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Can Information about Genetically Modified Corn and Its Oil Have Significant Effects on Japanese Consumers' Risk Perception and Their Valuation?

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This study investigates whether the information regarding the safety of genetically modified (GM) corn and GM corn oil can significantly affect the Japanese consumers' risk perceptions and whether these risk perceptions can determine their willingness-to-pay (WTP) premium for non-GM corn oil. This WTP premium was measured by using a contingent valuation method that is commonly applied for valuing non-market commodities. Our empirical results show that, when the scientific knowledge of the safety of GM corn and GM corn oil was provided, the risk perceptions expressed by the mean of a probability distribution and those by the variance both substantially decreased, while the WTP unchanged with the given information. In addition, Japanese consumers' premium percentage for non-GM corn oil was found to be about 40% of the price of the cooking corn oil sold in markets.

Key words: genetically modified, contingent valuation, willingness to pay, risk perception.

Introduction

Since 2001, the Japanese government has imposed mandatory labeling on the genetically modified (GM) soybean, corn, canola, potato, and cotton crops, as well as on 24 of the processed foods made from these GM crops. However, at present the GM-labeled foods are not available in markets in Japan because Japanese food manufacturers are apprehensive of consumers' oppositions to GM-labeled foods and have not produced any yet. In addition, most of the GM soybean and corn crops imported from the United States are used only for oil or animal feed, neither of which require GM labeling under the current Japanese law. Given these facts, if Japan's circumstances continue and in the future consumers become much more concerned for the safety of any GM food, the Japanese government will have to impose mandatory labeling on the other foods or even on animal feed as well. Consequently, this might force Japanese markets to oust any GM-related food.

To minimize consumers' worries, the Japanese government also conducts the public relations on the safety of GM foods by providing consumers with booklets or web pages that refer to the details of GM foods. With this dissemination of information about the safety of GM foods, if the consumers come to be less concerned about the risks from GM foods, the Japanese government would not have to enforce more strict labeling rules, and US stakeholders would not have to be involved in the problem that every GM food might be excluded from Japanese markets either. Therefore, this article asserts that it is important for US farmers and exporters to understand how scientific knowledge on the safety of GM foods affects Japanese consumers' acceptance.

Several studies have demonstrated the effect of information on consumer acceptance of GM foods by using non-market valuation techniques, such as contingent valuation (CV) approaches or experimental auctions (Jaeger et al., 2004; Li, McCluskey, & Wahl, 2004; Lusk et al., 2004; Noussair, Robin, & Ruffieux, 2004; Rousu, Huffman, Shogren, & Tegene, 2004; Tegene, Huffman, Rousu, & Shogren, 2003). For example, Rousu et al. (2004) showed that the negative GM information supplied by environmental groups could reduce consumer demand for GM food. Jaeger et al. (2004) found that information regarding health and environmental benefits could reduce the willingness to accept (WTA) compensation in order to consume GM food. Li et al. (2004) demonstrated that the willingness to pay (WTP) for GM-corn-fed beef would be increased by providing the scientific knowledge of it. These findings were all obtained from US consumer samples. On the other hand, Lusk et al. (2004) found that French consumers' WTA value for GM food was not reduced by positive GM information, while US and English consumers' WTA values were reduced by that information. Lusk et al.'s (2004) study also suggests a possibility that Japanese consumers' valuation for GM foods may not be affected by GM information.

This article examines whether information on the safety of GM corn and GM corn oil has significant impacts on Japanese consumers' perceptions of health risks from these GM foods and their WTP premium for non-GM corn oil. The degree of risk perception can be a useful measure for evaluating the consensus on GM labeling rules. In fact, several studies regarding food safety have focused on this qualitative risk perception (Dosman, Adamowicz, & Hrudey, 2001; Grobe, Douthitt, & Zepeda, 1999; Roosen, Hansen, & Thiele, 2004). As shown theoretically by Lusk and Coble (2005), risk perception can determine the value of GM food. Also, Moon and Balasubramanian (2004) argued that consumers' attributes can influence their attitude toward GM foods via the link between these attributes and their risk perception. We applied the Moon and Balasubramanian study's conceptual framework to our model and then investigated the link between information about GM corn and GM corn oil and risk perceptions, as well as the connections between risk perceptions and the WTP premium for non-GM corn oil.

The second section of this article develops the theoretical model that describes the relationship between the information about GM food and the WTP premium. The third section describes the outline of our CV survey. The fourth section explains the empirical models, and the fifth section shows the estimated results. The sixth section summarizes the obtained results and concludes the article.

Theoretical Modeling

In our theoretical model, the consumers' perception of risk from GM food is expressed by each of two measures: the mean and the variance of a probability distribution. The risk perception expressed by the mean indicates the states of health that would be expected to appear from consuming GM foods. For example, some people may expect that GM foods would be harmless to eat, but other people anticipate that consuming them would cause allergies. Such expected states of health imply the mean of the subjective probability distribution of health level. On the other hand, the risk perception expressed by the variance indicates the degrees of confidence in the expected health state. Some people assume that a disease will be caused by the intake of GM foods, but other people may predict the incidence of the same disease with a lower degree of confidence. Such degrees of confidence imply the variance of the subjective probability distribution of health level. Most previous studies of food safety valuation have focused only on the mean in the framework of the state dependent utility model (Hayes, Shogren, Shin, & Kliebenstein, 1995; Lin & Milon, 1995; Lusk et al., 2004).[1] Our model, however, explicitly includes the risk perception expressed not only by the mean, but also by the variance in order to analyze the relationship between the information and the WTP in more detail.

The WTP premium for non-GM food is theoretically described in the framework of the expected-utility theory. Now, an individual is assumed to consume a GM food q, and a composite good z, which is treated as the numeraire. Let r denote the level of health caused by consuming the GM food. The larger the value of r indicates a worse state of health in this model. Also, this r is assumed to be a continuous random variable with non-negative support, finite mean μ, and variance σ^2. In the theory of expected utility, the individual's utility maximization problem is represented as

$$\max_{z,\, q} \mathrm{E}\,[U(z, q, r)], \text{ s.t. } z + pq = y, \tag{1}$$

where $U(\bullet)$ is the utility function, E is the expectation operator for r, p is the price of q, and y is money income. By solving this maximization problem, the demand function $q(p, y)$ is derived, and the expected indirect utility function is represented by $\mathrm{E}[V(p, y, r)]$. Here, we consider the case where the individual consumes the non-GM food instead of the GM food. In this case, it is assumed that the probability that $r = 0$ is 1. Then, the individual's (expected) utility is given by $V(p, y, 0)$. The WTP premium for the non-GM food is, therefore, expressed as[2]

$$V(p+WTP, y, 0) = \mathrm{E}[V(p, y, r)]. \tag{2}$$

By using Equation 2, we investigate the effect of information on the WTP under the standard assumptions that $\partial V / \partial r < 0$ and $\partial^2 V / \partial r^2 < 0$. The level of information about the GM food that the individual possesses is denoted by I. It takes a positive value if the individual has more favorable information about the GM food and a negative value with more unfavorable information, as defined by Lusk et al. (2004). The μ and σ are assumed

1. *An exception is Lusk and Coble (2005), who employed variance as the measure of risk perception.*
2. *Hayes et al. (1995) defined the WTP for safer food as U(y-WTP, 0)=EU. Since we asked respondents in the survey to state what premium they would be willing to pay for non-GM food, we defined the WTP as the premium per item of the food.*

to be functions of I, where $d\mu / dI < 0$ and $d\sigma / dI^2 < 0$. The latter inequality implies that if $I \leq 0$, then $d\sigma / dI \geq 0$ and if $I > 0$, then $d\sigma / dI < 0$. The second order Taylor expansion of $V(p, y, r)$ around μ yields

$$V(p, y, r) \approx V(p, y, \mu) + V_r(p, y, \mu)(r - \mu) + \frac{1}{2} V_{rr}(p, y, \mu)(r - \mu)^2, \quad (3)$$

where $V_r(p, y, \mu)$ is $\partial V / \partial r$ evaluated at (p, y, μ), and $V_{rr}(p, y, \mu)$ is $\partial^2 V / \partial r^2$ evaluated at (p, y, μ). Then, the expected indirect utility function is approximated as

$$E[V(p, y, r)] \approx V(p, y, \mu) + \frac{\sigma^2}{2} V_{rr}(p, y, \mu). \quad (4)$$

Substituting Equation 4 into Equation 2 and totally differentiating it with respect to I and WTP yields

$$\frac{dWTP}{dI} = \frac{V_r(p, y, \mu)}{V_p(p + WTP, y, 0)} \frac{d\mu}{dI} + \sigma \frac{V_{rr}(p, y, \mu)}{V_p(p + WTP, y, 0)} \frac{d\sigma}{dI}, \quad (5)$$

where $V_p(p + WTP, y, 0)$ is $\partial V / \partial p$ evaluated at $(p+WTP, y, 0)$, and $\partial^3 V / \partial r^3$ is assumed to be 0. The first term of the right side of Equation 5 indicates the partial impact of information on the WTP via the link to μ, and the second term indicates an impact via the link to σ. Each partial impact of information on the WTP works in the same direction as the impact of information on μ or on σ, because $\partial V / \partial r < 0$, $\partial^2 V / \partial r^2 < 0$, and $\partial V / \partial p < 0$. This equation shows that, when the information about GM food is provided and the two kinds of risk perception both decrease, WTP must also decrease.

Equation 5 shows that when the information level increases, WTP remains unchanged under the following three conditions: (1) Both the mean and the variance are independent of the information level ($d\mu / dI = 0$ and $d\sigma / dI = 0$); (2) Only the mean is independent of the information level, and the individual is risk-neutral with respect to the health level ($d\mu / dI = 0$ and $\partial^2 V / \partial r^2 = 0$); and (3) the marginal utility of the health level is zero ($\partial V / \partial r = 0$). In the cases of Conditions 1 and 2, the positive WTP premium for non-GM food is measured under the assumption that $\partial V / \partial r > 0$. In the case of Condition 3, this positive WTP can be measured only when the individual's utility function with respect to r is represented as

$$V(r) = \begin{cases} c_0, & \text{if } r = 0 \\ c_1, & \text{if } r = k \quad \forall k > 0, \end{cases} \quad (6)$$

where c_0 and c_1 are constants and $c_0 > c_1$. The individuals who have this utility function prefer non-GM food to GM food and are not concerned about the level of health caused by GM food consumption.

Survey Outline

We conducted the CV survey with focus on GM corn and GM corn oil. There are two specific reasons for choosing corn for our research theme.[3] The first is that corn is one of the most important trade commodities for both the United States and Japan. At present, the corn export value in the United States is the second largest US agricultural commodity compared with that of soybeans, and Japan is the country that imports the most corn from the United States (Ministry of Finance of Japan, 2006; United States Department of Agriculture, 2006). The second reason for choosing this theme is that GM corn (Bt corn) is well-known as an insecticidal plant that may cause an unfavorable impression of GM foods among people. As described in the next paragraph, Bt corn can be harmless to human health in terms of scientific perspective. But, many consumers in this country might be confined to believe that eating an insecticidal plant could be dangerous to human health. Then, we predicted that Japanese consumers' unfavorable attitudes to such a GM food could be reduced by providing the correct information regarding the safety of Bt corn.

Bt corn includes the gene *Bacillus thuringiensis*, which produces an insecticidal protein. Although eating a plant with insecticidal properties seems to be risky to human health, in fact, Bt corn is scientifically considered to be safe because there is a difference in the digestive systems between humans and insects. For example, the inside of the human stomach is acidic, whereas the inside of an insect's stomach is alkaline. Bt protein is not fully digested in the alkaline environment and as a result the insecticidal peptide can survive in the digestive tract. On the other hand, the insecticidal activity is lost in the acidic environment because Bt protein is fully

3. *Several studies have examined Japanese consumers' attitudes to GM foods, such as vegetable oil (Chern, Rickertsen, Tsuboi, & Fu, 2002), noodles (McCluskey, Grimsrud, Ouchi, & Wahl, 2003), and canola oil (Kaneko & Chern, 2004), but no study has, as of yet, measured the premium for non-GM corn oil.*

Table 1. Risk perception questions in informed and uninformed version questionnaires.

Question	Informed version	Uninformed version
Risk perception (GM corn)	*There is a difference in the digestive systems between humans and insects. Even if we eat GM corn, the protein included in the corn that kills insects is resolved in our stomachs, and it is not taken into our bodies via the intestines. Therefore, GM corn is generally considered to be harmless to human health.* How dangerous do you think it is to eat GM corn?	How dangerous do you think it is to eat GM corn?
Risk perception (GM corn oil)	At present, GM corn and the processed foods in which GM corn is the main ingredient have to be labeled as "genetically modified," but the oil made from GM corn does not have to be labeled. *The reason is that the introduced genes or the proteins produced by these genes are resolved, removed, or changed in the process of purification, and as a result, the traces of GM corn disappear.* How dangerous do you think it is to eat GM corn oil?	At present, GM corn and the processed foods in which GM corn is the main ingredient have to be labeled as "genetically modified," but the oil made from GM corn does not have to be labeled. How dangerous do you think it is to eat GM corn oil?

Note. The added sentences in the informed version are written in italics.

digested there. Moreover, insect intestinal cells have the receptors for Bt protein, whereas human intestinal cells have none of those receptors. In insect bodies, the insecticidal peptide is connected to the receptors in the intestinal cells, and then the cells are destroyed; there is no such mechanism in the human body (Ministry of Agriculture, Forestry and Fisheries of Japan [MAFFJ], 2002).

The cooking oils made from GM plants, such as soybean, corn, or canola oil, are generally considered to be harmless to human health because the introduced genes, or the proteins produced by those genes, have been resolved, removed, or changed in the process of purification. As a result, traces of the GM ingredients do not remain in the foods. Therefore, the Japanese government, at present, does not impose any labeling requirements on all the cooking oils, including the oil made from Bt corn. However, it imposes mandatory labeling requirements on Bt corn itself.

In our survey, two types of questionnaire were designed, as shown in Table 1. In the *informed* version, some reasons why GM corn and GM corn oil are safe were described in the risk perception questions; in the *uninformed* version, they were not described in those questions. The added sentences in the informed version were adapted from the booklet distributed to the public by the Japanese government (MAFFJ, 2002). The respondents were randomly put into two groups; respondents in one group received the informed version questionnaire (informed group), and the other group's respondents received the uninformed one (uninformed group). Interviews occurred at the entrance of a supermarket in Kusatsu-city, Shiga-prefecture, Japan, in February 2002.

The two risk-perception questions, respectively, asked respondents to choose one of four responses that represented their risk perception of GM corn and GM corn oil; the respondent (1) thinks it safe, (2) thinks it a little dangerous, (3) thinks it very dangerous, and (4) does not know. These can be expressed in the forms of probability distributions as shown in Figure 1. The various responses imply a unimodal distribution whose mean is small (for Response 1), medium (Response 2), large (Response 3), and only Response 4 is represented by a uniform distribution. In the empirical analysis, we assume that the mean of Response 2 is equal to the mean of Response 4, and the variances of Responses 1, 2, and 3 are the same. The means and variances of these four distributions are summarized as in Table 2.

After answering the questions about risk perceptions, respondents were asked to state how much premium they would be willing to pay for a bottle of non-GM corn oil compared to a bottle of corn oil that sold in supermarkets for 600 yen per 900 grams. Since GM labeling requirements are not imposed on oils in Japan, such a corn oil bottle on sale must include GM ingredients. This survey question was presented in an open-ended format, as this format is expected to work well in the case where respondents are familiar with paying for the commodity (Mitchell & Carson, 1989). Japanese consumers are well accustomed to buying non-GM foods in supermarkets.

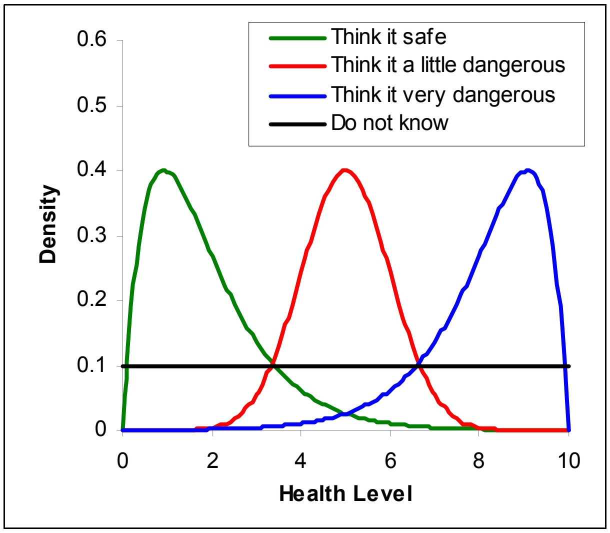

Figure 1. Probability distributions implied by responses to risk perception questions.

Empirical Modeling and Data

The empirical model used to examine the relationship between information level and risk perception expressed by the mean (RPM model) is specified as an ordered probit model. As shown in Table 2, the mean is described as three sizes: small, medium, or large. These three sizes are replaced with 0, 1, and 2, respectively. The model is represented as

$$RPM^* = \boldsymbol{\beta}'_m \mathbf{x}_m + \varepsilon_m \text{ and} \quad (7)$$

$$RPM = \begin{cases} 0, & \text{if } \quad RPM^* \leq 0 \\ 1, & \text{if } \; 0 < RPM^* \leq \eta \\ 2, & \text{if } \quad RPM^* > \eta, \end{cases} \quad (8)$$

where *RPM* is the proxy variable for mean size, RPM^* is the latent variable of *RPM*, $\mathbf{x}_m$ is the vector of personal attributes related to this mean, $\boldsymbol{\beta}_m$ is the coefficient vector of $\mathbf{x}_m$, η is the threshold parameter between *RPM*=1 and *RPM*=2, and ε_m is the stochastic error term that follows the standard normal distribution. The variable that reflects the information level is included in $\mathbf{x}_m$.

The model for examining the relationship between information level and risk perception expressed by the variance (RPV model) is specified as a binomial probit model. The variance is described as two sizes: small (0) or large (1). Hence, the model is represented as

$$RPV^* = \boldsymbol{\beta}'_v \mathbf{x}_v + \varepsilon_v \text{ and} \quad (9)$$

Table 2. Mean and variance of probability distributions implied by responses to risk perception questions.

Response	Distribution form	Mean	Variance
(1) Think it safe	Unimodal	Small	Small
(2) Think it a little dangerous	Unimodal	Medium	Small
(3) Think it very dangerous	Unimodal	Large	Small
(4) Do not know	Uniform	Medium	Large

$$RPV = \begin{cases} 0, & \text{if } RPV^* \leq 0 \\ 1, & \text{if } RPV^* > 0, \end{cases} \quad (10)$$

where *RPV* is the proxy variable for variance size, RPV^* is the latent variable of *RPV*, $\mathbf{x}_v$ is the vector of personal attributes related to this variance, $\boldsymbol{\beta}_v$ is the coefficient vector of $\mathbf{x}_v$, and ε_v is the stochastic error term that follows the standard normal distribution. The variable of information level is also included in $\mathbf{x}_v$, as well as in $\mathbf{x}_m$. These two risk perception models are specified for each of risk perception associated with GM corn and GM corn oil.

The WTP model includes the two kinds of risk perception as independent variables. Since the WTP data are left-censored at 0, the WTP model is estimated by using the Tobit model. It is represented as

$$WTP^* = \boldsymbol{\beta}'_w \mathbf{x}_w + \alpha_m RPM + \alpha_v RPV + \varepsilon_w \text{ and} \quad (11)$$

$$WTP = \begin{cases} 0, & \text{if } WTP^* \leq 0 \\ WTP^*, & \text{if } WTP^* > 0, \end{cases} \quad (12)$$

where WTP^* is the latent variable of *WTP*, which is observed when taking a positive value; $\mathbf{x}_w$ is the vector of personal attributes related to the *WTP*; $\boldsymbol{\beta}_w$ is the coefficient vector of $\mathbf{x}_w$, α_m and α_v are the coefficients of *RPM* and *RPV*, respectively; and ε_w is the stochastic error term that follows a normal distribution with a mean of zero and variance of γ^2.

The 112 respondents in the informed group and the 98 respondents in the uninformed group completed all of the questions about risk perceptions, WTP, and the candidate independent variables; they were used as the sample for model estimation. Table 3 shows the list of dependent variables and candidate independent variables, as well as their sample means and standard deviations. The Mantel extension tests (Mantel, 1963) in our

Table 3. Variable definitions and summary statistics.

Variable	Definition	Mean (std. dev.)	
		Informed	Uninformed
RPM_C	Risk perception expressed by mean (GM corn) 0=small 1=medium 2=large	1.188 (0.608)	1.347 (0.517)
RPV_C	Risk perception expressed by variance (GM corn) 0=small 1=large	1.098 (0.519)	1.163 (0.529)
RPM_O	Risk perception expressed by mean (GM corn oil) 0=small 1=medium 2=large	0.063 (0.243)	0.173 (0.379)
RPV_O	Risk perception expressed by variance (GM corn oil) 0=small 1=large	0.107 (0.311)	0.184 (0.387)
WTP	WTP premium for non-GM corn oil	406.143 (336.723)	372.959 (328.333)
INFO	1=informed group 0=uninformed group	-	-
GMTECH	Knowledge of GM techniques 1=know well 2=know somewhat 3=do not know	2.134 (0.608)	2.041 (0.552)
CORN	Knowledge of insecticidal corn 1=know well 2=know somewhat 3=do not know	1.839 (0.730)	1.816 (0.761)
LABEL	Knowledge of labeling system 1=know well 2=know somewhat 3=do not know	2.098 (0.657)	2.041 (0.669)
BUY	Purchase frequency of corn oil 1=buy frequently 2=buy sometimes 3=do not buy	2.161 (0.369)	2.204 (0.403)
FEMALE	1=female 0=male	0.723 (0.449)	0.704 (0.456)
AGE	Age in decades	3.723 (1.224)	3.694 (1.343)
JOB	1=office worker or official 0=otherwise	0.786 (0.412)	0.735 (0.441)
CHILD	1=with children of age 12 or younger 0=otherwise	0.491 (0.502)	0.439 (0.496)

study found no significant linear trend across the groups for all the candidate independent variables, even at the 20% level. This result shows that when information significantly affects risk perception, this relationship does not depend on the other factors. Also, the sample mean and the sample median of the WTP were 391 yen and 250 yen, respectively. In the case that the median is selected, the premium for non-GM corn oil accounts for about 40% of the price of the corn oil bottle that would include GM ingredients. This value is very similar to the average premium for non-GM foods found across the 22 studies reported by Lusk, Jamal, Kurlander, Roucan, and Taulman (2005).

Estimation Results

We estimated the models for risk perception (the RPM and RPV models) both on GM corn and GM corn oil. As shown in Table 4, in the GM corn models, the coefficients of the INFO variable were negative and significant at the 5% level. On the other hand, in the GM corn oil model (Table 5), the coefficients of the INFO variable were also negative, although we cannot say that they were highly significant (p-values=0.141 and 0.133, respectively). These results indicate that when information regarding the safety of GM corn and GM corn oil is provided, the risk perceptions expressed by the mean and by the variance substantially decrease. In addition, they are consistent with our model assumptions described in the second section. Moreover, since the effects of information on the variances were negative, one can predict from our theoretical model that the consumers possess more favorable information about GM corn and GM corn oil.

Since high correlations were observed between the RPM_C and RPM_O variables (Spearman's rank correlation coefficient=0.65, p-value=0.000) and between the RPV_C and RPV_O variables (Spearman's rank correlation coefficient=0.64, p-value=0.000), we separately estimated the WTP model that includes RPM_C and RPV_C as independent variables (Model 1) and the WTP model that includes RPM_O and RPV_O (Model 2). From Table 6, we can see that in each model neither of the coefficients of the two risk perception variables is significant, even at the 20% level. These results indicate that even if the additional information can reduce risk perception, the WTP would remain unchanged. It implies that Japanese consumers have such a preference as expressed by Equation 6 in the second section.

Let us also look at some other significant coefficients. First, the coefficients of the CORN variables

Table 4. Estimation results of risk perception models on GM corn.

Variable	RPM model			RPV model		
	Coefficient	Std. err	p-value	Coefficient	Std. err	p-value
Intercept	0.598	0.704	0.396	-0.756	1.035	0.465
INFO	-0.427	0.170	0.012	-0.608	0.257	0.018
GMTECH	0.165	0.171	0.335	-0.219	0.262	0.404
CORN	0.252	0.139	0.069	-0.092	0.201	0.647
LABEL	-0.031	0.136	0.819	-0.324	0.198	0.103
BUY	-0.277	0.220	0.209	0.196	0.304	0.519
FEMALE	0.720	0.192	0.000	-0.182	0.277	0.511
AGE	0.102	0.075	0.174	0.159	0.116	0.171
JOB	0.214	0.201	0.288	0.337	0.329	0.306
CHILD	0.119	0.182	0.512	-0.320	0.280	0.252
Threshold (η)	2.098	0.160	0.000	-	-	-
Log-likelihood	-165.287			-65.008		
Sample size	210			210		

Table 5. Estimation results of risk perception models on GM corn oil.

Variable	RPM model			RPV model		
	Coefficient	Std. err	p-value	Coefficient	Std. err	p-value
Intercept	0.405	0.721	0.574	0.037	0.972	0.969
INFO	-0.254	0.173	0.141	-0.338	0.225	0.133
GMTECH	0.183	0.176	0.297	0.028	0.230	0.903
CORN	0.264	0.143	0.063	-0.118	0.183	0.520
LABEL	-0.023	0.139	0.871	-0.302	0.177	0.088
BUY	-0.323	0.224	0.149	-0.185	0.308	0.548
FEMALE	0.570	0.198	0.004	-0.190	0.248	0.444
AGE	0.072	0.077	0.349	0.062	0.104	0.551
JOB	0.446	0.208	0.032	0.218	0.285	0.445
CHILD	0.211	0.188	0.261	-0.129	0.250	0.607
Threshold (η)	2.368	0.163	0.000	-	-	-
Log-likelihood	-151.998			-81.515		
Sample size	210			210		

included in the RPM models on GM corn and GM corn oil were both positive and significant at the 10% level. This means that the more consumers know about insecticidal corn, the less they think the corn and the oil made from such corn are dangerous. Since the Japanese mass media mainly feature the risky aspects of GM foods, people who do not know much about GM corn may be influenced to think the GM corn and its cooking oil are dangerous. Second, the coefficients of the FEMALE variables included in the RPM models were also both positive and significant at the 1% level. This result can clearly explain the tendency that females think more carefully about the safety of the GM corn and GM corn oil than males. It would be reasonable that females who usually cook meals at home must be more concerned about food risks. Third, the coefficient of the LABEL variable included in the RPV model on GM corn oil was negative and significant at the 10% level. This indicates that the more consumers know about the labeling system for GM foods, the greater confidence they will have in their own predictions for the level of health caused by consuming GM corn oil. It can be considered that people who know the labeling system well have strong concerns about the effects of food ingredients on human health. Therefore, they may be able to estimate health level with a greater confidence.

Table 6. Estimation results of WTP model.

Variable	Model 1			Model 2		
	Coefficient	Std. err	p-value	Coefficient	Std. err	p-value
Intercept	297.729	203.090	0.143	338.743	203.926	0.097
GMTECH	15.743	48.464	0.745	20.122	48.362	0.677
CORN	11.670	39.458	0.767	20.040	39.400	0.611
LABEL	-63.172	38.874	0.104	-63.336	38.867	0.103
BUY	44.989	63.398	0.478	35.969	63.384	0.570
FEMALE	3.532	55.656	0.949	22.289	54.965	0.685
AGE	21.084	21.782	0.333	23.244	21.639	0.283
JOB	-58.669	57.443	0.307	-49.235	57.862	0.395
CHILD	6.274	52.238	0.904	11.745	52.161	0.822
RPM_C	20.685	43.670	0.636	-	-	-
RPV_C	-8.141	76.996	0.916	-	-	-
RPM_O	-	-	-	-46.857	47.166	0.320
RPV_O	-	-	-	9.775	68.223	0.886
Std. Dev. (γ)	338.095	17.024	0.000	337.547	16.994	0.000
Log-likelihood	-1465.819			-1465.429		
Sample size	210			210		

Summary and Conclusion

Our empirical results show two major points: (a) Information regarding the safety of GM corn and of GM corn oil was able to reduce both the consumers' risk perceptions expressed by the mean and those by the variance and that (b) these affected risk perceptions did not function to reduce the WTP premium for non-GM corn oil. The result of the first finding suggests that GM labeling requirements might not be widely applied to the GM products of oils or animal feed in Japan because Japanese consumers' risk perception is expected to be reduced with information dissemination, although labeling requirements for these GM foods have been performed in the European Union since April 2004. However, by the result of the second finding, this suggestion can be denied in terms of WTP. As described in the section of theoretical modeling, such a phenomenon can occur in the case that the strength of the consumers' preference for non-GM food does not depend on the state of health caused by consuming GM food. It might be derived from the fact that Japanese consumers presently do not understand the risks of GM foods.

Our conclusion is that information about GM corn and GM corn oil has a significant effect on Japanese consumers' risk perception, but it does not have any effect on their WTP. Therefore, it is vital for US farmers and exporters to predict the trend in Japanese consumers' acceptance of GM foods by taking our unique finding into consideration. Doing so will establish better future strategies about exporting GM foods to Japan.

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