A comparative analysis of US and Canadian consumers' perceptions towards BSE testing and the use of GM organisms in beef production: evidence from a choice experiment

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Abstract

Since the May 2003 Canadian BSE case, food safety has become a major issue to policymakers and consumers alike. In both Canada and the US, governments and industry have responded with a variety of quality assurance, traceability and labeling schemes. However, there is little information available on the extent to which consumer perceptions differ regionally across North America towards labeling schemes. This paper attempts to fill this gap, by providing results on a variety of beef labeling strategies from choice experiments that were conducted in Alberta (Canada) and Montana (US). The analysis focuses on consumers' perceptions towards negative voluntary labeling with regard to BSE testing, genetically modified organisms (GMO) and the use of growth hormones in beef production. We find that four years after the first BSE case emerged in North America, consumers are willing to pay most to avoid risks associated with BSE. US and Canadian consumers are found not to be significantly heterogeneous in their preferences.

Keywords: choice experiments; multinomial logit; beef labeling

JEL classification: D12, L66, C35

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1 Introduction and objectives

Since the May 2003 Canadian BSE case, originating from Canada (Alberta), food safety issues have become major trade issues for Canada and the US. While beef producers in the US (Montana) have lobbied for a sustained border closure that lasted until August 2005, a second BSE case was discovered in June 2005, this time of US origin. Although annual beef per-capita consumption declined in 2004 in both the US and Canada, it rebounded in both countries to levels exceeding the pre-BSE consumption levels in 2006 (StatisticsCanada 2006). But despite similar aggregate consumption patterns across borders, we have little information on how consumer perceptions differ towards beef, and more specifically towards beef labeling strategies, across the US and Canada.

In the present market environment in the North American meat sector, it is likely that consumer trust is lower compared to the situation prior to 2003. It would thus be even more important for private firms to signal quality, yet it may also be even more difficult for firms to recoup food-safety related investments in cases where food hazards can enter the food supply chain at multiple points. As a result we would expect that the scope for market failures is likely to have increased. Thus, the role for labeling and the role for public quality assurance through regulating labeling (Caswell and Mojduszka 1996) is likely to have increased, in both the US and Canada. In the US, for example, the government has made nutrition labeling (nutrition information panels) mandatory since 1994 in order to improve the functioning of markets for nutritional quality (Caswell 1997). In Canada, nutrition labelling became mandatory for most prepackaged foods as of December, 2005 (StatisticsCanada 2007).[1] The strict regulation of health claims in both the US and Canada is also done under the premise of improving the market for nutritional qualities (Unnevehr and Hasler 2000). Further, the discussion in North America surrounding mandatory labeling for GMO content (Unnevehr and Hasler 2000) and origin labeling (Umberger, Feuz, Calkins, and Sitz 2003) is based on the understanding that government regulation has a role in mitigating market failure. The focus of this paper is on consumers' perceptions towards negative voluntary labeling in the case of beef. Canada does not require genetically modified foods (GMF) to be labeled unless the GMF is significantly different from the conventional food, or the GMF presents a health concern (Teisl and Caswell 2003).

Given the diversity of labeling approaches, Roosen, Lusk, and Fox (2003) suggest to categorize labels along four dimensions: the entity on whose behalf they signal (a single firm or a group); the information content of the label; the mechanism of accreditation (an independent organization or government); and the degree of government involvement (mandatory enforcement vs. voluntary industry compliance). In this paper, we abstract from both the entity on whose behalf the label signals, and the mechanism of accreditation. We are primarily interested in how distinct consumer groups value labeling information that relates to BSE testing, the use of growth hormones and the use of genetically modified organisms (GMO) in beef production.

[1] Smaller businesses have until December 12, 2007, to make nutrition information available (StatisticsCanada 2007).

2 Previous work

A number of studies that have explored consumer attitudes toward alternative beef labeling strategies, using both stated and revealed preference analyses. Hobbs *et al.* (2005) conducted experimental auctions in 2002 to assess Canadian consumers' willingness to pay (WTP) for traceability assurance, food safety assurance and on-farm production methods assurance for beef and pork products. Their key finding is that only when traceability is bundled with quality assurances will consumers value traceability. This conclusion that simple traceability assurance is valued less by consumers is stronger for beef than for pork, and is also consistent with results obtained in a comparable, experimental auction-based study in the US (Dickinson and Bailey 2002).

Based on three choice experiment-based surveys conducted in 2002 in London, Frankfurt, and Paris, Tonsor, Schroeder, Fox, and Biere (2005) analyze how consumers value beef steaks with attributes including "GM-free", farms-pecific source verification, and domestic origin. This study finds that consumers are significantly heterogeneous across regions in their preferences for beef steak attributes.

Lusk and Schroeder (2004) conducted choice experiments in 2002 in the US, in order to test for hypothetical bias in consumers' valuation of beef steak attributes, including steaks that were "guaranteed natural". The marginal WTP for steak attributes was found to be equivalent in both the hypothetical and real settings, where consumers where given the option to actually purchase steaks. However, purchasing propensities were found to be higher in the hypothetical setting, compared to the non-hypothetical setting.

Roosen, Lusk, and Fox (2003) conducted mail-back surveys in 2000 in France (n=76), Germany (n=43), and the UK (n=105) to analyze consumers' WTP for alternative beef labeling strategies. Their analysis focused on brands, origin labels, and mandatory labeling of beef from cattle fed genetically modified feed. Consumers were asked to state their preferences regarding a brand that signals on behalf of an individual firm (not accredited by a third party nor by government), regarding a label indicating the product origin (where it was indicated that producers belong to a regional collective), and regarding a mandatory label for beef from cattle fed GM crops, certified by a government agency. Consumers' preferences for the mandatory labeling program were analyzed using the double-bounded logit framework of Hanneman, Loomis, and Kanninen (1991). An ordered probit model was used to estimate the importance of origin in consumers' purchasing decision. Their results suggest that consumers value information about the origin of a product more than that on private brands. Origin information was found to be especially desired by consumers concerned about process attributes, but also by consumers concerned about product attributes such as freshness and contamination by pathogens.

Earlier studies have analyzed the effects of socio-demographic differences on consumer' attitudes towards beef that was assumed free of growth hormones (Verbeke and Viaene 1999), and for beef and pork that originated from Canada, rather than from the US (Quagrainie, Unterschultz, and Veeman 1998).

Our study differs from the above in several ways. First, this is, to the best of our knowledge, the first comparative US-Canada study that analyzes consumers' valuation for beef labeling attributes. Second, it appears to be the first choice-experiment based study focusing on beef labeling in which the survey was conducted in North America, after the first BSE incidence in 2003. It provides thus a useful comparison to previous studies that have explored labeling issues and consumers' GMO perceptions in the North American context (Hobbs, Bailey, Dickinson, and Haghiri (2005); Tonsor, Schroeder, Fox, and Biere (2005); Quagrainie, Unterschultz, and Veeman (1998)). Third, in contrast to previous choice-experiment based studies on beef (Quagrainie, Unterschultz, and Veeman (1998), Tonsor, Schroeder, Fox, and Biere (2005)), consumers in our study were first asked to identify their regular beef steak in terms of multiple attributes and attribute levels. This information was then used in the following choice experiment as consumers' status quo, such they were asked to trade off their status quo with alternative beef attribute combinations. In this way, we expect that consumers' trade-off decisions are close to trade-offs in the marketplace, since consumers are asked to compare less familiar steak options with a beef steak option that is close to their individual preference structure.

In section (3) we describe data collection and experimental design. Section (4) presents the econometric approach and the estimation results, and conclusions are presented in section (5).

3 Data and experimental design

Our analysis builds on two web-based surveys that were conducted during the same time period (April 2006) in Montana (US) and Alberta (Canada). The survey development was initiated by focus group research using Alberta consumers only, whereby two rounds of focus group discussions were facilitated with 8 to 10 consumers each. The focus group research was used to identify the key attributes and attribute levels for beef steaks, as well as to gain feedback on the web-format of the survey. Consumers for the first two focus groups were recruited from the student population of the University of Alberta. An international marketing firm was then commissioned to use random digital dialing (RDD) to recruit Alberta consumers for two additional focus groups. Then, the revised web-based survey was further tested by 8 individuals (members of the administrative, academic staff and graduate students). The survey was finally put live in the following manner: consumers were first contacted via phone and offered a $5 voucher upon participation; non-respondents received reminder emails and one reminder phone call. Following this procedure, the marketing firm first recruited 12 Alberta consumers via RDD and then stopped, so that final adjustments to the survey design could be performed. After these steps, the international marketing firm used RDD to recruit a total of 214 consumers from Montana, and another 215 consumers from Alberta.

The survey consisted of three parts. First, consumers were asked several rating and ranking questions that related to beef steak attributes, consumption behavior of organic foods and the way food was prepared in the household. This part was followed by a choice-

based experiment, which in turn was followed by questions on demographics. Before consumers proceeded to the choice experiment, they were asked to specify their regular beef steak purchase. This beef steak became their status quo in the following choice experiment, and was characterized in terms of four steak attributes. First, consumers could choose between four prices for their beef steak purchase. Second, they could choose a beef label that carried a guarantee for BSE testing. Third, consumers could choose a label that carried a guarantee for absence of growth hormones. Fourth, consumers could choose beef steaks that were labeled as "Guaranteed produced without genetically modified organisms (GMO)". Once consumers had selected their regular beef steak purchase, they proceeded to a repeated choice experiment. This consisted of four tables (four separate web-pages), in each of which they could choose one of three options at varying attribute levels (choice A: their regular beef steak; choice B: a specified beef steak; choice C: neither). For such a given set of four treatments, the treatment order was randomized. The individual respondents were also randomly assigned to a given set of treatments. In order to analyze the role of the status quo (consumers' regular beef steak), we also specified a restricted choice set, in which the status quo was no longer available.

For the choice experiment, we specified an orthogonal main-effects only design (Louviere, Hensher, and Swait 2000). To reduce the number of treatment combinations, we used fractional factorial design and generated the experimental orthogonal design in SPSS.

4 Econometric model and results

For an analysis of consumers' unordered responses in the above choice experiments, we assume that consumers follow the standard assumptions of random utility theory. We further assume that an individual n's utility for alternative i can be written as:

$$U_{ni} = V_{ni} + \varepsilon_{ni} \tag{1}$$

where the utility of an alternative consists of a deterministic component V (the beef steak attributes), and a random error term ε (unobservables and measurement error). The probability that individual n chooses alternative i from a choice set of alternatives J, can then be expressed as:

$$P_{ni} = P(U_{ni} > U_{nj}, \forall\ i \neq j \in J) = P(\varepsilon_{nj} > \varepsilon_{ni} + V_{ni} - V_{nj}, \forall\ i \neq j \in J). \tag{2}$$

We further assume that the random error terms follow an exteme value Type I distribution, and that they are independently and identically distributed across alternatives. The choice probabilities in equation (2) can then be expressed as a multinomial logit model (McFadden 1974),

$$P_{ni} = \frac{exp(\mu\beta^T X_{ni})}{\sum_{j=1}^{J} exp(\mu\beta^T X_{nj})}. \tag{3}$$

The deterministic part of the utility function is assumed to be linear in parameters,$V_{ni} = \mu\beta^T X_{ni}$, μ denotes a scale parameter of utilities normalized to $\mu = 1$, and β^T is a parameter vector associated with the vector of explanatory variables X_{ni}. Therefore,

the steak attributes (price, GMO, Growth hormones, BSE test) enter the consumer's utility function through X_{ni}. Interaction terms between socio-economic characteristics and the alternative-specific constants (as well as other attributes) were included to allow for preference heterogeneity (Louviere, Hensher, and Swait 2000).[2]

Table (1) provides summary statistics for the sample population in both Alberta and Montana.[3]

Table (1): Summary statistics of choice experiment participants

VARIABLE	CANADA (Alberta)	US (Montana)
male (%)	38	42
female (%)	62	58
average age (years)	45	49
white meat eaters (40%red/60%white or more white) %	30.55	25.48
red meat eaters (60%red/40%white or more red) %	44.15	53.37
urban (%)	43.91	31.25
rural (%)	56.09	68.75
smokers (%)	13.84	12.02
Ethnic background:		
Asian	3%	$< 1\%$
British Isles	16.5%	21%
Central/South American	2%	$< 1\%$
European	30.5%	45.2%
Family income in 2005 after tax (%):		
less than \$50000 (Can/US dollar, respectively)	40.81	50
\$50,000-\$100,000 (Can/US dollar, respectively)	41.05	36.54
more than \$100,000 (Can/US dollar, respectively)	18.14	0.1346
lived for less than 10 years in Can/US, respectively (%)	53.22	99.04
married (%)	68.74	69.71

Table (2) shows the procedure that was followed for the model selection. We used likelihood ratio-tests to choose between models. Models for the restricted choice sets, where consumers had no longer their regular steak available, were included in our estimation procedure. Based on this model selection procedure, model (3) was selected as final model specification: since the -2LL value (46.65) is smaller than the critical Chi-square value (55.76), the model with all interaction terms is inferior; similarly, comparing the LL of the pooled model (A,B,C pooled with restricted choice set B,C) with the likelihoods from the two separate models (unrestricted choice set model and restricted choice set model),

[2]A mixed logit model (Train 2002) was estimated, but did not converge

[3]Consumers were asked to what extent they consider themselves to be red meat or white meat eaters (faced with a sliding scale of percentage distributions). Respondents were asked whether they would consider their roots to be rural or urban, which is reflected in 'urban'/'rural', below. Ethnic background is shown to document the diversity between Alberta and Montana, yet it is acknowledged that the perceptions of what consititutes, e.g. "European" is likely to vary significantly across the regions.

the pooled model is rejected since 186.05 exceeds the critical Chi-square value (the base model is the unrestricted choice model (A,B,C) with reduced interaction terms).

Table (2): Model selection

	Unrestricted choice set (A,B,C), *no interactions* **model (1)**	Unrestricted choice set (A,B,C), *all interactions* **model (2)**	Unrestricted choice set (A,B,C), *reduced interactions* **model (3)**	Restricted choice (B,C), *reduced interactions* **model (4)**	Pooled data (A,B,C and B,C), *reduced interactions* **model (5)**
(R-squared Adjusted)	(.3208)	(.3615)	(.3564)		
LR ratio test with respect to model (3)	LR = -2LL((3)-(1)) =155.0989; Chi-sq (34)=48.6	LR = -2LL((2)-(3)) =46.6453; Chi-sq (34)=55.7585			
LR ratio test model (5): LR=-2LL([(3)+(4)]-(5))=186.0524; Chi-sq (36)= 51					

The results for model (3) are presented in Table (3).[4]

Table (3): estimation results for model (3)

[4]We used Limdep 8.0 and NLogit 3.0.1 for estimation.

VARIABLES	**PARAMETERS (standard errors)**
Choice A	4.5368*** (0.225)
Choice B	3.5554*** (0.2386)
Price	-0.1284 *** (0.0206)
BSE test guarantee	0.2735* (0.1521)
GMO guarantee	0.3045 (0.2009)
Guaranteed free of growth hormones	0.2295 (0.1815)
ChoiceA × Male	0.573*** (0.2186)
ChoiceB × Male	0.2242 (0.2338)
White Meat eater × Price	0.016** (0.0075)
Even white/red meat eater × Price	-0.0083 (0.0061)
Male × Price	-0.0101 (0.0112)
Age $<$ 20 × Price	0.0267 (0.034)
20$\leq$age$<$50 × Price	0.0089 (0.0178)
Edu less college × Price	-0.0025 (0.0052)
Regular smoker × Price	-0.0111* (0.0065)
$<$ 5 years in Can(US) × Price	-0.0148*** (0.0048)
White meat preferred × Guaranteed BSE test	0.1649** (0.0789)
Even white/red meat eater × Guaranteed BSE test	0.0066 (0.0638)
Male × Guaranteed BSE test	0.1* (0.0513)
Age $<$ 20 × Guaranteed BSE test	-0.2087 (0.2742)
20$\leq$age$<$50 × Guaranteed BSE test	0.1986 (0.1471)
Education below college × Guaranteed BSE test	0.1604*** (0.0571)
Regular smoker × Guaranteed BSE test	-0.2675*** (0.0723)
$<$ 5 years in Can(US) × Guaranteed BSE test	0.0015 (0.0492)
White meat preferred × Guaranteed free of GMO	0.1699** (0.0824)
Even white/red meat eater × Guaranteed free of GMO	-0.0055 (0.0685)
Male × Guaranteed free of GMO	0.0619 (0.056)
Age $<$ 20 × Guarantee free of GMO	-0.2338 (0.3758)
20$\leq$age$<$50 × Guarantee free of GMO	0.1226 (0.1958)
Education below college × Guaranteed free of GMO	-0.0896 (0.061)
Regular smoker × Guaranteed free of GMO	0.1784** (0.0789)
$<$ 5 years in Can(US) × Guaranteed free of GMO	0.0488 (0.0536)
White meat preferred × Guaranteed free of growth hormones	0.1226 (0.0808)
Even white/red meat eater × Guaranteed free of growth hormones	-0.0122 (0.0665)
Male × Guaranteed free of hormone	-0.1143** (0.054)
Age$<$20 × Guaranteed free of hormones	-0.525 (0.3373)
20$\leq$age$<$50 × Guarantee free of growth hormones	0.2555 (0.1779)
Education below college × Guaranteed free of growth hormones	0.1837*** (0.059)
Regular smoker × Guaranteed free of hormone	0.0016 (0.0743)
R square adjusted	.3564
LogLikelihood at convergence	-1170.8378
Number of observations	419

In order to test for differences between Canadian and US consumers' preferences, we used models with and without interaction terms between the design variables (and the alternative specific constants) and the regional dummies, as a basis for a likelihood ratio test. The test statistics suggest that perceptions of Alberta and Montana consumers are not significantly different. This is not unexpected, since Alberta and Montana share not only the same border, but beef consumption and production is important in both of these regions (Lawrence and Otto (2003); Davis and Lin (2005); TheDaily (2004); Su (2006)).

Given the inability to statistically differentiate consumer preferences in Alberta from those of Montana, the results in table 3 are based on a pooled data set (n = 419).[5] The results suggest that when consumers are given the option to value the above labeling attributes in a beef steak, namely (i) beef that is guaranteed produced without genetically modified organisms (GM guarantee), (ii) beef that is guaranteed raised without growth hormones (hormone guarantee) and (iii) beef that is guaranteed tested for BSE, the latter was valued most *irrespective of the country of origin of the consumer*. The strongly significant coefficient estimate for choice A suggests that consumers have, as expected, as strong preference for their status quo beef steak. Further, the estimation results suggest that risks associated with BSE appear to be less of concern to more educated consumers, whereas risks associated with GMO's appear to be more of concern to more educated consumers. Thus, in line with Roosen, Lusk, and Fox (2003), we find that consumers are concerned about the indirect consumption of genetically modified organisms, i.e. the use of GM feed in beef production. Further, female consumers show a lower marginal utility with regards to BSE testing and with regards to the GM guarantee than male consumers. Regular smokers appear to value BSE testing less than non-smokers, yet this result is reversed for the GM guarantee. We also differentiated consumers in terms of white vs. red meat eaters, and, as expected, white meat eaters show a higher marginal utility for all three labeling attributes, compared to a red meat eaters.

Since we were also interested in welfare measures, we computed the marginal WTP (MWTP) for attributes based on the unrestricted model (A,B,C) with reduced interaction terms (model 3),

$$MWTP_j = \frac{1}{MUM} * MU_j \tag{4}$$

where the negative marginal utility of price is the marginal utility of money (MUM), and MU_j denotes the marginal utility of jth attribute. The marginal utility of price was allowed to vary across individuals, since interaction terms between price and socio-economic variables were included in the model. Although an average consumer could be used to calculate the marginal WTP, due to the likely non-linear nature of the MWTP function, we calculated the individual MWTP's and then derived the average MWTP for specific attributes.

As a second welfare measure, we followed Freeman (1993) to obtain compensating variation measures (CV) for various attributes,

[5]The *,**,*** denote significance at the 10%, 5% and 1% level, respectively.

$$CV = \frac{1}{MUM} * (Log(\sum_i e^{v_i^1}) - Log(\sum_i e^{v_i^0})) \quad (5)$$

Table (4) displays both of the above welfare measures.

Table (4): Welfare measures

	MWTP BSE test	MWTP GMO free	MWTP GRH free	CV BSE test	CV GMO free	CV GRH free
Mean	**4.01**	2.42	3.33	**7.41**	4.44	6.01
Median	3.68	2.33	3.31	6.79	4.01	5.90
Mode	5.42	2.48	3.52	2.83	2.94	4.87
SD	2.79	1.71	2.04	5.34	3.24	3.77

Comparing beef steaks that are labeled as not being produced with GMO's with beef steaks that carry a guarantee for absence of growth hormones, our welfare measures suggest that consumers are willing to pay most to avoid risks associated with BSE: the average (median) CV for guaranteed tested for BSE were \$7.41/kg (\$6.79/kg). Further, when we compare the growth hormone guarantee with the GM guarantee, the CV measures suggest that consumers place a higher valuation on the guarantee that the animals were raised without growth hormones.

5 Conclusions

This paper uses an attribute-based repeated choice-experiment to explore consumers' valuation of beef labeling strategies, drawing on both a US and a Canadian sample. The analysis focuses on three labeling attributes in beef steaks: (i) beef that is guaranteed produced without genetically modified organisms), (ii) beef that is guaranteed raised without growth hormones and (iii) beef that is guaranteed tested for BSE. We used a web-based survey to sample from two neighboring regions, namely Alberta and Montana. Our results suggest that perceptions of Alberta and Montana consumers towards the above beef steak labeling strategies are not significantly different. Using a pooled data set, our estimates suggest that four years after the first BSE case emerged in North America from an Alberta cow, consumers are willing to pay most to avoid risks associated with BSE (compared to risks associated with GMO's and growth hormones), as reflected in consumers' valuation of labels that assure consumers that beef is guaranteed tested for BSE. However, more educated consumers appear to value a guaranteed BSE tested steak less compared to less educated consumers. In contrast, more educated consumers seem to value beef that is guaranteed produced without genetically modified organisms more highly, compared to less educated consumers. Given the long history of the use of growth hormones in North American beef, it is not surprising that consumers' willingness to pay

for a guarantee for BSE testing is higher compared to consumers' willingness to pay for a guarantee that the animals were raised without growth hormones.

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