WILLINGNESS TO PAY FOR GMO LABELING POLICIES: THE CASE OF KOREA

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Accepted for Publication August 12, 2010

doi:10.1111/j.1745-4565.2010.00280.x

ABSTRACT

With the increasing interest in food safety, genetically modified organisms (GMO) have been a topic of intense public debate. To provide a basis for rational debate and develop an appropriate GMO labeling policy, the Korean government is interested in consumer attitudes and responses to GMO labeling policies. In this light, by employing a survey approach that is called "contingent valuation," the present study attempted to measure the public's willingness to pay (WTP) that are more stringent than the prevailing policies in Korea. Furthermore, in order to enhance statistical efficiency in WTP estimation and reduce the response effect in the context of WTP elicitation, this study employed a one-and-one-half bound dichotomous choice format. The estimate of the annual mean WTP for GMO labeling policies is 3,756 Korean won (USD 4.04) per household. This quantitative information can be utilized in developing policies related to genetically modified foods.

PRACTICAL APPLICATION

The contingent valuation in this article provided a powerful tool for measuring the public's willingness to pay for genetically modified organisms labeling policies.

INTRODUCTION

With the increasing interest in food safety and knowledge about biotechnology, genetically modified organisms (GMO) have become a topic of intense public debate. Even though producers of genetically modified (GM) foods insist that such foods should be treated the same as traditional (non-GM) foods, most consumers are concerned about the safety of GMO and GM foods. Consumer organizations and other nongovernmental organizations have expressed concerns about antibiotic-resistant marker genes, potential allergic reactions, ethical and religious concerns, and the lack of consumer choice due to inadequate labeling. Such organizations have pushed for increasing regulation and GMO labeling in many parts of the world. In turn, proposals for such regulation make it more urgent and important to understand the extent of consumer acceptance and the factors that affect consumer attitudes and perceptions toward GMO and GM foods (Chern *et al*. 2002).

In 2005, according to the survey results of the Korean Food & Drug Administration, about 22% of imported agricultural products and processed foods, including infant soybean milk, involved GMO.[1] Owing to the concerns about food safety, the consumption of imported agricultural products and

[1] The sources of some facts are not available. Only a summary was published in newspapers. The source of other reports is the homepage of the Korean Food & Drug Administration (http://www.kfda.go.kr).

processed foods, including infant soybean milk, have dramatically decreased. The controversy concerning the harmfulness of GM products has deepened. As a result, consumer groups and environmental groups have become more vociferous about the safety of GM foods.

As GMO can have a negative environmental impact and possibly pose a risk to human health, governments around the world are striving to establish a regulatory process to monitor the effects of GMO. However, depending on the political, social and economic climate within a region or country, different governments are responding to this problem in diverse ways. For example, in Japan, the Ministry of Health and Welfare announced that the health testing of GM foods would be mandatory as of April 2001. GMO labeling for 30 crops and processed foods that include soybean, corn, potatoes, soybean paste and tofu has been implemented. In Europe, anti-GMO food protestors have been especially active. In the last few years, Europe has experienced two major food scares namely, the mad cow disease and dioxin-tainted foods. These food scares have undermined consumer confidence about European food supply. Moreover, Europeans generally have been the most concerned about the risks of GM foods. In response to consumer demand, Europe has mandated the labeling of GM food in stores and the European Commission has established a 0.5% threshold for the contamination of unmodified foods with GMO products. The U.S.A. is the world's top supplier of biotech crops. Thus, its regulations for GMO are less strict than those of other countries. In the U.S.A., the labeling of GM foods is voluntary; some foods have not been labeled as GMO in the market, even though these food products indeed contain GMO ingredients.

Of the various policies pertaining to GMO, the labeling policy may receive the most attention in many countries. Labeling policies help to reduce the problem of asymmetric information with regard to GMO that currently exists between producers and consumers. That is, producers know a priori what technology they use and whether or not their crops are GM, while consumers do not have that information. In the case of Korea, a majority of the agricultural products are imported.

According to the statistics of the Korean Ministry of Agriculture, in 2004, the degree of self-support of Korea was only about 0.4% for wheat, 0.7% for corn and 7.1% for soybean. Therefore, to secure cheaper grains, in 1996, for the first time, Korea bought GMO corn for food, thereby risking a backlash from consumer groups; till then, there had been no regulation for GMO.

In 1999, news broke out about the discovery of GMO soybeans in tofu and their risk for health, which spurred a response from the Korea Consumer Protection Board and ultimately led to the labeling of foods that contained GM soybeans and corn.

As a result, Korean tofu has been distinguished from internationally grown soybean that presumably contains GMO soybean; this allows consumers to choose between lower-priced GM foods and higher-priced non-GM foods. Furthermore, in 2001, the Korean government mandated the labeling of foods that contained GMO ingredients. Those food products for which GM ingredients account for at least 3% of the total weight must be labeled.

However, consumer groups and environmental groups have asked the Korean government to tighten the standards of GMO labeling as in the European Union. In spite of the tighter regulations, including GMO labeling, many consumers have not been satisfied with the Korean government's food safety standard for GMO labeling. Furthermore, the standard that consumers expect for GMO labeling will rise in conjunction with the increasing concerns of consumers with regard to food safety. Of late, consumers and the government have been increasingly at odds with each other with regard to the appropriate level of food safety standards. As a result, it is necessary for the Korean government to apprehend in advance consumers' opinions about GMO safety standards.

In addition, GMO labeling can entail significant costs to industry and society that must be carefully weighed against the benefits from such labeling (Roe and Teisl 2007). Therefore, it is necessary to conduct a cost–benefit analysis for GMO labeling to determine whether or not the raised standard is economically desirable. However, it is difficult to calculate the benefit that ensues from GMO labeling policies. Currently, it is becoming popular to value food-safety improvements and public policies through methods for valuing nonmarket goods. Such methods have been used by many researchers, who have worked with similar case studies (Burton *et al*. 2001; Moon and Balasubramanian 2001; Springer *et al*. 2002; Mccluskey *et al*. 2003; Carlsson *et al*. 2004; Curtis *et al*. 2004; Loureiro and Hine 2004; Moon *et al*. 2004; Curtis and Moeltner 2006; Hu 2006; Kimenju and Groote 2008).

In particular, European consumers have strong reservations about GMO. Burton *et al*. (2001) studied consumer attitudes toward GM food in the U.K. They found that significant differences exist between organic and nonorganic consumers on GM acceptance. They also concluded that infrequent, male shoppers of organic food would be willing to increase their food bill by 26% to avoid animal and plant GM technology, while their female counterparts would be willing to pay an extra 49.31%. For committed organic shoppers, these values go up to 352.12% for males and 471.95% for females. Moon and Balasubramanian (2001) showed that U.K. consumers would pay much higher premiums for non-GM food than their U.S. counterparts. Springer *et al*. (2002) reported that on average, 73% of consumers across 15 European countries rejected GM food; the percentage ranged from 58% in the U.K. to 85% in Greece. Swedish consumers also dislike GM

food and are willing to pay a premium to ban GM feed for their livestock (Carlsson *et al.* 2004).

According to Loureiro and Hine (2004), in the U.S.A., respondents' willingness-to-pay (WTP) values for mandatory and voluntary labeling programs were USD 134.27 and 116.67 per year, respectively. Hu (2006) showed that Japanese consumers are willing to pay relatively more for non-GM oil than Chinese consumers. Based on Hu's results, the price premium for non-GM oil in Japan can be as high as 60%, while in China, sales may drop when the price for non-GM oil exceeds that for GM oil by more than 30~45%. Mccluskey *et al.* (2003) also found that in Japan, GM noodles and GM tofu had to be discounted by 60 and 62%, respectively, to achieve the same level of acceptance as their non-GM counterparts. On the other hand, Chinese consumers have been found to be far less negative toward GM technology in food production (Li *et al.* 2002); as a result, their WTP for non-GM products is expected to be lower.

However, in Kenya, the mean WTP for a GMO meal was found to be 13.8% higher than the average price of a non-GMO meal (Kimenju and Groote 2008). Curtis and Moeltner (2006) said that consumer acceptance for GMO was much higher in countries with low-risk perceptions, such as China, than in countries with high-risk perceptions, such as Romania. Curtis *et al.* (2004) also showed that consumers in developing nations, such as China and Colombia, were found to have more positive attitudes than those in developed countries, such as the U.K. and the U.S.A.

Even though there are several studies of consumers' preferences for non-GMO goods and GMO labeling, there are few studies on consumers' preferences with regard to GMO labeling standards that are more stringent than the prevailing standards. More specifically, few studies analyze consumers' preferences on GMO labeling in Korea. In this light, by employing a survey approach called the contingent valuation (CV), the present study attempts to measure consumers' WTP for a new GMO labeling policy that is more stringent than the current policy, whereby all products that include GMO ingredients would be required to have a label.[2] The cornerstone concept that is used for measuring the benefits from a proposed GMO labeling policy is the consumer's WTP for the policy (Brent 1995). This concept represents how much people would be willing to pay for a GMO labeling standard that is more stringent. To achieve this objective, we adopted a survey approach, namely, CV. This method involves constructing a hypothetical market or referendum scenario and uses questionnaires in a survey to elicit respondents' preferences for the new GMO labeling policy by finding out how much they would be willing to pay (Mitchell and Carson 1989). Respondents utilize the established hypothetical market to state their WTP or vote either for or against the new GMO labeling policy at a particular tax (price). Furthermore, the CV method is acknowledged by the prestigious National Oceanic and Atmospheric Administration (NOAA) panel as a means of obtaining estimates that are reliable enough to be used as a starting point for administrative and judicial determinations.

In particular, this article employs a one-and-a-half bound (OOHB) dichotomous choice (DC) CV model for realizing statistical efficiency. Furthermore, in CV, respondents who say "no" to the given bids can be divided into two groups: those who really have a zero WTP and those who have a positive WTP that is less than the second, lower bid. To address this problem, this article applies a spike model. The remainder of the article is organized as follows. Section 2 presents the methodology that is employed in this study. Section 3 reviews the issues with regard to survey design. Discussions of the results appear in Section 4. Some concluding remarks are made in the final section.

METHOD

Sampling and Survey Method

The sample for this research was restricted to residents in the Seoul metropolitan area. The total number of households in the area was 4,046,086. In order to draw a random sample from this population, sampling was conducted by a professional polling firm. The survey was implemented over heads of household or housewives who were aged between 20 and 65 years in September 2007. The survey yielded 470 usable interviews, 20 of which were rated by enumerators as being of poor quality. Thus, the findings from the survey are based on an analysis of 450 interviews; the percentage of the population of households sampled is 0.011.

The survey could be conducted either by in-person face-to-face interviewing, telephone interviewing, or mail. Among these methods, we chose in-person face-to-face interviewing and used well-trained interviewers for the CV survey because this approach could offer the most scope for detailed questions and answers in Korea (Yoo and Chae 2001).

Elicitation Method

When measuring respondents' WTP, most designers of CV studies have employed a referendum or DC question to elicit respondents' WTP in accordance with the NOAA's "Blue

[2] Currently, in Korea, GMO labels are required only for soybean, corn and potatoes that are unintentionally mixed with over 3% of GMO crops and for processed foods that contain GMO soybean, corn and potatoes. The hypothetical GMO policy assumed that the Korean government has a plan to enforce the labeling system that even if only 0.001% of GMO ingredients are containing, all food products should be indicated.

Ribbon Panel" guidelines (Arrow *et al*. 1993). This DC question asks the respondent to accept or reject a suggested bid for GMO labeling. Especially, this study employed OOHB DC that should significantly reduce the risk of the survey by moving into a bargaining setting when the interviewer proposes a follow-up bid. In this question format, the interviewee is given two prices upfront and is informed that the exact cost is uncertain but is known to be bounded by the two extreme prices.

The application of this methodology requires that the interviewer first inform the respondent about the limits on the expected cost for GMO labeling before asking the questions that elicit the respondent's WTP. These are referred as the lower and upper bids. Next, the interviewer randomly chooses one of these two points as the initial value at which to elicit the respondent's WTP. Then, if the upper bid is chosen and the respondent says "no" the respondent is asked if he or she is willing to pay the lower bid. Similarly, if the lower bid is the first value to be examined and the respondent says "yes" he or she will be asked if he or she is willing to pay the upper bid. In the other two cases, the process of elicitation stops, i.e., when either the first price to be proposed is the upper bid and the respondent says "yes" or the first price to be proposed is the lower bid and the answer is "no"(Barreiroa *et al*. 2005).

Furthermore, the results of the pretest for a focus group were used to refine the range of bid amounts for the DC WTP questions. According to the pretest, minimum WTP of respondent was 0 and maximum WTP was 15,000 Korean won. In addition, about 50% of the respondents had no intention to pay for GMO labeling and the WTP of most of the respondents were lower than 10,000 Korean won. Respondents were randomly assigned to eight subgroups with each subsample being asked to respond to a different set of bids (in Korean won).[3] The sets of bids used in this study were: (1,000, 3,000) (2,000, 4,000) (3,000, 5,000) (4,000, 6,000) (5,000, 7,000) (6,000, 8,000) (7,000, 9,000) and (8,000, 10,000), where the first element of each set corresponds to the lower bid and the second element corresponds to the upper bid, which is higher than the lower bid by KRW 2,000.

Payment Vehicle

The payment vehicle should be familiar to respondents and should be obviously connected with the good being considered. However, among various taxes, including the property tax, valued-added tax and inhabitant's tax, few existing taxes are connected with GMO policy. Moreover, to encourage respondents to restrict their WTP amounts to a range that is associated with a fair or customary expenditure, it is better to use the existing tax as a payment vehicle than to establish new taxes. In addition, as the value-added tax is dependent on the product and indirect tax which is paid by company, the value-added tax is inappropriate as a payment vehicle for knowing respondents' WTP. Therefore, this study employed the income tax as a payment vehicle, which is likely to be familiar to most respondents. The WTP question format asked each household to pay a particular KRW amount each year for 10 years.

[3] At the time of the survey, USD 1.0 was approximately equal to 930 Korean won.

Questionnaire Design

We prepared a survey questionnaire with the assistance of experts at a polling firm and tested it with a focus group to see how much potential respondents understood the questions. The final version reflected the inputs of the focus group as well as the advice provided by the experts at the polling firm who were assigned to organize the fieldwork.

The final survey questionnaire comprised three sections. The first part was intended to measure respondents' general concerns about GMO and to elicit information about their past experiences with GMO. To enhance respondents' understanding, a color photograph of GM products and press release were inserted into this section. The second part contained CV questions designed to elicit respondents' WTP for GMO labeling policy. The final part elicited the socioeconomic information of the respondents such as income, age, education and so on.

The OOHB DC Model

According to Cooper *et al*. (2002), the OOHB DC-CV model can be described as follows. Let $i = 1, \ldots, N$ be the index for each respondent in the sample and A be the bid amount presented to a respondent. Each respondent is presented with two prices, A_i^L and A_i^U where $A_i^L < A_i^U$. If A_i^L is randomly drawn as the first price, then the possible responses are yes–yes, yes–no and no. If A_i^U is randomly drawn as the first bid, then the possible answers are yes, no–yes and no–no. Binary-valued indicator variables of these six possible outcomes are I_i^{YY}, I_i^{YN}, I_i^N, I_i^Y, I_i^{NY} and I_i^{NN}, respectively, such that:

$$\begin{aligned} I_i^{YY} &= \mathbf{1}(i\text{th respondent's response is 'yes-yes'}) \\ I_i^{YN} &= \mathbf{1}(i\text{th respondent's response is 'yes-no'}) \\ I_i^{N} &= \mathbf{1}(i\text{th respondent's response is 'no'}) \\ I_i^{Y} &= \mathbf{1}(i\text{th respondent's response is 'yes'}) \\ I_i^{NY} &= \mathbf{1}(i\text{th respondent's response is 'no-yes'}) \\ I_i^{NN} &= \mathbf{1}(i\text{th respondent's response is 'no-no'}), \end{aligned} \tag{1}$$

where a is an indicator function, whose value is one if the argument is true and zero otherwise.

WTP (hereafter denoted as C) is recognized as a random variable with a cumulative distribution function (cdf) defined here as $G_C(\cdot;\theta)$, where θ is a vector of parameters. Given the assumption of a utility-maximizing respondent, the log-likelihood function takes the form:

$$\begin{aligned}\ln L = \sum_{i=1}^{N} \{ & (I_i^{YY} + I_i^{Y}) \ln[1 - G_C(A_i^U;\theta)] \\ & + (I_i^{YN} + I_i^{NY}) \ln[G_C(A_i^U;\theta) - G_C(A_i^L;\theta)] \\ & + (I_i^{N} + I_i^{NN}) \ln G_C(A_i^L;\theta)\}\end{aligned} \quad (2)$$

Following the practice of previous studies, formulating $1 - G_C(\cdot)$ as logistic cdf and combining this with $\theta = (a,b)$ yields $G_C(A;\theta) = [1 + \exp(a - bA)]^{-1}$. Let C^+ be the mean WTP when C can be positive or negative. Thus, the mean WTP (C^+) can be computed as $C^+ = a/b$ (Hanemann 1984).

The Spike Model

The respondents, who report "no" and "no–no" are composed of two groups: those who really have a zero WTP and those who have a positive WTP that is less than the lower bid. For those respondents who gave a "no" response in case the lower bid was the starting price and a "no–no" response-sequence in case the upper bid was the starting price, a third follow-up question was asked, i.e., whether or not they had a positive WTP. A considerable number of respondents refused to pay anything for GMO labeling. Therefore, in order to allow for the zero-WTP responses, a spike model suggested by Kriström (1997) is applied. As the spike model suggested by Kriström (1997) is based on the SB DC model, this study tries to modify the spike model for the OOHB DC model following the procedures proposed Yoo and Kwak (2002) that adjusted it for DB DC model.

For people who were asked the additional follow-up question, the two binary-valued indicator variables can be defined as:

$$\begin{aligned} I_i^{AY} &= \mathbf{1}(i\text{th respondent's response to the additional question is 'yes'}) \\ I_i^{AN} &= \mathbf{1}(i\text{th respondent's response to the additional question is 'no'}) \end{aligned} \quad (3)$$

To estimate the distribution of WTP, WTP is assumed to be distributed as a logistic on the positive axis. The log-likelihood function for the OOHB spike model is given by:

$$\begin{aligned}\ln L = \sum_{i=1}^{N} \{ & (I_i^{YY} + I_i^{Y}) \ln[1 - G_C(A_i^U;\theta)] \\ & + (I_i^{YN} + I_i^{NY}) \ln[G_C(A_i^U;\theta) - G_C(A_i^L;\theta)] \\ & + I_i^{AY}(I_i^{N} + I_i^{NN}) \ln[G_C(A_i^L;\theta) - G_C(0;\theta)] \\ & + I_i^{AN}(I_i^{N} + I_i^{NN}) \ln G_C(0;\theta)\}\end{aligned} \quad (4)$$

$$\text{where: } G_C(A;\theta) = \begin{cases} [1+\exp(a-bA)]^{-1} & \text{if} \quad A > 0 \\ [1+\exp(a)]^{-1} & \text{if} \quad A = 0. \\ 0 & \text{if} \quad A < 0 \end{cases} \quad (5)$$

Thus, the spike is defined by $[1 + \exp(a)]^{-1}$. Using Eq. (5), the mean WTP in the spike model can be calculated as $C^+ = (1/b)1n[1 + \exp(a)]$. In CV studies, it is common to test for the internal consistency and theoretical validity of the model by estimating the model with covariates. If we want to estimate the model with covariates, in the above equations, a is simply replaced with $a + x_i'\beta$, where x_i is a vector of explanatory variables, including the bid, and β is a vector of parameters to be estimated.

RESULTS

Table 1 presents the distribution of responses to the WTP question, showing the total number and percentage of respondents who responded that they would be willing to pay each bid level, ranging from KRW 1,000 to 8,000 annually. Note that the percentage of "yes" responses to the bid amount roughly falls as the bid increases. For example, in the case of "from lower bid to upper bid" 16 (53.3%) favored the GMO labeling policy at an annual cost of KRW 1,000, whereas only eight (22.9%) approved of it at the level of KRW 8,000.

TABLE 1. DISTIRUBUTION OF RESPONSES BY THE BID AMOUNT

	From the lower bid to the upper bid (%)				From the upper bid to the lower bid (%)			
Bid (KRW)	Yes–yes	Yes–no	No–yes	No–no	Yes	No–yes	No–no–yes	No–no–no
1,000/3,000	9 (30.0)	7 (23.3)	2 (6.7)	12 (40.0)	7 (29.2)	7 (29.2)	0 (0)	10 (41.7)
2,000/4,000	11 (34.4)	5 (15.6)	0 (0)	16 (50.0)	8 (27.6)	6 (20.7)	4 (13.8)	11 (37.9)
3,000/5,000	7 (25.0)	4 (14.3)	4 (14.3)	13 (46.4)	8 (33.3)	5 (20.8)	1 (4.2)	10 (41.7)
4,000/6,000	5 (18.5)	2 (7.4)	2 (7.4)	18 (66.7)	5 (16.7)	4 (13.3)	10 (33.3)	11 (36.7)
5,000/7,000	4 (15.4)	4 (15.4)	3 (11.5)	15 (57.7)	8 (28.6)	3 (10.7)	8 (28.6)	9 (32.1)
6,000/8,000	5 (14.3)	4 (11.4)	9 (25.7)	17 (48.6)	4 (16.0)	5 (20.0)	2 (8.0)	14 (56.0)
7,000/9,000	5 (18.5)	2 (7.4)	4 (14.8)	16 (59.3)	5 (17.2)	2 (6.9)	6 (20.7)	16 (55.2)
8,000/10,000	8 (22.9)	0 (0)	7 (20.0)	20 (57.1)	4 (19.0)	2 (9.5)	6 (28.6)	9 (42.9)

TABLE 2. DEFINITIONS AND SAMPLE STATISTICS OF VARABLES

Variables	Definition	Mean	Standard deviation
Knowledge	Dummy for prior recognition of information about GMO in the questionnaire (0 = don't know; 1 = know well)	0.64	0.48
Media	Dummy for the reception of GMO news through mass media	0.56	0.50
Pesticide-free food	Dummy for the preference to buy pesticide-free food (0 = no; 1 = yes)	0.54	0.50
Domestic food	Dummy for the preference to buy domestic food (0 = no; 1 = yes)	0.66	0.47
Ingredient indicator	Dummy for confirming the ingredients before buying food (0 = no; 1 = yes)	0.44	0.50
Child	The number of children	0.94	0.93
Education	The respondent's level of education in years	13.72	2.10
Income	The respondent's monthly income (in KRW 10,000)	354.87	136.81
Age	The respondent's age	36.42	9.48

GMO, genetically modified organism.

In addition, Table 2 shows the definitions and sample statistics of respondents' purchasing habits and socioeconomic variables. Among the respondents, 64% knew what GM food was. Of the respondents, 56% received information or news about GMO through television, radio and newspapers. This highlights respondents' concerns about food safety. Thus, in spite of the high prices, 54% of the respondents preferred to buy pesticide-free food and 66% preferred to buy domestic food in lieu of buying imported food. Of the respondents, 66% verified the ingredients before buying food.

The average monthly household income of the respondents in this study was KRW 3.54 million (USD 3,806). The reported average income in Seoul for 2006 was KRW 3.41 million (USD 3,667). Therefore, the average income of the respondents in this study is very close to the reported average income of the population. The average age of respondents in this study was 36.4 years and the average level of education in years was 13.72. This means that the typical person in the sample likely had some college education. The average number of children in respondents' households was 0.94.

Table 3 shows the results of the estimation. The model was estimated by the maximum-likelihood estimation method. The second column of Table 3 shows the estimation results of the model without covariates. The coefficient for the bid is negative and statistically significant at the 1% level, as expected. That is, the upper bid makes a "yes" response less likely. The third column of the table describes the estimation results of the model that includes covariates or variables other than the bid amount that one might expect to affect the likelihood of respondents' voting "yes." It is also common to test for the internal consistency (theoretical validity) in CV studies by estimating the model with covariates.

TABLE 3. ESTIMATION RESULTS

Variables	Model without covariates	Model with covariates
Constant	0.0794 (0.85)	–1.6200(–1.81)*
Bid	–0.1953 (–12.74)***	–0.2485(12.86)***
Knowledge		0.8407(2.20)**
Media		0.8009(2.25)**
Pesticide-free food		0.7532(2.95)***
Domestic food		0.6440(2.29)**
Ingredient indicator		0.4208(1.84)*
Child		0.1243(1.16)
Education		0.0068(0.13)
Income		0.0005(0.67)
Age		–0.0197(–1.69)*
Spike	0.4802 (20.45)**	0.4877(17.88)***
Wald statistic† (*P* value)	177.54 (0.000)	319.87 (0.000)
Log-likelihood	–562.75	–488.53
Number of observations	450	

Notes: t values, computed from the analytic second derivatives of the log-likelihood function, are reported in the parentheses.

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

† The null hypothesis is that all the parameters are jointly zero, and the corresponding *P* value is reported in parentheses after the statistic.

TABLE 4. WILLINGNESS TO PAY (WTP) ESTIMATE FOR THE GMO LABELING POLICY

Annual mean WTP (unit: KRW)	95% confidence interval	99% confidence interval	*t* value
3,756	3,283–4,332	3,206–4,464	12.04***

Notes: The confidence intervals were computed by the use of the Monte Carlo simulation technique suggested by Krinsky and Robb (1986) with 5,000 replications.
*** denotes statistical significance at the 1% level.

The estimated coefficients of the Knowledge, Media, Pesticide-Free Food, Domestic Food and Ingredient Indicator covariates were found to be statistically significant at the 5% level. Individuals, who are already aware of GM food, prefer pesticide-free food and domestic food, and confirm the ingredient indicator before buying foods, are more likely to accept a given bid than others. In particular, the estimated coefficient of Media was statistically significant at the 5% level. This result shows that the media plays an important role in consumers' perceptions and attitudes toward GM foods. Except for Age, the estimated coefficients of Child, Education and Income were not statistically significant at the 5% level. On the whole, the estimation results indicate that respondents accepted the contingent market and were willing to contribute a significant amount, on average, per household. This willingness varies with individuals' concerns and attitudes about food safety rather than their socioeconomic characteristics.

The estimate of the mean WTP is shown in Table 4. The annual mean WTP is estimated as KRW 3,756 (USD 4.04) per household. The *t* value is estimated to be 12.04. Based on this, one can reject the hypothesis that the mean WTP is not different from zero and conclude that the mean WTP is statistically significantly different from zero. Moreover, the study adopted the strategy of constructing 95 and 99% confidence intervals for the point estimate of the mean WTP in order to allow for any uncertainty, rather than only reporting the point estimate. To this end, the Monte Carlo simulation technique of Krinsky and Robb (1986) was used.

DISCUSSION

This article attempted to measure how much Korean consumers are willing to pay for GMO labeling policy that is more stringent than is presently the case. To this end, a CV method was used. According to the estimation result, the annual mean WTP is estimated as KRW 3,756 (USD 4.04) per household. The overall results show that there appears to be considerable scope for the use of the CV approach in the valuation of GMO labeling policy for an urban area of Korea. This exercise provides important insights for both research and policy-making.

For research purposes, beyond the intrinsic interests of our results in relation to the valuation of GMO labeling policy, this study adjusted and applied the spike model suggested by Kriström to modeling OOHB DC CV data with zero WTP responses in order to obtain appropriate welfare measure. In the application reported herein, the OOHB spike model fitted the data well. Given a base design of OOHB DC CV surveys, there are two ways of improving the efficiency of the estimations: either increasing the sample size or asking an additional question to only the "no" and "no–no" respondents. Due to the usually high cost of increasing the sample size, asking a follow-up question is an inexpensive way of achieving this objective. Moreover, the spike model can be estimated as easily as the conventional model. Therefore, the OOHB spike model presented in this article can be said to be theoretically promising and practical.

For policy-making purposes, the results can provide a preliminary indication of the benefits of GMO labeling policy. The CV survey of 450 households was successfully conducted by a professional polling firm with well-trained interviewers. The results indicate that most respondents knew what GMO was and were concerned about food safety. Thus, many respondents preferred to buy pesticide-free food and domestic food rather than other foods and confirmed the ingredient indicator before buying foods. Regardless of their income, level of education and the number of children, those respondents who were more knowledgeable about GM food, preferred pesticide-free food and domestic food, and confirmed the ingredient indicator before buying foods, were more likely to pay for GMO labeling policies.

The annual mean WTP for GMO labeling policies is estimated to be KRW 3,756 (USD 4.04) per household. These results are useful starting points in understanding the possible implications of GMO labeling policies that are more stringent. The results imply that consumer demand is on the rise for GMO labeling standards that are more stringent than current standards and that consumers are willing to shoulder the burden for them regardless of their socioeconomic characteristics, including the income and level of education.

These findings have some implications. Above all, the standard of GMO labeling needs to be tightened and the government's regulation of GM food needs to be strengthened. Thus, given the benefits and costs, it is necessary to find the optimal standard of GMO labeling that can satisfy consumers, producers and the government. Second, in spite of the enforcement of a GMO labeling policy, most Korean

consumers are still concerned about GM food. For easing consumers' anxiety about harm from GM food, the Korean government needs to implement various policies, including a ban on GM food in school meals and military meals. Furthermore, with the expansion of international trade and the development of agricultural technology, the production of GM foods is expected to grow rapidly. It is imperative to develop national measures for imported GM foods. Third, the media were found to play an important role in consumers' perceptions and attitudes toward GM foods. Therefore, to develop proper GMO policies, the media is needed to provide accurate and objective information about GM food.

APPENDIX: THE SURVEY QUESTIONNAIRE

According to a survey of the Korean Food and Drug Administration, 22% of 869 target food crops were detected in the GMO. In spite of radical increase in GMO foods, current GMO food inspection system and labeling system are insufficient. Currently, in Korea, GMO labels are required only for soybean, corn, and potatoes that are unintentionally mixed with over 3% of GMO crops and for processed foods that contain GMO soybean, corn, and potatoes. Thus, the Korean government has a plan to enforce the labeling system that even if only 0.001% of GMO ingredients are containing, all food products should be indicated.

As you know, the reinforced GMO food labeling system would be costly and the government would need to ask citizens to pay for it by introducing an income tax increase. If people do not pay the costs, the reinforced GMO labeling system may be difficult to conduct. On the other hand, if many people agree to pay the costs, the GMO labeling system can be conducted smoothly. This survey has the purpose to know how much you're willing to pay for the reinforced GMO food labeling system.

By taking data from similar programs, a research team has estimated these costs to be somewhere between ( ) Korean won and ( ) Korean won per household per year.

Would you be willing to pay ( ) Korean won per year in order to enforce the reinforced GMO food labeling system?

YES ☐ NO ☐

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