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Nonparametric Test of Net Economic Benefits by Open-Ended and Closed-Ended Contingent Valuations : An Application to Downhill Skiing in Muju, Korea*

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開放型과 閉鎖型質問에 의한 Contingent Valuation의 純經濟的 價値評價에 대한 非母數的檢定 : 무주리조트 스키장의 事例*

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ABSTRACT

The contingent valuation method(CVM) has been used to evaluate the economic value of nonmarket goods such as forest recreation. There are two commonly used CVM questionnaire formats: open-ended and closed-ended. This study evaluates the net economic value associated with day use downhill skiing, using CVM. A random, on-site survey of skiers in Muju, Korea generated the value estimates. In this paper a nonparametric test is introduced to find whether the difference between value estimates from open-ended and closed-ended formats are significantly different because the distributions of WTPs are non-normally distributed.

The results show that the net economic benefits of a skier in Muju varies from ₩15,131 to ₩25,332. The closed-ended values were 1.15 to 1.67 times as large as the open-ended values, depending on the model specifications. In nonparametric test the mean WTPs of the open-ended and close-ended applications are significantly different. Its reason may be that closed-ended can be more reducing the incentive for strategic behavior than open-ended question. However, we cannot conclude that the closed-ended method is superior to the open-ended method.

Key words : Contingent valuation method, willingness-to-pay, open-ended question, closed-ended question, nonparametric test.

要 約

최근 들어 contingent valuation method는 산림휴양자원과 같은 非市場財(nonmarket goods)의 경제적 가치평가에 널리 이용되고 있다. 이 방법에는 개방형(open-ended) 질문과 폐쇄형(closed-ended) 질문이 사용되어지는데, 어느 것이 경제적 가치를 적절히 평가하느냐에 관한 결론적 증거는 없다. 따라서 본 연구는 최근 산림휴양활동중 그 수요가 급격히 증가하는 겨울철 야외스포츠인 스키를 사례로 하여 무주리조트 스키장의 방문객들에게 개방형과 폐쇄형질문을 실시하여 두 설문기법간의 추정결과에 차이가 있는 지를 非母數的檢定(nonparametric test)을 통하여 검토하고자 수행되었다.

지금까지 외국에서 개발된 여러 非市場財의 가치평가 모형을 적용하여 경제적 가치를 計量化한 결과, 무주리조트 스키장을 이용하는 방문자 한 사람당 純經濟的便益은 15,131원에서 25,332원까지 나

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타났으며, 폐쇄형질문을 적용한 純經濟的價値가 개방형질문보다도 약 1.15배에서 1.67배까지 높게 나타났다. 非母數的檢定 결과 두 질문형태간에는 유의성이 있는 것으로 나타났다. 그 이유로는 폐쇄형질문이 개방형질문보다 전략적 편의(strategic behavior bias)의 발생을 줄일 수 있는 것으로 사료되나, 본 연구 결과로서는 폐쇄형 질문이 개방형 질문보다 더 효율적이라는 증거는 찾을 수 없었다. 따라서 contingent valuation을 이용하여 非市場財의 경제적 가치를 측정할 경우, 이 두 가지의 질문형태를 함께 고려하여 경제적 가치를 결정해야할 것으로 판단된다.

INTRODUCTION

The contingent valuation method(CVM) is one of the most often used to measure the economic value of nonmarket goods. This method draws out individual's maximum willingness to pay (MWTP) in the hypothetical market. This method elicits stated preferences from a sample of consumers using either open-ended questions that ask directly for MWTP, or closed-ended(referendum) questions that present a bid to the consumer, and ask for a "yes" or "no" vote on whether each bid exceeds the subject's willingness to pay(McFadden, 1994). A single referendum experiment presents only one bid ; a double referendum experiment presents the second bid that is conditioned on the subject of the response to the first bid, lower if the first response is "no" and higher if it is "yes"(Hanemann, Loomis, & Kanninen, 1991).

Both question formats are used to estimate the same underlying construct, maximum willingness to pay, but it is not clear whether the two methods yield the same contingent values in practice. Also, questions remain about appropriate question format when asking about valuation (Boyle & Bishop, 1988).

Within this context, this article evaluates net economic benefits of day use downhill skiing in Korea and compares the WTP outcomes obtained by open-ended and closed-ended questions. In recent years, demand for downhill skiing in Korea has rapidly increased. In the light of the growth of downhill skiing, information of the net economic benefits of the downhill skiing placed on it by participants is useful to land management and outdoor recreation planners(McCollum, Gillbert and Peterson, 1990). To obtain this valuation information this study analyzed data gathered from a random on-site survey of the skiers at Muju resort in Korea.

The paper is structured as follows : Section II describes and contrasts the open-ended approach with closed-ended suggested in literature by Bishop and Heberlein(1979), Hannemann(1984), Boyle and Bishop(1988), and Kriström(1990). Section III analyzed the net economic benefits of the case of downhill skiing in Muju using a random on-site data. Section IV compares the open-ended estimators with the closed-ended.

WELFARE MEASUREMENTS OF OPEN-ENDED AND CLOSED-ENDED QUESTIONS

Open-Ended Format

Open-ended questionnaires ask directly people to specify for their MWTP-"how much would you be willing to pay?". The argument in favor of this approach is that it is the simplest MWTP to interpret. An open-ended question produced a set of welfare measures $W_i(i=1, \cdots, n)$ for the n respondents in the sample. An estimate of the total value of the welfare change for the population from which the sample is drawn can be obtained by calculating the sample mean W^* and multiplying by the total population.

However, the open-ended format has several weaknesses. Freeman(1993) indicated major problems with this approach. First, it confronts people with an unfamiliar problem. In most real market settings, individuals faced with choices among sets of goods with listed prices. People have difficulty dealing with the open-ended form of direct question. Second, surveys using this form of elicitation method typically result in non-response and zero responses(so-called protest zero values) to the valuation question. Zero responses occur when respondents reject some aspect of the constructed market scenario by reporting a zero value even though they place a positive

value on the amenity or resource being valued.

Following standard practice in open-ended question analysis, the responses were screened to remove nonresponse and zero responses bias. Freeman(1993) suggested one way that individuals giving a zero WTP were asked which one applies ; 1)this was because I can't afford to pay for the goods, 2)because the goods are not important to me, and 3)because I don't think that I should have to pay for the goods. Respondents of those choosing the third statement would be classified as protest zeros and deleted from the sample, while responses of those choosing the first and second would be considered valid zeros.

Closed-Ended(Referendum) Format

In recent years, referendum procedures have tended to replace open-ended elicitations, because they circumvent a relatively high incidence of nonresponse found in open-ended studies(McFadden, 1994). Among referendum procedures, dichotomous choice(DC) using discrete response valuation questions is one of the most often used methods. This approach has several advantages as indicated by Freeman(1993), it mimics our day-to-day market decisions more closely than the open-ended questions and reduces the incentive for strategic behavior. The second advantage is that since only a "yes" or "no" answer is required, the referendum question format poses a relatively simple decision problem for individuals. The third advantage is that there is no reason to expect starting point bias of iterative bidding game. However, these advantage come at the price of being forced to use fairly involved statistical procedures, such as the goodness-of-fit and misspecification test of the model(Kriström, 1990 ; Ozuna, Jang, and Stoll, 1993).

DC approach was first used by Bishop and Heberlein(1979). It is simple to administer because no interviewer is required. In this approach the respondent is asked if they would be prepared to pay a specified amount. They respond "yes" or "no", and this response is recorded. Thus this has a dichotomous choice dependent variable. To move from this binary response model to determining MWTP requires making inferences of MWTP from the observed pattern of "yes" versus "no" responses. The response to Bishop and Heberlein's question is a discrete variable ; hence, they use logit analysis and estimate this curve by logistic regression, and proceed by observing that the area under this curve can be used to infer mean WTP. They calculate this area by numerical integration, ranging from 0 to maximum in the used bid-set.

Hanemann(1984) reconsidered the Bishop and Heberlein approach and investigated the theoretical motivation for DC model. He provides both a utility difference approach and a alternative derivation based on the relationship of the individual's unobserved true valuation compared to the offered threshold sum. Following Hanemann, we observe a yes-answer to a suggested cost A_i for an environmental change z^0 to z^1, where z is a vector describing the environment before and after the change if :

$$V(z^1,\ Y-A\ ;\ s)+\varepsilon_1 \geq V(z^0,\ Y\ ;\ s)+\varepsilon_0 \qquad (1)$$

where $V(\cdot)$ is the indirect utility function, Y is the individual's net income, s is a vector of household characteristics, and $\varepsilon_i(i=0,\ 1)$ is identically, independently distributed(i. i. d), random variables. This representation is often interpreted in terms of information about the utility function from the researcher's point of view. The utility function is assumed known by the individual, but can only be recovered up to a random component by the researcher. The probability that an individual accepts a given cost follows directly from (1) and can be written in two ways :

$$Prob\{individual\ willing\ to\ pay\}=F_\eta(\Delta v) \qquad (2)$$

where $F_\eta(\cdot)$ is the cumulative distribution function of $\eta=(\varepsilon_1-\varepsilon_0)$, Δv is a utility difference, $V(z^1, Y-A_i\ ;\ s)-V(z^0, Y\ ;\ s)$. Thus, by the definition of the expected value of a non-negative random variable

$$E(WTP) = \int_0^\infty F\{\Delta V(A)\}\ dA \qquad (3)$$

Boyle and Bishop(1988) suggested that an alternative estimate of value is obtained by truncating the tenth percentile of the distribution of WTP. Also, Hanemann(1989) agrees to base a welfare evaluation truncating the tenth or quartile percentile of the distribution of WTP. Thus, an alternative estimate is as follows :

$$E(WTP) = \int_0^{Price^{Pr=0.1}} F\{\Delta V(A)\}\, dA \qquad (4)$$

Kriström(1990) introduced the nonparametric approach for discrete response valuation experiments. These functions suggested by Bishop and Heberlein(1979) and Hanemann(1984) are faced with the risk of misspecifying the distribution function because an assumption is made about something we possibly cannot observe. It is well-known that, in general, the maximum-likelihood estimates of the parameters in F_η will be inconsistent if the distribution assumption is incorrect. Nonparametric approach of the functional form of the cumulative distribution function $F(\cdot)$ of WTP is not specified, but is instead estimated by a piecewise linear function. Kriström(1990) used a Distribution Free Maximum Likelihood (DFML) estimator of the probability for acceptance. This approach has two main advantages with the proposed estimator ; it is extremely simple to compute and robust against distributional misspecification.

AN EMPIRICAL APPLICATION

Study Design and Data Source

The theoretical definition of the value to be measured, the Hicksian equivalent variation, A, is defined as

$$U = V(p^0,\ Y-A\ ; s) = V(p^1,\ Y\ ; s)$$

where, U is the defined level of utility, $V(\cdot)$ is an indirect utility function, s is a vector of other observable attributes of the individual which might affect preferences, Y is an income, p^0 is the existing travel cost level of skiers' day trip, and p^1 is the increased travel cost that day use skiers' are assumed to face given increased travel cost, and trail fees. Thus, A is interpreted as WTP of Hicksian equivalent variation.

The data for this study were collected by on-site personal interviews with day use recreationists at the Muju resort downhill skiing site during Dec. 1995 to Jan. 1996. The study was conducted using both open-ended and closed-ended (double-bounded dichotomous choice) approaches and direct interviewers contact with skiers.

Among 150 open-ended questionnaires, 5 people were unusable because they had chosen the third statement suggested by Freeman(1993). In 150 DC questionaries, 3 people were deleted from the sample, because they had refused to participate.

Empirical Results

Open-Ended Format

The mean WTP for open-ended questions is ₩15,131.03 with a standard error of 1,463.94 (n=145). The median WTP is ₩10,000.

Closed-Ended(Dichotomous Choice) Format

Dichotomous choice values are derived using respondents answers with the first bids and second bids to estimated a logit model. The result is presented in Table 1.

To estimate the model $\triangle V$ within a logit framework produced the parameter estimates, we introduced four approaches ; Bishop and Heberlein (BH), Hanemann(HA), Boyle and Bishop(BB), and nonparametric approach suggested by Kriström(KR).

Table 1. Proportions of yes-answers.

Bid(Won)	Proportion Yes	Probability('yes')
1000	11 / 12	.9166
2000	10 / 12	.8333
3000	12 / 15	.8000
5000	16 / 34	.4705
10000	16 / 47	.3404
20000	8 / 31	.2581
30000	10 / 35	.2857
40000	2 / 10	.2000
50000	6 / 41	.1463
70000	2 / 22	.0909
100000	2 / 24	.0833
200000	0 / 11	.0000

Note. Bid is given in Won(₩), where Won is monetary unit in Korea($1=₩780 in 1996).

Table 2. Logit estimates of $\triangle V = \alpha + \beta \cdot ln(A)$

	Estimate	Standard Error	Chi-square	Prob
α	8.1939	1.1890	47.49	0.0000
β	-0.9294	0.1247	55.52	0.0000
Likelihood Ratio(D)			6.83	0.7417
Log-Likelihood		-147.7180		

Table 3. Logit estimates of $\triangle V = \alpha + \beta \cdot A$

	Estimate	Standard Error	Chi-square	Prob
α	0.3114	0.1940	2.58	0.1084
β	-0.00004	7.039E-6	32.20	0.0000
Likelihood Ratio(D)			24.03	0.0075
Log-Likelihood		-156.3217		

Table 4. Estimates of not monotonic points.

Bid	Proportion Yes	Probability('yes')
20000	8 / 31	.2727*
30000	10 / 35	.2727*

* (ki+ki+1)/(ni+ni+1). Where, ki is the number of accepting the cost Ai, and ni is the number of sub-sample the cost Ai.

The BH estimate is computed via numerical integration. Estimating the model $\triangle V = \alpha + \beta \cdot ln(A)$ within a logit model produced the parameter estimates as shown in Table 2. In order to show the goodness-of-fit of the model, the generalized likelihood ratio test (D) was introduced. The resulting model goodness was fitted.

The BH estimate is computed via numerical integration from 0 to maximum bid amount. Then, the BH estimate was computed as follows ;

$$E(WTP) = \int_0^{200,000} [1+\text{Exp}-\{\alpha + \beta \cdot \ln(A)\}]-1 \; dA$$

Also, BB estimate is obtained by truncating the tenth percentile of the distribution of WTP.

$$E(WTP) = \int_0^{71,708} [1+\text{Exp}-\{\alpha + \beta \cdot \ln(A)\}]-1 \; dA$$

Hanemann(1984) suggested two functional forms : linear logit function and log-logit function. Linear logit model, $\triangle V = \alpha + \beta \cdot (A)$, produced the parameter estimates, as shown in Table 3. The resulting goodness-of-fit test of

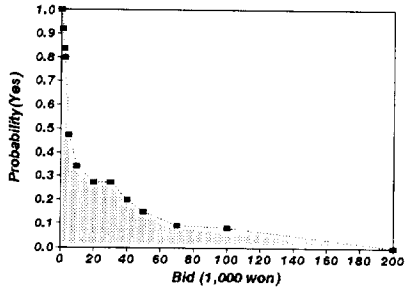

Fig. 1. The Empirical Survivor Function.

the model was not fitted(Likelihood Ratio= 22.58). In log-logit model estimates(Table 2), the relevant integral does not converge because a sufficient condition for convergence of relevant integral is $\beta < -1$(Hanemann, 1984)[1].

In nonparametric approach, Kriström(1990) used the linear interpolation between not monotonic points. Table 4 presented the distribution-free estimates of the not monotonic points. We will assume that probability 1 at the A=0. Therefore, the mean of WTP can be obtained by the area under this rough curve(Fig. 1).

The mean and median WTP estimates for the two question formats are summarized in Table 5.

A TEST OF OPEN-ENDED AND CLOSED-ENDED VALUES

In the comparison of the value estimates for the two question formats of CVM, one important point must be noted whether respondents' socio-economic characteristics in each question format are homogeneous because socioeconomic characteristics can influence an individual's willingness to pay(Walsh, 1986). Socio-economic factors include respondent's income, travel time, level of education, and age. Hence, this study was tested by statistical analysis(F-test) for two sample groups ; 145 respondents of the open-ended, and 147 respondents of the closed-ended approach. The resulting test is not significantly different at the 0.15 level because homogeneous hypothesis

1) mean WTP = $\int_0^{\infty} \{1+\text{Exp}-\alpha-\beta \cdot \ln(A)\}^{-1} dA = -\text{Exp}(-\alpha/\beta) \cdot \{(\pi/\beta)/\sin(-\pi/\beta)\}$
where, $0 > (1/\beta) > -1 \quad \therefore \beta < -1$

Table 5. Estimated willingness to pay.

Methods	mean WTP	median WTP	n
Open-ended	15,131.03	10,000.00	145
Closed-ended			
Bishop and Heberlein(BH)	25,332.00	6,743.49	294
Hanemann(HA)	N.C.	6,743.49	294
Boyle and Bishop(BB)	17,412.30	6,743.49	294
Kristrom(KR)	24,988.90	4,821.40	294

N.C. = Integral does not converge.

Table 6. Nonparametric test of the difference of mean WTP for open-ended and closed-ended.

Closed WTP-Open WTP	Difference of mean WTPs	T-test(t-value)	Signed-rank test(W)
BH estimate - OEQ_i[1]	10200.97	6.9681***	3403.5***
BB estimate - OEQ_i	2281.27	1.5582	1670.5***
KR estimate - OEQ_i	9857.86	6.7337***	3037.5***

[1] OEQ_i : individual's willingness to pay from the open-ended questions.
*** indicates significance at the 1% level.

is not reject. The results of F-test would not be mentioned in this paper.

The open-ended approach can find the distribution of individuals' WTPs while the closed-ended format can find one estimates, mean WTP. Therefore, the difference of mean WTP estimates by question methods can be tested whether the mean WTP difference made by subtracting individuals' WTPs of open-ended question from mean WTP of the closed-ended is significantly different.

By the way, the general assumptions of the distribution are concerned largely with data where the underlying distribution is normal. If we do specify the normal distribution of individuals' MWTPs, then we will ordinary deal with T-test. However, the distribution of individual's MWTP in the hypothetical market is not easily specified. If we do not specify the normal distribution, we will deal with nonparametric test.

In order to show distribution of individuals' MWTP, a Shapiro-Wilk normal test(1965)[2] whether the distribution of individuals' MWTPs is normal or not is used. The resulting test hypothesis of normal distribution is rejected at the 0.15 level (W : normal=0.7838).

Therefore, a nonparametric test was considered. The test is based on Wilcoxon's signed-rank-test of open-ended and closed-ended WTP responses asked of the homogeneous sample of downhill skiers, at Muju resort, in Korea. The test results are presented in Table 6. Based on the nonparametric test, the mean WTPs of the open-ended and close-ended applications are significantly different at the 0.01 level.

CONCLUSION AND DISCUSSION

Open-ended and closed-ended CVMs were used to estimate the net economic benefits of day use skiers at Muju resort, Korea. CVM estimates were based on the Hickian equivalent variation using two question formats. The results show that the net economic benefits of a skier in Muju varies from ₩15,131 to ₩25,332. The closed-ended values were 1.15 to 1.67 times as large as the open-ended values, depending on the model specifications.

In this paper, the distribution of individuals' MWTP based on open-ended question format is not specified as normal. Therefore, a nonparametric test is introduced to find whether the difference of net economic benefits between open-ended

2) Shapiro-Wilk statistic, W, is the ratio of the best estimator of the variance to the usual corrected sum of squares estimator of the variance. The null hypothesis of the data values is a random sample from a normal distribution. W is obtained by Royston's (1982) approximate normalizing transformation
$Z_n = \{(1-W_n)^{\nu} - \mu\} / \sigma$
where, Z_n is a standard normal variate, ν, μ, and σ are function of n, obtained from simulation results.

and closed-ended contingent valuations are significant. The mean WTPs of the open-ended and close-ended applications are significantly different.

It is not clear what question format is appropriate to value the welfare measure. However, Seller, Stoll, and Chavas(1985) suggest that the closed-ended question format should be more reliable than the open-ended format, because people are familiar with market situations where they face a particular price and must decide whether to pay it. Also, Mitchell and Carson(1989) argue that the closed-ended method is considered easier for respondents to answer than any other elicitation formats that use the open-ended question.

Our test reveals that the value estimates are sensitive to question formats. According to Freemann(1993), it may be that closed-ended can be reducing the incentive for strategic behavior by the respondent relative to the open-ended question. However, as Kealy and Turner(1993) indicate though the closed-ended question format people are placed in relatively familiar social context, they cannot conclude that the closed-ended method is superior to the open-ended method.

Considering CVM, it would be wise to consider both estimates obtained by two question formats until it is clear how best to resolve the inconsistency in welfare estimates based upon question format.

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