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WILLINGNESS TO PAY FOR NON-GENETICALLY MODIFIED FOOD: EVIDENCE OF HYPOTHETICAL BIAS FROM AN AUCTION EXPERIMENT IN JAPAN

NAOYA KANEKO AND WEN S. CHERN

This paper presents the results of experimental auctions of a genetically modified (GM) food that were conducted in Japan. A series of experimental auctions were conducted to elicit consumers' willingness to pay (WTP) for the selected non-genetically modified (non-GM) food along with WTP for its GM counterpart. The paper provides mean bidding prices for the non-GM and GM food products and analyzes the relationship between bidding prices and consumers' attitudinal and demographic variables. It also elicit hypothetical willingness to pay a premium for the non-GM product. Whereas auction experiments yield a premium of 30-40% of base price, a comparable hypothetical premium is nearly 90-100% of base price, which provides evidence of large hypothetical bias. Although it is impossible to claim that the experimental subjects are representative of the regional population, let alone the Japanese population, both qualitative and quantitative information gathered from the study is useful for anyone involved in the distribution of GM foods.

Keywords: Genetically Modified, Experimental Auction, Willingness to Pay, Stated Choice.

1 Introduction

Since they became commercial reality in the late nineties, genetically modified (GM) foods have been controversial. The European Union have implemented strict labeling rules for GM foods, and other countries followed suit, largely pushed by popular demands. There are some activities even in the United States for the introduction of labeling requirements. A number of questions need to be addressed with regard to the labeling of GM foods, such as whether or not labeling increases social welfare, or who should pay the cost of labeling. These questions cannot be fully answered without investigating consumer acceptance. Thus, the main topic of this article is how to measure consumer acceptance accurately in terms of monetary values.

Japan is one of the most important single countries for U.S. agricultural exporters, importing from 2001 to 2002 more than 3 million metric tons of soybeans (74% of total imports) and more than 14 million tons of corn (90% of total imports) from the U.S., which makes the country the first and third largest U.S. export markets of soybeans and corn, respectively. American exporters have a serious concern in the development in the political environment surrounding the trade of GM commodities. This article deals with the behavior of Japanese consumers.

In order to study the behavior of Japanese consumers, nonmarket valuation techniques are useful. Although Japan already has a labeling requirement for GM foods, it has not seen food products labeled GM in the shelves of the supermarkets in the entire country. The labeling law consists of two provisions, one for mandatory labeling and the other for voluntary labeling. The food manufactures chose not to subject themselves to the provision for mandatory labeling of GM foods; they chose instead to label their products as “non-genetically modified” under the voluntary labeling provision. This choice means that they switched from GM to non-GM varieties whenever their product must be labeled as GM. The outcome is that the Japanese consumers face the choice between non-labeled and non-GM-labeled foods, both of which are not genetically modified. Thus, the market data at the retail level do not reveal the premia the Japanese consumers are willing to pay to avoid the GM foods, except for a limited number of cases. The nonmarket valuation techniques are required to overcome the difficulty.

A number of studies have used experimental auctions in order to explore consumers' willingness to pay for nonmarket commodities such as food safety (Hayes et al., 1995; Fox et al., 2002) or novel technology such as new packaging (Hoffman et al., 1993). The use of experimental method is not the only way to elicit consumers' WTP: contingent valuation or conjoint analysis surveys can also perform the task. However, survey-based methods are known to yield biased welfare measures because of their hypothetical nature. Unlike the survey-based methods, experimental auction poses consumers nonhypothetical decision-making, which is expected to yield a more reliable estimate of WTP.

It is reported by many authors that the willingness-to-pay values tend to be overstated when consumers answer hypothetical survey questions (Fox et al., 1998; List and Shogren, 1998; Lusk and Fox, 2003). Experimental auctions may be conducted to remove hypothetical bias, but it is not clear how effective the experiments are for that purpose, without a direct comparison.[1] For this reason, we asked the experimental subjects to answer a stated-choice question that does not involve actual transactions. The mean WTP value from the stated choice is compared against the mean WTP value from the experimental auction in this study.

2 Experimental Design

We conducted an experiment in which GM and non-GM canola oil were involved. The choice of canola oil was made because it was the only available and acceptable choice. The purpose of the experiment was to measure the price difference the consumers were willing to support between the GM and non-GM alternatives when the alternatives were exactly the same in product characteristics except for the use of GM and non-GM ingredients. One might be tempted to use false products and make the participants believe that one of the product were made of GM canola while the other were made of non-GM canola, but the use of deception was hardly justifiable because the auction winners had to pay money to buy the product, and we did not wish the unscrupulous practice to attract the attention of the Japanese media that is always on the lookout for an outrage related to GM foods. Since the auctioned products were displayed in front of the experimental subjects, they needed to look exactly the same. The only product we could manage to find that had both GM and non-GM varieties readily available in supermarkets and that looked the same was canola oil. We bought GM and non-GM canola oil of the same size (i.e., 1000 gram bottle) from supermarkets, peeled off the product labels, and placed plain labels that said only the name of the products (namely, either GM or non-GM oil) and their GM status.[2] Although the products for display had plain labels, we guaranteed to the participants that they would purchase the products with the same original labels as found in store shelves.

We adopted simultaneous bidding for GM and non-GM oil without endowment products. A number of studies endowed the participants with a baseline product from which the participants would bid to upgrade to the auctioned product (Buhr et al., 1993; Hayes et al., 1995; Fox, 1995). The perceived advantages of product endowment include an added incentive to actively participate in the auction and direct bidding for the price difference between the baseline and auctioned products. The main disadvantage is that the participants who prefer the baseline product to the auctioned product cannot express their willingness to pay a premium for the baseline product. The disadvantage is especially acute when the product involves ambiguous product characteristics. It may be true that many consumers prefer the non-GM alternative, but we also expect a minority of consumers who prefer the GM alternative. The use of product endowment needs a split sample design with different baseline treatments, which requires a larger sample size to achieve a given statistical precision. Since our study could not attain a large sample size, we avoided product endowment and chose simultaneous bidding for GM and non-GM alternatives for its flexibility in valuation. Thus, in each trial, all participants were asked to bid simultaneously for the GM and non-GM oil.

The winner of the auction was determined by the second-price sealed-bid auction as well as the two-tier random mechanism. There were two trials in each auction. The participants simultaneously submit their bids for the GM and non-GM alternatives. The identification number of the participant who submit the highest bid was announced along with the second highest bid for each product. Another trial was done by asking the participants to submit their bids once again. Then a straw was randomly drawn to determine which trial was binding (i.e., either first or second), and then another random draw of a straw was made to determine which product (i.e., either GM or non-GM) was binding in the chosen trial. A real transaction was made for only the binding product in the binding trial so that only one product was sold to only one participant in each experimental session.[3] The second-price auction was adopted because it is relatively easy to implement and because it is a weakly dominant strategy for the participants to reveal their true valuations (Vickrey, 1961; Milgrom and Weber, 1982). The use of random draws was made to control for the so-called wealth effect, or demand reduction (for demand reduction, see List and Lucking-Reiley 2000).

Each experimental session had two stages. At the first stage there were two trials of candy bar auctions, and at the second stage there were two trials of canola oil auction. The purpose of the first stage was to get participants acquainted with the mechanism of the second-price sealed-bid auction and random determination of binding trial and product. In each stage, participants bid for two products, but only one product was actually sold. At the beginning of the experiment, each respondent was given a small amount of "budget" with which bids were made.

After the experimental auction, the participants were asked to make hypothetical purchase decisions under given price scenarios. A number of studies have made comparison between hypothetical and nonhypothetical consumer decisions. Blackburn et al. (1994) compared the percentages of yes responses of hypothetical and nonhypothetical dichotomous choice questions to find out that the participants tend to be more willing to give a yes response in a hypothetical question than in a nonhypothetical question. The comparison was made for the hypothetical and nonhypothetical responses from the same group of respondents. Neill et al. (1994) and Fox et al. (1998) compared the hypothetical bids in an open-ended contingent valuation with the nonhypothetical bids in a Vickrey second-price auction. Both studies are based on in-sample comparison, but the latter provides some basis for between-group comparison. The first study does not compare bid values, and the latter studies, while they compare bid values, use open-ended contingent valuation. In the contingent valuation literature, there is ample evidence that open-ended hypothetical questions are less reliable than closed-ended questions, as suggested by the NOAA guidelines (Arrow et al., 1993). It is of much interest to see if bid values from experimental auction is comparable to the equivalent values estimated from closed-ended contingent valuation. Thus, we use a paired-comparison contingent valuation question that is a variant of normal dichotomous choice contingent valuation format. Specifically, we provide the respondents a choice between GM and non-GM canola oil given the price scenarios. The price of GM oil was set at 250 yen, which is roughly the market price of GM canola oil. The price of the non-GM oil was set so that it would be 30, 50, 70, and 90% more expensive than the GM oil. The price scenarios were randomly distributed among the participants. After answering to the contingent valuation questions, the participants filled out a questionnaire about demographic information, food purchasing behavior, and perception of GM foods.

3 Data

A total of 39 consumers were recruited on December 8, 2003, in front of a large supermarket to participate in the auction experiments in Tsukuba, a city that is one-hour drive from Tokyo (the Tsukuba group, henceforth). A sign board was placed throughout the day in front of the main entrance to the supermarket, and a recruitment effort was continued until an enough number of participants were obtained before each experimental session. There were a total of 6 sessions conducted on the same day and from 4 to 8 people participated in these sessions.

Another group of 28 consumers were recruited from the staff members of the agricultural economics department of the University of Tokyo (the Tokyo group, henceforth). An announcement of recruitment was distributed to the staff members that only said that the experiment was about consumer decision making. There were a total of three experimental sessions, one held in the evening of December 16 and two held in the evening of December 17. Eleven, eight, and nine people participated in the first, second, and third sessions, respectively.

The data from the two groups were pooled for the econometric analysis. Table 1 summarizes key demographic characteristics of the two groups of participants. A column is added to provide the comparable figures for the Japanese population.[4] The demographic characteristics of the two samples are similar, and where some differences are observed, the difference in recruitment can explain them. The Tsukuba group consists of people of more diverse demographic background than the Tokyo group because the former was intercepted in front of a supermarket whereas the latter consists of staff members of an academic department. The Tsukuba group contains more women and more married people because women and married people are more likely to go to a supermarket for grocery shopping. The difference in the presence of kids can also be explained similarly.

4 Results

Table 2 presents the auction bids for the GM and non-GM canola oil plus the observed premiums for non-GM oil. A number of facts are observed about the bidding behavior. First, both the mean and median bids are invariably higher for Tsukuba than for Tokyo irrespective of GM status of the product. This confirms the finding of Lusk and Fox (2003), who report higher bids among field experimental subjects, since Tsukuba was a field experiment while Tokyo a lab experiment. Second, the mean and median premiums are smaller for Tsukuba than for Tokyo. This is an interesting result since field subjects are more willing to purchase the GM oil. This means that the lab subjects submit disproportionately low bids for the GM oil. It remains unclear whether this is a result specific to our study or a general pattern because we cannot separate the effect of field-lab variation from that of sample variation. If it is confirmed in a larger-scale study with appropriate separation of the above confounding effect, it will have an important implication for similar valuation studies. Third, the percentage of zero bids is lower in the field setting, which lends further support to the hypothesis that the field subjects are more willing to make a purchase. Finally, it appears that the mean bids decline from the first trial to the second. However, pooled-variance t-tests and Wilcoxon tests did not reject the null hypotheses that the mean bids are equal over trials. Nonetheless, a regression result (not reported here) indicated that the second-trial bids were affected by the announced price, which may be an indication of affiliation or preference learning. If we believe in affiliation, then the first trial bid should be used, and if we believe in learning, then the second should be used. If both effects are present, it seems more likely that affiliation dominates learning with only two trials because learning is expected to take more time. Hence, the following econometric analysis will be based on the first trial bids.

Since there are some differences in the demographic characteristics between the Tsukuba and Tokyo experiments, it is desirable that the non-GM premium be calibrated by key demographic variables to derive the sample statistics on which to base the policy recommendations. Table 3 provides the results of OLS regression of non-GM premium on individual characteristic variables. With a small sample of cross-sectional observations, the regression equations do not necessarily have a good fit. However, the coefficient estimates indicate interesting results. First, as with many studies of consumer acceptance of GM foods, risk perception significantly affects the non-GM premium (Chern et al., 2002; Kaneko and Chern, 2003). The more the participants perceive risks about GM foods, the more premium they are willing to pay for the non-GM alternative. The presence of children also positively affects the non-GM premium. Participants living with children are willing to pay more premiums on non-GM. In contrast, awareness, trust in the government, gender, education, and income do not affect the non-GM premium significantly. A possible reason for this is that the dependent variable was constructed by subtracting the GM bid from the non-GM bid, which is not a binary choice between GM and non-GM. If participants were asked to make a binary choice, demographic variables may have been more significant. In any case, the estimated coefficients give a predicted value of non-GM premium, which is taken to be a nonhypothetical willingness to pay for the non-GM oil relative to the GM oil.

The participants answered a hypothetical paired-comparison stated-choice question after they participated in the experimental auction. They chose either GM or non-GM oil given the price scenarios. Since the question does not directly elicit the participants' willingness to pay, we need to invoke some econometric models to estimate the individual WTP. We consider two models here. The first is the minimum legal WTP model due to Harrison and Kriström (1995). According to this model, the respondent's choice is treated as simply agreeing to a legal contract. If the respondent chose the non-GM oil when the non-GM and GM prices were 325 yen and 250 yen, respectively, then the choice would be taken to mean that the respondent were willing to pay a premium of 75 yen to the non-GM oil. If, under the same price scenario, the respondent chose the GM oil, then that choice would simply mean that the respondent were willing to pay a non-GM premium of zero. Clearly, this model is inefficient in that it reject the notion of bounding the WTP in an interval, but it can never demand that the respondents pay a premium that they never agreed to pay. You should be upset if you chose a product priced at 250 yen but were charged 270 yen even though your reservation price for the product were 300 yen.

The other approach is a standard probit model. Let U^{NG} and U^{GM} be the utility functions for the non-GM and GM alternatives. Suppose the utility functions have a linear form:

$$\begin{aligned} U_i^{NG} &= \beta_0^{NG} + \beta_1 P_i^{NG} + \boldsymbol{\beta}_2^{NG} \boldsymbol{x}_i + \varepsilon_i^{NG}, \quad \text{and} \\ U_i^{GM} &= \beta_0^{GM} + \beta_1 P_i^{GM} + \boldsymbol{\beta}_2^{GM} \boldsymbol{x}_i + \varepsilon_i^{GM}, \end{aligned}$$

where P_i^{NG} and P_i^{GM} indicate the non-GM and GM prices, respectively, and $\boldsymbol{x}_i$ is a vector of respondent characteristics. Respondent i chooses the non-GM alternative if and only if $U_i^{NG} > U_i^{GM}$. This condition is alternatively expressed by the statement that $U_i > 0$ where $U_i := U_i^{NG} - U_i^{GM}$. Let us write

$$U_i = \beta_0 + \beta_1 P_i + \boldsymbol{\beta}_2 \boldsymbol{x}_i + \varepsilon_i,$$

where $P_i := P_i^{NG} - P_i^{GM}$, $\beta_0 := \beta_0^{NG} - \beta_0^{GM}$, $\boldsymbol{\beta}_2 := \boldsymbol{\beta}_2^{NG} - \boldsymbol{\beta}_2^{GM}$, and $\varepsilon_i := \varepsilon_i^{NG} - \varepsilon_i^{GM}$. Assume that ε_i has a normal distribution. Since the non-GM premium is the maximum amount the respondent is willing to pay for the non-GM relative to the GM price, it is the price difference such that $U_i = 0$. However, since the utility is itself a random variable, we need to take the expected value to remove randomness. Thus, the expected non-GM premium is

$$E[WTP_i] = -\frac{\beta_0 + \boldsymbol{\beta}_2 \boldsymbol{x}_i}{\beta_1}.$$

Table 4 shows the parameter estimates of the probit model. Here, significant variables in the previous OLS regression are not significant, but the awareness variable (GMUSE) is significant. The positive sign of its coefficient means that the more strongly participants believe GM ingredients are used in the current product, the more likely they will avoid GM products. The awareness does not mean knowledge, so this result is not in conflict with the result reported in the literature that scientific knowledge increases acceptance of biotechnology. Risk perception variable (RP) was not included as an explanatory variable because it was too strongly correlated with the dependent variable, which is a binary variable of choosing either GM or non-GM. The difference between the

OLS and probit results is not necessarily unreasonable. The OLS and probit model are based on the different criteria, plus the dependent variables are different, so the results need not exactly match between the two models. It is important to recognize that the price difference variable (PDIFF) is significant and has an expected sign, so the participants responded to the price information in a reasonable manner. The estimated coefficients are used to compute the expected non-GM premium for each individual so that the premium will be a variable in its own right.

It is interesting to compare different estimates of the non-GM premium. Table 5 presents the sample statistics for the alternative estimates of the non-GM premium. The column heading "auction" indicates the premium based on the original auction bids while "OLS" is the nonhypothetical premium based on the prediction of the OLS regression. Likewise, "legal" indicates the premium from the minimum legal WTP model while "probit" is for the premium from the probit analysis. As is evident from the table, the hypothetical non-GM premiums are higher than their nonhypothetical counterparts as far as the central tendency is concerned. The auction and OLS premiums are close to each other, with the OLS range $(-56.34, 244.82)$ smaller than the "auction" range (-200,450), as is expected because OLS is a method of fitting a line through the mean. Minimum legal premium is not so much higher than the nonhypothetical premiums, which indicates the method's namesake that the estimated WTP is minimum. The biggest drawback of the method is its inefficiency. Furthermore, the estimated premium is expected to depend heavily on the distribution of price scenario among the participants. In our study, the sample size is small, so the minimum legal WTP model may not be quite reliable. The probit non-GM premium is by far the highest of all, with the maximum premium being more than double the corresponding values for the original auction and its OLS prediction. Since the sample size is small, we could not obtain a precise estimate of the premium for the Japanese population, but we still use both the legal minimum and probit premiums for the purpose of comparison between the hypothetical and nonhypothetical valuations to obtain insights that might apply to a larger population.

Table 6 presents the OLS regression of hypothetical non-GM premium on nonhypothetical non-GM premium. The NOAA guidelines advise that the hypothetical WTP be multiplied by 0.5 if there is no evidence otherwise (Arrow et al., 1993). This can be interpreted as the bias function having the following form:

$$(\text{Hypothetical WTP}) = \alpha_0 + \alpha_1 \times (\text{Nonhypothetical WTP}),$$

where α_0 is zero and $\alpha_1 = 2$. As table 6 indicates, we have no evidence that α_0 is zero. This implies that the current sample does not support the presumption that hypothetical bias may be removed by the multiplication by 0.5. Instead, it suggests that the bias function has a more complex form if there is a stable functional relation at all between the hypothetical and nonhypothetical WTPs. It is not our purpose to find such a functional form. We would rather consider how WTPs are related by comparing mean hypothetical and nonhypothetical WTPs.

Table 7 gives the ratios of the hypothetical WTP to the nonhypothetical WTP. The figures in the first row were calculated by dividing the mean hypothetical WTP by the mean nonhypothetical WTP. Since we had two hypothetical WTPs and two nonhypothetical WTPs, there are four columns of figures. As is evident, the minimum legal WTP yields a quite comparable hypothetical WTP because it involves as little inflation of WTP as possible. By contrast, the probit WTP leads to serious hypothetical biases with hypothetical WTPs being more than twice as much as the nonhypothetical WTPs. Nonetheless, the result shows that the NOAA guidelines may be a bit off the mark. The second row presents the means of the bias factors calculated for each individual except when the division by zero occurs. Here, the minimum legal WTP method does not perform well, which suggests that there are some participants who has relatively small auction WTP but casually choose the non-GM alternative in a hypothetical question. Even so, it gives a smaller bias factor than the probit model, which produces even higher bias factors of around five. The last row presents the bias factors based on the regression without intercept in table 6. Since the intercept is highly significant in all cases in table 6, the figures in the last row in table 7 are only for the sake of additional comparison. Here, the minimum legal WTPs are once again quite comparable to the nonhypothetical WTPs while the probit WTPs come much closer to the nonhypothetical WTPs. So long as OLS prediction is used, we consistently obtain the evidence that probit model yields some hypothetical bias. Our results also show that legal minimum WTPs are not as much biased.

Table 8 shows an interaction between hypothetical bias and field-lab variation. In contrast to table 7, we measure the WTPs against the GM market price of 250 yen (although no mention was made to this price when the auction bids were elicited). The column headings “Auction” and “Survey” represent the original auction WTP and WTP resulting from the probit regression. The percentage WTPs are calculated by dividing the auction and survey bids by the market price. If we combine the field and lab samples, we obtain the same result as in table 7, with bias factor of 2.64. It is notable that the auction WTP of 34.6% is quite close to the observed retail market non-GM premium of 30%.[5] It is true that auction experiment need not elicit true consumer WTP because the environment is essentially artificial, but our results indicate that experimental results closely match the reality. We also included the information about interaction between the bias and setting. There is a large difference between the field and lab samples. As we observed in table 2, the auction WTP is lower for the field sample. However, the result is reversed for the survey WTP: the lab sample actually has a lower hypothetical WTP. This comes from the fact that a smaller percentage of lab sample chose non-GM in the binary hypothetical choice. This suggests that lab subjects are not willing to pay for the GM oil when there is a real chance of buying it while they are when there is no real chance. As was mentioned before, we cannot separate the sample and setting effects, but if there were no sample effect, the above result would have an important implication for the use of lab and field experiments.

5 Conclusion

A series of experimental auctions were conducted to investigate the consumers’ homegrown values for the non-GM and GM canola oil. The auction WTP was calculated by subtracting the bid for GM oil from the bid for non-GM oil. The participants revealed a willingness to pay a non-GM premium of roughly 30-40% of the market price of the GM oil. The estimated premium provides yet another support for the claim that the Japanese consumers are willing to pay much to avoid the GM products. Yet, the non-GM premiums derived from the auction were much smaller than the hypothetical premiums if the probit model was used to derive them. But the probit model or related models are routinely used to estimate a hypothetical WTP in many studies. Our results advise us to take due caution when interpreting the findings of contingent valuation studies. The legal WTP model has not been used extensively in the contingent valuation literature, but the model has some advantages such that it may bridge the gap between the hypothetical and nonhypothetical WTPs with its conservatism in interpreting the respondents' choices observed in hypothetical surveys.

The regression of WTP derived from auction bids showed that the risk perception, presence of kids, and regular use of the product are significant determinants. The more keen risk perception the consumers have, the higher premium they are willing to pay for the non-GM product. Consumers living with children are likely to spend more for the given non-GM product. Awareness, gender, age, education, and income were not significant determinants of the non-GM premium. The hypothetical choice between the GM and non-GM products was not explained well by the above demographic variables. Only awareness was significant. However, the choice was well explained by the price difference between the alternative products, which provides an added confidence to the estimation of WTP.

Since the sample is small and nonrandom, the sampling error cannot be calculated, and our findings will not guarantee correct inferences about the consumers living in the Tokyo area, let alone the entire country. Nonetheless, all of the participants were sampled from the general public, not from college students. Hence, we can put more confidence on the non-GM premium estimates than if the student subjects were used. It is certainly helpful to conduct auction experiments in a larger scale with more rigorously sampled subjects. In such a study, it is interesting to study carefully the difference between the field and lab settings. In our study, the field participants exhibited higher bids for both GM and non-GM products, yet they indicated a lower WTP than the lab participants. This phenomenon could not be explained because it was not possible to separate the sample group difference effect and the setting difference effect in our study. If the field-lab difference affects the results in a meaningful and predictable way, studying such differential effects is most useful in applying the experimental auction method to many purposes including marketing of novel or ambiguous product qualities.

In conclusion, we consider some practical implications of our results. As we observed, there is potentially a large hypothetical bias involved in a stated-choice survey. Discounting a survey result is certainly advised, but our experimental results suggest that the Japanese consumers still have a substantial willingness to pay a non-GM premium. Hence, non-GM products have a great market opportunity in Japan. Our results also indicate that there are a large number of Japanese consumers who are willing to pay a positive price for GM products. These consumers are willing to accept GM foods so long as they are reasonably priced. In our analysis, the discount needed on the GM foods is the flip side of the non-GM premium, which is affected by consumer risk perception. Thus, it is expected that the acceptance of GM foods will increase if the level of risk perception becomes lower. It is important that food manufacturers considering the marketing of GM foods take steps to disabuse the consumers of the dangers (not risks) of consuming GM foods that may be input by various groups vehemently opposing GM foods.

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Endnotes

[1]Many authors treat WTP values derived from experimental auctions as "real" WTPs. It is important to note, however, experimental auction is nonetheless a contrived market. Therefore, we use the term "nonhypothetical" in this article.

[2]We treat "nonlabeled" oil as GM oil because in all likelihood nonlabeled oil uses nonsegregated ingredients. If segregated ingredients are used, the manufacturer should label its product as "non-GM." Oil is exempt from mandatory labeling, meaning that even though GM ingredients are clearly used, the manufacturer is not required to label its oil product as GM.

[3]Ties were broken by random draws of straws.

[4]The subjects used for the present study consist of food shoppers of 18 years of age or older. However, some of the figures for the Japanese population include Japanese people of 15 years of age or older (e.g., MARITAL) due to data availability. Thus, the population figures are not strictly comparable.

[5]We purchased the non-GM canola oil at 325 yen and the GM canola oil at 250 yen. The non-GM premium is exactly 30%.

Table 1: Description of Sample Characteristics

Variable	Definition	Tsukuba	Tokyo	Japan
CANOLA	1 if canola oil is used regularly; 0 otherwise.	0.39 (0.50)	0.39 (0.50)	· · ·
GMUSE	1 if one knew if GM ingredients were used for oil; 0 otherwise.	0.59 (0.50)	0.44 (0.51)	· · ·
OILCON	1 if oil consumption is far more than average; 2 if a little more than average; 3 if about the average; 4 if a little more than average; 5 if far more than average;	3.77 (0.90)	3.79 (0.96)	3.00
RP	1 if GM foods are extremely or somewhat risky; 0 otherwise.	0.49 (0.51)	0.30 (0.47)	· · ·
GOV	1 if government regulations are excellent or good; 0 otherwise.	0.10 (0.31)	0.11 (0.32)	· · ·
AGE		49.16 (13.93)	47.23 (11.82)	48.29
FEMALE	1 if female; 0 if male.	0.87 (0.34)	0.63 (0.49)	0.51
MARITAL	1 if married; 0 otherwise.	0.69 (0.47)	0.56 (0.51)	0.60
EDU	1 if bachelor's or higher; 0 otherwise.	0.45 (0.50)	0.70 (0.47)	0.49
SIZE	Household size.	2.97 (1.28)	2.81 (1.11)	3.23
KIDS	1 if living with kids 18 years or younger; 0 otherwise.	0.39 (0.50)	0.25 (0.44)	0.28
INCOME	Household income. 1 if less than 2 million yen; 2 if 2-3 million yen; 3 if 3-4 million yen 4 if 4-5 million yen 5 if 5-6 million yen 6 if 6-7 million yen 7 if 7-8 million yen 8 if 8-9 million yen 9 if 9-10 million yen 10 if 10-15 million yen 11 if 15 million yen or more.	6.17 (3.10)	6.26 (2.26)	5.72
LAB	1 if belonging in Tokyo group; 0 if belonging in Tsukuba group.	· · ·	· · ·	· · ·
Num. Obs.		39	28.0	· · ·

Table 2: Auction Bids for GM and Non-GM Canola Oil

Item		Trial 1		Trial 2	
		Tsukuba	Tokyo	Tsukuba	Tokyo
GM oil	Mean	245.0	138.8	227.4	130.4
	Std. Dev.	184.3	113.4	154.0	99.1
	Median	250.0	150.0	250.0	150.0
	% Zero	20.5%	28.6%	20.5%	32.1%
Non-GM oil	Mean	319.3	241.9	306.5	250.0
	Std. Dev.	154.3	127.0	121.9	110.5
	Median	298.0	245.0	300.0	260.0
	% Zero	0.0%	7.1%	0.0%	7.1%
WTP	Mean	74.3	103.1	79.1	119.6
	Std. Dev.	84.1	152.6	76.7	151.6
	Median	52.0	70.0	60.0	80.0
	% of Base	29.7%	41.2%	31.6%	47.8%
Num. Obs.		39	28	39	28

Note: The percentage figures of WTP were calculated as the ratio of bid differences to the market price of 250 yen.

Table 3: Regression of WTP values from Auction

	Trial 1		Trial 2	
	Coeff.	Std.Err.	Coeff.	Std.Err.
ONE	−37.89	90.48	−24.04	87.03
GMUSE	20.67	33.32	27.22	32.05
RP	74.13**	33.19	79.14**	31.92
GOV	46.78	48.54	39.30	46.69
AGE	−0.09	1.43	−0.07	1.37
FEMALE	−22.34	39.39	−16.60	37.89
EDU1	−24.03	33.80	−13.34	32.51
KIDS	70.71*	40.16	66.74*	38.63
LINC	47.69	46.66	33.44	44.88
LAB	46.23	33.09	54.17	31.83
CANOLA	−56.43*	31.47	−48.77	30.27
R-squared	0.28		0.28	

Note: The symbols ** and * indicate that the coefficients are significant at the 5% and 10% levels, respectively.

Table 4: Probit Model for Hypothetical Responses

	Coeff.	Std.Err.
ONE	4.63*	2.74
GMUSE	2.20**	0.90
GOV	−0.74	0.75
AGE	−0.03	0.04
FEMALE	−0.31	0.64
EDU1	−1.54	0.94
KIDS	0.36	0.85
LINC	0.45	0.92
LAB	−0.70	0.70
CANOLA	−0.36	0.60
PDIFF	−0.02**	0.01
Log-likelihood	−14.40	
McFadden's R^2	0.47	

Note: The symbol ** indicates that the coefficient is significant at the 5% and 10% levels, respectively.

Table 5: Sample Statistics of Alternative WTP values

	Nonhypothetical		Hypothetical	
	Auction	OLS	Legal	Probit
Mean	86.36	82.48	117.39	228.40
Std.Dev.	117.52	62.42	89.65	89.59
Median	52.00	82.06	125.00	229.84
Minimum	-200.00	-56.34	0.00	60.12
Maximum	450.00	244.82	450.00	421.71

Table 6: Regression of Hypothetical WTP on Nonhypothetical WTP

	Legal Minimum WTP				Probit WTP			
	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio	Coeff.	t-ratio
Auction								
Constant	107.80	7.10	...	...	212.16	13.55	...	...
Original Auction WTP	0.14	1.17	0.61	4.19	0.10	1.00	0.89	4.72
R-squared	0.03		-1.01		0.02		-3.88	
OLS								
Constant	101.85	4.43	...	...	198.25	9.27	...	...
Predicted Auction WTP	0.25	1.06	1.09	6.08	0.28	1.33	1.82	8.70
R-squared	0.03		-0.45		0.04		-1.76	

Table 7: Hypothetical-Nonhypothetical Bias Factors

	Legal/Auction	Probit/Auction	Legal/OLS	Probit/OLS
Ratios of Means	1.36	2.64	1.42	2.76
Means of Individual Ratios	3.61	5.26	2.06	4.88
Regression without Constant	0.61	0.89	1.09	1.82

Table 8: Hypothetical Bias and Setting

		Auction	Survey
Both field and lab	WTP (% of Base)	34.6%	91.4%
	Hyp/Auc	2.64	
Field only	WTP (% of Base)	29.7%	106.8%
	Hyp/Auc	3.59	
Lab only	WTP (% of Base)	41.3%	72.3%
	Hyp/Auc	1.75	