}$
Status quo	-139.115	-171.564	***
Emphasis on *Hard* defenses	-45.676	-15.448	***
Emphasis on *Soft* defenses	14.380	-45.728	***

⇒ relative transfers slightly better

Attributes defined as continuous variables

	WTP per relative unit (per one percentage point change)			**WTP per cardinal unit** (units indicated in square brackets)		
	WTP_{OS}	WTP_{W}	$WTP_{OS} \neq WTP_{W}$	WTP_{OS}	WTP_{W}	$WTP_{OS} \neq WTP_{W}$
Homes [number]	-9.295	0.103	***	-0.185	0.001	***
Wetlands [acre]	-9.951	-13.978	***	-2.002	-18.154	***
Beaches [acre]	-8.129	-8.480		-27.095	-23.556	***
Seawalls [mile]	-0.084	1.801	***	-0.167	6.928	***

Reliability assessment

$$TE = \frac{|V_S - V_P|}{V_P} \cdot 100$$

TE ratios greater than 1 imply that cardinal transfer errors are greater than relative transfer errors

	Transfer from Old Saybrook to Waterford			**Transfer from Waterford to Old Saybrook**		
	TE for **relative** transfer	TE for **cardinal** transfer	TE ratio (cardinal / relative TE)	TE for **relative** transfer	TE for **cardinal** transfer	TE ratio (cardinal / relative TE)
Homes	9,130.26%	15,276.01%	1.67	101.11%	100.66%	1.00
Wetlands	28.81%	88.97%	3.09	40.47%	806.66%	19.93
Beaches	4.14%	15.03%	3.63	4.32%	13.06%	3.02
Seawalls	104.64%	102.41%	0.98	2,254.33%	4,242.94%	1.88
Mean TE ratio			2.34			6.46

Reliability assessment

$$TE = \frac{|V_S - V_P|}{V_P} \cdot 100$$

TE ratios greater than 1 imply that cardinal transfer errors are greater than relative transfer errors

	Transfer from Old Saybrook to Waterford			Transfer from Waterford to Old Saybrook		
	TE for **relative** transfer	TE for **cardinal** transfer	TE ratio (cardinal / relative TE)	TE for **relative** transfer	TE for **cardinal** transfer	TE ratio (cardinal / relative TE)
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Beaches	4.14%	15.03%	**3.63**	4.32%	13.06%	**3.02**
Seawalls	104.64%	102.41%	0.98	2,254.33%	4,242.94%	**1.88**
Mean TE ratio			2.34			6.46

- In six out of the eight cases, transfer errors are substantially smaller for relative transfers
- In the two other cases, the differences are trivial, with the ratios close to 1
- Transfer errors are, on average, two- to six-times larger for cardinal than for relative transfers

⇒ relative transfers better

Punchline

- **Transfers in relative units may substantially outperform transfers in cardinal units**

- Suggested by both theoretical and empirical approaches
- The same findings when the empirical model controls for socio-demographic differences between the two communities

Conclusions

- Measurement conventions for environmental goods are often considered to be second-order or even trivial issues within primary non-market valuation studies
- But measurement conventions can be of critical importance for benefit transfer
- Basic methods used to quantify goods can be more important for transfer accuracy than sophisticated aspects of transfer methodology
- Valuation study designers may wish to consider not only primary study considerations but also benefit transfer consequences when choosing commodity measurement scales
- To our knowledge, this is the first acknowledgement of this type in the literature

THANK YOU!

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