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With or Without You: A Heuristic Approach to Value Multiple Programs Using the Contingent Valuation

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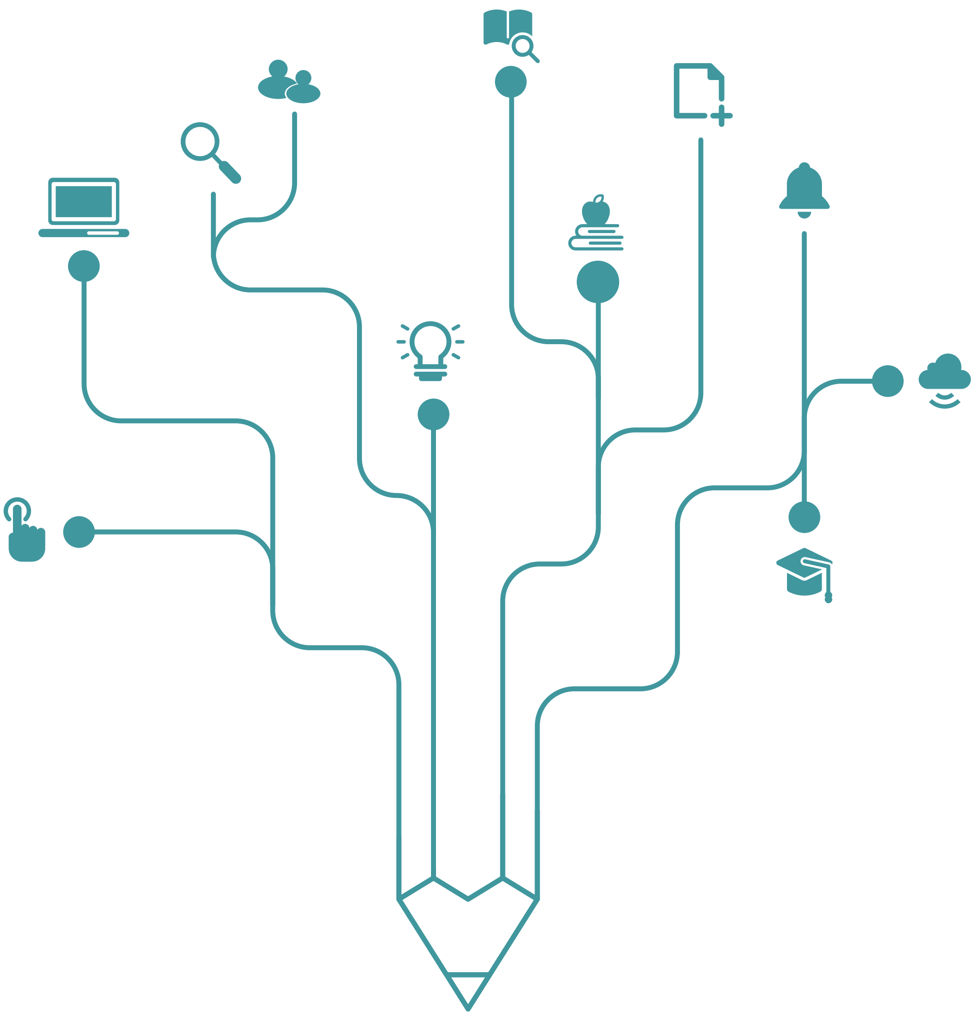

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We propose a cost-effective and bias-avoiding approach to value multiple programs using the contingent valuation. After eliciting the willingness to pay for a program given all other programs in a package are assumed to be implemented, the approach adopts a value adjustment scheme with which the respondent is given a chance to modify the initial willingness to pay when the package excludes one of other programs. The approach attempts to limit the number of respondents and the number of questions to a respondent to save cost and time, and to reduce the cognitive burden in response for minimizing potential biases, respectively. The proposed approach is applied to a case with six facilities in a complex to find reasonable substitution effects among facilities empirically. The further analysis with value reduction responses also verifies that the respondents' perception on the substitution effect between facilities are economically intuitive. Finally, precautions are listed when using this approach for benefit estimation for the purpose of the cost-benefit analysis in practice.

Key Word: Contingent Valuation Method, Non-use Value, Part-Whole Bias, Multivariate Probit, Cost-Benefit Analysis
JEL Code: Q51, D61, H43, C83

I. Introduction

The contingent valuation (CV) has been widely used in valuating non-market goods. It is a stated preference (survey) approach in which respondents are asked to state their preferences in hypothetical (or contingent) markets to elicit how much they are willing to pay for the proposed hypothetical changes. It has been pointed out that the CV method is exposed to various biases in that it obtains a virtual willingness to pay (WTP) for a hypothetical situation through a questionnaire, rather than observing a revealed preference through actual consumption expenditure.

For the last several decades, however, the methodology of the CV studies has been sufficiently improved by devising devices to minimize biases to be used as a basis for making actual policy decisions. In Korea, the method has been extensively used in the preliminary feasibility study (PFS) to estimate the benefits of large-scale public investment projects that have not yet been built to determine whether to implement or not.

Nevertheless, the challenges of applying the CV method to decide whether or not to build multiple facilities simultaneously have not been completely resolved yet. The issue here is twofold: (i) cost of survey and (ii) scope insensitivity. First, when there are n possible facilities to be included in or excluded from a portfolio, in theory, there are 2^n combinations of facilities including the *status quo*. Therefore, to elicit precise values of each possibility, we need to conduct a maximum of $2^n - 1$ CV surveys. Usually, CV surveys are time consuming and costly because they must be carefully designed and conducted to minimize biases. Accordingly, it is generally not recommended to conduct a survey for each and every combination. In particular, when the number of facilities is five or more, it requires to conduct more than 30 CV surveys, which is almost impossible to realize.

Second, even if the surveys were somehow conducted on several combinations, the question still remains whether it is possible to compare them with each other. When the CV method is applied to valuate multiple amenities, the scope effect is well-known, namely the “part-whole bias,” as a discrepancy in individuals’ valuations. If the component parts of a whole are evaluated separately, the sum of those valuations tends to exceed the valuation placed on the whole (Bateman et al, 1997).

After confirming the above scope insensitivity of the CV study results, Boyle et al (1994) stated that it is an extremely difficult task of valuing marginal changes, when those changes represent small proportions of the total assets in question. They conjectured that this difficulty may arise from the public’s inability to appropriately process small proportions and the respondents’ general lack of familiarity with the commodity being evaluated.

In addition to the embedding effect of sub-additivity above, studies have been conducted on possible biases when evaluating the multiple programs using the CV method, for which each *program* (“part”) is a nested subset of the *package* (“whole”). They have explored problems in which the value of a program or its combinations vary depending on how they are presented to respondents, namely the sequencing and ordering effects, among others.

Considering the cost and the possibility of such biases, the purpose of the present study is to suggest and empirically verify a fast and frugal approach to valuate multiple programs using the CV survey. With n possible programs, applying the approach proposed in this study, one needs to conduct only n of equivalent surveys. Therefore, compared to $2^n - 1$ surveys required in full, the new approach becomes more cost-effective alternative as n grows.

The proposed approach is then applied to a real case with six facilities (or programs) in a complex (or package). Using the CV survey instrument designed as proposed, the results are promising as the scope sensitivity is reasonably appeared, and the value adjustment with or without other programs in a package makes economic senses by analyzing the data with a multivariate probit model.

The remainder of this paper is structured as follows. Section II proposes the contingent valuation survey design to evaluate multiple programs in a heuristic manner along with a succinct value reduction scheme. Section III introduces a case study applying the proposed approach in which we describe data, exhibit estimation results, and show empirical evidences of verification of the new approach. Lastly, Section IV is devoted to concluding remarks.

II. Methodology

We suppose a task of valuing each program in a (policy) package using the CV survey. After observing the valuation, the policy maker can decide on each program whether to implement or not to form an optimal portfolio. Therefore, we rule out the application of attribute-based approaches for the CV survey such as Moore et al (2011) in which there is only one program whose multifaceted scope is variable.

In general, the programs bundled in a package are interrelated with each other with potential substitution and complementary effects. Therefore, the decision maker has to be aware of the influence of these effects when subtracting or adding a program from/to the package. In addition, we assume a situation where cost and time for evaluation are limited in order to implement the policy in a timely manner.

Moreover, the number of programs possibly included in the package is fairly large, at least four or more. If there are not many programs, conventional multiple programs CV studies which explicitly valuate each combination of programs in the exhaustive list of possibilities can be applied (for example, Dachary-Bernard and Rambonilaza, 2012).

Given the above situation, we need a cost-effective heuristic application that derives the respondent's WTP by using the CV survey to valuate multiple programs. That is, we want to find an alternative that can be utilized under the trade-off between the accuracy of each program value and the cost required for valuations. In terms of cost, as described in the previous section, the approach should not raise the cost of survey incrementally as the number of programs increases.

In terms of accuracy, we need a way that lowers the possibility of several biases discussed in previous studies. The most meticulous topic in evaluating multiple programs using the CV survey is the embedding effect. Since Kahneman and Knetsch (1992) confirms the possibility of this effect with experiment results, studies followed to find arrangements to reduce it including Loomis et al (1993), Carson and Mitchell (1995), Christie (2001), and Bateman et al (2004).

In the meantime, the respondents' cognitive burden can affect the reliability of the results. For the situation when a respondent faces a series of valuation questions, Kahneman et al (1982) emphasized the "anchoring and adjustment" heuristic, which suggests that an initial valuation provides an anchor for subsequent responses (Powe and Bateman, 2003). Furthermore, the likelihood and magnitude of bias increases as the number of questions asked to a respondent increases and the content of the questions differs. Payne et al (2000) identified the sequencing effect in which the WTP is much larger for the first good than for goods evaluated afterward. Longo et al (2015) and Powe and Bateman (2003) found the ordering effect denoting that the valuations are affected by the order in which the programs are presented. These effects are exacerbated when respondents are required to answer more questions.

A. *Value Adjustment by Program Exclusion*

We assume that there are n programs in a package. Each of n programs are the target of each CV survey, i.e. we conduct n sets of independent CV survey for the same number of different respondent groups.

To curtail the cognitive burden in responding to valuation questions, the respondents are asked to valuate only one of the programs although they are presented entire information on the package. After they stated their WTP for a program, a subsequent value adjustment was made on the initial WTP. Even in the nascent stage of the CV method, the value adjustment tool was already suggested and applied to the CV studies on a single program (for example, Hanemann, 1992 and McClelland et al, 1992).

In this case, we can consider two methods: “top-down” and “bottom-up.” The top-down method initially includes all programs in the package, and only a specific program is asked to be evaluated. Subsequently, the value is adjusted by observing responses of how the WTPs change when other programs are excluded from the package. The bottom-up method is in the opposite direction starting from a single program. We adopt the top-down method because it is known that valuating with advance knowledge (corresponding to top-down approach in this study) is scope sensitive while the converse is not so (Christie, 2001 and Bateman et al, 2004). Additionally, we suggest to include follow-up questions to verify that value adjustments are reasonable from the economic sense.

More in detail, the procedure of eliciting the respondent’s WTP is as follows:

First, a typical front part of CV questionnaire is administered face-to-face including immersing questions and background surveying.

Second, the description of the package and each program is provided along with visual aids. In general, relatively more detailed descriptions of the program to be evaluated (target program) are required.

Third, the dichotomous choice (DC) questions for eliciting the WTP is asked for the target program given all other $n-1$ programs are included in the package.

Fourth, a subsequent set of questions for value adjustment is asked. In this case, how the initial WTP to the target program will change when a program among the other $n-1$ programs is excluded is asked so that a total of $n-1$ value adjustments are made by a respondent. Here, further value adjustments when different combinations of programs are excluded can be asked, but we do not pursuit beyond the exclusion of one other program to ease the cognitive burden and abate consequent biases discussed above. Moreover, we implicitly assume that the net (or additional) interaction effect between three or more programs is negligible compared to the interaction effect between two programs.

To account for both substitution and complement effects between programs, and to leave open the possibility that the goods are actually bads to the respondent, the value adjustment in this case allows for both directions although typically the reductions are expected. For example, we can consider a CV survey on a plan for sports complex accommodating multiple facilities including a baseball park and a swimming pool. Suppose a respondent who lives near the planned site of the complex, goes to the pool regularly but does not enjoy baseball, and concerns about traffic congestion on baseball game days making the way to the swim inconvenient. Then, the respondent's WTP for the swimming pool may increase if the baseball park is excluded from the sports complex. Figure 1 shows an example of this set of value adjustment questions used in this article's case study in which the target goods are six museums to be potentially established in a museum complex.

Fifth, follow-up questions to verify if the value adjustments in the previous step make economic sense. In the case of recreational amenities, for example, it would be necessary to ask if the respondent is willing to visit in the future when they are available. The high willingness to visit implies that the respondent appreciates the use value more seriously compared to the non-use values. Respondents who appreciate the use value may tend to reduce the value of a facility more significantly as the number of facilities within a complex decreases.

Question: If some of the museums in the XYZ Museum Complex plan cannot be built due to policy changes, will there be any change in your household's willingness to pay for additional income tax for Museum A? If yes, please indicate the degree of change in percentage.

	Degree of change in willingness to pay additional income tax for Museum I if the next museum will not be built (%)		
	A No Change	B Decrease (%)	C Increase (%)
1) Museum II	A No Change ( )	B Decrease (%)	C Increase (%)
2) Museum III	A No Change ( )	B Decrease (%)	C Increase (%)
3) Museum IV	A No Change ( )	B Decrease (%)	C Increase (%)
4) Museum V	A No Change ( )	B Decrease (%)	C Increase (%)
5) Museum VI	A No Change ( )	B Decrease (%)	C Increase (%)

FIGURE 1. EXAMPLE OF VALUE ADJUSTMENT QUESTION

III. Case Study

We apply the proposed approach to a case of a complex with multiple museums planned by central government ministries in Korea. It is a well-established and mandated practice in Korean to carry out a PFS, managed by the central budget authority, on all large-scale public investment projects with sufficient central government expenditure. To account for non-use values to be provided by museums, since mid-2000s, the CV method has been extensively used to estimate benefits in the cost-benefit analysis (CBA), one of the main analyses of the PFS. Because the implementation of each museum plan had not been decided at the time of the CV surveys, the WTPs for different possibilities of plan combinations were needed.

Following the PFS guidelines on using the CV studies for the CBA that abides by the recommendations of NOAA panel (Arrow et al, 1993), the CV surveys were conducted on a total of six museum plans. The payment vehicle was the (additional) income tax which has been used for all CV studies for the PFS because it is easy to understand and realistic when eliciting the WTP.

After the focus group interviews, the pilot surveys were conducted with open-ended WTP elicitation questions with 50 households each (300 total) to determine the bid amounts for DC questions. Finally, with the bid amounts of (500, 1,000, 2,000, 5,000) Korean Won (KRW) determined by the pilot surveys, the CV surveys were conducted face-to-face with 550 stratified households each (3,300 total) for four weeks in August 2014. Notice that the cost-effectiveness was also considered when the number of respondents were chosen. Usually, for a CV study on a single target facility, the PFS collects 1,000 responses. Due to the budgetary limitation on each PFS, however, this convention cannot be fulfilled and the sample size had to be reduced in this case. The contents of each survey instrument are identical except the target facility. Moreover, although the distributions of respondents' socio-economic characteristics in surveys are similar, no respondent is asked to valuate more than one museum to eliminate the anchoring, sequencing, and ordering effects discussed above.

TABLE 1—WILLINGNESS TO PAY FOR EACH MUSEUM

Museum	% Protest bids	% Willing to pay	Mean WTP (KRW)	95% Confidence interval
A	43.3%	31.64%	1,367.36	[309.123, 2.13835]
B	43.3%	32.36%	1,161.42	[375.818, 1,752.97]
C	42.2%	37.82%	1,503.71	[1,040.66, 1,972.13]
D	38.7%	39.82%	1,428.28	[948.914, 1,879.89]
E	39.1%	41.1%	1,225.64	[768.374, 1,629.11]
F	40.0%	38.9%	2,113.37	[1,629.69, 2,688.57]

Note: The mean WTP is estimated by a model proposed by Hanemann (1984) and the 95% confidence interval is obtained by a method proposed by Krinsky and Robb (1986).

As a result, the fourth column of Table 1 shows the mean WTP for each museum estimated by a model proposed by Hanemann (1984). Shown in the rightmost column of Table 1, the 95 percent confidence interval for each WTP is obtained by a method proposed by Krinsky and Robb (1986). Consequently, all WTPs are statistically significantly different from zero at the 5 percent significance level. Meanwhile, the WTP for museum F is the greatest with a considerable gap from the others, and those for museums A through E differ each other with a difference of some 10 percent between adjacent values of WTPs.

In estimating the WTP, the protest bids are excluded because respondents who are reluctant to pay (or state zero WTP) for the target museum even though their true valuation is greater than zero for reasons relating to the responsibility of the government or against taxation in general may distort the results. The second column of Table 1 reveals the proportion of protest bids for each museum, while the third column shows the proportion of respondents who are willing to pay for the museum.

Remember the results in Table 1 is obtained from the DC questions which include all other five museums are assumed to be constructed. As discussed above, if there is complementary effect between two museums, not having a neighbor museum in the complex may affect the WTP for the target museum negatively, and vice versa. Therefore, by asking value adjustment questions after the DC questions as shown in Figure 1, we obtained adjustments in the WTP as calculated in Table 2. For example, the WTP for museum A would be reduced by 3.92 percent if museum B is excluded from the complex plan. In the extreme case, if museum A exists only in the complex, the WTP would be 1,070.37 KRW, which is 21.72 percent less than 1,367.36 KRW estimated under the assumption that all museums B through F are constructed as well.

TABLE 2—VALUE ADJUSTMENT BY EXCLUDING A MUSEUM IN COMPLEX

(unit: %)

Museum	Excluded museum						Total
	A	B	C	D	E	F	
A	-	-3.92	-4.64	-4.85	-4.86	-3.45	-21.72
B	-3.06	-	-2.95	-2.64	-1.80	-1.80	-12.25
C	-0.70	-0.54	-	-2.54	-1.60	-1.05	-6.42
D	-2.76	-1.92	-1.96	-	-1.71	-1.85	-10.21
E	-2.10	-1.69	-2.31	-2.21	-	-1.92	-10.23
F	-3.64	-4.14	-2.85	-2.85	-2.52	-	-16.00
Average	-2.11	-2.56	-2.81	-2.86	-2.53	-1.60	-14.47

The value reductions obtained here is comparable to one of the rare previous empirical studies in a similar setting. Searching for the substitution effect, Hoehn and Loomis (1993) found independent valuation and summation overstate the benefits of two- and three-program policies by an average of 24 percent and 54 percent, respectively.

We can point out two findings here. First, there seems to be no relationship between the size of the WTP and the value adjustment from the results in Tables 1 and 2. Furthermore, there seems no convincing reason why the WTP value for the target museum directly affects the change when other museum is excluded except the effect of anticipated regret. If a museum other than the target is not built, given an opportunity to reduce the initial WTP, all other things being equal, those who responded with a high WTP may feel relatively more anxious. In other words, a respondent may concern that he/she still has to actually pay the WTP that he/she initially responded to in a new and worse scenario by excluding a museum. Because respondents anticipate such regrets, an initially high WTP value may act to reduce the WTP further than the actual change. This hypothesis will be tested below with individual response data.

Second, although the cases are rare and do not appear in Table 2, there were respondents who increase their WTPs after facing a situation without a neighboring museum. Although this is not common, such as the example of the baseball park and swimming pool described above, it may be a sufficiently reasonable adjustment. In the case of adjustment in the opposite direction to general expectation like this, therefore, it will be necessary to confirm the reliability of the value adjustment through additional questions.

A. *Estimation for Verification*

When applying the method proposed in this study, it is important to find out whether the response is suitable from an economic point of view. More precisely, we can analyze factors affecting respondents' value adjustment by utilizing the information on the related experience or preference as well as the socio-economic characteristics obtained through responses in the survey process. For more general interpretations, although we use the data from the case study on valuation of museums, we replace the term museum with *facility* in this sub-section.

In our case, one respondent responded to five additional questions of value adjustment assuming that one of the remaining five facilities is excluded. Therefore, considering a regression approach, we face a multivariate model in which the dependent variable is a vector of five elements. Because the value adjustment was occurred a small proportion of the respondents (close to 10 percent of sample) and the magnitude of adjustment suffers a severe fixed effect, it is not appropriate to apply the multivariate linear regression model.

Instead, we code a binary variable p_{ijk} representing whether or not the value was reduced, which is equal to 1 if respondent i reduces his/her WTP for the target facility j when the kth facility is assumed to be excluded for j=1, 2, …, 6 and k=1, 2, …, 5, and 0 otherwise. Notice that respondent i is asked to evaluate only one facility j in our case above, and thus we can rewrite $p_{ijk} = p_{ik}$. More formally, we consider the pentavariate (or 5-equation multivariate) probit model such that

$$p_{ik}^* = X_{ij}'\beta + Y_{ik}'\gamma + Z_i'\delta + \varepsilon_{ik}$$

$$p_{ik} = 1 \text{ if } p_{ik}^* > 0 \text{ and 0 otherwise.}$$

for k=1, 2, …, 5. The error terms ε_{ik} are distributed as multivariate normal, each with a mean of zero, and variance–covariance matrix V, where V has values of 1 on the leading diagonal and correlations $\rho_{kl} = \rho_{lk}$ as off-diagonal elements. The covariates X_{ij}, Y_{ik}, and Z_i represent information on respondent i associated with the target facility j, the kth facility is assumed to be excluded, and himself/herself (socio-economic characteristics), respectively.

Table 3 shows the definitions and summary statistics of variables used in the pentavariate probit model. The first part of covariates X_{ij} consists of two variables $Visit_{ij}$ and WTP_{ij}. The former represents the respondent i's willingness to visit facility j in a 5-point Likert scale where 1 is for *strongly disagree* (lowest willingness) and 5 is for *strongly agree* (highest willingness), and the latter denotes his/her WTP for facility j when all other facilities are included, measured in thousand KRW, which was obtained by asking an open-ended question followed by the DC questions before asking the value adjustment.

We include the first variable $Visit_{ij}$ to check how much the use value has an effect distinguishable to non-use values. Respondents who think they are likely to visit the target facility will tend to have a high proportion of use value in their WTP. In this case, we can presume that the use value may be more sensitive to changes in the size of overall complementary effect that accommodates the non-use values as well. Visitors can embrace the synergy between two facilities more vividly during their visits. Meanwhile, we include the second variable WTP_{ij} to test whether there was an effect of anticipated regret as discussed above.

Similarly, the second part of covariates Y_{ik} related to the facility to be excluded consists of two variables $DVisitAlong_{ik}$ and $\overline{WTP}_k$. The former is a dummy for willingness to visit as well if the respondent visits the target facility. It was obtained by asking which facilities in the complex they would like to additionally visit if visiting the target facility, and allowing respondents to select multiple facilities. The latter is the mean WTP of the facility to be excluded, which was estimated as shown in Table 1 and measured in thousand KRW. Notice that respondent i did not participate in the survey targeted facility k, and thus it is a proxy for respondent i's valuation of facility k.

The influence of these variables is much clearer than before. On one hand, for a facility high likely to be visited being excluded, the large synergy decline is obvious. On the other hand, if a facility with high value is excluded, the decline in synergy is also predictable to be relatively large.

The last part of Table 3 summarizes covariates Z_i including the socio-economic characteristics of respondents likely to affect the attitude toward the target facility. First, the variable $Distance_i$ is the time distance between the residence of respondent i and the complex, measured in minutes. From the perspective of visitors, we considered the time aspect because the time required to visit is more relevant and decisive than the geographical distance. In this case, we need to know the transportation mode, day of the week, and departing time, among others. Since we could not collect information about them other than the address information of each respondent, we need to designate them reasonably. Supposing a typical situation of visiting a museum, we measured the time required to travel by car departing at 10:00 am on Saturday to the complex from the address by using the optimal route considering both cost and time to travel. If a visit takes a lot of time, we can generally expect a visit to be less likely, so the effect of distance will act the same as the previous two variables $Visit_{ij}$ and $DVisitAlong_{ik}$, only with the opposite sign.

TABLE 3—SUMMARY STATISTICS OF VARIABLES

Variable	Description	Mean	Std. Dev.	Min	Max
p_{ik}	Binary dependent variable (1=WTP for facility j is reduced if for the kth facility is excluded, 0=otherwise)	0.08368	0.2770	0	1
		0.08203	0.2745	0	1
		0.08696	0.2819	0	1
		0.07875	0.2695	0	1
		0.07055	0.2562	0	1
$Visit_{ij}$	Willingness to visit facility j (5-point Likert scale in which 1=Strongly disagree, 5=Strongly agree)	3.581	0.8770	1	5
WTP_{ij}	WTP for facility j when all other facilities are included (thousand KRW)	2,137	2,301	100	20,000
$DVisitAlong_{ik}$	Dummy for willingness to visit the kth facility as well when visiting facility j (1=Yes, 0=No)	0.3240	0.4682	0	1
		0.3388	0.4735	0	1
		0.2174	0.4126	0	1
		0.2133	0.4098	0	1
		0.2002	0.4003	0	1
$\overline{WTP}_k$	Mean WTP for the kth facility to be excluded (thousand KRW)	1,338	72.07	1,161	1,367
		1,260	155.2	1,161	1,504
		1,469	37.61	1,428	1,504
		1,299	97.36	1,226	1,428
		1,958	337.9	1,226	2,113
$Distance_i$	Time distance between residence and complex (minutes)	146.3	46.24	21	237
$DExperience_i$	Dummy for visits to museums in last two years (1=Yes, 0=No)	0.4241	0.4944	0	1
$Kids_i$	Number of children (0 to kindergarten) in family	0.2904	0.6059	0	3
$Students_i$	Number of students in family	0.9779	0.9331	0	3
$Income_i$	Monthly family income after tax (11-point scale in which 1 is 990 thousand KRW or less and 11 is 8 million KRW and above)	6.545	1.996	1	11
$Education_i$	Education level (1=Middle school or less, 2=High school, 3=College and above)	2.517	0.5189	1	3
Age_i	Age of respondent (years)	44.65	9.612	22	65
Sex_i	Sex of respondent (1=Male, 0=Female)	0.5062	0.5002	0	1

Second, the variable $DExperience_i$ is a dummy variable representing if the respondent has visited a museum in last two years. If one has such an experience, we can consider him/her as a frequent visitor and expect the same effect as the visit-related variables above. Moreover, Boyle et al (1993) found that respondent experience in a similar situation as the CV survey's scenario plays a significant role in value formation. By adding this covariate, we can check if the experience affects the perceived magnitude of interaction effect between complementary facilities.

Third, the variables $Kids_i$ and $Students_i$ represent the number of children up to kindergarten and students in a family, respectively. In the survey, 25.1 percent and 20.0 percent of the respondents said that the purpose of visiting existing museums was to help their children's educational process and to cultivate their children's cultural emotions, respectively. That is, we can expect the presence of children in the family increases the possibility of museum visits, and the effects of these variables can still be interpreted the same as that of $DExperience_i$.

Lastly, information on usual socio-economic control variables $Income_i$, $Education_i$, Age_i, and Sex_i are asked and included. Among them, $Income_i$ and $Education_i$ are categorical, Age_i is measured in years, and Sex_i is a dummy for males.

To estimate the multivariate probit model beyond the bivariate case, we rely on the simulated maximum likelihood (SML) approach because there is no closed form solution to the integrals in the log-likelihood function. Among possible SML approaches, we use the Geweke-Hajivassiliou-Keane (GHK) smooth recursive conditioning simulator (See for more details Börsch-Supan and Hajivassiliou, 1993 and Cappellari and Jenkins, 2003).

It is well known that simulation bias is reduced to negligible levels when the number of random draws for simulation is raised with the sample size. Although it has been reported that a relatively small number of draws may work well for smooth likelihoods like the GHK simulator, we can ensure above level by choosing the number of draws such that the ratio of the number to the square root of sample size is sufficiently large (Hajivassiliou and Ruud, 1994). Considering the sample size of 1,219, we chose the number of draws to be 500.

Table 4 displays the estimation results using the multivariate probit model. Above all, the time to travel from the respondent's residence to the complex, $Distance_i$, was by far the most significant factor that affects the value reduction from the initial WTP. Respondents who live close to the site are more familiar with the survey site and will likely visit the site relatively frequently in the future. During possible multiple visits, it is likely that other facilities within the complex will also be visited. Therefore, they are more willing to pay for the target facility if facilities other than the target are built together.

The next relevant factor was willingness to accompanying visits to target facilities. What we can tell from these is that if there is a high possibility of visiting the complex in the future, the complementary effect between facilities is intensely felt. As discussed above, therefore, we can infer that the interaction effect has a greater effect on the use value than on non-use values.

We found that the magnitudes of the estimated values of the facility, both WTP_{ij} and $\overline{WTP}_k$, did not have a statistically significant effect on the value adjustment. In other words, the anticipated regret effect when the respondents are allowed to adjust their initial WTP could not be confirmed with our data.

The number of students in the family, $Students_i$, was also analyzed to have some influence. As discussed above, since the target facility of this analysis is a museum, it seems that the meaning of children's education was greatly reflected in the response. This is even more remarkable in that the number of children not yet entering school, $Kids_i$, did not have an effect.

TABLE 4—MULTIVARIATE PROBIT ESTIMATION RESULTS

Variable	First	Second	Third	Fourth	Fifth
$Visit_{ij}$	-0.07119	0.01448	-0.01222	0.008198	-0.06549
	(0.06737)	(0.06689)	(0.06479)	(0.06719)	(0.06887)
WTP_{ij}	0.03064	0.01576	0.01081	0.01108	0.02438
	(0.02105)	(0.02120)	(0.02136)	(0.02129)	(0.02205)
$DVisitAlong_{ik}$	0.3112***	0.1746**	0.08787	-0.05366	0.1921**
	(0.08413)	(0.08427)	(0.08526)	(0.07943)	(0.08870)
$\overline{WTP}_k$	-0.03291	0.3952	-1.239	-0.5359	-0.03144
	(0.4675)	(0.2542)	(1.004)	(0.3747)	(0.1101)
$Distance_i$	-0.002235**	-0.002207**	-0.003585***	-0.004537***	-0.003001***
	(0.001064)	(0.001054)	(0.001017)	(0.001032)	(0.001091)
$DExperience_i$	0.144	0.1101	0.06504	0.1088	0.1321
	(0.1087)	(0.1090)	(0.1068)	(0.1091)	(0.1138)
$Kids_i$	0.05018	0.04431	0.09142	0.139	0.09026
	(0.09778)	(0.09808)	(0.09818)	(0.09720)	(0.09831)
$Students_i$	-0.1158*	-0.1212*	-0.0852	-0.05941	-0.07769
	(0.06354)	(0.06332)	(0.06273)	(0.06444)	(0.06705)
$Income_i$	0.05812**	0.03905	0.04665*	0.05483**	0.007152
	(0.02772)	(0.02750)	(0.02725)	(0.02776)	(0.02914)
$Education_i$	0.06567	0.06464	0.1596	0.1957*	0.1651
	(0.1108)	(0.1096)	(0.1101)	(0.1142)	(0.1183)
Age_i	0.001739	0.001831	0.004083	0.007164	-0.001036
	(0.006534)	(0.006437)	(0.006422)	(0.006605)	(0.006721)
Sex_i	-0.2254**	-0.165	-0.2161**	-0.148	-0.1087
	(0.1087)	(0.1069)	(0.1060)	(0.1083)	(0.1130)
Constant	-1.444*	-2.092***	0.205	-1.285*	-1.239**
	(0.8231)	(0.6037)	(1.547)	(0.7150)	(0.5895)
No. of observations			1,219		
Log-likelihood			-999.2		
Wald statistic			86.07 (*p*=0.0153)		

Note: Numbers in parentheses refer to standard errors. Asterisks indicate statistical significance: *, $p < 0.1$; **, $p < 0.05$; ***, $p < 0.01$.

Among the typical socio-economic characteristics, income and sex matter in value adjustment in the sense that higher income group and female tend to apprehend the complementary effect more sensitively. Education level, however, does not have a significant effect.

Lastly, Table 5 shows the estimated variance-covariance matrix. As the leading diagonal elements are all set to be ones, it reports the off-diagonal elements only. They are all positive and statistically significant. It shows that there is a strong complementarity between facilities other than the target facility, which is expected since all facilities are considered to be preferred goods in our .

TABLE 5—ESTIMATED VARIANCE-COVARIANCE MATRIX (OFF-DIAGONAL ELEMENTS)

Element position	2	3	4	5
1	0.8853***	0.8405***	0.9165***	0.9265***
	(0.02618)	(0.03244)	(0.02128)	(0.01927)
2		0.8964***	0.8836***	0.8673***
		(0.0238034)	(0.02683)	(0.02957)
3			0.9386***	0.8371***
			(0.01646)	(0.03255)
4				0.9236***
				(0.02005)
No. of observations		1,219		
Likelihood ratio		1,287 (*p*=0.000)		

Note: Numbers in parentheses refer to standard errors. Asterisks indicate statistical significance: *, p < 0.1; **, p < 0.05; ***, p < 0.01.

IV. Concluding Remarks

Given limited budget and time for surveys, this study proposed a heuristic approach to value multiple programs (or facilities) using the CV survey. As a cost-effective and bias-avoiding approach, it suggests a top-down method in which all possible programs are informed to the respondents and they are asked to state their WTP on a (target) facility, followed by a series of value adjustment questions. The value adjustments are requested to the initial WTP for the target for the cases when each of the accompanying programs is excluded from the package. To our best knowledge, it is the first ever attempt to accommodate the value adjustment scheme with multiple programs in a parsimonious configuration in the CV study.

A case study shed light on a few features of the proposed approach. First, the approach can be applied in practice without procedural hardship, e.g. there were no respondents who had resistance or difficulties to the additional value adjustments. Second, the magnitude of value adjustment was reasonable. Third, when analyzing the characteristics of value adjustments, the results were in line with expectations.

As a result, the approach proposed by this study can be applicable in practice. Several biases were prevented by reducing the cognitive burden of the respondents.

Since information on various combinations of programs is not directly obtained through questionnaires, it is advantageous in terms of cost.

Nevertheless, the approach requires cautions in exchange of its brevity. First, the approach introduced in this study relies on the assumption that when there are three or more programs, the pairwise interaction effects are dominant so that the additional substitution or complementary effects among three or more programs are negligible. If a researcher wants to relax it, the value adjustment scheme can be extended to ask when two of other facilities are excluded and so forth. However, it should be noted that those additional series of questions are inherently exposed to well-known biases.

Second, it is not suggestive to apply the approach to programs unfamiliar to respondents. In fact, this caution is applicable not only to this approach but also to general cases attempting to value multiple programs. From previous literature, familiarity to the target good seems critical for scope insensitivity. Veisten et al (2004) obtained a mixed result of scope insensitivity in which an unfamiliar sub-group of the target good showed scope-insensitive valuations. Whitehead et al (1998) found the WTP estimates are sensitive to the scope of the policy even with inexpensive surveys because the target goods are familiar to respondents.

Third, for an application to the CBA such as the PFS, it is necessary to be careful to avoid the overstatement of benefits. Hoehn (1991) pointed out the overestimation of benefit when the policy is complex with multidimensional effects. The reason why the top-down method was used here is that it is more scope sensitive compared to the bottom-up method according to previous studies, but it should be noted that it does not guarantee completely responsive sensitivity. In particular, in the case of policy programs that may make a specific group worse off, there may be concerns about overestimation of WTP when adjusting the value using the top-down method.

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