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Consumer Willingness to Pay for Genetically Engineered Edamame

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Abstract

This study examined the effect of GM labeling on consumer willingness to pay (WTP) for edamame. It also investigated how people reacted to different messages and whether the order of receiving positive or negative information about GM technology impacted their willingness to pay (WTP). The study had three components: (1) a sensory test of GM and non-GM labeled products; (2) a non-hypothetical experimental auction to assess WTP for GM, non-GM and unlabeled products; and (3) a questionnaire to collect demographics and other information from the participants. Results of the sensory evaluation revealed no statistically significant difference between GM and non-GM edamame in terms of aroma, taste, appearance, texture and overall impression with GM edamame rated slightly higher in three of the five sensory categories. Despite no differences in these sensory attributes between GM and non-GM edamame, there was a statistically significant and large premium for non-GM edamame over the GM and unlabeled edamame products. Further, WTP for unlabeled and GM edamame were similar suggesting existence of preconceived negative notions about GM edamame. The estimated discounts for GM edamame therefore do not support GM breeding efforts for edamame at this time. Overwhelmingly, negative information about GM technology had a large negative, statistically significant impact on WTP that could not be reversed with smaller positive GM technology information effects on WTP regardless of order of information provided. However, modifying the opinion about GM technology also had a large statistically significant effect on WTP. With responses on knowledge about GM technology suggesting a poor understanding of GM technology, it may well be fruitful to educate consumers to sway their opinion toward greater GM acceptability. Targeting this message to female and younger population demographics was supported as WTP for GM edamame by women was statistically

significantly lower than WTP for GM edamame by men. By the same token WTP for GM edamame declined statistically significantly with age suggesting that younger consumers may be more accepting of GM technology than older buyers.

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Dedication

This thesis is dedicated parents and siblings for their support they have shown me throughout my life. They have always believed in me and I will always appreciate their support.

I would like to also dedicate this thesis in memory of my grandfather, Jake Evan Clements.

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Chapter 1

I. Introduction

Overview

Soybeans (*Glycine max* (L). Merr) have occupied the largest percent of crop acreage among principle competing crops of corn (*zea mays*), cotton (*gossypium hirsutum*) and rice (*oryza sativa*) in Arkansas for decades. Further, Arkansas ranks among the top 10 soybean producing states in the US with 2.8 to 3.6 million acres grown annually between 1995 and 2015 (NASS, 2016). In 41 of Arkansas's 75 counties, soybeans are produced with average yields around 50 bushels per acre. The most concentrated Arkansas soybean production occurs in the Grand Prairie region of Eastern Arkansas which is made up of Arkansas, Prairie, Lonoke, and Monroe counties. Other notable areas that grow soybeans are the Western Arkansas River Valley (Crawford, Sebastian, Logan, Johnson, Yell, Pope, Perry counties) and the Southwest Red River Valley (Little River, Miller, Hempstead, Lafayette counties). Soybeans are the world's largest source of animal protein feed (meal) and the second largest source of vegetable oil (ERS, 2012). Soybeans are used for human consumption in the forms of cooking oils, soy milk, tofu, and edamame. Genetically engineered soybeans are an increasing trend with 17% of US soybean acreage being herbicide-tolerant as of 1997 to 94% having the genetically engineered trait of herbicide-tolerance in 2014 (ERS, 2015). Soybeans grown in Arkansas and the United States are genetically modified (GM) because the use of herbicide-tolerant crops allow farmers to reduce hours controlling weeds and to decrease cost of production although herbicide drift may have forced the hand of producers with respect to this technology adoption. Since the first Round-up Ready soybean seeds were introduced in 1996, weeds have become more herbicide-resistant, and this has some farmers interested in returning to conventional soybeans and different weed control protocols. Consumer awareness of genetically modified products has also increased and many have lobbied for stricter controls on the cultivation of GM crops as well as products manufactured from these crops. Research results about consumer decision-making processes regarding genetically engineered products remain mixed and inconclusive about willingness to purchase GM foods (Salazar-Ordonez, Rodriguez-Entrena, and Becerra-Alonso, 2014). Legal developments for GM labeling are most common at the state level and could potentially alter demand with labels such as "Genetically Engineered" as a requirement on packaging. With the growing demand of soy foods in the United States and the potential for mandatory GM labeling, conventional soybeans may regain popularity among producers if domestic consumers are willing to pay higher prices for non-GM products.

This study aims to find consumer maximum willingness to pay (WTP) for an edible soybean product (edamame), to explore product labeling effects and taste differences in "genetically engineered" and Non-GMO verified food products.

Edamame

Soybeans are primarily harvested to be crushed to extract oils and meal for animal feed. Another type of edible soybean called edamame has been a popular dish in East Asia that dates back to 1300s. It is harvested green and produces a nutritious bean that is a great source of fiber, omega-3 fatty acids, micronutrients, and is low in calories (Konovsky, Lumpkin, & McClary, 1994) (See Figure 1). Edamame has seen growing sales in the US from 2004 to 2007 of 40% (Roseboro, 2012). In 2010 to 2011 the Soyfoods Association of North America reported frozen edamame sales grew 4.3%. According to an interview on CBSnews, Americans consumed between 25,000 to 30,000 tons of the frozen bean in 2012 (CBSnews, 2014). According to Kerry Clark, a soybean breeder at the University of Missouri, 97% of the edamame sold to frozen food markets have been imported from China and other Asian nations (Roseboro, 2012). In Mulberry, Arkansas, a new edamame company called American Vegetable Soybean and Edamame Inc., has been created. The company was created in 2012 to mass produce US edamame to be sold to Americans, rather than importing edamame from Asian countries like China (Magsam, 2012). Farmers in Arkansas, and other states like California, Minnesota and Ohio, are growing edamame to supply the demands from Asian restaurants and American supermarket chains like Costco, Whole Foods, and Sam's Clubs (Roelich, 2013). Mulberry, Arkansas farmers such as Mark Schluterman have seen the potential in Arkansas. Schluterman increased the 40 acres of edamame planted in 2012 to 400 acres in 2013, earning an estimated 1,000 US dollars per acre on the edamame fields (McBryde, 2014).

Genetically Engineered Labeling

There are over 50 countries in the world that require GM labeling. Neither the US nor Canada have adopted this policy and still do not require labeling. However, individual states in the US, like Connecticut, Maine, and Vermont have already voted to have GM labeling in the future. Oregon, California, and Washington proposed legislation for GM labeling (Pifer, 2014). Oregon was the first state in the US to propose "Genetically Engineered" legislation on the ballet under Measure No. 27 during their November 2002 election. The measure lost by a margin of 70-30 in favor of not requiring mandatory labeling. The US Food and Drug Administration (FDA) supports "*voluntary labeling whether foods have or have not been developed through genetic engineering, provided that such labeling is truthful and not misleading*" (FDA, 2015). The FDA has recognized that US consumers are interested in knowing if their food was produced using genetically modified breeding techniques. The arguments against labeling are the increased cost, government bureaucracy, no health or safety benefits, and special interest exemptions. Lucht (2015) argued that since the label would not give any relevant information about the product, there should not be mandatory labeling.

Literature Review

In studies like Delwaide (2014), countries in the European Union (EU) have voiced strong opinions about GM foods. EU countries have adopted policy to slow down the adoption process of biotech crops. GM crops are viewed as having a negative impact on human health and the environment (Salazar-Ordonez, Rodriguez-Entrena, & Becerra-Alonso, 2014). The US has very different views on GM crops and has adopted biotech crops of corn, soybeans, and cotton. Since GM foods are known as a new technology, many consumers assume the long-term effects are unknown. Consumers may believe that adding a GM label may not be of use when making decisions to purchase (Roe & Teisl, 2007). One study used an edible soy food, tofu, in a hypothetical choice experiment with face-to-face survey of consumers in Taiwan. The study found that GM labelling was helpful to Taiwanese tofu consumers and that preference or antipathy towards GM tofu were split (Jan, Fu, & Huang, 2006).

Eliciting consumer values for products and services in hypothetical and non-hypothetical auctions is common (Lusk & Shogren, 2007). The random n^{th} price auction allows bids to be placed by bidders without them knowing if their bid will become binding. If someone wants to act irrationally and bid a higher than usual price, they could potentially have to pay a price that is not what they are willing to pay (Lusk & Hudson, 2003). As such, the random n^{th} price auction offers advantages over other auctions in the sense that it is discourages over- or under bidding and allows auctioning of multiple products as only a single product becomes binding.

This reduces the wealth effect or impact of budgetary constraints that may results among participants bidding on multiple products.

Information attributes and a sensory test were added to the non-hypothetical auction so consumer views not only on GM labeling, but taste and information would become testable. In Nalley, Hudson, and Parkhurst (2006), consumer valuations with different information treatments influenced their decision to repeat purchase sweet potatoes products. Consumers preferred GM foods produced domestically to GM foods imported from foreign countries (Xie, Kim, & House, 2013). Individuals with information on consumer benefits, producer benfits, and environmental benefits were willing to pay more than individuals without information (Xie, Kim, & House, 2013). Soy foods have emerged in recent years as a major functional food. Non-soy users or infrequent soy users accept soy foods more readily when positive information is given with soy food purchasing decisions (Moon, Balasubramaniam, & Rimal, 2011).

Purpose of the study

The objectives of this protocol are to find consumer maximum willingness to pay (WTP) for an edible soybean product (edamame), to explore product labeling effects and taste differences in "genetically engineered" and non-GM food products. To do this, participants were asked to complete a taste test of edamame, and participate in a non-hypothetical auction, where repeated bidding (with different sets of information) allowed elicitation of maximum WTP for edamame that came from "genetically engineered" or non-GM plants grown at the Fayetteville Agricultural Experiment Station. After the auction was over, one product was randomly selected as the binding product that participants had to purchase. This study will add information about taste differences between GM and non-GM edamame products and then value what they taste. Information effects on consumer WTP for biotech crops will be tested by giving the participants negative and postitive information. The information was randomly assigned to analyze order of information effects. Pending the outcome of the study, GM edamame breeding efforts may either be encouraged or discouraged for producers in Arkansas. If labeling is found to have an effect on consumer WTP it will influence the decision to grow these varieties as labeling policies as lobbied by various organizations may require GM labeling or consumers may become suspicious of unlabeled product.

The objectives of Chapter 2 were to i) compare sensory aspects between GM and non-GM edamame; ii) estimate consumer WTP for edamame products that are labeled as GM and non-GM or without a label; iii) compare consumer mean WTP across demographic factors, opinions, and knowledge of GM technology; iv) determine what explanatory factors drive WTP; and v) examine the effect of an overall impression sensory rating on WTP for GM and non-GM edamame.

The objectives of Chapter 3 are to i) examine label effects on WTP (Unlabeled, GM, and non-GM); ii) to determine how the positive and negative information provided influenced consumer WTP after receiving no information; iii) compare consumer mean WTP across two treatments that vary in order of information given; and iv) determine what explanatory factors drive WTP when comparing the order of information treatments.

The appendix provides information about informed consent procedures including the screening survey. The appendix also summarizes questionnaire responses of the participants of the edamame auction.

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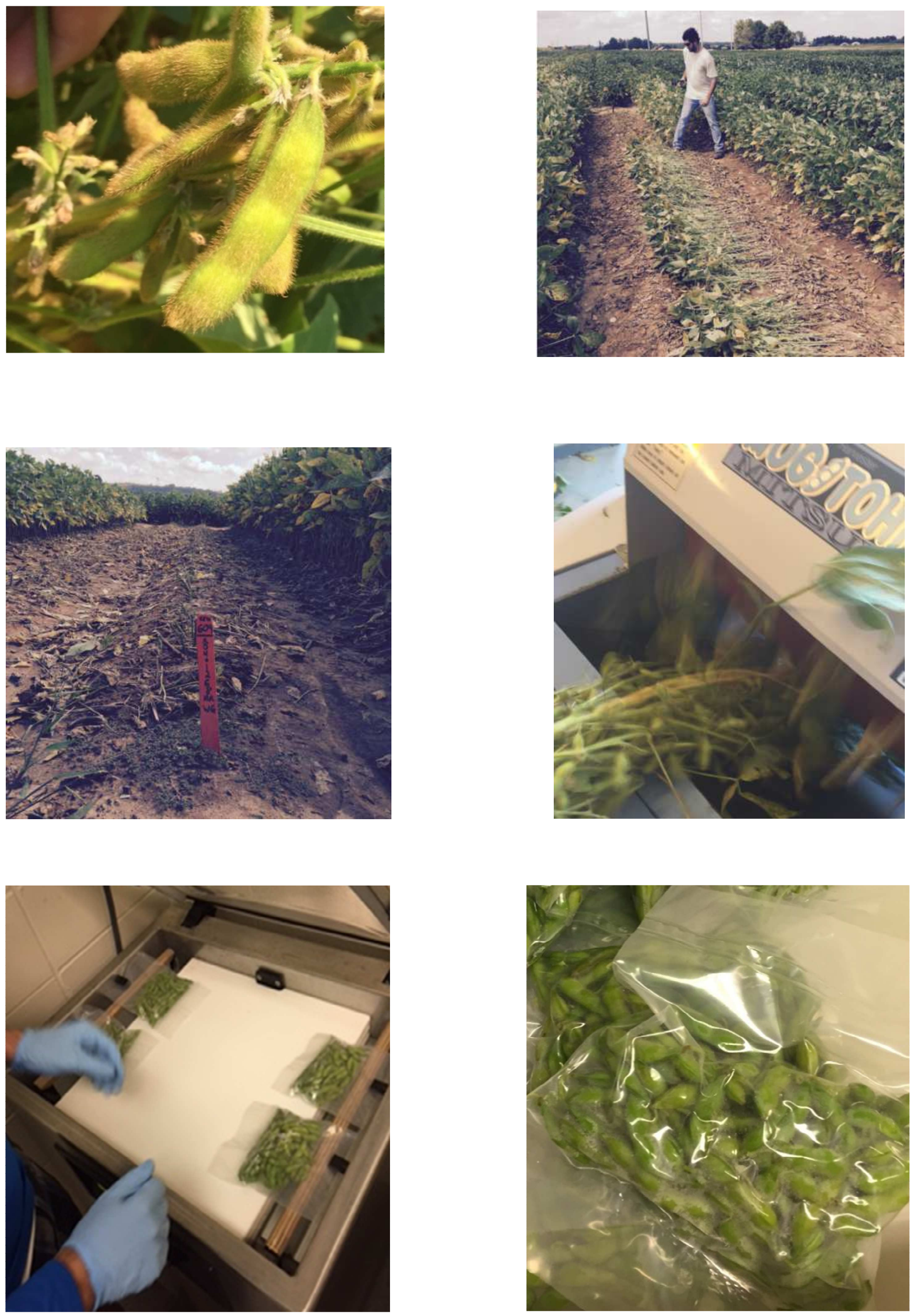
Figure 1. Edamame at various stages of processing at the Arkansas Research and Extension Center in Fayetteville, AR.



Chapter 2

Consumer Willingness to Pay for Edamame with a Genetically Modified Label

By

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II. Consumer Willingness to Pay for Edamame with a Genetically Modified Label

Abstract

Soybean (*Glycine max* (L.) Merr.) production in the US is predominantly genetically modified (GM) given economic and production advantages compared to conventional soybean. Edamame, green immature soybean bred specifically for harvest at the end of the pod filling stage, has experienced demand growth in the US. Although the technology is available to grow GM edamame, anticipated consumer resistance and labeling requirements for GM foods might have influenced the industry not to invest in GM edamame. This study examined the effect of GM labeling on consumer willingness to pay (WTP) for edamame. The study had three components: (1) a sensory test of labeled products, (2) a non-hypothetical experimental auction to assess WTP for GM, non-GM and unlabeled products, and (3) a questionnaire-based survey to collect demographics and other information from the participants. Results showed that participants expressed greater WTP for non-GM labeled edamame compared to unlabeled and GM labeled edamame. The latter two received similar bids suggesting that participants had a preconceived notion that the unlabeled product is likely to be GM. This is noteworthy since there was no difference in sensory acceptability between GM and non-GM edamame. Participants who consume edamame more often bid higher for the products than participants who consume edamame less often. Responses on knowledge and opinion questions suggested that consumer education could be an option to enhance GM acceptability. The estimated discounts for GM edamame, however, do not support GM breeding efforts for edamame at this time.

Keywords: Edamame soybean; Non-hypothetical auction; genetically modified (GM); GM labeling; willingness to pay (WTP); sensory evaluation

Highlights:

- Edamame soybean has experienced a recent demand growth in the US.
- Producers potentially interested in genetically engineered edamame to save on cost of production or enhance yield need information about consumer acceptance of GM edamame.
- WTP for non-GM edamame is significantly higher in comparison to unlabeled and GM labeled edamame in the absence of significant differences in sensory evaluations of GM and non-GM edamame.
- GM and unlabeled edamame led to similar WTP suggesting preconceived negative notions about GM among the participants.
- GM breeding efforts in edamame are not justified at this time but consumer education about GM technology may lead to enhanced GM acceptability.

Introduction

Genetically modified (GM) or genetically engineered crops are crops that have had their DNA altered in a way that does not naturally occur by reproduction (WHO, 2014). There are over 50 countries in the world that require GM labeling but neither the US nor Canada have adopted this policy. However, discussion about GM food labeling legislation is currently ongoing in the US. A number of states in the US, including Connecticut, Maine, and Vermont, have already voted to have GM labeling in the future (Pifer, 2014). The US Food and Drug Administration (FDA) supports "*voluntary labeling whether foods have or have not been developed through genetic engineering, provided that such labeling is truthful and not misleading*" (FDA, 2015). The FDA has recognized that US consumers are interested in knowing if their food is produced using GM breeding techniques. The arguments against labeling are the increased cost of labels, government bureaucracy, no health or safety benefits, and special interest exemptions. For example, the FDA believes that GM crops have no difference in composition to non-GM crops. Ronald (2011) also indicated that GM crops pose just as big a risk to human health and the environment as crops grown under conventional breeding techniques (European Commission Directorate-General for Research and Innovation 2010). Lucht (2015) argued however that since the label would not give any relevant information about the product, there should not be mandatory labeling. The FDA only requires labeling if GM food has a different nutritional property or allergen (Du, 2014). Mandatory "genetically engineered" labels could change the way that consumers value products at grocery stores.

To examine these GM labeling issues, this study focuses on edamame which is soybean (*Glycine max* (L.) Merr.) harvested near the end of the pod filling stage (Mozzoni, Morawicki, & Chen, 2009) and intended for human consumption as a vegetable. It is harvested green, and produces a nutritious bean that is a great source of fiber, omega-3 fatty acids, micronutrients, and is low in calories (Konovsky, Lumpkin, & McClary, 1994). Edamame has also been found to have anti-diabetic effects (Zang, Sato, & Igarashi, 2011). Given these nutritional properties, the demand for edamame has been increasing in recent years. It is a popular product in East Asia, and has experienced rapid sales growth of 40% in the US from 2004 to 2007 (Roseboro, 2012).

Given increasing demand for edamame, there is an incentive to produce more edamame for the US market. For example, the American Vegetable Soybean and Edamame Inc. (AVS), opened the first ever edamame processing plant in the US in 2012 to commercially produce "made in the US" edamame (McBryde, 2014). Currently, all edamame sold in the US market are non-GM. However, the soybean market for feed and oil in the US is dominated by GM soybeans. Given the increasing demand for edamame in the US, there would be an incentive to develop higher yielding soybeans that could be developed through GM to produce edamame. An interesting and important question, however, is whether there would be a market for GM edamame or whether labeling non-GM edamame as "non-GM" could command a premium in the market. This question can be answered by assessing consumer willingness to pay (WTP) for GM edamame and non-GM edamame. While there have been a number of studies that examined consumer preferences and WTP for various GM food products, no other study has examined this specific issue about edamame to our knowledge. This topic is also interesting given the recent past and current debate about GM labeling regulations in a number of states in the US.

A non-hypothetical auction was used in this study to determine whether consumers would discount edamame produced using GM seed in comparison to an unlabeled or conventionally bred, non-GM edamame. The non-hypothetical approach was employed for two main reasons. In comparison to hypothetical valuation methods 1) the products being auctioned were available for winners to physically purchase; and 2) there is well-known hypothetical bias that could arise in the use of hypothetical valuation methods, e.g., stated preference methods (Carlsson & Martinsson, 2001; Carpenter, Harrison, & List, 2005; Murphy et al., 2005; Silva et al., 2011).

A number of GM foods have been studied to test consumer willingness to pay (WTP). For example, Huffman et al. (2003) demonstrated that there was a 14% premium for non-GM vegetable oil, tortilla chips, and potatoes compared to their GM labeled counterparts. Lusk et al. (2001) also showed that 20% of respondents were willing to pay 25 cents per ounce more for the non-GM product. However they also found that 70% were not willing to pay a difference between GM corn chips over non-GM corn chips. Furthermore, people who believe GM foods have a positive effect on food quality and safety were more likely to approve of GM foods (Baker & Burnham, 2001).

Given the mixed signals on GM technology presented above, the objectives of this study were to 1) compare sensory aspects between GM and non-GM edamame; 2) estimate consumer WTP for edamame products that are labeled as GM and non-GM or without a label; 3) compare consumer mean WTP across demographic factors, opinions, and knowledge of GM technology; 4) determine what explanatory factors drive WTP; and 5) examine the effect of an overall impression sensory rating on WTP for GM and non-GM edamame. The study is original in the sense that both a sensory test and an experimental auction were performed on edamame using GM and non-GM soybean consumed as a vegetable rather than as a processed food such as soybean oil, tofu or meat from animals fed with soybean meal.

Materials and Methods

This study was conducted according to the Declaration of Helsinki for studies on human subjects. The protocol was approved by the Institutional Review Board of a major land grant university in the US. The experimental procedure was explained to all participants and a written informed consent was obtained prior to participation. Each participant was given a $25 gift card as payment for the opportunity cost associated with spending time on the experiment.

Participants

A total of 117 volunteers participated in both a sensory test and a non-hypothetical auction. Participants were recruited through the consumer profile database of the university's sensory service center. The consumer profile database contains approximately 6,200 area residents. The participants reported that they had no soy allergies and demographics of the participants are described below.

Edamame sample and preparation

Soybean grown for intended end use as feed and oil using both a GM and a non-GM cultivar were harvested at the edamame stage. Blanching and packaging took place at the university's research center located within walking distance of the soybean field. Blanching was done at 100ºC for 90s to sufficiently inactivate lipoxygenase activity before packaging (Mozzoni, Morawicki, & Chen, 2009). This step is important for the edamame pods to keep their desirable green color and textural attributes. The packages used were clear 8 oz. (237 mL) bags that were vacuum sealed after being cooled from the blanching. After sealing, the packages were labeled as GM, non-GM, and unlabeled (randomly GM or non-GM) and frozen until the auction.

Valuation measure

Applied economists are using incentive compatible experimental auctions because real world simulation requires that real money and real products are used (Lusk, Feldkamp & Schroeder, 2004; Cummings, Harrison, & Rutström, 1995; Fox et al*.*, 1998.; List & Shogren, 1998). There are many types of non-hypothetical auctions, such as Vickrey's second-price auction, the Becker-DeGroot-Marschak (BDM) mechanism, and random n^{th} price auctions (see Table 1) (Lusk & Shogren, 2007). The random n^{th} price auction was chosen over the other methods because of its ability to keep off-margin bidders engaged. An off-margin bidder is any bidder who does not feel that he/she has a chance of winning the auction (Shogren et al., 2001b). A random n^{th} price auction is an auction that allows all bids to influence the results of the auction as the second lowest bid could become binding and thereby lead to a large percentage of participants purchasing product in the auction (Lusk, 2003). In this type of auction, all participants submit a bid and these are then ranked from the highest to lowest. The auction can be multiple rounds with a variety of products for sale. A random number (n) is selected by the experimenter, from 2 to the total number of bidders in the auction. The n^{th} highest price becomes the market price. The market price (i.e., n^{th} highest bid) is the price that anyone who bids above the n^{th} highest bid has to pay. Therefore, there are (n-1) winners in this auction. If there are multiple rounds and products, then a randomly selected round and a single product can be chosen to remove wealth effects (Shogren et al., 2001a). Wealth effects would occur when participants have the potential to buy multiple products. This could make them stop bidding their true WTP given a budget constraint.

Procedure

Participants were first asked to complete a sensory test so that they had an actual experience of tasting GM and non-GM edamame before making a purchasing decision. The participants were shown the label of the two edamame samples, "GM" or "non-GM", prior to tasting the products. Similar to Wszelaki et al.'s study (2005), all participants received the two edamame samples served in a sequential monadic fashion in individual sensory testing booths. Each sample was served on a tray identified by a 3-digit randomized code. Participants were asked to rate their hedonic impression for each sample with respect to appearance, aroma, flavor, and textural attributes on a 9-point hedonic scale ranging from 1 (dislike extremely) to 9 (like extremely). Participants were also asked to provide an overall impression for each sample using the same 9-point hedonic scale. Finally, participants were asked to provide any additional comments on the samples tasted during the sensory test. Data were collected using Compusense® five (Release 5.6, Compusense Inc., Guelph, ON, Canada) software.

After completing the sensory test, the participants were asked to take part in a non-hypothetical auction to determine their WTP for edamame. The random n^{th} price auction, as described above, was used to compare and contrast WTP across the three types of edamame products: GM, non-GM, and unlabeled. The random n^{th} price auction allowed participants to provide incentive compatible bids as bidding above their true WTP would increase the likelihood of purchasing the product at an inflated price and underbidding would increase the likelihood of not obtaining the product at a profitable price (Capra, Lainer, & Meer, 2010). The auction included three rounds of bidding. In the first round, participants were told only the label of the three products. In the next two rounds, participants either received positive or negative information about GM food prior to placing their bids. The order of information was randomly assigned to the session the participants were in. After all bids were submitted, one of the three products was randomly selected as the binding product, and one of the three rounds was randomly selected as the binding round to remove wealth effects discussed above. Next, the bids were ranked from highest to lowest for the binding product. Last, a number, *n*, was randomly chosen between 2 and the number of participants in the session. The top *n-1* bidders of the binding product in the binding round were the winners. The auction winners took home the binding edamame product and paid the n^{th} highest bid price for this product in the binding round. Again, this study aimed to explain the effect of labels on the bids. Since the focus of this paper is the effect of labeling on WTP, only the first round bids were used to explain the label's effect on consumer evaluations of the edamame products. No information about the products was given in the first round. Therefore, data from the second and third round bids were not examined in this paper because of expected influenced of positive and negative information.

Before the auction, a practice candy bar auction and quiz ensured that the auction procedures were clearly understood by all participants. The practice candy bar auction was the same format as the edamame auction. The only difference was that the candy bar auction was hypothetical. The quiz asked simple questions about the rules of the auction since it is important that all participants understand the procedure and provide accurate results. The (real) non-hypothetical auction required participants to actually pay for the binding product chosen at the market price determined in the auction.

Follow-up survey

Following the auction, participants were asked to fill out a questionnaire that contained questions about their opinions and knowledge about GM food as well as their typical level of edamame consumption. A knowledge rating was assigned to each participant according to how they answered four true/false questions (Table 2). An opinion score was calculated for each participant based on how they answered six questions on GM foods (Table 3). Demographic questions regarding age, gender, household size, and income level were also included in the survey as shown in Table 4.

Data analysis

Ratings of the two edamame samples labeled GM and non-GM were compared on appearance, aroma, flavor, texture, and overall impression. A two-way analysis of variance (ANOVA) was conducted with "Edamame sample" included as a fixed effect and "consumer panel" as a random effect. The analysis was conducted using JMP 12 software (SAS Institute, Cary, NC) using a statistical significance level of $p < 0.05$.

The auction produced multiple bids from one individual. Bids with a value of zero were common either because the participant did not want the product, or the participant was not interested in paying for the product during the auction. A Tobit model was used given the data was truncated at zero. The model was designed to test for statistical significance of explanatory factors and estimated marginal effects of individual factors (Canavari & Nayga, 2009; Schott & Bernard, 2015). The y_i denoted the bid for each participant $i = 1, 2, 3\ldots, N$:

$$y_i = \begin{cases} y_i^* \; if \; y^* > 0 \\ 0 \; if \; y^* \leq 0 \end{cases}$$

and y_i^* is the latent bid where observed values were greater than 0.

$$(1) \qquad y_i^* = X_i\beta + u_i, \qquad u_i \sim N(0, \sigma^2)$$

where y_i^* or *WTP* was a function of X_i or variables hypothesized to influence *WTP*. The β's were the coefficients of each variable and were converted into marginal effects indicating the effect of a one unit change in *X* on *WTP* using STATA (StataIC v.13, StataCorp LP. College Station, TX).

Alternatively, Eq. 1 was represented as follows:

(2) $WTP = \beta_0 + \beta_1\ FEMALE + \beta_2\ AGE + \beta_3\ EDUC\ BA + \beta_4\ EDUC\ MS + \beta_5\ INC\ MID + \beta_6\ INC\ HIGH + \beta_7\ CHILD + \beta_8\ KNOW + \beta_9\ OPINION + \beta_{10}\ HHS + \beta_{11}\ CONSUMP\ HIGH + \beta_{12}\ GM + \beta_{13}\ NOGM + u$

where *WTP* is the latent bid or willingness to pay for an 8 oz. package of frozen edamame, *FEMALE, EDUC BA, EDUC MS, INC MID, INC HIGH,* and *CHILD* are demographic binary 0/1 variables on gender, education level, income level, and presence or absence of children in the household, respectively. *AGE, KNOW, OPINION,* and *HHS* are continuous variables measuring participant age, knowledge (Table 2), opinion score (Table 3), and household size, respectively, while *CONSUMP HIGH, GM*, and *NOGM* are binary 0/1 variables concerning frequency of consumption as well as labeled presence or absence of GM and *u* is the error term. These variables are further described in Table 4.

Effect of Consumption Frequency on WTP

To analyze impacts of consumption frequency on WTP, the model was estimated using the whole sample and two sub-samples on the basis of frequency of edamame consumption. In the questionnaire, respondents were asked to choose among five levels of consumption frequency in the past three months (Never, 1-5, 6-10, 11-15, 16 times or more). Hence, Eq. 2 was estimated using: 1) all responses; 2) a sub-sample of respondents who indicated up to 10 eating events over the past three months for the low frequency model specification (*CONSUMP HIGH* = 0); and 3) a sub-sample of respondents consuming edamame more than 10 times per quarter (*CONSUMP HIGH* = 1).

Effect of Overall Impression on WTP

The last two Tobit models were estimated using results of the sensory test to determine whether overall impression would impact marginal effects on WTP. Since the sensory test was only done for GM and Non-GM edamame, the WTP data on unlabeled edamame were omitted from these analyses. With the sessions, already at approximately 35 minutes, sensory testing of unlabeled product would have taken twice as long and was therefore not conducted. Similar to Eq. 2, two Tobit models were constructed to separately estimate WTP for each of the products as follows:

(3) $GMWTP = \gamma_0 + \gamma_1\ FEMALE + \gamma_2\ AGE + \gamma_3\ EDUC\ BA + \gamma_4\ EDUC\ MS + \gamma_5\ INC\ MID + \gamma_6\ INC\ HIGH + \gamma_7\ CHILD + \gamma_8\ KNOW + \gamma_9\ OPINION + \gamma_{10}\ HHS + \gamma_{11}\ CONSUMP\ HIGH + \gamma_{12}\ GMLIKE + \varepsilon$

(4) $NOGMWTP = \rho_0 + \rho_1\ FEMALE + \rho_2\ AGE + \rho_3\ EDUC\ BA + \rho_4\ EDUC\ MS + \rho_5\ INC\ MID + \rho_6\ INC\ HIGH + \rho_7\ CHILD + \rho_8\ KNOW + \rho_9\ OPINION + \rho_{10}\ HHS + \rho_{11}\ CONSUMP\ HIGH + \rho_{12}\ NOGMLIKE + \lambda$

The independent variables were the bids for the GM product in Eq. 3 and Non-GM bids in Eq. 4, respectively. In addition to the explanatory variables already described in Eq. 2, overall impression scores for the GM (*GMLIKE*) and the Non-GM (*NOGMLIKE*) edamame were added to Eq. 3 and Eq. 4, respectively.

Results

Participant demographics

Table 4 summarizes participant demographic profiles. The minimum age of the participants was 25 and the maximum age was 54, with an average age of 39. About half of the participants had children in the household. The participants were comprised of 75% women and 25% men.

Approximately 50% of the participants had less than a Bachelor's degree, while 25% had a Bachelor's degree, and 25% had a Graduate degree. The largest household size was 7, while the average household size was 2.79. Monthly income of the participants was divided into three groups, *INC HIGH* (more than $6,000), *INC MID* ($3,000-$5,999), and the baseline (less than $2,999). Consumption frequencies showed 57% of participants consuming more than 10 servings per quarter with the remainder consuming less.

The demographics of the high consumption and low consumption groups were similar except that the education level of infrequent edamame consumers was skewed toward higher education compared to participants who ate edamame more often (Table 4). Higher frequency edamame consumers also had higher income when compared to the low consumption subsample. Finally, high frequency of consumption was more common in larger families with children.

Comparisons in hedonic impression for edamame samples

Hedonic impressions of the two edamame samples, labeled GM and non-GM edamame, were compared with respect to appearance, aroma, flavor, texture, and overall impression. As shown in Figure 1, the responses to the two edamame samples appeared quite similar. The hedonic ratings did not significantly differ in terms of appearance ($p = 1.00$), aroma ($p = 0.15$), flavor ($p = 0.72$), texture ($p = 0.21$), as well as overall impression ($p = 0.26$). In sum, there was no statistically significant effect of GM label claims on hedonic impression for edamame samples. Answers to the open-ended question regarding sensory preference revealed similar results. Most of the respondents seemed to be indifferent to choosing one product over the other as revealed in responses such as: "*I felt that both are same in taste*," "*They both had the same flavor to me*," and "*Both samples seemed the same to me*." However, some participants may have made a decision based on preconceived opinions about GM foods. For example, one participant typed "*While I don't like the IDEA of GM, I do like the product a little better*." Another respondent who chose non-GM stated, "*I believe it said the first sample was non-GM so I would prefer that*." Nonetheless, the majority concluded that the products were similar in all product attribute categories.

Effects of gender, education and income level on WTP for GM labeled edamame

Figure 2 presents the empirical means of WTP for the three products. Participants were generally willing to pay significantly more for non-GM than unlabeled product (at least 42 cents based on marginal effects) (Table 5). The unlabeled and GM products were very similar in terms of empirical WTP means (Figure 2) and marginal effects from the regression model (Table 5). The empirical mean difference between non-GM and GM products was 49 cents. The empirical mean difference between unlabeled and GM products was 5 cents. Men had a higher WTP for the three products than women (Figure 2).

Figure 2 revealed higher empirical WTP means for the non-GM product in the low education sub-group. With a MS degree level education or higher, WTP bids were lower for all three products when compared to the two lesser educated participant categories. Low-, middle-, and high- income groups all had higher mean bids for the non-GM edamame compared to the unlabeled or GM product (Figure 2). The middle income group had the highest mean bids for all three products when compared to low and high income groups.

The results suggest that consumers would value a non-GM labeled edamame product more than a GM labeled or unlabeled edamame product. Interestingly, not labeling the product led to nearly the same discount as GM relative to non-GM, even though unlabeled product could be either GM or non-GM in this study. Labeling is thus in the interest of the producer as currently all US produced edamame sold in the US market is non-GM.

Effect of edamame consumption level on WTP for GM labeled edamame

Table 5 shows the three TOBIT models (All, High Consumption, and Low Consumption) that were estimated to evaluate whether results would vary across participants with low *vs.* high consumption frequency. Estimating Eq. 2 using subgroups as indicated above would test for a possible interaction between consumption levels and the other explanatory variables. Results suggest that both groups of participants were generally willing to pay significantly more for a non-GM product than the unlabeled product (at least 44 and 42 cents based on marginal effects) (Table 5). Marginal effect values for unlabeled and GM products were not significantly different among the three models specified. However, there was statistical significance among the high frequency consumption respondents in the income groups. More specifically, a high frequency consumer of edamame that is in the middle income group is willing to pay 68 cents more than a participant in the low income group, and a participant in the high income group is willing to pay 82 cents more than a participant in the low income group (Table 5) indicating a positive income effect for high frequency consumers that was not statistically significant in the model using all observations. Also, for each additional member of the household, a high frequency consumer of edamame is willing to pay 40 cents less for edamame. Participants that frequently consume edamame were thus possibly looking for quantity discounts. Participants in the low frequency consumption group with high knowledge of GM foods bid 18 cents more per correctly answered question based on the marginal effects. Providing consumer education about GM technology may therefore lead to positive WTP effects.

The effect of overall impression on WTP

The overall impression of the two products in the sensory test was added to Eq. 2 to evaluate the impact of sensory aspects on WTP. Table 6 shows the results of the two models estimated.

The GM edamame model had four statistically significant marginal effects: 1) household size negatively affected bids suggesting again that participants looked for quantity discounts; 2) the presence of children in the household, however, resulted in an increase in bids which may be a result of participant awareness about health effects of edamame or participants being more interested in buying edamame as their children like the product; 3) as expected, the opinion rating about GM technology negatively impacted bids in the sense that those with a less favorable attitude toward GM technology bid less that those with a more favorable inclination toward GM products; and 4) the overall impression of the GM edamame in the sensory test had a positive effect on WTP, was statistically significant at the $p < 0.01$ level and large. This may suggest that participants were surprised that the GM product was similar in taste to the non-GM product.

For the second model evaluating overall impression ratings on non-GM edamame, the coefficient estimate on the *NOGMLIKE* was not statistically significant, of the anticipated sign and much smaller than for *GMLIKE*, the GM counterpart. This result strengthens the claim that participants may have had a preconceived notion about non-GM edamame in the sense that overall impression did not impact WTP. Consumer acceptance of edamame as revealed in the statistically significant premium for those consumers eating edamame on a frequent basis may have absorbed the effect of overall impression on WTP.

Discussion

To determine the effects of GM labeling, a sensory test, followed by a non-hypothetical auction and a questionnaire, were used to elicit effects on WTP for edamame. The results showed that in the presence of labeled non-GM product, an unlabeled product would be valued similarly as a GM labeled product. It is therefore in the interest of the producer to label edamame, as all US produced edamame sold in the US is non-GM. This holds as long as the premium is higher than the labeling cost (easily so in this case). Further, the findings of a non-GM premium were the same across all subgroups tested (e.g., all vs. high consumption vs. low consumption as well as participant groups separated by gender, education and income level). This finding has significant implications for GM labeling policy since presence of credible non-GM labeling would generally mean that an unlabeled or GM product counterpart would be significantly discounted in the market. This finding is similar to Huffman et al. (2003) were a 14% premium for non-GM vegetable oil, tortilla chips and potatoes was found compared to the GM labeled products. Likewise, in Lusk et al. (2001) a 25 cent per ounce premium was found for non-GM corn chips.

Melton et al. (1996) showed that taste can positively influence participant preferences and bids. Similar highly statistically significant results of large magnitude, albeit using overall impression ratings, were found in this study for the GM edamame. For non-GM edamame, however, the effect was much smaller and not statistically significant. Hypothesized preconceived negative notions about consumer opinion on safety or nutrition associated with GM are similar to findings of Lusk and Briggeman (2009) who suggest that GM labeling effects had a more important impact on WTP than taste.

Conclusion

Given the significantly higher WTP values observed for non-GM labeled edamame compared to GM-labeled edamame, producers may be advised to label edamame as non-GM, especially since no GM edamame is currently available in the US market. At the same time, the added non-GM labeling could command a premium for the product as higher prices can be attached to the product without modifying the product. Interestingly, additional results suggest that knowledge of and opinions about GM products showed weak statistically significant effects in a direction that could lead to greater eventual acceptance of GM foods. Consumer education about GM foods could thus potentially help lessen the negative WTP effects associated with GM and unlabeled edamame in comparison to non-GM edamame.

Future work on this project will determine what type of information (positive or negative) about GM edamame will influence consumer WTP across the three product categories. The robustness of the findings could be improved with replication of the procedures in other areas of the US, different countries, or over the course of time. A future study could also include a group that did not participate in the sensory test. This would allow comparison of results to determine if the sensory test had an impact on WTP.

Finally, with estimated retail price discounts for GM products, yield improvement with GM edamame and likely, to a lesser extent, production cost savings in comparison to non-GM edamame, are not expected to be large enough to justify GM edamame breeding efforts at this time.

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Table 1. Comparisons of three auctions types, BDM, Vickery's Second Price Auction, and Random nth Price Auction.

Auction Type	**BDM**	**Vickery's Second-Price**	**Random *n*th Price**
Procedures:	Individual participants submit a bid. If bid > market price, pay market price	Simultaneous bids are collected from each participant. Highest bidder pays market price	Simultaneous bids are collected from each participant, if bid > market price, pay market price
Market Price:	Price is randomly selected	Second highest bid.	Random n is chosen, the n^{th} highest bid is the market price
Winners:	Each individual has an opportunity to win	1	n - 1
Strengths	Ability to test consumer's in natural settings (grocery stores)	Preparation for experiment is easy with only one product needed per session	Any bidder can influence the results of the auction. Everyone should feel engaged
Weaknesses	Individuals do not get the opportunity to compete against each other	Low bidders know they will not influence the results	Very complex and take longer to sort bids. Amount of product needed is random.

Sources: Lusk and Shogren (2007) and Lusk (2003)

Table 2. Question used to form knowledge variable towards GM technology.

Question	True[a]	False	Not Sure
Planting RoundUp Ready® soybean allows farms to grow soybean and spray RoundUp® herbicide to control weeds without killing soybean whereas using RoundUp® herbicide on conventional (Non-genetically engineered soybean) would not only kill weeds but also the conventional soybean.	● 1	o 0	o 0
Some soybean oil sold in the U.S. is derived from Roundup Ready® soybean.	● 1	o 0	o 0
In addition to Roundup Ready® soybean, other genetically engineered crops are currently grown in the U.S.	● 1	o 0	o 0
Chemicals in RoundUp® herbicide remain effective for weed control in the soil forever.	o 0	● 1	o 0

Notes:

[a] The knowledge rating is the sum of correct answers. (4 being all correct and 0 being all wrong).

Table 3. Question used to form opinion variable towards GM technology.

Question[a]	Strongly Agree[b]	Somewhat Agree	Somewhat Disagree	Strongly Disagree
Genetically engineered food such as Roundup Ready® Soybeans present no danger for future generations.	o 1	• 2	o 3	o 4
I think it is safe for me to eat genetically engineered food.	o 1	o 2	• 3	o 4
Physical harm to mankind is bound to happen as a result of genetically engineered foods.	o 4	o 3	• 2	o 1
Growing genetically engineered crops will be harmful to the environment.	• 4	o 3	o 2	o 1
There are benefits to developing genetically engineered foods such as higher yields and a more sustainable food source.	o 1	o 2	• 3	o 4
Small-scale farmers are negatively impacted by the development of genetically engineered foods as the cost of seed will be higher.	o 4	o 2	o 3	• 1

Notes:

[a] Information about the knowledge statements was sourced from Riar et al. (2011), Norsworthy et al. (2011) and Nalley et al. (2012).

[b] The opinion score is the average of values assigned to each of the agreement levels for each statement. The score represents a summary of all rankings for each statement. Note that some statements are reverse scored to reflect a consistent estimate of concerns over genetically engineered food (Spector, 1992). Participants with an average opinion score of 1 are in favor of genetically engineered food whereas a score of 4 reveals the opposite.

Table 4. Summary of variables for all responses vs. high (> 10 times per quarter) and low (<= 10 times) edamame consumption.

		All		*High Consumption*		*Low Consumption*	
Variable	**Definition**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Gender (FEMALE)	1 if female, 0 if male	0.748		0.714		0.773	
Age (AGE)	Age in years	38.59	25-54	39.38	28-54	38.02	25-54
Less than Bachelor's Degree	Baseline	0.496		0.510		0.485	
Bachelor's Degree (EDUC BA)	1 if Bachelor's Degree earned; 0 otherwise	0.252		0.286		0.227	
Graduate Degree (EDUC MS)	1 if MS Degree or higher; 0 otherwise	0.252		0.204		0.288	
Up to $2,999 per month	Baseline	0.396		0.240		0.500	
$3,000-$5,999 (INC MID)	1 if $3,000-$5,999; 0 otherwise	0.421		0.480		0.375	
More than $6,000 (INC HIGH)	1 if More than $6,000; 0 otherwise	0.193		0.280		0.125	
Children (CHILD)	1 if children < 18 years old living at home; 0 otherwise	0.496		0.592		0.424	
Knowledge (KNOW)	See Table 2	2.27	0-4	2.28	0-4	2.27	0-4
Opinion (OPINION)	See Table 3	2.58	1.3-4	2.61	1.7–4	2.55	1.3-3.7
Number in Household (HHS)	# of people living in house	2.79	1-7	3.20	1-7	2.49	1-5
Consumption Frequency (CONSUMP HIGH)	1 if more than 10 servings per quarter; 0 otherwise	.427		0		1	
Overall Impression							
(GMLIKE)	1 if dislike extremely to 9 like extremely	6.26	2-9				
(NOGMLIKE)		6.07	2-9	na		na	
Number of observations		117		50		67	

Table 5. Average marginal effects of the TOBIT model by consumption frequency. All responses vs. high (> 10 times per quarter) and low (<= 10 times) edamame consumption.

	All (N = 117)		High Consumption (N = 50)		Low Consumption (N = 67)	
Variables[a]	ME[b] (dy/dx)	*p*-value	ME (dy/dx)	*p*-value	ME (dy/dx)	*p*-value
FEMALE	-0.030	0.892	-0.069	0.831	0.039	0.885
AGE	-0.005	0.701	-0.008	0.702	0.006	0.659
EDUC BA	0.004	0.988	-0.588	0.085*	0.589	0.112
EDUC MS	-0.213	0.371	-0.422	0.290	-0.161	0.566
INC MID	0.218	0.341	0.683	0.035**	-0.090	0.749
INC HIGH	0.064	0.823	0.824	0.029**	-0.631	0.047**
CHILD	0.307	0.249	0.816	0.071*	-0.017	0.954
KNOW[c]	0.043	0.596	-0.178	0.159	0.187	0.073*
OPINION[c]	-0.177	0.379	0.049	0.872	-0.117	0.664
HHS	-0.173	0.101	-0.406	0.012**	0.005	0.971
CONSUMP HIGH	0.329	0.103				
GM	0.003	0.962	-0.165	0.107	0.119	0.162
NOGM	0.427	0.000***,	0.442	0.000***	0.428	0.000***

Notes:

[a] See Table 4 for variable descriptions

[b] Marginal effects are the partial derivative of WTP with respect to *X* from Eq. 2.

[c] See Tables 2 and 3 for knowledge and opinion variables.

[d] *, ** and *** represent statistical significance at $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Table 6. Average marginal effects of the TOBIT model by Genetically Modified (GM) and non-GM product including overall impression obtained in the sensory test.

	GM Edamame (N = 117)		Non-GM Edamame (N = 117)	
Variables[a]	ME[b] (dy/dx)	*p*-value	ME (dy/dx)	*p*-value
FEMALE	0.090	0.680	-0.095	0.706
AGE	-0.003	0.828	-0.010	0.483
EDUC BA	0.115	0.657	-0.083	0.775
EDUC MS	-0.321	0.244	-0.321	0.247
INC MID	0.072	0.753	0.216	0.418
INC HIGH	0.126	0.676	0.070	0.837
CHILD	0.525	0.053*	0.077	0.802
KNOW[c]	0.049	0.552	0.033	0.729
OPINION[c]	-0.355	0.078*, [d]	0.083	0.722
HHS	-0.177	0.100*	-0.140	0.248
CONSUMP HIGH	-0.045	0.823	0.425	0.064*
GMLIKE	0.257	0.000***	na	na
NOGMLIKE	na	na	0.030	0.700

Notes:

[a] See Table 4 for variable descriptions

[b] Marginal effects are the partial derivative of WTP with respect to *X* from Eq. 2.

[c] See Tables 2 and 3 for knowledge and opinion variables.

[d] *, ** and *** represent statistical significance at $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Figure 1. Mean comparison of hedonic impression for the two edamame samples labeled with genetically modified (GM) edamame and non-GM edamame.

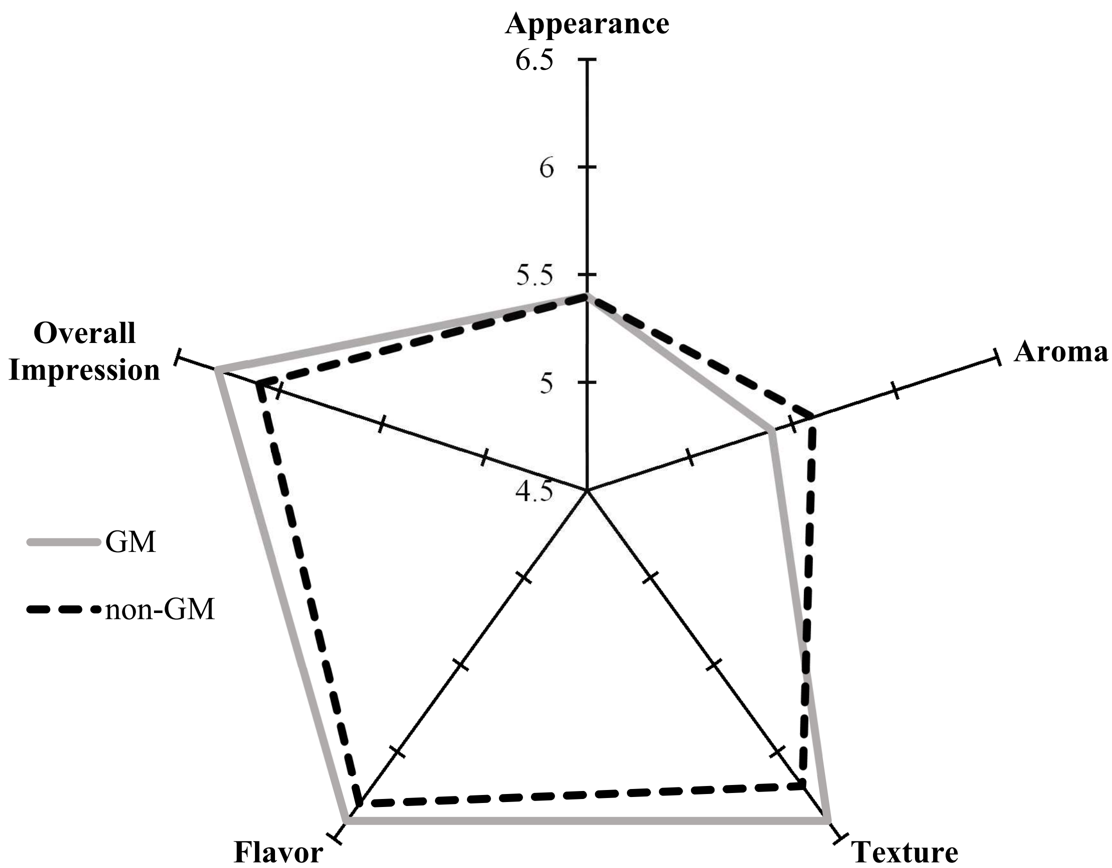
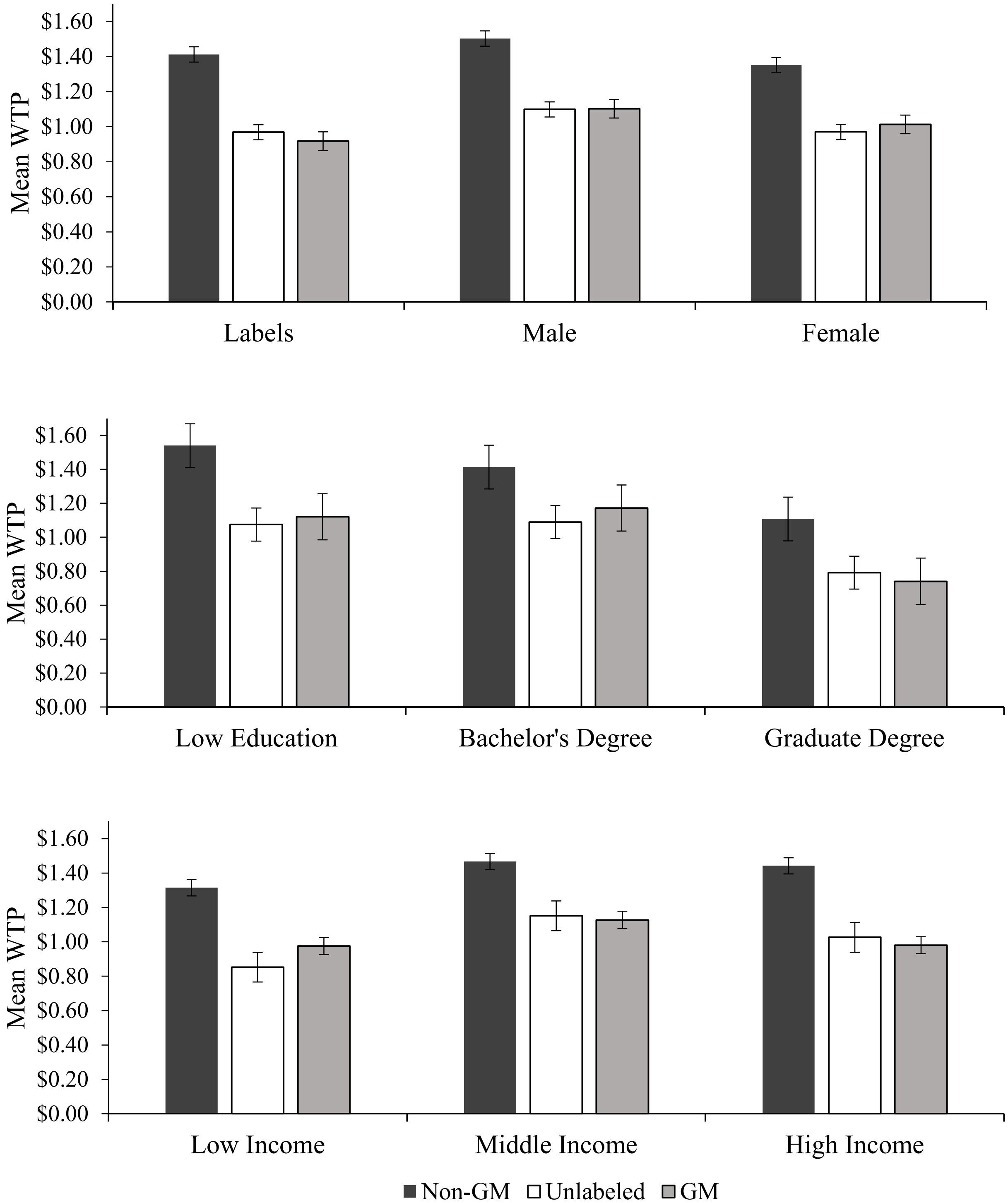


Figure 2. Mean comparisons of willingness to pay for edamame samples with three different label conditions with respect to demographics such as gender, education, and income level. Error bars represent the standard error of the means.



Chapter 3

Willingness to Pay for Edamame: GM Technology, Message Type and Order Effects

By

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II. Willingness to Pay for Edamame: GM Technology, Message Type and Order Effects

Abstract

With debate over mandatory genetically modified (GM)-labeling intensifying, decision makers need information on how people will react to different messages and whether the order of receiving positive or negative information on GM technology impacts their willingness to pay (WTP). In this study, WTP for GM, non-GM and unlabeled edamame are compared to examine this issue using a non-hypothetical, random n^{th} price auction. Participants in the study were randomly assigned to two treatments: one where the positive information is presented before the negative information and another where the negative information is presented before the positive information. The WTP for edamame with a non-GM label was not statistically significantly influenced by the positive or negative information concerning GM technology. However, the WTP for both unlabeled and GM-labeled products declined with negative information about GM that outweighed any positive information. A large marginal effect of consumer opinion toward GM technology suggested that educational efforts on GM technology is needed and may be targeted toward women and younger target audiences.

Introduction

Information about new and existing technologies can influence consumer viewpoints and their purchasing behavior. Currently, there are a lot of negative messages about genetically modified (GM) foods in the popular press and positive messages from agricultural biotech stakeholders. When introducing new products in such an environment, the question of whether one should i) avoid a controversial issue in a product attribute and react to potential negative backlash later or ii) confront the issue by providing positive information first and potentially drawing negative attention to the issue, is often a difficult decision. Hence, information about the impact of the order in which positive or negative messages is received can be helpful for product managers facing this issue as it is uncertain how consumers will react to negative or positive information. To that point, this study focuses on edamame, which is soybean harvested at the pod filling stage and consumed as a vegetable either as the seed or served as the whole pod. Edamame has been experiencing recent sales growth in the US and is being commercially processed in the US using exclusively non-GM edamame cultivars. Breeding efforts toward GM edamame, to lower cost of production, increase yield, or enhance other desirable product characteristics, have not led to GM edamame sales in the US as breeders, processors, and retailers may be worried about potential GM backlash.

Wolfe et al. (2016) performed sensory analyses, a non-hypothetical, random n^{th} price auction and a follow up survey using 117 study participants to show that willingness to pay (WTP) indeed declined for GM labeled and unlabeled edamame in comparison to non-GM labeled edamame. They concluded that the price discount for GM labeled and unlabeled edamame was large enough to discourage GM breeding efforts even though sensory evaluation of the GM and non-GM edamame revealed no statistically significantly different results. With this GM label effect present and consumers interested in knowing if their food was produced using GM breeding techniques, the question then of whether to mandate GM labeling in the US is controversial. Given that the FDA supports "*voluntary labeling whether foods have or have not been developed through genetic engineering, provided that such labeling is truthful and not misleading*" (FDA, 2015), the labeling issue for edamame is interesting as i) currently there are no GM edamame varieties and adding a non-GM label would lead to needlessly higher prices for consumers, at least in the short run; and ii) the product is a relatively newly introduced vegetable product for US consumers. Wolfe et al.'s (2016) findings are consistent with other GM label studies (Baker & Burnham, 2001; Huffman et al. 2003; Lusk et al. 2001) and hence, the question of how information about GM technology could be used to i) alter WTP or ii) reverse negative information effects on WTP by providing positive information about GM technology, is an interesting issue.

Using a large scale US survey, the Pew Initiative on Food and Biotechnology (2001) found that over half of the respondents had little experience talking about GM foods or biotechnology. Findings such as this have influenced economists to conduct valuation experiments to test whether consumer WTP values are influenced by information about GM technology given during WTP experiments (e.g., Rousu et al. 2002; Lusk et al. 2004b; and Xie, Kim, and House, 2013). For example, Rousu et al. (2002) used different sets of positive information, negative information, and both types of information to elicit WTP values for GM labeled oil, chips, potatoes, and their unlabeled counterparts using a random nth price auction. The positive message for GM technology created a small premium of less than 1% for the three GM labeled products compared to the unlabeled products. GM labeled foods were discounted by 35% relative to the unlabeled products when negative information was provided, however. The combined information of positive and negative information decreased the discount for GM labeled product from 35% to 22% (Rousu et al. 2004). Lusk et al. (2004b) also tested different categories of positive information about GM technology with consumers in the US, UK, and France. In their willingness to accept (WTA) study, the minimum amount of money needed for participants to trade a non-GM cookie for a GM cookie was elicited. They found that in the US, consumers from Texas, California, and Florida would trade their non-GM cookie for less money after they received positive information than when they had not yet received the information. For example, Texas participants decreased their WTA by 4% when given information about the increase of food supply with GM technology. When presented with environmental and health benefits of GM technology, the mean WTA for US participants decreased by 46% and 40%, respectively. Likewise, an experiment about consumer, producer, and environmental benefits on WTP for GM apples in a choice experiment (Xie, Kim, and House, 2013) led to increases of $0.24, $0.88, and $1.21 per pound of apples, respectively, when compared to uninformed bids.

In this study, the effect of positive and negative information about GM technology and the order in which the information is presented is analyzed using participant bids for GM and non-GM edamame. The objectives are i) to examine label effects on WTP (Unlabeled, GM, and non-GM); ii) to determine how the positive and negative information provided influenced consumer WTP after receiving no information; iii) compare consumer mean WTP across two treatments that vary in order of information given; and iv) determine what explanatory factors drive WTP when comparing the order of information treatments.

Materials and Methods

Before the experiment started, instructions were explained and participants were required to sign an informed consent form. Once the experiment was completed, each participant was given a $25 gift card as payment for the opportunity cost associated with spending time on the experiment.

Participants

Participants were randomly recruited from a relatively large consumer profile database. The only requirement for participants was that they have no soy allergies. A sensory test, the auction and a follow-up survey were completed by 117 participants. Table 1 shows the demographic profiles of the participants across the two information treatment groups in this study.

Edamame sample and preparation

GM and non-GM soybeans, using cultivars exhibiting similar pod and seed size at the end of the pod filling stage, were grown near the land grant university's sensory research center and were harvested at the edamame stage. Once harvested, the edamame was i) blanched at 100ºC for 90 seconds to sufficiently inactivate lipoxygenase activity before packaging to keep the edamame pods' desirable green color and textural attributes (Mozzoni, Morawicki, & Chen 2009); ii) packaged in clear, 8 oz. (237 mL) bags containing approximately 40-50 pods; and iii) vacuum sealed. The packages were then frozen and labeled as GM, non-GM, and unlabeled. Unlabeled product was randomly filled with GM or non-GM edamame.

Valuation measure

Non-hypothetical auctions are now one of the most popular valuation methods used by applied economists. These non-hypothetical auctions are often called incentive compatible and have been studied in many experiments (Lusk, Feldkamp & Schroeder, 2004a; Cummings, Harrison, & Rutström, 1995; Fox et al*.,* 1998.; List & Shogren, 1998). In this study, we use the random n^{th} price auction because of its ability to keep off-margin bidders engaged (see Table 2). A participant who does not feel that they have a chance of winning the auction is considered an off-margin bidder (Shogren et al., 2001b). In a random n^{th} price auction, everyone participating places a confidential bid on the item or items being auctioned. The bids are then ranked from highest to lowest. A random number (n) is selected by the experimenter, from 2 to the total number of bidders in the auction. The n^{th} highest price becomes the market price that anyone who bids above it has to pay. Therefore, there are (n-1) winners. Further, if there are multiple rounds and products in the auction, a binding round and a binding product can be selected to keep participants from having to buy multiple products during multiple rounds. This broadens the array of comparisons that can be performed and lessens wealth or demand reduction effects associated with having to buy many products (Shogren et al. 2001a).

Procedure

A short summary of the experimental procedures was read aloud to the participants in each session. Using a framework similar to Wszelaki et al.'s study (2005), the sensory test was conducted first to allow each participant to taste the GM and non-GM edamame. All participants received the two products individually in a sensory testing booth. Each sample was served on a tray identified by a 3-digit randomized code with the "GM" or "non-GM" label on the computer monitor in front of the participant. A hedonic impression was created for each sample with respect to appearance, aroma, flavor, and textural attributes as well as an overall impression rating on a 9-point hedonic scale ranging from 9 (like extremely) to 1 (dislike extremely). A *GM PREF* variable was created by subtracting the non-GM overall impression score from the GM overall impression rating (see Table 1) to include sensory information as an explanatory variable for WTP.

Following the sensory test, a hypothetical candy bar auction and quiz were used as teaching instruments before the random n^{th} price auction of the unlabeled, non-GM, and GM edamame products to make sure that all participants clearly understood the auction mechanism and procedures. A candy bar auction, of the same format as the eventual edamame auction aside from actual payment for and distribution of the candy bars, was used to help the participants understand the procedures to enhance the likelihood of collecting accurate bids for the edamame auction.

As depicted in Table 3, the participants were randomly assigned to two treatments. The random nth price auction contained three rounds. Three products were simultaneously auctioned in each round: unlabeled edamame, non-GM labeled edamame, and GM labeled edamame. In the first treatment, no information was given in the first round (i.e., participants only were shown the three products with no information provided), then positive information was given in the second round, and then negative information was given in the third round. In the second treatment, no information was given in the first round, then negative information was given in the second round, and then positive information was given in the third round.. To avoid wealth effects, one of the three products was randomly chosen as the binding product after the three auction rounds. Similarly, one of the three rounds was randomly chosen as the binding round. Hence, only the winners of the binding product in the binding round received and paid for the binding product. As mentioned earlier, the price paid by the winners is the randomly chosen nth highest bid for the binding product. This price was incentive compatible as the procedure discouraged paying more than what a participant was willing to pay when bidding truthfully, and, likewise, underbidding could lead to not obtaining the product at a profitable price (Capra, Lainer, & Meet, 2010). While winners were only selected for one product and one round, all bids were used as data for the WTP study. Since participants received positive or negative information in the second and third rounds, the bids were expected to be influenced by information effects. The effects of the information on WTP and the order of the information on WTP were thus testable.

Follow-up survey

Demographic questions about gender, age, education level, presence of children in the household, knowledge of GM foods, opinion on GM foods, number of people in the household, and frequency of quarterly edamame consumption were collected after the auction was complete using a paper survey. The questions used to measure knowledge of and opinions about GM food are exhibited in Tables 4 and 5.

Data analysis

The auction produced a total of nine bids (3 products in 3 rounds) from each participant. Bids with a value of zero were common either because the participant did not want the product, or the participant was not interested in paying for the product during the auction. A random effects Tobit model was used given the data were truncated at zero and of panel data in nature. The model was designed to jointly test for statistical significance of the information between the two information treatments (positive first and negative first) and impact of other explanatory variables that were hypothesized to impact WTP. The y_i denoted the bid for each participant $i = 1, 2, 3\ldots, N$:

$$y_i = \begin{cases} y_i^* \; if \; y^* > 0 \\ 0 \; if \; y^* \leq 0 \end{cases}$$

and y_i^* is the latent bid where observed values were greater than 0. Latent bids were regressed against explanatory variables X_i to measure their effect on bids

(1) $y_i^* = X_i\beta + u_i, \qquad u_i \sim N(0, \sigma^2)$

which can be expressed alternatively as follows for each of the three products:

(2) $NOLABEL\ WTP = \beta_0 + \beta_1\ POSITIVE + \beta_2\ NEGATIVE + \beta_3\ FEMALE + \beta_4\ AGE + \beta_5\ EDUC\ BA + \beta_6\ EDUC\ MS + \beta_7\ INC\ MID + \beta_8\ INC\ HIGH + \beta_9\ CHILD + \beta_{10}\ KNOW + \beta_{11}\ OPINION + \beta_{12}\ HHS + \beta_{13}\ CONSUMP\ HIGH + \beta_{14}\ GM\ PREF + \zeta$

(3) $NO\ GM\ WTP = \gamma_0 + \gamma_1\ POSITIVE + \gamma_2\ NEGATIVE + \gamma_3\ FEMALE + \gamma_4\ AGE + \gamma_5\ EDUC\ BA + \gamma_6\ EDUC\ MS + \gamma_7\ INC\ MID + \gamma_8\ INC\ HIGH + \gamma_9\ CHILD + \gamma_{10}\ KNOW + \gamma_{11}\ OPINION + \gamma_{12}\ HHS + \gamma_{13}\ CONSUMP\ HIGH + \gamma_{14}\ GM\ PREF + \varepsilon$

(4) $GM\ WTP = \rho_0 + \rho_1\ POSITIVE + \rho_2\ NEGATIVE + \rho_3\ FEMALE + \rho_4\ AGE + \rho_5\ EDUC\ BA + \rho_6\ EDUC\ MS + \rho_7\ INC\ MID + \rho_8\ INC\ HIGH + \rho_9\ CHILD + \rho_{10}\ KNOW + \rho_{11}\ OPINION + \rho_{12}\ HHS + \rho_{13}\ CONSUMP\ HIGH + \rho_{14}\ GM\ PREF + \lambda$

The β's, γ's, and ρ's or the coefficients of the independent variables were converted into marginal effects indicating the effect of a one unit change in *X* on *WTP* using STATA (StataIC v.13, StataCorp LP. College Station, TX). Further, *NOLABEL WTP*, *NO GM WTP*, or *GM WTP* were the latent bids or WTP for an 8 oz. package of frozen edamame which was unlabeled or labeled non-GM and GM, respectively. The information treatment effect was captured using binary variables of *POSITVE* and *NEGATIVE* as shown in Table 3. Demographic variables, *FEMALE, EDUC BA, EDUC MS, INC MID, INC HIGH,* and *CHILD* were binary 0/1 variables on gender, education level, income level, and presence or absence of children in the household, respectively. Participant age, knowledge, opinion and household size were measured using continuous variables *AGE, KNOW* (Table 4)*, OPINION* (Table 5)*,* and *HHS*, respectively, while *CONSUMP HIGH* is a binary 0/1 variable concerning frequency of consumption in the past three months, and *GM PREF* is a measure of differential overall impression from the sensory test with positive/negative values indicating a preference for GM/non-GM edamame, respectively. Error terms for each equation were ζ, ε, and λ. Information about the explanatory variables is summarized in Table 1. Bids from each treatment (positive first or negative first) were divided into their own models so a comparison could be made across treatments. Hence, results of Eqs. 2 to 4 were separately summarized by order of information to make comparisons across information treatment.

Results

Participant demographics

Statistical comparisons of subsamples of participants randomly assigned to the positive first or negative first information treatments showed the subsamples to have the same characteristics (Table 1) at $p < 0.05$. Hence, the randomization procedure appears to have successfully balanced the observable covariates across the two treatments.

Effects of information on non-parametric average WTP by product

As mentioned above, the two treatments differed only in the order of information given before the second and third rounds (Table 3). The unlabeled, non-GM labeled, and GM labeled edamame product mean bids, with and without the zero bids, are reported in Figure 1.

Unlabeled

The unlabeled product had very irregular results as the positive information first treatment lead to a reduction in WTP from 89 to 87 cents and increased back to 94 cents after negative information was provided (Figure 1 including zero bids). For the negative information first treatment, however, results were as expected and reduced WTP by 12 cents with negative information. Subsequently adding positive information subtracted 2 cents (Figure 1 including zero bids). These results are not unexpected as the participants did not know whether the edamame in the package was in fact GM or non-GM. Similar irregular trends were observed when zero bids were excluded. There were a total 135 zero bids across all rounds for unlabeled edamame or approximately 38.5% of zero bids.

Non-GM

The non-GM edamame bids were the highest among the three products (Figure 1 both including and excluding zero bids). Further, information about GM technology led to small changes in mean bids. For example, in the negative information first treatment, the negative information about GM technology led to only a 2 cent increase in WTP for non-GM labeled edamame after the no information first round. The ensuing positive information in the third round decreased bids by an average of 3 cents (Figure 1 including zero bids). For the positive information first treatment, positive information about GM decreased WTP for non-GM edamame by 5 cents whereas negative information led to a larger increase. The direction of change was as expected as negative information about GM technology is expected to heighten WTP for non-GM products. Information effects were larger in absolute terms for negative information than for positive information. There were a total of 67 zero bids for non-GM edamame or 19% of non-GM edamame bids, the lowest of the three products, signaling greater acceptance of non-GM edamame compared to unlabeled and GM edamame.

GM

For GM edamame, the negative information reduced WTP by 26 and 20 cents for the negative and positive information treatments, respectively (Figure 1 including zero bids). Hearing negative news first thus had a greater impact than hearing it second. Positive information after negative information added a 3 cent increase. Releasing positive information about GM technology heightens awareness toward the GM technology attribute which may explain why 2 cent lower WTP bids were obtained for GM edamame after positive information was provided compared to the no information first round (Figure 1 including zero bids). The following negative information still lowered WTP. The total WTP reaction to information (after all 3 rounds of bidding) was a negative 23 cents for the negative information first treatment and 22 cents for the positive information first treatment suggesting that release of positive information about a controversial issue marginally lessens the overall impact and that negative information effects are difficult to reverse. Figure 1 excluding zero bids shows findings that were similar and somewhat more consistent with *a priori* expectations with respect to the effect of positive information first. There were a total of 148 zero bids for GM edamame or 42% of GM edamame bids, the most of the three products, suggesting that participants were least comfortable to bid on GM edamame.

Parametric Information Effects on WTP by order of information

The random effects Tobit analysis was used to determine the marginal effects of positive and negative information treatments in different order of presentation. The signs of the marginal effects and their statistical significance allowed the analysis of additive effects in comparison to the no information first round bids..

Positive first

Positive information first treatment effects are shown in Table 6 and reveal no statistically significant impacts of positive information across any of the products. The same held true for negative information when provided for unlabeled and non-GM products. Negative information did, however, statistically significantly lower GM edamame bids by 16 cents. This suggests that participants may have had relatively strong *a priori* opinions about GM technology, that the positive information was not strong enough to lead to anticipated results or that negative information has a greater impact than positive information.

Negative first

Negative information first treatment effects are summarized in Table 7 and revealed more statistically significant information treatment effects than the results in Table 6 with leading positive information. Negative information had larger marginal effects that were statistically significant for both unlabeled and GM edamame in comparison to Table 6 results. Positive information effects were also statistically significant. While positive information dampened the effects of negative information on GM edamame (the difference in WTP bids after information are only 4.2 cents apart), adding GM technology information may have heightened the awareness about GM issues and thereby led to declines in WTP. Lesser marginal information effects for non-GM and unlabeled products are likely a function of GM technology not directly affecting non-GM products and uncertainty about what kind of edamame product was in the unlabeled package. Negative information about GM technology did boost the non-GM WTP although not to a large degree and not statistically significantly so. The overall effect of adding information about GM technology was more negative when negative information is provided first.

Effects of demographic and other explanatory variables by order of information subsamples

<u>Positive first</u>

The presence of children in the household consistently increased WTP of unlabeled, non-GM, and GM edamame, by \$0.60, \$0.48, and \$0.62, respectively (Table 6). This suggests that edamame is a product that children enjoy or that families with children in the household perceive edamame to have good product attributes for their children. For unlabeled product, household size had a negative impact on WTP which may be a function of budgetary implications where participants are in search of a quantity discount. For GM edamame, female participants bid significantly less than their male counterparts with similar signs on marginal effects, albeit insignificant, for the other two products. This suggests that women are more sensitive to the issue of GM technology than men when bidding on GM product. A similar trend was observed for the *AGE* variable suggesting that marketing efforts toward edamame may be more fruitful with a younger target audience. Finally, the strong statistically significant and sizable effect on the *OPINION* variable (Tables 5 and 7) for GM edamame provides justification that positive information about GM technology is needed to sway public opinion toward greater acceptance of GM products if GM products are to gain traction with consumers or marketers who are interested in selling GM product at a lesser discount to non-GM product.

<u>Negative first</u>

The *OPINION* variable again had the expected negative sign for unlabeled and GM edamame and strengthens the contention that consumer information about GM technology may be needed as relatively poor knowledge about GM technology was evident with participants answering approximately 57% of questions correctly (Table 1). High frequency of consumption (over 10 servings per 3 months) reflects greater familiarity with edamame and thereby leads to increased WTP. It may be that the *CONSUMP HIGH* variable captured most of the effect of overall impression as the *GM PREF* variable did not lead to statistically significant findings.

Discussion

To determine the effects of order of information on GM labeling, a non-hypothetical auction was conducted with three rounds of bidding with two order of information treatments. The WTP data collected from the auction led to the conclusion that negative information about GM technology had larger effects than positive information. Negative information has been found by psychologists to have a greater influence on the human brain than positive information of larger or equal magnitude (Ito et al. 1998) and hence the results reported herein are consistent with this effect. Further, negative information led to price discounts where positive information was insufficient to return bids to the point when they had not received any information (Figure 1 and Table 7). Similar to multiple WTP studies of GM products, this study also supports the contention that consumers will pay more money for a non-GM product than a GM product (Baker & Burnham, 2001; Huffman et al., 2003; Lusk et al., 2001; Wolfe et al., 2016; Xie, Kim, and House, 2013). Similar to these studies, non-GM labeled edamame was valued higher than the unlabeled and GM labeled edamame products. Information about GM technology bore no statistically significant effects on non-GM WTP although one of the reasons consumers would prefer non-GM product over GM product is the absence of GM technology.

Unlike Lusk et al. (2004b) and Rousu et al. (2004), the positive information used in this experiment did not influence GM edamame WTP. In all positive information treatments in Lusk et al. (2004b), the willingness to accept a GM cookie over a non-GM cookie was increased by informing participants about either environmental, health, or third world benefits. While negative information was not used in Lusk et al.'s (2004b) experiments, positive information in this study did not statistically significantly increase WTP for GM edamame even when positive information was provided first.

Positive marginal effects of consumer opinion on WTP regardless of product suggested that swaying consumer opinion toward GM technology would be of interest as general know how about the technology was modest. Aside from educational efforts toward informing consumers about GM technology, the analysis also revealed gender and age effects. Female respondents exhibited lesser WTP for GM edamame than males and younger participants revealed greater WTP for GM edamame.

Level of education, income and overall impression score differences had no statistically significant impact on WTP. These findings are similar to those reported by Wolfe et al. (2016) who reported no significant differences in participant sensory evaluation of GM and non-GM edamame.

Conclusion

An important finding in this analysis is the strength of negative information on consumer WTP. Whether well founded or not, positive information about a controversial product attribute was less powerful regardless of order of presentation. Product managers interested in finding an answer on the order of information release, faced with marketing new products with a potentially controversial product attribute, thereby face no easy solution. Informative and positive, from a GM product manager's perspective, is the positive and large effect of opinion toward GM technology on WTP and the generally modest level of knowledge reflected in the participant answers about GM technology. Research on how to modify consumer opinion toward greater acceptance of GM, perhaps best targeted at a younger and female demographic, could therefore bear fruit for product managers interested in selling GM foods.

Additional research is needed on the use of stronger emotional messages to convey positive and negative information. The information provided in this experiment was targeted at production and environmental effects of GM technology for edamame growers. It could have been interesting to also test the effect of positive information that more directly involves consumers. For example, it would be interesting for future studies to test the effect of a message about third world countries' yield improvements to aid world hunger and health benefits of nutritional additions similar to golden rice (beta-carotene) that could reduce incidence of disease.

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Table 1. Socio-demographic characteristics of the sample.

	Positive Treatment	Negative Treatment	Statistics
Gender (*FEMALE*)			
Male (0)	20%	30%	Pearson χ^2 (1) = 1.522
Female (1)	80%	70%	*p*-value = 0.217
Age (*AGE*)			t-value = 0.1094
Mean Age	38.63	38.54	*p*-value = 0.475
Education (1 if true, 0 otherwise)			
Less than Bachelor's degree	52%	47%	Pearson χ^2 (2) = 0.844
Bachelor's degree (*EDUC BA*)	27%	24%	*p*-value = 0.656
Master's degree or higher (*EDUC MS)*	22%	29%	
Income (1 if true, 0 otherwise)			
Less than $2,999 per month	33%	44%	Pearson χ^2 (2) = 2.023
$3,000 - $5,999 (*INC MID*)	43%	41%	*p*-value = 0.364
More than $6,000 (*INC HIGH*)	23%	15%	
Children (*CHILD*)			Pearson χ^2 (1) = 1.482
Presence of < 18 year old in the household (yes = 1, no = 0)	43%	55%	*p*-value = 0..223
Knowledge Rating[a] (*KNOW*)			Pearson χ^2 (4) = 7.245
True/False mean score (0 - 4)	2.32	2.23	*p*-value = 0.123
Opinion Rating[a] (*OPINION*)			Pearson χ^2 (14) = 12.935
Rating from 1 to 4 (low score = GM friendly)	2.54	2.61	*p*-value = 0.532
Household Size (*HHS*)			Pearson χ^2 (5) = 5.855
Number of people living in house	2.71	2.87	*p*-value = 0.321
Consumption (*CONSUMP HIGH*)			
>10 servings per quarter (1)	39%	47%	Pearson χ^2 (1) = 0.778
<=10 servings per quarter (0)	61%	53%	*p*-value = 0.378
GM Preference (*GM PREF*)			Pearson χ^2 (10) = 14.737
Mean of GM minus non-GM overall impression rating	-0.09	0.45	*p*-value = 0.142

Notes:
[a] See Table 4 and 5 for knowledge and opinion variables

Table 2. Comparisons of three auctions types, BDM, Vickery's Second Price Auction, and Random n^{th} Price Auction.

Auction Type	**BDM**	**Vickery's Second-Price**	**Random *n*th Price**
Procedures:	Individual participants submit a bid. If bid > market price, pay market price	Simultaneous bids are collected from each participant. Highest bidder pays market price	Simultaneous bids are collected from each participant, if bid > market price, pay market price
Market Price:	Price is randomly selected	Second highest bid.	Random *n* is chosen, the n^{th} highest bid is the market price
Winners:	Each individual has an opportunity to win	1	*n* - 1
Strengths	Ability to test consumer's in natural settings (grocery stores)	Preparation for experiment is easy with only one product needed per session	Any bidder can influence the results of the auction. Everyone should feel engaged
Weaknesses	Individuals do not get the opportunity to compete against each other	Low bidders know they will not influence the results	Very complex and take longer to sort bids. Amount of product needed is random.

Sources: Lusk and Shogren (2007) and Lusk (2003)

Table 3. Information treatments

Treatment 1 – Positive First

- ✓ Round 1 – No information
- ✓ Round 2 – Positive information
- ✓ Round 3 – Negative information

Treatment 2 – Negative First

- ✓ Round 1 – No information
- ✓ Round 2 – Negative information
- ✓ Round 3 – Positive information

Positive Information [a] *– POSITIVE*

Genetically engineered soybean food products are cheaper to produce as more effective herbicides can be sprayed over a larger window of time. This leads to higher yields and greater producer flexibility in managing production. It also lessens the amount of resources needed per amount of edible food as fewer inputs are needed. This helps lower the carbon footprint of edamame.

Negative Information [b] *– NEGATIVE*

Today's use of genetically engineered seed allows producers to apply herbicides to control weeds that would normally also kill soybeans. An unintended side effect of this technology has been the growing weed tolerance to these herbicides as well. As a result, farmers now use more herbicide and also pay higher prices for biotech seed causing their profit margins to decline.

Sources:

[a] (Nalley et al. 2012)

[b] (Norsworthy et al. 2011: Riar et al. 2011)

Table 4. Question used to form knowledge variable towards GM technology.

Question	True[a]	False	Not Sure
Planting RoundUp Ready® soybean allows farms to grow soybean and spray RoundUp® herbicide to control weeds without killing soybean whereas using RoundUp® herbicide on conventional (Non-genetically engineered soybean) would not only kill weeds but also the conventional soybean.	● 1	o 0	o 0
Some soybean oil sold in the U.S. is derived from Roundup Ready® soybean.	● 1	o 0	o 0
In addition to Roundup Ready® soybean, other genetically engineered crops are currently grown in the U.S.	● 1	o 0	o 0
Chemicals in RoundUp® herbicide remain effective for weed control in the soil forever.	o 0	● 1	o 0

Notes:

[a] The knowledge rating is the sum of correct answers. (4 being all correct and 0 being all wrong).

Table 5. Question used to form opinion variable towards GM technology.

Question[a]	Strongly Agree[b]	Somewhat Agree	Somewhat Disagree	Strongly Disagree
Genetically engineered food such as Roundup Ready® Soybeans present no danger for future generations.	o 1	● 2	o 3	o 4
I think it is safe for me to eat genetically engineered food.	o 1	o 2	● 3	o 4
Physical harm to mankind is bound to happen as a result of genetically engineered foods.	o 4	o 3	● 2	o 1
Growing genetically engineered crops will be harmful to the environment.	● 4	o 3	o 2	o 1
There are benefits to developing genetically engineered foods such as higher yields and a more sustainable food source.	o 1	o 2	● 3	o 4
Small-scale farmers are negatively impacted by the development of genetically engineered foods as the cost of seed will be higher.	o 4	o 2	o 3	● 1

Notes:

[a] Information about the knowledge statements was sourced from Riar et al. (2011), Norsworthy et al. (2011) and Nalley et al. (2012).

[b] The opinion score is the average of values assigned to each of the agreement levels for each statement. The score represents a summary of all rankings for each statement. Note that some statements are reverse scored to reflect a consistent estimate of concerns over genetically engineered food (Spector, 1992). Participants with an average opinion score of 1 are in favor of genetically engineered food whereas a score of 4 reveals the opposite.

Table 6. Random effects Tobit analysis of three edamame products (Unlabeled, Non-GM, and GM) when positive information was provided first.

	Unlabeled		Non-GM		GM	
Explanatory Factor[a]	ME (dy/dx)[b]	*p*-value	ME (dy/dx)	*p*-value	ME (dy/dx)	*p*-value
POSITIVE	-0.057	0.249	-0.081	0.117	-0.057	0.302
NEGATIVE	0.053	0.294	0.015	0.777	-0.164***[c]	0.003
FEMALE	-0.183	0.604	-0.403	0.203	-0.593*	0.089
AGE	-0.006	0.735	-0.009	0.623	-0.042**	0.011
EDUC BA	-0.161	0.593	-0.126	0.728	-0.248	0.468
EDUC MS	0.008	0.982	-0.085	0.822	-0.383	0.201
INC MID	0.413	0.164	0.225	0.423	-0.194	0.579
INC HIGH	-0.179	0.705	0.065	0.878	-0.302	0.453
CHILD	0.595**	0.034	0.477*	0.086	0.616*	0.068
KNOW	0.047	0.743	0.010	0.944	0.067	0.609
OPINION	-0.052	0.840	-0.010	0.969	-0.617**	0.022
HHS	-0.208*	0.093	-0.138	0.251	-0.002	0.989
CONSUMP HIGH	0.090	0.725	0.079	0.751	-0.370	0.183
GM PREF	0.056	0.500	-0.025	0.777	0.132	0.104

Notes found on following page

Table 7. Random effects Tobit analysis of three edamame products (Unlabeled, Non-GM, and GM) when negative information was provided first.

	Unlabeled		Non-GM		GM	
Explanatory Factor	ME (dy/dx) [a]	*p*-value	ME (dy/dx)	*p*-value	ME (dy/dx)	*p*-value
NEGATIVE	-0.124**	0.020	0.023	0.667	-0.270***	0.001
POSITIVE	-0.151***,[b]	0.005	-0.017	0.752	-0.228***	0.004
FEMALE	0.014	0.965	-0.052	0.869	0.136	0.633
AGE	0.021	0.203	-0.002	0.908	0.019	0.234
EDUC BA	0.002	0.996	-0.142	0.698	-0.108	0.707
EDUC MS	-0.179	0.591	-0.487	0.162	0.097	0.773
INC MID	0.315	0.322	0.113	0.699	0.266	0.341
INC HIGH	0.013	0.972	-0.084	0.813	0.046	0.893
CHILD	-0.023	0.953	-0.331	0.396	-0.103	0.761
KNOW [c]	0.079	0.448	0.090	0.374	0.015	0.875
OPINION [d]	-0.656**	0.014	-0.012	0.961	-0.548**	0.032
HHS	-0.088	0.576	-0.040	0.813	-0.157	0.262
CONSUMP HIGH	0.786***	0.004	0.483*	0.065	0.607**	0.016
GM PREF	-0.106	0.137	-0.008	0.917	-0.032	0.639

Notes found on following page

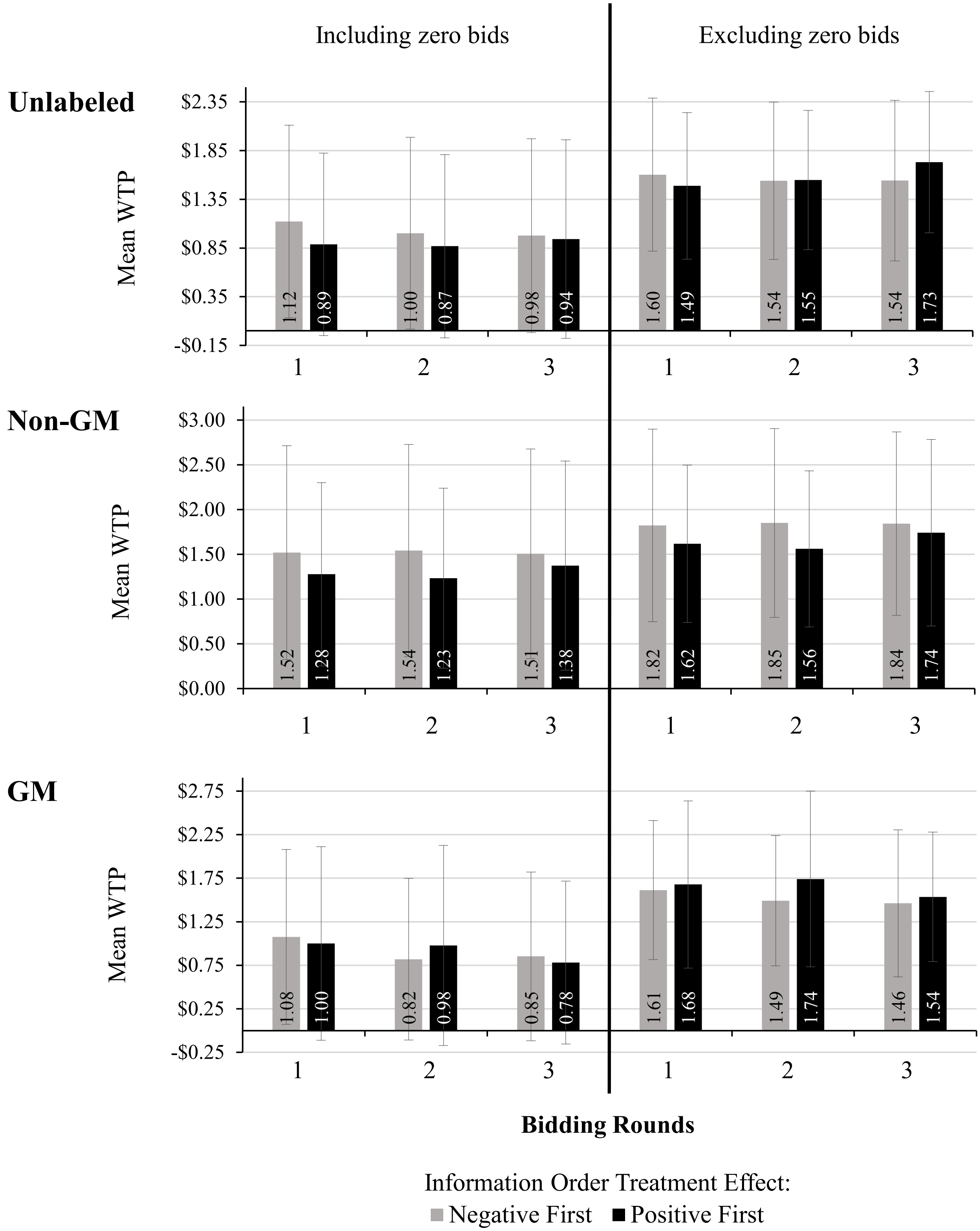
Notes for Table 6 and Table 7:

a See variable descriptions in Tables 1 to 4. *POSITIVE* and *NEGATIVE* are order of information effects compared to the first round bids without information. *FEMALE*, *AGE*, *EDUC*, *INC* and *CHID* variables relate to participant gender, age, level of education, household income and presence or absence of children in the house, respectively. *KNOW* is the participant knowledge level about GM technology with a higher *KNOW* score reflecting greater knowledge. *OPINION* is the participant's attitude score toward GM technology with a low value favoring GM technology and a high value reflecting anti-GM sentiment. *HHS* is the household size in number of consumers. *CONSUMP HIGH* reflects >10 servings of consumption per quarter and thereby familiarity and taste preference for edamame. *GM PREF* is positive if the participant provided a higher overall impression score for GM than non-GM edamame and negative for the opposite case.

b Marginal effects are the partial derivative of WTP with respect to *X* from Eqs. 2 to 4 using the 60 participants that received negative information first.

c *, ** and *** represent statistical significance at $p < 0.10$, $p < 0.05$, and $p < 0.01$, respectively.

Figure 1. Mean comparisons of willingness to pay for edamame samples for unlabeled, Non-GM, and GM samples between positive first and negative first treatments including or excluding zero bids.



Chapter 4

IV. Conclusion

In Chapter 2, higher statistically significant WTP values were observed for non-GM labeled edamame compared to GM-labeled edamame and unlabeled edamame. It is advised that labeling edamame non-GM will allow producers to charge a premium over unlabeled and potential GM edamame in US markets if study results are generalizable to the US population. Consumer education about GM foods could potentially lessen the negative WTP effects associated with GM and unlabeled edamame in comparison to non-GM edamame. Further, results in Chapter 2 suggest that knowledge of and opinions about GM products showed weak statistically significant effects in a direction that could lead to greater eventual acceptance of GM foods. This finding was consistent with the literature and Chapter 3 that focused its attention to the effects of information and order of information on the three differently labeled edamame products. Finally, with estimated retail price discounts for GM products, yield improvement with GM edamame and likely, to a lesser extent, production cost savings in comparison to non-GM edamame, are not expected to be large enough to justify GM edamame breeding efforts at this time.

Chapter 3 analyzed different information shocks in the positive and negative direction in two different orders. Negative information was found to be the stronger based on the WTP analysis. A controversial topic of GM technology attracted negative information to influence the bids more than the positive information. A product manager that is looking for ways to market GM foods is faces difficult circumstances because of the negative information's effect on WTP for GM products. Nonetheless, modifying opinion toward GM with information had the desired effect on WTP and as such research to examine ways to best provide that information is another research venue to pursue.

Limitations

The major limitation of this experiment was the size of the edamame pods. Restated from the introduction, GM edamame is currently not grown in the market. However, GM and non-GM field soybeans were harvested at the same time edamame should have been harvested. The two products compared were identical except for the breeding techniques. If GM edamame was actually grown and compared to non-GM edamame, one could make an assumption that similar results would occur.

Another limitation to the experiment were the small sample size of 117 participants. A larger sample in different areas could have resulted in a more thorough representation of consumer WTP. Budget and time were the limitation.

Specifically in Chapter 2, doubling the sample size and adding a second non-sensory group would allow analysis of the sensory test on WTP. Likewise in Chapter 3, different types of messages could have been used. For example, a message about third world countries' yield improvements to aid world hunger and health benefits of nutritional additions similar to golden rice (beta-carotene) that could reduce incidence of disease may lead to larger WTP effects

Future Research

This experiment added to the current literature by incorporating a sensory taste testing to an non-hypothetical random nth price auction and survey to elicit WTP effects of GM labeling jointly with information effects on an edible soybean product. The topic can be expanded further with more types of information treatments and adding a non-tasting group to be compared with the participants who tasted the products. Different labels could be investigated in addition to GM and non-GM labels. Expanding the experiment to different food products could potentially yield different results. Results may also differ if the study were conducted in another geographic region using a different sample of participants. Should similar findings result, the study results would be more generalizable to a great population of potential edamame consumers.

Appendix

Appendix 1 – Informed Consent e-mail and Screening Survey

Appendix 2 – Edamame Questionnaire

Appendix 3 – IRB Approval Form

Appendix 1. Informed Consent e-mail and Screening Survey

Information Letter
Emailed to Food Science Database using Survey Monkey

Dear potential participants,

The Sensory Science Laboratory (Department of Food Science) is conducting a research project on a food product.

The experiment will take 30 to 45 minutes. After completing both sensory testing and auction, you will receive a Wal-Mart gift card ($25). For the auction, you will be asked to bring some cash to buy a frozen food product for later in-home consumption. Please bring some cash and change (< $10).

Participation is voluntary. Even if you decide to participate, you may withdraw from the project at any time without giving a reason and without any academic penalty. Your decision to withdraw will have no negative consequences.

If you are interested in this study, please follow the link http://xxxxxx/xx/xx to register for a set of time slots for the sensory evalutaion and auction. You will be selected on a first-come first-serve basis for a particiaption time on August 20 or 21. If you have questions, please contact me at (xxx@xxx.xxx).

Thank you for considering this invitation,

Elijah Wolfe
AEAB Research Assistant

IRB #15-04-704
Approved: 07/31/2015
Expires: 06/08/2016

Recruitment Survey

Please complete all questions on this form.

1. Gender: □ Male □ Female
2. Age: _______________ years old
3. Ethnic background:

   □ White / Caucasian
   □ Black / African American
   □ Hispanic / Latin American
   □ Asian
   □ Native American
   □ Others (Specify: _____________)

4. Food Allergy: Do you have any known allergies to foods or odors?

   □ No
   □ Yes (Specify:_________________________).

5. Please select products you would not be willing to consume (check all that apply).

   □ Tofu
   □ Chocolate
   □ Edamame
   □ Bell Peppers
   □ Carrots
   □ Milk

6. Are you unfamiliar with any of these products? Only select products that you have never heard of.

   □ Tofu
   □ Chocolate
   □ Edamame
   □ Bell Peppers
   □ Carrots
   □ Milk

7. Are you allergic to any of these products? Only select product you are allergic to.

   □ Tofu
   □ Chocolate
   □ Edamame
   □ Bell Peppers
   □ Carrots
   □ Milk

8. Would you be available for the following time slots? (*dates can be changed*)

   Thursday, August 20, 2015
   □ 08:00 a.m. - 9:00 a.m.
   □ 10:00 a.m. - 11:00 a.m.
   □ 11:00 a.m. - 12:00 p.m.
   □ 12:00 p.m. - 1:00 p.m.

   Friday, August 21, 2015
   □ 09:00 a.m. - 10:00 a.m.
   □ 10:00 a.m. - 11:00 a.m.
   □ 11:00 a.m. - 12:00 p.m.
   □ 12:00 p.m. - 01:00 p.m.
   □ 1:30 p.m. - 02:30 p.m.

Willingness to Pay for Edamame Soybean grown using different technology

Consent to Participate in a Research Study
Principal Researcher: Elijah Wolfe
Faculty Advisor: Michael Popp

INVITATION TO PARTICIPATE

You are invited to participate in a research study about Edamame soybean. You are being asked to participate in this study because you have indicated no food allergies to Edamame or soy products

WHAT YOU SHOULD KNOW ABOUT THE RESEARCH STUDY

Who is the Principal Researcher?
Elijah Wolfe. Graduate Research Assistant. Department of Agricultural Economics and Agribusiness.

Who is the Faculty Advisor?
Michael Popp. Professor. Department of Agricultural Economics and Agribusiness.

What is the purpose of this research study?
The purpose of this study is to perform a sensory evaluation involving taste, smell, touch, sight and overall impression of Edamame soybean grown using different technology and determine associated willingness to pay for the Edamame products.

Who will participate in this study?
120 panelist will be pre-screened through Survey Monkey to: i) attend an Edamame sensory evaluation; ii) actually bid on Edamame; and iii) fill out a survey. Participants will be screened to gain access to participants that have previously eaten Edamame products. Participants are adults 18 years or older and will be selected on a first-come, first-serve basis.

What am I being asked to do?
Your participation will require the following:

- Sensory evaluation of three Edamame products.
- Cash auction bids on these three Edamame products (only randomly selected participants will actually pay for their bids).

What are the possible risks or discomforts?
Risk includes food allergies of the edible soybean food product Edamame. Participants will be asked to bid for Edamame, but can choose to bid zero if they do not want to pay for the Edamame. Participants have also been prescreened for Edamame allergies.

What are the possible benefits of this study?
Results of this study will be used to assess the market for Edamame products.

How long will the study last?
All sensory evaluations and auction experiments are scheduled for the period of Aug. 20 to 21, 2015 and will last approx. 30 minutes per group of participants.

Will I receive compensation for my time and inconvenience if I choose to participate in this study?
Using survey monkey the participants will chose a time slot of their choosing and receive a $25 Wal-Mart gift card at the completion of their sensory evaluation, survey completion and bidding process.

Will I have to pay for anything?
An experimental auction will take place during your participation. Bids for three Edamame products will occur in three rounds. One of the rounds and one of the products will be selected as the binding product. Of the 15 prices bid, one of them will be randomly selected by a random N^{th} number. The N^{th} bid will become the market price for the Edamame. All participants who bid more than the market price will pay the market price for the binding Edamame product. Not everyone is guaranteed to walk out with an Edamame product. Only bidders who bid more than the randomly drawn market price for the binding product. No price ceiling will be included; however, at any time, you may choose to bid a zero amount if you truly do not wish to purchase the product at any price, so you will not be required to pay for anything unless you want to. However, even if you bid a price and it is not high enough, you will not receive Edamame and also not have to pay.

What are the options if I do not want to be in the study?
If you do not wish to be in the study, you are free to leave.

How will my confidentiality be protected?
All information will be kept confidential to the extent allowed by applicable State and Federal law. ID#'s of participants will be distributed at random at the onset of the experiment and records linking ID#'s to individual participants will not be kept except to record whether participants appeared for their assigned time slot.

Will I know the results of the study?
At the conclusion of the study you will have the right to request feedback about the results. You may contact the faculty advisor, Michael Popp.

What do I do if I have questions about the research study?
You have the right to contact the Principal Researcher or Faculty Advisor as listed below for any concerns that you may have.

Elijah Wolfe. Graduate Research Assistant. Department of Agricultural Economics and Agribusiness. xxx@xxx.xxx.

Michael Popp. Professor. Department of Agricultural Economics and Agribusiness. xxx@xxx.xxx.

You may also contact the University of Arkansas Research Compliance office listed below if you have questions about your rights as a participant, or to discuss any concerns about, or problems with the research.

Ro Windwalker, CIP
Institutional Review Board Coordinator, Research Compliance
E-mail: xxx@xxx.xxx

I have read the above statement and have been able to ask questions and express concerns, which have been satisfactorily responded to by the investigator. I understand the purpose of the study as well as the potential benefits and risks that are involved. I understand that participation is voluntary. I understand that significant new findings developed during this research will be shared with the participant. I understand that no rights have been waived by signing the consent form. I have been given a copy of the consent form.

Signed: ____________________________ Date:_____________________

IRB #15-04-704
Approved: 07/31/2015
Expires: 06/08/2016

Appendix 2. Questionnaire

All of your responses will be kept confidential. Please circle the number to the left of the answer, if one is provided.

Edamame Consumption

Please circle the appropriate number (choose one) next to the response below:

A1. How often did you eat edamame in the **PAST THREE MONTHS**?

0. Never
1. 1-5 times
2. 6-10 times
3. 11-15 times
4. 16 times or more

A2. How often did you buy edamame to prepare meals for your household in the **PAST THREE MONTHS** (e.g. grocery store, farmer's market)?

0. Never
1. 1-5 times
2. 6-10 times
3. 11-15 times
4. 16 times or more

A3. How many servings of edamame did you buy away-from-home for your household in the **PAST THREE MONTHS** (e.g. restaurant)?

0. Never
1. 1-5 times
2. 6-10 times
3. 11-15 times
4. 16 times or more

Opinions about Genetically Engineered Food

Please circle the appropriate number (choose one) next to the response below:

B1. Regarding **genetically engineered food production technology used on farms**, how informed do you consider yourself?

0. Extremely well-informed
1. Well-informed
2. Somewhat informed
3. Not very informed
4. Not informed at all

B2. Regarding **genetically engineered foods**, how informed do you consider yourself?

0. Extremely well-informed
1. Well-informed
2. Somewhat informed
3. Not very informed
4. Not informed at all

B3. Planting RoundUp Ready® soybean allows farms to grow soybean and spray RoundUp® herbicide to control weeds without killing soybean whereas using RoundUp® herbicide on conventional (non-genetically engineered soybean) would not only kill weeds but also the conventional soybean.

0. True 1. False 2. Not sure

B4. Some soybean oil sold in the U.S. is derived from Roundup Ready® soybean.

0. True 1. False 2. Not sure

B5. In addition to Roundup Ready® soybean, other genetically engineered crops are currently grown in the U.S.

0. True 1. False 2. Not sure

B6. Chemicals in RoundUp® herbicide remain effective for weed control in the soil forever.

0. True 1. False 2. Not sure

B7. Do you think you have eaten genetically engineered food in the past month? (don't count today's study)

1. Yes
2. No

B8. How much would you say you've heard or read about genetically engineered foods?

1. Nothing at all
2. Not much
3. Some
4. A great deal

B9. How often have you discussed genetically engineered foods?

1. Frequently (typically once or more often per week over the last year)
2. Occasionally (no more than once a month in the last year)
3. Only once or twice over the last year
4. Never

Question	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree
B10. Genetically engineered food such as Roundup Ready® Soybeans present no danger for future generations.	o	o	o	o
B11. I think it is safe for me to eat genetically engineered food.	o	o	o	o
B12. Physical harm to mankind is bound to happen as a result of genetically engineered foods.	o	o	o	o
B13. Growing genetically engineered crops will be harmful to the environment.	o	o	o	o
B14. There are benefits to developing genetically engineered foods such as higher yields and a more sustainable food source.	o	o	o	o
B15. Small-scale farmers are negatively impacted by the development of genetically engineered foods as the cost of seed will be higher.	o	o	o	o

B16. Who would you trust the most to provide you information about genetically engineered crops (Please circle **THREE**)?

1. Research institutions
2. Seed Technology Companies
3. FDA
4. Universities
5. Religious Groups
6. Media (Fox, CNN, etc)
7. Farmer groups
8. Non-GMO Project Groups
9. Social Media (Facebook, etc)
10. USDA
12. Friends and Family
11. Others (please specify) ___________________________________

Your Information

C1. What is your gender?

0. Male 1. Female

C2. How old are you?

_____ years old

C3. Are you a current University of Arkansas student?

0. No
1. Yes

C4. What is the highest education level you have completed?

0. Less than high school
1. High school/GED
2. Some college/2 year associate degree
3. Bachelor's degree
4. Master's degree
5. PhD
6. Other _______________

C5. What is your current employment status?

1. Employed part time (fewer than 40 hours per week)
2. Employed full time (40 or more hours per week)
3. Retired
4. Other (please specify): ___________

<u>Your Household Information</u>

Depending on your situation, we would like you to think of your household as the person or persons who you are financially responsible for, including yourself, even if you are not a wage earner.

C6. How many people, including yourself, are in the following age categories in your household?

Age 5 and younger ____
Age 6 to 17 ____
Age 18 to 39 ____
Age 40 to 54 ____
Age 55 and above ____

C7. How much money do you typically spend on groceries per week for your household?

0. None
1. $1-$50 per week
2. $51-$100 per week
3. $101-$200 per week
4. $201 or more per week

C8. How much do you typically spend on away-from-home food per week for your household?

0. None
1. $1-$50 per week
2. $51-$100 per week
3. $101-$200 per week
4. $201 or more per week

C9. What is your total **household monthly allowance and/or income before taxes** from all sources, including family or other sources of economic support that is used to support your household)?

0. Less than $999
1. $1,000 - $1,999
2. $2,000 - $2,999
3. $3,000 - $3,999
4. $4,000 - $4,999
5. $5,000 - $5,999
6. $6,000 - $6,999
7. $7,000 - $7,999
8. More than $8,000

C10. What percentage (%) of your total grocery purchase dollars are spent at the following stores?

____ Wal-Mart Supercenter
____ Harps/Price Cutter
____ Ozark Natural Foods
____ Sam's Club
____ ALDI
____ Marvin's Savers Club
____ Wal-Mart Neighborhood Market
____ Farmer's Markets
____ List Others ____________
100%

C11. Please select how important each factor is to you in making a grocery purchase.

Factors	**Not at all Important**	**Slightly Important**	**Moderately Important**	**Very Important**	**Extremely Important**
Appearance	o	o	o	o	o
Brand	o	o	o	o	o
Price	o	o	o	o	o
Expiration Date	o	o	o	o	o
Organic production	o	o	o	o	o
Non GMO production	o	o	o	o	o
Eco packaging/Recyclable	o	o	o	o	o
Package Size	o	o	o	o	o
Locally produced	o	o	o	o	o

Appendix 3. IRB Approval Form

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

June 16, 2015

MEMORANDUM

TO:	Elijah Wolfe Rodolfo Nayga Han-Seok Seo Pengyin Chen Jennie Popp Michael Popp
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	15-04-704
Protocol Title:	*Eliciting Consumer Preferences about Edamame*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 06/16/2015 Expiration Date: 06/08/2016

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/units/rscp/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 120 participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.

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