Consumer Willingness to Pay for Food Safety Interventions: The Role of Message Framing and Involvement

Kofi Britwum
University of Nebraska-Lincoln
kbritwum@huskers.unl.edu

Amalia Yiannaka
University of Nebraska-Lincoln
ayiannaka2@unl.edu

Selected Paper prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, Massachusetts, July 31-August 2

Abstract

Research on recent pre-slaughter interventions in the beef industry, particularly vaccinations and direct-fed microbials, have proven their effectiveness in reducing *E. coli* contamination in beef. In spite of such evidences, adoption of these technologies have been minimal. This study determined consumer response and willingness to pay (WTP) for beef products from cattle vaccinated against *E. coli* and given direct-fed microbials, and evaluated multiple message frames and their persuasive impacts on WTP for the technologies. Respondents were grouped into six information treatments, and were exposed to gain-framed and loss-framed messages, a media food safety story, and combinations of the media story and the gain-framed and loss-framed messages. A survey which included a choice experiment targeted a representative, random sample of 1,879 residents across the U.S in July and August 2015. A random parameters logit model found that consumers preferred animal vaccines over direct-fed microbials, and preferred either intervention to none at all. Corroborating prospect theory's loss aversion, the loss-framed message, and the combined loss-framed message with the media story were the most persuasive, inducing the highest WTP. These findings altogether present an optimistic outlook about consumers' openness to these technologies, and are of interest to agents in the beef sector who influence the variety and presentation of consumption choices available to consumers.

Key words: direct-fed microbials, message framing, vaccines, willingness to pay.

JEL: D11 D12 Q13.

1 Introduction

Outbreaks due to virulent strains of *E. coli* bacteria (such as *E.coli* O157:H7) have received particular public and media attention because they can cause severe health problems such as kidney failure, paralysis or even death. Cattle are a major reservoir of the *E. coli* O157 strain, and many cases of *E. coli* related infections in humans have been traced to cattle. Produce farms in proximity to feedlots and pastures are also affected, with existing risks of cross-contamination through irrigation water and the environment, making the *E. coli* bacteria a threat even outside the beef sector. Beef safety compromises have obvious economic implications to beef producers and processing industries. Between the ten year period from 1993 to 2003, *E. coli* O157:H7 was estimated to have cost $2.7 billion to the beef industry, including $1.6 billion in lost demand (Kay 2003). Efforts at reducing contamination have yielded some successes, but these achievements tend to be short-lived. The Centers for Disease Control for example, reported declines in *E. coli* O157 infections in 2003 and 2004, but new cases of infections re-emerged in 2005 and 2006 (CDC 2006). Such developments underscore the inadequacy of tackling beef contamination only at the processing and post-slaughter stages in meat packing industries. Government agencies and the food industry have been investing in research and the development of technologies that can reduce the incidence of foodborne illness. Findings from some of these studies on pre-slaughter interventions such as vaccinations and direct-fed microbials have proven their effectiveness in reducing *E. coli* contamination in beef. Direct-fed microbials are a source of live, naturally occurring microorganisms that compete against *E. coli* O157:H7 for nutrients in cattle. Hurd and Malladi (2012) state an 80% reduction of *E. coli* bacteria in the shedding of vaccinated cattle, while Brashears (2012) reports at least a 50% reduction of *E. coli* on hides and shedding when cattle are given direct-fed microbials. Matthews et al. (2013) predict that vaccinating cattle against *E. coli* bacteria has the potential to decreasing human cases of infections by at least 85%. These interventions, vaccines against *E. coli* in cattle, and the use of direct-fed microbials, have been approved for use by the U.S. Department of Agriculture (USDA) and FDA, respectively.

As is often the case with new technologies in the food sector, however, consumer perceptions regarding their effectiveness and safety are key determinants of their adoption by producers, processors and/or retailers. In this context, the goal of this study is to evaluate consumer preferences and willingness to pay (WTP) for the two technologies/interventions effective in reducing beef food safety risks. Motivated by Kahneman and Tversky's (1979) prospect theory which suggest that individuals are more sensitive to losses than they are to gains of the same magnitude, the study investigates the impact of providing gain-framed and loss-framed messages on consumer WTP for beef products from cattle treated with the interventions. The study also examines the influence of involvement elicitation on WTP by including a story published in the New York Times in its October 3, 2009 edition that reports the case of a young woman who suffered a severe form of foodborne illness that left her paralyzed after consuming an *E. coli O157* contaminated hamburger. Given that due to minimal adoption by producers beef products from cattle treated with these interventions are not widely available in the market at present, a survey instrument which included a hypothetical choice experiment was developed to achieve the study objectives. The experimental design involved six information treatments, and each information group was exposed to different information before participating in the choice experiment.

This research contributes to existing literature by exploring preferences and WTP for beef safety technologies that have had limited adoption among beef producers, and within the framework of prospect theory. Findings will be illuminating to multiple agents along the beef supply chain including beef producers as they assess and consider these technologies, and the potential role for government agencies in regulating and mandating their use. Additionally, the influence of message framings on consumer WTP do suggest effective ways of communicating the benefits of new food safety interventions.

2 The Role of Information Framings and Preferences for Food Safety Interventions

Consumer preferences for safer food options and their WTP for them have been the subject of an expanding literature. Findings from a number of such studies show that consumers are usually accepting of interventions and processes that improve food safety standards. Shogren et al. (1999) found for instance, that consumers were willing to pay a premium price for irradiated chicken breast, as the irradiation process offered a reduced risk from foodborne pathogens. In a study to investigate WTP for irradiated beef by Nayga, Woodward and Aiew (2006), participants were given the option of exchanging a pound of conventional ground beef for one that had been irradiated, using a randomly allotted cash as the WTP bid. The authors found that not only were consumers willing to pay for irradiated beef products, they were also willing to pay amounts that favored irradiation of ground beef on a commercial scale. Other findings that support consumers' preferences for food safety interventions include the study by Mukhopadhaya et al. (2004) that examined WTP for a hypothetical vaccine that protected against major foodborne pathogens, and that had varying durations of protection. Consumers were willing to pay, they found, to be protected against harmful pathogens, and placed a premium on being protected against the *E. coli* bacteria. Teisl and Roe (2010) found similar results when they investigated consumers' WTP for products that offered a reduced probability of contamination – consumers would pay to reduce the probability of becoming ill.

There is abounding evidence regarding the impact of message framings on consumer preferences and behavior. Studies that have investigated the persuasive influence of message framings have utilized an array of information types, such as media stories, negative and positive information, and gain and loss-framed messages. Such studies employ both hypothetical and non-hypothetical approaches in determining the impact of message framings on consumers' attitudes. Overall, findings prove that the persuasiveness of such messages is in part determined by the manner in which they are presented. Within the purview of food safety and consumer behavior, some attention has been devoted to the information effects on consumer attitudes towards interventions that reduce food contamination. Nayga, Aiew and Nichols (2004) investigated this by exposing random shoppers to information about the nature and benefits of food irradiation, and how that influenced purchasing behavior. Respondent buying decisions were positively impacted by the information. Other literature that has explored the effects of message framings on attitudes includes the study by Schroeter, Penner, and Fox (2001), who examined consumers' risk perceptions of foodborne illnesses from beef consumption. The authors concluded that providing information that dispelled the misperception that irradiation triggered the incidence of cancers induced a positive WTP from approximately 70% of respondents. A number of studies that has investigated information effects on consumers' behavior have been inspired by Kahneman and Tversky's (1979) prospect theory. Messages when tweaked either as losses or gains, or when presented as positive or negative messages, have been noted to influence consumers' attitudes differently. As defined by Kahan et al. (2008), "message framing occurs when some element of presentation that is logically unrelated to the content of information nevertheless affects the impact of that information on beliefs or behavior". Within the sphere of prospect theory, message framings are the presentation of comparable information in terms of benefits and losses. There are research findings in a variety of disciplines that suggest that the persuasiveness of message framings may be context specific. To this end, both gain-framed and loss-framed messages have been found to be strongly persuasive under different domains. A study by Meyerowitz and Chaiken (1987) concluded that loss-framed messages had a stronger persuasive influence in encouraging voluntary breast-self-examination. Abhyankar, O'Connor and Lawton (2008) exposed participants to either a loss-framed or gain-framed message with the objective to investigating the role message framings played in encouraging vaccination of children against measles, mumps and rubella. The authors found that the loss-framed message had a stronger persuasive effect in inducing intent to vaccinate children, compared to gain-framed information. Further buttressing the effectiveness of loss-framed messages across other domains such as banking, Gonzach and Karsahi (1995) found that the rate of re-use of a credit card more than doubled among customers who had discontinued the use of the card for three months, when they were exposed to loss-framed messages about the benefits they forfeited, than with customers who received a gain-framed message. However, Gallagher and Updegraff (2012) concluded that gain-framed information was more persuasive in promoting preventative behavior and measures against illness, compared to loss-framed information.

In other instances, the persuasive influence of message framings hinge on the extent of participants' involvement to the issue(s) at stake. Issue involvement is defined as the extent to which the attitudinal issue under consideration is of personal importance (Petty and Cacioppo, 1979). Maheswaran and Meyers-Levy (1990) investigated the impact of information on health-related attitudes when issue involvement is high. Using college students for the study, a group received information about the existing high risk of coronary heart disease for people under 25 years, and this group was considered been highly involved, whereas the low involvement group was informed that the risk of coronary heart disease was higher among older people. Findings showed that the negatively framed message was more persuasive in urging respondents to test for coronary heart disease when issue involvement was high. Other studies have looked at consumer responses to the provision of either positive or negative information. Fox, Hayes and Shogren (2002) used auctions of irradiated pork to determine the effect of positive and negative information on consumer attitudes. The positive information was sourced from a scientific body and communicated the benefits of irradiation, while the negative information from a consumer advocacy group cautioned against the consumption of irradiated food because of its risk. Participants provided with the positive information had a greater WTP, and those provided negative information a lower WTP. Nevertheless, the negative information on irradiation was reported to have had a stronger influence on participants who were simultaneously provided with both information types. Dillaway et al. (2011) investigated the role of food safety information and its lingering effect on WTP for poultry products over time. Subjects were recruited for a seven-weeklong lab experiment and were randomly assigned to a control or treatment group. Subjects in the treatment group received either positive or negative media-related food safety information on four poultry products and submitted bid amounts for these products while those in the control group did not receive any information. Compared to the control group, consumers' WTP were significantly influenced by the information provided, with those who received negative information having a lower WTP and those receiving the positive information having a higher WTP. These findings were consistent over the seven week span of the study, suggesting that information on food safety has a long lasting effect on consumer demand

3 Expected Utility Theory and Prospect Theory

The persuasiveness of message framings is explained by Kahneman and Tversky's (1979) prospect theory which describes the framing of preferences in the face of uncertainty and risk. Prospect theory is an alternative hypothesis to the expected utility theory. According to the expected utility theory, choices between uncertain prospects are made on the basis of their expected utilities. Decisions are thus dependent on the weights or probabilities attached to each of its outcome. Following Barberis' (2012), an individual will evaluate *i* sets of decisions under expected utility theory as:

$$\sum_{i}^{n} p_i U(W + x_i) \tag{1}$$

where x_i represents the outcome of decision *i* with probability p_i, W represents current wealth and $U(\cdot)$ is an increasing and concave utility function. However, under prospect theory, the decision sets are evaluated as:

$$\sum_{i}^{n} \pi_i v(x_i) \tag{2}$$

where $v(\cdot)$ is a value function and π_i are decision weights.

Prospect theory proposes that the manner in which decisions are framed has an influence on preferences and outcomes. For this reason, individuals define utility in terms of deviations from a reference point (gains and losses). This notion contrasts with an individual's von Newmann-Morgenstern expected utility, which is defined in terms of initial wealth. The 'S' shaped value function explains the concept of loss aversion, that is, individuals being more sensitive to losses than to gains of the same magnitude. The value function is steeper in the loss region than in the gain region (as shown in Figure 1), which indicates that an individual's valuation of their loss is deemed greater than the value they attach to gains, even when both gains and losses are on the same scale.

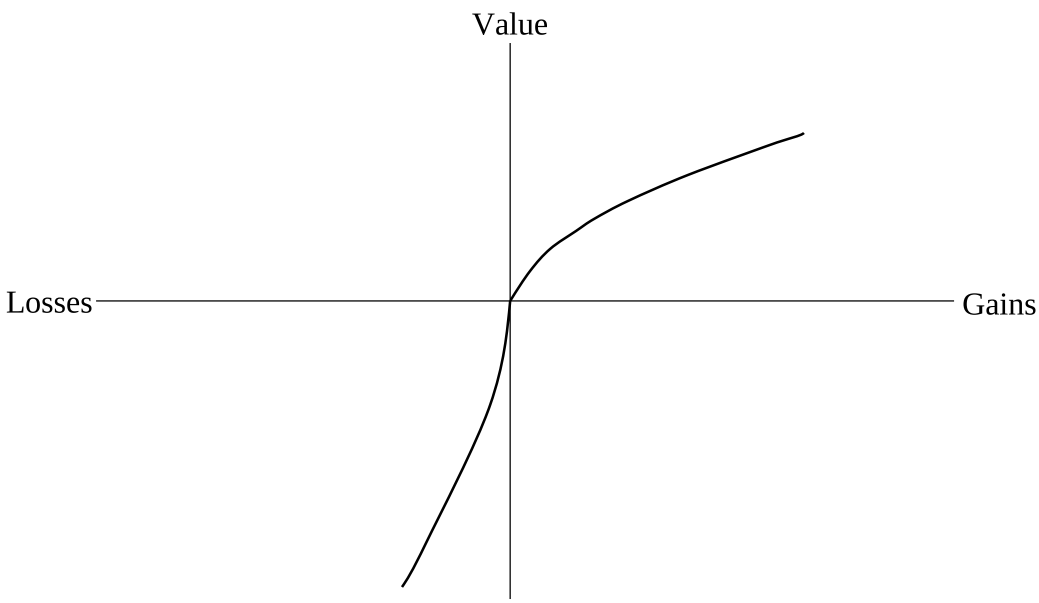

Figure 1. A hypothetical value function

Within the context of beef food safety, the horizontal axis of the value function indicates gains or losses from the reduced risk of an *E. coli* food infection from beef consumption, and the vertical axis is the value assigned to them. The concavity of the value function in the region of gains and the convexity in the region of losses depict the concept of diminishing sensitivity. Diminishing sensitivity means that the impact of a marginal change diminishes with increasing distance from the reference point. The decision weights as used in equation 2 is different from the probabilities in expected utility theory. The weights that individuals attach to decisions do not necessarily correspond to their objective probabilities. Individuals tend to overweight smaller probabilities or unlikely outcomes, and place less premium on higher probabilities. Prospect theory thus suggests that individuals' responses are contingent on how messages are framed, either as losses, or as gains (Abhyankar, O'Connor and Lawton 2008). In line with prospect theory, respondents are expected to attach greater weights to the benefits from the reduced risk of an *E. coli* infection when information is presented in terms of losing these benefits, rather than having or gaining them.

4 Information Treatments

A growing body of literature in consumer behavior lends sufficient evidence to the role information provision plays in influencing individual perceptions of products, attributes or processes (Fox, Hayes and Shogren 2002; Schroeter, Penner, and Fox 2001; Nayga, Aiew and Nichols 2004). The experimental design for the study involved six information groups, with respondents assigned randomly to the groups. The information treatments were gain-framed and loss-framed messages, a control group, a media story, and a combination of the media story with the gain-framed and loss-framed messages. To put respondents on the same base of knowledge regarding the two pre-slaughter interventions, all groups were provided a general information about the benefits of vaccines and direct-fed microbials. The general information also highlighted the efficacy of the treatments: the potential for vaccines to reduce human cases of *E. coli* infections by as much as 80%, and direct-fed microbials by as much as 50%. The FDA's approval of direct-fed microbials, and the USDA's approval of vaccines with no known risks were additional information provided to all groups. Both gain-framed and loss-framed messages had a common theme, recounting the potential reduction of human *E. coli* cases by up to 80% if cattle were vaccinated against *E. coli* O157, and had direct-fed microbials included in their diet.

In detail, the gain-framed message narrated that by choosing to consume beef products that underwent these interventions, respondents significantly reduced their risks of an *E. coli* infection. Included in the gain-framed message was the private benefit of the interventions, which narrated that reducing *E. coli* bacteria in cattle also reduced their environmental dissemination into irrigation water and eventually onto produce, which altogether decreased human exposure to the bacteria. This implied that consumers who did not consume beef also stood to benefit from the interventions. The loss-framed message reported that choosing to consume beef products from cattle that had not undergone either of the pre-slaughter interventions increased one's risk of an *E. coli* food infection. The loss-framed message also had the private benefit component, that health risks to humans were greater if cattle were not treated with these interventions, because of the potential environmental dissemination of *E. coli* bacteria into irrigation water, and consequently onto produce. Apart from the gain and loss-framed messages, another of the information treatments reported a media story about the plight of a consumer who became infected with *E. coli*. Statistics about human cases of *E. coli* in the United States preceded the story, which referenced a news article published in The New York Times in its October 3, 2009 edition, about a children's dance instructor, Stephanie Smith, 22, who suffered a severe form of an *E. coli* infection after consuming a hamburger prepared by her mom for a Sunday dinner. The illness left her paralyzed, with her kidneys at the risk of failure. The objective of including Stephanie Smith's story was to elicit high respondent involvement with the issue, with the cue that young, energetic individuals also faced the risk of an *E. coli* infection. Literature about information framings show that people tend to process and integrate issues more cautiously when they are highly involved with the subject matter ((Maheswaran and Meyers-Levy 1990 ; Chaiken 1980). The survey instrument for the control group had only the general information as previously described. Table 1 summarizes the information framings for the six treatment groups.

Table 1. Treatment groups

Treatment Group	Type of Information	Number of Respondents
Control Group	General information	306
Treatment 2	Gain-framed information	295
Treatment 3	Loss-framed information	304
Treatment 4	Media story	309
Treatment 5	Media story & Gain-framed information	312
Treatment 6	Media story & Loss-framed information	316

5 Choice Experiment

Choice Experiments (CEs) present a combination of attribute levels under different alternatives and are widely used in marketing research and across other disciplines such as economics and transportation (Kuhfeld 2005). CEs are useful in their demand revealing properties for stated preference surveys and have been employed in studies by Lusk and Parker (2009), Onken et al. (2011) and Goibov et al. (2012), among others. CEs are noted to closely resemble choice scenarios experienced by consumers in an actual market setting (Lusk and Schroeder 2004). The CE design used in this study closely followed the techniques developed by Kuhfeld (2005) using the SAS software (SAS Institute Inc., 2010).

Respondents were presented with credence attributes for a pound of ground beef, from which they chose among alternative attribute levels, at a given price. The use of ground beef for the CE was primarily because of its susceptibility to, and its risk of contamination from *E. coli*, making it germane to the beef safety interventions studied. Ground beef's proneness to *E .coli* contamination stems from the way they are processed – a combination of meat from different animals and farms finely chopped by a meat grinder during the processing stages. Another reason for the choice of ground beef was that its consumption accounts for over half of the total beef consumed (Pruitt and Anderson 2012), which effectively makes it a familiar product among beef consumers. The CE as used in this study had five attributes: price per pound, production method, leanness, feeding management and treatment. The treatment attribute had three levels: Vaccinated against *E. coli*, Fed direct-fed microbials (Dfms) and No treatment. The "No treatment" level in the treatment attribute was included to capture the status quo, that is, beef producing cattle not treated with the proposed interventions. The price attribute had three levels, \$3.49/lb, \$4.49/lb and \$5.49/lb. The average price of a pound of ground beef across the United States as at 2015 (\$4.49) served as a guide for the price levels. There were two levels of the production method attribute, organic and conventional. Low, medium and high-end leanness percentages were the levels used to capture the leanness attribute. These levels were given as 73% lean, 85% lean and 93% lean. As a result of continued consumer interest in the nutritional composition of cattle feed (Daley et al. 2010), the feeding management attribute with its two levels: grass-fed and grain-fed were included. The attributes and the levels as used in the CEs are summarized in Table 2.

Table 2. Attributes and Levels for Choice experiments

Attribute	Levels
Price	\$3.49/lb, \$4.49/lb, \$5.49/lb
Production Method	Organic, Conventional
Leanness	93% Lean, 85% Lean, 73% Lean
Feeding Management	Grass-fed, Grain-fed
Treatment	Vaccinated against *E. coli*, Fed Direct-fed microbials, No treatment

The treatment attribute was designated as the alternative specific attribute, which meant that the three levels, 'Vaccinated against *E. coli*', 'Fed direct-fed microbials' and 'No treatment', were labels appearing in each alternative in the choice sets. Kuhfeld's (2005) methods and macros were closely followed in the design of the CE. Having decided on the treatment attribute as the alternative specific attribute, four attributes remained. Two attributes (price and leanness) of the four had three levels, with the remaining two attributes (production method and feeding management) having two levels. Randomizing these levels across the three alternatives (Vaccinated against *E. coli*, Fed Direct-fed microbials and No treatment) yielded a full factorial design of 46,656 different combinations ($3^{3x2}.2^{3x2}$). Evidently, these many treatment combinations were practically infeasible to be completed by a single respondent, for which reason techniques were used to achieve a fractional factorial design that is both balanced and orthogonal. With the attribute levels, reasonable fractional factorial sizes were created using the *%mktruns* macros in SAS 2013. An orthogonal fractional factorial design with a size of 36 and with zero violations was eventually settled on. The D-efficiency, a measure of the goodness and efficiency of a design was 100% for the chosen design, indicating very minimal variance matrix. Constructing the linear design further resulted in 36 choice sets. Again, recognizing that 36 different choice sets were still too many for a single respondent, the *%mktblock* macro was used to create three blocks of 12 sets each. Thus, each respondent completed 12 choice sets from one of the blocks. The *%mktblock* macro creates a blocking variable to the linear design, at the same time ensuring that it is uncorrelated in each alternative with every attribute, thus preserving the orthogonality of the design (Kuhfeld 2005). To preclude the situation where respondents felt compelled to necessarily make a choice from the attribute combinations among the three alternatives, a situation which could potentially lead to over-inflation of the estimates (Hensher et al. 2005), a new option, “I will not purchase”, was added to each choice set. This then presented a more realistic market scenario where respondents could choose to opt out of a purchase. Figure 2 shows an example of a choice set.

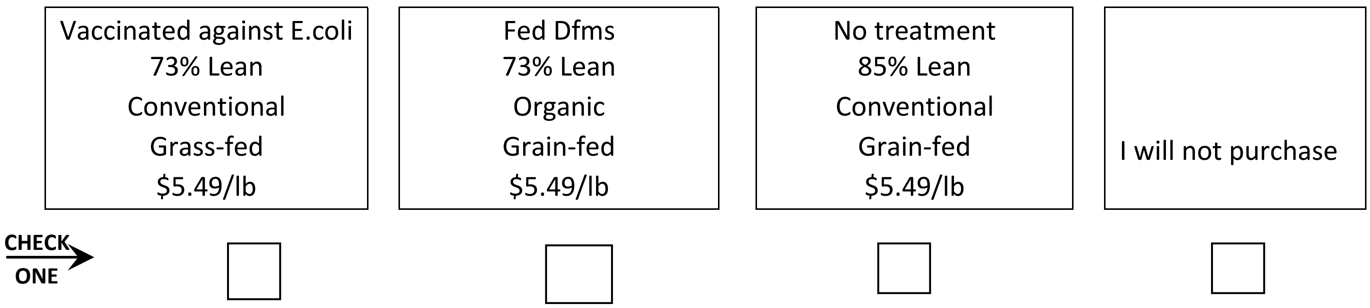

Figure 2. Sample Choice Set

To mitigate potential stated choice hypothetical bias in the choice experiments, a brief cheap talk script (Cummings and Taylor 1999) preceded the choice sets in each block. Although the impact of cheap talk scripts are mixed in terms of the accuracy of hypothetical purchases reflecting real purchases, Bosworth and Taylor (2012) notes that cheap talk scripts make respondents more price sensitive in their choices. The brief script used in this study narrated how respondents in similar surveys often overstated their willingness to pay for a good compared to how much they would pay in an actual store setting, and emphasized the importance for choices to be made to reflect one’s true WTP.

6 Data and Descriptive Statistics

The survey instrument for the study was administered to a diverse, nationally representative sample of 2,999 individuals across the United States between July and August, 2015. These individuals were targeted from the web-panel pool of respondents from the Gfk Group, which specializes in web-based surveys. Of this number, 1,879 responses were received, yielding a response rate of 62.7%. After accounting for missing data, responses from 1,842 individuals were used. With 12 choice sets and four alternatives from one of three blocks, a total of 88,416 (12 x 4 x 1842) observations were generated, across the 1,842 respondents. This consisted of 12 choice sets for each respondent and 4 alternatives per choice set, noting that each alternative in a choice set represents an observation. The total number of observations from the choice sets were however divided among the six information treatment groups, which approximates to 14,736 observations per information group.

Table 3. Demographic variables of respondents

Variable	**Description**	**Mean**	**Std Dev**
Male	1 if subject is male; 0 otherwise	0.50	0.50
College	1 if subject has some college education; 0 otherwise	0.61	0.49
Income	Household income, in thousands	72.75	51.59
Age	Age, in years	50.67	16.98
Farm animals	1 if subject grew around farm animals; 0 otherwise	0.28	0.45
Beef consumption	1 if subject has high beef consumption; 0 otherwise	0.69	0.46
Self-reported knowledge:	*Scale*: 1 = nothing to 4 = a great deal		
E. coli bacteria		2.25	0.77
Animal Vaccines		1.79	0.81
Direct-fed microbials		1.39	0.67

Table 3 shows the statistics of respondents' demographics. There were half as many males as there were females, which reflects the 2010 national population of 49% males and 51% females (US Census Bureau 2010). Over 61% of respondents had at the least been to college, while the average income was estimated at $73,000. The average age of respondents was 51 years. Approximately 28% of respondents grew up around farm animals, which is indicative of the rather large non-farm population. About 69% of respondents were high beef consumers, a proportion created from an index of consumption averaged over the frequency of consuming ground beef, hamburgers cooked at home or in a restaurant, and beef steaks. Respondents were on average more knowledgeable about *E. coli* bacteria than they were about animal vaccines and direct-fed microbials. Not very surprising, direct-fed microbials were the least known intervention.

7 Econometric Model

7.1 Random Parameters Logit

The random parameters logit (RPL) model was used in the estimation of the choice data. The RPL model overcomes the independence of irrelevance alternatives' limitation of the multinomial logit model, it allows the coefficients in the model to vary across respondents, and also allows correlations over alternatives (Revelt and Train 1998; Hensher, Rose and Greene 2005). Following Revelt and Train (1998) and Train (1998), the standard logit model is

$$U_{njt} = \beta_n' x_{nit} + \varepsilon_{nit} \quad (3)$$

where n is the n^{th} respondent in the survey, $j = 1 \ldots\ldots J$ is the $J = 4$ alternatives: Vaccinations, Direct-fed microbials, No Treatment, and No Purchase. Subscript $t = 1 \ldots\ldots T$ are the 12 choice sets per respondent. x_{nit} is a vector of observed variables, β_n is a vector of coefficients unobserved for each n, and distributed as $f(\beta'_n|\theta)$ where θ are the parameters of the distribution and $\varepsilon_{nit} \sim iid$ extreme value. The coefficient β_n in equation 3 can be decomposed into the means and standard deviation for each respondent, given by $\beta_n' = b' + \eta_n'$, where b is the population mean, and η_n the random deviation which denotes the presence of unobservable heterogeneity in the sampled population. The standard deviation allows β_n to vary across respondents. Conditional on β_n, the probability that person n chooses alternative i in choice set t is

$$L_{nit}(\beta_n) = \frac{e^{\beta_n' x_{nit}}}{\sum_j e^{\beta_n' x_{njt}}} \quad (4)$$

Respondent preferences for the alternatives vary in the population with density $f(\beta_n|\theta)$, and the unconditional probability is obtained by integrating the conditional probability over all possible values of β_n, with a density of $f(\beta_n|\theta)$.

$$Q_{nit}(\theta) = \int L_{nit}(\beta_n) f(\beta_n|\theta) d\beta_n \quad (5)$$

As noted by Revelt and Train (1998) and Train (1998), the probability of each respondent's sequence of choices is needed for maximum likelihood estimation, as there were repeated choices in the choice experiment. If *i(n, t)* is the chosen alternative by the n^{th} person for choice set *t*, and if β_n were known, then respondent *n's* observed sequence of choices is:

$$S_n(\beta_n) = \prod_t L_{ni(n,t)t}\,\beta_n \qquad (6)$$

However, because β_n is unknown, the unconditional probability is the integral of equation 6 over all values of β_n.

$$P_n\,(\theta) = \int S_n(\beta_n) f(\beta_n|\theta) d\beta_n \qquad (7)$$

β_n, which is the coefficient vector associated with the n^{th} person reflects the individual's unique taste, and varies over all respondents. The log-likelihood function is $LL(\theta) = \sum_n InP_n\,(\theta)$. Because an analytical computation of equation 7 is not feasible, the exact maximum likelihood estimation is not possible. However, the probability can be estimated using a simulated log-likelihood function. This probability is approximated by summing over randomly chosen values of β_n drawn from its distribution. With this draw, the product of the standard logits, $S_n(\beta_n)$ is calculated. The process is repeated for many draws for which the probability is approximated by averaging the product of the standard logits, i.e.:

$$SP_n\,(\theta) = \frac{1}{R} \sum_{r=1,\ldots,R} S_n(\beta^{r|\theta}) \qquad (8)$$

where *R* is the number of draws of β_n, $\beta^{r|\theta}$ is the r^{th} draw from the density $f(\beta_n|\theta)$, and $SP_n\,(\theta)$ is the simulated probability of a respondent's choices. The simulated log-likelihood function is $SLL(\theta) = \sum_n InSP_n\,(\theta)$, where the simulated log-likelihood function is maximized by the estimated parameters. This study was evaluated at 1,000 Halton draws, and was accomplished in STATA using the *mixlogit* command written by Hole (2007). The price coefficient in the RPL model was assumed to be fixed, while the remaining variables were specified as random and normally distributed. Fixing the price coefficient ensures that the estimated WTP estimates are normally distributed, and obviates any possibility of a respondent having a positive coefficient for price (Revelt and Train 1998; Layton and Brown 2000). For the n^{th} individual, the coefficient vector is given as $\beta_n = b + \sigma\mu_n$ where μ_n is the vector of independent standard normal deviates, and σ a diagonal matrix of standard deviations.

7.2 Random Parameters Logit with Correlated Parameters

The random parameters logit model assumes that the parameters are independently distributed. However, it is possible that the vaccination attribute is correlated with direct-fed microbials, or with the organic attribute. These possible attribute correlations were investigated using the dataset from the control group. Respondents in the control group were exposed to minimal information, and so any possible correlations are deemed less likely to be induced by the information effect, compared to other groups for example. Other than the price variable which was fixed, the remaining random parameters were assumed to have a normal distribution, where $\beta_n \sim N(b, \Omega)$, and Ω is the variance covariance matrix. Taking the potential attribute correlations into account, the n^{th} consumer's vector of coefficient as shown by Revelt and Train (1998) is $\beta_n = b + L\mu_n$, where L is the lower triangular Cholesky factor of the covariance matrix, and $LL' = \Omega$.

7.3 Mean Willingness to Pay

The estimated coefficients from the RPL model can be used to derive the marginal rate of substitution between attributes. The coefficient of the price attribute can be used to determine the amount of money respondents are willing to pay when it is divided by an attribute of interest, and the result multiplied by -1. That is, the rate at which a respondent is willing to forfeit an amount of money for an increase in an attribute being examined, when all other attributes are held constant. This is empirically derived as:

$$mean\, WTP = \frac{\partial V / \partial Attribute}{\partial V / \partial Price} = -1\left(\frac{\beta_{non-market\ attribute}}{\beta_{monetary\ attribute}}\right) \quad (9)$$

This conveniently allows the estimation of mean WTP values for a pound of ground beef for any particular attribute specified. For the RPL model, having price as a fixed parameter, rather than a random parameter allows the estimated WTP to have the same distribution as the coefficient, thus simplifying its interpretation (Revelt and Train 1998).

8 Results and Discussion

8.1 Random Parameters Logit Model

Results from the RPL estimation are displayed in Table 4. Nearly all the variables in the model were significant, apart from the organic and grass-fed attributes in some of the information groups. With the organic attribute in the gain-framed and the loss-framed groups as exceptions, the remainder of the information groups had a statistically significant estimated standard deviations for all attributes, an indication that the parameters varied in the population. The relative magnitudes of the alternative specific constants illustrate that vaccines were preferred to direct-fed microbials, and the latter preferred to the no treatment option, compared to not at all purchasing a pound of ground beef across all information treatments. For instance, the coefficient for the vaccines attribute in the loss-framed group was 4.11, while that of direct-fed microbials and no treatment were 3.42 and 1.41 respectively, relative to the no purchase option. The estimated standard deviations for these attributes reflect significant preference heterogeneity among respondents. For the loss-framed group, the estimated standard deviations were 3.36 for vaccines, 2.89 and 3.27 for direct-fed microbials and no treatment, respectively. These findings reveal that although there was a strong preference for the interventions, there was also some degree of variability in preferences for these options.

Table 4. Results from Mixed Logit Model

Mixed Logit Model						
Variable	**Control**	**Gain-framed**	**Loss-framed**	**Media Story**	**Gain + Media S**	**Loss + Media S**
Random parameters						
Vaccines	2.9140*** (0.2702)	3.0110*** (0.3164)	4.1149*** (0.3134)	2.9287*** (0.2466)	3.2992*** (0.2654)	4.3637*** (0.3060)
Dfm	2.4705*** (0.2569)	2.4686*** (0.2819)	3.4235*** (0.2754)	2.5134*** (0.2384)	2.9975*** (0.2710)	3.1434*** (0.2631)
No Treatment	1.5215*** (0.2798)	1.3858*** (0.2903)	1.4100*** (0.3240)	1.4672*** (0.2624)	1.1608*** (0.3436)	1.6071*** (0.3110)
Lean 93%	1.2392*** (0.1236)	0.9927*** (0.1167)	1.3317*** (0.1369)	1.0740*** (0.1126)	1.1006*** (0.1148)	1.2234*** (0.1194)
Lean 85%	0.9491*** (0.0950)	0.6428*** (0.1029)	0.7118*** (0.1065)	0.6879*** (0.0916)	0.8630*** (0.0875)	0.8438*** (0.0948)

Organic	0.1058 (0.0862)	0.1272** (0.0367)	0.1311*** (0.0309)	0.1402 (0.0867)	0.1121 (0.0815)	0.0431 (0.0631)
Grass-fed	0.2572** (0.1037)	0.2042** (0.0963)	0.0058 (0.0932)	0.2942*** (0.0881)	0.2473*** (0.0962)	-0.0304 (0.0957)
Fixed parameter						
Price	-0.7165*** (0.0439)	-0.6947*** (0.0430)	-0.7993*** (0.0451)	-0.6685*** (0.0407)	-0.7598*** (0.0436)	-0.7848*** (0.0447)
Standard deviation						
Vaccines	2.8991*** (0.2025)	3.0810*** (0.2948)	3.3574*** (0.2316)	2.7425*** (0.1789)	3.0411*** (0.2122)	3.1286*** (0.2018)
Dfms	2.3570*** (0.1592)	2.7711*** (0.2205)	2.8999*** (0.1917)	2.1300*** (0.1561)	2.7626*** (0.1886)	2.8734*** (0.1941)
No Treatment	2.9736*** (0.2404)	2.8216*** (0.2472)	3.2697*** (0.2275)	2.6237*** (0.1955)	3.0555*** (0.2125)	2.9945*** (0.2406)
Lean 93%	1.3978*** (0.1292)	1.2465*** (0.1325)	1.7193*** (0.1501)	1.2562*** (0.1231)	1.2684*** (0.1204)	1.3772*** (0.1261)
Lean 85%	0.6386*** (0.1427)	0.9190*** (0.1152)	-1.0601*** (0.1364)	0.7162*** (0.1224)	0.4739*** (0.1436)	-0.7327*** (0.1218)
Organic	1.0682*** (0.1315)	-0.1864 (0.1368)	0.0520 (0.1390)	-1.1713*** (0.1107)	0.9067*** (0.1505)	0.7396*** (0.1173)
Grass-fed	1.3713*** (0.1136)	1.0136*** (0.1032)	1.0158*** (0.1115)	1.0236*** (0.1105)	1.1580*** (0.1150)	1.1814*** (0.1103)
Log Likelihood	-3409.51	-3370.73	-3228.53	-3636.80	-3478.85	-3419.86

***significant at 1%, ** significant at 5%, and * significant at 10%. Standard errors in parenthesis.

In the model, the loss-framed (with media story) group recorded the highest magnitudes for the vaccines and direct-fed microbials' attributes. Whereas the coefficients for the control group that received only minimal information were 2.91 and 2.47 respectively, for vaccines and direct-fed microbials, the coefficients for the loss-framed with media story group were 4.36 and 3.14 for the same attributes. The loss-framed (only) group recorded coefficients of 4.11 and 3.42 respectively, for vaccines and direct-fed microbials. The group that registered somewhat low coefficients compared to the control was the media story group. The coefficient for *vaccines* for this group was 2.93, compared to 2.91 in the control group. For the direct-fed microbials' attribute, the coefficient was 2.51 for the media story group, and 2.47 for the control group. While the persuasiveness of the news story cannot be inferred directly by simply comparing coefficients, it is nonetheless striking that the coefficients measured similarly with the control group. Turning to the other attributes, there was an unambiguous preference for 93% leanness attribute level over 85% leanness, relative to the base case of 73% leanness. The coefficients for the leanness attributes across all information groups were significant, at the 1% level or better. The organic attribute was surprisingly significant in only two of the information groups, the gain-framed and loss-framed message groups. Their positive coefficients indicate preference for organic rather than conventional beef. Similarly, the grass-fed attribute was positive and significant in four of the information groups, other than the loss-framed and the loss-framed with media story groups, indicating that respondents showed greater preferences for beef from grass-fed cattle, rather than grain-fed. The price attribute was significant at the 1% level for all groups, and in sync with consumer theory had negative coefficients.

Following Train (2003), the proportion of respondents who prefer an attribute can be determined using the z-score from the RPL results. This is approximated under the cumulative normal distribution and cumulative probabilities, as shown in equation 10 below:

$$Z = \frac{\beta - mean}{std.dev} \sim N(0,1) \qquad (10)$$

Results for these proportions are given in Table 5 for the vaccines and direct-fed microbials' attributes levels. Over 80% of respondents in all the information groups favored vaccines or direct-fed microbials as an option in beef production, including the control group where minimal information about the interventions were provided. In line with earlier findings, at least 88% of respondents in the loss-framed group had a favorable view of both interventions. For the loss-framed with the media story group, approximately 92% of respondents preferred vaccinations, and 86% of them favored the direct-fed microbials' attribute. Overall, these results point to a positive outlook in terms of consumers' acceptance of the beef safety interventions. For policy makers and beef industry players, this outcome affirms broader consumer acceptance for the beef safety interventions.

Table 5. Proportion of respondents in favor interventions, under the cumulative normal distribution curve

	Control	**Gain**	**Loss**	**Media Story**	**Gain + Media S**	**Loss + Media S**
Vaccines	0.843	0.836	0.890	0.857	0.861	0.918
Direct-fed microbials	0.853	0.813	0.881	0.881	0.861	0.863

8.2 Mean Willingness to Pay

Displayed in Table 6 are the estimated mean WTP from the RPL estimation and the 95% confidence intervals using the Krinsky-Robb procedure (Krinsky and Robb 1986). The equality of the WTP valuations in each information group was tested against the control group. This was accomplished using the likelihood ratio (LR) test to test for equal coefficients between the pooled model (control and an information treatment group) and the model corresponding to the respective information treatment group (Layton and Brown 2000). The test results (reported in Appendix I) revealed significant differences between the models for the control group and each of the information treatment groups at the 2% level of significance or better, with the exception of the gain-framed information group which was not significantly different from the control group. The mean WTP estimates for the remaining information treatment groups can consequently be compared with the control group. Respondents were willing to pay a higher amount for a pound of ground beef with the vaccinated attribute, than with the direct-fed microbials. Mean WTP was also higher for ground beef with the two treatment interventions when compared to the no-treatment attribute.

Table 6. Mean Willingness to Pay (Mixed Logit)

Attribute	WTP Estimate	Control	Gain	Loss	Media Story	Gain+ Media S	Loss+ Media S
Vaccination	Point Estimate	$4.07	$4.33	$5.15	$4.38	$4.34	$5.56
	Lower 95% CI	$3.53	$3.66	$4.58	$3.88	$3.86	$5.02
	Upper 95% CI	$4.60	$5.01	$5.73	$4.88	$4.83	$6.12
Direct-fed microbials	Point Estimate	$3.45	$3.55	$4.28	$3.76	$3.94	$4.01
	Lower 95% CI	$2.94	$2.91	$3.81	$3.26	$3.44	$3.53
	Upper 95% CI	$3.92	$4.17	$4.76	$4.24	$4.44	$4.48
No Treatment	Point Estimate	$2.12	$1.99	$1.76	$2.19	$1.53	$2.05
	Lower 95% CI	$1.45	$1.24	$1.01	$1.52	$0.66	$1.34
	Upper 95% CI	$2.73	$2.67	$2.45	$2.80	$2.33	$2.69

Overall, there were some variations in the WTP, evidenced by the relatively high standard deviations in respondents WTP (the estimate of the standard deviation of interest divided by the price coefficient). The mean WTP for ground beef with the vaccine attribute for the control group, for example, was $4.07, with a standard deviation of $4.05. A striking finding was the extent of spread for mean WTP for ground beef with the direct-fed microbials' attribute for the gain-framed message, and the gain-framed message with media story groups. In the gain-framed message group, the mean WTP for ground beef with the direct-fed microbials' attribute was $3.55, and its estimated standard deviation was $3.99. This represents a wide variability in WTP for the direct-fed microbials' attribute. A similar result was found for the combined gain-framed message with media story group, for the direct-fed microbials' treatment. The highest mean WTP for ground beef with the vaccines and direct-fed microbials' attributes were seen in the loss-framed message with media story group, at $5.56 and $4.01 respectively. The loss-framed only information group also registered similarly high mean WTP values for these two attributes. Average WTP for beef with the vaccine and direct-fed microbial attributes for both loss-framed message and the combined loss-framed message with media story groups were higher than the upper limit of the 95% confidence interval in the control group. Figure 3 provides a graphical display of the mean WTP for vaccines, direct-fed microbials and no treatment attributes over the six information groups. Average WTP in each of the groups was higher than that for the control group for the vaccines and direct-fed microbials' attributes which corroborate the influence of information on consumer WTP (Nayga, Woodward and Aiew 2006; Schroeter, Penner and Fox 2001; Nayga, Aiew and Nichols 2004; Dillaway et al. 2011). Additionally, the findings validate the persuasive effect of loss-framed (with high issue involvement) messages, as in Kahneman and Tversky's (1979) prospect theory. Further affirming their strong persuasive influences, estimated mean WTP for the no treatment attribute was $1.76 for the loss-framed group, compared to the average WTP at $2.12 for the control group. With the highest WTP value at $2.19 for the no treatment attribute (corresponding to the media story group), respondents can be seen to be less willing to pay for ground beef without the beef safety interventions, than for beef products with the interventions, a confirmation of consumer acceptance for the beef safety interventions. Predictably, the mean WTP for ground beef with 93% leanness was higher than the 85% leanness attribute levels, both relative to the base case of 73% leanness.

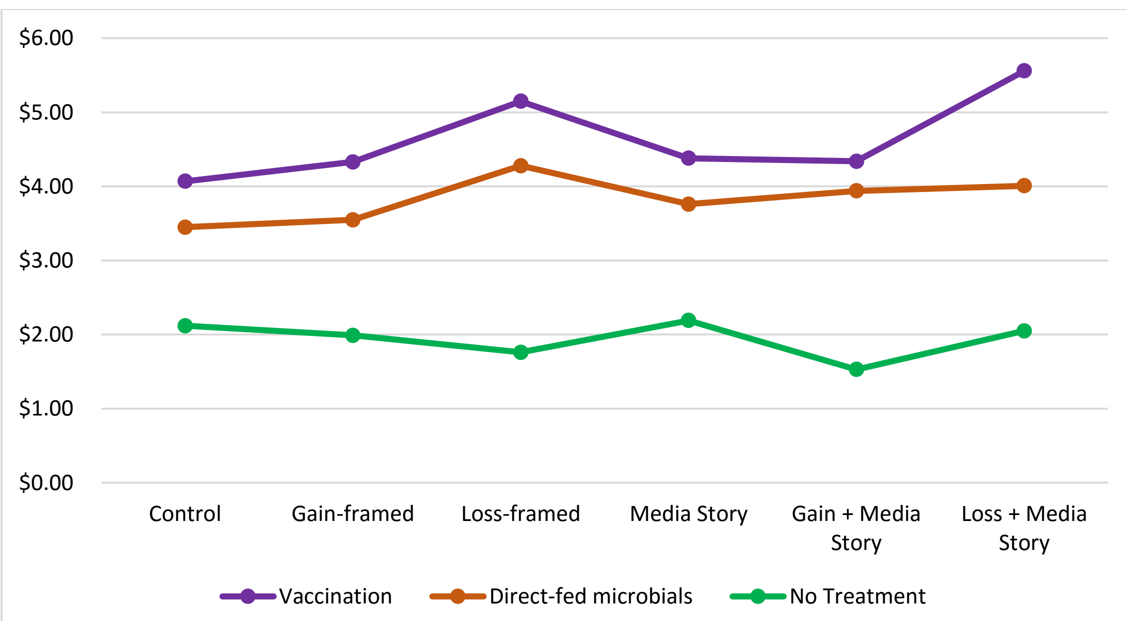

Figure 3. Mean Willingness to Pay for Interventions / lb. of beef

8.3 Correlated Attributes

Table 7 displays the estimated covariance matrix for the random parameters, using the dataset corresponding to the control group. Recall that for the RPL, $\beta_n = b + L\mu_n$ when the random parameters in the model are assumed to be correlated. L is the lower triangular Cholesky factor of the covariance matrix, and $LL' = \Omega$. The *mixlogit* command by Hole (2007) was used in STATA 14 to fit the model with the correlated attributes, and the *mixlcov* command used subsequently to obtain the estimated covariance matrix of the random parameters.

Table 7 Estimated Covariance Matrix (from control group)

	93% Lean	85% Lean	Organic	Grass-fed	Vaccination	Direct-fed microbial	No Treatment
93% Lean	3.991						
85% Lean	2.197	1.213					
Organic	0.000	-0.034	0.977				
Grass-fed	-0.039	0.006	0.271	1.820			
Vaccination	-1.725	-0.975	0.454	-0.118	23.422		
Direct-fed m.	-0.835	-0.463	0.928	-0.184	19.314	18.950	
No Treatment	-2.212	-1.128	0.032	0.571	10.155	11.322	17.492

Organic preferences are positively correlated with the vaccinated and direct-fed microbials' attributes. As organic products are considered safer and healthier than their conventional versions, it was expected that consumers with a large valuation of the organic attribute would also prefer the use of vaccines and direct-fed microbials to tackle *E. coli* bacteria. In addition, vaccinations are allowed in organic cattle production practices, which may further explain the correlation. The vaccination and direct-fed microbials' attributes were also positively correlated with each other, which means that consumers were open to either beef cosafety intervention, even though vaccines were more preferred. The 93% and 85% leanness attributes, as well as the grass-fed attributes were all negatively correlated with both vaccines and direct-fed microbials, although their covariance with direct-fed microbials were not significant. It is perhaps the case that consumers associate the leanness attribute with other characteristics, such as taste and tenderness, than with safety from *E. coli* bacteria.

9 Conclusion

Consumer opinion and acceptance of food safety technologies are among other important factors that determine the successful rollout of such technologies. To this end, examining WTP for vaccines and direct-fed microbials as safety interventions against *E. coli* contamination in beef was both timely and relevant. While animal vaccines against *E. coli* and direct-fed microbials have been approved for use by the USDA and FDA respectively, their adoption has been modest notwithstanding scientific evidence about their effectiveness. The study explored the persuasive influence of gain-framed and loss-framed messages, a media story that elicited issue involvement, and combinations of these messages on consumers' WTP.

A significant finding from the study was the fact that respondents were willing to pay for ground beef treated with the two interventions. This is an especially optimistic result, coming against the heels of scant knowledge of the technologies. Respondents' self-reported knowledge suggested a significant level of unfamiliarity with the interventions, especially with direct-fed microbials. Between the two interventions, respondents demonstrated greater preference for animal vaccines than direct-fed microbials. This may be in response to the general information provided in the survey instrument that indicated that animal vaccines reduced the incidence of *E. coli* in cattle by as much as 80%, compared to 50% for direct-fed microbials. For both animal vaccines and direct-fed microbials, more than 80 percent of respondents favored their use in beef production to reduce the risks of *E .coli* contamination. Respondents preferred ground beef with 93% leanness and 85% leanness to 73% leanness, and favored organic and grass-fed beef than their conventional and grain-fed versions.

An equally interesting finding was the stronger persuasive influence of the loss-framed message, and the combined loss-framed message with the media story on WTP. Respondents who were exposed to these messages recorded the highest WTP for ground beef with both vaccines and direct-fed microbials' attributes relative to the control group. The stronger persuasive influence of the loss-framed messages on WTP syncs with Kahneman and Tversky's (1979) prospect theory about the greater impulses individuals demonstrate when losses are apparent, in this case losing the opportunity of reducing the risk of an *E. coli* infection. For policy makers and communicators, this outcome may suggest more effective communication strategies for new food safety interventions: disseminating such information in terms of benefits forgone. A somewhat surprising finding was the seeming ineffectiveness of the media story on respondents' WTP. Even though the story was intended to elicit issue involvement concerning the risk of *E. coli* from beef consumption, respondents may arguably have downplayed their vulnerability to *E. coli* infections. Debatably, the story may have come across as a lone or an isolated case of an infection. However, presenting the media story together with the loss-framed information seemed to reinforce the significance of the technologies and the seriousness of the risks, making the combined information more persuasive (Maheswaran and Meyers-Levy 1990).

The research can be expanded upon in a number of ways. Going beyond consumers' WTP from this study, it will be useful to examine how beef products from cattle treated with these technologies can be differentiated from others in the market. A pertinent consideration is to investigate how beef products treated with the technologies should be labeled, and how the benefits from the reduced risks of *E. coli* infection can be communicated on such labels.

References

Abhyankar, P., D. B. O'Connor and R. Lawton. 2008. "The Role of Message Framing in Promoting MMR vaccination: Evidence of a Loss-Frame Advantage". *Psychology Health and Medicine* 13(1): 1-16.

Brashears, M. 2012. "The Big Beef Challenge: Pathogen Intervention Strategies". In *The Alltech 28th Annual International Symposium, Lexington, Kentucky.*

Bosworth, R. and L. O. Taylor. 2012. "Hypothetical Bias in Choice Experiments: Is Cheap Talk Effective at Eliminating Bias on the Intensive and Extensive Margins of Choice"? *The B. E. Journal of Economic Analysis & Policy* 12(1).

Centers for Disease Control and Prevention (CDC), 2006. "Preliminary FoodNet Data on the Incidence of Infection with Pathogens Transmitted Commonly through Food--10 States, United States, 2005". *MMWR. Morbidity and Mortality Weekly Report*, *55*(14): 392.

Cummings, R. G. and L. O. Taylor. 1999. "Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method." *The American Economic Review* 89(3): 649-665

Daley, C. A., A. Abbott, P. S. Doyle, G. A. Nader and S. Larson. 2010. "A Review of Fatty Acid Profiles and Antioxidant Content in Grass-fed and Grain-fed Beef". *Nutrition Journal* 9(1):1.

Dillaway, R., K. D. Messer, J. C. Bernard and H. M. Kaiser. 2011. "Do Consumer Responses to Media Food Safety Information Last?" *Applied Economic Perspectives and Policy* 33(3): 363-383.

Fox, J. A., D. J. Hayes, and J. F. Shogren. 2002. "Consumer Preferences for Food Irradiation: How Favorable and Unfavorable Descriptions Affect Preferences for Irradiated Pork in Experimental Auctions". *The Journal of Risk and Uncertainty* 24(1): 75 – 95.

Gallagher, K. M. and J. A. Updegraff. 2012. "Health Message Framing Effects on Attitudes, Intentions, and Behavior: A Meta-Analytic Review". *Annals of Behavioral Medicine* 43(1): 101-116.

Goibov, M., P. M. Schmitz, S. Bauer, and M. N. Ahmed. 2012. "Application of a Choice Experiment to Estimate Farmers Preferences for Different Land Use Options in Northern Tajikistan". *Journal of Sustainable Development* 5(5):2

Hensher, D. A., J. M. Rose and W. H. Greene. 2005. "*Applied Choice Analysis: A Primer*". Cambridge University Press.

Hole, A. R. 2007. "Estimating Mixed Logit Models by Using Maximum Simulated Likelihood". *Stata Journal* 7(3): 338 – 401.

Hurd, H. S. and S. Malladi. 2012. "An Outcomes Model to Evaluate Risks and Benefits of Escherichia coli Vaccination in Beef Cattle". *Foodborne Pathogens and Disease* 9(10): 952-961.

Kahan, D. M., D. Kysar, D. Braman, P. Slovic, G. Cohen and J. Gastil. 2008. "Cultural Cognition and Nanotechnology Risk Perceptions: An Experimental Investigation of Message Framing". *Unpublished Paper, Yale University.*

Kahneman, D. and A. Tversky.1979. "Prospect Theory: An Analysis of Decision under Risk". *Econometrica: Journal of the Econometric Society* 47(2): 263-291.

Kay, S. E. 2003. "E. coli O157:H7: The Costs during the Past 10 Years". *Meat and Poultry Magazine* 26 – 34

Krinsky, I. and A. L. Robb. 1986. On Approximating the Statistical Properties of Elasticities. *The Review of Economics and Statistics*: 715-719.

Kuhfeld, W.F., 2005. "Marketing Research Methods in SAS". *Experimental Design, Choice, Conjoint, and Graphical Techniques. Cary, NC, SAS-Institute TS-722*.

Layton, D.F. and G. Brown. 2000. "Heterogeneous Preferences Regarding Global Climate Change". *Review of Economics and Statistics*, *82*(4), pp.616-624.

Lusk, J. L. and T. C. Schroeder. 2004. "Are Choice Experiments Incentive Compatible? A Test with Quality Differentiated Beef Steaks". *American Journal of Agricultural Economics* 86(2): 467 – 482.

Lusk, J. L., and N. Parker. 2009. "Consumer Preferences for Amount and Type of Fat in Ground Beef". *Journal of Agricultural and Applied Economics* 41(1): 75-90.

Matthews, L., R. Reeve, D. L. Gally, J. C. Low, M. E. J. Woolhouse, S. P. McAteer, M. E. Locking, M. E. Chase-Topping, D. T. Haydon, L. J. Allison, M. F. Hanson, G. J. Gunn, and S. W. J. Reid. 2013. "Predicting the Public Health Benefit of Vaccinating Cattle against Escherichia coli O157". *Proceedings of the National Academy of Sciences* 110(40): 16265-16270.

Maheswaran, D. and J. Meyers-Levy. 1990. "The Influence of Message Framing and Issue Involvement". *Journal of Marketing Research* 27: 361 – 7.

Meyerowitz, B. E. and S. Chaiken. 1987. "The Effect of Message Framing on Breast Self-Examination Attitudes, Intentions and Behavior". *Journal of Personality and Social Psychology* 52(3): 500-510.

Mukhopadhaya, K., B. Adhikari, G. Mumma and M. Teisl. (2004). "Consumers' Willingness to Pay for Food Safety: A Pathogen Specific Analysis". In *American Agricultural Economics Association Annual Meeting, Denver, Colorado,* August 1-4, 2004.

Nayga, R. M. Jr., W. Aiew, and J. P. Nichols. 2004. "Information Effects on Consumers' Willingness to Purchase Irradiated Food Products". *Applied Economic Perspectives and Policy* 27(1): 37 – 48.

Nayga, R. M. Jr., R. Woodward, and W. Aiew, 2006. "Willingness to Pay for Reduced Risk of Foodborne Illness: A Nonhypothetical Field Experiment". *Canadian Journal of Agricultural Economics* 54(4): 461 – 475.

Onken, K. A., J. C. Bernard and J. D. Pesek Jr. 2011 "Comapring Willingness to Pay for Organic, Natural, Locally Grown, and State Marketing Program Promoted Foods in the Mid-Atlantic Region". *Agricultural and Resource Economics Review* 40(1): 33-47.

Petty, R. E., and J. T. Cacioppo. 1979. "Issue Involvement Can Increase or Decrease Persuasion by Enhancing Message-Relevant Cognitive Responses". *Journal of Personality and Social Psychology* 37(10): 1915 – 1926.

Pruitt, J. R., and D. P. Anderson. 2012. "Assessing the Impact of LFTB in the Beef Cattle Industry". *The Magazine of Food, Farm, and Resource Issues* 27: 1-4.

Revelt, D. and K. Train. 1998. "Mixed Logit with Repeated Choices: Households' Choices of Appliance Efficiency Level". *The Review of Economics and Statistics* 80(4): 647 – 657.

Shogren, J. F., J. A. Fox, D. J. Hayes, and J. Roosen. 1999. "Observed Choices for Food Safety in Retail, Survey, and Auction Markets". *American Journal of Agricultural Economics* 81(5): 1192 – 1199.

Schroeter, C., K. P. Penner, and J. A. Fox. 2001. "Consumer Perceptions of Three Food Safety Interventions Related to Meat Processing". *Dairy, Food and Environmental Sanitation* 21(7): 570 – 581.

SAS Institute Inc. 2013. SAS® 9.4. Cary, N.C: SAS Institute Inc

Teisl, M. F., and B. E. Roe. 2010. "Consumer Willingness to Pay to Reduce the Probability of Retail Foodborne Pathogen Contamination". *Food Policy* 35(6): 521 – 530.

Train, K. E. 1998. "Recreation Demand Models with Taste Differences over People". *Land Economics* 74(2): 230 – 239.

Train, K. 2003. "*Discrete Choice Method with Simulation*". Second Edition. Cambridge University Press

United States Census Bureau 2010. http://www.census.gov/2010census/

APPENDIX

I: Likelihood Ratio Tests for Willingness to Pay Comparison

Control and Gain-framed group						
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
control_gain	28,624	-9393.29	-6768.575	15	13567.15	13691.08
control	14,592	-4773.99	-3409.512	15	6849.023	6962.847
gain	14,032	-4603.608	-3370.726	15	6771.452	6884.688
Likelihood Ratio stat	-23.32					
Prob > Chi2	1.0000					

Control and Loss-framed group						
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
control_loss	29,036	-9433.008	-6675.331	15	13380.66	13504.81
loss-framed	14,592	-4773.99	-3409.512	15	6849.023	6962.847
loss	14,444	-4635.172	-3228.527	15	6487.053	6600.724
Likelihood Ratio stat	74.58					
Prob > Chi2	0.0000					

Control and Media story group						
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
control_media-story	29,288	-9595.169	-7064.433	15	14158.87	14283.14
control	14,592	-4773.99	-3409.512	15	6849.023	6962.847
media-story	14,696	-4816.597	-3636.802	15	7303.603	7417.533
Likelihood Ratio stat	36.24					
Prob > Chi2	0.0016					

Control and gain-framed + Media story						
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
control_gain-media	29,460	-9605.147	-6907.687	15	13845.37	13969.74
control	14,592	-4773.99	-3409.512	15	6849.023	6962.847
gain + media	14,868	-4822.684	-3478.854	15	6987.708	7101.813
Likelihood Ratio stat	38.64					

Prob > Chi2	0.0007					

Control and loss-framed + Media story						
Model	Obs	ll(null)	ll(model)	df	AIC	BIC
control_loss-media	29,632	-9579.823	-6848.063	15	13726.13	13850.58
control	14,592	-4773.99	-3409.512	15	6849.023	6962.847
loss + media	15,040	-4769.551	-3419.856	15	6869.713	6983.99
Likelihood Ratio stat	37.39					
Prob > Chi2	0.0011					