



Development of a bias ratio to examine factors influencing hypothetical bias

James W. Mjelde^{a,*}, Yanhong H. Jin^b, Choong-Ki Lee^c, Tae-Kyun Kim^d, Sang-Yoel Han^e

^a Department of Agricultural Economics, Texas A&M University, College Station, TX 77843-2124, USA

^b Department of Agricultural, Food and Resource Economics, Rutgers, The State University of New Jersey, 55 Dudley Road, New Brunswick, NJ 08901, USA

^c College of Hotel & Tourism, Kyung Hee University, 1 Hoigi-dong, Dongdaemun-gu, Seoul 130-701, South Korea

^d Department of Agricultural Economics, Kyungpook National University, Daegu, South Korea

^e Department of Forestry, Kyungpook National University, Daegu 702-701, South Korea

ARTICLE INFO

Article history:

Received 15 March 2011

Received in revised form

2 June 2011

Accepted 5 October 2011

Available online 2 November 2011

Keywords:

Bias ratio

Contingent valuation

Hypothetical

Multivariate logit

ABSTRACT

Using data from three contingent valuation studies, this study investigates if socio-economic factors and the type of good being valued can help explain changes in respondents' answers. A bias ratio, defined as the ratio of respondents who change their choice under hypothetical and "real" settings, is developed to help explain changes in respondents' answers. Marginal changes in the bias ratio resulting from a change in a particular independent variable consist of changes in responses in both the hypothetical and real situation. Results provide limited evidence that socio-economic variables and type of good being study can help in explaining bias. Respondents who are older, have a higher level of education, and are environmentally conscious tend to show less bias. Familiarity with the good also tend to decrease bias. A large amount of the variation in bias, however, remains unexplained.

© 2011 Elsevier Ltd. All rights reserved.

1. Introduction

Social scientists frequently need to elicit people's preferences when addressing policy and social issues. One such elicitation is obtaining values for nonmarket goods and services (henceforth goods). Progress has been made in developing techniques to estimate values for nonmarket goods (Peterson et al., 1988; Venkatachalam, 2004; Whitehead et al., 2008; Vuletic et al., 2009). Concerns, however, persist that the monetary values obtained from such nonmarket valuation techniques overstate individuals' true values of the good (Venkatachalam, 2004; Morrison and Brown, 2009). Various authors have identified and proposed different taxonomies for biases in these methods (Hoehn and Swanson, 1988; Mitchell and Carson, 1989). Hoehn and Swanson (1988, p. 151) state (attributed to an unpublished manuscript by Cummings et al., 1984) "...one can identify four nonexclusive sets of errors..." In their taxonomy, three sets of errors, hypothetical context, information conveyed, and strategic behavior of the individual, are particularly relevant to the current study, whereas, the fourth, differences between willingness-to-pay (WTP) and

willingness-to-accept (WTA) is at odds with theoretical analyses. In applied settings, separation of the first three biases is difficult at best. Here, hypothetical bias is broadly defined to mean a difference between stated WTP and "revealed" WTP regardless of the cause. This definition of hypothetical bias, which is similar to Whitehead and Cherry (2007) usage, includes various behaviors including attempts to influence policy (strategic bias) and to please the interviewer (yea saying).

Numerous studies have attempted to understand the factors that may lead to people misstating their actual preferences for a good. List and Gallet (2001), Little and Berrens (2004), and Murphy et al. (2005) examine potential factors influencing hypothetical bias using meta-analyses. All three analyses suggest the elicitation method is important in explaining bias with weak evidence for higher biases when valuing public versus private goods and using WTA versus WTP. Further, Murphy et al. (2005) suggest that student subjects (or group experiments) may be a source of bias. It also appears results are sensitive to model specification and lack of variability in the meta-analysis data sets. Little and Berrens (2004, p. 7) state "...it is clear that there is still much we don't know about magnitude, extent, and determinants of hypothetical bias." List and Gallet (2001, p. 251) conclude "More research is necessary." In these analyses, observations are at the study level and not the individual response level. By design, these meta-analyses could not include respondents' individual socio-economic factors that may influence hypothetical bias.

* Corresponding author. Tel.: +1 979 845 1492.

E-mail addresses: j-mjelde@tamu.edu (J.W. Mjelde), yjin@aesop.rutgers.edu (Y.H. Jin), cklee@khu.ac.kr (C.-K. Lee), tkkim@knu.ac.kr (T.-K. Kim), syhan@knu.ac.kr (S.-Y. Han).

Ajzen et al. (2004) applied the theory of planned behavior to explain differences between hypothetical and real payments to a scholarship fund by 160 students. They state “Previous studies have demonstrated the hypothetical bias, have explored its boundary conditions, and have tried to correct for it. To the best of our knowledge, this is the first study that tried to test alternative explanations of the hypothetical bias” (Ajzen et al., 2004, p. 1118). The current study draws from Ajzen et al.’s (2004) observation, namely a lack of studies attempting to explain hypothetical bias at the individual level. Using data from three previous contingent valuation (CV) studies, our study attempts to explain potential causes of hypothetical bias at the individual level.

Specifically, the objective here is to determine if socio-economic factors and differences across survey settings can help explain hypothetical bias. To achieve this objective, the concept of a bias ratio is introduced. Marginal changes in this ratio measure respondents’ changes in responses to both hypothetical and real situations. The literature has generally ignored that changes in both the hypothetical and real situations will affect hypothetical bias.

2. Selected literature review

Numerous disciplines are concerned with why people fail to act in accordance with their stated intentions. LaPeire’s (1934) study on racial prejudice is one of the first, if not the first, empirical study examining differences between stated and actual intentions. Within the CV literature, Bohm (1972) began the work on hypothetical versus actual payments within an experimental framework. Although there is a long history of concern between revealed and stated intentions (preferences), Murphy et al. (2005, p. 313) state “Despite an abundance of studies, there is no consensus about the underlying causes of hypothetical bias...”

Techniques, however, are being developed to minimize such bias with varying success. Morrison and Brown (2009) discuss the three main approaches that have been used in the literature to avoid/adjust for hypothetical bias: certainty scales, cheap talk, and dissonance minimizing format. Certainty scales involve the use of follow-up question(s) which allow the respondent to indicate how sure they are that they would pay the stated amount. Certainty scales are widely used in dichotomous choice CV studies (Champ et al., 1997; Samnaliev et al., 2006; Vossler et al., 2003). Cheap talk involves communication between the experimenter and participant about what to consider in responding to the CV questionnaire prior to the participant making a hypothetical commitment. Cheap talk has been adopted in various studies (Carlsson et al., 2005; Cummings and Taylor, 1999; List, 2001; Lusk, 2003). Finally, the dissonance minimizing format provides a category beyond the simple yes/no categories in dichotomous choice and referendum CV. This category allows a respondent to support a good without having to state they would pay the amount provided in the dichotomous choice question. Hence, it reduces possible yes saying and identifies respondents who protest against the payment vehicle, but would otherwise support the program (Chien et al., 2005). Morrison and Brown (2009) investigate the effectiveness of these different approaches, but do not examine profiles of respondents who may be more likely to show bias. Blackburn et al. (1994, p. 1088) conclude “...bias functions do have some statistical ability to describe the effects of observable socio-economic characteristics on the extent to which subjects misrepresent their preferences in hypothetical DC [dichotomous choice] surveys.”

Studies suggest that choice modeling methodologies may be less prone to hypothetical bias than stated preferences approaches (Hoyos, 2010). Hoyos (2010), however, notes that design issues are

as important in choice modeling as in CVM; he stresses the importance of survey design to mitigate biases.

Another fruitful line of study has been to examine the differences between the revealed and hypothetical WTP by estimating calibration functions. These studies are summarized in the aforementioned meta-analyses (Little and Berrens, 2004; List and Gallet, 2001; Murphy et al., 2005). Calibration studies are divided between laboratory (experimental) and field, with more laboratory than field studies. Fox et al.’s (1998) study concerning consumer preference for irradiated pork is an example of both a laboratory and field survey. They conducted 182 telephone surveys of which 82 respondents participated in the laboratory experimental auctions. They find that hypothetical bias may be product specific (supported by results in the meta-analyses), gender does not impact bias, and higher bid amounts are associated with higher biases.

Based on 346 student respondents, Ehmke et al. (2008) find significant differences in hypothetical bias between students from China, France, Indiana (U.S.), Kansas (U.S.), and Niger. Nape et al. (2003) divide 139 student subjects into real and hypothetical situations, but no respondent responded to both situations. They conclude that hypothetical bias exists in WTA and demographic variables (race and income) contribute to the existence of hypothetical bias. Johnston (2006) compares stated choice responses (survey conducted before announcement of an actual referendum) to aggregate votes in a binding referendum for an identical program. He finds evidence that hypothetical bias is not universal. He suggests familiarity of the good (water supply project), equivalence of the information between the survey and actual referendum, and explicit linkage of the survey and official governmental process may have contributed to the lack of bias. Subjects in Camacho-Cuena et al.’s (2004) faced a real payment after responding to the hypothetical situation for improvement in the recyclability of a product. At the population level there is no significant difference on WTP under real and hypothetical situations. At the individual level, however, respondents stating a low hypothetical bid tended to underestimate their real WTP and vice versa.

Different hypothesis/theories have been sent forth to explain hypothetical bias. Among other issues, Ajzen et al. (2004) consider the viability of the latent disposition hypothesis. Using 46 college students they examine voting in real and hypothetical payment referenda to a scholarship fund. They note the latent disposition hypothesis “...leads us to expect that individuals who vote in favor of the disposition not only in a hypothetical situation but also under real payment conditions hold more favorable beliefs and attitudes than individuals who support the hypothetical proposition but vote against it when it is for real” (Ajzen et al., 2004, p. 1116). They, however, find no support for this hypothesis. Ajzen and Peterson (1988) note the theory of reasoned actions and traditional utility theory differ in that traditional utility maximization theory is not explicitly a function of what others expect of an individual but the theory of reasoned actions suggest people’s actions depend on social pressures. They suggest hypothetical situations must accurately reflect this social pressure. Kaiser et al. (2010) advocate an idea set forth by Campbell (1963), in that differences in attitudes and behavior lie in relative costs. They state “For example, verbally endorsing the importance of financially supporting an environmental cause is probability easier for most people than actually donating money to an environmental organization” (Kaiser et al., 2010, p. 351). Such relative costs could also be a source of hypothetical bias.

This brief literature review provides a sampling of the issues that have been addressed concerning hypothetical bias and CV methods. The current study extends the literature by introducing the bias ratio and examining a) how changes in responses to both the hypothetical and real situation impacts hypothetical bias; and b) how social economic factors affect the bias ratio.

3. Data

Data come from two published studies (Han and Lee, 2008; Lee and Mjelde, 2007) and one unpublished study conducted in South Korea. The studies are similar in that each was a field survey using a dichotomous choice framework. All three studies provided communication between survey administrators and respondents, a limited form of cheap talk. Further, each survey included a very specific certainty scale. To avoid problems with specifying a numerical certainty level after answering the dichotomous choice question, respondents indicating they were willing-to-pay the bid amount were asked to provide additional information on how they could be contacted to obtain payment. This question avoids the problem eliciting a numerical (or categorical) probability from respondents by asking for information respondents know and commonly provide. An implicit 100% certainty of payment, however, is placed on the respondents' answers.

Two general approaches to examining bias are using two independent (split) samples and using one sample. In the split sample design, respondents in one sample who were asked to provide a hypothetical WTP are compared to a second sample who usually were asked to contribute (Nape et al., 2003; Venkatachalam, 2004). In the single sample design, the hypothetical WTP is elicited from the respondents. Then, the same group of respondents is asked to contribute (Fox et al., 1998; Venkatachalam, 2004). All three surveys used in this study employed the single sample design. Although the split sample design is more common, our contention is the two designs are complimentary; neither design is superior in all cases.

3.1. Demilitarized Zone (DMZ) valuation

Although the Korean DMZ arose from and remains because of tragic events, the DMZ has developed into a sanctuary for rare species, including birds, animals, and plants because it has been untouched by human interference for the last half century. Its 1597 species of plants, 201 species of birds, 52 species of mammals, and 106 species of fish create a unique ecological park (Korean National Tourism Organization, 2004). The DMZ and related Civilian Control Zone with their unique and rich biodiversity reserves are in jeopardy because of increasing pressure for agricultural, industrial, and urban development from both the south and north (Westing, 1998). Having grown up in the shadow of the DMZ, the Korea people are familiar with various aspects of this unique area. The DMZ is part of the Korean school curriculum and the Korean War is commemorated on June 25. In fact the DMZ, including ecological tours, has become a popular tourist site.

An offsite survey was conducted in five metropolitan cities (Seoul, Daejeon, Daegu, Busan, and Kwangju) in May and June, 2005. A quota sampling approach for each city was used according to sex and age groups based on national population statistics. Direct face-to-face survey method was employed. Field researchers approached residents, outlined the purpose of the research project, and invited them to participate in the survey. If a family or a group of people was approached, only one person from that group was asked to participate in the survey. Upon consent, a self-administered questionnaire was presented to each respondent to complete. A total of 1050 questionnaires were collected from the survey, but 54 questionnaires were excluded from the analysis because of missing answers to one or more of the questions. Therefore, 996 questionnaires (observations) are used in the analysis. Approximately 90% of the respondents indicate they had knowledge of the DMZ with over 70% feeling development of the DMZ would negatively affect the natural environment.

The question proposed to respondents to derive willingness-to-pay was (Lee and Mjelde, 2007, p. 515):

The law of "Support for the Borderline" may have a negative impact on the natural ecosystem of the DMZ and CCZ. In order to preserve the ecosystem of the DMZ and CCZ and compensate the communities for economic loss due to control and restrictions, if you were asked to donate ___ won to the "DMZ preservation fund," would you be willing to donate that amount?

Seven different donation amounts were included in the study (1000, 2000, 5000, 10,000, 20,000, 50,000, and 1,000,000 Korean won: (US \$1 is equivalent to approximately 1000 Korean won at the time of the study). Each respondent was randomly assigned one donation amount. Answers to this question were deemed the hypothetical scenario. Respondents that declined to pay the bid amount (answered "no") are considered not willing-to-pay in the hypothetical setting. Respondents that agreed to the donation amount (responded "yes") were given the following instructions (Lee and Mjelde, 2007, p. 515):

If you have agreed to donate toward the preservation of the DMZ and CCZ, please indicate environmental organizations and then provide your name, address, and signature to indicate that you agree to the amount you are willing to donate, so that your indicated environmental organization can send a bill to you.

This question comprised the real scenario. Respondents that did not provide their address were considered respondents not willing-to-pay the bid amount in the real setting. Those individuals providing their addresses were considered the "yes" respondents in the real setting.

Lee and Mjelde (2007) estimate the mean WTP for the preservation of the Korean DMZ is US \$19.78 per capita in the hypothetical setting; whereas, the mean WTP for the real setting is US \$16.74.

For use in the current study, the observations are classified as follows. Six hundred eighty-seven respondents answered "no" to the first question (Table 1). These respondents are denoted as "no." Among 309 respondents who answered "yes" to the first question, 260 respondents provided their address in the follow-up question are denoted as "yes–yes" respondents. Finally, the 49 respondents

Table 1

Mean and standard deviations of the relevant variables and measures in the three survey data sets.

Groups	DMZ	Black Bear	Mud	Combined
<i>Calculated bias ratio</i>				
Bias ratio (%)	15.86	52.91	29.86	29.90
<i>Dependent variables</i>				
No	687	169	184	1040
Yes–No	49	100	63	212
Yes–Yes	260	89	148	497
Number of observations	996	358	395	1749
<i>Independent variables (standard deviation in parenthesis)</i>				
Bid amount (1000 won)	26.28 (33.41)	9.74 (15.40)	21.65 (28.03)	21.84 (30.03)
Age (years)	36.47 (11.38)	38.29 (11.30)	30.98 (8.91)	35.60 (11.15)
Female	0.48 (0.50)	0.31 (0.47)	0.54 (0.50)	0.46 (0.50)
Education: above high school	0.69 (0.46)	0.47 (0.50)	0.90 (0.30)	0.70 (0.46)
Income (1,000,000 won)	2.84 (1.95)	2.68 (3.41)	2.03 (1.91)	2.63 (2.33)
Environmental consciousness	0.89 (0.30)	0.88 (0.33)	0.78 (0.41)	0.87 (0.34)
Belief in humankind	0.34 (0.47)	0.56 (0.50)	0.37 (0.48)	0.39 (0.49)

who were willing-to-pay the bid amount but failed to provide their address are denoted as “yes–no.”

3.2. Manchurian black bear valuation

The Manchurian black bear, also known as the crescent bear, has been classified as an endangered species by the Korean Ministry of Environment. Although the wild population was thought extinct in Korea, in 1997 a small group of bears was found living in the thick forests of the Chirisan National Park, South Korea. Since then interest in preserving and increasing the number of wild bears has increased. Research, campaigns to protect the bear, and breeding programs have been developed by national and local government agencies, along with non-governmental agencies.

To estimate the preservation value of the Manchurian black bear, Han and Lee (2008) conducted an on-site survey of visitors to the Chirisan National Park on weekends in September 2005. Face-to-face interviews of visitors to the Park were conducted. Respondents could either complete the questionnaire as administered by the field researcher or complete a self-administered questionnaire. Respondents were presented with the following question (Han and Lee, 2008, p. 460):

Efforts to preserve endangered wildlife, partly sponsored by central and local governments, have helped to save several wildlife species on the brink of extinction. For example, at least ten Manchurian black bears have been preserved in Chirisan National Park. If budget cuts were to eliminate this program, and a non-government trust fund was required to manage and preserve the Manchurian black bears, would your family contribute ___ won to this fund per year?

Bid amounts considered were 100, 200, 500, 1000, 2000, 5000, 10,000, 20,000 and 50,000 won (US \$1 is equivalent to approximately 1034 Korean won at the time of the study). Similar to Lee and Mjelde (2007), responses to this question were deemed the hypothetical setting. Respondents answering “yes” to the above question were then presented with an additional question (Han and Lee, 2008, p. 461):

If you have agreed to donate to the Manchurian black bears' preservation program, please choose one of the following non-governmental environmental movement organizations and then provide your name, address, and signature indicating that you agree to the amount you are willing-to-pay so that your chosen organization can send a bill to you.

Responses to this second question were deemed the real scenario. Han and Lee (2008) find that the mean WTP is US \$10.49 in the hypothetical setting and US \$4.99 in the real setting.

Four hundred questionnaires were collected but 42 were deemed incomplete, leaving 358 responses for analysis. Of these responses, 169 fall in the “no,” 89 in the “yes–yes,” and 100 in the “yes–no” categories (Table 1).

3.3. Mud valuation

The Boryeong Mud festival began as a way to promote public awareness of the superiority of Boryeong Mud and promoting the abundant resources, beautiful mountain scenery, and beaches surrounding Boryeong City (Boryeong Mud Festival, 2010). Mud, which is closely associated with core natural resource of marine ecosystems, is widely embedded in the 55 festival programs. Given the quality of festival, the Ministry of Culture and Tourism designated this festival as Korea's “Best Festival” for three years, 2007–2009 (Lee et al., forthcoming). The 2009 Mud Festival was held over nine days in July. Over two million visitors including

104,000 international visitors participated in this festival (Organizing Committee of Boryeong Mud Festival, 2009).

An on-site survey was administered during the 2009 festival. After ensuring the visitors had enough time to experience various aspects of the festival, the field researchers approached visitors, outlined the purpose of the research, and invited them to participate in the survey. Questionnaires were completed through personal interviews, unless the visitor preferred to complete the questionnaire on their own. The field researchers contacted 612 visitors, 442 participated in the survey. Forty-seven questionnaires were incomplete giving 395 useable observations.

The questionnaire included the following information.

The Boryeong Mud festival provided visitors with variety of enjoyment. Also, mud not only purifies nature, but also performs an important role as a habitat of ecology (or ecosystem). However, careless use of natural resources and oil spills will possibly destroy the ecological purification system.

Visitors were then asked to answer “yes” or “no” to the following valuation question.

Environment pollution will destroy ecological function of mud. If you were asked to donate ___ won to preserve the ecological function of mud, would you be willing to donate that amount?

Respondents who answered “yes” to the first question were then asked to provide information as to where to payment could be obtained.

If “yes,” would you agree that you are sent giro so that you could pay for to the amount you are willing to donate?

1. Yes 2. No

If “yes,” are you willing to present name and to receive giro?

1. Yes 2. No

The 395 observations are categorized as “no” (184 observations) if answered “no” to the first questions, “yes–yes” (148 observations) if answered “yes” to the first questions and “yes” to the giro question, and “yes–no” (63 observations) if answered “no” to the giro question (Table 1).

4. Methodology

To determine if there are any systematic differences between the three groups, “no,” “yes–yes,” and “yes–no,” a multinomial logit (MLOGIT) model is estimated.¹ MLOGIT models assume the error terms are independently and identically distributed with a Weibull distribution. MLOGIT exhibits the behavioral property of the independence of irrelevant alternatives (IIA) meaning the odds ratios in the logit model are independent of the other alternative (Greene, 1997). A Hausman test (Hausman and McFadden, 1984) is conducted for the appropriateness of this property.

¹ In addition to the multinomial logit specification, nested logit specifications were estimated. The MLOGIT model is deemed more appropriate, as such it is presented in some detail here. Nested logit models are estimated that include two nests. The first nest includes two alternatives, accepting the initial bid or not. Conditional on accepting the initial bid, the second nest is either providing or not providing their address. For those who decline the initial bid, no further choice is required. The nested logit model is obtained by assuming that the vector of unobserved utility has a cumulative distribution given by $\exp(-\sum_{k=1}^K e^{-\epsilon_{nj}/\lambda_k})^{\lambda_k}$, where λ_k is the dissimilarity parameter measuring the degree of independence in unobserved utility among the alternatives in nest k (Train, 2003). A value of $\lambda_k = 1$ indicates complete independence within a nest k , that is, no correlation. When $\lambda_k = 1$ for all k , representing independence among all the alternatives in all nests, which suggests that the standard logit model is a reasonable specification against the general nested logit model. The null hypothesis of $\lambda_k = 1$ for all k is fail to be rejected; providing evidence MLOGIT is appropriate.

Using the “yes–no” group as the base ($j = 0$), the probability being in an alternative group j ($j = 1$ for “no” and 2 for “yes–yes”) for individual i is:

$$P_{ij} = \begin{cases} \text{prob}(Y_i = j) = \frac{e^{\beta_j X_i}}{1 + \sum_j e^{\beta_j X_i}} \text{ for } j = 1 \text{ and } 2, \text{ and} \\ \text{prob}(Y_i = 0) = \frac{1}{1 + \sum_j e^{\beta_j X_i}} \text{ for } j = 0 \end{cases} \quad (1)$$

where the categorical dependent variable, Y_i , indicates one of the three possible groups (“no”, “yes–yes”, “yes–no”), X_i is a vector of independent variables (discussed below), and β_j is a coefficient vector associated with alternative j . MLOGIT models are estimated for each individual study and combined data from all three studies. Data set dummies are incorporated in the estimation using the combined data sets.

4.1. Independent variables

Socio-economic independent variables are the bid amount, age, gender, education, income, and two variables concerned with perceptions toward the environment and the respondents’ beliefs concerning the ability and limits of humankind when balancing their activities with the environment. Given differences in the survey designs, some concessions had to be made in defining several of the independent variables. These concessions allowed for a consistent set of variables. Bid amount is a continuous variable given by the amount on the valuation dichotomous choice questions. Age in years also enters the models as a continuous variable. Gender is equal to one for female and zero for male respondents. Education is a qualitative variable that takes on the value of one if the respondent had at least some education beyond high school and a value of zero otherwise. Based on the selected income intervals among the respondents, the mean for each income interval is estimated using a maximum entropy procedure proposed by Wu and Perloff (2007) and successfully used in Musumba et al. (2009). The estimated mean of the interval corresponding to the interval provided by the respondents are used as a continuous income variable.

Questions on the three surveys concerning people’s perceptions toward the environment and beliefs toward human’s ability to overcome environmental problems differed. Two variables, “environmental consciousness” and “belief in humankind” are defined as follows. In the DMZ and Mud studies, respondents were asked to complete six of the 12 statements on the new environmental paradigm (Dunlap and Van Liere, 1978; Dunlap et al., 2000). The following three specific questions are used to create an indicator variable for environmental consciousness:

- The balance of nature is very delicate and easily upset,
- Humans must live in harmony with nature in order to survive, and
- When humans interfere with nature it often produces disastrous consequences.

If respondents answered neutral to at most one of the above three statements and agree or strongly agree to at least two statements, the respondent was coded as a one for environmental consciousness; otherwise zero. Unfortunately, the Black Bear study did not ask the same questions. Instead, it asked respondents whether they perceive “condition of the world environment as (a small problem/a large problem).” Respondents perceive a large problem for the current environment condition are coded as a one for strong environmental consciousness and zero otherwise.

Belief in humankind is developed in a similar manner. For the DMZ and Mud studies, respondents were coded as one if they were neutral to at most one of the following statements and agree or strongly agree to at least two statements:

- Mankind was created to rule over the rest of nature,
- Plants and animals exist primarily to be used by humans, and
- Humans have the right to modify the natural environment to suit their needs.

A respondent in the Black Bear is coded as a one for belief in humankind variable, if he/she choose “agree” to “Scientific development can solve environmental problems” or “disagree” to “There are limits to growth beyond which our society cannot expand.”

Because the DMZ and black bear surveys were conducted in 2005, but the Mud study was conducted in 2009, bid amount and annual income for the Mud study are adjusted by the Korean consumer price index using 2005 as the base. Summary statistics of the three survey data sets are provided in Table 1. Respondents in the three surveys are qualitatively similar in term of their demographic and economics variables, as well as, in their environmental consciousness and belief in humankind. More specifically, on average, respondents are in their middle 30’s and earn monthly income of 2.69 million won (approximately US \$2000–3000). About 46% of the respondents are females, and 70% achieved education beyond high school. The majority of the respondents are environmental consciousness (87%) and only 39% believe humankind has unlimited power to change the environment.

4.2. Marginal effects on the probabilities

Consistent with previous MLOGIT studies, besides the estimated coefficients, marginal effects are also presented. As discussed in the results section, marginal effects help explain bias. Based on equation (1), the marginal effects of an independent variable on the probabilities of being in one of the three dependent variable groups (“no”, “yes–yes,” and “yes–no”) are given by

$$\frac{\partial P_j}{\partial X_i} = P_j \left[\beta_j - \sum_k P_k \beta_k \right]. \quad (2)$$

For any particular independent variable (x_i), the marginal effects $\partial P_j / \partial x_i$ and the estimated coefficient, β_j , do not necessarily have to have the same sign. That is, the sign of the estimated coefficient does not indicate whether a marginal change associated with an independent variable increases or decreases the probability of being in one of the particular groups. Further, the significance level of a particular coefficient and associated marginal effect may also differ.

4.3. Measuring bias and the marginal effects of independent variables on the bias

Respondents who initially choose “yes” in a hypothetical setting but switch to “no” in the real situation are coded as “yes–no.” These respondents are the source of bias. The bias ratio is the ratio of respondents in the “yes–no” group to the total number of respondents who initially choose “yes” in the hypothetical setting. Formally, the bias ratio is

$$\alpha = \frac{\text{prob}(\text{yes} - \text{no})}{\text{prob}(\text{yes} - \text{no}) + \text{prob}(\text{yes} - \text{yes})} = \frac{1 / (1 + e^{\beta_1 X_i} + e^{\beta_2 X_i})}{(1 + e^{\beta_2 X_i}) / (1 + e^{\beta_1 X_i} + e^{\beta_2 X_i})} = \frac{1}{1 + e^{\beta_2 X_i}} \quad (3)$$

where α is the bias ratio and the remaining expressions are as previously defined.

Changes in any independent variable have two potential effects on the bias ratio. The first effect is a change in probability of responding “yes” or “no” to the hypothetical question; whereas, the second effect is a change in the probability of responses to the “real” question. Marginal effects discussed above do not take into account both of these changes, but do help explain overall marginal changes of independent variables on the bias as discussed later. Differentiating equation (3) with respect to any independent variable, x_i , yields the marginal effect of this particular independent variable on the bias ratio:

$$\frac{\partial \alpha}{\partial x_i} = -\frac{\beta_2 e^{\beta_2 x_i}}{(1 + e^{\beta_2 x_i})^2} \quad (4)$$

As shown by the negative sign in equation (4), using the “yes–no” group as a base, the marginal effect of an independent variable on the bias ratio has an opposite sign of its estimated coefficients for the “yes–yes” group (β_2), note the remaining components are positive. Determining the significance level of a particular independent variable on the bias ratio is more complicated. As such, the delta method is used to test for statistical significance associated with the marginal effect of each independent variable on the bias ratio. A brief discussion on the delta method is presented, but details can be found in (Oehlert, 1992).

A consistent estimator $\hat{\beta}$ converges in probability to its true value β . Using the central limit theorem, asymptotic normality is defined as $\sqrt{n}(\hat{\beta} - \beta) \xrightarrow{D} N(0, \Sigma)$, where n is the number of the observations and Σ is a symmetric positive semi-definite covariance matrix. From equation (4) it is clear the marginal effects of a particular independent variable on the bias ratio are a function of the estimated parameters denoted by $M(\hat{\beta})$. Using a Taylor series expansion the associated variance can be estimated as follows:

$$M(\hat{\beta}) = M(\beta) + \nabla M(\hat{\beta})^T (\hat{\beta} - \beta), \text{ and} \quad (5a)$$

$$\text{VAR}(M(\hat{\beta})) = \nabla M(\hat{\beta})^T (\Sigma/n) \nabla M(\hat{\beta}). \quad (5b)$$

The delta method, therefore, implies that $\sqrt{n}(M(\hat{\beta}) - M(\beta)) \xrightarrow{D} N(0, \nabla M(\hat{\beta})^T (\Sigma/n) \nabla M(\hat{\beta}))$. Statistical inferences on the marginal effects of independent variables on the bias ratio are based on this asymptotic property.

5. Results

As noted earlier, four different models are estimated, an individual model for each data set and a model in which the data sets are combined. Hausman tests are performed to test for the appropriateness of the MLOGIT model. In this test, the null hypothesis is that differences in the estimated coefficients based on the full sample and the estimated coefficients based on a sub-sample excluding any alternative are not systematic. Tests fail to reject the null hypothesis for all four models (Table 2). Furthermore, a likelihood ratio test for IIA after the nested logit estimation is also conducted with a null hypothesis that two the dissimilarity parameters are equal to one.¹ The likelihood ratio tests fail to reject the null hypothesis; therefore, the IIA property holds. These results imply the standard multinomial model is appropriate.

Estimation results for the MLOGIT models are provided in Table 2. There are both differences and similarities between the four models. The combined data set has more significant coefficients than the other models, most likely because of increased variability in the independent and dependent variables and a larger number of observations. Marginal effects on the probabilities of

falling in each of the three groups are presented in Table 3. As noted earlier, marginal effects can be significant even if the associated estimated coefficient is insignificant in the multinomial model. Results in Tables 2 and 3 are used to develop and explain changes in the bias ratios as an independent variable changes.

5.1. Bias ratio

Marginal changes of independent variables on the bias ratio calculated at the mean of the independent variables are given in Table 4. A positive marginal change indicates as the relevant independent variable increases there is an increase in the bias ratio, therefore an increased in the probability of bias occurring. Likewise, a negative change indicates increases in the independent variable decreases the bias ratio indicating a decrease in bias. Similar to the MLOGIT estimation, higher degrees of statistical significance are shown on the marginal effects on the bias ratio when using the combined data set than for each individual data set. The most likely reason is again the increase in variability in the variables and a larger number of observations. Considering the combined data set, marginal changes in the bias ratio are statistically significant at the 10% or less level and negative for bid, age, education, environmental consciousness, and the two dummy variables representing the studies. Among the four data sets, all significant variables are negative. The remaining discussion concentrates on the combined data set.

To illustrate the bias ratios and marginal effects on the bias consider bid amount. The marginal change in the bias ratio is negative indicating a decrease in bias as bid amount increases taking into account changes in both the hypothetical and real situations. The marginal effects of bids on the probabilities (Table 3) indicate that as bid amount increases respondents are more likely to say “no” to the hypothetical question. This is seen by the positive marginal effects value (0.006) for the “No” category. As bid amount increases, the denominator for the bias ratio decreases (lower probability respondents will answer “yes” to the hypothetical question). At the same time, an increase in the bid amount decreases the probability a respondent will be in the “yes–no” category (as indicated by the negative -0.002), which decreases the nominator in the bias ratio. The bias ratio takes into account both of these changes with the change in responding to the hypothetical question dominating. Caution is noted to the reader, because of the nonlinear aspects of the MLOGIT model and the definition of marginal and bias ratio, one cannot simply sum the marginal effects. Effects for the remaining independent variables are interpreted in a similar fashion.

As age increases, there is very little change in the respondents likelihood to answer “yes” to the hypothetical question, but they are less likely to be in the “yes–no” category. As such, the bias ratio decreases as age increases. The cumulative effect is older respondents show less bias than younger respondents. Similarly, respondents with at least some education above high school also show a decrease in bias. This decrease in bias comes about with an increase in education because the probability of a “yes” answer to the hypothetical WTP question decreases and the likelihood of being in the “yes–no” category decreases. Increases in environmental consciousness not only increase the probability of answer “yes” to the hypothetical question but also answering “no” (although statistically insignificant) to the real question. The overall impact of environmental consciousness is negative, that is, a reduction in bias. Marginal changes for the dummy variables for DMZ and Mud are negative and significant. Bias is decreased for these two studies relative to the black bear study, which is consistent with the calculated values for the bias ratio (Table 1). The bias ratio is the largest for the black bear data study (52.9%),

Table 2
Estimated coefficients and standard deviations associated with the multinomial logit estimations.

	DMZ	Black Bear	Mud	Combined
<i>Dependent variable yes–yes compared to base yes–no</i>				
Bid (1000 won)	0.003 (0.010)	0.014 (0.022)	0.007 (0.009)	0.011 (0.008)
Age (years)	0.000 (0.016)	0.065*** (0.014)	0.011 (0.020)	0.032 (0.023)
Female	–0.074 (0.320)	0.204 (0.350)	–0.213 (0.302)	–0.092 (0.099)
Education: above high school	0.286 (0.374)	0.662** (0.316)	–0.389 (0.507)	0.366 (0.238)
Income (1,000,000 won)	0.043 (0.081)	0.009 (0.035)	0.001 (0.077)	–0.003 (0.005)
Strong envi. consciousness (ES = 1)	–0.525 (0.759)	0.745 (0.563)	0.823** (0.392)	0.586** (0.293)
Superior man power (SM = 1)	–0.516 (0.329)	0.097 (0.311)	0.141 (0.342)	–0.128 (0.192)
Data set dummies (base = Black bear)				
DMZ				1.696*** (0.081)
Mud				1.021*** (0.165)
Constant	2.021* (1.077)	–3.731*** (0.790)	0.138 (0.933)	–1.994* (1.198)
<i>Dependent variable no compared to base yes–no</i>				
Bid (1000 won)	0.027*** (0.009)	0.094*** (0.017)	0.025*** (0.008)	0.036*** (0.012)
Age (years)	–0.011 (0.015)	0.067*** (0.013)	–0.012 (0.020)	0.023 (0.026)
Female	0.144 (0.307)	0.149 (0.320)	–0.065 (0.303)	0.079 (0.089)
Education: above high school	0.193 (0.350)	0.299 (0.295)	0.555 (0.587)	0.335*** (0.055)
Income (1,000,000 won)	–0.039 (0.077)	–0.185* (0.111)	–0.097 (0.085)	–0.110*** (0.031)
Environmental consciousness	–1.188 (0.732)	–0.206 (0.407)	0.017 (0.371)	–0.212 (0.214)
Belief in humankind	0.142 (0.308)	0.316 (0.289)	0.618* (0.329)	0.362*** (0.079)
Data set dummies (base = Black bear)				
DMZ				1.886*** (0.064)
Mud				0.194 (0.123)
Constant	3.467*** (1.035)	–2.373*** (0.690)	0.418 (0.969)	–0.599 (1.103)
No. of observations	996	358	395	1749
R-square	0.08	0.16	0.07	0.12
Log likelihood	–692	–316	–373	–1418
Test statistics of Hausman tests for IIA in the MLOGIT model using the combined data set				
<i>Excluding one particular data set</i>		<i>Excluding one particular group</i>		
Black Bear: $\chi^2(8) = -79.34$		(no) group: $\chi^2(9) = -185.72$		
DMZ: $\chi^2(8) = 0.22$		(yes–no) group: $\chi^2(9) = 1.01$		
Mud: $\chi^2(8) = 0.45$		(yes–yes) group: $\chi^2(9) = -1.51$		

Statistics of LR test for IIA after the nested logit model using the combined data sets: $\chi^2(2) = 3.10$; p -value = 0.21.

*Significant at an alpha level of 10%.

**Significant at an alpha level of 5%.

***Significant at an alpha level of 1%.

followed by the Mud study (29.9%), and smallest for the DMZ study (15.9%).

5.2. Predictability

Both in-sample and out-of-sample predictions are conducted. The corresponding percent of correctly predicted observations is used to examine the prediction power of the various models. For each MLOGIT model based on each single data set, in-sample predictions of that particular data set, as well as, out-of-sample predictions for the other two data sets are presented in the first three rows of Table 5. The combined data set is also used for in-sample prediction (fourth row of Table 5). As expected, the combined estimation predicts the entire sample better than only using a single data set (63.18% for the combined data set compared with 48.66%, 55.63%, or 61.41% if using only Mud, Black Bear, or DMZ data set). The in-sample predictions using either DMZ or Mud are much better than the out-of-sample predictions, but surprisingly the result is reversed for the black bear. Further, the in-sample predictions using DMZ are better than for the other data sets. The higher prediction power of DMZ may reflect that the respondents are more familiar with DMZ and have reported their perception in a more truthful fashion.

Finally, one half of each of three data sets was randomly selected. Both in-sample prediction and out-of-sample prediction for the other halves are presented in the last two rows of Table 5. As expected the percentage correct is higher for the in-sample predictions, but the out-of-sample percentage correct is only

slightly smaller. Given the models have relatively good predictive power lends credence to the bias ratio analysis.

6. Discussion and implications

Results on the socio-economic variables are influenced by the data set used to estimate the bias function. Results from the individual data sets differ by study. By combing the data sets, variability is increased in both dependent and independent variables. Increase in variability and degrees of freedom lead to more variables being significant in explaining bias. A bias ratio is developed that reflects respondents' answers to the bid question under both the hypothetical and real situations. Both of these changes must be accounted for in determining bias. Previous literature does not include such a ratio. Further, the level of predictability shown by the estimated MLOGIT model provides a level of confidence to the bias ratio analysis which is derived from the MLOGIT model.

Income is not a statistical significant factor affecting the bias ratio. This result is consistent with the fact that one time bid amounts are generally a small percentage of the respondents' income. With a good comprising a small percentage of one's income, respondents may be more apt to act on their stated intentions. This finding may provide limited support for Kaiser et al.'s (2010) relative costs ideas and notion Campbell's (1963) ideas hold potential in both theory and practice. This is a notion economists should embrace in further research. Similarly, gender did not play a role in determining significant changes in the bias ratio. *A priori*, it was felt that in today's world females may be more

Table 3
Comparison of marginal effects for the combined model.

	Marginal effect on the prob. of following in each group		
	No	Yes–No	Yes–Yes
<i>Combined</i>			
Bid (1000 won)	0.006*** (0.001)	–0.002*** (0.001)	–0.004*** (0.001)
Age (years)	–0.000 (0.002)	–0.002 (0.002)	0.002*** (0.000)
Female	0.035*** (0.011)	–0.002 (0.007)	–0.033*** (0.011)
Education (above high school)	0.013 (0.030)	–0.027*** (0.007)	0.014 (0.037)
Income (1,000,000 won)	–0.025*** (0.006)	0.006*** (0.001)	0.019*** (0.005)
Environmental consciousness	–0.136*** (0.005)	0.001 (0.017)	0.135*** (0.016)
Believes in humankind	0.104*** (0.023)	–0.016** (0.007)	–0.088*** (0.026)
DMZ	0.147*** (0.013)	–0.161*** (0.022)	0.014 (0.009)
Mud	–0.153*** (0.001)	–0.032*** (0.007)	0.185*** (0.016)
<i>DMZ</i>			
Bid (1,000,000 won)	0.005*** (0.001)	–0.001*** (0.000)	–0.004*** (0.001)
Age (years)	–0.002 (0.001)	0.000 (0.001)	0.002 (0.001)
Female	0.041 (0.029)	–0.004 (0.012)	–0.038 (0.027)
Education (above high school)	–0.01 (0.036)	–0.009 (0.015)	0.018 (0.034)
Income (1000 won)	–0.015** (0.008)	0.001 (0.003)	0.014** (0.007)
Environmental consciousness	–0.126*** (0.040)	0.030** (0.014)	0.096** (0.038)
Belief in humankind	0.109*** (0.028)	0.000 (0.012)	–0.110*** (0.027)
<i>Black Bear</i>			
Bid (1000 won)	0.022*** (0.003)	–0.012*** (0.003)	–0.009*** (0.003)
Age (years)	0.008*** (0.003)	–0.012*** (0.002)	0.004 (0.002)
Female	0.011 (0.068)	–0.030 (0.052)	0.019 (0.056)
Education (above high school)	–0.010 (0.063)	–0.075 (0.048)	0.084* (0.051)
Income (1,000,000 won)	–0.047* (0.028)	0.022 (0.014)	0.025* (0.015)
Environmental consciousness	–0.129 (0.086)	–0.006 (0.071)	0.135** (0.061)
Belief in humankind	0.067 (0.061)	–0.045 (0.048)	–0.022 (0.049)
<i>Mud</i>			
Bid (1000 won)	0.005*** (0.001)	–0.002** (0.001)	–0.003** (0.001)
Age (years)	–0.005 (0.004)	0.000 (0.002)	0.005 (0.003)
Female	0.021 (0.056)	0.017 (0.036)	–0.039 (0.053)
Education (above high school)	0.197** (0.089)	–0.006 (0.067)	–0.191** (0.090)
Income (1,000,000 won)	–0.024 (0.015)	0.007 (0.010)	0.017 (0.015)
Environmental consciousness	–0.129* (0.072)	–0.046 (0.052)	0.176*** (0.060)
Belief in humankind	0.129** (0.059)	–0.052 (0.038)	–0.076 (0.056)

*Significant at an alpha level of 10%.

**Significant at an alpha level of 5%.

***Significant at an alpha level of 1%.

reluctance to provide their addresses to strangers than males. That is, social pressures may lead to bias. Insignificance indicates no support for this hypothesis based on the theory of reasoned actions, at least for gender and social pressure. The remaining insignificant variable was belief in humankind. Differences in measuring this variable between studies may lead to the insignificance of this variable.

Both education and age are significant in explaining marginal changes in the bias ratio. Older and/or more educated respondents showed less bias. Possible reasons include an increased maturity level of older respondents and a better understanding of the need

to protect the environment. Another plausible explanation for age decreasing bias is that with increasing age comes an increasing familiarity and experience with making pledges for environmental goods. This increasing familiarity and experience may indicate older respondents have a better implicit understanding of tradeoffs made in revealing WTP. These reasons should provide the bases for future inquiry. Increased understanding of the environmental issues is related to the environmental consciousness variable.

Significance of the environmental consciousness variable provides support for the latent disposition hypothesis. People with favorable beliefs and attitudes toward the environmental are more

Table 4
Marginal changes of each independent variable on the bias ratio.

	DMZ	Black Bear	Mud	Combined
Bid (1000 won)	–0.000 (0.001)	–0.003 (0.006)	–0.013*** (0.002)	–0.002* (0.001)
Age (years)	0.000 (0.002)	–0.016*** (0.004)	–0.002 (0.004)	–0.005* (0.003)
Female	0.010 (0.043)	–0.051 (0.087)	0.041 (0.058)	0.015 (0.017)
Education (above high school)	–0.038 (0.050)	–0.165** (0.079)	0.075 (0.098)	–0.061* (0.037)
Income (1,000,000 won)	–0.006 (0.011)	–0.002 (0.009)	–0.002 (0.017)	0.000 (0.001)
Environmental consciousness	0.070 (0.104)	–0.186 (0.140)	–0.158** (0.072)	–0.098** (0.043)
Belief in humankind	0.070 (0.044)	–0.024 (0.077)	–0.027 (0.065)	0.021 (0.034)
DMZ				–0.283*** (0.027)
Mud				–0.171*** (0.021)

*Significant at an alpha level of 10%.

**Significant at an alpha level of 5%.

***Significant at an alpha level of 1%.

Table 5
Predictive power as measured by percent of successful predictions.

Data used for estimation	Sample predicted			
	DMZ	Black Bear	Mud	Combined
Black Bear	58.63	53.63	49.87	55.63 (I + O)
DMZ	70.48	49.72	49.11	61.41 (I + O)
Mud	51.20	33.52	55.95	48.66 (I + O)
Combined	69.88	54.75	53.92	63.18
Combined – random half sample of each data set	71.28	55.31	55.05	64.34
	67.27	51.40	54.82	61.21

Figures in shaded cells are percents of successful in-sample prediction, while others are for out-sample prediction except those indicated for both in- and out-sample prediction (I + O).

likely to provide their addresses than individuals with less favorable views. That is, an increase in environmental consciousness leads to a decrease in the probability of bias.

The significance of the study variables is in line with previous studies that there are differences in hypothetical bias based on the type of good being valued. Respondents that answered yes to the bid amount in both the DMZ and Mud study are more apt to provide their addresses than respondents in the black bear study. Given the similarity between the studies one possible explanation is familiarity of the good being valued. Although the DMZ study was offsite, since birth Koreans are exposed to issues pertaining to the DMZ. Respondents in the Mud study had just experienced festival activities related to Mud. In contrast, respondents in the black bear study had experienced the national park, but few if any actually observed the black bear. This familiarity may be akin to differences previous studies have noted concerning differences between public and private goods. Generally, less bias is seen in private good valuation. Ajzen et al. (2004) suggest a corrective entreaty decreases bias by informing the respondents. Although not the exact same, the results on the study variables confirm this idea. Familiarity with the good in question leads to less bias.

Results on bid have a catch 22 implication for survey design. Although in designing a survey one must include a range of bids, it appears that including lower bids leads to a potential increase in bias. Research needs to weight these two conflicting aspects. Further, results suggesting that high bid amounts tend to decrease hypothetical bias are inconsistent with some previous studies. One possible explanation is the bias ratio accounts for changes in both the hypothetical and real situations, but previous studies do not account for both changes.

The bias ratio shows promise in expanding our understanding of how various factors influence differences between people's stated and revealed actions. Differences in various factors affect not only respondent's stated action but also their revealed action. The bias ratio takes into account both of these changes. Additional research on the potential of the bias ratio in explaining bias is necessary. Research should include both field and laboratory studies. A large amount of the variation in bias remains unexplained in the estimated models. It is our hope that this study will foster additional work in this area. This brings up another issue that of split versus single sample methodologies to examine hypothetical bias. Our contention is the methodologies are complimentary; each methodology has its own strengths and weaknesses. Additional work on the comparison of the two methodologies is warranted.

References

- Ajzen, I., Brown, T.C., Carvajal, F., 2004. Explaining the discrepancy between intentions and actions: the case of hypothetical bias in contingent valuation. *Personality and Social Psychology Bulletin* 30, 1108–1121.
- Ajzen, I., Peterson, G.L., 1988. Contingent value measurement: the price of everything and the value of nothing? In: Peterson, G.L., Driver, B.L., Gregory, R. (Eds.),

- Amenity Resource Valuation Integrating Economics with Other Disciplines. Venture Publishing, Inc, State College, PA.
- Blackburn, M., Harrison, G.W., Ruström, E.E., 1994. Statistical bias functions and informative hypothetical surveys. *American Journal of Agricultural Economics* 76, 1084–1088.
- Bohm, P., 1972. Estimating the demand for public goods. *European Economic Review* 3, 111–130.
- Boryeong Mud Festival, 2010. Origins. <http://www.mudfestival.or.kr/english/festival/festival1.php> (accessed 31.03.10.).
- Camacho-Cuena, E., Garcia-Gallego, A., Georgantzis, N., Sabater-Grande, G., 2004. An experimental validation of hypothetical WTP for a recyclable product. *Environmental and Resource Economics* 27, 313–335.
- Carlsson, F., Frykblom, P., Lagekvist, C.J., 2005. Using cheap talk as a test of validity in choice experiments. *Economic Letters* 89, 147–152.
- Champ, P., Bishop, R., Brown, T., McCollum, D., 1997. Using donation mechanisms to value nonuse benefits from public goods. *Journal of Environmental Economics and Management* 33, 151–163.
- Campbell, D.T., 1963. Social attitudes and other acquired behavioral dispositions. In: Koch, S. (Ed.), *Psychology: A Study of a Science*, vol. 6. McGraw-Hill, New York, NY, pp. 94–172.
- Chien, Y.L., Huang, C.J., Shaw, D., 2005. A general model of starting point bias in double-bounded dichotomous contingent valuation surveys. *Journal of Environmental and Economics and Management* 50, 362–377.
- Cummings, R.G., Taylor, L.O., 1999. Unbiased value estimates for environmental goods: a cheap talk design for the contingent valuation method. *American Economic Review* 89, 649–665.
- Cummings, R.G., Brookshire, D.S., Schulze, W.D., Coursey, D.L., 1984. Valuing Environmental Goods: A State of the Arts Assessment of the Contingent Valuation Method. Unpublished Manuscript, Department of Economics, University of New Mexico, Albuquerque.
- Dunlap, R.E., Van Liere, K.D., 1978. The new environmental paradigm: a proposed measuring instrument and preliminary results. *Journal of Environmental Education* 9, 10–19.
- Dunlap, R.E., Van Liere, K.D., Mertig, A.G., Jones, R.E., 2000. New trends in measuring environmental attitudes: measuring endorsement of the new ecological paradigm: a revised NEP scale. *Journal of Social Issues* 56, 425–442.
- Ehmke, M.D., Lusk, J.L., List, J.A., 2008. Is hypothetical bias a universal phenomenon? A multinational investigation. *Land Economics* 84, 489–500.
- Fox, J.A., Shogren, J.F., Hayes, D.J., Kliebenstein, J.B., 1998. CVM-X: calibrating contingent values with experimental auction markets. *American Journal of Agricultural Economics* 80, 455–465.
- Greene, W.H., 1997. *Econometrics Analysis*, third ed. Simon & Schuster Co, Upper Saddle River, N.J.
- Han, S.Y., Lee, C.K., 2008. Estimating the value of preserving the Manchurian black bear using the contingent valuation method. *Scandinavian Journal of Forest Research* 23, 458–465.
- Hausman, J., McFadden, D., 1984. Specification tests for the multinomial logit model. *Econometrica* 52, 1219–1240.
- Hoehn, J.P., Swanson, C.S., 1988. Toward a satisfactory model of contingent valuation behavior in a policy valuation context. In: Peterson, G.L., Driver, B.L., Gregory, R. (Eds.), *Amenity Resource Valuation Integrating Economics with Other Disciplines*. Venture Publishing, Inc, State College, PA.
- Hoyos, D., 2010. The state of the art of environmental valuation with discrete choice experiments. *Ecological Economics* 69, 1594–1603.
- Johnston, R.J., 2006. Is hypothetical bias universal? Validating contingent valuation responses using a public referendum. *Journal of Environmental Economics and Management* 52, 469–481.
- Kaiser, F.G., Byrka, K., Hartig, T., 2010. Reviving Campbell's paradigm for attitude research. *Personality and Social Psychology Review* 14, 351–367.
- Korea National Tourism Organization, 2004. Master Plan for Development of Peace Tourism Belt in the DMZ and Its Vicinity. Government Printers, Seoul.
- LaPiere, R.T., 1934. Attitudes vs. actions. *Social Forces* 13, 230–237.
- Lee, J.S., Lee, C.K., Choi, Y.J., 2007. Examining the role of emotional and functional values in festival evaluation. *Journal of Travel Research*, forthcoming. doi:10.1177/0047287510385465.
- Lee, C.K., Mjelde, J.W., 2007. Valuation of ecotourism resources using a contingent valuation method: the case of the Korean DMZ. *Ecological Economics* 63, 511–520.
- List, J.A., 2001. Do explicit warming eliminate the hypothetical bias in elicitation procedures? Evidence from field auctions for sports cards. *American Economic Review* 91, 1498–1507.
- List, J.A., Gallet, C.G., 2001. What experimental protocol influence disparities between actual and hypothetical stated values? evidence from a meta-analysis. *Environmental and Resource Economics* 20, 241–254.
- Little, J., Berrens, R., 2004. Explaining disparities between actual and hypothetical stated values: further investigation using meta-analysis. *Economics Bulletin* 3, 1–13.
- Lusk, J.L., 2003. Effects of cheap talk on consumer willingness-to-pay for golden rice. *American Journal of Agricultural Economics* 85, 840–856.
- Mitchell, R.C., Carson, R.T., 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Resources for the Future, Washington, D.C.
- Morrison, M., Brown, T.C., 2009. Testing the effectiveness of certainty scales, cheap talk, and dissonance-minimization in reducing hypothetical bias in contingent valuation studies. *Environmental and Resource Economics* 44, 307–326.

- Murphy, J.J., Allen, P.G., Stevens, T.H., Weatherhead, D., 2005. A meta-analysis of hypothetical bias in stated preference valuation. *Environmental and Resource Economics* 30, 313–325.
- Musumba, M., Jin, Y.H., Mjelde, J.W., 2009. Factors Influencing International Graduate Students Career Preferences Education Economics URL: <http://dx.doi.org/10.1080/09645290903102902>.
- Nape, S., Frykblom, P., Harrisaon, G.W., Lesley, J.C., 2003. Hypothetical bias and willingness-to-accept. *Economic Letters* 78, 423–430.
- Organizing Committee of Boryeong Mud Festival, 2009. Final Report of 12th Boryeong Mud Festival. Boryeong City.
- Oehlert, G.W., 1992. A note on the delta method. *The American Statistician* 46, 27–29.
- Peterson, G.L., Driver, B.L., Gregory, R., 1988. Introduction. In: Peterson, G.L., Driver, B.L., Gregory, R. (Eds.), *Amenity Resource Valuation Integrating Economics with Other Disciplines*. Venture Publishing, Inc, State College, PA.
- Samnaliev, M., Stevens, T.H., More, T., 2006. A comparison of alternative certainty calibration techniques in contingent valuation. *Ecological Economics* 57, 507–519.
- Train, K.E., 2003. *Discrete Choice Methods with Simulations*. Cambridge University Press, Cambridge.
- Venkatachalam, L., 2004. The Contingent valuation method: a review. *Environmental Impact Assessment Review* 24, 89–124.
- Vossler, C.A., Kerkliet, J., Polasky, S., Gainutdinova, O., 2003. Externality validating contingent valuation: an open-space survey and referendum in Corvallis, Oregon. *Journal of Economic and Behavior Organization* 31, 145–159.
- Vuletic, D., Benko, M., Dubravac, R., Krajer, S., Novotny, V., Indir, K., Balenovic, I., 2009. Review of nonmarket forest goods and service evaluation methods. *Pereiodicum Biologorum* 111, 515–521.
- Westing, A.H., 1998. A transfrontier reserve for peace and nature on the Korean peninsula. *International Environmental Affairs* 10, 8–17.
- Whitehead, J.C., Cherry, T.L., 2007. Willingness to pay for a green energy program: a comparison of ex-ante and ex-post hypothetical bias mitigation approaches. *Resource and Energy Economics* 29, 247–261.
- Whitehead, J.C., Pattanayak, S.K., Van Houtven, G.L., Gelso, B.R., 2008. Combining revealed and stated preference data to estimate the nonmarket value of ecological services: an assessment of the state of the science. *Journal of Economic Surveys* 22, 872–908.
- Wu, X.M., Perloff, J., 2007. GMM estimation of maximum entropy density with interval data. *Journal of Econometrics* 138, 532–546.