Stated Preference and Perception Analysis for Traceable and BSE-tested Beef: An Application of Mixed Error-Component Logit Model

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Abstract

Recent studies shows that marketing potential for BSE-tested and traceable beef might exist (Abidoye, et al. 2011, Bailey, et al. 2005, Dickinson and Bailey 2002, Dickinson and Bailey 2005, Loureiro and Umberger 2007). Although consumers' willingness to pay for is a necessary condition for adoption of an attributes, agribusiness and policy makers can benefit from understanding why consumers are willing to pay for such attribute. We conducted a choice experiment to elicit consumer willingness to pay (WTP) for BSE-tested and traceable beef. We adopted the perceived risk framework suggested by Pennings et al 2002 to explore the relation between consumer perceived risk and WTP for these food-safety attributes. Our results revealed that risk perception, risk attitude, BSE-concern, and perceived level of control agribusiness has on food safety significantly influenced WTP for traceable and BSE-tested beef

Key Words: Food Safety Attributes, Choice Experiment, Risk Perception, Risk Attitude, Choice Experiment

Introduction

Recent studies shows that marketing potential for BSE-tested and traceable beef might exist (Abidoye, et al. 2011, Bailey, et al. 2005, Dickinson and Bailey 2002, Dickinson and Bailey 2005, Loureiro and Umberger 2007). Although consumers' willingness to pay for is a necessary condition for adoption of an attributes, agribusiness and policy makers can benefit from understanding why consumers are willing to pay for such attribute. Despite decent coverage of WTP studies on BSE-tested and traceability, the underlying intention for consumers to willing to pay for these attributes is not well understood.

Food safety issues on beef have been a recurring concern for many American consumers. Beef consumption is susceptible to multiple food borne diseases; in particular, periodical outbreak of BSE cases propagate consumers concern, which was documented to disrupt consumption in some cases. The perceived risk framework was successfully applied to explain disruption in consumption (Pennings, et al. 2002, Schroeder, et al. 2007). Adaptation of perceived risk framework could be promising in unveiling the reason of consumers WTP for the food safety attributes.

In this study, we conducted a choice experiment to elicit consumer willingness to pay (WTP) for BSE-tested and traceable beef. We adopted the perceived risk framework suggested by Pennings et al 2002 to explore the relation between consumer perceived risk and WTP for these food-safety attributes. Our results revealed that risk perception, risk attitude, BSE-concern, and perceived level of control agribusiness has on food safety significantly influenced WTP for traceable and BSE-tested beef.

Literature Review

Consumers inherently face uncertainty from eating food, as multitude of food-borne disease are not easily detected by human senses (Buzby, et al. 1998). Further, mounting evidence now suggest that consumers are motivated by perceived risk, rather than the actual probability of risk itself (Slovic 1987, Starr 1969). Pennings, et al. (2002) suggested that perceived risk could be disintegrate into risk perception and risk attitude, namely, the probability of a negative consequence from consuming a product and the willingness of an individual to accept risk from consuming a product. Scrutinizing the WTP for traceability in the light of perceived risk could provide useful information to marketers and policy makers on the implication of implementing traceability. Schroeder, et al. (2007) argued that the decision maker's optimal response could depend on whether risk perception or risk attitude is the dominant factor; namely if consumers perceived higher risk than the actual risk presence, then an effective risk communication could eliminate such discrepancy. However, if the driver was risk aversion of consumers, then high levels of food safety assurance could be the only instrument. Since traceability conceivably influence

consumers' perceived risk, it could be an effective risk management tool in handling both effects from risk perception and risk attitude.

Beef traceability are often discussed in conjunction with BSE (Bailey, et al. 2005, Golan, et al. 2004). Souza-Monteiro and Caswell (2004) suggested that traceability could enhance ability of food safety agencies to identify hazard source following a discovery of BSE outbreak. Traceability does not directly reduce food risk per say. However, it could indirectly mitigate food risk by providing necessary information to hold offending food producers liable for introducing food hazards. This could in turn create incentive for food producers to implement measures that encourage food safety, and have a proactive attitude towards prevention and identification of food safety hazards (Souza-Monteiro and Caswell, 2004). Implementation of traceability could increase consumer confidence through reduction of consumers perceived risk, which could manifest in a form additional WTP.

A number of studies have investigated consumer WTP for traceability for various food type. Dickinson and Bailey (2002) conducted an experimental auction on meat sandwiches, they found that a sizable price premium on meat sandwiches with traceability feature. However, the participants of the experiment were all either university students or employees, thus attracting the question of the representativeness of their sample.

Abidoye, et al. (2011) conducted a national online choice experiment on consumer preference of traceable beefsteak. They examined three types of traceable beef of varying depth—traceable to birth / feedlot / or processing plant only. Again, Abidoye, et al. (2011) reported significant and positive WTP for traceable beef; however, their experiment design omitted the no traceability level, which improvised the ability of the study to measure the difference in WTP between untraceable and traceable beef. Further, none of these studies addressed as to why consumers were WTP for traceability in beef.

Loureiro and Umberger 2007 also conducted a choice experiment that studied among other attributes traceable beefsteak. Their results also indicated a positive WTP for traceable beef. However, they claimed

their model did not detect unobserved taste heterogeneity on consumers' preference for traceable beef, which unrealistic suggested that the premium for traceable beef is universally applicable for all U.S. consumers.

Research Design

Building on previous literature, we conducted an online survey in May 2010 through TNS Global, a survey company. A national sample of 1079 American consumers was randomly selected from the vast panel maintained by the company.

The survey consisted of two major components. The first part included questions adapted from related literature about consumer preferences for beef, and the second part consisted of a choice experiment intended to elicit consumers WTP for country of origin labeled beef and other attributes. The design of the choice experiments was similar to that developed by Schroeder, et al. (2007) and Tonsor, et al. (2009). However, this analysis focuses on BSE testing and traceability, rather than the risk reduction examined in the other studies. Strip loin steak (one pound) was chosen as the representative product for its well-defined characteristics and relatively homogeneity.

Although traceability and BSE-tested beef are the focus of this paper, the choice experiment included other attributes to avoid single-cue bias (Bilkey and Nes 1982). The choice profiles consisted of five categories: price, country, production practices, tenderness, and food-safety assurance. Table 1 provides the description of these attributes as given to respondents. Four levels of prices were chosen ranging from $5.50 to $16.00 per pound to reflected low-end and high-end prices that could be observed in actual grocery store settings at the time of this study.

The three countries of origin were the USA and its two major beef suppliers, Australia (*AUS*)[1] and Canada (*CAN*). The two elements in production practices were natural – which means the beef was derived from cattle not treated with hormones and antibiotics, or standard practices – which means the beef was derived from cattle treated with government-approved hormones and antibiotics. The tenderness categories encompassed two elements, with or without tenderness guarantees (*TENDER*). The food-safety assurance consisted of four elements; none—which included no additional food-safety attributes, BSE-tested (*BSE*)– which means the cattle were tested for BSE prior to slaughtering, traceable (*TRACE*)– which means that the steak was traceable from its producing farm to the point of sale, or a steak could be both BSE-tested and traceable (*BSE*TRC*). We did not name any designated agency that verified the accuracy of these attributes as consumer valuation and trust of the verifying agency is not a focus of this study (Steiner, et al. 2010).

Although the ability of an online survey to represent the population is still being debated, Hu, et al. (2011) showed that for a survey on food products, the two survey methods could produce highly consistent results. Olsen (2009) also showed that the difference in WTP estimation between mail and online surveys was minimal.

Summary Statistics

Table 2 presents the descriptive summary statistics of the sample. Our sample corresponded closely to the U.S. population in terms of gender, education, and income. The sample reflected heavy representation of older consumers, a phenomenon also observed in other online survey, including Hu, et al. (2006) and Tonsor, et al. (2009). However, sufficient observations existed in each age group to evaluate behavior across a wide range of age.

[1] Abbreviation used in subsequent sections were provided in parentheses

Perceived Risk Statistics

We measured perceived risk with psychometric measurements. These measurements were grouped into two categories. The first were consumer risk perception and risk attitude for beef products, which were product-class measurements for inherent risk (Mitchell 1999). The next two were statements inquiring about the extent of concern respondents have towards BSE, and the extent they think farmers, processors and retailers have influence over food safety.

Consumers' risk perception and risk attitude were captured using the adaptation of scaling procedure proposed in Pennings et al (2002). These scales were developed to mirror as closely as possible the Pratt and Arrow framework (Pennings, et al. 2002). The distribution and statements used are described in Table 3.

Using a rating of three as a position of neutral, it appears that most American consumers believed that eating beef posed a minimal risk based on the observed average sum score of 3.47. A closer look reveals that fewer than 20% of the respondents stated that eating beef was risky and fewer than half of the respondents perceived beef as a low risk food. From the risk attitude statements, most American consumers were not risk averse towards the risk from eating beef. More than half responded with ratings of 1 and 2, and fewer than 20% responded that they were not willing to accept risk from eating beef. These results compared closely to those in Pennings, et al. (2002) and Schroeder, et al. (2007).

Additionally, concerns about BSE and vCJD are dichotomous, 35% of the sample do not and have little concern about the disease; conversely, about 30% of the respondent are highly or extremely concerned about the disease.

About 65% of the respondent thought safety of food products is influence by not themselves but intermediaries in the food chain, such as farmers, processors and retailers; this perhaps points to that, respondents perceived food risk is involuntary imposed upon them.

Econometric Model

We present a model on consumer preference for BSE-tested and traceable beef, and account for relation between preference for the attributes and perceived risk. Consumer utility associated with the attributes examined in the choice experiment is formally represented in a Random Utility Model, such that:

$$\boldsymbol{U}_{njt} = \begin{cases} \propto_n price_{n1t} + \boldsymbol{\beta}_n{}'\boldsymbol{x}_{n1t} + \boldsymbol{\delta}_n'\mathbf{d}_{n1t} + \mu_n z_{n1t} + \varepsilon_{n1t} & , if\ j = 1 \\ \propto_n price_{n2t} + \boldsymbol{\beta}_n{}'\boldsymbol{x}_{n2t} + \boldsymbol{\delta}_n'\mathbf{d}_{n2t} + \mu_n z_{n2t} + \varepsilon_{n2t} & , if\ j = 2 \\ \boldsymbol{\beta}_n{}'\boldsymbol{x}_{n3t} + \varepsilon_{n3t} & , if\ j = 3 \end{cases} \quad (1)$$

where subscript *n* corresponds to individual, *j* corresponds to alternative (*j*=1, 2, and 3) and *t* corresponds to choice sets. The price coefficient α is specified as a fixed parameter rather than a random parameter to avoid unrealistic welfare measures associated with a random price parameter (Meijer and Rouwendal 2006, Olsen 2009). The 8 × 1 vector random coefficient $\boldsymbol{\beta_n}$ captured taste heterogeneity associated with attributes in the vector **x**. The elements vector **x** describe alternatives given in choice set with series of dummy variables:

$$\mathbf{x}_{njt} = [WOULD - NOT - BUY, AUS, CAN, BSE, TRACE, BSE * TRC, TENDER, NATURAL] \quad (2)$$

The variables in **x** correspond to attributes in the choice experiment as described in Table 1. The base cases are *USA* origin labeling, *APPROVED STANDARDS* in production practices, *NONE* in food-safety assurance and *NOT SPECIFIED* in tenderness assurance.

WOULD-NOT-BUY, *TRACE*, *BSE*, and *TRC_BSE* are interacted with the key variables: risk attitude (*RA*), risk perception (*RP*), the interacted term between risk perception and risk attitude (*RA*RP*), concern about BSE (*BSECONCERN*), and believe that others in the food chain influence food safety (*FC*). Age, education level and income level were also interacted with *TRACE*, *BSE*, and *TRC_BSE* to reveal the demographic characteristic of the consumers. As consumers may shy away from consuming beef when RA or RP is high, we interacted *WOULD-NOT-BUY* with the perceived risk variables since omitting these terms could result in omitted variable bias, where the effect from RA and RP resulted non-consumption of the product spill over to the coefficients associated with the food-safety attributes.

These interaction terms are collectively represented by the vector $\mathbf{d}_n$. The product of coefficient vector $\boldsymbol{\delta}_n$ and $\mathbf{d}_n$ accounts for the contribution of these interaction terms to the utility function. Although other interaction terms not included may have significant impact on the utility, we limit the model on to the interaction effects between the food safety attributes examined for to be concise to the focus of this paper.

Two separate components comprised the error term in the utility function. First, $\boldsymbol{\varepsilon}_{nt}$ is assumed iid and distributed as a standard maximum extreme value type I distribution as in a conditional logit model. The second error term, $\boldsymbol{\mu}'_n\mathbf{z}_{nt}$, corresponds to the error component, which captures correlation between the two non-empty alternatives (the first two alternatives in each choice set). We specify the 3×1 vector $\mathbf{z}_{nt}$ to be equal to [1, 1, 0] to reflect the correlation structure in individuals' decision-making process (Scarpa, et al. 2008) .The random coefficient $\boldsymbol{\mu}_n$ is assumed to be independently normally distributed: $\boldsymbol{\mu}_n \sim N(0, \sigma)$ (Train 2003),where σ, the additional parameter to be estimated, is the covariate between alternative 1 and 2.

(3) $$\boldsymbol{\beta}_n \sim \mathrm{F}(\boldsymbol{\theta}_0, \boldsymbol{\Omega}_n)$$

Analysts are free to choose any appropriate mixing distributions that reflect behavior of the subject (Train 2003). As there is no prior theory to suggest any particular form of distribution is associate with the random variables in this study, all random coefficients in this study are specified as normally distributed.

Results

The results of the mixed logit model and results from a conditional logit model of identical specification were included in Table 4 and Table 5 respectively. Comparing the log-likelihood score between the two models indicated a large improvement in goodness-of-fit on the mixed logit model. The efficiency improvement of the Mixed Logit Model could be attributed to the inclusion of unobserved taste heterogeneity, as evident by multiple significant estimated standard deviation values for the random coefficient; in addition to the error component structure reflected by the significant estimated value of the standard deviation of the error component.

As the random coefficients are specified to be correlated, we used the diagonal values of the Cholesky matrix indicates presence of unobserved taste heterogeneity (Hensher, et al. 2005). The statistically significant diagonal values on TRC, BSE points to diverse consumers' preference of traceable and BSE-tested beef.

Although ceteris paribus interpretation is feasible in mixed logit model setting, we presented the interpretation of the results in the more meaningful form of marginal willingness to pay. To account for non-linearity, the WTP estimates and standard errors were produced with Krinsky and Robb Simulation with 5000 replications specified (Hensher and Greene 2003). Table 6 presented the WTP estimates.

First, we examined the marginal WTP for TRC, BSE, and TRC_BSE attributed to consumers concern of BSE. Concern on BSE is positively and statistically significant impact on the WTP of these food-safety attributes. On average, a single point increase in concern about BSE, for example, from "not concerned at all" to "minor concern" raised the WTP by $1.10/lb, $1.22/lb and $1.60/lb for TRC, BSE-Tested, and TRC_BSE respectively. These are evidence that consumers seeks to alleviate BSE concern with traceability and BSE-test beef cattle.

We then examine the marginal WTP that correlate to the variable FC, which reflect WTP that attribute to consumers feeling that others in the food chain determined food safety. On average, a unit increment in FC resulted $0.52/lb, $0.66/lb and $0.91/lb extra in WTP for TRC, BSE-Tested and TRC_BSE beef.

Next, we turn to marginal WTP on the added food-safety features attributed to risk perception and risk attitude. These estimates reflect changes on WTP for the attributes resulted from one-unit change in either risk attitude or risk perception. As interaction terms between risk perception and risk attitude were included in the model, the appropriate marginal WTP estimated is calculated as:

$$WTP_{attribute*RP} = -\frac{\beta_{attribute*RP} + \beta_{attribute*RP*RA} * RA}{\beta_{price}}$$

$$WTP_{attribute*RA} = -\frac{\beta_{attribute*RA} + \beta_{attribute*RP*RA} * RP}{\beta_{price}} \quad (4)$$

from equation (4), the marginal willingness to pay due to risk perception is a function of risk attitude, and vice versa, the marginal willingness to pay due to risk attitude is a function of risk perception. For this reason, marginal willingness to pay due to risk perception are calculated with

varying levels of risk attitude, and marginal willingness to pay due to risk attitude are also calculated with varying levels of risk perception.

Marginal WTP for Risk Attitude

The marginal WTP for risk attitude represents the changes in WTP for traceable and BSE-tested beef accompany by a unit change in risk attitude, i.e. increase or decrease in WTP for the attributes when consumers become less risk averse.

For traceable beef, consumer who perceived beef as very low risk (RP = 1) are willing to pay $1.02 less, as each unit increment on risk attitude. In other words, as consumers become more averse to risk from consuming beef, consumers who perceived beef as safe are willing to pay less for traceable beef. Consumers with high-risk perception for beef showed no significant relationship between risk attitude and WTP for traceable beef.

In contrast, for BSE-tested beef, for each unit increment in consumers' risk aversion to consume beef, consumers who perceived beef as risky (RP = 3, 4, 5) are willing to pay more for BSE-tested beef. Changes in risk attitude have no statistically significant impact the WTP on low risk perception consumers.

Finally, for beef marketed with both traceability and BSE-tested, significant negative marginal WTP were found on consumers who perceived beef as very low risk (RP=1) and very risky (RP=5). Respectively, consumers who perceived beef as very low risk (RP=1) were WTP $1.02/lb less for the beef as they become more risk averse; Consumers who perceived beef as very risky (RP=5) were WTP $1.40/lb more for the beef as they become more risk averse.

Marginal WTP for Risk Perception

We examine the effect from one-unit change in risk perception to consumers' WTP for traceable and BSE-tested beef. The marginal WTP for risk perception measures changes in WTP for traceable and BSE-tested beef, in response to one unit increment in risk perception.

We observed that consumers who are most risk averse (RA = 5) were WTP $1.29/lb more for traceable beef on average. However, no statistically significant impact was observed on consumers in lower risk aversion group.

For BSE-tested beef, increasing risk perception results in $1.25/lb and $0.74/lb less in WTP on consumers who are less risk averse (RA = 1 or 2). Nonetheless, the impact is statistically indifferent from zero for consumers in higher risk aversion group.

Lastly, for traceable and BSE-tested beef, consumers who claimed higher risk aversion (RP = 3, 4, or 5) are willing to pay more for the beef with a unit increment in risk perception. The marginal WTP measured at 0.66/lb, $1.27/lb and $1.88/lb for risk perception of 3, 4, and 5 respectively.

Estimates of Total WTP

The total WTP compare WTP for beef with and without the added food-safety attributes beef without the attributes. Total WTP is calculated as:

$$\mathrm{WTP}_{attribute} = -\left(\frac{\beta_{attribute} + \beta_{attribute*RP} \times RP + \beta_{attribute*RA} \times RA + \beta_{attribute*RP*RA} \times RA \times RP}{\beta_{price}} + \frac{\boldsymbol{\beta}_{attribute*demographc} \times \mathbf{demographic}}{\beta_{price}}\right) \quad (5)$$

$$\mathbf{demographic} = [age, education, income]$$

Infinite number of total WTP could be calculated based on various combinations of demographic and risk profiles. To simplify, a profile of a typical middleclass American were adopted, the demographic variables are set as 40 years of age, 14 years of education and household income of $52,000. Total WTP of all (5 by 5) twenty five risk profiles were calculated. Table 7 presents the estimates of total WTP

The model estimated that a wide range of WTP for the attributes, which strongly points to significant influence of risk perception and risk attitude to consumers' WTP for the attributes. The WTP for traceable beef ranged from $1.76/lb to $6.85/lb, the WTP for BSE-tested beef ranged from $0.73/lb to $7.12/lb, and the WTP for TRC_BSE ranged from $3.99/lb to $11.41/lb. As most combinations of profiles exhibit positive and statistically significant WTP, these findings strongly suggest that premium could exist for traceable beef and BSE-tested beef.

However, the premium could diminish with the number of food safety attributes added, as the WTP for the features combined were lower than the aggregate of the two features marketed individually, which is in line with findings from Gao and Schroeder (2009).

The inclusion of interaction terms risk attitude and risk perception (RA*RP) allowed the model to uncover a rich set of consumer behavior. Consistent trends were observed throughout the WTP for the three attributes. First, low risk averse (RA=1) consumers' WTP decrease as they perceived more risk in eating beef, while the WTP remain positive in most cases. Second, risk-averse (RA=5) consumers are willing to pay more for these food-safety features as their risk perception on eating beef becomes higher. This may suggest that consumers with low risk aversion are not confident that these food-safety attributes mitigates risk if consuming beef is

risky. Conversely, consumers who are risk averse are more likely to be using the food-safety features as a tool to increase their confidence and afford extra food-safety in beef consumption.

From a different angle, among consumers who think beef is relatively safe (RP=1), the WTP decreases as risk aversion rises. This suggests that the food-safety attributes do not serve to counterbalance consumer's lack of willingness to accept risk from eating beef. Further, this may reflect consumers' belief that a scarce budget allocated to food safety attributes could be better spent elsewhere than on beef traceability, BSE-test or both. In contrast, among consumers who perceived beef as risky (RP=5), their WTP increases as risk aversion increases. This may reflect that consumers who perceived beef to be risky, believes that the food-safety attributes may help to counteract risk from eating beef. In summary, strong marketing potential of traceable and BSE-tested beef exist among consumers who are risk averse and perceived beef as risky.

Conclusion

We investigated the underlying reasons by linking consumers WTP for these attributes with perceived risk adapted from the psychometric framework in Pennings et al (2002). Our results showed that consumers are willing to pay a premium for traceable and BSE-tested beef. We also found that concerns about BSE, influence of food manufacturer/ retailers over food safety, risk perception and risk attitude were factors that influence consumers' WTP for traceable and BSE-tested beef. In particular, we found that consumers who perceived beef as high in risk and unwilling to accept risk from eating beef showed strong WTP for the attributes.

The finding of a positive consumers demand for traceable and BSE-tested beef lead to more unanswered policy questions and opportunities for future research. Given that both traceable and BSE-tested beef are relatively uncommon in present market, it is not clear how much consumers

understood the function validity of traceability and BSE-tested beef. For example, it is not clear whether consumers would trust a voluntary traceable system designed and maintained by agribusiness or third party as much as a mandatory traceable system regulated by government authority. Further, it is not clear that consumers are aware of the inconclusiveness of present BSE-test on cattle aged less than 30 months, which are the dominant beef cattle age group.

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Table 1. Attributes Description

Categories	Levels	Abbr.	Descriptions
Price ($/lb)			Refers to steak price in retail grocery store or butcher where the respondent typically shops.
	5.50		
	9.00		
	12.50		
	16.00		
Country of Origin			Refers to country in which the cattle were raised
	USA		
	Canada	CAN	
	Australia	AUS	
Production Practices			Refers to the method used in production.
	Approved Standards		**Approved Standards** means production involved government-approved synthetic growth hormones and antibiotics.
	Natural	NAT	**Natural** means animal was raised without the use of synthetic growth hormones or antibiotics
Food Safety Assurance			Refers to the food safety assurance offered with the steak
	None		
	BSE-Tested	BSE	**BSE-Tested** means that cattle are tested for BSE prior to slaughtering process
	Traceable	TRC	**Traceable** means the product is fully traceable back to farm of origin from the point of purchase
	BSE-Tested and Traceable	BSE-TRC	**BSE-Tested and Traceable** were offered in combination
Tenderness			Refers to the softness in the steak's eating quality
	Not Specified		**Not Specified** means there are no guarantees on tenderness level of the steak
	Assured Tender	TENDER	**Assured Tender** means the steak is guaranteed tender by testing the steak using a tenderness measuring instrument

Table 2. Sample Description

Variable	Group	Percent	Sample Mean/Median	US Census Data
Age	15-19	0.93%	56.62	36.8[a]
	20-24	3.52%		
	25-29	2.22%		
	30-39	7.78%		
	40-49	12.70%		
	50-64	32.25%		
	65+	40.59%		
Gender	Male	47.54%		49.20%
	Female	52.46%		50.80%
Education	<High School	1.11%	14[a]	12[a]
	High School	23.08%		
	Some College	39.39%		
	4 year Degree	24.28%		
	Graduate	12.14%		
Household Income ($)	<25k	24.10%	52.37k	51.42k
	25k-40k	23.54%		
	40k-65k	23.82%		
	65k-80k	9.55%		
	80k-100k	7.32%		
	100k-120k	6.12%		
	>120k	5.56%		
Freq. grocery shopping	Never	1.85%		
	Sometimes	14.74%		
	Frequently	83.42%		

Table 2. Psychometric Statements

Risk Perception Statements	1	2	3	4	5	mean	std dev
When eating beef, I am exposed to … (1 = a great deal of risk … 5 = very little risk)	4.45	12.99	38.22	26.44	17.90	3.40	1.06
I think eating beef is risky (1 = strongly agree …5 = strongly disagree)	5.29	11.04	32.10	28.94	22.63	3.52	1.11
For me, eating beef is … (1 = risky … 5 = not risky)	5.01	12.80	33.30	27.18	21.71	3.48	1.11
Average Sum Score						3.47	0.98
Risk Attitude Statements							
I accept the risks of eating beef (strongly disagree … strongly agree)	5.47	8.44	29.13	35.16	21.80	3.59	1.08
For me, eating beef is worth the risk (strongly disagree … strongly agree)	6.49	10.39	31.91	29.78	21.43	3.49	1.13
I am … the risk of eating beef (not willing to accept … willing to accept)	6.12	8.72	30.06	32.93	22.17	3.56	1.11
Average Sum Score						3.55	
To what extent are you concerned about BSE and Creutzfeldt Jakob Disease (vCJD) (1 = not at all … 5 = extremely concerned)	17.61	17.61	34.85	17.98	11.96	2.89	1.24
The safety of food products is mainly influenced by parties in the food chain other than myself [strongly disagree, … , strongly agree]	2.13	4.91	27.43	46.62	18.91	3.75	0.89

Table 3. Conditional Logit Model

	Coef. Estimates		Std. Err.	t-value	[95% Conf. Int]	
Main Effects						
CHOOSENO	-1.4572	***	0.2586	-5.64	-1.9640	-0.9504
AUS	-1.1120	***	0.0356	-31.21	-1.1818	-1.0421
CAN	-0.8574	***	0.0340	-25.22	-0.9240	-0.7908
BSE	0.6311		0.3905	1.62	-0.1343	1.3966
TRACE	0.5276		0.3915	1.35	-0.2397	1.2948
TRC_BSE	0.5919		0.3781	1.57	-0.1491	1.3328
TENDER	0.6882	***	0.0288	23.93	0.6319	0.7446
NATURAL	0.0250		0.0292	0.86	-0.0323	0.0824
PRICE	-0.1657	***	0.0039	-42.13	-0.1734	-0.1580
Socio-Demographic Interaction						
BSE*AGE	-0.0090	***	0.0021	-4.34	-0.0131	-0.0050
BSE*BSECONCERN	0.2016	***	0.0385	5.24	0.1261	0.2770
BSE*EDU	0.0248	*	0.0145	1.71	-0.0036	0.0531
BSE*FC	0.1216	**	0.0486	2.50	0.0263	0.2168
BSE*INC	0.0028	***	0.0010	2.83	0.0009	0.0048
CHOOSENO*BSECONCERN	0.1243	***	0.0315	3.95	0.0626	0.1861
CHOOSENO*FC	0.1812	***	0.0397	4.56	0.1034	0.2590
TRACE*AGE	-0.0113	***	0.0020	-5.66	-0.0152	-0.0074
TRACE*BSECONCERN	0.2397	***	0.0376	6.38	0.1660	0.3133
TRACE*EDU	0.0371	***	0.0136	2.72	0.0104	0.0638
TRACE*FC	0.1472	***	0.0477	3.08	0.0536	0.2408
TRACE*INC	0.0023	**	0.0010	2.40	0.0004	0.0042
TRC_BSE*AGE	-0.0067	***	0.0021	-3.19	-0.0108	-0.0026
TRC_BSE*BSECONCERN	0.1805	***	0.0385	4.69	0.1050	0.2559
TRC_BSE*EDU	0.0303	**	0.0145	2.09	0.0020	0.0587
TRC_BSE*FC	0.1085	**	0.0484	2.24	0.0136	0.2034
TRC_BSE*INC	0.0024	**	0.0010	2.36	0.0004	0.0044
Perceived Risk Interaction						
BSE*RA	-0.2540	**	0.1056	-2.41	-0.4611	-0.0470
BSE*RA*RP	0.1199	***	0.0410	2.93	0.0397	0.2002
BSE*RP	-0.3530	***	0.1074	-3.29	-0.5636	-0.1425
CHOOSENO*RA	-0.3047	***	0.0876	-3.48	-0.4763	-0.1330
CHOOSENO*RA*RP	0.2647	***	0.0347	7.62	0.1966	0.3328
CHOOSENO*RP	-0.5572	***	0.0904	-6.17	-0.7343	-0.3801

TRACE*RA	-0.3394	***	0.1038	-3.27	-0.5428	-0.1361
TRACE*RA*RP	0.1289	***	0.0401	3.21	0.0503	0.2075
TRACE*RP	-0.1929	*	0.1055	-1.83	-0.3996	0.0137
TRC_BSE*RA	-0.3293	***	0.1069	-3.08	-0.5389	-0.1198
TRC_BSE*RA*RP	0.1014	**	0.0415	2.45	0.0202	0.1827
TRC_BSE*RP	-0.2149	**	0.1083	-1.98	-0.4272	-0.0027
Log Likelihood	-13330.52					
McFadden R2	0.17					
AIC	26737.10					

Notes: ***, **, and * indicate significant at the 1%, 5%, and 10% significance levels

Table 4. Mixed Logit Model with Error Component

	Coef. Estimates		Std. Err.	t-value	[95% Conf. Int]	
Main Effects						
CHOOSENO	-2.5736	***	0.6054	-4.25	-3.7602	-1.3870
AUS	-1.8195	***	0.0847	-21.48	-1.9856	-1.6535
CAN	-1.3278	***	0.0736	-18.04	-1.4720	-1.1835
BSE	0.0213		0.6878	0.03	-1.3268	1.3694
TRACE	0.0472		0.6544	0.07	-1.2353	1.3297
TRC_BSE	0.2295		0.7465	0.31	-1.2337	1.6926
TENDER	1.0640	***	0.0505	21.07	0.9650	1.1630
NATURAL	0.0313		0.0473	0.66	-0.0615	0.1240
PRICE	-0.2587	***	0.0040	-64.34	-0.2666	-0.2508
Socio Demographic Interaction						
BSE*AGE	0.0068		0.0043	1.57	-0.0017	0.0153
BSE*BSECONCERN	0.3165	***	0.0605	5.23	0.1979	0.4352
BSE*EDU	0.0193		0.0296	0.65	-0.0388	0.0774
BSE*FC	0.1678	**	0.0759	2.21	0.0190	0.3166
BSE*INC	0.0009		0.0020	0.44	-0.0031	0.0049
CHOOSENO*BSECONCERN	0.2433	***	0.0764	3.18	0.0935	0.3930
CHOOSENO*FC	0.2186	**	0.0952	2.30	0.0320	0.4052
TRACE*AGE	0.0103	**	0.0042	2.46	0.0021	0.0184
TRACE*BSECONCERN	0.2836	***	0.0581	4.88	0.1698	0.3975
TRACE*EDU	0.0255		0.0278	0.92	-0.0290	0.0801
TRACE*FC	0.1324	*	0.0735	1.80	-0.0117	0.2766
TRACE*INC	-0.0002		0.0021	-0.10	-0.0043	0.0039
TRC_BSE*AGE	0.0009		0.0046	0.19	-0.0081	0.0099
TRC_BSE*BSECONCERN	0.4143	***	0.0666	6.22	0.2837	0.5448
TRC_BSE*EDU	0.0327		0.0315	1.04	-0.0291	0.0945
TRC_BSE*FC	0.2332	***	0.0831	2.81	0.0703	0.3960
TRC_BSE*INC	-0.0006		0.0023	-0.25	-0.0050	0.0039
Perceived Risk Interaction						
BSE*RA	-0.2489		0.1774	-1.40	-0.5966	0.0989
BSE*RA*RP	0.1325	**	0.0629	2.11	0.0092	0.2557
BSE*RP	-0.4579	***	0.1605	-2.85	-0.7725	-0.1433
CHOOSENO*RA	-0.6939	***	0.2031	-3.42	-1.0920	-0.2958
CHOOSENO*RAC	0.5110	***	0.0740	6.91	0.3660	0.6561
CHOOSENO*RP	-0.9328	***	0.2033	-4.59	-1.3313	-0.5343

TRACE*RA	-0.3878	**	0.1796	-2.16	-0.7398	-0.0359
TRACE*RA*RP	0.1243	*	0.0682	1.82	-0.0093	0.2579
TRACE*RP	-0.2877		0.1787	-1.61	-0.6379	0.0625
TRC_BSE*RA	-0.4210	**	0.2026	-2.08	-0.8180	-0.0239
TRC_BSE*RA*RP	0.1574	**	0.0755	2.09	0.0095	0.3054
TRC_BSE*RP	-0.3010		0.2016	-1.49	-0.6961	0.0941
Diagonal Values in Cholesky Matrix						
CHOOSENO	1.0754	***	0.1205	8.93	0.8393	1.3115
AUS	0.9300	***	0.1050	8.86	0.7242	1.1358
CAN	0.4502	***	0.0759	5.93	0.3014	0.5989
BSE	1.1724	***	0.0874	13.41	1.0010	1.3437
TRACE	0.4566	***	0.1079	4.23	0.2450	0.6681
TRC_BSE	0.1292		0.1363	0.95	-0.1379	0.3964
TENDER	0.3857	***	0.0824	4.68	0.2242	0.5472
NATURAL	0.2840	***	0.0909	3.13	0.1059	0.4621
Std Dev of Error Component	2.6551	***	0.0857	30.98	2.4871	2.8230
Log Likelihood	-10481.6					
McFadden R2	0.3514					
AIC	21113.2					

Notes: ***, **, and * indicate significant at the 1%, 5%, and 10% significance levels
Results produced with NLOGIT 4.0, 200 Halton Draws

Table 5. Marginal WTP Estimates

		$/lb		Std Err.	t-value	[95% Conf.	Int.]
Marginal WTP associated with BSE Concern							
TRACE		1.10	***	0.22	4.89	0.66	1.54
BSE		1.22	***	0.24	5.18	0.76	1.69
TRC_BSE		1.60	***	0.25	6.29	1.10	2.10
Marginal WTP associated with Perceived Control of Food Chain							
TRACE		0.52	*	0.29	1.80	-0.05	1.08
BSE		0.66	**	0.29	2.24	0.08	1.23
TRC_BSE		0.91	***	0.32	2.87	0.29	1.54
Marginal WTP associated with Risk Attitude							
	Risk Perception						
Traceable	1	-1.02	**	0.47	-2.14	-1.95	-0.09
	2	-0.53		0.33	-1.61	-1.19	0.12
	3	-0.05		0.37	-0.14	-0.77	0.66
	4	0.43		0.54	0.79	-0.64	1.49
	5	0.91		0.77	1.18	-0.60	2.42
BSE-Tested	1	-0.45		0.48	-0.92	-1.40	0.50
	2	0.06		0.34	0.19	-0.61	0.74
	3	0.58	*	0.34	1.67	-0.10	1.25
	4	1.09	**	0.49	2.23	0.13	2.04
	5	1.60	**	0.69	2.32	0.25	2.95
BSE-tested and Traceable	1	-1.02	*	0.54	-1.86	-2.08	0.05
	2	-0.41		0.38	-1.09	-1.15	0.33
	3	0.19		0.39	0.49	-0.58	0.97
	4	0.80		0.58	1.37	-0.34	1.94
	5	1.40	*	0.83	1.69	-0.23	3.03
Marginal WTP associated with Risk Perception							
	Risk Attitude						
Traceable	1	-0.63		0.47	-1.33	-1.55	0.29
	2	-0.15		0.32	-0.46	-0.78	0.48
	3	0.33		0.35	0.94	-0.36	1.02
	4	0.81		0.53	1.53	-0.23	1.85
	5	1.29	*	0.76	1.70	-0.20	2.77

BSE-Tested	1	-1.25	***	0.42	-2.96	-2.08	-0.42
	2	-0.74	**	0.31	-2.36	-1.36	-0.13
	3	-0.23		0.37	-0.62	-0.95	0.49
	4	0.28		0.54	0.53	-0.77	1.33
	5	0.80		0.75	1.07	-0.67	2.26
BSE-tested and Traceable	1	-0.56		0.54	-1.05	-1.62	0.49
	2	0.05		0.37	0.13	-0.68	0.77
	3	0.66	*	0.40	1.65	-0.12	1.44
	4	1.27	**	0.59	2.14	0.10	2.43
	5	1.88	**	0.85	2.21	0.22	3.54

Notes: ***, **, and * indicate significant at the 1%, 5%, and 10% significance levels
Results produced with NLOGIT 4.0, 5,000 Krinsky and Robb Simulations

Table 6. Total WTP Estimates

Traceable Beef		Risk Attitude									
		1		2		3		4		5	
Risk Perception	1	5.81	***	4.79	***	3.78	***	2.76	**	1.76	
		(0.79)		(0.64)		(0.80)		(1.16)		(1.58)	
	2	5.17	***	4.63	***	4.11	***	3.58	***	3.03	***
		(0.62)		(0.48)		(0.54)		(0.77)		(1.05)	
	3	4.53	***	4.48	***	4.44	***	4.39	***	4.31	***
		(0.77)		(0.51)		(0.44)		(0.64)		(0.93)	
	4	3.89	***	4.32	***	4.77	***	5.20	***	5.58	***
		(1.12)		(0.71)		(0.59)		(0.89)		(1.33)	
	5	3.24	**	4.17	***	5.10	***	6.01	***	6.85	***
		(1.53)		(0.98)		(0.87)		(1.32)		(1.95)	

BSE-tested Beef		Risk Attitude									
		1		2		3		4		5	
Risk Perception	1	5.75	***	5.30	***	4.84	***	4.40	***	3.97	**
		(0.82)		(0.66)		(0.83)		(1.18)		(1.57)	
	2	4.50	***	4.56	***	4.62	***	4.68	***	4.75	***
		(0.62)		(0.48)		(0.57)		(0.79)		(1.07)	
	3	3.24	***	3.82	***	4.39	***	4.96	***	5.54	***
		(0.68)		(0.47)		(0.47)		(0.66)		(0.95)	
	4	1.99	**	3.07	***	4.16	***	5.25	***	6.33	***
		(0.96)		(0.64)		(0.62)		(0.91)		(1.33)	
	5	0.73		2.33	***	3.93	***	5.53	***	7.12	***
		(1.32)		(0.90)		(0.91)		(1.34)		(1.93)	

BSE-tested and Traceable Beef		Risk Attitude									
		1		2		3		4		5	
Risk Perception	1	8.01	***	6.99	***	5.97	***	4.95	***	3.99	**
		(0.93)		(0.73)		(0.89)		(1.27)		(1.75)	
	2	7.46	***	7.04	***	6.63	***	6.22	***	5.84	***
		(0.71)		(0.54)		(0.60)		(0.84)		(1.17)	
	3	6.90	***	7.10	***	7.29	***	7.50	***	7.70	***
		(0.84)		(0.56)		(0.50)		(0.71)		(1.03)	
	4	6.34	***	7.15	***	7.96	***	8.77	***	9.55	***
		(1.21)		(0.78)		(0.67)		(0.99)		(1.46)	
	5	5.78	***	7.20	***	8.62	***	10.04	***	11.41	***
		(1.67)		(1.08)		(0.97)		(1.46)		(2.14)	

Notes: ***, **, and * indicate significant at the 1%, 5%, and 10% significance levels. Standard error in parentheses.
Results produced with NLOGIT 4.0, 5,000 Krinsky and Robb Simulations