Utilizing Subjective Beliefs in Stated Preference Models: Issues and Solutions

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Motivation

Payment for Ecosystem Service (PES) programs that reduce agricultural runoff

- Offered to farmers
- CRP and EQIP, for example

Farmers sign contracts to i) retire land or ii) engage in some agricultural best management practices (BMPs) in exchange for payment

Contracts typically include several characteristics

- Contract Length
- Annual Payment
- Administrative Burden
- Required Management Practices

Discrete Choice Experiments (DCEs)

Select attributes

Determine attribute levels

Vary in a manner that

- Promotes efficiency
- Ensures exogeneity

Ideally, all relevant attributes of choice would be open to exogenous variation

Motivation: *Does it ever make sense for the researcher to elicit an attribute level from the respondent instead of choosing it him/herself? And what new issues arise from this decision?*

Discrete Choice Experiments (DCEs)

PES contracts typically include several characteristics

- Contract Length
- Annual Payment
- Administrative Burden
- Required Management Practices

What about program effect? (how will the proposed program change runoff from your farm?)

Can the researcher exogenously vary this?

PES Program DCEs

Program effect is often excluded in this context

Could be useful to policy makers

Tradeoff between incentive programs and information/extension campaigns

Why might this be excluded?

"Ideally, all relevant attributes of choice would be open to exogenous variation"

Discrete Choice Experiments (DCEs)

Consider the random utility model:

$$U_{ni} = V_{ni} + \varepsilon_{ni}$$

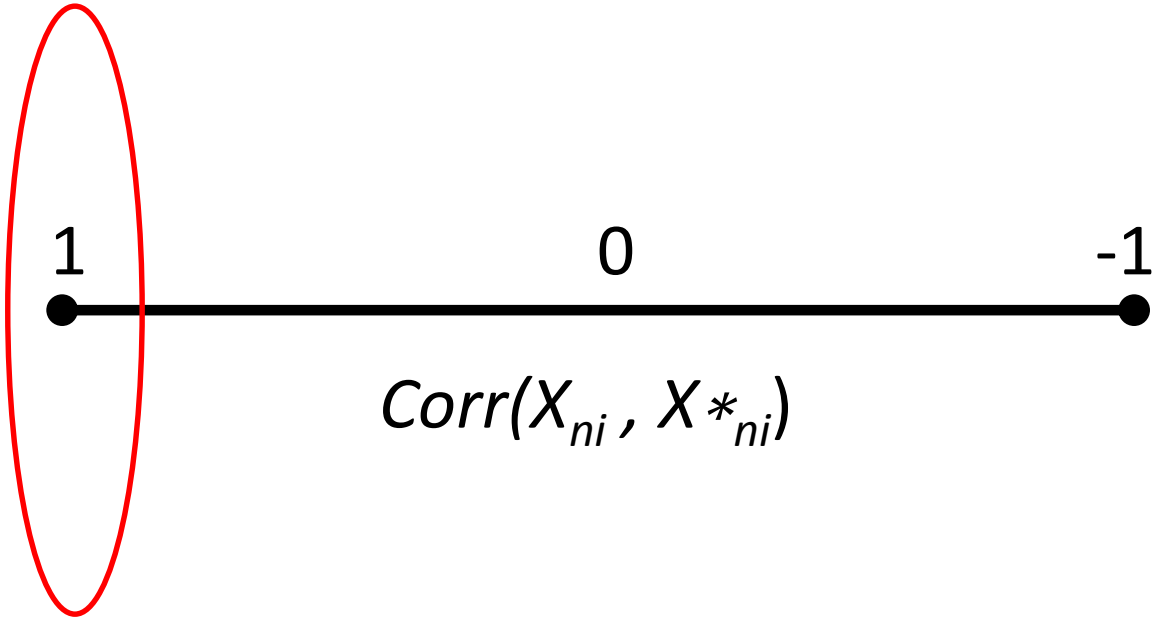
$$V_{ni} = \beta X^*_{ni}$$

Where X^*_{ni} is the attribute level perceived by agent *n* for choice *i*

Ideally, $X_{ni} = X^*_{ni}$

Where X_{ni} is the attribute level specified by the researcher

Continuum for relationship between X_{ni} and X^*_{ni}



Subjective Beliefs

When $X_{ni} \neq X^*_{ni}$, elicit X rather than assign it

Addresses some problems, but creates others

1. Interpretation of marginal willingness-to-accept (WTA)
2. Potential endogeneity issues

Data

Survey of corn and soybean farmers

- Maumee watershed (OH, small parts of IN and MI)
- Conducted winter 2012
- 381 completed surveys
- Choice Experiment on PES program to establish edge-of-field grass filter strip
- Elicited subjective beliefs about probability of runoff from field

Survey

Consider a situation where there is a voluntary program to establish *filter strips*. Sufficient state and federal funds are available to ensure that all applicants will be enrolled. Two options are available. Both options fe… e filter strip plus an annual rental p… lined in the table.

Please circle yo… mn.

11. Given the soil type, slope, fertilizer use, proximity to water, drainage, and crop and tillage practices in this field, and <u>without a filter strip</u>, how likely is it that a 1-inch rainfall during a 30-minute storm event in mid-June would cause soil to run off into nearby surface water? *Put a mark on the scale below….*

			Your Current Situation
Length of Pro…			--
Maintenance…			--
Inspection frequency	Annual, announced	Annual, announced	--
Paperwork bu…			--
Width of Filte…			--
Annual Renta…			--
Please rank…			Best
Circle one 'Be… and one 'Wor…			Middle
	Worst	Worst	Worst

17. Now consider this field <u>as if you installed a 25-foot filter strip</u>. How likely would it be that the same June storm event would cause soil to run off this field into nearby surface water?

Models

Standard Utility Model:

$V = \beta_X X + \beta_{SQ} * SQ\_ASC + \varepsilon_{in}$

Subjective Beliefs Utility Model:

$V = \beta_X X + \beta_{SQ} * SQ\_ASC + \beta_{Runoff} * Runoff + \varepsilon_{in}$

Subjective Beliefs: Marginal WTA

Consider a PES program that requires management practice X and is accompanied by perceived effect E

Full Effect

Indirect Effect

$$\frac{dU}{dX} = \frac{\partial U}{\partial X} + \frac{\partial U}{\partial E}\frac{\partial E}{\partial X}$$

Direct Effect

Models: Marginal WTA

WTA for 1-unit increase in attribute X: $\frac{-\beta_X}{\beta_{Payment}}$

Standard Utility Model

- Full Effect (Both Direct and Indirect Effect)
- Policy-relevant

$$\frac{dU}{dX} = \frac{\partial U}{\partial X} + \frac{\partial U}{\partial E}\frac{\partial E}{\partial X}$$

Subjective Belief Utility Model

- Captures only the Direct Effect
- Less Policy-relevant

Models: Marginal WTA

Runoff/Subjective Beliefs Model:

$$Runoff = \delta_X X + \delta_{SQ} * SQ\_ASC + \varepsilon_{in}$$

Complete-Effect Willingness-to-accept (CEWTA)

$$\frac{-(\beta_X + \beta_{Runoff} * \delta_X)}{\beta_{Payment}}$$

Full Effect while using the Subjective Belief Utility Model

Marginal WTA: Hypotheses

If we generate three WTA estimates:

WTA0 = WTA from the Standard U Model

WTA1 = WTA from the Subjective Beliefs U Model

CEWTA1 = CEWTA from the Subjective Beliefs U Model

Hypothesis 1: WTA0 ≠ WTA1 for BMP attributes

Hypothesis 2: WTA1 ≠ CEWTA1 for BMP attributes

Hypothesis 3: WTA0 = CEWTA1 for BMP attributes

Hypothesis 4: WTA0 = WTA1 = CEWTA1 for non-BMP attributes

Remember, $\frac{dU}{dX} = \frac{\partial U}{\partial X} + \frac{\partial U}{\partial E}\frac{\partial E}{\partial X}$

WTA Results: Conditional Logit Models OLS for Runoff Model

	1: No Subjective Beliefs	2: Subjective Beliefs, Standard Formula	3: Subjective Beliefs, CE WTA
Width	**$1.22**	**$1.45**	**$1.23**
Paperwork	**$8.66**	**$8.52**	**$8.61**
Years	$2.29	$2.29	$2.27
SQ Preference	**$62.69**	**$83.15**	**$58.30**

Test for Differences between WTA Estimates (p values)

	1 vs. 2	1 vs. 3	2 vs. 3
Width	**< 0.005**	0.348	**< 0.005**
Paperwork	0.356	0.671	0.567
Years	0.987	0.904	0.933
SQ Preference	**< 0.005**	0.148	**< 0.005**

Bolded values indicate statistical significance at the 5% confidence level.
Statistical inference obtained using bootstrapping with 1,000 replications.

WTA Results: Conditional Logit Models Tobit for Runoff Model

	1: No Subjective Beliefs	2: Subjective Beliefs, Standard Formula	3: Subjective Beliefs, CE WTA
Width	**$1.22**	**$1.45**	**$1.08**
Paperwork	**$8.66**	**$8.52**	**$8.55**
Years	$2.29	$2.29	$2.26
SQ Preference	**$62.69**	**$83.15**	**$57.53**

Test for Differences between WTA Estimates (p values)

	1 vs. 2	1 vs. 3	2 vs. 3
Width	**< 0.005**	**< 0.005**	**< 0.005**
Paperwork	0.481	0.520	0.890
Years	0.987	0.892	0.934
SQ Preference	**< 0.005**	0.230	**< 0.005**

Bolded values indicate statistical significance at the 5% confidence level.
Statistical inference obtained using bootstrapping with 1,000 replications.

Endogeneity

Control Function Approach to endogeneity

Use field characteristics as instruments in Runoff model

- Soil type
- Distance from field edge to surface water
- Interactions with filter strip width

Results: Control Function

	No Control Function	OLS First Stage	Tobit First Stage
Payment	**0.012**	**0.013**	**0.013**
	(< 0.005)	(< 0.005)	(< 0.005)
Width	**-0.018**	**-0.019**	**-0.018**
	(< 0.005)	(< 0.005)	(0.022)
Paperwork	**-0.108**	**-0.108**	**-0.108**
	(< 0.005)	(< 0.005)	(< 0.005)
Years	-0.029	-0.029	-0.029
	(0.113)	(0.111)	(0.115)
SQ ASC	**1.052**	1.102	**1.027**
	(< 0.005)	(0.064)	(0.045)
Runoff	**-0.024**	-0.028	-0.021
	(< 0.005)	(0.527)	(0.549)
Control Fn		0.005	-0.002
		(0.919)	(0.950)

Bolded values indicate statistical significance at the 5% confidence level. P values in parentheses.

Summary and Conclusion

Problem if $X_{ni} \neq X^*_{ni}$

When $\frac{\partial E}{\partial X} \neq 0$, WTA estimates are altered if E is included in the model

Evidence that CEWTA generates the policy-relevant WTA of the standard utility model in the subjective beliefs utility model

Endogeneity concerns:

- Instruments & Control Function
- Individual effects from panel data
- Method of eliciting E might impact endogeneity
- No-instrument endogeneity fix?

Thanks!!

Questions/Comments?

WTA Results: Mixed Logit Models

	1: No Subjective Beliefs	2: Subjective Beliefs, Standard Formula	3: Subjective Beliefs, CE WTA
Width	**$1.11**	**$1.45**	**$1.16**
Paperwork	**$9.50**	**$9.20**	**$9.09**
Years	**-$19.67**	**-$17.36**	**-$17.42**
SQ Preference	**$98.00**	**$95.79**	**$66.08**

Test for Differences between WTA Estimates (p values)

	1 vs. 2	1 vs. 3	2 vs. 3
Width	0.602	0.904	**< 0.005**
Paperwork	0.920	0.891	0.525
Years	0.378	0.390	0.901
SQ Preference	0.927	0.173	**< 0.005**

Bolded values indicate statistical significance at the 5% confidence level.
Statistical inference obtained using bootstrapping with 50 replications.

Papers that have this issue

Jaeck and Lifran 2014

Ma, Swinton, Lupi and Jolejole-Foreman 2012

Canales et al 2015

No-instrument fix

Consider attributes X, subjective beliefs E and unobservables W

Assuming E is correlated with X, the standard utility model is given by

$$U_{ni} = \widehat{\beta^x} X_{ni} + \varepsilon_{ni},$$

Where $\widehat{\beta^x} = \beta^x + \beta^E * \delta^x$

From this, we can back out the unbiased coefficient for E:

$$\beta^E = \frac{\widehat{\beta^x} - \beta^x}{\delta^x},$$

Where $\widehat{\beta^x}$ is estimable in the standard utility model, β^x is estimable from the subjective belief utility model, and δ^x is estimable from the subjective belief model