Will consumers pay for voluntary testing for BSE? Double-bound CVM evidence from Canada

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Abstract

The 2003 discovery of BSE infected cattle in North America led to efforts to ensure the safety of beef produced in that region, and to some discussion regarding testing live cattle for the BSE prion. This paper investigates consumer acceptance and valuation of beef from live cattle that have been voluntarily tested for BSE. Using data from an internet-based survey of English speaking Canadians, double bound estimates of WTP are measured. Consumption behaviour and perception covariates were significant predictors of expected WTP, while socio-economic and demographic effects had no measurable effect. Expected WTP was not significantly different from zero, but ranged from eight per cent for respondents with a high purchase intention, to -3.5 per cent for those with low/moderate purchase intention. Further decomposition showed expected WTP ranges from -5 to five per cent for those with low/moderate purchase intention and from five to 21 per cent for those with a high purchase intention.

Keywords: BSE, Canada, consumer demand, willingness-to-pay

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1 Introduction

Since the discovery of BSE infected cattle in Canada and the U.S. in 2003, a number of efforts have been undertaken to assess the impact of BSE on the North American cattle industry. This work has focused on developing estimates of the broad economic costs associated with BSE (Klein and Le Roy, 2010; Wieck and Holland, 2010), trade implications (Wigle et al., 2007; Weerahewa et al., 2008; Carlberg et al., 2009), structural changes in the beef industry (Rude et al., 2007), and impact on prices along the value chain (Nardella, 2006; Marsh et al., 2008; Jin et al., 2008). A deeper understanding of consumer reactions to food scares has also emerged from analysis of micro- (Maynard et al., 2008; Wang et al., 2010; Maynard and Wang, 2010; Muringai et al., 2011) and aggregate level demand analysis related to BSE (Ding et al., 2011, and Yang and Goddard, 2011a,b).\(^1\)

In addition, some have measured willingness to pay (WTP) to avoid risk of exposure to the BSE prion. Studies have explored this by asking respondents to indicate whether, or how much, they would pay for beef that would not transmit the human variant of BSE (or Creutzfeldt-Jakob disease, CJD) (Latouche, 1998; Muringai et al., 2011), or measure willingness to pay for beef from animals tested for the BSE prion (McCluskey et al., 2005; Moore 2005; Aubeluck, 2010; Aizaki et al., 2012; Lim, 2012; Lim et al., 2013a,b; Lee et al., 2013). A general conclusion is that consumers are willing to pay a premium, but the value varies with the type of beef (i.e. muscle cut versus mince) and country. The role of country-of-origin (COO) has also been addressed in the context of WTP for beef from animals that have been tested for BSE (e.g. Aubeluck, 2010; Aizaki et al., 2012; Lim, 2012; Lim et al., 2013a,b; Lee et al., 2013), with COO premiums and discounts measured in different contexts. Coupled with testing for BSE and COO, is emerging evidence that consumers are willing to

\(^1\)While the latter are Canadian focused studies, a larger literature has emerged that seeks to understand the impact of BSE on consumer preference in other regions of the world (e.g. Burton and Young, 1996; Verbeke and Ward, 2001; Jin and Koo, 2003; Peterson and Chen, 2005; Schlenker and Villas-Boas, 2009; Ishida et al., 2010)
pay for traceability in beef (Aubeeluck, 2010; Lim, 2012; Lim et al., 2013a,b), often with complementary effects when bundled with testing for BSE.

While some of these previous studies have explored the use of labels as a means of conveying information about the product’s characteristics, not all have. In a number of these studies, the role of labels indicating whether the beef product is from an animal that has been tested for BSE is unclear. Moreover, the literature has been unclear in its treatment of whether a ‘Tested for BSE’ label appears on all products (i.e. mandatory testing and labelling) or some products (i.e. voluntary testing and labelling). Such differentiation could be particularly important if, in the absence of mandatory testing, voluntary testing emerges as a product differentiation strategy for some firms. Such a strategy could lead to beef products in a meat case, some of which have a ‘Tested for BSE’ label, while others do not have such a label. In these circumstances, understanding consumer’s reaction to the coexistence of labelled and unlabelled beef products becomes important.

This paper attempts to address this gap by investigating consumer acceptance and valuation of beef labelled as coming from live cattle that have been tested for BSE, along side beef that does not have such a label. It does so using discrete choice analysis of double-bounded contingent valuation data collected using an internet survey implemented on a nationally representative sample of English speaking Canadians. Beyond populating the literature with an additional study exploring consumer reaction to testing for BSE, the paper and results also situate within the broader literature of the economics of food labels (see, e.g., Golan et al., 2001). Indeed, this paper fits within the labelling literature exploring consumer reaction to labels in the context of: nutrition (e.g. Crutchfield et al., 2001; Cowburn and Stockley, 2005; Kiesel et al., 2011); GMOs (e.g. Huffman, 2003; Huffman et al., 2003; Hu et al., 2005; Carlsson et al., 2007); traceability (e.g. Golan et al., 2004; Verbeke and Ward, 2006); and country-of-origin (e.g. Loureiro and Umberger, 2003, 2007; Roosen et al., 2003; Lim, 2012; Lim et al., 2013a,b; Lee et al., 2013).
Broadly speaking, the survey builds on a previously published paper by McCluskey et al., (2005) that explored Japanese consumers WTP for beef that has been tested for BSE. Results from this study indicate that the market for such beef products voluntarily tested for BSE is comparatively small, and that expected WTP for such a product is not significantly different from zero. However, further analysis points to heterogeneity of preferences, with a small segment of consumers willing to pay a 21 per cent premium for such products.

Discussion of the experimental design and methods is presented next, followed by discussion of the survey and data used in the analysis. Presentation of results initially focuses on econometric estimates of a double-bound choice model, followed by discussion of the estimates of WTP. The last section contains discussion and conclusions.

2 Experimental Design & Methods

To understand better consumer reaction to testing for BSE, and to gauge willingness to pay for beef that has been tested, a double-bound contingent valuation experiment was undertaken. As is common with CV surveys (the survey proper is discussed below), respondents were provided with a brief information paragraph related to BSE. Such a paragraph is included to normalize the information set to which respondents are exposed to prior to encountering the choice question. This information passage was developed using information available from Health Canada; Agriculture and Agri-Food Canada; the Canadian Food Inspection Agency; and the World Organization for Animal Health, and read as follows:

*Bovine spongiform encephalopathy (BSE), or mad cow disease, is a nervous system disease of cattle. Scientific research from around the world indicates that BSE is concentrated in specific nervous system tissues, and as such these tissues are treated as hazardous and removed from the food system. Any animals found to be positive for BSE are immediately destroyed*
and completely removed from the food system. As such, common cuts of beef (such as roast, steaks, and ground beef) are considered safe by the Canadian Food Inspection Agency, and international agencies such as the World Organization for Animal Health. Because of this, BSE poses an extremely low risk to human health. While Canada maintains a BSE surveillance program for Canadian cattle, it does not require mandatory testing of all cattle for BSE because there is no scientific basis for doing so.

After encountering this information script, respondents answered several questions related to BSE and beef, followed by the choice questions. The initial choice question asked each respondent if they would:

...be willing to purchase the cut of beef (such as a steak or a roast) that has the label ‘Tested for BSE’ when it is offered at a price that is [PERCENTAGE PREMIUM] more expensive than the same cut of beef that does not have the ‘Tested for BSE’ label?

and given the response options ‘Yes’, ‘No’ and ‘Don’t know’. For the first choice question, the percentage premium to which respondents were randomly assigned initially ranged from ten to 50 per cent, in ten percentage point intervals (i.e. there were five price premium cells, with a minimum cell size of 200 respondents). If respondents answered ‘Yes’ (‘No’ or ‘Don’t know’) to the first choice question, a follow-up question was included with a percentage premium that was five percentage points higher (lower). In the analysis that follows, ‘Don’t know’ responses were treated as ‘No’ responses.

Given the nature of the choice questions, and following Hanemann and Kanninen (1999), the choice data were modelling using a double-bound contingent valuation model. This approach has the advantage that the follow-up question provides additional information that helps to bound willingness to pay. Moreover, as Hanemann et al. (1991) showed, such
an approach can improve the efficiency of estimated WTP. The model was implemented using the `doubleb` command in STATA.

The `doubleb` command leads to estimates of a WTP function that reflects an underlying utility function. Conventional estimation, i.e. single bound estimates, lead to a utility function such as: \( U = \alpha + P\gamma_P + z'\zeta \) and corresponding marginal WTP for the \( j \)th attribute calculated as: \( -\zeta_j/\gamma_P \). With `doubleb`, the WTP function can be expressed as:

\[
WTP_i = z_i\beta + \mu_i
\]

where \( WTP_i \) is the \( i \)th respondents WTP, \( z_i \) is a vector of covariates, \( \beta \) is vector of parameters to be estimated, and \( \mu_i \) is an error term assumed to follow a Normal distribution with mean zero and finite variance \( \sigma^2 \). In this context, the \( j \)th element of \( \beta \) is the marginal WTP for the \( j \)th covariate in the model. Also note that the variance of the choice model is estimated directly, unlike a probit model where the coefficients are standardized to reflect the assumption of a Standard Normal error term. Variables reflecting respondent’s behaviours and experiences in the food and beef domain, as well as underlying attitudes and perceptions related to beef and BSE, and soci-economic and demographic variables were included in the WTP function. The next section includes discussion of the survey proper, as well as data and covariates used in this analysis.

3 Survey & Data

3.1 Survey Design

The survey (which is available upon request) used to gather data for this paper had five sections related to: screening for eligibility; household beef consumption; perceptions of food safety; consumer awareness and perceptions of BSE; contingent valuation/WTP; and
respondent socio-economic and demographic characteristics. Development and implementation of the survey occurred in April and May 2010. The sample (n≈1,000) targeted English-speaking Canadians in British Columbia, Alberta, Saskatchewan, Manitoba, Ontario or Atlantic Canada. Budget limitations prevented surveying French-speaking Canadians; this coupled with the heavy concentration of French speakers in Quebec, meant Quebec was excluded from the sample. Cost of transport and subsequently higher food prices in northern regions of Canada (i.e. Yukon, Northwest Territories, and Nunavut) led to these regions also being excluded. Provincial/regional sampling quotas were established using each province’s share of the population in the eligible (i.e. sampled) provinces. Eligibility requirements included: residing in the sampled provinces; being 18 years of age or older; not being employed in TV/radio/press/newspaper/magazine, ad agency/public relations or marketing research/marketing; either be the primary grocer shopper for the home or to share in this responsibility; and having consumed beef in the six weeks prior to completing the survey. The survey was implemented by a professional marketing research company (Ipsos Forward Research) using their iSay consumer panel as the sample-frame for the survey. The final dataset included 1,008 complete observations, and fulfillment of all provincial/regional sample quotas.

3.2 Behavioural & experiential variables

A number of food and beef behavioural variables control for factors that might be strong predictors of choice of a beef product from animals that have been tested for BSE. Frequency of consumption of different meats has been shown to be associated with liking/acceptance and/or WTP for new or novel meat products (e.g. Verbeke et al. 2005; Krystallis et al. 2007; Froehlich et al. 2009; van Loo et al. 2011). As such, beef specific behaviours include a dummy variable (highfreq) that equals one if the respondent has a high frequency of consumption of beef, zero otherwise (where high frequency is defined as consuming beef more than once a
week). This variable controls for those with possibly higher levels of awareness or familiarity with beef and is expected to have an inverse relationship with the decision to purchase beef from animals that have been voluntarily tested for BSE.

Acceptance of quality differentiated meat products has been shown to have association with the channel in which consumers purchase meats (e.g. Verbeke et al. 2005; Fortomaris et al. 2006; Krystallis et al. 2007). To capture this potential effect, the model also includes a dummy variable (storefrmt) accounting for the retail format at which the respondent usually buys beef. This variable equals one if respondents indicated they usually purchase beef at one of the following formats: ethnic grocery stores; health food stores; butcher shops; farmers’ markets or direct from a farm or farmer, zero otherwise. As respondents who frequent such formats are likely in the market for speciality or premium beef products, a positive sign is expected on this coefficient.

The model controls for respondents who might have experience and knowledge about food and farming systems. The dummy variable farming equals one if the respondent, or someone in their family or close friend, is engaged in farming (zero otherwise), while ownfoag equals one if the respondent has expertise or is employed in the food or agricultural industry (zero otherwise). One might expect these individuals to have knowledge related to beef and beef production, or BSE, that goes beyond the general population, including knowledge about regulations related to feedstuffs in beef production. As such, a negative sign is expected on coefficients for these variables.

Two additional dummy variables account for other food consumption behaviours. A dummy variable (growown) equals one if the respondent indicated they grow food for their own household’s consumption (zero otherwise), while organic equals one if the respondent indicated they purchased organic food products in the past three months (zero otherwise). Cranfield et al. (2011; 2012) report these variables to carry strong predictive power in the context of local food purchases, and the purchase of functional foods. Coefficients on both
of these variables are expected to be positive, a reflection of either a higher degree of food engagement or being in the market for food products of a perceived higher quality. Table 1 shows the means and standard deviations for these behavioural variables.

Table 1. Mean and standard deviation of the behavioural and experiential variables (n=1,008)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Name</th>
<th>Mean</th>
<th>Std dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>High frequency of purchase</td>
<td>highfreq</td>
<td>0.571</td>
<td>0.495</td>
</tr>
<tr>
<td>Format of store where usually buy beef</td>
<td>storefrmt</td>
<td>0.364</td>
<td>0.481</td>
</tr>
<tr>
<td>Self or know others engaged in farming</td>
<td>farming</td>
<td>0.154</td>
<td>0.361</td>
</tr>
<tr>
<td>Self or know others employed in food or ag</td>
<td>ownfoag</td>
<td>0.071</td>
<td>0.258</td>
</tr>
<tr>
<td>Grow food for home consumption</td>
<td>growown</td>
<td>0.380</td>
<td>0.486</td>
</tr>
<tr>
<td>Purchased organic food in last three months</td>
<td>organic</td>
<td>0.451</td>
<td>0.498</td>
</tr>
</tbody>
</table>

3.3 Perception variables

Previous research related to acceptance of attribute differentiated meat products has included variables reflecting respondent’s concern (or importance) they place on a variety of quality related domains, including: production practices (e.g. Grunert et al. 2004; Lim et al 2013a,b); BSE related risk perceptions (e.g. Lim et al 2013b); food safety concerns or importance of food safety (e.g. Roosen et al. 2003; Krystallis et al. 2007; Umberger et al. 2009); and price (e.g. Roosen et al. 2003). To capture these constructs the survey includes a statement bank with nine items reflecting different aspects of beef production, risk and value. Respondents were asked to consider each statement in the context of making a purchase decision for beef and to then indicate their level of concern using a five point Likert scale (1=‘not at all concerned’, 5=‘very concerned’). Factor analysis was then used to extract any underlying latent constructs. A Kaiser-Meyer-Olkin (KMO) statistic of 0.895 indicates a high degree of correlation between responses to these items. Principle component extraction with varimax rotation yields two factors with eigenvvalues exceeding one. Table 2 shows the nine items in the statement bank and associated factor loadings.
### Table 2. Results from exploratory factor analysis on items respondents consider when purchasing beef (n=1,008)

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1 (Non-price factors)</th>
<th>Factor 2 (Price factor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whether antibiotics are used during the raising of beef cattle</td>
<td>0.8697</td>
<td>0.1028</td>
</tr>
<tr>
<td>Whether hormones are used during the raising the beef cattle</td>
<td>0.8545</td>
<td>0.1055</td>
</tr>
<tr>
<td>Whether beef is from cattle which have been raised using enhanced animal welfare production methods</td>
<td>0.8365</td>
<td>0.1666</td>
</tr>
<tr>
<td>Whether beef is from cattle which have been produced using certified organic production methods</td>
<td>0.8129</td>
<td>0.0636</td>
</tr>
<tr>
<td>Whether beef is from cattle which are raised locally (i.e. within 100 kilometers of where I live)</td>
<td>0.6955</td>
<td>0.0863</td>
</tr>
<tr>
<td>The price I pay for beef at retail</td>
<td>0.0063</td>
<td>0.8828</td>
</tr>
<tr>
<td>Risk of exposure to food borne contamination</td>
<td>0.6281</td>
<td>0.4611</td>
</tr>
<tr>
<td>Risk of exposure to mad cow disease/BSE</td>
<td>0.5667</td>
<td>0.4476</td>
</tr>
<tr>
<td>Cholesterol and fat</td>
<td>0.4844</td>
<td>0.4392</td>
</tr>
<tr>
<td>Per cent variation</td>
<td>47.5</td>
<td>16.1</td>
</tr>
<tr>
<td>Cronbach Alpha</td>
<td>0.889</td>
<td>Not calculated</td>
</tr>
<tr>
<td>Mean score</td>
<td>3.716</td>
<td>4.095</td>
</tr>
</tbody>
</table>

Factor 1 loads heavily on items related to production practices, animal welfare and locality of production, and is named ‘Non-price factors’ (*nonpf*). Factor 2 loads heavily on only one item, ‘The price I pay for beef at retail’, and is named ‘Price factor’ (*pricef*). Together these two factors explain 64 per cent of the variation in responses to the nine items. A Cronbach alpha of 0.89 for the ‘Non-price factors’ indicates a high degree of reliability. Since the price factor only included only one item, its Cronbach alpha is not calculated. The mean value of the heavily loaded items (in bold) in the non-price factor was 3.72, while the mean value of the price factor was about 4.1. A statistically significant difference in the mean scores for these two factors (*t*=−10.75, *p*-value<0.001) indicates respondents have a higher level of concern over the price they pay at retail than the non-price factors.
Building on the literature that has explored meat safety, the survey includes a question to gauge respondent perceptions (rated on a four point scale ranging from very safe to very unsafe, with a don’t know option) of the food safety of various meats produced in Canada. At least 40 per cent of respondents believe that pork, beef and chicken produced in Canada is very safe. Close to 90 per cent of respondents indicate these meats are at least somewhat safe. Fifty per cent of respondents view beef as very safe. To capture perceptions of the safety of beef produced in Canada the model includes a dummy variable, beefsafe, that equals one for those who indicate beef is very safe (zero otherwise).

Part of this study focuses on the role labels indicating beef is from an animal that has been tested for BSE. Much of the literature related to consumer preference for beef has focused on labelling as a means of articulating country-of-origin (e.g. Loureiro and Umberger, 2003, 2007; Roosen et al., 2003; Lim et al., 2013a,b; Lee et al., 2013), while a growing body of work relates to labels related to food safety of beef and testing for BSE (e.g. Aubeeluck, 2010; Aizaki et al., 2012; Lim, 2012; Lim et al., 2013a,b; Lee et al., 2013). In the context of voluntary testing, it is possible that a consumer might encounter beef in the meat case that has a label ‘Tested for BSE’ along side beef not bearing such a label. To help understand the potential impact of such labels, the survey includes the following item (this appeared after the BSE information script discussed above):

Suppose you are shopping for a cut of beef (such as steak or a roast) in the retail store where you typically buy beef and you notice that some packages of beef have a label saying ‘Tested for BSE’, while other packages of beef do not have the ‘Tested for BSE’ label. Based on your existing perception of the safety of Canadian beef, what is your perception of the safety of...

(Please select one only per row)

Subjects then indicate their perception of the safety of beef with a ‘Tested for BSE’ label and
beef without such a label (using a four point scale ranging from very safe to very unsafe, with a don’t know option). Beef with no ‘Tested for BSE’ label is ranked ‘Very safe’ by 21 per cent of subjects, and ‘Safe’ by 54 per cent of subjects. Beef bearing a ‘Tested for BSE’ label is ranked ‘Very safe’ by 60 per cent of subjects, and ‘Safe’ by 37 per cent of subjects. On the basis of differences in these ratings, the model includes two variables capturing respondent perceptions of the safety of beef with the ‘Tested for BSE’ label ($l_{safe}$), or not bearing this label ($n_{safe}$). In both instances, responses are recoded so very safe has a value of 5, don’t know has a value of 3 and very unsafe has a value of 1. Significant differences in the means of $l_{safe}$ and $n_{safe}$ ($t=23.62$, p-value$<0.001$) indicate the presence of ‘Tested for BSE’ label is associated with perceptions of safety. One might expect respondents that perceived higher safety of beef without a label to be less likely to purchase the alternative with a ‘Tested for BSE’ label and hence, have a lower willingness to pay, while those with a higher perception of safety of the labelled beef to be more likely to purchase this option and have a higher willingness to pay.

Consumer’s perceived familiarity with or knowledge of BSE could be a mediating factor influencing choice of beef from animals that have been tested for BSE (see, e.g. Moore 2005; Muringai et al. 2011). To account for this, a dummy variable, $v_{fambse}$, is included in the model. The variable $v_{fambse}$ equals one if the respondent indicates they are very familiar with BSE. (A four point rating scale ranging from very familiar to very unfamiliar captures responses to the question ‘How familiar are you with ‘mad cow’ disease, or bovine spongiform encephalopathy (BSE)?’). If familiarity with BSE is a mediating factor, then one would expect an inverse relationship between WTP and the $v_{fambse}$ variable.

Acceptance and WTP for beef from animals tested for BSE could also depend on the relative importance of testing for BSE in a beef purchase decision. Furthermore, dimensions of quality (or expected quality) have been shown to play an important role in shaping preferences for new and emerging meat products (e.g. Bredahl et al. 1998; Roosen et al.
2003; Krystallis et al. 2007; Lim et al. 2013a). To this end, a question in the survey asks respondents to assign 100 points to eight different factors associated with beef quality. Based on Bello Acebrón and Dopico (2000) and Banović et al. (2009), these items include: colour; external fat cover; freshness; marbling; premium brand; price; region or country of origin. We add to this whether the beef has been tested for BSE. On average across the sample, the ordered ranking of the top three items was: freshness; price; and tested for BSE. Hence, the model includes a variable that captures the importance of testing for BSE, $bsetimprt$, which equals the weight (out of 100) the respondent assigns to ‘Tested for BSE’ option in the above listing of factors thought important in a beef purchase decision. Table 3 shows the means and standard deviations for the perception variables.

Table 3. Mean and standard deviation of the perception variables ($n=1,008$)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Name</th>
<th>Mean</th>
<th>Std dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-price factors</td>
<td>nonpf</td>
<td>3.717</td>
<td>0.892</td>
</tr>
<tr>
<td>Price factors</td>
<td>pricef</td>
<td>4.095</td>
<td>0.876</td>
</tr>
<tr>
<td>Beef in Canada is very safe</td>
<td>beefsafe</td>
<td>0.496</td>
<td>0.500</td>
</tr>
<tr>
<td>Perceived safety of beef with no ‘Tested for BSE’ label</td>
<td>nlsafe</td>
<td>3.709</td>
<td>1.083</td>
</tr>
<tr>
<td>Perceived safety of beef with a ‘Tested for BSE’ label</td>
<td>lsafe</td>
<td>4.543</td>
<td>0.622</td>
</tr>
<tr>
<td>Very familiar with BSE</td>
<td>vfambse</td>
<td>0.138</td>
<td>0.345</td>
</tr>
<tr>
<td>Importance of testing for BSE</td>
<td>bsetimprt</td>
<td>14.19</td>
<td>14.32</td>
</tr>
</tbody>
</table>

3.4 Socio-economic & Demographic variables

The model includes controls that account for a variety of socio-economic and demographic characteristics. Table 4 shows summary statistics for the socio-economic and demographic controls, and where available similar measures from the 2006 Census of Canada. Survey respondents were disproportionately female compared to the Canadian population; this is expected given the exclusion of those who do not play a major role in grocery shopping for the home. On average, the sample was also older than the Canadian population, but again this is expected given the exclusion of under 18 year olds from the survey. The sample
does an adequate job of capturing those with education levels below a post-graduate level, but under-samples those with a post-graduate degree. Compared to the 2006 Census of Canada, the sample under-represents households on the extreme ends of the income distribution (i.e. households with income under $25,000 (incu25) or over $100,000 (inc100p)), but over-represents the other household income classes. As expected given the provincial/regional sampling quotas, the regional breakdown of the sample mimics the regional population breakdown. Overall, the sample represents broadly characteristics of Canadian population.

Table 4. Mean and standard deviation of demographic and socio-economic information from the surveyed sample of Canadian residents (n=1,008)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std dev</th>
<th>Canadaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>13.19%</td>
<td>33.86%</td>
<td>49%</td>
</tr>
<tr>
<td>Age (in years)</td>
<td>49.75</td>
<td>14.55</td>
<td>39.5b</td>
</tr>
<tr>
<td>Children in the home</td>
<td>33.43%</td>
<td>47.20%</td>
<td>N.A.</td>
</tr>
</tbody>
</table>

Highest level of education attained by respondent:

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean</th>
<th>Std dev</th>
<th>Canadaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less high (less than high school)</td>
<td>6.55%</td>
<td>24.75%</td>
<td>23.76%</td>
</tr>
<tr>
<td>High school (high school diploma)</td>
<td>46.43%</td>
<td>49.90%</td>
<td>25.54%</td>
</tr>
<tr>
<td>College (college diploma)</td>
<td>34.72%</td>
<td>47.63%</td>
<td>32.56%</td>
</tr>
<tr>
<td>Undergrad (undergrad degree)</td>
<td>10.02%</td>
<td>30.04%</td>
<td>11.62%</td>
</tr>
<tr>
<td>Postgrad (post-grad degree)</td>
<td>2.28%</td>
<td>14.94%</td>
<td>6.52%</td>
</tr>
</tbody>
</table>

Household income in 2009:

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Mean</th>
<th>Std dev</th>
<th>Canadaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under $25,000 (incu25)</td>
<td>17.56%</td>
<td>38.07%</td>
<td>20.33%</td>
</tr>
<tr>
<td>$25,000-$49,999 (inc2545)</td>
<td>26.69%</td>
<td>44.25%</td>
<td>21.51%</td>
</tr>
<tr>
<td>$45,000-$69,999 (inc4570)</td>
<td>23.02%</td>
<td>42.11%</td>
<td>21.50%</td>
</tr>
<tr>
<td>$70,000-$99,999 (inc7099)</td>
<td>18.06%</td>
<td>38.48%</td>
<td>17.30%</td>
</tr>
<tr>
<td>$100,000 or higher (inc100p)</td>
<td>14.68%</td>
<td>35.41%</td>
<td>19.36%</td>
</tr>
</tbody>
</table>

Province/region of residence:

<table>
<thead>
<tr>
<th>Region</th>
<th>Mean</th>
<th>Std dev</th>
<th>Canadaa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic Canada</td>
<td>9.42%</td>
<td>29.23%</td>
<td>9.53%</td>
</tr>
<tr>
<td>Ontario</td>
<td>51.09%</td>
<td>50.01%</td>
<td>50.74%</td>
</tr>
<tr>
<td>Man/Sask.</td>
<td>9.03%</td>
<td>28.67%</td>
<td>8.83%</td>
</tr>
<tr>
<td>Alberta</td>
<td>13.49%</td>
<td>34.18%</td>
<td>13.73%</td>
</tr>
<tr>
<td>British Columbia</td>
<td>16.96%</td>
<td>37.55%</td>
<td>17.16%</td>
</tr>
</tbody>
</table>

a. Based on the Statistics Canada (2008), Census of Canada 2006
b. Median age
4 Results

This section contains discussion of the econometric results and analysis of willingness to pay. The model is estimated using the entire sample, and with two sub-samples. The sub-samples were differentiated based on respondent’s self-declared purchase intention (asked before the choice questions). The survey includes a question asking respondents to indicate the likelihood that they would purchase beef that has a ‘Tested for BSE’ label versus beef that does not have such a label. Response options to this question ranged from ‘not very likely’ (1) to ‘very likely’ (7), with a neutral middle option. The pattern of responses to this question lead to development of three ‘purchase intention’ categories. The sub-sample analysis applies the model to those in the high purchase intention category, and to those in the low and medium purchase intention categories.

4.1 Econometric Results

The double bound model estimated with the full sample initially includes all behavioural and experiential, perception and socio-economic and demographic variables discussed above. Systematic testing of the joint significance of these groups of variables was undertaken to possibly exclude those with little explanatory power and to aid in the preservation of degrees of freedom. Wald test results indicated the behavioural and experiential variables were jointly significant at the five per cent level ($\chi^2=16.13$, df=6, p-value=0.013), while the perception variables were jointly significant at the one per cent level ($\chi^2=110.17$, df=7, p-value $\leq 0.001$). However, the test failed to reject the null that the socio-economic and demographic variables jointly equal zero ($\chi^2=14.0$, df=15, p-value=0.526). Testing also lead to failure to reject

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2The low purchase intention category includes those with a response of unlikely, somewhat unlikely and very unlikely, and account for nine per cent of the sample. The moderate purchase intention category includes those with a response of unsure, likely and somewhat likely, and account for 56 per cent of the sample. The high purchase intention category includes those with a ‘very likely’ response, and account for 35 per cent of the sample.
sets of joint null hypotheses that coefficients on the following groups of socio-economic and
demographic variables jointly equal zero: regional effects; income effects; education effects;
gender, age and children in the home. As such, the final model excluded the socio-economic
and demographic variables.

As mentioned above, results from the doubleb estimator in STATA lead to a willingness to
pay function that can be used to predict WTP, and where the coefficients of the explanatory
variables are marginal WTPs. While WTP is discussed later in this section, the parameter
estimates are discussed here. Table 5 shows the coefficient estimates and z-statistics for
the estimated models. For the model estimated with the whole dataset, the magnitude
of the Wald test statistic indicates failure to accept the null hypothesis that all estimated
coefficients jointly equal to zero at the one per cent level.

Both the intercept and estimate of $\sigma$ are significant. Amongst the behavioural and
experiential variables, coefficients on the store format (storefrmt), grow own (growown) and
organic (organic) variables are significant at the ten per cent level or better. The negative
sign on storefrmt means respondents who usually purchase beef at ethnic grocery stores,
health food stores, butcher shops, or farmers’ markets or direct from a farm or farmer have
a lower willingness to pay for beef from animals that have been tested for BSE, compared to
respondents who purchase beef at other retail outlets. The negative sign on growown means
respondents who grow food for home consumption also have a lower willingness to pay than
those who do not grow food for own consumption. A positive sign on organic implies that
respondents who have purchased organic food in the three months prior to the survey have a
higher willingness to pay for beef that is from animals that have been tested for BSE. Across
the perception variables, negative signs on nolsafe and pricef implies a lower WTP amongst
respondents who: 1) felt that beef with no ‘Tested for BSE’ was safer, and 2) are concerned
with price when purchasing beef. As well, respondents’ WTP is higher if they feel beef with
a ‘Tested for BSE’ label is safer (i.e. lsafe is positive and significant), the more concerned
they are with non-price factors when purchasing beef (i.e. *nonpf* is positive and significant), and if they report BSE testing is important (i.e. *bseimprt* is positive and significant).

Application of the model to respondents with a self-reported high purchase intention led to similar results (see columns four and five in Table 5). Within the high purchase intention sub-sample, those with a high frequency (*highfreq*) of beef use have a lower WTP, but those who purchased organic food in the three months prior to the survey (*organic*) had a higher WTP. Except for the coefficient on *lsafe* (which is now insignificant), qualitatively identical results are noted when the model was applied to the high purchase intention sub-sample.

**Table 5. Double-bound estimation results**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Whole sample</th>
<th></th>
<th></th>
<th>High purchase intention</th>
<th></th>
<th></th>
<th>Low/medium purchase intention</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td><em>z</em>-stat</td>
<td>Estimate</td>
<td><em>z</em>-stat</td>
<td>Estimate</td>
<td><em>z</em>-stat</td>
<td>Estimate</td>
</tr>
<tr>
<td>Intercept</td>
<td>-26.955**</td>
<td>-2.437</td>
<td>-2.571</td>
<td>-0.130</td>
<td>-35.933**</td>
<td>-2.522</td>
<td></td>
</tr>
<tr>
<td>highfreq</td>
<td>-0.326</td>
<td>-0.159</td>
<td>-7.917**</td>
<td>-2.499</td>
<td>5.609**</td>
<td>2.020</td>
<td></td>
</tr>
<tr>
<td>storefrmt</td>
<td>-3.688*</td>
<td>-1.670</td>
<td>-1.176</td>
<td>-0.346</td>
<td>-5.785*</td>
<td>-1.955</td>
<td></td>
</tr>
<tr>
<td>farming</td>
<td>3.355</td>
<td>1.163</td>
<td>-0.022</td>
<td>-0.005</td>
<td>6.622*</td>
<td>1.783</td>
<td></td>
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<tr>
<td>ownfoag</td>
<td>-2.108</td>
<td>-0.471</td>
<td>-7.077</td>
<td>-1.040</td>
<td>1.667</td>
<td>0.289</td>
<td></td>
</tr>
<tr>
<td>growown</td>
<td>-4.733**</td>
<td>-2.150</td>
<td>-4.941</td>
<td>-1.463</td>
<td>-6.130**</td>
<td>-2.070</td>
<td></td>
</tr>
<tr>
<td>organic</td>
<td>6.290***</td>
<td>2.967</td>
<td>8.356**</td>
<td>2.473</td>
<td>5.395*</td>
<td>1.926</td>
<td></td>
</tr>
<tr>
<td>beefsafe</td>
<td>-1.115</td>
<td>-0.510</td>
<td>1.497</td>
<td>0.438</td>
<td>-2.861</td>
<td>-0.996</td>
<td></td>
</tr>
<tr>
<td>nosafe</td>
<td>-5.657***</td>
<td>-5.657</td>
<td>-6.489***</td>
<td>-4.312</td>
<td>-4.559***</td>
<td>-3.292</td>
<td></td>
</tr>
<tr>
<td>lsafe</td>
<td>8.824***</td>
<td>4.393</td>
<td>4.442</td>
<td>1.214</td>
<td>8.998***</td>
<td>3.634</td>
<td></td>
</tr>
<tr>
<td>nonpf</td>
<td>3.969***</td>
<td>2.952</td>
<td>6.076***</td>
<td>2.674</td>
<td>3.334**</td>
<td>1.980</td>
<td></td>
</tr>
<tr>
<td>pricf</td>
<td>-2.569**</td>
<td>-2.169</td>
<td>-3.710**</td>
<td>-2.098</td>
<td>-1.693</td>
<td>-1.050</td>
<td></td>
</tr>
<tr>
<td>vambse</td>
<td>2.297</td>
<td>0.800</td>
<td>4.534</td>
<td>1.084</td>
<td>-0.587</td>
<td>-0.146</td>
<td></td>
</tr>
<tr>
<td>bseimprt</td>
<td>0.335**</td>
<td>4.744</td>
<td>0.243***</td>
<td>2.820</td>
<td>0.437***</td>
<td>3.060</td>
<td></td>
</tr>
</tbody>
</table>

Sample size 1008 347 661
Wald 121.31 56.87 47.82
p-value <0.0001 <0.0001 <0.0001

Notes:
*** significant at the one per cent level
** significant at the five per cent level
* significant at the ten per cent level

Estimates of the model using respondents with a low/medium purchase intention are
reported in the sixth and seventh column in Table 5. While there are some similarities in the estimates compared to the full model, there are a number of differences. Amongst those with a low/medium purchase intention, those with a high frequency of beef consumption have a higher WTP (note the opposite sign compared to the model estimated with high purchase intention respondents). Results for storefrmt, growown and organic are qualitatively identical to the full sample model. The coefficient on farming is now significant and positive, indicating respondents with a low/medium purchase intention and who are engaged in farming, have a higher WTP. Except for the coefficient on pricf (concern about price when purchasing beef), results for the perception variables in the low/medium purchase intention version of the model are qualitatively identical to those in the full sample model.

4.2 Analysis of Willingness to pay

The point estimate of willingness to pay (evaluated at the means of the data) for beef from animals that have been voluntarily tested for BSE, based on the model estimated with the full sample, was 0.76 per cent and was not significantly different from zero ($z=0.49$). To obtain a better sense of the distribution of predicted WTP, Figure 1 shows the histogram of WTP calculated across all respondents, plus a normal and kernel smoothed density of WTP (based on the fitted values of the WTP function). As evident from this figure, there is a wide distribution of WTP across the sample, but there also appears to be some WTP values that are positive and large.
Figure 1. Histogram and density plots of WTP across the full sample

To explore potential heterogeneity in valuation, WTP (evaluated at the means of respective sub-samples) was calculated for those who answered ‘No’ and ‘Yes’ to the follow-up question. Mean WTP equals -0.61 \((z=-0.37, N=883)\) amongst respondents answering ‘No’ to the follow-up and 10.44 \((z=7.97, N=125)\) for those answering ‘Yes’. Figure 2 adds further detail by plotting the range of WTP across responses to the first choice question and follow-up question. While sub-sample sizes vary across the different response options, WTP (evaluated at the means of respective sub-samples) for the ‘No, No’ option was -1.63 \((z=-0.97, N=795)\), for ‘No, Yes’ 5.74 \((z=4.04, N=52)\), for ‘Yes, No’ 8.59 \((z=6.48, N=88)\) and for ‘Yes, Yes’ 13.78 \((z=9.82, N=73)\) per cent.
Figure 2. Box plot of WTP across choice and follow-up question’s response options

WTP (evaluated at the means of respective sub-samples) using results from the high purchase intention model equaled 8.78 per cent \((z=4.42, N=347)\), but -3.56 per cent \((z=-1.57, N=661)\) using results from the low purchase intention model. Figure 3 shows histograms for WTP for these two models and highlights a differential pattern of WTP across respondents based on their self-declared purchase intention. WTP values for high purchase intention respondents (panel a of Figure 3) was right skewed, suggesting there is a small segment of consumers for whom WTP (i.e. price premium) for BSE tested beef is higher than the mean would suggest.
Figure 3. Histogram of WTP across purchase intention

Figure 4 presents box plots of the WTP from the high and low purchase intention models across the response options to the first choice question, and follow-up question. As one might expect, the range of WTP generally rises as one moves through the different response options to the two choice questions. As well, the WTP values for those with a high purchase intention are generally higher than for those with a low purchase intention.
Figure 4. Box plot of WTP across choice response options and purchase intention

Table 6 shows the point estimates of WTP, z-statistics and sub-sample size across respondent purchase intention categories and response options to the choice questions (evaluated at the means of respective sub-samples). Amongst those with a high purchase intention expected WTP across all response options was positive and significant. What is more, the point estimate of WTP increases as one moves from the ‘No, No’ option to the ‘Yes, Yes’ options. For the latter group, albeit a small group of respondents, expected WTP is 22 per cent. WTP point estimates are significant amongst those with a low/medium purchase intention, and generally rises as one progresses across from the ‘No, No’ choices to the ‘Yes, Yes’ choices. Note that WTP is negative and significant for those with a low purchase intention and who answered ‘No, No’, but is positive in the other response options. Note too
that WTP is lower in the low/medium purchase intention group than in the high purchase intention category. Welch’s t-test of within response option differences in WTP indicates significant differences in WTP across purchase intention groups (p-values all less than 0.001).

Table 6. Estimates of WTP across purchase intention (P.I.) and choice question response combinations

<table>
<thead>
<tr>
<th>Purchase Intention</th>
<th>No-No</th>
<th>No-Yes</th>
<th>Yes-No</th>
<th>Yes-Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>High P.I. WTP</td>
<td>5.18**</td>
<td>10.55***</td>
<td>14.30***</td>
<td>21.54***</td>
</tr>
<tr>
<td>z-stat</td>
<td>(2.30)</td>
<td>(4.90)</td>
<td>(7.81)</td>
<td>(10.42)</td>
</tr>
<tr>
<td>N</td>
<td>236</td>
<td>45</td>
<td>22</td>
<td>44</td>
</tr>
<tr>
<td>Low/medium P.I. WTP</td>
<td>-5.09**</td>
<td>3.57*</td>
<td>4.49**</td>
<td>5.52***</td>
</tr>
<tr>
<td>z-stat</td>
<td>(-2.10)</td>
<td>(1.84)</td>
<td>(2.34)</td>
<td>(2.77)</td>
</tr>
<tr>
<td>N</td>
<td>559</td>
<td>43</td>
<td>30</td>
<td>29</td>
</tr>
</tbody>
</table>

Notes:
*** significant at the one per cent level
**  significant at the five per cent level
*    significant at the ten per cent level

5 Discussion & Conclusions

The discovery of BSE infected cattle in Canada and the United States in 2003 precipitated a number of efforts to ensure the BSE prion does not enter the human food chain. While many of these efforts have been regulatory based, some discussion has focused on developing a test of live cattle for the BSE prion. While action related to testing for BSE has yet to be taken, scope exists for voluntary testing regimes. Should voluntary testing emerge, retail store meat cases could contain beef products bearing a label ‘Tested for BSE’ alongside beef products without such a label. In light of potential coexistence of labelled and unlabelled beef products, an open question remains whether consumers prefer beef with a ‘Tested for BSE’ label or not, and whether they are willing to pay a premium for such a product.

This paper investigates consumer acceptance and valuation of beef from live cattle that have been tested for BSE. To that end, a double-bound contingent valuation survey was undertaken to measure Canadian consumer willingness to pay for beef from cattle that have
been voluntarily tested for BSE. The market for a beef product bearing a ‘Tested for BSE’ label appears small. In analysis of the double-bound choice model, only 16 per cent of respondents indicated they would purchase such a product (i.e. indicated yes on a follow-up question). Predicted willingness to pay is also small and, when evaluated at the means of the data, is not significantly different from zero. However, amongst respondents with a high purchase intention (measured separately from the choice question), expected WTP equalled eight per cent and was significant. Across response options to the initial choice question and follow-up, expected WTP ranged from five to 21 per cent for those with a high purchase intention, but between -5 and five per cent for respondents with a low/moderate purchase intention.

The premiums for beef from animals tested for BSE in this study are small compared to those reported previously in the literature. Previously reported premium (stated in per cent terms for comparability) range from: 14 to 20 per cent for France (Latouche et al. 1999); 56 per cent (McCluskey et al. 2005) and between 31 to 194 per cent (Aubeeluck 2010) for Japan; between 41 and 106 per cent for Canada (Aubeeluck 2010); while estimates in the U.S. range from 59 per cent (Moore 2005) to 98 per cent (Lim et al. 2013b). Several factors might underlie the differences in WTP estimates reported here and those reported previously. Obvious factors include: heterogeneous preferences across different countries; timing of BSE crisis in each country relative to the latest scientific knowledge about BSE; differences in how countries have communicated with citizenry regarding the potential risks associated with exposure to the BSE prion; and differences in survey design and analytical methods used.

Aubeeluck’s (2010) premiums are based off a comparison of striploin steaks from domestically produced animals with no safety assurances to the same cut and country-of-origin but from animals that have been tested for BSE. Lim et al.’s (2013b) report a marginal WTP of $5.70/lbs. According to data on the the U.S. Bureau of Labor Statistics (2014) website, the average price of sirloin steaks (a close substitute to striploin, for which no price is available) in the U.S. in 2010 was about $5.83/lbs, thus leading to a 98 per cent premium.
The latter could be particularly important in that a double-bound CVM approach leads to tighter bounds on estimates of WTP compared to single bound CVM (the approach used by McCluskey et al. 2005 and Moore 2005). A more likely source of the differences in WTP between this paper and its antecedents is the voluntary nature of BSE testing considered here. The absence of mandatory testing (which was noted in the information script for BSE in the survey) through public regulation might signal to consumers that the risk of exposure to the BSE prion is low (in the eyes of a regulator). In turn, this signal could inform consumer decision making when confronted with a choice between an labelled and unlabelled beef product (when testing is voluntary) in a manner that favours the unlabelled product. The idea here is that if the product which does not have a ‘Tested for BSE’ label is viewed as safe, in the eyes of a regulator, why should a consumer pay more for a beef product that has been voluntarily tested.

The results from this analysis suggest that coexistence of beef products with and without a ‘Tested for BSE’ label is unlikely. The small market coupled with low WTP for beef with such a label suggests that beef processors and producers would gain little in the way of economic benefits from voluntary testing. While the study did not consider substitutability between products with and without a such label, the low purchase probability for labelled products suggests that substitution effects between labelled and unlabelled beef would likely be small.

One limitation of this study relates to the beef product considered by respondents. The current study used a muscle cut as the product under consideration, without reference to a specific type of cut. Future research should consider exploring consumer preference and valuation for different types of cuts from animals that have been tested for BSE, as well as preference and valuation of ground beef and food products containing beef and beef by-products. Understanding such valuation would be beneficial in terms of calculating the value of a carcass from a bovine animal that has been voluntarily tested for BSE.
6 References


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