WILLINGNESS-TO-PAY FOR TRANSPORTATION INFRASTRUCTURE IMPROVEMENT IN KOREA USING CONTINGENT VALUATION

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ABSTRACT

This article analyses willingness-to-pay for transportation infrastructure improvement for the transportation vulnerable by using the contingent valuation method(CVM) in Korea. We used the CVM to quantify the willingness-to-pay for transportation infrastructure improvement using the nationwide survey data. Respondents overall accepted the hypothetical market and were willing to pay a significant amount per household monthly to improve the mobility of the transportation vulnerable as well as the general population. The mean monthly willingness-to-pay for the improved transportation infrastructures toward the universal design is 5726 Korean won (GBP 3.20) per household, and the aggregated value to nationwide scale would then be 1091.63 billion Korean won (GBP 610.87 million) per year. The estimation results show how people appraise non-market services of public works, and can be used as quantitative information on the benefits in ex-ante analysis of the public policy.

1. INTRODUCTION

The universal design originated in the United States is rapidly spreading in transportation infrastructure sectors. The basic idea of this emerging trend is to design services, equipments and infrastructures that are accessible to, not just those who can use standard services, but as much of the population as possible, and further to supplement of specialized provision for those who cannot cope. During the past decade since Convenience Improvement legislation in 1997, South Korea has also endeavored to improve public transport modes, passenger facilities and pedestrian environments for the transportation vulnerable such as the disabled, the pregnant women, the elderly persons and children who account for some 25.8 per cent among the population. Nevertheless, improving mobility standards in transportation infrastructures could be an inefficient and expensive solution if the transportation vulnerable were the only beneficiaries. The universal design, however, strives to be a broad-spectrum solution that helps everyone, not just those with disabilities. Therefore, the beneficiaries from transportation

infrastructure improvement are not limited to the mobility handicapped, but comprise the general population.

The diverse attributes of goods or services is generally valued through revealed preference model if an explicit market exists. This not being the case for the transportation infrastructure improvement, I created a specific market by means of surveys using the contingent valuation (CV) method. One of the greatest advantages of the CV technique is that it allows us to include all types of values or benefits of improved transportation infrastructure, such as use value, option value, and existence value, depending on whether they come from its direct use, the possibility of its future use, or the use others could make out of it, respectively (Turner, 1999).

The CV method has been extensively applied to wide range of transport externalities such as air pollution (Carlsson and Johansson-Stenman, 2000; Navrud. 2001) and nuisance from traffic noise (Bateman et al. 2000; Maier et al., 2002; Walton et al., 2004). Yamaguchi and Kawakami (2007) also estimated the values for both improvement of a sidewalk and barrier-free education for primary school children. However, there has hitherto been no study which has analyzed recent CV in the field of transport policy for the disadvantaged. This paper therefore analyses the willingness-to-pay (WTP) for transportation infrastructure improvement toward the universal design for the mobility handicapped and presents the aggregated value to South Koreans by using data collected from a nationwide survey. Thus, the quantitative information can be used as preliminary evidence for public policy analysis related to the transportation vulnerable.

The paper is organized as follows. Section 2 briefly describes several issues related to the survey and Section 3 presents the model for the CV study. The estimation results are given in Section 4. Lastly, Section 5 summarizes the main points of the paper.

2. SURVEY AND DATA

The CV method uses survey questions to elicit people's preferences for typically public goods by finding out what they would be willing to pay for specified improvements in them (Mitchell and Carson, 1989). The creation of a hypothetical market is made through correctly prepared surveys and undertaken by specially trained personnel. To achieve this, the creation and preparation of the survey has to go through a period of different tests, including the use of focus groups and personal interviews. Pre-test surveys will allow any potential biases to be eliminated from the survey questions and the accompanying material such as photographs.

The issues relating to the survey design can be summarized as follows. The survey was carried out for heads of household or housewives whose ages range from 20 to 60 in the

month of October 2006. Face-to-face interviews were conducted by well-trained interviewers. To draw a representative sample of the population, a professional survey firm extracted a stratified sample in 8 metropolitan areas, and then randomly selected respondent households within the areas, each of which was chosen on the basis of the ratio of populations and ages. The basic survey unit was not an individual but a household. Prior to the main survey, a pre-test was done with a focus group comprising 50 persons to determine the range of bid amounts for the dichotomous choice (DC) WTP questionnaires. Respondents were assigned randomly into 4 sub-groups, each of which was asked a different bid. The bids consisted of 20, 40, 60 and 80th percentile of the WTP distribution- 2000, 4000, 6000 and 10 000 Korean won, respectively- following the technique suggested in Alberini (1995). At the time of the survey, GBP 1 was approximately 1787 Korean won. The survey yielded 500 useable interviews, 9 of which were rated by enumerators as being of poor quality since they did not provide some of the necessary information for analyzing their WTP. The findings from the survey are therefore based on the analysis of 491 interviews.

I presented the hypothetical market which covers transport means equipped with perceptible information system, no-step and low floors, and wheelchair locking devices; stations or terminals equipped with wheelchair lifts, elevators, braille blocks, and sanitary facilities; walk environments equipped with trimmed pavements, green zones, and traffic islands. To provide adequate information concerning the proposed market, the survey was communicated to respondents in simple terms and in detail with visual aids such as photographs and blueprints. Then respondents were asked whether they would be in favor of increased household taxation to improve the transportation infrastructures.

Cummings et al. (1986) found that the choice of payment vehicle would seem to be an important determinant of values derived with the CV technique. In this study the income tax was chosen as a payment vehicle for financing the public project for the transportation vulnerable, although respondents with an aversion to higher taxes might understate their WTP for the transportation infrastructure improvement. The frequency of the payment is once a month for the next five years and the payment mechanism is an increase of income taxes.

3. MODEL AND WELFARE MEASURE

The present research employed DC-CV surveys based on the utility difference model used by Hanemann (1989). The DC question asks the respondent to accept or reject a suggested bid for a given change. When each respondent is presented with a bid (*A*), there are two outcomes such as *YES* or *NO*. Given the assumption of a utility-maximizing respondent, for respondent $i = 1, 2, 3, ..., N$, the log-likelihood function of the DC model takes the explicit form

$$\ln L = \sum_{i=1}^{N} \{I_i^Y \ln[1 - G(A_i)] + (1 - I_i^Y) \ln G(A_i)\}$$

where $G(A_i)$ is the probability of a *NO* response to A_i, and $I_i^Y = \mathbf{1}$ (*i*th respondent's response is *YES*) where $\mathbf{1}(\cdot)$ is an indicator function, which is one if the argument is true and zero otherwise. Following the practice of previous studies, I formulated $G(A) = [1 + \exp(a - bA)]^{-1}$.

The purpose of conducting a CV study is frequently to obtain a welfare measure such as the mean (or truncated mean) WTP. To this end, I employed the mean WTP formula, which is calculated a/b, provided by Hanemann (1989). The bid amounts used to elicit WTP were selected from the initial pre-test of the WTP survey as discussed earlier.

4. ESTIMATION RESULTS

As seen in Table 1, the results of survey show high response rates in the survey. Only nine respondents of the sample refused to answer any of the questions. Among the valid answers, 251 respondents accepted proposed bid amount and the others didn't. The survey also captured verbatim the motives why the households rejected paying for the transportation infrastructure improvement for the transportation vulnerable. The main reasons were alleged lack of money (64 per cent), lack of consciousness of its need (22 per cent) and objection to or rejection of the valuation scenario (8 per cent).

Table 1 - Distribution of responses at different bid amounts

Bid amount (Korean won)	Responses		Valid answers
	YES	NO	
2000	91	35	126
4000	67	58	125
6000	44	75	119
10 000	49	72	121
Total	251	240	491

Notes: Bid amount is designed based on pre-test result. GBP 1 is equivalent to 1787 Korean won approximately as of October 2006.

To estimate the DC-CV model, maximization of the log-likelihood function was performed using TSP software, version 4.5. Table 2 describes the results of the estimation. All the parameters in the model are statistically significant at the 1 per cent level. Using the Wald statistic, the estimated equation is statistically significantly different from zero at the 1 per cent level. The coefficient for the bid is negative, as expected. That is, a higher bid makes

a *YES* response less likely. This result corresponds with the intuitive rationale and economic theory. The estimate of the mean WTP is also shown in Table 2. The mean WTP estimate is computed as 5726 Korean won (GBP 3.20) per household per month, and statistically meaningful based on its t-values.

Table 2 - Estimation results of WTP model

Parameters	Estimation results
Constant	0.900 (4.588)**
Bid[a]	0.157 (4.917)**
Mean WTP in Korean won (GBP)	5726 (3.20)
Bootstrapped *t*-value[b]	9.45**
95% confidence interval in Korean won[c]	[4667-6830]
95% confidence interval in GBP[c]	[2.61-3.82]
Number of observations	491
Log-likelihood	-327.525
Wald-statistics (p-value)[d]	24.709 (0.00)

Notes: The numbers in parentheses below the coefficient estimates are t-statistics, computed from the analytic second derivatives of the log-likelihood. ∗* indicates statistical significance at the 1 per cent level.

[a] The unit of measurement is 1000 Korean won.

[b] The mean of 10 000 t-value.

[c] The confidence intervals were calculated by using the non-parametric bootstrap method with 10 000 replications.

[d] The hypothesis is that all the parameters are jointly zero.

Furthermore, Table 2 presents confidence intervals for the point estimate of mean WTP in order to allow for uncertainty, rather than report the point estimate only. The 95 per cent confidence interval is computed by using the non-parametric bootstrap method of Efron (1979) with 10 000 replications. It showed a range from 4667 Korean won (GBP 2.61) to 6830 Korean won (GBP 3.82).

Finally, I attempt to expand the sample value to the population estimate in order to obtain a preliminary indication of the proposed transportation infrastructure improvement project for governmental policy options. When expanding the sample to the population, one critical concern is the external generalization of the sample values to the population. This is dependent on the representativeness of the sample frame and the survey response rate. As described earlier, the sample frame was a random sample of the households extracted by a professional survey firm and the sample response rate by the face-to-face interview was almost 100 per cent. Thus our data can be seen to provide accurate figures for total social value.

Using the mean WTP from Table 2, one can generate an estimate of the total WTP for the entire households of the study area by multiplying the estimate per household by the

number of the households in the study area. According to the Korean National Statistical Office, there were 15 887 128 households in 2005. Multiplying this by WTP yields a total of approximately 1091.63 billion Korean won (GBP 610.87 million) annually.

In CV studies, it is common to test for internal consistency and theoretical validity of the model by estimating the models with covariates. If we would estimate the model with covariates, in former equations, a is simply replaced with $a + x_i'\beta$ where x_i is a vector of explanatory variables including bid and β is a vector of parameters to be estimated. Definitions and sample statistics of variables used in this study are shown in Table 3.

Table 3 - Estimation results of WTP model with covariates

Variables	Definition	Coefficients[a]	Mean
constant		1.631 (3.16)***	
BID	Bid amount	0.172 (5.30)***	
INCOME	Monthly household total income before tax deductions (unit: million Korean won)	0.130 (1.97)**	2.896
AGE	Age of the respondent (number of years)	-0.020 (-2.14)**	41.904
EDUCATION	Dummy, 1=over high school graduate otherwise 0	-0.370 (-1.69)*	0.52
Mean WTP in Korean won		5.212***	
Number of observations		491	
Log-likelihood		-319.9792	
Wald statistics[b]		28.119***	
(p-value)		(0.000)	

[a] The numbers in parentheses below the coefficient estimates are *t*-values, computed from the analytic second derivatives of the log-likelihood.

[b] The hypothesis is that all the parameters are jointly zero and the corresponding *p*-value is reported in the parentheses below the statistic.

***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

The estimation results of parameters are enumerated in the following Table 3. Using the Wald statistic in Table 3, the estimated equation is statistically significantly different from zero. We can ascertain that respondents accepted the contingent market and were willing to contribute a significant amount, on average, per household. This willingness varies according to individual characteristics. For example, those who have more income would be likely to vote ‘yes’ for the proposed program. The age of the respondent and education level has a negative relation to voting ‘yes’.

All the covariates are statistically significant at less than the 10% level . Thus we can conclude that most covariates are statistically significant. On the other hand, mean WTP for the model with covariates were similar to those for the model without covariates. It is concluded that the welfare measures are not significantly changed by adding covariates. This is why we do not expand the sample WTP estimate for the model with covariates to the population and report it in this study.

5. CONCLUDING REMARK

In this article, I used the CV technique to quantify the WTP for transportation infrastructure improvement in Korea using the nationwide survey data. Respondents overall accepted the hypothetical market and were willing to pay a significant amount per household monthly to improve the mobility of the transportation vulnerable. Note that these benefits from the transportation infrastructure improvement include not merely those for the mobility handicapped but those for the general population. The results provide preliminary evidence that the CV method can be a useful approach to measuring the value of public policy analysis in government decision-making.

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