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**A Theoretical and Empirical Analysis of Transaction
Value Embedded in Stated Preference Data**

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ABSTRACT

The economic theory of the scope test and of transaction value in stated preference (SP) data is analyzed. Scope tests are applied to several contingent valuation studies to determine whether willingness to pay (WTP) is derived from consumption or from transaction value. Although the *scope insensitivity hypothesis* is rejected, WTP may be overestimated due to the inclusion of transaction value. A choice experiment (CE) is analyzed, to estimate the effects of transaction value in SP data. The empirical results show that the WTP is overestimated due to the inclusion of transaction value. (JEL Q26)

Keywords

transaction value, scope test, choice experiment, stated preference

I. INTRODUCTION

The *scope insensitivity hypothesis* represents one of the main criticisms of the contingent valuation (CV) method. Kahnemann and Knetsch (1992) showed that CV survey respondents do not place different values on goods of varying scope. Diamond et al. (1993), Desvousges et al. (1993), and Schkade and Payne (1994) demonstrated likewise. Kahnemann and Knetsch argued that this apparent insensitivity to scope is due to the inability of respondents to base their WTP on environmental resource valuation. Instead, the WTP derived from CV surveys represents the value derived from moral satisfaction or the “warm glow” effect.

Although individuals clearly derive value from consuming goods and services, they may also derive utility from the act of giving (Olsen 1965; Becker 1974; Andreoni 1989, 1990). Proposed guidelines for CV surveys conducted by The National Oceanic and Atmospheric Administration (NOAA) panel define the latter as "transaction value", and recommend that this value be deflected (Arrow et al., 1993).

Carson et al. (1996) argued that scope test failures can be attributed to one of three factors: (i) a lack of statistical power used to detect value differences, (ii) problems with the design of CV surveys, or (iii) CV survey results that violate economic theory. Carson (1995) found that 31 studies rejected the *scope insensitivity hypothesis* while four did not; and that these four suffered from either small sample size or poor survey design.

However, does the rejection of the *scope insensitivity hypothesis* imply that the WTP of survey respondents represents the value of environmental resources rather than a measure of transaction value? This paper analyzes a model of transaction value and the scope test. In section II, money measures of the change in environmental quality and transaction value are defined, along with ex-ante and ex-post transaction values. The ex-ante measure is defined as the transaction value allocated to initial environmental quality; the ex-post measure represents the value of final environmental quality.

Scope tests for ex-ante and ex-post money measures of transaction value are analyzed in section III. The scope test cannot determine whether the respondents' WTP is derived from the value of the environmental change or from the ex-post transaction

value. Furthermore, even if the WTP does not represent ex-post transaction value, it may be overestimated because transaction value is included. Section IV presents an empirical study. The *scope insensitivity hypothesis* and *no transaction value hypothesis* are discussed. Section V provides conclusions.

II. A MODEL OF TRANSACTION VALUE

Consider an individual who derives a warm glow of satisfaction from voluntarily contributing to environmental change. Assume that the individual consumes one unit of a commodity associated with this contribution. The individual maximizes the following utility function:

$$\begin{aligned} & \text{Max} U(\mathbf{x}, q, k) \\ & \text{s.t. } \mathbf{p}\mathbf{x} = M \end{aligned} \quad (1)$$

where U is the utility function, \mathbf{x} is the vector of private goods ($\mathbf{x} = x_1, x_2, \dots, x_n$), \mathbf{p} is the vector of prices ($\mathbf{p} = p_1, p_2, \dots, p_n$), q represents the quality of environmental resources, M is income, and k defines the warm glow of satisfaction ($k=0$ or 1). The individual does not pay prior to the environmental change, and therefore there is no warm glow ($k=0$). Following the environmental change, the individual receives the warm, glowing feeling ($k=1$). Further assume a typical, well-behaved utility function. When q , k , and M are held constant, the solutions of (1) represent uncompensated demand functions:

$$\mathbf{x} = \mathbf{x}(\mathbf{p}, q, k, M) \quad (2)$$

Substituting the expressions for \mathbf{x} into the utility function gives the indirect utility function:

$$\begin{aligned} U &= U(\mathbf{x}(\mathbf{p}, q, k, M), q, k) \\ &= V(\mathbf{p}, q, k, M) \end{aligned} \quad (3)$$

Welfare can be defined for changes in environmental quality q . Assume that environmental quality changes from q^0 to q^1 . When the environmental quality is q^0 , the individual does not pay for environmental change ($k=0$). After changing to q^1 , the individual is assumed to pay ($k=1$). The compensating surplus measure of total value (CS_t) that includes the value of the environmental change and the transaction value is the solution to

$$V(\mathbf{p}, q^0, 0, M) = V(\mathbf{p}, q^1, 1, M - CS_t) = U^0 \quad (4)$$

CS_t can also be defined by using the expenditure function:

$$\begin{aligned} CS_t(q^0, q^1) &= e(\mathbf{p}, q^0, 0, U^0) - e(\mathbf{p}, q^1, 1, U^0) \\ &= \mathbf{ph}(\mathbf{p}, q^0, 0, U^0) - \mathbf{ph}(\mathbf{p}, q^1, 1, U^0) \end{aligned} \quad (5)$$

where U^0 is the initial utility level, $e(\cdot)$ is the expenditure function, and \mathbf{h} is the Hicks-compensated demand function.

Similarly, the transaction value -- the money measure of the warm, glowing feeling -- can be defined by using the indirect utility function:

$$V(\mathbf{p}, q, 0, M) = V(\mathbf{p}, q, 1, M - CS_k) = U \quad (6)$$

CS_k is the compensating surplus of the transaction value with environmental quality held at q and utility at U . In this model, individuals experience the warm, glowing feeling even without a change in environmental quality. Or, using the expenditure function,

$$\begin{aligned} CS_k(q, U) &= e(\mathbf{p}, q, 0, U) - e(\mathbf{p}, q, 1, U) \\ &= \mathbf{ph}(\mathbf{p}, q, 0, U) - \mathbf{ph}(\mathbf{p}, q, 1, U) \end{aligned} \quad (7)$$

CS_k can be defined for all q and all U . However, only two money measures are considered: the ex-ante and the ex-post compensating surplus of transaction value. The ex-ante compensating surplus ($CSEA_k$) is the compensating surplus of transaction value with environmental quality held at the initial level q^0 and utility held at the initial level U^0 . The ex-post compensating surplus ($CSEP_k$) is the compensating surplus at the final level q^1 , with utility at its initial level.

$$\begin{aligned}
CSEA_k(q^0, q^1) &= CS_k(q^0, U^0) \\
&= e(\mathbf{p}, q^0, 0, U^0) - e(\mathbf{p}, q^0, 1, U^0) \\
CSEP_k(q^0, q^1) &= CS_k(q^1, U^0) \\
&= e(\mathbf{p}, q^1, 0, U^0) - e(\mathbf{p}, q^1, 1, U^0)
\end{aligned} \tag{8}$$

The value of the environmental change (CS_q) -- i.e. the removal of the transaction value from the total value of this change -- can be defined as the difference between CS_t and $CSEP_k$:

$$\begin{aligned}
CS_q(q^0, q^1) &= CS_t - CSEP_k \\
&= e(\mathbf{p}, q^0, 0, U^0) - e(\mathbf{p}, q^1, 1, U^0) \\
&\quad - e(\mathbf{p}, q^1, 0, U^0) + e(\mathbf{p}, q^1, 1, U^0) \\
&= e(\mathbf{p}, q^0, 0, U^0) - e(\mathbf{p}, q^1, 0, U^0)
\end{aligned} \tag{9}$$

III. THE SCOPE TEST OF TRANSACTION VALUE

The scope test is used in many CV studies to identify whether respondents' willingness to pay is derived from the money measure of environmental change or from transaction value. It examines whether respondents are willing to pay more for a good of greater quality or quantity.

Consider three states: q^0 , q^1 , and q^2 ($q^0 < q^1 < q^2$). The scope test compares the

WTP for the change from q^0 to q^1 ($WTP(q^0, q^1)$) and from q^0 to q^2 ($WTP(q^0, q^2)$). If the WTP of respondents is the total value (CS_t), the difference between these WTPs is

$$\begin{aligned}
& WTP(q^0, q^2) - WTP(q^0, q^1) \\
&= CS_t(q^0, q^2) - CS_t(q^0, q^1) \\
&= e(q^0, 0, U^0) - e(q^2, 1, U^0) - e(q^0, 0, U^0) + e(q^1, 1, U^0) \\
&= e(q^1, 1, U^0) - e(q^2, 1, U^0)
\end{aligned} \tag{10}$$

(with \mathbf{p} omitted due to constant prices). This generally exceeds zero. If the WTP of respondents is the ex-ante compensating surplus of transaction value ($CSEA_k$), the difference between these WTPs is equal to zero.

$$\begin{aligned}
& WTP(q^0, q^2) - WTP(q^0, q^1) \\
&= CSEA_k(q^0, q^2) - CSEA_k(q^0, q^1) \\
&= CS_k(q^0, U^0) - CS_k(q^0, U^0) \\
&= 0
\end{aligned} \tag{11}$$

Therefore, the rejection of the *scope insensitivity hypothesis* implies that WTPs are not ex-ante money measures of transaction value ($WTP \neq CSEA_k$). However, this does not mean that the transaction value equals zero. Firstly, a scope test cannot identify whether the WTPs are the total value or ex-post transaction value ($CSEP_k$). When the WTPs represent ex-post transaction value, the difference between these WTPs will not generally equal zero, except in cases where CS_k is constant for q :

$$\begin{aligned}
& WTP(q^0, q^2) - WTP(q^0, q^1) \\
&= CSEP_k(q^0, q^2) - CSEP_k(q^0, q^1) \\
&= CS_k(q^2, U^0) - CS_k(q^1, U^0) \\
&= e(q^2, 0, U^0) - e(q^2, 1, U^0) - e(q^1, 0, U^0) + e(q^1, 1, U^0)
\end{aligned} \tag{12}$$

Secondly, even if the WTPs represent total value (CS_t) rather than transaction value

($CSEP_k$), they may include an ex-post transaction value ($CSEP_k$). When the WTPs represent total value, the difference between WTPs will generally not equal zero.

$$\begin{aligned}
 & WTP(q^0, q^2) - WTP(q^0, q^1) \\
 &= CS_t(q^0, q^2) - CS_t(q^0, q^1) \\
 &= CS_q(q^0, q^2) - CS_q(q^0, q^1) + CSEP_k(q^0, q^2) - CSEP_k(q^0, q^1)
 \end{aligned} \tag{13}$$

Therefore, even if the *scope insensitivity hypothesis* is rejected, the WTPs may include some amount of ex-post transaction value. The WTPs may overestimate the value of the environmental change, because they include this value of ex-post transaction value. Expressions (10) - (13) produce the following proposition:

PROPOSITION (Scope Test)

The scope test can generally identify whether the measures of willingness to pay (WTPs) are the total value (CS_t) or the ex-ante money measure of transaction value ($CSEA_k$). However, it generally cannot identify whether the WTPs are the total value (CS_t) or the ex-post transaction value ($CSEP_k$). Furthermore, even if the WTPs represent the total value rather than the transaction value, the WTPs may include a measure of the ex-post transaction value ($CSEP_k$), thereby overestimating the value of the environmental change ($WTP > CS_q$). Thus, rejection of the scope insensitivity hypothesis does not imply an absence of transaction value.

IV. EMPIRICAL STUDY

This empirical study estimates WTPs using choice experiment (CE) data -- a method of multi-attribute preference-elicitation used widely in marketing research, transportation studies, and psychometrics (Louviere, 1988 and 1994). Choice experiment is a type of conjoint analysis: respondents are asked to choose their

preferred profile of attributes from a given group. Previous CE studies of environmental valuation include Adamowicz et al. (1994, recreation), Boxall et al. (1996, hunting), Adamowicz et al. (1997, hunting), Adamowicz et al. (1995; 1998, habitat protection), Kuriyama (1997; 1998a, ecosystem protection), and Kuriyama and Ishii (1998b; recycled wood wastes).

The data is from a stated preference survey of residents of Sapporo, Japan, using the mole-intercept interview method. A questionnaire was developed to evaluate a protected area for a wetland ecosystem¹ near Kushiro. The following CE question was posed to participants:

Let us assume the following 5 environmental proposals for the protection of the Kushiro wetland ecosystem, and that your choice affects which proposal is chosen. Which do you prefer?

Figure 1 Map of the Protected Area

Table 1 Protection Alternatives for the Wetland Ecosystem

We conducted a mole-intercept survey on the general public in Sapporo, Japan on August 1995. The sample size was 845, the protest bid was 71, and the valid sample for the CE was 670. Assume the following indirect utility function:

$$U_{ij} = V_{ij} + \varepsilon_{ij} \quad (14)$$

where U_{ij} is the total utility derived by individual i from alternative j . V_{ij} is the observable component of the total utility, and ε_{ij} is the unobservable component. McFadden (1974) showed that if the error terms in (14) are independently and identically distributed with type I extreme-value distribution (Gumbel distribution), then

¹ Survey details are described in Kuriyama (1998a).

the choice probability P_{ij} has a closed-form representation:

$$P_{ij} = \frac{e^{\lambda V_{ij}}}{\sum_k e^{\lambda V_{ik}}} \quad (15)$$

where λ is a scale parameter conventionally normalized to one. McFadden's model is known as a conditional logit model.

Consider the following two models:

$$\text{Model 1:} \quad V_{ij} = \beta_T T_{ij} + \beta_{\log Q} \log(Q_j) \quad (16)$$

$$\text{Model 2:} \quad V_{ij} = \beta_T T_{ij} + \beta_{\log Q} \log(Q_j) + \beta_S k_{ij} \quad (17)$$

where T_{ij} is individual i 's payment, and Q_j is the protected area of alternative j . Transaction value is described in k_{ij} as a dummy variable: $k_{ij} = 1$ when the payment exceeds zero and $k_{ij} = 0$ when the payment is zero. The β s represent parameters. The questionnaire was based on voluntary payment; this increased the likelihood of the 'warm glow' response, relative to a tax payment (Andreoni 1989). Table 2 shows the payment mechanism used in the survey.

Table 2 Payment Mechanism

The value of environmental change from Q_1 to Q_j can be estimated by

$$CS_q = \frac{\beta_{\log Q}}{\beta_T} (\log Q_1 - \log Q_j) \quad (18)$$

Consider the following two hypotheses.

Internal scope insensitivity hypothesis: $\beta_{\log Q} = 0$

No transaction value hypothesis: $\beta_S = 0$

If $\beta_{\log Q}$ is equal to zero, then the WTPs are not affected by the change of Q and the *internal scope insensitivity hypothesis* is not rejected. This is the internal scope test that uses the survey data from questioning the same respondents. Carson et al.(1996) argue that internal scope tests have much greater statistical power than external scope tests, which rely upon asking two different sub-samples. If β_k is equal to zero, there is no utility gained by making a voluntary payment, and consequently no difference between the WTPs of models 1 and 2.

Table 3 shows the results of the conditional logit models. These models were estimated by the maximum likelihood method (using LIMDEP). In both models the *scope insensitivity hypothesis* is rejected at $p < 0.001$. However, the *no transaction value hypothesis* is rejected. The individual may have a transaction value from contributing to public good, and the estimated WTPs may include a value of ex-post transaction value.

Table 3. Results of the Conditional Logit Models

Table 4 shows the estimated WTPs of both models. While WTP 1 is the estimated willingness to pay for environmental change from Q_1 to Q_j using the parameters of model 1, WTP 2 is estimated by using the parameters of model 2. Note that WTP 1 is the total value (*CS_t*), which may include transaction value, and WTP 2 is the environmental value (*CS_q*). The ratio of WTP 1 to WTP 2 is roughly 1.5; WTP 1 is overestimated because of the effect of transaction value.

Table 4 Estimated WTPs^a

V. CONCLUSIONS

Transaction value is embedded in stated preference data. The results above demonstrate that:

- (i) The scope test cannot identify whether WTP represents the compensating

surplus from environmental change or the ex-post compensating surplus of transaction value. Even if WTPs do represent total value, they may include a measure of ex-post transaction value, and therefore may overestimate the value of the environmental change.

(ii) The empirical study shows that transaction value can exist even if the *scope insensitivity hypothesis* is rejected. The WTPs estimated by the usual model are roughly 1.5 times larger than the WTPs estimated by the model that eliminates the effects of transaction value.

Following its recommendation to deflect transaction value, the NOAA panel stated that "Because of various possible biases, a discount factor is included in the proposed rule to apply to estimated WTP. The proposed rule gives a default factor of fifty percent for the purposes of soliciting comment." (NOAA, 1996). The above results demonstrate that stated WTP is overestimated because of the inclusion of transaction value, and that the appropriate calibration factor is 67 percent when payment is voluntary (as opposed to 50 percent). The estimation of transaction values and calibration factors for other payment methods, such as taxes or price increases, deserves further study.

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Table 1. The Protection Alternatives of the Wetland Ecosystem

No	Description	Payment
1	status-quo	T _{i1}
2	Additional protection of the wetland outside the National Park	T _{i2}
3	Additional protection of the forest around the rivers and lakes	T _{i3}
4	Additional protection of all forest around the wetland	T _{i4}
5	Additional protection of all land around the wetland	T _{i5}

Table 2. Payment Mechanism

yen / year / household

No	T ₁	T ₂	T ₃	T ₄	T ₅
1	0	20	100	300	600
2	0	40	200	500	1,000
3	0	60	300	800	1,500
4	0	80	400	1,000	1,900
5	0	100	600	1,500	2,900
6	0	100	800	2,000	3,900
7	0	200	1,100	3,000	5,800
8	0	300	1,900	5,000	9,700
9	0	600	3,000	8,000	15,400
10	0	700	3,800	10,000	19,300
11	0	1,000	5,700	15,000	29,000
12	0	1,400	7,600	20,000	38,600
13	0	2,100	11,400	30,000	57,900
14	0	2,800	15,200	40,000	77,200
15	0	3,500	19,000	50,000	96,500

Table 3. The Result of Conditional Logit Analysis

Model 1

Variable	Coefficient	t statistics	P-Value
COST	-0.0001282	-11.613	0.000
LogQ	1.217	12.622	0.000
Log likelihood	-928.17		
n	670		
Pseudo R2	0.139		

Model 2

Variable	Coefficient	t statistics	P-Value
COST	-0.0001524	-11.880	0.000
LogQ	0.967	9.254	0.000
S	1.818	9.957	0.000
Log likelihood	-857.03		
n	670		
Pseudo R2	0.204		

Table 4. The Estimated WTPsa

Q ha	WTP1 ^b \$/year/household	WTP2 ^c \$/year/household	WTP2/WTP1
Q1 26,861	0 [0.0 - 0.0] ^d	0 [0.0 - 0.0]	-
Q2 31,361	15 [13.4 - 17.5]	10 [8.4 - 12.0]	0.67
Q3 51,361	63 [55.9 - 73.2]	42 [35.1 - 50.3]	0.67
Q4 91,361	120 [105.7 - 138.2]	80 [66.3 - 94.9]	0.67
Q5 151,361	169 [149.2 - 195.2]	113 [93.7 - 134.0]	0.67

NOTE:

- a The unit of the variable of T is yen and these values in this table are converted the unit from yen to dollar (\$1=102.91 yen).
- b WTP1 is the estimated WTP by model 1 and it may include the transaction value.
- c WTP2 is the estimated WTP by model 2. WTP2 is pure value of environmental change.
- d The numbers in the brackets are 95% confidential intervals which are obtained by the method of Krinsky and Robb (1986), and based on 1000 random draws.

FIGURE 1. Map of the Protected

