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# Measurement of Use and Non-use Values of Shirakami Mountain Range by using CVM Consistent with TCM

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**Abstract:** In this study, we have constructed a valuation model based on the CVM consistent with the TCM, in order to measure the use and the non-use values of environmental goods consistently. And the practicality of our model has been examined, by applying this model to measurement of environmental economic value of Shirakami Mountain Range. The result indicated that the non-use value was estimated 1,028 JPY/person/year everywhere in Japan, and that the use value was estimated as 11,154 JPY/person/year in Aomori where is the local area of Shirakami Mountain Range, 5,579 JPY/person/year in Tokyo, 3,759 JPY/person/year in Osaka, and 2,666 JPY/person/year in Fukuoka.

**JEL classification:** L83, Q26, Q51

**Keywords:** *travel cost method, contingent valuation method, use value, non-use value, Shirakami Mountain Range*

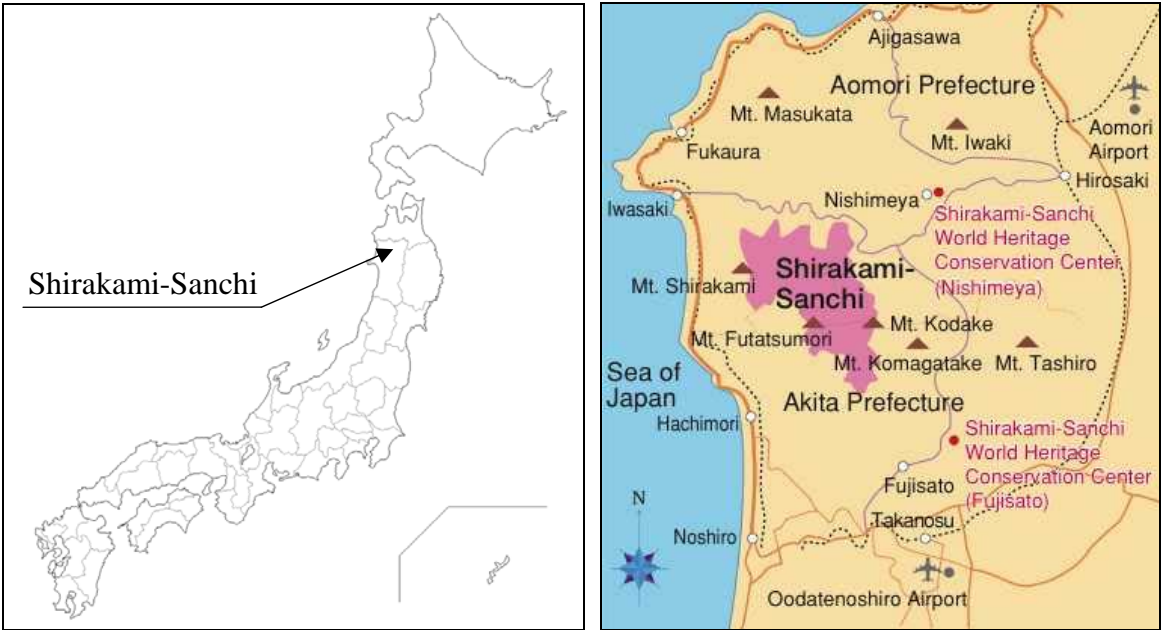
## 1. Introduction

In 1993, Shirakami Mountain Range (Shirakami-Sanchi) was registered into the UNESCO World Heritage (Natural Heritage) along with Yaku Islands (Yaku-Shima) for the first time in Japan. Shirakami-Sanchi is the general name for the mountainous region, which has 450 km<sup>2</sup> areas and is located on the prefectural borders of the southwestern part of Aomori Prefecture and the northwestern part of Akita Prefecture as shown in Figure 1. The heritage site has 170 km<sup>2</sup> areas and is located at the heart of the mountains, and has the largest primeval beech forest in the world.

The beech forest in Shirakami-Sanchi has diverse plant communities and abundant animal groups. More than 500 plant species have been identified from Shirakami-Sanchi. All mammals found in northern Honshu exist in the area, other than two species whose existence is restricted by heavy snowfall. The 87 bird species currently identified from the area include Golden eagle, which has limited breeding record and is endangered in Japan (Ministry of the Environment, 2013).

Generally, beech forest has interest and important public functions; the land and water conservation function, the health and recreation function, the regional promotion function, and so on. These functions of beech forest must give people much benefit. However, the decline of beech forest progresses by global warming in recent years.

This study aims to provide the basic unit of economic evaluation, which is needed when cost-effectiveness concerning the protection for such beech forest will be examined, and tries to measure environmental economic value of Shirakami-Sanchi by using the travel cost method (TCM) and the contingent valuation method (CVM).



Source) Ministry of the Environment (2006)

Figure 1: Location maps of Shirakami-Sanchi

## **2. Review of precedent studies**

The TCM and the CVM are well-known as the typical technique of environmental economic valuation. The TCM can measure only the direct and current use value of environmental goods, but the CVM can measure the whole value including the non-use value of them. In the practice of environmental economic valuation, it is often adopted that the use value is measured by the TCM and that the non-use or the whole values are measured by the CVM. However, there is no statistical significance in the difference between those values measured by the TCM and the CVM, because these methods are modeled independently and have no theoretical consistency. In this study, we construct a valuation model based on the CVM consistent with the TCM, in order to measure the use and the non-use values of environmental goods consistently.

Quite many studies on environmental economic evaluation by the TCM and/or the CVM have so far been accumulated. And many studies which compared the result of the TCM with the result of the CVM also exist (Carson et al., 1996). Some studies tried to compensate the uncertainty of the stated preference method, CVM, by the certainty of the revealed preference method, TCM.

However, there are not many studies which argued about the theoretical compatibility of the CVM and the TCM. Huang et al. (1997) indicated that the values evaluated by three methods changed consistently on the range of the object of evaluation; where three methods are the CVM, the TCM under stated preference, and the combined method of the CVM and the TCM. Nakatani et al. (2003) proposed a method to eliminate the overestimation by the embedding effect in the CVM using the estimated values by the TCM under stated preference, and provided more reliable estimation.

Furthermore, the TCM and the CVM are partial equilibrium approaches for individual cases, and it is difficult to measure ripple effects through the economy. Sakamoto and Nakajima (2012) developed a theoretical framework of the computable general equilibrium model consistent with the utility function derived from the tourism demand function estimated by the TCM.

Then, we will construct a valuation model based on the CVM consistent with the TCM, in order to measure the use and the non-use values of environmental goods consistently, and examine the practicality of the method, in this study.

### 3. Evaluation model

When we construct an evaluation model consistent based on the CVM consistent with the TCM, individual utility function  $U$  is specified as a function of numeraire demand  $m$ , leisure demand  $n$  and tourism demand  $x$ . But labor supply  $l$  is not included in the utility function. Then we assume that people maximize one's utility  $U$  by controlling  $m$ ,  $n$  and  $x$  under income and time constraints, and one's behavior is formulated as follows.

$$\max_{m, n, x} U = \alpha \cdot m + \beta \cdot n + \gamma \cdot x \cdot (\ln[x] - f[q] - 1) + \delta \cdot q \quad (1)$$

$$s.t. \quad c_0 \cdot m + c \cdot x = w \cdot l \quad (2)$$

$$t_0 \cdot n + t \cdot x + l = T \quad (3)$$

$$f[q] = \gamma_1 + \gamma_2 \cdot \ln[q] \quad (4)$$

where  $m$ : numeraire demand,

$n$ : leisure demand,

$x$ : tourism demand to Shirakami-Sanchi,

$l$ : labor supply,

$q$ : quality level of Shirakami-Sanchi,

$c_0$ : unit price of numeraire ( $c_0 = 1$ ),

$t_0$ : unit time consumption of leisure ( $t_0 = 1$ ),

$c$ : transport cost to visit Shirakami-Sanchi,

$t$ : transport time to visit Shirakami-Sanchi,

$w$ : wage rate,

$T$ : total time, and

$\alpha, \beta, \gamma, \gamma_1, \gamma_2, \delta$ : unknown parameters.

Equation (1) is formulated so that a tourism demand function is derived as an exponential function as equation (6). Equations (2) and (3) mean income and time constraints, respectively. By combining equations (2) and (3), an integrated constraint is derived as follows.

$$s.t. \quad m + w \cdot n + (c + w \cdot t) \cdot x = I \quad (5)$$

$$I = w \cdot T \quad (6)$$

Then, by solving the optimization problem formulated as equations (1) and (5), demand

functions are derived as follows.

$$x = \exp[f[q] + \gamma_3 \cdot (c + w \cdot t)] \quad (7)$$

$$m + w \cdot n = I - (c + w \cdot t) \cdot \exp[f[q] + \gamma_3 \cdot (c + w \cdot t)] \quad (8)$$

$$\gamma_3 = \alpha / \gamma \quad (9)$$

And, by substituting equations (7) and (8) in equation (1), indirect utility function is derived as follows.

$$V = \alpha \cdot I - \frac{\alpha}{\gamma_3} \cdot \exp[f[q] + \gamma_3 \cdot (c + w \cdot t)] + \delta \cdot q \quad (10)$$

The second term of the right side of equation (10) means consumer surplus  $CS$  of tourism demand shown by equation (7).

$$CS = \int_{c+w \cdot t}^{\infty} \exp[f[q] + \gamma_3 \cdot p] dp = -\frac{1}{\gamma_3} \cdot \exp[f[q] + \gamma_3 \cdot (c + w \cdot t)] \quad (11)$$

Then, equation (10) is reformulated as follows.

$$V = \alpha \cdot (I + CS) + \delta \cdot q \quad (12)$$

Equation (10) means that indirect utility level  $V$  is a function of income  $I$ , consumer surplus  $CS$  and environmental quality level  $q$ .

Now, based on the equivalent surplus, we define the value of environmental quality. The equivalent surplus  $ES$  concerning to environmental change of Shirakami-Sanchi is indicated as follows.

$$ES = (I^1 - I^0) + (CS^1 - CS^0) + \frac{\delta}{\alpha} \cdot (q^1 - q^0) \quad (13)$$

where superscript 0: the case without environmental preservation, and  
superscript 1: the case with environmental preservation.

In the right side of equation (13), the first term can be interpreted as the change of income, the

second term is the change of use value (recreational value) of environmental quality, and the third term is the change of non-use value of environmental quality. When the quality level in the case without environmental preservation assumed to be zero and the quality level in the case with environmental preservation assumed to be present level, the ES of equation (13) means the value of present environmental quality.

**4. Interview survey**

Interview survey has been implemented at Shirakami-Sanchi, in order to estimate utility function which is used for benefit measurement of environmental preservation. The survey was entitled as “the attitude survey on use and preservation of Shirakami-Sanchi”. It was held on the Shirakami-Sanchi World Heritage Conservation Center Fujisato-kan in Akita prefecture, 18-19 August and 8-9 October in 2011, and the Shirakami-Sanchi Visitor Center in Aomori prefecture, 8-9 October in 2011. Respondents were visitors to Shirakami-Sanchi through these facilities, where people would collect tourism information.

We have got 226 samples totally. Basic statistics of respondents in this survey are shown in Table 1.

Table 1: Basic statistics of respondents

Gender	Proportion	Age	Proportion	Occupation	Proportion
Male	51.33%	under 29	14.60%	Company employee	46.46%
Female	48.67%	30-39	18.14%	Self-employed person	4.42%
Total	100.00%	40-49	22.57%	National public official	1.33%
		50-59	17.26%	Local public official	7.52%
		over 60	27.43%	Organization staff	3.98%
		Total	100.00%	Part-time worker	6.64%
				Househusband/wife	12.39%
				Student	3.10%
				No occupation	12.39%
				Others	1.33%
				No reply	0.44%
				Total	100.0%

The survey form was constructed by using the computer system. Questions were indicated in the monitor, respondents touched the keyboard when they answered, and their answers were input the EXCEL sheet automatically. Questions are based on and the contingent valuation method (CVM) and the travel cost method (TCM), and consist of 8 parts as follows.

< Questions based on the CVM >

1. Degree of recognition on feature of Shirakami-Sanchi,
2. Degree of interest on influence due to global warming in Shirakami-Sanchi,
3. WTP for avoiding damage due to global warming in Shirakami-Sanchi,

< Questions based on the TCM >

4. Frequency of tourism to Shirakami-Sanchi,
5. Place of residence, in order to estimate the transport cost and time, and

< Other questions >

6. Personal attributes; gender, age, occupation, and so on.

As introduction of survey, we prepared some general questions about Shirakami-Sanchi which has some functions; the species preservation function, the cultivation function for land, and the recreation function for people. The main question is concerning to the willingness to pay (WTP) for avoiding damage in Shirakami-Sanchi, which is shown in Table 2. Now, we have 9 patterns of the suggested amount of money such as 3,000, 5,000, 1,000 JPY, in Table 2. The patterns are shown in Table 3.

Table 2: Sample of questionnaire sheet about the WTP

By a climate change in recent years, the near future has a possibility that the beech forest in Shirakami-Sanchi may decline. (Detailed explanation is omitted.)

However, in order to avoid such a situation, the fund for carrying out the further measure is needed. Then, we assume a policy to establish a new source of revenue for protecting the beech forest in Shirakami-Sanchi, Please answer to the following hypothetical questions.

In order to establish the new source of revenue as mentioned above, the household must pay an additional tax in the policy. The additional tax which you pay is used only for protecting beech forest in Shirakami-Sanchi, and all the purpose for spending is released. If you pay the tax, the goods and services which you can purchase, of course, decrease as much as you pay.

< 1<sup>st</sup> question >

If the additional tax is 3,000 JPY annually, do you agree with the policy?

1. YES
2. NO

< 2<sup>nd</sup> question: in the case that you answered “YES” at the 1<sup>st</sup> question >

If the additional tax is 5,000 JPY annually, do you agree with the policy?

1. YES
2. NO

< 2<sup>nd</sup> question: in the case that you answered “NO” at the 1<sup>st</sup> question >

If the additional tax is 1,000 JPY annually, do you agree with the policy?

1. YES
2. NO



Table 3: Patterns of the suggested amount of money

Pattern	提示金額 (円)			Number of samples
	1 <sup>st</sup> question	2 <sup>nd</sup> question ( YES at 1 <sup>st</sup> )	2 <sup>nd</sup> question ( NO at 1 <sup>st</sup> )	
1	100	300	50	27
2	300	500	100	26
3	500	700	300	26
4	700	1,000	500	24
5	1,000	3,000	700	24
6	3,000	5,000	1,000	24
7	5,000	7,000	3,000	25
8	7,000	10,000	5,000	25
9	10,000	30,000	7,000	25
Total				226

## 5. Estimation of evaluation model

When we estimate equation (7), which is the tourism demand function, by the TCM, the parameter  $\gamma_2$  assumes to be positive in equation (4).

$$f[q] = \gamma_1 + \gamma_2 \cdot \ln[q] \quad (4)'$$

where  $\gamma_2$ : positive value.

And, assuming that the quality level in the case without environmental preservation is zero ( $q^0 = 0$ ), and the level in the case with environmental preservation is present level ( $q^l = 0$ ), some tourism demand functions are set as follows.

< Case without environmental preservation >

$$x = \exp[\gamma_1 + \gamma_2 \cdot \ln[0] + \gamma_3 \cdot (c + w \cdot t)] = 0 \quad (14)$$

< Case with environmental preservation >

$$x = \exp[\gamma_1 + \gamma_2 \cdot \ln[1] + \gamma_3 \cdot (c + w \cdot t)] = \exp[\gamma_1 + \gamma_3 \cdot (c + w \cdot t)] \quad (15)$$

In this interview survey, we asked frequency of tourism to Shirakami-Sanchi only at present level, which is the level in the case with environmental preservation, so that the burden of reply does not become large. Therefore, only equation (15) as the tourism demand

function can be estimated in this study.

Substituting parameters  $\gamma_1$  and  $\gamma_3$  estimated by the TCM in equation (10), the remaining parameters  $\alpha$  and  $\delta$  are estimated by the CVM. Here, the income level  $I$  assumed not to be change even if the quality level  $q$  changed due to the environmental preservation. The utility levels in the case without and with environmental preservation,  $V^0$  and  $V^1$ , are set as follows.

$$V^0 = \alpha \cdot I^0 + \alpha \cdot CS^0 + \delta \cdot q^0 = \alpha \cdot I + \alpha \cdot CS^0 \quad (16)$$

$$V^1 = \alpha \cdot (I^1 - d) + \alpha \cdot CS^1 + \delta \cdot q^1 = \alpha \cdot (I - d) + \alpha \cdot CS^1 + \delta \quad (17)$$

where  $d$ : suggested amount of money.

Based on the random utility theory, we can express one's choice behavior as the following logit model.

$$P_{yes} = \frac{\exp[\omega \cdot V^1]}{\exp[\omega \cdot V^1] + \exp[\omega \cdot V^0]} = \frac{1}{1 + \exp[-\omega \cdot \{\alpha \cdot (CS^1 - CS^0 - d) + \delta\}]} \quad (18)$$

$$P_{no} = 1 - P_{yes} \quad (19)$$

where  $P_{yes}$ ,  $P_{no}$ : theoretical probability of one's decision to answer YES or NO, and

$\omega$ : parameter of variance (generally  $\omega = 1$  for convenience).

The simultaneous probability density function, that is likelihood function, is constructed by using equations (18) and (19). And unknown parameters of equation (10) are estimated by the maximum likelihood procedure, by applying one's choice behavior for agreement with the policy.

Finally, the WTP for avoiding damage in Shirakami-Sanchi, which is defined as the value of  $d$  when  $P_{yes} = 0.5$  in equation (18), is derived as follows.

$$WTP = (CS^1 - CS^0) + \frac{\delta}{\alpha} \quad (20)$$

Equation (20) is equal to the case of  $I^0 = I^1$ ,  $q^0 = 0$  and  $q^1 = 1$  in equation (13), and indicates that the WTP means the total of use value and non-use value.

The results of parameter estimation are shown in Tables 4 and 5. Table 4 indicates the estimated parameters of tourism demand function by the TCM. Table 5 indicates the estimated parameters of indirect utility function by the CVM. It is found that the estimated parameters  $\gamma_1$ ,  $\gamma_3$  and  $\alpha$  have enough statistical significance level because their t-values exceed 3.291 at the significance level 0.05%. Unfortunately, the estimated parameter  $\delta$  does not have enough statistical significance level. Now, the numbers of samples which are used for estimating

parameters of tourism demand function are 226, namely, all samples are valid responses for the TCM questions. On the other hand, the numbers of samples which are used for estimating parameters of indirect utility function are 224 (each sample has two responses), namely, 2 samples are invalid responses for the CVM questions.

Table 4: Estimated parameters by the TCM

Parameter	Estimated value	t-value
$\gamma_1$	-1.511	-11.702
$\gamma_3$	$-1.875 \times 10^{-5}$	-5.040
Correlation	0.319	
Samples	226	

Table 5: Estimated parameters by the CVM

Parameter	Estimated value	t-value
$\delta$	$1.512 \times 10^{-1}$	1.076
$\alpha$	$1.471 \times 10^{-4}$	6.100
Hit ratio	0.710	
Likelihood ratio	0.085	
Samples	448	

## 6. Measurement of WTP

The results which have measured environmental economic value of Shirakami-Sanchi are shown in Figures 2 and 3. Figure 2 shows the relation between the estimated values (use value, non-use value and whole value) and the generalized transport cost; where the values are expressed by the WTP for the environmental preservation of Shirakami-Sanchi. Figure 3 shows the estimated values for each prefecture in Japan.

Figure 2 indicated that the whole value was estimated as 6,679 JPY/person/year by using the precedent model which is the CVM which had no consistency with the TCM, but that the use value was estimated over 6,679 JPY/person/year in the area where the generalized transport cost is under about 30,000 JPY. That is to say, the precedent model produces some strange cases that the whole value is under the use value. On the other hand, by using our new model based on the CVM consistent with the TCM, the non-use value was estimated as 1,028 JPY/person/year, and the whole value was calculated by total of the use value and the non-use value. Then, there is no strange case noted above, in our new model. That is to say, our new model could measure the use and the non-use values of environmental goods consistently.

Figure 3 indicated that the non-use value was estimated 1,028 JPY/person/year everywhere in Japan, and that the use value was estimated as 11,154 JPY/person/year in Aomori where is the local area of Shirakami-Sanchi, 5,579 JPY/person/year in Tokyo, 3,759 JPY/person/year in Osaka, and 2,666 JPY/person/year in Fukuoka.

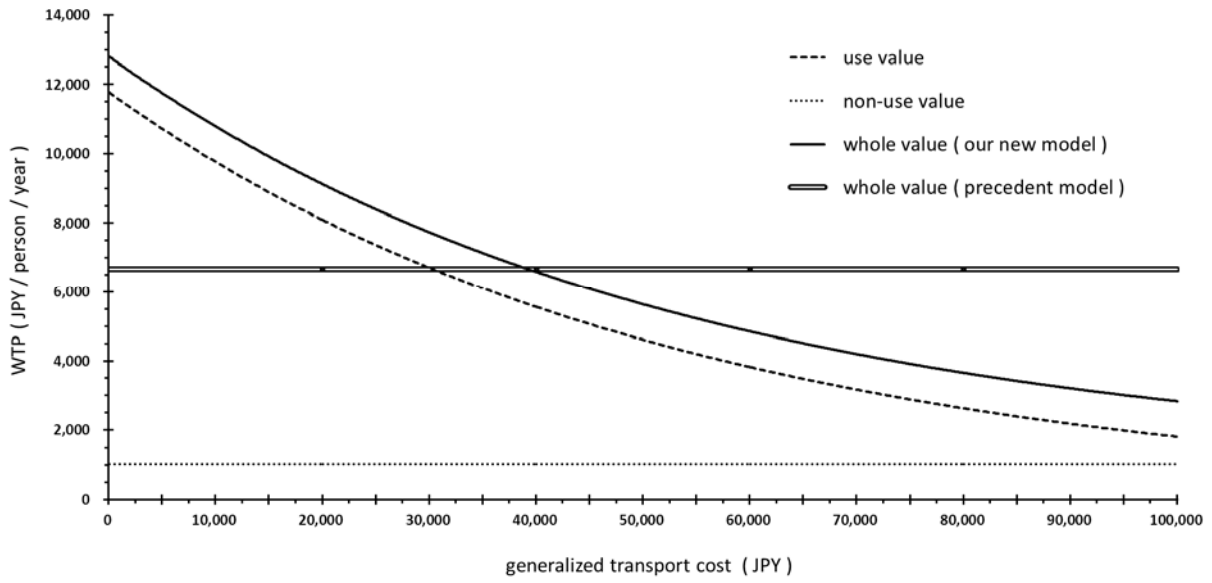


Figure 2: Relation between estimated values and generalized transport cost

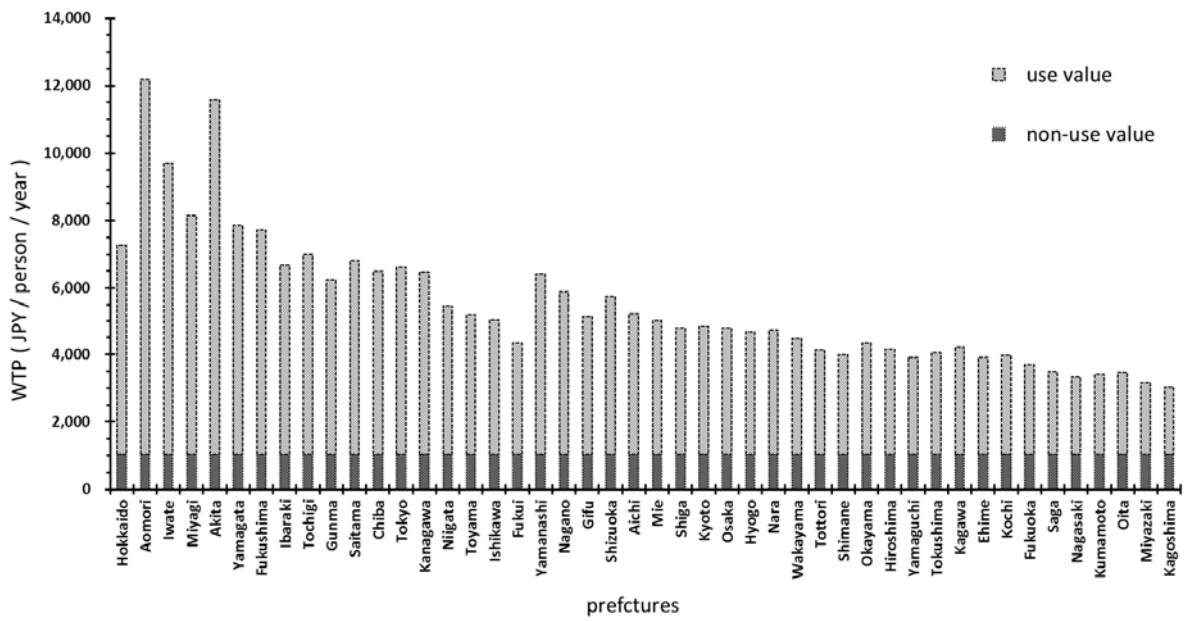


Figure 3: Estimated values for each prefecture in Japan

## 7. Concluding remarks

This study aims to construct a valuation model based on the CVM consistent with the TCM, in order to measure the use and the non-use values of environmental goods consistently, and to examine the practicality of our model has been examined by applying this model to Shirakami-Sanchi.

The result indicated that the WTP for the environmental preservation of Shirakami-Sanchi was estimated as 6,679 JPY/person/year by using the CVM which had no consistency with the TCM, but it was estimated as 1,028 JPY/person/year by using our model based on the CVM consistent with the TCM. Now, 6,679 JPY/person/year means the whole value of Shirakami-Sanchi, but 1,028 JPY/person/year means the non-use value. On the other hand, by using the TCM, the consumer surplus (CS) was estimated as 11,154 JPY/person/year in the local area of Shirakami-Sanchi and 5,579 JPY/person/year in Tokyo. Here, these values mean the use value of Shirakami-Sanchi. That is to say, the whole value was estimated as lower than the use value by using the CVM which had no consistency with the TCM. As a result, our model could measure the use and the non-use values of environmental goods consistently.

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