Consumer Response to Genetically Modified Food Products in Japan

Jill J. McCluskey, Kristine M. Grimsrud, Hiromi Ouchi, and Thomas I. Wahl

In Japan, a large U.S. export market, there has been growing public opposition against genetically modified (GM) foods. Using a dichotomous choice contingent valuation method, findings show the discount needed for Japanese Seikyou consumers to purchase GM food products is positively affected (i.e., a greater discount is required) by higher levels of self-reported risk perceptions toward GM food, higher levels of concern about food safety and the environment, higher self-reported knowledge about biotechnology, education levels, and income. Interestingly, gender does not significantly affect the discount needed for GM food. Further, it can be inferred from the results that a transformation of Japanese consumers' perceptions and attitudes is needed for GM food products to successfully enter the Japanese market.

Key Words: biotechnology, consumers, genetically modified foods, Japan, willingness to purchase

Biotechnology has been touted as the future of agriculture. However, the business leaders, producers, and scientists involved in biotech did not foresee how controversial genetically modified (GM) foods would be with consumers, particularly for export markets such as Japan. A better understanding of consumer attitudes and behavior toward genetically modified food products in these export markets is essential for designing market strategies. This study focuses on consumers' choices and willingness to purchase GM food products with possible discounts.

In Japan, 34 local self-governing bodies are engaged in research and development of GM products (*Asahi Shimbun*, 2001). Yet, most of their products will not be marketed in Japan because of the growing public opposition to GM foods. Reflecting this trend, U.S. export orders have increased for soybeans and corn which are not genetically modified, even at premium prices.

In the United States in 1999, premiums of 8¢ to 15¢ per bushel were offered for non-GM corn, and premiums of 5¢ to 35¢ per bushel were offered for non-GM soybeans at the farm level (Nelson et al., 1999). In response, some Japanese food companies and farmers have switched to non-GM ingredients and seeds. For example, Asahi and Kirin, the two leading Japanese beer companies, have announced they will switch entirely to non-GM ingredients, and soybean farmers who do not use GM seeds are enjoying a huge demand for their beans (Tolbert, 2000).

Labeling policies for GM foods are rapidly evolving worldwide. Japan's new system of labeling GM foods went into effect on April 1, 2001. Foods made from GM crops are required to be labeled as "genetically modified." Foods made from non-GM crops, which have been identity preserved, can be voluntarily labeled as "not genetically modified." Finally, foods that have not been identity preserved must be labeled as "not segregated from GM product." While few Japanese products carry labels identifying them as "genetically modified," many products claim to be free of genetically modified organisms (*Shinano Mainichi Shimbun*, 2001). GM status labels not only provide consumers with information, they also give

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the consumer the opportunity to choose. McCluskey (2000) argues that the appropriate labeling policy for GM foods depends on the size of the market and willingness to pay for non-GM foods relative to the costs of identity preservation.

The heated debate over labeling issues in Japan reflects increasing consumer concerns about food safety issues, including effects on human health and the environment. Several Japanese consumer groups actively campaigning against genetic modification of food are insisting on mandatory labeling of GM food products. These groups assert GM products are not being adequately tested for safety. Many school lunch programs in Japan serve non-GM foods to the extent possible, despite the efforts of the Japanese Ministry of Agriculture to convince consumers that GM products are safe to eat.

The objective of this study is to identify and analyze specific factors which induce Japanese consumers to choose GM foods. The remainder of the article is organized as follows. In the section below, we discuss the previous literature on consumer preferences and attitudes toward GM foods, with particular attention given to Japanese attitudes toward food safety. A description of the survey data utilized in this analysis is then provided. The next section presents the empirical analysis, and the factors that affect consumers' willingness to purchase discounted GM food products are analyzed. Concluding remarks are offered in the final section.

Related Studies

In recent years, the issue of GM labeling has received considerable attention. However, only a few published studies have analyzed consumer willingness to pay (WTP) or willingness to accept (WTA) compensation for food products containing GM ingredients. Lusk et al. (2001) estimated willingness to pay for corn chips made without genetically modified ingredients. In their experimental study, junior- and senior-level agricultural economics students at Kansas State University indicated their WTP by exchanging a bag of GM corn chips for a bag of GM-free corn chips. WTP findings revealed that an individual who is very concerned about GM foods would be 50% more likely to pay a premium to exchange GM chips for non-GM chips compared to an individual with little concern for GM foods. However, 70% of the study participants stated they were not willing to pay a premium for non-GM chips. The average bid to exchange GM chips for non-GM chips was $0.07/ounce. Still, 20% of participants were willing to pay at least $0.25/ounce for the exchange, and 2% offered bids of $0.50/ounce, suggesting there may be a potential niche market in the United States for non-GM food products.

Baker and Burnham (2001) investigated U.S. consumers' acceptance of GM corn flakes, and reported that 30% of those surveyed based their purchasing decision on GM content. Their findings show that cognitive variables (opinions, beliefs, knowledge) have a great influence on consumer preferences. The level of risk aversion, knowledge about genetic modification, and opinion about genetic modification are highly significant in explaining the purchasing decision. Earlier studies investigating the relationship between consumer characteristics and food safety concerns have generally found that socio-demographic variables (such as education and income) perform poorly as explanatory variables for purchasing decisions regarding GM food products. The exception is that women, in general, are more concerned with food safety.

Lusk, Roosen, and Fox (2003) estimate consumer willingness to pay for beef in France, Germany, the United Kingdom, and the United States. Their analysis uses a variety of quality variables, including whether the cattle were fed GM corn. Results suggest European consumers place a much higher value on beef from cattle that have not been fed genetically modified corn compared to their consumer counterparts in the United States. Yet, in a study of the discrepancy between European public opinion and consumer purchase behavior with regard to GM food products, Noussair, Robin, and Ruffieux (2002) found that consumers are typically unaware of the labeling indicating GM content.

A small number of survey studies have assessed consumer perceptions about food safety and biotechnology in developed societies, including the United States and Japan. Jussaume and Judson (1992) studied the effects of sociological characteristics on consumer attitudes toward food safety. Using responses to mail surveys in Seattle, Washington, and Kobe, Japan, they examined differences between consumers in the two countries. Residents of Kobe were found to be significantly more concerned about food safety than residents in Seattle. For both countries, households more likely to care about food safety issues are those with children under the age of 18, who belong to consumer cooperatives, and with relatively high incomes.

Using telephone surveys conducted in Japan and the United States in 1995 and in 1998, Hoban (1999) studied consumer awareness and acceptance

of biotechnology and willingness to purchase GM foods. Despite the recent controversy over the use of biotechnology, Hoban observed increasing acceptance of genetic modification for food production by Japanese and U.S. consumers between 1995 and 1998, and increasing numbers of consumers who are willing to buy GM foods in both countries. He concludes that the use of biotechnology does not negatively affect consumers' willingness to purchase those foods. However, Hoban cautions that consumer awareness and understanding of biotechnology is still relatively low in Japan compared with the United States.

Consumer attitudes toward biotechnology have been changing since Hoban's study, as more information has been provided to the pubic—primarily through the media. Macer and Chen Ng (2000) report that support for biotechnology and genetic engineering in Japan is decreasing, especially for agricultural applications. Based on a mail survey spanning the years 1991, 1993, 1997, and 2000, they found Japanese interest in science and biotechnology increased from 30% in 1991 to 47% in 2000. From the 2000 survey, 97% of respondents reported familiarity with the term "biotechnology," implying awareness of biotechnology has increased significantly among the Japanese public. Also from the 2000 survey, only 31% of respondents stated they are likely to support GM foods, and only 20% said they are willing to buy GM fruits. Macer and Chen Ng conclude that although the majority of Japanese consumers are optimistic about biotechnology, they hold increasingly negative views toward its application for agriculture.

Since these studies were conducted, recent events in Japan may have affected consumer sentiments. The disappointing economy, government scandals, and the discovery of bovine spongiform encephalopathy (BSE, also known as "mad cow disease") in Japan may have caused consumers to be less trusting of government reassurances and GM food products.

Survey Data

After pre-testing with Japanese subjects in Nagano and Matsumoto, Japan, the survey used in this study was conducted at the Seikatsu Club Consumer Cooperative (Seikyou), a grocery store-like setting, in Matsumoto City, Japan, during June 2001. The survey data were collected with in-person interviews carried out in Japanese. By collecting data from consumers at the same time and place where actual purchase decisions are made, we hoped to better elicit consumers' true preferences about the products. Respondents were selected randomly, with the criterion that the interviewer was to solicit every third customer who came into the survey area.

Every respondent was given a gift certificate valued in Japanese yen (worth approximately U.S.$12, where U.S.$1 = 121 yen) as an incentive in return for participation in the survey. The turndown rate was about 50%, as observed by interviewers when they asked for participation.

In total, 400 consumers were surveyed. The majority of respondents are the primary food shoppers of the household (77%) and female (78%). Sixty-seven percent reported they shop for groceries daily or between two and five times a week. Most of the respondents are in their 40's, which is the average age of the population in Matsumoto City, as well as in Japan. Fifty-four percent of all respondents reported having children under the age of 18 years living in their household. This percentage is higher than Japan's national average, where 28% of all households have children under the age of 18.

For the 2000 fiscal year, the average household income of survey respondents ranged between 5,100,000 yen (U.S.$42,011) and 7,600,000 yen (U.S.$62,604).[1] The Matsumoto average income of 6,178,884 yen falls within this average income range. However, the average income level reported by survey participants is somewhat below Japan's average yearly household income for fiscal year 2000, which was 7,100,000 yen (U.S.$58,485). The average education level of survey respondents included some years of college, while the Japanese average includes only high school. Summary statistics and descriptions of variables are presented in table 1.

The survey solicited information regarding respondents' attitudes about the environment and food safety, and their self-reported knowledge and perceptions about biotechnology (see table 2). Information about environmental and food safety attitudes was obtained by presenting tradeoff situations between environmental quality and economic growth, and between food safety and low prices, respectively (refer to the appendix for an English translation of the tradeoff questions).

Eliciting these attitudes from tradeoff scenarios is an effective way of ensuring the survey information is informative as well as useful in an empirical

[1] In order to obtain a high response rate, respondents were asked to place themselves in income intervals, rather than state their exact income amount. Survey respondents are typically reluctant to divulge information about income. The exchange rate used is U.S.$1 = 121.398 yen.

Table 1. Summary Statistics for Demographic Variables: Matsumoto City, Japan, Survey Participants, June 2001 (N = 400)

Variable	Description (coding)	Distribution of Responses, with Related Information	
Age	# 30 years	12%	Mean = 45.5 years; Std. Dev. = 13.9 years
	30 to 50 years	50%	
	50 to 70 years	32%	
	> 70 years	5%	
Female	1 if female	78%	
	0 if male	22%	
Shopper	1 if main shopper	77%	
	0 otherwise	24%	
Education	Compulsory school	3.75%	CODING FOR ESTIMATION:
	HS diploma	42.50%	0 if compulsory school, HS diploma, or refuse;
	2–3 years college	19.50%	1 if 2-year college, 4-year degree, or advanced/ professional degree
	4–5 year college degree	17.25%	
	Advanced/professional degree	13.50%	
	Refuse to answer	3.50%	
Children	1 if children under 18 years in household	54%	
	0 otherwise	46%	
Income (in 1,000 yen)	< 2,500 yen	3.75%	Mean = 6,350 yen; Std. Dev. = 2,500 yen
	2,510–5,000 yen	22.25%	CODING FOR ESTIMATION:
	5,010–7,500 yen	26.00%	0 if less than average income;
	7,510–10,000 yen	15.75%	1 if above average income
	> 10,010 yen	11.50%	
	Refuse to answer	20.75%	
Household	Number of people in household	—	Mean = 3.53 people; Std. Dev. = 1.31 people

Table 2. Summary Statistics for Consumer Information and Perception Variables: Matsumoto City, Japan, Survey Participants, June 2001 (N = 400)

Variable	Description (coding)	Distribution of Responses
Environment	Importance of environmental sensitivity vs. economic growth, based on a scale of 1 to 10 where:	
	1 = economic growth is all-important	Mean = 6.5
	10 = environment is all-important	Std. Dev. = 1.91
Safety	Importance of food price vs. food safety, based on a scale of 1 to 10 where:	
	1 = food price is all-important	Mean = 7.9
	10 = food safety is all-important	Std. Dev. = 1.94
Risk	Risk associated with GM foods:	
	1 if high or low risk	74%
	0 if no risk	26%
Opinion	Opinion about use of biotechnology:	
	1 if favorable or neutral opinion	12%
	0 if negative opinion	88%
Knowledge	Self-reported knowledge about biotechnology:	
	1 if high or little knowledge	82%
	0 if no knowledge	18%
Label	Importance of labeling GM foods:	
	1 if labeling very important	98%
	0 if labeling somewhat or not very important	2%
Import	Preference for domestic vs. imported food products:	
	1 if preference is for domestic food	92%
	0 if no preference	8%

modeling context. For example, without the trade-off, most respondents will state that they value the environment highly. The resulting lack of variation in response can lead to a lack of statistical significance of the effect of the environmental variable.

As in all surveys, a primary consideration is that the sample is representative of the population under study. The potential bias of greatest concern in this study is the population choice bias—i.e., the possibility that the population chosen does not adequately correspond to the population which will purchase genetically modified food products.

As a marketing strategy, consumer cooperatives usually focus on offering "safe foods," and target members who are more willing to purchase safe foods (Jussaume, 1998). Therefore, as members of a consumer cooperative, we expect Seikyou consumers to have stronger concerns about food safety than consumers who shop at other grocery stores. A mitigating factor is that the Seikyou has significant power in the Japanese marketplace. A potential offsetting bias is that Matsumoto is a relatively agricultural area. About 13% of Matsumoto's population is represented by farm households, compared to 2% for all of Japan (Japan Ministry of Public Management, 2002). Consequently, residents of Matsumoto may be more closely associated with agricultural production and have more knowledge about the production processes.

Slovic (1987) suggests risk is influenced by two major factors: dread risk and unknown risk. We suspect agricultural residents are less sensitive to GM products because their level of unknown risk is probably lower. Further, while our response rate of approximately 50% is respectable, it does suggest the possible presence of nonrespondent bias.[2] Given the preceding concerns, we caution that the extent to which the findings can be fully generalized to broader populations is uncertain.

Empirical Analysis

The empirical analysis associated with this research is divided into three subsections. The first provides a discussion of the contingent valuation dichotomous choice methodology used in the study. The second describes the econometric model used in the quantitative analysis of the data. The final subsection presents an analysis of the factors affecting consumers' willingness to accept discounts to purchase GM foods.

Contingent Valuation Dichotomous Choice Methodology

The contingent valuation method (CVM) is a standard approach to elicit people's willingness to accept (WTA) through a dichotomous choice, market-type questioning format with a direct survey such as via telephone, mail, and in-person questionnaire (Kanninen, 1993). In the dichotomous choice CVM, each respondent is asked whether he/she would be willing to accept a particular discount for a particular good in a hypothetical market. A respondent answers with "yes" or "no," to the discount "bid" amount offered.

There are typically two types of bidding procedures used in the CVM: the single-bounded and the double-bounded dichotomous choice, with the double-bounded model gaining in popularity (Kanninen, 1993). The single-bounded model approach recovers the bid amount as a threshold by asking only one dichotomous choice question (Hanemann, Loomis, and Kanninen, 1991). The statistical efficiency of this approach can be improved by use of the double-bounded model, which engages in two bids.

Recent works using the double-bounded approach include an analysis by Yoo and Yang (2001) who estimated the benefit of a tap water quality improvement in Korea, and Hutchinson et al. (2001) who estimated the benefits from outdoor recreation in Northern Ireland. In the latter study, the authors provide empirical evidence of the gains in the statistical efficiency of both benefit and parameter estimates obtained by analyzing follow-up responses with double-bounded interval data analysis.

However, the double-bounded approach has also been critically evaluated. Hanemann, Loomis, and Kanninen (1999) note: "… there is also some bias in going from a single- to a double-bounded format because there is some evidence that some of the responses to the second bid are inconsistent with the first bid" (p. 382). They conclude, even if the double-bounded approach produces some bias, "the experience to date suggests that the bias is in a conservative direction and is greatly outweighed by the

[2] Although 50% is lower than the commonly accepted 70% CV standard, there is not enough evidence to determine whether 50% is low for intercept interviews in Japan. One concern with a lower response rate is that people with a lower value of time, such as retirees or unemployed people, may be overrepresented. A mitigating factor in this survey is that the summary statistics suggest the average age of the sample is representative of the general population. A second concern is that those individuals who are more concerned about genetically modified foods elected to participate in the survey. If this is the case, it would bias the WTA results upward.

gain in efficiency in terms of minimizing overall mean squared error" (p. 388).

Our survey included contingent valuation questions regarding willingness to accept a discount to purchase noodles made from genetically modified wheat.[3] The hypothetical market for the good in question must be as close as possible to a real market in order to reveal consumers' true preferences if an actual market existed (Pearce and Turner, 1990). The food product (noodles) chosen for this study is appropriate for examination, because noodles are a frequently consumed food product by most of the Japanese population.

Consumers were first asked if they were willing to pay the same price for the GM noodles as the non-GM noodles. If the respondent's answer to this question was "no," a follow-up question was asked where the respondent was offered a percentage discount on the GM noodles relative to the non-GM noodles. The discount was set at one of the following levels: 5%, 10%, 25%, 40%, or 50%. Each discount level was used for one-fifth of the surveys—i.e., 80 of the 400 surveys had a 5% discount for GM noodles, another 80 surveys had a 10% discount for GM noodles, and so on. The assignment of survey version (and thus discount) was random to the respondent.

No follow-up question was asked if the consumer's answer was "yes" to the initial question, indicating a willingness to purchase the GM noodles at no discount. The rationale for no follow-up to a "yes" response is that the type of genetic modification associated with GM noodles is a *process attribute*, which reduces production costs (as opposed to a *product-enhancing* attribute). An example of a GM product with a product-enhancing attribute is the Flavr Savr tomato. Proponents claim the GM products with process attributes are identical to non-GM products.[4] Opponents view genetic modification as a negative attribute. Therefore, it would not make economic sense, after an initial "yes" response, to pose a follow-up question involving payment of a premium for these GM products which have only cost-reducing attributes.

Of the 400 respondents, only 3% said they would be willing to purchase the genetically modified noodles at the same price as the non-GM noodles (the "yes" group). Further, only 17% of consumers in the sample stated they would be willing to purchase the GM noodles if they were less expensive than the non-GM noodles (the "no, yes" group). The remaining 80% of respondents were not willing to purchase the GM noodles, even with the discount (the "no, no" group). For more specific statistics on the distribution of responses over the various discounts, see table 3.

The Econometric Model

There are three possible outcomes in our methodology, instead of the four possible outcomes in the standard double-bounded model: (*a*) the respondent is not willing to purchase the GM noodles at the same price as non-GM noodles or at a discount relative to the non-GM noodles—i.e., a "no" response to both bids; (*b*) the respondent is not willing to purchase the GM noodles at the same price, but is willing to buy the GM food product at the random discount offered—i.e., a "no" response followed by a "yes"; and (*c*) the respondent is willing to purchase the GM product at the same price as the non-GM product, implying a "yes" response.

The applicable model for examining the outcomes of our survey can be considered a special case of the double-bounded logit model (Hanemann, Loomis, and Kanninen, 1991). In this model, the initial bid (B_0) equals zero and implies no price difference between GM noodles and non-GM noodles. The second bid (B_D) is the GM noodles offered at a random percentage discount relative to the non-GM noodles. This second bid is only given to individuals who state they would not buy GM noodles at the same price as non-GM noodles. We refer to this model as a "semi-double-bounded" model.

Modeling of this type can be found in the literature since at least the 1989 work of Cameron and Huppert, and is envisioned in the multiple-bounded discrete choice modeling considered in Welsh and Poe (1998).

The sequence of questions isolates the range in which the respondents' true WTA discounts lie for GM products relative to non-GM food products. The second bid (B_D), in conjunction with the response to the initial preference decision, allows bounds to be placed on respondents' unobservable true WTA for GM food. Note that a discount greater than 100% can be interpreted as the discount a respondent would need to be paid to choose the GM product.

[3] In a second set of contingent valuation questions, survey respondents were asked about their willingness to purchase tofu made with genetically modified soybeans. The results are very similar, and are not presented here.

[4] Note that the GM noodles are made with Roundup Ready wheat; thus, reduced pesticide usage is not a benefit.

Table 3. Distribution of Response Rates to the Randomly Assigned Discount Offer for GM Noodles

Description	"Yes"	<! ! ! ! ! ! ! ! ! ! "Yes" with Discount ! ! ! ! ! ! ! ! ! ! !>					"No" with Discount	Total
Discount	0%	5%	10%	25%	40%	50%		
Response rate to each discount	3.5%	1.8%	2.5%	3.5%	5.3%	3.8%	79.8%	100%

Let *WTA* denote an individual's WTA compensation (or bid function) for GM noodles, relative to non-GM noodles, and let $B_D \# 0$ denote the discount bid[5] on GM noodles relative to non-GM noodles. The following three discrete outcomes of the bidding process are observable:[6]

$$(1)\quad D = \begin{cases} 1: & WTA \# B_0, \\ 2: & B_0 < WTA \# B_D, \\ 3: & B_D < WTA. \end{cases}$$

Respondents who indicate they require no discount fall into the first group of expression (1), because they are willing to purchase the GM noodles at zero discount compared to the non-GM noodles. Those who fall into the second group require a discount that is positive but less than or equal to B_0 for GM noodles. In order to choose the GM noodles, the price of the GM noodles must be discounted relative to the corresponding non-GM noodles by an amount less than or equal to the discount bid. Finally, those who require the largest discount to choose GM noodles fall into the third group. Customers in this group are not willing to purchase the GM product at the discount offered. The WTA function for noodles for individual *i* is specified as:

$$(2)\quad WTA_i = \alpha + \rho B_i + \lambda \mathbf{z}_i + \gamma_i, \quad i = 1, \ldots, n,$$

where B_i is the ultimate discount bid individual *i* faces, $\mathbf{z}_i$ is a column vector of observable characteristics of the individual, and γ_i is a random variable accounting for random noise and possibly unobservable characteristics. Unknown parameters to be estimated are α, ρ, and λ. Linearity in $\mathbf{z}$ and γ is assumed for all individuals. Furthermore, the distribution of the error term is assumed to follow $\gamma \sim G(0, \sigma^2)$, where $G(0, \sigma^2)$ denotes a cumulative distribution function with mean zero and variance σ^2.

Under these assumptions, the choice probabilities for individual *i* can be characterized as:[7]

$$(3)\quad \text{Prob}(D_i = j) = \begin{cases} G(\tilde{\alpha} + \tilde{\rho} B_{0i} + \tilde{\lambda} \mathbf{z}_i) \\ G(\tilde{\alpha} + \tilde{\rho} B_{D_i} + \tilde{\lambda} \mathbf{z}_i) - G(\tilde{\alpha} + \tilde{\rho} B_{0i} + \tilde{\lambda} \mathbf{z}_i) \\ 1 - G(\tilde{\alpha} + \tilde{\rho} B_{D_i} + \tilde{\lambda} \mathbf{z}_i) \end{cases} \quad \text{for } j = \begin{cases} 1 \\ 2 \\ 3 \end{cases}.$$

Thus, the log-likelihood function becomes:

$$(4)\quad L = \sum_i \begin{cases} I_{D_i = 1} \ln G(\tilde{\alpha} + \tilde{\rho} B_{0i} + \tilde{\lambda} \mathbf{z}_i) \\ + I_{D_i = 2} \ln \left[G(\tilde{\alpha} + \tilde{\rho} B_{D_i} + \tilde{\lambda} \mathbf{z}_i) - G(\tilde{\alpha} + \tilde{\rho} B_{0i} - \tilde{\lambda} \mathbf{z}_i) \right] \\ + I_{D_i = 3} \ln \left[1 - G(\tilde{\alpha} + \tilde{\rho} B_{D_i} + \tilde{\lambda} \mathbf{z}_i) \right] \end{cases},$$

where $D_i = j$ denotes that the *j*th outcome occurred. In the empirical implementation of the model, we define $G(\cdot)$ to be the standard logistic distribution function with mean zero and standard deviation $\sigma = \pi / \sqrt{3}$.

The bid information and other demographic information were used to estimate the magnitude of factors affecting Japanese consumers' WTA for GM food products, and how much of a relative discount Japanese consumers will require to purchase GM food products.

[5] The randomly assigned discount bids are $B_D = \{0.05, 0.1, 0.25, 0.4, 0.5\}$.

[6] Although we previously argued that with process attributes, it is not rational to pay a premium, we do allow for it by not restricting WTA to equal zero for the first group. If it is the case that the WTA = 0 restriction should be imposed for the first group and it is not, then we admit that the likelihood function does not fully account for what amounts to censoring of the WTA value. However, in this particular application, the degree of such censoring is very small, where only 3.5% said "yes" to a zero discount for GM noodles. Thus, in that case, our specification of the likelihood function is only an approximation, but the censored component is a minor term in the overall likelihood specification.

[7] The condition of linearity on $\mathbf{z}$ is a simplifying assumption widely used in random utility models (RUMs). This assumption implies that consumers' willingness to accept *c* dollars is generally represented as follows: $U(0, x_0, m) \# U(1, x_1, m + c)$, $\Pr\{WTA \# c\} = \Pr\{V_0 + \gamma_0 \# V_1 + \gamma_1\} = \Pr\{\gamma_1 - \gamma_0 \# V_0 - V_1\}$, where $V_0 - V_1 = \alpha + \beta c$.

Table 4. Parameter Estimates for the WTA Model

Parameter	Variable	Estimate	Std. Error	*t*-Value	*p*-Value
$\tilde{\alpha}$	Intercept	!1.3214	0.3375	!3.915	0.0000
$\tilde{\rho}$	*Bid*	5.3704	0.4623	11.616	0.0000
λ_1	*Safety* (*Environment*	!0.0846	0.0335	!2.523	0.0058
λ_2	*Knowledge*	!0.6543	0.3024	!2.164	0.0152
λ_3	*Risk*	!1.7128	0.4229	!4.050	0.0000
λ_4	*Female*	!0.0368	0.3104	!0.119	0.4528
λ_5	*Income*	!0.4604	0.3240	!1.421	0.0776
λ_6	*Education*	!0.4965	0.2847	!1.744	0.0406

Analysis of Factors Affecting WTA for GM Food

The variables included in the model are food safety and environmental attitudes (see the appendix for the tradeoff question corresponding to this variable), self-reported knowledge and risk perceptions about biotechnology, gender, income, and education. The model in equation (2) is estimated where $\mathbf{z}_i = \{Safety_i \; (\; Environment_i \; Knowledge_i \; Risk_i \; Female_i \; Income_i \; Education_i\}$. Variable definitions and descriptions are given in table 2. Estimated parameters are $\boldsymbol{\lambda} = \{\lambda_1 \; \lambda_2 \; \lambda_3 \; \lambda_4 \; \lambda_5 \; \lambda_6\}$, in addition to α and ρ. Other variables are not included because of multicolinearty problems. The parameter estimates are presented in table 4.

The estimation results show that variables representing food safety and environmental attitudes, self-reported knowledge about biotechnology, self-reported risk perceptions toward GM foods, income, and education all significantly increase the WTA compensation for choosing GM foods (i.e., increase the required discount). The variable representing gender is not statistically significant in explaining WTA compensation to purchase GM food.

Based on the data, the mean WTA (the required discount to be willing to purchase) for our sample is at least 50%. However, we do not present an estimated mean willingness-to-accept value because this estimate would be outside of the highest discount offered (50%). Mean WTA estimates are obtained from an extrapolation of the WTA function, so that the level of uncertainty increases as one gets further outside the data. With an extrapolation, the confidence intervals around the mean WTA estimate must be wider than otherwise would be necessary. The "no, no" group likely includes people who would not choose GM foods even if they were given away for free.

An improvement for future work in evaluating consumer preferences for GM foods in Japan should include offering respondents much larger discounts, possibly even offering to pay a segment of respondents to consume GM foods (i.e., a discount greater than 100%). Even without the mean WTA estimate, we can infer from the results that a transformation of Japanese consumers' perceptions and attitudes is needed for GM food products to successfully enter the Japanese market.

Conclusions

A better understanding of Japanese consumers' attitudes and behavior toward genetically modified food products will be essential for designing market strategies for Japan. This study analyzes factors affecting Japanese consumers' WTA for GM food products. Eighty percent of the Seikyou consumers who participated in our survey would not choose the GM noodles over non-GM noodles, even with a discount set at one of the following levels: 5%, 10%, 25%, 40%, and 50%. Each discount level was used for one-fifth of the 400 surveys. The econometric model developed for this analysis is a semi-double-bounded logit model. Although the double-bounded dichotomous choice model is commonly used for estimating willingness to pay/accept compensation, the semi-double-bounded model better suits the case of a product with a cost-reducing attribute.

The results show that attitudes toward food safety and the environment, self-reported knowledge about biotechnology, self-reported risk perceptions toward GM foods, income, and education all significantly increase the WTA compensation for choosing GM foods (i.e., increase the required discount). These results support the findings of Baker and Burnham (2001) that cognitive variables (opinions, beliefs,

knowledge) are very important in consumer preferences for GM foods.

Although these findings may not represent the attitudes and preferences of the general Japanese population, this study is nevertheless useful for firms desiring to sell food products in Japan. An implication of this study is that there is an opportunity to market food segregated from GM products in Japan. For those firms who want to market GM products, the picture is not so rosy. Japanese consumers need to be convinced of the safety of GM foods if these products are to be marketed successfully there. Firms who sell GM products must engage in consumer education and risk communication about biotechnology.

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Appendix: English Translation of Selected Survey Questions

Questions Used to Elicit Food Safety and Environmental Attitudes:

- Where would you place yourself on a scale from 1 to 10, *if economic growth at all costs is a* 1, and *saving the environment at all costs is a* 10?

[CIRCLE JUST ONE]

1 2 3 4 5 6 7 8 9 10

- When you are purchasing food, how important are *lower food safety* risks versus *lower cost food*? Please place yourself on a scale of 1 to 10, where 10 means *food safety is all-important*, and 1 means *lower food prices are all-important.*

  [CIRCLE JUST ONE]

  1 2 3 4 5 6 7 8 9 10

Questions About GMO Knowledge and Attitudes:

- How knowledgable are you about biotechnology and genetically modified (GM) foods?

  1. Very knowledgeable
  2. Somewhat knowledgeable
  3. Not informed

- How do you feel overall about use of biotechnology in foods?

  1. Very positive
  2. Somewhat positive
  3. Neutral
  4. Somewhat negative
  5. Very negative
  6. Don't know

- How much risk, if any, do you associate with genetically modified foods?

  1. High level risk
  2. Low level risk
  3. No risk
  4. Don't know

- How important is it to you that foods with genetically modified ingredients are labeled?

  1. Very important
  2. Somewhat important
  3. Not very important

- Do you prefer domestic to imported food products?

  1. Yes
  2. No

Questions Related to Willingness to Accept:

- A U.S. university is developing genetically engineered wheat. Would you be willing to purchase noodles made with this wheat if they were offered at the same price as noodles without genetically engineered wheat?

  1. Yes
  2. No

- Would you be willing to purchase these noodles if they were offered at a price that is [*insert random discount %*] less than noodles without genetically engineered wheat?

  1. Yes
  2. No