The Disparity between WTP and WTA with or without Money

Koichi KURIYAMA
School of Political Science and Economics
Waseda University
1-6-1 Nishi-Waseda, Shinjuku-ku
Tokyo 169-8050, JAPAN
Tel/Fax: +81 3 5286 9822
E-mail: kkuri@mn.waseda.ac.jp

Kenji TAKEUCHI
Department of Economics
Kobe University

July 2001
Draft

ABSTRUCT

We have developed theoretical models of non-monetary willingness-to-pay (WTP) and willingness-to-accept compensation (WTA) for quantity change of public goods, and analyzed the disparity between non-monetary WTP and WTA. Our results show that there is a strong similarity between the monetary WTP/WTA disparity and non-monetary WTP/WTA disparity: both being influenced by the substitution effect. However, large WTP/WTA disparity does not imply large non-monetary WTP/WTA disparity. Empirical results show that large WTP/WTA disparity in monetary valuation case, however, non-monetary WTP is close to non-monetary WTA. (JEL Q2)

The Disparity between WTP and WTA with or without Money

Koichi KURIYAMA and Kenji TAKEUCHI[1]

Compensation for environmental degradation can take two forms: pecuniary and non-pecuniary. Under pecuniary compensation, environmental damages are evaluated in monetary terms, and the polluter pays victims a cash settlement. Non-pecuniary compensation consists of "in kind" payments, such as supplying public goods to offset the loss in utility arising from environmental degradation. Either way, compensation for environmental degradation is necessary when mandated under certain legislative provisions. The Comprehensive Environmental Response, the Compensation and Liability Act of 1980 (CERCLA) and the Oil Pollution Act of 1990 (OPA) of the United States are a few examples of such provision under the spirit of the public trust doctrine.

In monetary valuation format, contingent valuation (CV) has been used traditionally been used to estimate the use and non-use value of environmental resources (Carson et al., 1995). One of debate over CV is the disparity between willingness to pay (WTP) and willingness to accept compensation (WTA) . In many empirical CV studies, large difference between WTP and WTA has been demonstrated. Brown and Gregory (1999) reviewed CV studies comparing WTP and WTA and most studies have reported that WTA/WTP ratios ranged from 2 to 5.

Willig (1976) showed that the differences between compensating variation and equivalent variation for price changes depended on income elasticity of demand for the good in question and consumer surplus as a percentage of income. Randall and Stoll (1980) extended Willig's analysis to welfare measures for quantity changes and they showed that the differences between WTP and WTA depended on income elasticity of the demand price for quantity, which is sometime called the price flexibility of income. Hanemann (1991) showed that income elasticity of the demand price can be expressed as the ratio of the income elasticity of demand for quantity and the elasticity of substitution between quantity and the composite goods.

While many empirical and theoretical studies analyzed the disparity between monetary WTP and WTA, there is only a few study for the disparity between non-monetary WTP and WTA. As we will show later, we compared the disparity between WTP and WTA with or without money. We found that large WTP/WTA disparity in monetary valuation case, however, non-monetary WTP is close to non-monetary WTA. Furthermore, they reported fairly stable marginal rate of substitutes between public in both monetary and non-monetary cases.

The purpose of this paper is to develop economic model for non-monetary WTP and WTA, and analyze the WTP/WTA disparity between monetary and non-monetary format. By the latter, we show that the smaller the substitution effect the greater the disparity between non-monetary WTP and WTA. Furthermore, even if the disparity between monetary WTP and WTA is large, non-monetary WTP can be equal to non-monetary WTA. Section I provides economic models of non-monetary WTP and WTA. In section II, we extend Randall and Stoll's model and Hanemann's model to non-monetary WTP/WTA disparity. Section III provides the numerical

[1] Kuriyama: School of Political Science and Economics, Waseda University, 1-6-1 Nishi-Waseda, Shinjuku-ku, Tokyo 169-8050, JAPAN (e-mail: kkuri@mn.waseda.ac.jp). Takeuchi: Department of Economics, Kobe University, 2-1 Rokkodai, Nada-ku, Kobe, JAPAN (e-mail: takeuchi@econ.kobe-u.ac.jp). This study was funded by the "Research for the Future" program of the Japan Society for the Promotion of Science (JSPS). We thank Toyoaki Washida.

example of our model and section IV presents the empirical analysis of monetary and non-monetary WTP/WTA disparities. Finally, section V provides concluding comments.

I. Non-Monetary Measures of Quantity Change

Assume individual's utility function is $u(\mathbf{x}, q, z)$, where x is a vector of the quantities of market goods, q and z are vectors of the quantities or qualities of public goods. The utility maximization problem can be expressed as

(1) $$\underset{\mathbf{x}}{Max}\, u(\mathbf{x}, q, z) \quad s.t. \sum_i p_i x_i = M$$

where p is a vector of prices and M is income. The solution leads to a set of ordinary demand function $x_i = x_i(\mathbf{p}, q, z, M)$. Individual's indirect utility function is $v(\mathbf{p}, q, z, M) = u(\mathbf{x}(\mathbf{p}, q, z, M), q, z)$. Suppose that q is increasing from q^0 to q^1 ($q^0 < q^1$). The monetary welfare measure of this change in q , compensating and equivalent surplus, are solution to

(2) $$\begin{aligned} v(\mathbf{p}, q^0, z, M) &= v(\mathbf{p}, q^1, z, M - C) \\ v(\mathbf{p}, q^0, z, M + E) &= v(\mathbf{p}, q^1, z, M) \end{aligned},$$

where C is the compensating surplus and E is the equivalent surplus. The expenditure minimization problem is

(3) $$\underset{\mathbf{x}}{Min} \sum_i p_i x_i \quad s.t.\, u(\mathbf{x}, q, z) = u^0,$$

which yields a set of compensated demand function $h_i = h_i(\mathbf{p}, q, z, u^0)$ and expenditure function $e(\mathbf{p}, q, z, u^0) = \sum_i p_i h_i(\mathbf{p}, q, z, u^0)$. In term of expenditure function, the compensating and equivalent surplus can be expressed as

(4) $$\begin{aligned} C &= e(\mathbf{p}, q^0, z, u^0) - e(\mathbf{p}, q^1, z, u^0) \\ E &= e(\mathbf{p}, q^0, z, u^1) - e(\mathbf{p}, q^1, z, u^1) \end{aligned}.$$

Hanemann (1999) shows that the difference between ES and CS is

(5) $$E - C = -\int_{q^0}^{q^1} \int_{u^0}^{u^1} e_{qu}\, dq\, du\,.$$

This means that the disparity between E and C depends on the size of e_{qu}.

Now consider non-monetary measures of change in q: non-monetary compensating surplus and equivalent surplus. Non-monetary compensating surplus gives the maximum (minimum) amount of other public goods (say, z) that can be taken from (must be give to) individual while leaving it just as well off as it was before increasing (decreasing) in q. Non-monetary equivalent surplus gives the minimum (maximum) amount of other public goods (z) that can be must be given to (taken from) individual to make it as well off as it would have been after increasing (decreasing) in q. Then non-monetary measures are solution to

$$v(\mathbf{p},q^0,z,M)=v(\mathbf{p},q^1,z-C^Z,M) \qquad (6)$$
$$v(\mathbf{p},q^0,z+E^Z,M)=v(\mathbf{p},q^1,z,M)$$

where C^Z is non-monetary compensating surplus and E^Z is non-monetary equivalent surplus measured by z. A sign of C^Z and E^Z is equal to a sign of the utility difference from change in q. When q is increasing, C^Z measures non-monetary WTP (C^Z=WTP^Z) and E^Z measures non-monetary WTA (E^Z=WTA^Z) which are measured by change in z. The indirect utility function $v(\mathbf{p},q,z,M)=u^0$ may be inverted to obtain $z=z(\mathbf{p},q,M,u^0)$, non-monetary expenditure function of z. Using this function, CZ and EZ can be written as

$$C^Z=z(\mathbf{p},q^0,M,u^0)-z(\mathbf{p},q^1,M,u^0) \qquad (7)$$
$$E^Z=z(\mathbf{p},q^0,M,u^1)-z(\mathbf{p},q^1,M,u^1).$$

Then the disparity between C^Z and E^Z is

$$E^Z-C^Z=-\int_{q^0}^{q^1}\int_{u^0}^{u^1} z_{qu}\,dq\,du. \qquad (8)$$

Thus the disparity between C^Z and E^Z depends on the size of z_{qu}.

In order to compare (5) with (8), it is convenient to introduce virtual price of the public goods. Assume that individual could purchase q at a price π and z at ω. Then the utility maximization problem can be expressed as

$$\underset{\mathbf{x},q,z}{Max}\, u(\mathbf{x},q,z) \quad s.t. \sum_i p_i x_i+\pi q+\omega z=M \qquad (9)$$

which generates a set of ordinary demand functions $x_i=\hat{x}_i(\mathbf{p},\pi,\omega,M)$, $q=\hat{q}(\mathbf{p},\pi,\omega,M)$ and $z=\hat{z}(\mathbf{p},\pi,\omega,M)$. For given p, q, z and M, simultaneous equations of $\hat{q}$ and $\hat{z}$ may be solved to obtain the demand price functions $\pi=\hat{\pi}(\mathbf{p},q,z,M)$ and $\omega=\hat{\omega}(\mathbf{p},q,z,M)$

The dual to (9) is expenditure minimization problem:

$$\underset{\mathbf{x},q,z}{Min} \sum_i p_i x_i+\pi q+\omega z \quad s.t.\, u(\mathbf{x},q,z)=u^0 \qquad (10)$$

This yields a set of compensated demand functions $h_i=h_i(\mathbf{p},\pi,\omega,u^0)$, $q=\hat{q}^h(\mathbf{p},\pi,\omega,u^0)$ and $z=\hat{z}^h(\mathbf{p},\pi,\omega,u^0)$. $\hat{q}^h$ and $\hat{z}^h$ hold usual property of compensated demand function of private goods, including Shepard's lemma $e_\pi=q, e_\omega=z$. Simultaneous equations of $\hat{q}^h$ and $\hat{z}^h$ may be solved to obtain the compensated demand price functions $\pi=\hat{\pi}^h(\mathbf{p},q,z,u^0)$ and $\omega=\hat{\omega}^h(\mathbf{p},q,z,u^0)$. First order condition of (10) implies $\pi/\omega=v_q/v_z$.

It follows from definition of non-monetary expenditure function that

$$u^0=v(\mathbf{p},q,z(\mathbf{p},q,M,u^0),M) \qquad (11a)$$

$$M=e(\mathbf{p},q,z(\mathbf{p},q,M,u),u). \qquad (11b)$$

Differentiation of (11a) yields

$$z_q(\mathbf{p},q,M,u^0)=-\frac{v_q}{v_z}=-\frac{\pi}{\omega} \qquad (12)$$

(13) $$\zeta_z \equiv \frac{\partial z}{\partial q}\cdot\frac{q}{z} = -\frac{\pi}{\omega}\cdot\frac{q}{z},$$

where ξ_z is *the quantity elasticity of non-monetary expenditure function*. Thus a derivative of non-monetary expenditure function for q is equal to an absolute value of marginal rate of substitution between q and z, and it is equal to ratio of virtual prices. Differentiation of (11b) by q yields

(14) $$z_{qu} = \frac{e_{qz}z_u + e_{qu} + (e_{zz}z_u + e_{zu})\cdot z_q}{e_{qz}z_u + e_{zq} + (e_{zz}z_q + e_{zu})\cdot z_q}\cdot z_{qq}$$

which implies the difference between non-monetary WTP and WTA depends on the convexity of the non-monetary expenditure function (z_{qq}).

II. The Elasticity of Substitution and The Disparity between Non-Monetary WTP and WTA

Randall and Stoll show that the difference between WTP and WTA for quantity change depend on income elasticity of the demand price for quantity:

(15) $$E - C \approx \frac{\eta_\pi S^2}{M}$$

where η_π is the income elasticity of the demand price for quantity, and S is consumer's surplus. Hanemann (1991) showed that η_π can be written as

(16) $$\eta_\pi = \frac{\eta_q}{\sigma}$$

where η_q is the income elasticity of demand for q, σ is the Allen-Uzawa elasticity of substitution between q and the composite goods.

We extend Randall and Stoll's analysis to the difference between non-monetary WTP and WTA. Suppose that the demand price ratio θ is the ratio of the demand price π of public good q and the demand price ω of z ($\theta = \pi/\omega$). We can define *quantity elasticity of the demand price ratio*:

(17) $$\eta_\theta = \frac{\partial \theta}{\partial z}\frac{z}{\theta}.$$

From (12), $z_q = -\theta$. Integrating this, as Randall and Stoll's analysis, yields

(18) $$C^z = z - z\left[1 - \frac{1-\eta_\theta}{z}\Delta\right]^{\frac{1}{1-\eta_\theta}}$$
$$E^z = z\left[1 + \frac{1-\eta_\theta}{z}\Delta\right]^{\frac{1}{1-\eta_\theta}} - z$$

where $\Delta = \int_{q^0}^{q^1}\theta(q,z)dq$. Applying a Taylor approximation, we can obtain

(19) $$E^z - C^z \approx \frac{\eta_\theta \Delta^2}{z}$$

This implies the difference between non-monetary WTP and WTA depends on the quantity elasticity of the demand price ratio η_θ. This results is similar to Randall and Stoll's results (15).

Now consider that the relation between quantity elasticity of the demand price ratio and the elasticity substitution between q and z. Allen-Uzawa elasticity substitution between q and z is defined to

(20) $$\sigma_{qz} = -\frac{\partial\left(\hat{q}^h / \hat{z}^h\right)}{\partial(\pi/\omega)} \cdot \frac{(q/z)}{(\pi/\omega)}.$$

The ratio of compensated demand function of q and z is

(21) $$\frac{q^h}{z^h} = \frac{\hat{q}^h(p,\pi,\omega,u)}{\hat{z}^h(p,\pi,\omega,u)}.$$

Differentiation of this yields

(22) $$\frac{\partial\left(q^h/z^h\right)}{\partial z} = \frac{\partial\left(\hat{q}^h/\hat{z}^h\right)}{\partial(\pi/\omega)} \cdot \frac{\partial(\pi/\omega)}{\partial z}.$$

Converted to elasticity form, we can obtain

(23) $$\eta_\theta = -\frac{\eta_{qz}}{\sigma_{qz}}$$

where $\eta_{qz} = \frac{\partial\left(\hat{q}^h/\hat{z}^h\right)}{\partial z} \cdot \frac{z^2}{q}$ is the quantity elasticity of compensated demand ratio for q and z. This equation demonstrates that the extent of difference between CZ and EZ depend on substitution effects (σ_{qz}). When $\sigma_{qz} = \infty$ (perfect substitution between q and z), then $\eta_\theta=0$ and $C^Z=E^Z$. On the other hand, when there are no close substitutes between q and z, σ_{qz} is close to 0, leading a large difference between C^Z and E^Z.

Differentiation of the demand price ratio θ by M yields

(24) $$\theta_z = -\frac{1}{\hat{z}_M \cdot \omega^2}\left[\left(\hat{\pi}_M \omega - \hat{\omega}_M \cdot \pi\right) + \left(\hat{\pi}_q \omega - \hat{\omega}_M \cdot \pi\right) \cdot \hat{q}_M\right]$$

where all derivatives are evaluated at (**p**,π,ω,M+πq+ωz). Converted to elasticity form, this becomes

(25) $$\eta_\theta = \frac{-\eta_\pi + \eta_\omega - \left[\xi_\pi - \xi_\omega\right] \cdot \eta_q}{\eta_z}$$

where

$$\eta_q = \frac{\partial \hat{q}}{\partial M}\frac{M}{q}, \eta_z = \frac{\partial \hat{z}}{\partial M}\frac{M}{z}$$

is the income elasticity of demand function for q,

$$\eta_\pi = \frac{\partial \hat{\pi}}{\partial M}\frac{M}{\pi}, \eta_\omega = \frac{\partial \hat{\omega}}{\partial M}\frac{M}{\omega}$$

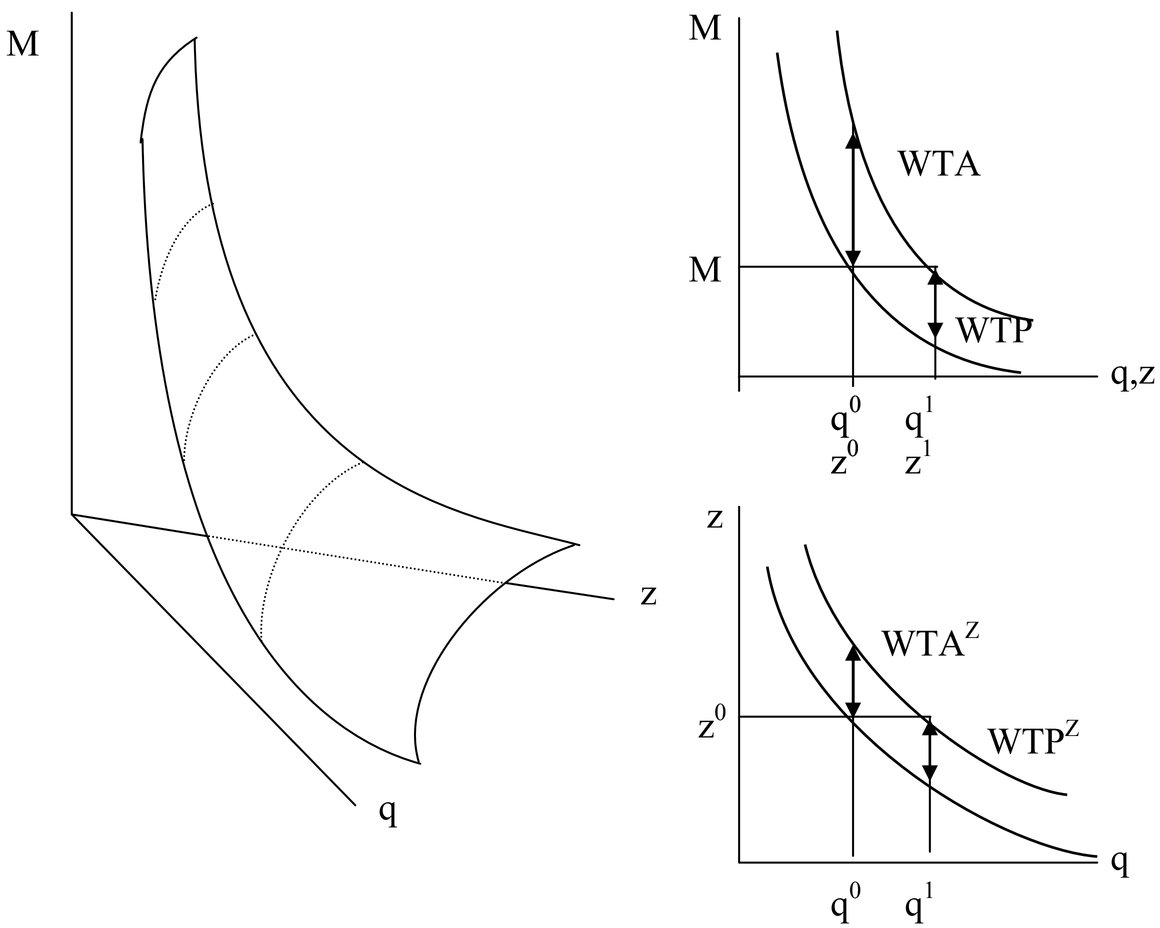
are the income elasticity of demand price functions, which are related to the disparity between WTP and WTA for change in q,

$$\xi_\pi = \frac{\partial \hat{\pi}}{\partial q}\frac{q}{\pi}, \xi_\omega = \frac{\partial \hat{\omega}}{\partial q}\frac{q}{\omega}$$

are the quantity elasticity of demand price functions. From equation (25), when $\eta_\pi \approx \eta_\omega$ and $\xi_\pi \approx \xi_\omega$, the differences between C^Z and E^Z could be close to 0, even if the disparity between C and E is large.

Figure 1 shows this situation. In this figure, the disparities between WTP and WTA for changes in q and z widen by the substitution effects, however, non-monetary WTP is close to non-monetary WTA because of high substitution between q and z.

Figure 1. monetary and non-monetary WTP/WTA disparities



To summarize, there is a strong similarity between the WTP/WTA disparity and non-monetary WTP/WTA disparity: both being influenced by the substitution effect. However, large WTP/WTA disparity does not imply large non-monetary WTP/WTA disparity. When elasticity of substitution between two public goods is high value, non-monetary WTP/WTA disparity could be close to 0, even if WTP/WTA disparity for quantity change is large.

III. Applications

For example, individual's utility function is assumed to be

(26) $$u = T\left(\left[M^{\frac{\sigma-1}{\sigma}} + K(\mathbf{p})\cdot \exp\left(\frac{\sigma}{\sigma-1}\cdot\frac{z^{1-\eta_\theta}}{1-\eta_\theta}\right)\cdot q^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \mathbf{p}\right)$$

where T is some function that is homogeneous of degree zero, increasing in its first argument, and non-increasing in its other arguments, K is some function which is homogeneous $(\sigma-1)/\sigma$. This is a special case of Hanemann's generalized CES utility model (Hanemann, 1991). The demand price ratio which is generated from (26) is

(27) $$\theta = \frac{u_q}{u_z} = \frac{z^{\eta_\theta}}{q}.$$

This implies quantity elasticity of the demand price ratio η_θ is constant. When q is increasing from q^0 to q^1, then non-monetary WTP and WTA measured by z is

(28) $$WTP^z = z^0 - \left[(1-\eta_\theta)\ln\left(\frac{q^0}{q^1}\right) + \left(z^0\right)^{1-\eta_\theta}\right]^{\frac{1}{1-\eta_\theta}}$$
$$WTA^z = \left[(1-\eta_\theta)\ln\left(\frac{q^1}{q^0}\right) + \left(z^0\right)^{1-\eta_\theta}\right]^{\frac{1}{1-\eta_\theta}} - z^0.$$

Thus $WTP^Z = WTA^Z$ when $\eta_\theta=0$, the non-monetary WTP/WTA disparity is infinity when $\eta_\theta = \infty$.

On the other hand, monetary WTP and WTA for change in q are

(29) $$WTP = M - \left[M^{1-\eta_\pi} + k(\mathbf{p})\exp\left(\frac{\sigma}{\sigma-1}\cdot\frac{z^{1-\eta_\theta}}{1-\eta_\theta}\right)\left((q^0)^{\frac{\sigma}{\sigma-1}} - (q^1)^{\frac{\sigma}{\sigma-1}}\right)\right]^{\frac{\sigma-1}{\sigma}}$$
$$WTA = \left[M^{1-\eta_\pi} + k(\mathbf{p})\exp\left(\frac{\sigma}{\sigma-1}\cdot\frac{z^{1-\eta_\theta}}{1-\eta_\theta}\right)\left((q^1)^{\frac{\sigma}{\sigma-1}} - (q^0)^{\frac{\sigma}{\sigma-1}}\right)\right]^{\frac{\sigma-1}{\sigma}} - M$$

When σ is low value, the WTP/WTA disparity could be large. Table 1 shows the results of simulations of monetary and non-monetary WTP/WTA disparities. This table demonstrates non-monetary WTP/WTA disparity could be close to 0, even if monetary WTP/WTA disparity is large.

TABLE 1 Simulations of monetary and non-monetary WTP/WTA disparities for a generalized CES utility model

K	η_θ	σ	WTA^Z	WTP^Z	WTA^Z/WTP^Z	WTA	WTP	WTA/WTP
1	1.1	1.4	14.907	3.515	4.242	3.074	3.008	1.022
0.5	0.001	0.1	1.100	1.100	1.000	0.165	0.162	1.016
20	0.001	0.114	1.100	1.100	1.000	47.725	8.245	5.788
0.0001	1.2	0.47	25.430	3.670	6.930	256.105	39.464	6.490

Note: M=100, q^0=1, q^1=3, z^0=5

IV. Empirical Results

This empirical study uses survey data concerning the provision of protection from oil spills in Tokyo Bay, Japan. A sample of households were asked questions that requested choices of policy on oil spill prevention in Tokyo bay[2]. There could be various kinds of damage by oil spill at Tokyo bay area, because of its congested sea traffic, dense population and diversity in land use.

Our survey questionnaire firstly explains the scenario assuming that a large oil spill, the size of 150,000 kiloliter, happens at Tokyo bay within ten years. The details of damages caused by the spill are explained next. There are four kinds of the damages. 1) Areas of beach and fishing recreation site polluted by the oil ("recreation" attribute), 2) the number of people who feel smell of oil and dizziness ("health" attribute), 3) areas of tideland ("tideland" attribute), 4) the number of commercial fishing port ("fishery" attribute). To avoid these damages, the government has to prepare additional measure. However, it is not possible to prevent all of the damages because of the budget limitation. Therefore, the respondent faces the tradeoff between these attributes, which has the priority to be saved.

Table 2 shows the sub-sample group prepared for comparison. In the second column, "type" indicates how subject described. Description contains "protection" and "damage". For example, "100% protection of commercial fishing port" means same thing as "0% damage to commercial fishing port". Thus, difference in "type" is only rhetorical.

TABLE 2 Sub-sample Groups

	Type	Public Goods Attribute	Money Attribute
Group A	Protection	Yes	WTP
Group B	Protection	Yes	None
Group C	Damage	Yes	WTA
Group D	Damage	Yes	None

"Public goods attribute", which are common to all sub-samples, involves attributes of "recreation", "health", "tideland", and "fishery". "Money attribute" shows whether the attribute relates to money is included or not, and whether included money attribute is "WTP (Willingness To Pay to avoid the damages by oil spill)" or "WTA (Willingness To Accept compensation in exchange to damages by oil spill)".

Figure 2 shows example of profiles and Table 3 shows levels that are given to each attribute. Respondents choose most preferable profile from three alternative policy profiles as Figure 2. This kinds of survey is frequently termed as "choice experiment" or "choice-based conjoint analysis".

Figure 2 Example of Card in Questionnaire (Group A)

No.	1	2	3
Cost (increment in tax payment)	90,000 yen	90,000 yen	0 yen
Recreation site	69% protection	24% protection	7% protection
Smell and Dizziness	No one	10,000 people	10,000 people
Tideland	90% protection	24% protection	24% protection
Fishery	66% protection	100% protection	66% protection

TABLE 3 Summary of the Levels Given to Attributes

WTP	5,000 yen	10,000 yen	30,000 yen	90,000 yen
WTA	0.1 m. yen	0.2 m. yen	0.5 m. yen	1 m. yen
Recreation site	7%	24%	69%	93%
Health	No one	10,000 people		
Tideland	24%	48%	79%	90%
Fishery	66%	100%		

Note: Percentages show ratios of protection to full-damage, i.e. damage when oil spill which size is 1,5000 kiloliter occurs without any additional policy measure. We subtracted these figures from 1 to make profiles for Sub-sample Group C and D.

We assume that the respondent i's utility function of choosing alternative j (U_{ij}) is represented by

$$U_{ij} = V_{ij} + \varepsilon_{ij} = V(\mathbf{x_{ij}}) + \varepsilon_{ij} = \beta' \mathbf{x_{ij}} + \varepsilon_{ij} \qquad (30)$$

where V_{ij} is a deterministic component of utility, ε_{ij} is a stochastic component of utility, x_{ij} is a vector of the attributes of alternative j, and β is a vector of parameters. Let P_1 be the probability that a respondent choose profile 1 from three profiles. That is, the probability of the utility of choosing profile 1 is higher than choosing other profiles. McFadden (1974) show that when the distribution of the error term ε_{ij} is Gumbel, the probability can be as;

$$P_1 = \frac{\exp(V_1)}{\sum_k \exp(V_k)} \qquad (31)$$

This is so called conditional logit model. The log likelihood function is

$$\log L = \sum_i \sum_j d_j \ln \frac{\exp(V_1)}{\sum_k \exp(V_k)} \qquad (32)$$

where d_j is dummy variable which is 1 when the respondent choose profile j, otherwise zero. Parameters of the

[2] For more details about the survey, see Takeuchi et al. (2000).

attributes are estimated by maximizing the log likelihood function.

Estimated parameters were shown in Table 4. The "money" variable means attribute relating to money, that is, increment in tax payment for group A and decrease in tax payment for group C. All coefficients except "recreation" variable of group A are significant at 5%.

TABLE 4 Estimated parameters

	Sub-sample Groups			
Variables	Group A	Group B	Group C	Group D
Money	-0.173		0.002	
	(-12.07)		(2.23)	
Recreation	0.049	0.556	0.380	0.506
	(0.70)	(6.05)	(4.83)	(5.68)
Health	0.605	1.059	0.544	0.957
	(10.34)	(16.74)	(8.81)	(15.73)
Tideland	0.589	1.405	0.777	1.262
	(5.89)	(11.21)	(7.34)	(10.49)
Fishery	0.857	2.453	1.157	2.478
	(5.11)	(13.10)	(6.75)	(13.63)
Sample Size	1024	960	1024	992
Log Likelihood	-1728.43	-1460.41	-1676.84	-1539.70

Note: The numbers in the parenthesis indicates t-ratio.

Assuming linearity between marginal WTP and WTP, Monetary Willingness To Pay (M-WTP) and Willingness To Accept (M-WTA) for attribute s can be calculated by

(33) $$M\text{-}WTP_s = -\frac{\beta_s}{\beta_T} * 100 \quad , \quad M\text{-}WTA_s = \frac{\beta_s}{\beta_T} * 100$$

where β_s is the coefficients of the attribute s and β_T is the coefficient of offered bid. Non-Monetary Willingness To Pay (NM-WTP) and Willingness To Accept (NM-WTA) can be calculated by

(34) $$NM\text{-}WTP_s = NM\text{-}WTA_s = \frac{\beta_s}{\beta_r} * 100 \quad .$$

As shown in Table 5, calculated monetary WTP-WTA disparity is large while calculated non-monetary WTP-WTA disparity is quite small.

TABLE 5 Comparison of Disparities

	M-WTP	M-WTA	M-WTA /M-WTP	NM-WTP	NM-WTA	NM-WTA /NM-WTP
Recreation	2,800	1,592,800	568.857			
Health	35,000	2,278,100	65.089	190.5	189.0	0.992
Tideland	34,100	3,255,300	95.463	252.9	249.3	0.986
Fishery	49,600	4,845,600	97.694	441.3	489.4	1.109

Note: NM-WTP and NM-WTA are calculated with coefficient of recreation attribute as denominator. NM-WTP was calculated from estimated model of Group C, while NM-WTA was calculated from that Group D. $1 = 115.98 yen on January 1999.

V. Conclusion

We have developed theoretical models of non-monetary WTP and WTA for quantity change of public goods, and analyzed the disparity between non-monetary WTP and WTA. Our results show that there is a strong similarity between the monetary WTP/WTA disparity and non-monetary WTP/WTA disparity: both being influenced by the substitution effect. Thus non-monetary WTP/WTA disparity could range from 0 to infinity. However, large WTP/WTA disparity does not imply large non-monetary WTP/WTA disparity. When the elasticity of substitution between two public goods is high value, non-monetary WTP/WTA disparity could be close to 0, even if WTP/WTA disparity for quantity change is large. Therefore asymmetry between monetary and non-monetary WTP/WTA disparity, which was founded by our empirical analysis, is consistent with standard economic theory.

While a large disparity between monetary WTP and WTA have been observed in many CV studies, there is only a few study for the disparity between non-monetary WTP and WTA. Further studies will be necessary to analyze the non-monetary WTP/WTA.

References

Brown, Thomas C. and Gregory, Robin. “Why the WTA–WTP disparity matters.” *Ecological Economics*, 1999, *28*(3), pp. 323–35.

Carson, Richard T., Wright, Jennifer, Carson, Nancy, Alberini, Anna and Flores, Nicholas. “A Bibliography of Contingent Valuation Studies and Papers.” CA. San Diego.: Natural Resource Damage Assessment, Inc., 1995.

Hanemann, W. Michael. "Willingness to pay and willingness to accept: How much can they differ?." *American Economic Review*, June 1991, *81* (3), pp. 635-47.

Hanemann, W. Michael. “The Economic Theory of WTP and WTA,” in Bateman, Ian J. and Willis, Ken. G. eds., *Valuing Environmental Preferences: Theory and Practice of the Contingent Valuation Method in the US, EU, and Developing Countries*. Oxford University Press, 1999, pp. 42-96.

McFadden, Danniel. “Conditional Logit Analysis of Qualitative Choice Behavior,” in Zarembka, Paul. eds., *Frontiers in Econometrics*. New York, Academic Press, 1974, pp. 105-142.

Takeuchi, Kenji, Kuriyama, Koichi and Washida, Toyoaki. “Environmental Valuation with or without Money: A Conjoint Analysis of Oil Spill Prevention in Tokyo Bay.” Paper presented at the Kobe Conference on the Theory and Application of Environmental Valuation, Kobe University, Kobe, Japan. January, 2000

Randall, Alan and Stoll, John R. "Consumer's Surplus in Commodity Space." *American Economic Review*, June 1980, *70*(3), pp. 449-55

Willig, Robert D. "Consumer's Surplus without Apology." *American Economic Review*, September 1976, *66*(4), pp. 589-97