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LABELING FOOD SAFETY ATTRIBUTES: TO INFORM OR NOT TO INFORM?

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LABELING FOOD SAFETY ATTRIBUTES: TO INFORM OR NOT TO INFORM?

Abstract

Even though consumers expect and demand safe food, foods produced with unique food safety enhancing processes have been challenging to differentiate in the market. The goal of this study is to explore ways of communicating food safety attributes and to examine consumer attitudes towards, and willingness to pay (WTP) for food safety labeling cues. The food labels used in this study include vague, unsubstantiated claims of food safety and more precise descriptions of a food safety enhancing technology to test the hypothesis that uninformative or unsubstantiated food labels with a positive message may be preferred to labels that provide factual information to corroborate food safety claims. Using the case of cattle vaccines against *E. coli* which could be effective in reducing human cases of *E. coli* infections from beef consumption, a hypothetical survey was developed and conducted in several grocery stores. Participants decided between ground beef with a standard label, and one that, in addition to the standard label, included a label with food safety information. Three versions of the food safety label were designed, and participants were randomly assigned to one of the three labels. More than two thirds of respondents who received the label with the unsubstantiated food safety claims chose this option, in contrast with the remaining two labeling options that provided more precise descriptions of the food safety enhancing technologies to support food safety claims. Empirical results from a double-bounded dichotomous choice model found an average premium price of $1.63 for a pound of ground beef with a food safety label, with the highest premium recorded for the label with the unsupported food safety claims. These findings suggest a potential market for products with food safety interventions, but also suggests careful communication of such interventions on food labels.

Key words: vaccines against *E. coli*, food safety enhancing attributes, food labels, hypothetical survey, willingness to pay.

1. Introduction

Food labels have gradually evolved from simply conveying nutritional information to communicating the presence of desirable or the absence of undesirable food attributes and/or production technologies. The development of several niche food markets has been enabled by labels highlighting the existence of positive or the absence of "negative" food attributes and/or technologies, effectively targeting consumers valuing this type of information. Examples include the "*All Natural*", "*No antibiotic*", "*No GMOs*", "*Cage-free*", and "*rBST-free*" food labels.

Evidence that consumers value and are willing to pay for such labels abounds. Wang et al. (1997) found that consumers concerned about rBST use in dairy production were also willing to pay more for the rBST-free label. Kanter, Messer and Kaiser (2009) showed that having rBST-free milk reduced willingness to pay (WTP) for conventional milk by as much as 33%, after participants had been introduced to information about rBST-free milk. Liaukonyte et al. (2013) used experimental auctions to examine consumer response to "*Contains*" and "*Free of*" labels, and how complementing such labels with negatively or positively framed messages influence opinions of them. The study examined some strongly debated production processes such as the use of genetically modified organisms (GMOs), antibiotics, irradiation, use of growth hormones, and high fructose corn syrup. They found that without any additional information, the "*Free of*" labels did not have a significant influence on WTP. The authors also noted that the "*Contains*" label exerted a negative impact on the bidding behavior of participants, even when it was complemented with positively-framed information.

There is also evidence that consumers are concerned about, and are willing to pay price premiums for healthy, safe and good quality foods (Loureiro and McCluskey 2000). Verbeke and Ward (2006) reported that beef labeling cues that were rated as important by consumers were those related to perceived meat quality and safety. In a study that examined consumer preferences for beef attributes, Loureiro and Umberger (2007) observed that respondents were willing to pay higher premiums for the USDA safety inspection label in ribeye steaks which surpassed WTP amounts for country of origin and traceability characteristics. A number of studies have also found that consumers are willing to pay for specific food safety enhancing technologies such as irradiation. Nayga, Poghosyan and Nichols (2002) surveyed consumers to investigate their attitudes towards food irradiation and reported that approximately 60% of those surveyed were willing to pay a premium price for irradiated beef. Nayga, Aiew, and Woodward (2004) examined consumer preferences for irradiated beef, and found WTP premium amounts between 75 cents to 78 cents for a pound of irradiated ground beef, amounts considered adequate to cover the cost of the technology on a commercial scale. Huang, Wolfe, and McKissick (2007) reported that consumers in the U.S state of Georgia were open to the use of irradiation in foods, with 65% of them expressing intent to purchase.

Despite consumer expectation of,[1] and preference for safer food, foods produced with unique food safety enhancing interventions have been rather challenging to differentiate in the market. This challenge stems in part from consumer misapprehension of the technologies adopted to ensure safer food products and in part due to food labeling claims that are uninformative or ambiguous, and the use of terms that do not have

[1] According to the 2012 Food and Health Survey by the International Food Information Council, 78% of American consumers expressed confidence in the safety of foods in the United States.

standardized interpretations (Palma, Collart, and Chammoun 2015). Thus, even though consumers are willing to pay, and are accepting of certain food safety enhancing technologies when they are provided with information about their potential beneficial effects, the challenge is how to effectively communicate such technologies on food labels, and how much detail to provide to substantiate food safety claims. This is particularly so for technologies consumers may be unfamiliar with (e.g., nanotechnology), or technologies not yet introduced.

The goal of this study is to identify effective ways of communicating food safety attributes on food labels and, in this context, examine consumer attitudes towards, and willingness to pay (WTP) for various food safety labeling cues. The food labels used in this study include both vague, unsubstantiated claims of food safety and more precise descriptions of a food safety enhancing technology to test the hypothesis that uninformative or ambiguous food labels with a positive message may be preferred to labels that provide factual information to corroborate food safety claims. Specifically, the study investigates consumers' response to, and their labeling preferences for beef products from cattle vaccinated against virulent strains of *E. coli*. Vaccines against *E. coli* O157:H7 have been approved for use by the United States Department of Agriculture (USDA), have been shown to be effective in reducing the incidence of the bacteria in cattle by as much 80% (Hurd and Malladi 2012), and can potentially decrease human cases of *E. coli* infections by at least 85% (Matthews et al. 2013). Notwithstanding the evidence supporting their effectiveness, they have received only limited adoption by beef producers (Callaway et al. 2009). This is partly attributable to the cost of the recommended application of the vaccine intervention, which can possibly erode producer

surpluses if not matched by an increase in demand (Tonsor and Schroeder 2015). For this reason, capturing a price premium for beef products produced with this food safety intervention makes their differentiation in the retail market particularly pertinent for producers and processors. However, signaling food safety attributes through food labels, and more so in the case of vaccines against *E. coli* may be challenging for two reasons. First, the word "vaccine" on a food label may elicit mixed reactions among consumers, from concerns about drug resistance to the skepticism surrounding the long-term effect of vaccinations held by some. The second concern involves having the name of bacteria such as *E. coli* on a beef label, which may be subject to diverse interpretations.

Focusing on a technology that has not seen widespread adoption, a major contribution of the study is in the design of the food safety labels using both vague food safety claims and precise descriptions of the technology to gauge consumer labeling preferences. This approach sheds light on labeling food technologies that consumers may be apprehensive about, or unfamiliar with. Albeit study goals were accomplished using a hypothetical survey, we sought to mitigate potential bias by using shoppers in grocery stores.

Empirical results suggest a stronger preference for the food safety label with the unsupported claim of food safety than the food safety labels that provided information about the vaccine intervention to corroborate the food safety claim. Results further show that the food safety label with the unsupported food safety claims recorded the highest WTP among participants who were exposed to, and who chose this option, providing important insights about consumer response to divergent food safety labeling cues.

The rest of the study is structured into six sections. Section 2 describes the experimental design used in the survey, followed by a summary of the data in section 3.

Section 4 describes the multinomial logit model and the double bounded dichotomous choice (DBCV) elicitation method. Results from the empirical findings are discussed in section 5, followed by a discussion on participants' preferences for the standard ground beef label in section 6. The paper ends with concluding thoughts from the findings in section 7.

2. Experimental Method

A hypothetical survey was developed to achieve study goals in light of the fact that beef products from cattle treated with vaccines against *E. coli* O157 are not widely available in the market. Shoppers at five different grocery stores in Lincoln, Nebraska were recruited to participate in the survey between December 2016 and January 2017, yielding a total of 445 participants who were also beef consumers. The stores include three Nebraska local grocery brands, a Mid-western chain, and a co-operative natural foods store. The five stores were selected to ensure a demographically diverse sample.[2] Designed using the *Qualtrics* software, participants completed the survey, which on average took 7 minutes on a laptop computer. Each store session lasted approximately 5 hours. A session began by setting a table and laptop computers in a heavily trafficked part of the store, and asking shoppers whether they were beef consumers, and if so, whether they would be willing to participate in a short survey and earn a $15 store gift card.

[2] The first grocery store was located in a suburban neighborhood, to help sample views from the largely middle class shoppers who live in the surrounding community. Shoppers in the second store were a demographically diverse mix, most likely a result of its location in a shopping district with adjoining shops and restaurants. The third and fourth grocery stores belonged to the same chain as the second; whereas the third store was situated in a largely low-income community, the fourth was in a more affluent part of town surrounded by a shopping mall and relatively new suburban communities. The fifth store, a cooperative natural foods store was chosen to represent consumers who are more inclined towards local and organic food products.

The main part of the survey involved asking participants to choose between ground beef with a 'standard' label (i.e., found on a typical ground beef product) and one that, in addition to the standard label, had a second label with food safety information. Three versions of the food safety labels were designed. The first showed the phrase "Safer Choice" in a circle with a sentence below indicating that the product is "from cattle raised under strict health standards to ENHANCE beef safety". In this version, no evidence is provided to support the food safety claim. We refer to this version as the 'uninformative' or 'unsubstantiated claim' version (Safer Choice/Enhance hereafter). The second food safety label showed the same "Safer Choice" phrase with a sentence below that provided precise information about the technology used to enhance food safety, describing the product as originating "from cattle **vaccinated against *E. coli*** to REDUCE the risk of illness" (Safer Choice/Vaccinated hereafter). The third label showed the word *E. coli* in a red circle with a diagonal strikethrough to buttress the safety of the beef product from *E. coli* bacteria with a sentence below identical to the second food safety label (*E. coli*/Vaccinated hereafter). The *E. coli* with the slash through design for the third label was intended to mimic other *'free of'* labels such as 'No antibiotics' and 'No hormones', without the claim, however, that the product is entirely free of *E. coli* bacteria. Even though the second and third food safety labels shared the same accompanying description/information, the distinguishing characteristic was the name of a bacteria (*E. coli*) on the third label, contrasting with the more positive display (Safer Choice) on the second.

Each of the designed food safety labels was displayed to the left of the standard label on the ground beef product. The survey was designed such that participants were

randomly assigned to one of the three food safety labeling options, with approximately 150 participants in each group. Thus, each participant saw only one (of the three) food safety label and had to choose between two options; ground beef with the standard label (option A), or ground beef with the standard plus a food safety label (option B). To reflect food labels in an actual retail store setting, and to solely examine consumers' response to the food labels, no additional information about *E. coli* or vaccines were included in the survey. The food labels used in the survey are shown in section I of the Appendix.

2.1 Methodological Approach

To determine participants' WTP for the ground beef with the additional food safety label, those who chose option B (the standard label plus food safety label) answered follow-up questions using the double bounded contingent valuation (DBCV) elicitation format which presents two random premium bid amounts, with the second bid contingent on the first, following Hanemann, Loomis and Kanninen (1991). The DBCV is an improvement over the single bounded dichotomous choice model, which elicits Yes/No responses about WTP a monetary amount for a good. By asking the second question, the DBCV uses more information to determine WTP values, which improves the efficiency of the estimation (Hanemann, Loomis and Kanninen 1991).

In our study, participants who chose option B were assigned a random premium bid amount, in excess of the base price of conventional ground beef (option A) which was given as $4.30, and were asked whether they would be willing to pay this premium in addition to the original price for a pound of ground beef with the food safety label. If they answered Yes to the first premium bid, they were asked about their willingness to pay an

amount greater than the initial bid. If they answered No to the first premium bid, the subsequent question posed a bid lower than the initial (still a premium over option A). As indicated, there were only two bidding rounds, with the follow-up bid conditioned on a participant's answer to the first bid. Respondents who chose option A (i.e., the ground beef with only the standard label) were subsequently asked whether they would be willing to purchase option B at a discount, if that were their only choice. Figure 1 depicts participants' labeling choice.

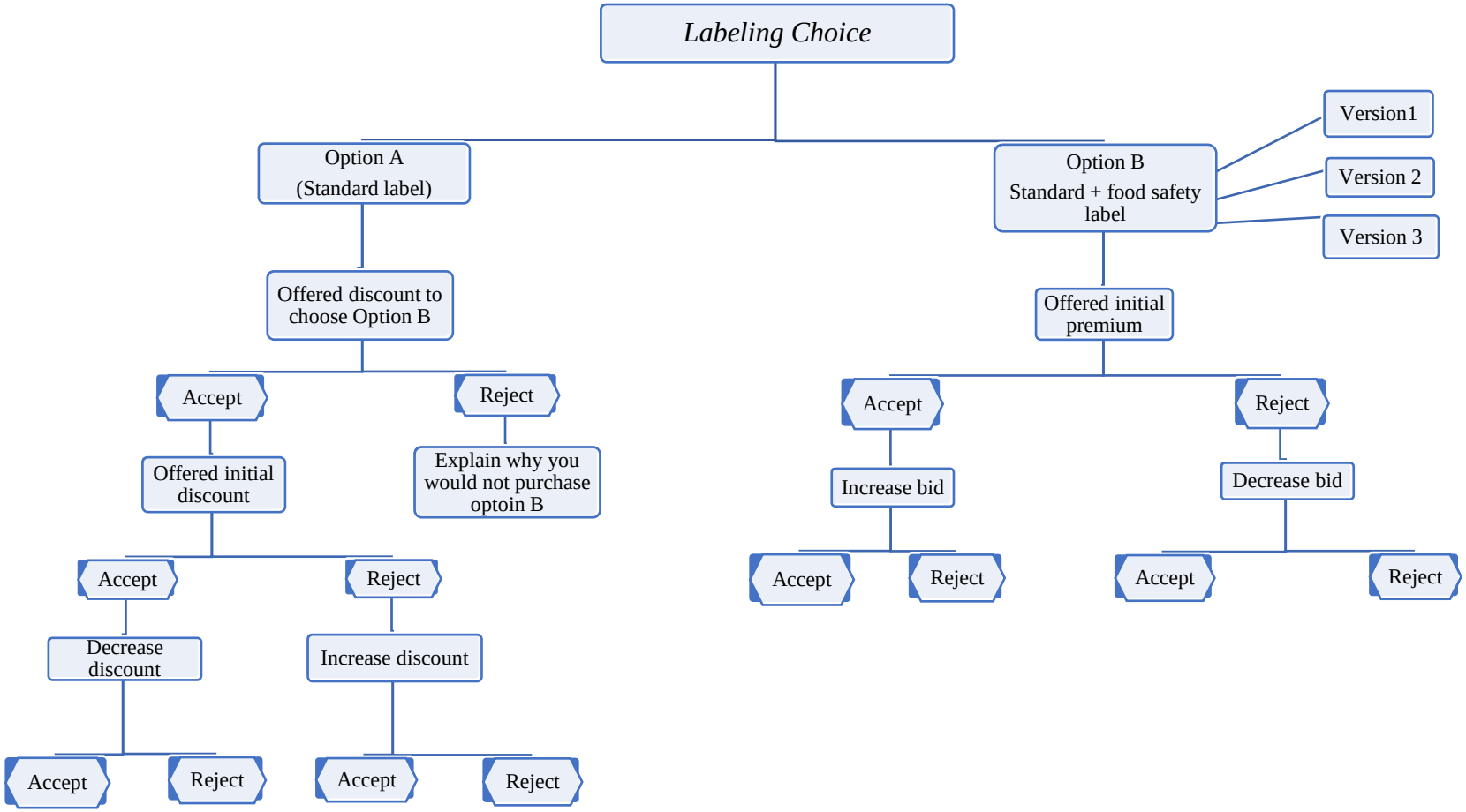

Figure 1. The Labeling Choice

The range of bid values that were used as premiums over the base price of the ground beef with the standard label were 40 cents, 80 cents, $1.20, $2.00, and $3.00, guided by a previous study (Britwum and Yiannaka 2016) determining consumer WTP for ground beef from cattle treated with vaccines against *E. coli*. Five bid values were considered sufficient, following suggestions about loss of information and efficiency when more than six bid values are used (Creele 1998; Hanemann and Kanninen 2001). The premium bids are shown in Table 1.

Table 1. Premium Bids used

Initial Bid	Lower Bid (if answered NO to initial bid)	Higher Bid (if answered YES to initial bid)
$0.80	$0.40	$1.20
$1.20	$0.80	$2.00
$2.00	$1.20	$3.00

The discount bids were also presented as two random amounts, with the second discount amount conditioned on the first, drawing parallels with the premium bid range.[3] The discount amounts used are shown in Table 2.

Table 2. Discount Bids used

Initial discount	Lower discount (if YES to initial discount offer)	Higher discount (if NO to initial discount offer)
$0.40	$0.20	$0.80
$0.80	$0.40	$1.20
$1.20	$0.80	$1.50

[3] This set-up is similar to McCluskey (2003), who posed a second question to respondents willing to purchase a genetically modified (GM) food product at the same price as the non-GM version. Respondents who answered Yes were asked whether they were also willing to purchase the GM product at a percentage premium, otherwise at a discount.

3. Data and Descriptive Statistics

In addition to each participant's labeling decision, the survey gathered information about knowledge and opinions of animal production practices, beef consumption habits, views about the government's role in ensuring food safety, and demographic characteristics. Table 3 displays descriptive statistics of participants' responses.

Table 3. Descriptive Statistics and Variable Definition

Variable	Description	Mean	Std. Dev.
Attitudes, knowledge & opinion			
Personal health issues	Food purchasing decision based on health issues, 1= never to 4= always	2.81	0.85
Food labels	Food purchasing decision based on food labels, 1= never to 4= always	2.85	0.81
Read labels	Frequency of reading food labels, 1= never to 4= always	2.95	0.80
Knowledge vaccines	Knowledge of animal vaccines, 1= nothing to 4= a great deal	2.33	0.95
Accept vaccines	Acceptance of animal vaccines, 1= totally unacceptable to 5= totally acceptable	3.09	1.12
Burgers cooked	Preference of cooking beef burgers 1= rare to 4= well done	3.07	0.81
Opinion about the government's role			
Label vaccines	Meat from vaccinated cattle should be labeled, 1= strongly disagree to 5= strongly agree	3.91	1.11
Ensure safety	Government should ensure safety of food, 1=strongly disagree to 5= strongly agree	4.14	1.13
Mandate vaccines	Government should mandate the use of animal vaccines, 1= strongly disagree to 5= strongly agree	3.34	1.24
Demographics			
Primary shopper	1 if subject does most of household grocery shopping, 0 otherwise	0.93	0.26
Children at home	1 if subject lives with children under 18 years, 0 otherwise	0.38	0.49
College	1 if subject has some college education or higher, 0 otherwise	0.82	0.38

Male	1 if subject is male, 0 otherwise	0.40	0.49
White	1 if subject's ethnicity is white, 0 otherwise	0.71	0.45
Income	Household income, in thousands	57.32	51.13
Age	Age in years	46.49	16.66

Personal health issues and food labels were rated as important in food purchasing decisions. With means at 2.81 and 2.85, respectively, participants were frequently influenced by these factors in their food purchases. Consistent with these findings, participants reported a high frequency of reading food labels. Respondents on average had little to moderate knowledge of animal vaccines, with modest acceptance of their use in animal production. There was strong approval for labeling meat products from cattle vaccinated against *E. coli*, and for the government to be involved in ensuring safer foods. Participants were in general approving of having the government mandate the use of animal vaccines, with a mean of 3.34 on a 1 to 5 scale ranging from strongly disagreeing to strongly agreeing. Demographic variables show that 93% of respondents were principal grocery shoppers in their households, which is an expected outcome given that the surveys were conducted in grocery stores. About 82% had some college background, or at least a bachelor's degree. The majority of respondents, at 71%, were whites, slightly lower than the state of Nebraska's 89%, and the city of Lincoln's 86% white population. Average household income was about $57,000, with the average age at 47 years.

Statistics of some key demographic characteristics were also examined across preferences for the ground beef labeling options, as displayed in Table 4. The highest average household income, at $66,197, was recorded for participants who were assigned to, and who chose the ground beef with the *E. coli*/Vaccinated label. A subsequent t-test showed that average income among those who chose option B in this group was

significantly different from the average income of participants who chose option A at the 5% level of significance (see test in section II of the Appendix).

Table 4. Demographic Characteristics Based on Ground Beef Label Choices

Demographic characteristic	Option A / Standard label	Option B / Food safety label		Will not purchase
Income	$49,662	Safer Choice/Enhance	$64,109	$56,607
		Safer Choice/Vaccinated	$52,747	
		E. coli/Vaccinated	$66,197	
College	0.77	Safer Choice/Enhance	0.84	0.89
		Safer Choice/Vaccinated	0.80	
		E. coli/Vaccinated	0.83	
Children at home	0.43	Safer Choice/Enhance	0.36	0.33
		Safer Choice/Vaccinated	0.34	
		E. coli/Vaccinated	0.42	

Average household income for participants who were exposed to, and who chose the 'Safer Choice/Enhance' label was also statistically different from household income for participants who chose option A, at the 5% level of significance (see test in section II of the Appendix). What is noteworthy here is that participants who chose option B (from any one of the three food safety labels seen) had a higher average income than participants who chose the standard label only. Clearly, this presents a more nuanced result of participants and their responses to safer food options based on unique demographic characteristics. An interesting observation concerned participants who

chose neither option A nor option B (will not purchase). For those in this group, 89% of them had a least a college background. At least 80% of participants who chose option B (any one of the three food safety labels assigned) had more than a high school education. Also, 43% of respondents who opted for the ground beef with only the standard label (option A) lived with children less than 18 years, with this proportion decreasing to 34% among those who saw, and chose the 'Safer Choice/Vaccinated' label version. This difference was not statistically significant (Chi-square = 0.66 [1 df]), however. Among participants who were assigned to, and who chose the *E. coli*/Vaccinated food label, 42% of them lived with children less than 18 years at home, similar to the 43% of participants who also chose option A.

4. Empirical Models

4.1 Multinomial Logit Model

The multinomial logit model was used to model choice among *J* alternatives as a function of individual characteristics (Hoffman and Duncan 1988). The alternatives comprised of a participant's choice among the ground beef with only the standard label (option A), the ground beef with the standard label plus a food safety label (option B), and the choice to purchase neither of these two options. Participants are assumed to be utility maximizers, and choose the option that yields the highest utility. Let U_{ij} be an individual's indirect utility function for a given option, expressed as:

$$U_{ij} = x_i'\beta_j + \varepsilon_i \quad (1)$$

where the subscript *i* represents an individual, and *j* the alternative. The vector x_i captures individual *i*'s characteristics, and ε_i the random error term that consists of unidentified

factors that influence a participant's choice, and is independently and identically distributed with an extreme value type 1 distribution. Since an individual's true utility cannot be observed, the probability of a choice is used as a proxy in the estimation, and given as:

$$Prob\{y_i = j\} = Prob\{\max(U_{i1,} \ldots\ldots, U_{iJ})\} \quad (2)$$

The probability that individual *i* chooses alternative *j*, as shown by McFadden (1973), is:

$$Prob(y_i = j|x_i) = \frac{e^{x_i'\beta_j}}{\sum_{k=1}^{J} e^{x_i'\beta_k}} \quad (3)$$

Equation 3 is the multinomial logit model. For this study, the first response (option A) was designated as the reference or base category, and its probability is given as:

$$Prob(y_i = 1|x_i) = \frac{1}{1 + \sum_{k=1}^{J} e^{x_i'\beta_k}} \quad (4)$$

The odds ratio of individual *i* choosing alternative *j* is:

$$\frac{Prob(y_i = j)}{Prob(y_i = 1)} = \exp(x_i'\beta_j) \quad (5)$$

The multinomial logit model was estimated using the maximum likelihood procedure.

4.2 Double-bounded Contingent Valuation method

The contingent valuation method is utilized to measure changes to an individual's expenditure function, or their indirect utility function (Haab and McConnell 2002). An individual faced with a well-behaved utility function subject to an income constraint maximizes their utility given as:

$$v(p, q, y) = max\ \{u(x, q) \mid px \leq y\} \tag{6}$$

where *x* is a vector of private goods, *q* is a vector of public goods, and *y* is the individual's income. Unlike *x* which is endogenous, *q* is exogenous to the individual. Using the compensating variation measure, we can determine the amount an individual is willing to pay for an improvement in the public good from q^0 to q^1, such as their WTP for safer food attributes, defined as:

$$v(p, q^1, y - WTP) = v(p, q^0, y) \tag{7}$$

where $q^1 > q^0$, and *q* is a desirable good such that $\partial V / \partial q > 0$. If the cost of the public good improvement is *t*, the individual will agree to pay this amount only if their WTP ≥ t. For the DBCV method, bivariate dichotomous choice valuation questions are asked, which results in four outcomes. Responses may fall into one of these four categories:

i. Yes to both bids (yes, yes)

ii. Yes to the first bid and no to the second (yes, no)

iii. No to the first bid and yes to the second bid (no, yes), and

iv. No to both bids (no, no).

Assume that t^1 and t^2 are the two bid amounts, and WTP_i represents a participant's WTP a premium price for ground beef with the additional food safety label. Following Hanemann, Loomis and Kanninen (1991) and Lopez-Feldman (2012), answers to the two valuation questions will result in the following outcomes:

$$D_i = \begin{cases} t^2 \leq WTP_i < \infty, & if\ yes\ to\ both\ bids \\ t^1 \leq WTP_i < t^2, & if\ yes\ to\ first\ bid\ and\ no\ to\ second \\ t^2 \leq WTP_i < t^1, & if\ no\ to\ first\ bid\ and\ yes\ to\ second \\ \quad WTP_i < t^2, & if\ no\ to\ both\ bids \end{cases} \tag{8}$$

Let a participant's WTP be defined as:

$$WTP_i = z_i'\beta + \varepsilon_i \tag{9}$$

where z_i is a vector of independent variables, β is a vector of estimable parameters and ε_i a random error term which is normally distributed with a constant variance $\{\varepsilon_i \sim N(0, \sigma^2)\}$. Given this, the probability of each of the outcomes is given by equations (10), (11), (12) and (13).

$$\begin{aligned} Prob(yes, yes) &= Prob(WTP_i \geq t^2) \\ &= Prob(z_i'\beta + \varepsilon_i \geq t^2) \\ &= Prob\left(\frac{\varepsilon_i}{\sigma} \geq \frac{t^2 - z_i'\beta}{\sigma}\right) \\ &= 1 - \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) \\ &= \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right) \end{aligned} \tag{10}$$

$$\begin{aligned} Prob(yes, no) &= Prob(t^1 \leq WTP_i < t^2) \\ &= Prob(t^1 \leq z_i'\beta + \varepsilon_i < t^2) \\ &= Prob\left(\frac{t^1 - z_i'\beta}{\sigma} \leq \frac{\varepsilon_i}{\sigma} < \frac{t^2 - z_i'\beta}{\sigma}\right) \\ &= \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{t^1 - z_i'\beta}{\sigma}\right) \\ &= \Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right) \end{aligned} \tag{11}$$

$$
\begin{aligned}
Prob(no, yes) &= Prob(t^2 \leq WTP_i < t^1) \\
&= Prob(t^2 \leq z_i'\beta + \varepsilon_i < t^1) \\
&= Prob\left(\frac{t^2 - z_i'\beta}{\sigma} \leq \frac{\varepsilon_i}{\sigma} < \frac{t^1 - z_i'\beta}{\sigma}\right) \\
&= \Phi\left(\frac{t^1 - z_i'\beta}{\sigma}\right) - \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) \\
&= \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right)
\end{aligned} \tag{12}
$$

$$
\begin{aligned}
Prob(no, no) &= Prob(WTP_i < t^2) \\
&= Prob(z_i'\beta + \varepsilon_i < t^2) \\
&= Prob\left(\frac{\varepsilon_i}{\sigma} < \frac{t^2 - z_i'\beta}{\sigma}\right) \\
&= \Phi\left(\frac{t^2 - z_i'\beta}{\sigma}\right) \\
&= 1 - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right)
\end{aligned} \tag{13}
$$

$\Phi(.)$ is the standard normal cumulative distribution function of the error term, ε_i. Given the outcomes from equations (10) through (13), the log likelihood function for N participants is:

$$
\begin{aligned}
lnL = \sum_{i=1}^{N} \Bigg[& {I_i}^{yes,yes} ln\left(\Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right)\right) \\
& + {I_i}^{yes,no} ln\left(\Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right)\right) \\
& + {I_i}^{no,yes} ln\left(\Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right) - \Phi\left(\frac{z_i'\beta - t^1}{\sigma}\right)\right) \\
& + {I_i}^{no,no} ln\left(1 - \Phi\left(\frac{z_i'\beta - t^2}{\sigma}\right)\right)\Bigg]
\end{aligned} \tag{14}
$$

$I_i^{yes,yes}$, $I_i^{yes,no}$, $I_i^{no,yes}$ and $I_i^{no,no}$ are indicator variables equal to 0 or 1, depending on the outcome for each participant.

Although the double-bounded dichotomous choice model has been shown to be more efficient than the single-bounded approach with no follow-up question (Hanemann, Loomis and Kanninen 1991), starting point bias can reduce the efficiency of the WTP estimates, with implications for statistical inference (Herriges and Shogren 1996). Where the initial bids are not close to the mean WTP, the estimates could also be potentially biased (Herriges and Shogren 1996; Alberini, Kanninen and Carson 1997). Starting point bias, also known as anchoring effect occurs when participants uncertain about the true cost of an attribute or a good misconstrue the starting bid as the true value. When participants anchor their WTP on the starting point bid, the follow-up question becomes a weighted average of a respondent's prior WTP and the initial bid (Herriges and Shogren 1996), given as:

$$WTP_2 = WTP_1(1-\gamma) + \gamma t_1 \quad (15)$$

where $0 \leq \gamma \leq 1$ is the anchoring weight placed on the initial bid t^1, WTP_1 is the prior WTP, and WTP_2 is the posterior WTP. According to Alberini, Kanninen and Carson (1997), an underlying assumption of the double-bounded model is that answers given to both the initial and follow-up bids are consistent with a subject's true WTP, i.e., $WTP_1=WTP_2$. With starting point bias, however, this assumption is violated, and as the anchoring weight γ increases, WTP approaches the initial bid, t^1.

A second potential violation of the underlying assumption of the double-bounded dichotomous choice model can be attributed to the shift effect (Alberini, Kanninen and Carson 1997; Whitehead 2002). As expounded by Alberini, Kanninen and Carson (1997),

shift effect occurs when a participant's WTP shifts between the two responses. In this case, the follow-up valuation questions do not induce subjects to reveal their true WTP. In the presence of a shift effect, a subject's true WTP is equal to their stated WTP with a shift (Whitehead 2002), given as:

$$WTP_2 = WTP_1 + \delta \tag{16}$$

where δ is the shift parameter. In relation to this study, this phenomenon could happen if the second valuation bids were not incentive compatible. In the presence of both shift and anchoring effects, WTP for the follow-up question becomes:

$$WTP_2 = WTP_1(1-\gamma) + \gamma t_1 + \delta \tag{17}$$

A respondent answers yes to the follow-up question if:

$$\begin{aligned} &WTP_2 \geq t_2 \\ &WTP_1(1-\gamma) + \gamma t_1 + \delta \geq t_2 \\ &WTP_1 \geq \frac{t_2 - \gamma t_1 - \delta}{1-\gamma} \end{aligned} \tag{18}$$

Both starting point bias and shift effect were accounted for in the empirical estimation. Starting point bias was controlled for by using two approaches, one proposed by Chien, Huang and Shaw (2005), and the other by Whitehead (2002). Following Chien, Huang and Shaw (2005), two bid set dummies were constructed and included in the model for the three premium bid sets shown in Table 1. The last bid set ($2.00, $1.20 and $3.00) was assigned as the reference dummy. Following Alberini, Kanninen and Carson (1997) and Whitehead (2002), the shift effect was empirically determined as the coefficient of a dummy variable equal to 1 for the follow-up question, and 0 otherwise, following the transformation of the data into a pseudo-panel dataset. The starting point bias which is

determined by the anchoring weight γ is the coefficient of the interaction effect between the dummy variable on the follow-up question and the starting point bid.

5. Results and Discussion

Respondents' choice for their preferred beef labels is examined prior to investigating the models' findings. Recall that participants were randomly assigned to one of the three food safety label versions, and had to choose between the ground beef with only the standard label (option A), or the ground beef with the standard label and a food safety label (option B), as described in Section 2. Participants also had the choice to select neither of the two ground beef options. As Figure 2 shows, the most chosen food safety label was the 'uninformative version' that provided no support for the food safety claims made (Safer Choice/Enhance). Nearly 70% of participants in this group chose option B, with just about 15% of them choosing option A. A little over 60% of respondents who were exposed to the food safety label with the Safer Choice phrase, and additional information describing that the ground beef originated from cattle vaccinated against *E. coli* bacteria (Safer Choice/Vaccinated) chose this option. The food safety label that was least preferred among the three was the version with the word *E. coli* with the diagonal strikethrough and additional information describing that the ground beef originated from cattle vaccinated against *E. coli* bacteria (*E. coli*/Vaccinated). Less than half of respondents in this group chose this option, with 37% choosing option A, which represented the highest fraction of respondents who chose option A.

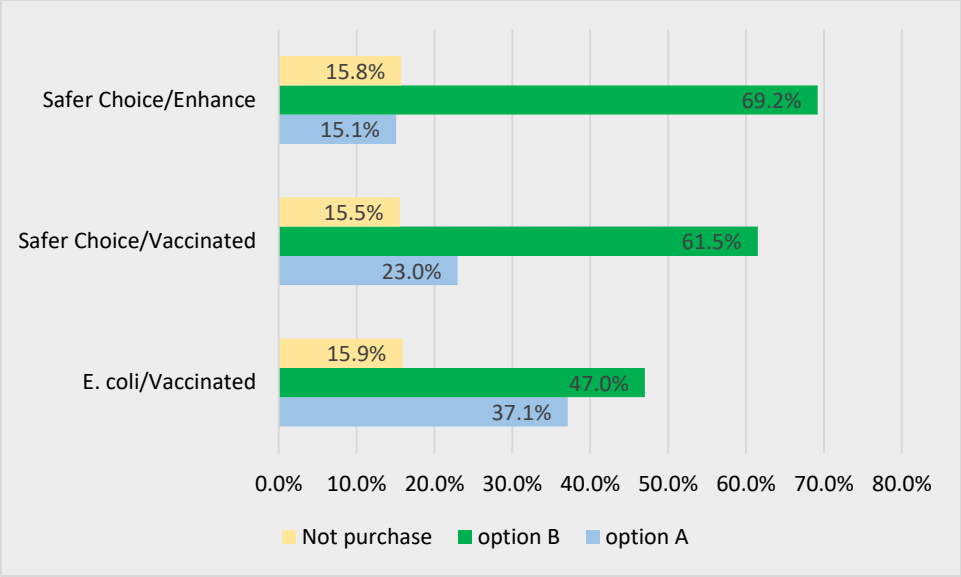

Figure 2. Response to Ground Beef Options

The results suggest that accurate or detailed information about a process attribute or a food safety enhancing production process may not necessarily win over consumers. These findings are consistent with the positive consumer opinions associated with food labels without standardized interpretations, or with ambiguous claims such as the *"All Natural"* claim (Liu et al. 2017). As Kahan et al. (2007) assert, factual information about new food technologies should be framed in a manner that allays concerns about such technologies. Very likely, the *E. coli*/Vaccinated label may have achieved the opposite effect for some respondents and possibly heightened their concerns. Another hypothesis could be the varied interpretations 'vaccines' or '*E. coli*' are subjected, despite the precise description of the vaccine intervention. What appears obvious, however, is that consumers' response may be more drastic towards labels that highlight a contaminant they wish to avoid. As it turned out, highlighting *E. coli* on the label was likely to be perceived negatively, even though the *E. coli*/Vaccinated label communicated that the product was safe from the bacteria.

Table 5 reports actual count or frequencies for respondents' choices based on the type of label they were exposed to. A Chi-square test was used to test for differences among responses; test results were significant at better than the 1% level (as shown in Table 5), indicating that differences in response among the food safety labels are significant and not due to chance. Key demographic characteristics such as income, age, and education were not statistically different from each other among participants in the three food safety label versions (see tests in section III of the Appendix). Consequently, we can conclude that a participant's choice was not independent of the type of food safety label they had been exposed to.

Table 5. Statistics of Subjects' Response to Ground Beef Options

	Option A	Option B	Not purchase	Total
Safer choice/Enhance	22	101	23	146
	15.07%	69.18%	15.75%	100.00%
Safer choice/Vaccinated	34	91	23	148
	22.97%	61.49%	15.54%	100.00%
E. coli/Vaccinated	56	71	24	151
	37.09%	47.02%	15.89%	100.00%
Total	112	263	70	445
	25.17%	59.10%	15.73%	100.00%
Pearson Chi-square = 21.11 *p-value* = 0.000				

Among respondents who chose option B (the standard label plus a food safety label), there was consistency in the distribution of their answers across the three initial bids, as displayed in Figure 3. Each respondent answered a dichotomous Yes/No question about paying a premium amount equal to an initial bid, with this starting bid assigned randomly

from the three initial bid amounts shown in Table 1. More than 60% of respondents who were assigned a premium bid of 80 cents for a pound of ground beef with a food safety label were willing to pay that amount, compared to the about a third in this group who answered No. Responses were similar among participants who received the premium amounts of $1.20 and $2.00, in terms of both Yes and No answers.

Figure 3. Distribution of Initial Bids for Participants who Chose Option B

Figure 4 shows the distribution of responses to the follow-up premium bids, which were asked contingent on the response to the initial bid.[4] About 67% of respondents who were asked about their WTP a second bid of 40 cents extra for the ground beef in option B answered Yes, compared to the roughly 30% who rejected the bid. More than two thirds of respondents who were assigned a second bid of 80 cents answered No to this amount, having responded No to the initial bid of $1.20. For the

[4] 40 cents and 80 cents were assigned to respondents who answered No to an initial bid of 80 cents and $1.20, respectively. A second bid of $1.20 could be in response to a Yes answer to an initial bid of 80 cents, or No to an initial bid of $2.00. Second bids of $2.00 and $3.00 were in response to an initial bid of $1.20 and $2.00, respectively.

remaining three second bids ($1.20, $2.00, and $3.00), approximately half of respondents who saw each of these second bids answered Yes.

Figure 4. Distribution of Follow-Up Bid for Participants who Chose Option B

5.1 Multinomial Logit Results

This section presents results from the multinomial logit model which examines choices for the ground beef with the standard label (option A), the standard label plus a food safety label (option B), and the option to purchase neither. Option A was designated as the reference category, and option B and the 'Purchase neither' option were measured against it. The results are displayed in Table 6, showing both the estimates for the regressors as well as the odds ratios.

Compared to the group that saw the food safety label *E. coli*/Vaccinated, those in the Safer Choice/Enhance or Safer Choice/Vaccinated food safety label versions were more likely to choose option B than option A. Being in the Safer Choice/Enhance group, which recall provided no justification for the safety claims made, significantly increased the odds of participants choosing option B. Participants in this group were 4.41 times

more likely to choose option B relative to option A, and 2.45 times more likely to choose the neither option compared to option A, both significant at the 5% level or better. Participants in the Safer Choice/Vaccinated group, whose label included information about the use of vaccines to reduce *E. coli* risk as a justification for the safer choice claim were also more likely to choose option B, although the odds ratio for this group at 1.89 was lower than that of the Safer Choice/Enhance group.

The fact that participants who received the 'unsubstantiated' food safety label without the words 'vaccines' or '*E. coli'* (Safer Choice/Enhance) were more likely to choose this version, compared to those who were exposed to the more informative versions may hint at how such interventions can be labeled. Frequency of reading food labels, acceptance of animal vaccines and preferences for how well beef burgers should be cooked were all statistically significant in determining the likelihood of choosing option B. For every level up the scale of the frequency of reading food labels, the partial odds of choosing option B relative to option A increased by a factor of 1.79. Similarly, participants who frequently read food labels were 1.75 times more likely to choose neither beef option, compared to option A. Given that all participants are consumers of ground beef, the increase in the odds of food label readers in choosing neither of the ground beef options is an outcome that would require further investigation. As expected, participants who are accepting of animal vaccines were more likely to choose option B, with a 51% increase in their odds. Although significant at the 10% level, the more participants preferred their beef burgers well cooked, the more likely they were to choose option B relative to option A. While it cannot be concluded that consumers who like their beef burgers well-cooked do so predominantly for safety reasons, there is nonetheless

some level of association between this characteristic and choosing the ground beef in option B.

Table 6. Multinomial Logit Results for the Three Labeling Choices

	Choose Option B		***Choose neither option***	
Parameter	Estimate	Odds ratio	Estimate	Odds ratio
Intercept	-5.7008*** (1.2621)		-7.1452*** (1.9240)	
Food safety label				
Safer choice enhance	1.4835*** (0.3379)	4.4082	0.8948** (0.4413)	2.4468
Safer choice vaccines	0.6361** (0.2955)	1.8890	0.3139 (0.4082)	1.3687
Attitudes, knowledge & opinion				
Personal health issues	-0.0794 (0.1677)	0.9236	0.0957 (0.2299)	1.1004
Food labels	-0.2440 (0.2006)	0.7835	-0.1266 (0.2723)	0.8811
Read labels	0.5847*** (0.2146)	1.7943	0.5600** (0.2831)	1.7506
Knowledge vaccines	-0.0622 (0.1537)	0.9397	0.1232 (0.2012)	1.1311
Accept vaccines	0.4118*** (0.1269)	1.5095	-0.1780 0.1610	0.8369
Burgers cooked	0.3146* (0.1657)	1.3697	0.2283 0.2258	1.2564
Opinion about the government's role				
Label vaccines	0.3373*** (0.1174)	1.4012	0.4429*** (0.1652)	1.5573
Mandate vaccines	0.3745*** (0.1156)	1.4543	-0.0590 (0.1420)	0.9427
Demographics				
Primary shopper	0.5572 (0.4433)	1.7458	1.0779 (0.8256)	2.9384
Child at home	-0.2690 0.2877	0.7641	-0.3787 0.3928	0.6848
College	0.17164 (0.3487)	1.1873	0.4403 0.5043	1.5532
Male	0.6240** (0.2820)	1.8664	0.1070 0.3894	1.1129
Income	0.0067** (0.0031)	1.0068	0.0031 0.0041	1.0031

Age	-0.0132	0.9869	-0.0064	0.9936
	(0.0087)		0.0117	
Location				
Shopping district	0.0438	1.0448	1.2766	3.5846
	(0.3799)		0.8286	
Natural Foods store	0.1319	1.1410	2.0621**	7.8628
	(0.4312)		0.8264	
Mid-low income area	-0.2527	0.7767	1.6943**	5.4429
	(0.4334)		0.8566	

∗ Estimated coefficient is significant at the 10% level. ∗∗At the 5%significance level. ∗∗∗At the 1% significance level. Standard errors are given in parentheses.
Note: Reference category: Option A (ground beef with only the standard label)

Participants who wanted beef products treated with vaccines labeled as such, were also 1.40 times more likely to choose option B, relative to option A. An interesting finding is that participants in this group also had a 56% increase in their odds of choosing neither of the two options, relative to option A. It can thus be inferred that consumers in the latter group might prefer having the vaccine intervention indicated on a beef label in order to avoid it, likely the result of their concerns about these interventions. This result is similar to Lusk and Fox (2002) who found a strong demand to mandatorily label beef products treated with hormones. Another interesting finding is that participants who advocated for vaccines against *E. coli* to be mandatorily adopted had a 45% increase in their odds of choosing option B, relative to option A. Regarding demographics, *Male* and *Income* were the two variables that emerged significant at the 5% level. Males were more likely to choose option B compared to option A. Regardless of household income, there was a similar likelihood in choosing either option A or B, with the odds ratio equal to 1.

The final segment in Table 6 are variables related to the venue of the grocery store visited. The two grocery stores located in two different affluent neighborhoods were considered as one location, and was assigned as the reference category. Relative to the grocery stores in the upscale suburban neighborhoods, shoppers in the natural foods store

were 7.86 times more likely to choose neither of the ground beef options, relative to option A. Even though this is not an entirely surprising finding, it also suggest that such consumers would be more difficult to convince concerning food safety technologies. In a similar result, shoppers in the store located in the mid-low income area were also more likely to opt for neither of the two ground beef options, compared to shoppers in the suburban communities. These results indicate diversity in preferences among shoppers sampled for the study.

5.2 Double-bounded Contingent Valuation Results

Responses of 263 participants who chose option B only (i.e., the ground beef with standard label plus a food safety label) were analyzed using the DBCV method, results of which are shown in Table 7. Three variations of the model were estimated. First, a basic model (Model I) which did not control for anchoring (starting point bias) and shift effects was estimated. The second model (Model II) controls for starting point bias using Chien, Huang and Shaw's (2005) approach with the bid set dummies, while the third model (Model III) controls for both anchoring and shift effects following Alberini, Kanninen and Carson (1997) and Whitehead (2002). The coefficients of the bid set dummies in Model II are both statistically significant at better than the 1% level, an indication of starting point bias in the data. The coefficient of the anchoring weight (γ) and the shift parameter (δ) in Model III are also statistically significant at better than the 1% level. The positive coefficient of the anchoring weight parameter suggest that response to the second bid was anchored to the first (Herriges and Shogren 1996; Whitehead 2002). The significant shift effect parameter also indicates that subjects' WTP shifted between the

two valuation questions. Thus, Models II and III are superior to Model I, the standard model.

The type of food safety label participants were exposed to was controlled for in the models using two dummy variables. The reference dummy was assigned as the *E. coli*/Vaccinated food safety label. Respondents randomly assigned to the Safer Choice/Enhance food safety label were willing to pay more, in both Models II and III, compared to respondents who saw the *E. coli*/Vaccinated label, a further indication that the food safety label with no justification about the food safety claim was more appealing. The coefficient of the Safer Choice/Vaccinated label was not statistically significant, relative to the *E.coli*/Vaccinated label version in all three models.

In relation to respondents' attitudes, knowledge and opinion, those who rated personal health issues as important in food purchasing decisions were also willing to pay more for the ground beef with a food safety label. Being more accepting of the use of animal vaccines in food production methods lowered marginal WTP, which was significant in all three models at the 5.4% significance level or better. This outcome is somewhat surprising, and suggests that support for a production process or attribute may not necessarily translate into a higher WTP for that attribute. Other studies show that support for a good or a policy is not always accompanied by a higher WTP for them. For example, Lusk and Fox (2002) found that while consumers favored mandatory labels for beef products from hormone-induced cattle as well as cattle fed GM corn, they were reluctant to pay more to have such products differentiated. In our study, however, support for labeling vaccines translated into higher WTP in all three models. This result mirrors findings from the literature reporting that the *'Contains'* label exerted a negative effect on

bidding behavior even when it was complemented with positive information (Liaukonyte et al. 2013). The difference here is that vaccination may be seen as a desirable attribute among respondents who would like to have them labeled on meat products. The remaining two variables that considered opinions about the government's role were not statistically significant in all three models.

Among demographics variables, *College* was statistically significant in Model III at the 1.5% level of significance. It is remarkable though, that the coefficient of this variable is negative, suggesting that respondents who had a college background or higher were willing to pay less for ground beef with a food safety label. Albeit this finding calls for further investigation, the fact that more educated respondents were willing to pay less does not necessarily indicate an aversion for the food safety label, or the vaccine intervention. It could potentially suggest that highly educated respondents were also more likely to question or doubt the *E. coli* reduction claim from vaccine use on the food safety label, or the unsupported claim about enhanced safety from cattle raised under strict health standards, to warrant an extra cost to them. The statistically significant *Income* variable in Models I and III indicate a higher WTP among respondents with high household incomes.

The grocery shop location variables were significant in all three models at the 10% level or better, relative to the more affluent locations designated as the reference category. Shoppers in the mid-low income area had a higher marginal WTP for a food safety label compared to those in the high income location. The most striking result, however, was that of the natural food shoppers, whose marginal contribution to WTP surpassed those in the shopping district and the mid-low income area, relative to the

shoppers sampled from the more affluent districts. It is plausible to suggest that since the natural food shoppers are understandably the most concerned about healthy foods, those in this group who chose the ground beef in option B were also willing to pay more for them, compared to shoppers in the affluent stores. The location variables were interacted with the food safety label variables to investigate interaction effects between grocery store location and the type of food safety label shoppers chose. The interaction effects were not statistically significant in any of the three model variations, and a likelihood ratio test concluded that the interaction models were not significantly different from models without interaction.

Table 7. Results from Double-Bounded Contingent Valuation Method

	Model I Standard Model		Model II With bid set dummies		Model III Anchoring & shift	
Variable	Estimate	p-value	Estimate	p-value	Estimate	p-value
Intercept	-0.405	0.563	0.081	0.891	-0.363	0.431
Food safety label						
Safer choice enhance	0.324	0.121	0.346	0.048	0.328	0.016
Safer choice vaccines	0.155	0.461	0.183	0.300	0.174	0.206
Attitudes, knowledge & opinion						
Personal health issues	0.329	0.002	0.255	0.005	0.296	0.000
Read labels	0.100	0.404	0.098	0.328	0.097	0.215
Accept vaccines	-0.163	0.046	-0.132	0.054	-0.151	0.005
Opinions about the government's role						
Label vaccines	0.230	0.020	0.233	0.006	0.229	0.000
Mandate vaccines	0.062	0.440	0.028	0.676	0.049	0.356
Ensure safety	-0.069	0.439	-0.024	0.751	-0.052	0.378

Demographics						
College	-0.431	0.058	-0.267	0.165	-0.364	0.015
Income	0.003	0.092	0.002	0.185	0.002	0.036
Children at home	0.093	0.595	0.091	0.536	0.098	0.390
Location						
Shopping district	0.454	0.060	0.370	0.073	0.389	0.014
Natural Foods store	0.895	0.001	0.732	0.001	0.802	0.000
Mid-low income area	0.724	0.008	0.719	0.002	0.702	0.000
Bid set dummies						
bid11			-0.841	0.000		
bid12			-0.792	0.000		
Anchoring and shift effects						
Anchoring (γ)					0.711	0.000
Shift (δ)					-0.986	0.000
Log likelihood	-343.81		-330.85		-677.59	

Associated mean WTP estimates for the three model variations for a pound of ground beef with a food safety label given individual characteristics are displayed in Table 8. The point estimates are comparable across the models, from $1.61 to $1.64. The WTP estimate from the standard model (Model I) has the widest 95% confidence interval, from $1.49 to $1.80. However, a t-test concluded that predicted values from Model I were not significantly different from Model II at the 5% level of significance, and likewise between Model I and Model III. Using the result from Model III, respondents on average were willing to pay a price premium of $1.63 for a pound of ground beef with a food safety label, which represents a 38% price premium over the average price of $4.30 per pound of ground beef with the standard label as given in the

survey. Nayga, Aiew and Woodward (2004) found that Texas consumers were willing to pay 75 cents to 78 cents as premium amounts for a pound of irradiated ground beef. Other studies have concluded that consumers were willing to pay a premium price for ground beef with the irradiation intervention (Huang, Wolfe, and McKissick 2007; Nayga, Poghosyan and Nichols 2002).

Table 8. Estimates of Mean WTP

Mean WTP estimate	Model I Basic Model	Model II With bid set dummies	Model III Anchoring & shift
Mean WTP	$1.64	$1.61	$1.63
Lower 95% CI	$1.49	$1.48	$1.52
Upper 95% CI	$1.80	$1.74	$1.73

Given consumer interest in beef labels that communicate quality and safety (Verbeke, and Ward 2006), our findings that respondents are willing to pay a premium price for ground beef with an additional food safety label is consistent with the general demand for safe food. However, the main issue of interest is participants' response to each of the three food safety label versions, and how they valued ground beef with these labels. To answer this, price premiums for each food safety label were estimated using results from Model III, and are shown in Table 9. The highest average price premium was $1.77, recorded for the ground beef product with the uninformative claim (Safer Choice/Enhance). Participants exposed to the Safer Choice/Vaccinated food safety label were willing to pay an average of $1.62 more for this option. A notable result was the response from participants in the group who saw the *E. coli*/Vaccinated food safety label version, who were willing to pay $1.44 as price premium for a pound of ground beef with this label, approximately 19% lower than the price premium for the food safety label

without the words "vaccines" or "*E. coli*" (Safer Choice/Enhance). While the 95% confidence interval for the Safer Choice/Vaccinated food label overlaps with the Safer Choice/Enhance version, the latter overlaps only slightly with the confidence interval for the *E. coli*/Vaccinated food safety label.

Table 9. Estimates of mean WTP for the food safety labels

Mean WTP estimate	Safer Choice/ Enhance	Safer Choice/ Vaccinated	*E. coli*/Vaccinated
Mean WTP	$1.77	$1.62	$1.44
Lower 95% CI	$1.60	$1.44	$1.24
Upper 95% CI	$1.94	$1.79	$1.65

Overall, our results show that labels that make a positive claim about a food product by providing vague information that is not necessarily substantiated could command higher premiums, compared to factual and accurate information that also emphasizes the positive attributes of the same intervention. As Liaukonyte et al. (2013) note, positive information about contested food production processes may not be enough to mitigate consumer biases. Even though vaccine use in animal production has not attracted widespread public debate compared to other interventions and production processes, there are concerns about their health impacts on humans, which might perhaps have influenced respondents' perceptions of ground beef products from vaccinated cattle.

6. Preference for Standard Labeled Ground Beef

6.1 Willingness to accept a discount

Table 10 shows the count and frequency for the discount bids among participants who chose the ground beef with the standard label (option A), but indicated a willingness to purchase option B (standard label and a food safety label) only at a discounted price if

that was their only choice. The range of discounts is shown in Table 2. In total, there were 65 such respondents, which represents 15% of all participants, and 58% of those who chose option A. Nearly 82% of participants in this group answered Yes to the first discount amount compared to the about 18% who answered No.

Table 10. Count and Frequency of Discount Response

	Discount 2		
Discount 1	No	Yes	Total
No	6	6	12
	37.50%	12.24%	18.46%
Yes	10	43	53
	65.50%	87.76%	81.54%
Total	16	49	65
	100.00%	100.00%	100.00%

This suggest that many respondents who were not strongly convinced about the additional food safety label were willing to accept a price discount to choose them. Six respondents, however, answered No to both discount questions, despite indicating a willingness to accept a discount if that was their only option. Six other respondents answered No to the initial discount offers, but Yes to higher discount amounts. In general, the willingness to accept discounts for the ground beef in Option B by participants who did not initially choose this alternative shows the diversity of opinions and perceptions concerning the food safety labeling cues.

6.2 Qualitative Response to Food Safety Labels

To shed further insights into subjects' labeling preferences, participants who chose ground beef option A (with the standard label only), and were unwilling to purchase option B even at a discount (46 participants in all, which is approximately 10.3% of the total sample) were requested to provide reasons for this choice [32 participants saw the *E. coli*/Vaccinated label version, 11 saw the Safer Choice/Vaccinated version, and 3 saw the Safer Choice/Enhance version]. Consistent with findings in Figure 2, the majority of the comments received were from participants who were randomly assigned to the *E. coli*/Vaccinated food safety label version (see select comments in section IV of the Appendix). Among these participants, their concerns were generally about the design of the food safety label and their uncertainty about animal vaccines. Such respondents noted that the label repulsed them, appeared scary, or was poorly designed. What is perhaps a significant concern were respondents misreading the food safety label, with remarks that suggested that the ground beef in option B contained harmful *E. coli*, harbored foodborne illness, or that vaccines were directly injected in the ground beef, rather than the cattle; an indication that these respondents did not read the additional information provided in the label. Other participants also indicated that cooking meat properly kills *E. coli* bacteria, or that vaccinations and other food safety interventions are poor production practices. The Safer Choice/Vaccinated food safety label elicited fewer comments, but they suggested aversion or doubts about the use of animal vaccines.

7. Conclusions

Despite evidence that consumers value safe food products, communicating food safety enhancing attributes/technologies on labels has remained difficult, partly due to

insufficient understanding or apprehension of food safety interventions. Building on and extending previous studies that show that consumers are willing to pay for specific food safety interventions (Nayga, Poghosyan and Nichols 2002; Nayga, Aiew, and Woodward 2004; Huang, Wolfe, and McKissick 2007) when they are provided with information about them, this study explored ways to effectively communicate food safety attributes through different labeling cues, and determined consumers' response and their WTP for such attributes. Using the case of vaccines against *E. coli* as an intervention proven to mitigate *E. coli* contamination in beef products, a hypothetical survey was designed and administered in five grocery stores. The survey asked shoppers to choose between two types of ground beef; one with a standard/generic label, and one that in addition to the standard label also had a food safety label. Three such food safety labels were designed and randomly assigned to participants. The first label provided unsupported claims about the safety of the ground beef product (Safer Choice/Enhance). The remaining two labels (Safer Choice/Vaccinated and *E. coli*/Vaccinated) provided information about the use of animal vaccines to corroborate food safety claims, differing in that one provided a positive message of food safety ('Safer Choice') while the other tried to communicate the absence of a harmful bacteria in the product ('*E. coli*' with a strikethrough).

For respondents exposed to the Safer Choice/Enhance food safety label with the uninformative claim of safety, 69% of them opted for this alternative, while about 62% of respondents exposed to the ground beef with the Safer Choice/Vaccinated food safety label chose this option. In contrast, less than half of participants (47%) in the last group chose the *E. coli*/Vaccinated food safety label. These results offer some insights into food safety labeling decisions; providing detailed information about food safety technologies

may not necessarily appeal to consumers. In our study, the most preferred label was the one that did not provide information about the intervention and its role in enhancing food safety. These findings align with Kahan et al. (2007) who suggest a careful framing of technologies in a manner that is assuring to consumers and alleviates potential concerns. Even though the *E. coli*/Vaccinated food safety label was the least liked among participants who were exposed to them, participants who nevertheless chose this label over the ground beef with the standard label had higher household incomes, than those who were assigned to, and chose the other two food safety labels.

Results also show that participants were willing to pay as much as 38% on average, as price premium for the ground beef with a food safety label. Participants who were exposed to, and who chose the Safer Choice/Enhance food safety label were willing to pay the highest price premium of $1.77, compared to those shown the other two food safety label versions. With such a high valuation of ground beef with a food safety label option, its presence in retail markets could potentially drive down the price of regular beef, drawing parallels with findings from Kanter, Messer and Kaiser (2009) who found in an experimental study that the presence of rBST-free milk reduced WTP for conventional milk. Another interesting finding is that preferences and WTP for safer foods may not follow conventional demographic patterns. For example, participants who had a high school education or less were willing to pay more for a food safety label, relative to those with higher educational backgrounds. We also found that participants in stores located in mid-low income areas and shoppers in natural food stores who chose the ground beef with a food safety label were willing to pay a higher price for them, relative to shoppers in stores located in more affluent neighborhoods.

However, having approximately a quarter of respondents choose the ground beef with the standard label also underscores the challenge of labeling food safety attributes. Among these participants, the majority indicated a willingness to purchase the ground beef with a food safety label at a discount if that was their only choice. Participants' concerns about the ground beef option with the additional food safety label in this case included mistrust or skepticism for vaccinations particularly among those who saw the labels with the precise description of the intervention, or some level of uncertainty among participants exposed to the label that made "unsubstantiated" claims about safety. Remarks shared by respondents who were completely opposed to ground beef with a food safety label, and would not purchase it even at a discount, echoed their aversion for vaccinations for a variety of reasons. These remarks included comments that suggested participants' doubts of the food safety labels, and insufficient knowledge of vaccines.

Pieced together, these findings suggest a potential market for beef products with additional food safety attributes, and a consumer segment willing to pay more for such products. Appealing to this segment will nevertheless require a tactful framing of information on such food labels; one that simultaneously eases consumers' doubt and signals the enhanced safety of the product. Given the limited consumer pool used in the study, however, as well as its regional focus, it will be useful for future research to target a sample that better reflects the demographics of the United States.

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APPENDIX

I. Food safety label versions

First version of option B: ‘Safer Choice/Enhance’ provides no information to support the food safety claim.

Second version of Option B: 'Safer Choice/Vaccinated' provides more precise description of the vaccine intervention

Third version of Option B: '*E. coli*/Vaccinated' also provides more precise description of the vaccine intervention

II. Household income comparison between Options A & B

Two-sample t test with equal variances for income

Group	Obs	Mean	Std. Error	Std. Dev	95% Conf. Interval	
Option A	111	49.66	4.17	43.97	41.39	57.93
Option B - (E.coli/vaccinated)	71	66.20	7.58	63.86	51.08	81.31
Combined	182	56.11	3.93	53.08	48.35	63.88
Diff		-16.54	7.99		-32.30	-0.76

diff = mean(1) - mean(2) t = -2.0685

Ho: diff = 0 degrees of freedom = 180

Ha: diff < 0	Ha: diff ≠ 0	Ha: diff > 0
Pr(T < t) = 0.0200	Pr(|T| > |t|) = 0.0400	Pr(T > t) = 0.9800

Group	Obs	Mean	Std. Error	Std. Dev	95% Conf. Interval	
Option A	111	49.66	4.17	43.97	41.39	57.93
Option B - (Safer choice/vaccinated)	91	52.75	4.96	47.28	42.90	62.59
Combined	202	51.05	3.19	45.40	44.75	57.35
Diff		-3.09	6.43		-15.77	9.60

diff = mean(1) - mean(2) t = -0.4796

Ho: diff = 0 degrees of freedom = 200

Ha: diff < 0	Ha: diff ≠ 0	Ha: diff > 0
Pr(T < t) = 0.3160	Pr(|T| > |t|) = 0.6320	Pr(T > t) = 0.6840

Group	Obs	Mean	Std. Error	Std. Dev	95% Conf. Interval	
Option A	111	49.66	4.17	43.97	41.39	57.93
Option B - (Safer choice/enhance)	101	64.11	5.51	55.33	53.19	75.03
Combined	212	56.54	3.44	50.11	49.76	63.33
Diff		-14.45	6.83		-27.92	-0.97

diff = mean(1) - mean(2) t = -2.1137

Ho: diff = 0 degrees of freedom = 210

Ha: diff < 0	Ha: diff ≠ 0	Ha: diff > 0
Pr(T < t) = 0.0179	Pr(|T| > |t|) = 0.0357	Pr(T > t) = 0.9821

III. Demographic differences among the food label version groups

Chi square test – Educational background

Food safety label	High school or less	Some college or higher	Total
Safer Choice/Enhance	22.32	77.68	100
Safer Choice/Vaccinated	17.49	82.51	100
E. coli/Vaccinated	11.43	88.57	100
Total	17.75	82.25	100

Pearson chi2(2) = 3.5309 Pr = 0.171

Analysis of Variance – Household income

Source	SS	df	MS	F	Prob > F
Between groups	1544.19	2	772.095	0.29	0.7451
Within groups	1156541	441	2622.543		
Total	1158086	443	2614.189		

Analysis of Variance - Age

Source	SS	df	MS	F	Prob > F
Between groups	93.29408	2	46.64704	0.17	0.8458
Within groups	123106.4	442	278.5213		
Total	123199.7	444	277.4769		

IV. Select comments from participants about the food safety label versions

Selection of comments from participants averse to the Safer Choice/Vaccinated label version

It looks scary

How do I know 100% what the cattle were vaccinated with

I don't think *E. coli* vaccine prevents *E. coli* infections in meat

Only eat natural, farm raised beef, no antibiotics. Grass fed, free to roam

I do not trust vaccinated meat

Selection of comments from participants averse to the E. coli/Vaccinated label version

Not necessary to vaccinate for *E. coli*

Because it has an illness, and no one would like to eat something that will get them sick

Vaccines and medicinal treatments for animals are generally poor practices

E. coli can be killed using proper cooking and handling techniques

Just seeing the word *E. coli* turns me off

Clearly states it contains *E. coli* which is harmful

Bad label design. At a glance it's got a bit *E. coli* sticker on it

I do not like meat that is vaccinated

I only purchase "healthy" beef

The label advertising the "No *E. coli*" seems a bit odd and a little scary, so to speak