International Food and Agribusiness Management Review
Volume 8, Issue 2, 2005

An American BSE Crisis: Has it affected the Value of Traceability and Country-of-Origin Certifications for US and Canadian Beef?

Ruby Ward [a]ⓘ, DeeVon Bailey [b] and Robert Jensen [c]

[a] *Associate Professor, Economics, Utah State University, 3530 Old Main Hill, Logan, Utah, 84322, USA.*
[b] *Professor, Economics, Utah State University, Business Building Room 606, 3530 Old Main Hill, Logan, Utah, 84322, USA.*
[c] *Graduate Student, Economics, Utah State University, 3530 Old Main Hill, Logan, Utah, 84322, USA.*

Abstract

With a BSE incident in the United States (US) in December of 2003, questions arose about the effect of the incident on consumers in the US. The purpose of this paper is to determine if traceability systems for beef can help preserve consumer demand following the discovery of *BSE*. Auctions were conducted approximately 3 weeks before and after the December 2003 BSE incident in the U.S It was found that overall there was no effect on the size of the bribes needed by the BSE incidence. However, for some groups there were important changes. The results indicate that information about traceability and country of origin is valuable to consumers. They also suggest that greater uncertainty about certifications and assurances for beef existed among the participants after December 23rd than before December 23rd.

Keywords: BSE, traceability, country-of-origin, beef market, auctions

ⓘ Corresponding author: Tel: + 435-797-2323
Email: rward@econ.usu.edu
Other contact information: D. Bailey: d.bailey@usu.edu; R. Jensen: robjensen@cc.usu.edu

Introduction

The announcement on December 23, 2003 that a dairy cow in the state of Washington had been diagnosed with *Bovine Spongiform Encephalopathy* (*BSE* or Mad-Cow Disease) was a watershed event for US livestock markets. Although US consumer demand for beef appeared to remain strong in the weeks following the event, US beef industry and US government recognized the need to move rapidly forward with plans to implement some type of traceability in US livestock systems.

Traceability is a critical element for dealing with *BSE*.[2] Although traceability cannot prevent the disease, once *BSE* is detected traceability is essential for tracking the source of the disease. Traditional inspection systems focus on eliminating pathogens in the food marketing chain, mostly at the processor and food preparation levels of the chain. Because *BSE* is thought to originate with contaminated farm-level inputs (feed), the farms where an infected animal has been must be identified together with any partner animals on those farms that may have also been infected through the same feed source. Animal identification (ID) is essential for tracking these movements.

Support for the US National Animal Identification System (NAIS),[3] a plan suggested as a blueprint for implementing animal identification (ID) in the US by the summer of 2005, began to build following the discovery of *BSE* in Canada (Alberta) in May 2003 and became quite general among US livestock producer groups after December 2003 (e.g., Breckendorf (2004); Lyon (2004); Denis (2004); Philippi (2004); and Smith (2004)). The apparently high level of support now enjoyed by the NAIS belies much of the discussion prior to May 2003 surrounding the possible implementation of traceability systems in the US meat system. Prior to 2003, these discussions centered on market solutions to the traceability issue and specifically the ability of firms to recapture costs incurred in implementing the systems. Specifically, these discussions centered on 1) if consumers were willingness to pay (WTP) for these additional costs through paying premiums for traceable meat products, and 2) how benefits and costs of traceability would be shared in the marketing chain (e.g., Wiemers (2001); Buhr (2002); Sparks (2002); Dickinson and Bailey (2002); Dickinson and Bailey (2003); and Bailey, Jones, and Dickinson (2002)).

The purpose of this paper is to determine if traceability systems for beef can help preserve consumer demand following the discovery of *BSE*. We focus specifically on the US and examine whether consumer willingness to accept (WTA)[4] non-traceable

[2] Traceability is also essential for dealing with other animal disease control and eradication issues, addressing bio-terrorism concerns in the food chain, and narrowing the focus (limiting) of food recalls.
[3] This plan was originally called the US Animal Identification Plan (USAIP) but has evolved into the NAIS.
[4] WTA is an alternative method for examining WTP.

beef either imported from Canada or produced domestically changed following the US *BSE* case in December 2003.

Although public discussion in the US since December 2003 has shifted somewhat away from proprietary interests such as WTP to now focus on public goods (e.g., animal disease control and eradication and bioterrorism), consumer acceptance of beef products and certifications made to consumers about beef products in light of *BSE* remain important issues.

US livestock systems have lagged principal competitors and customers in the development of livestock traceability systems (Lewis (2001); Liddell and Bailey (2001); Bailey and Dickinson (2002)). For example, Canada implemented a mandatory cattle identification plan in the summer of 2002 with oversight by the Canadian Cattle Identification Agency (CCIA) (see http://www.canadaid.com/). The European Union, Japan, Australia, New Zealand, and Uruguay have either implemented animal traceability systems or are actively engaged in doing so (Baines and Davies (1998) and (2000); Lewis (2001); Liddell and Bailey (2001)).

Canada is an important case study for the US beef industry in relation to *BSE* because the US and Canadian beef systems are quite similar and because the US and Canada have traditionally competed in the same markets. Prior to May 2003, Canadian live cattle imports into the US accounted for as much as 8% of total US cattle slaughter but this was reduced to zero virtually overnight following the *BSE* case in Alberta. The CCIA's system provided valuable assistance in tracking the infected animal's movements. Given that a traceability system was in place in Canada before the discovery of *BSE* there, and that Canadian beef can be purchased in the US, [5] one could ask if the existence of the CCIA's traceability system has helped to bolster US consumer demand for Canadian beef both before the Canadian *BSE* case and after the US *BSE* case. The same question could be asked about foreign consumer demand for US beef exports following the December 2003 event.

The question is whether or not traceability and country-of-origin information have become more valuable to American consumers since December 2003. This is an important issue because it has implications not only for beef markets but also for public policy. For example, as the US government and US meat industry move toward implementing the NAIS, the issue of who should pay for the system has become important (Farm Foundation (2004)). This study presents results from two sets of auction experiments examining US consumer WTA non-traceable beef from the US and Canada both before the US *BSE* case in December 2003 and after the US *BSE* announcement. The data allow for this comparison because one set of the auction experiments was serendipitously completed just prior to the December 2003

[5] Boneless Canadian beef from animals less than 30 months of age resumed in September 2003. The US border remains closed to live cattle shipments at the time of this writing (Robb (2004)).

US *BSE* case and the other set of auction experiments was completed in January 2004.

Past Work

A substantial body of literature has examined how consumers value information about food products. The foundation for much of this work was laid by research that established the value of labeling products for attributes such as food safety (e.g., Caswell (1998); and Caswell and Padberg (1992); Huffman et al. (2003a)). This work suggested that consumer choices are influenced by the information provided by food labels.

Other research has focused on the value of information on individual characteristics that could either be placed on labels or communicated to consumers in other ways.[6] Recently a substantial body of research has focused on consumer acceptance of and government policy towards genetically-modified organisms (GMOs) in food products (e.g., Rousu et al. (2004); Lusk, Roosen, and Fox (2003); Lusk and Fox (2002); Huffman et al. (2003a) and (2003b); and Caswell (2000)). Other studies have examined the possibility of adding value to commodity or food products by providing consumers information on a myriad of different single or bundled characteristics including certifying enhanced food safety, the processes used to produce food, the location where food was produced, or the certifying agency (e.g., Loureiro (2003); Loureiro and Umberger (2003); Dickinson and Bailey (2003); Dickinson and Bailey (2002)).

Traceability is a unique form of information for a food product because it provides information as a single characteristic (e.g., provides the potential of legal recourse) but also is used as a method to verify other product characteristics (e.g., enhanced food safety, humane animal treatment, environmental responsibility, social responsibility, etc.). A few studies have addressed the issue of traceability directly and have found traceability to be a valuable characteristic in food products (e.g., Hobbs (1996a) and (1996b); Dickinson and Bailey (2002) and (2003); and Buhr (2002)).

While the studies mentioned above used various methods, they generally support the notion that information, including traceability, is valuable to consumers and other members of the marketing chain, they also indicate that many consumers express a willingness to pay for this additional information. The uniqueness of the problem addressed in this paper is that we examine consumer attitudes about traceability immediately preceding and immediately following a major food safety event (the American *BSE* case in December 2003). The data also help address a major policy question about whether or not American consumers are willing to pay

[6] Other methods of communications could include advertising, point of sale materials, etc.

for implementing an animal traceability system. Although traceability is a fundamental component of any livestock system attempting to deal with *BSE*, it is costly to implement (USAIP (2004); Sparks (2002); and Buhr (2002)). Consequently, measuring consumer attitudes about traceability can gauge political support for these systems and how costs for implementing the systems might be shared by the public and private sectors.

Methods and Data

We focus specifically on US consumers and examine whether consumer WTA non-traceable beef, either imported from Canada or produced domestically, changed following the US *BSE* case. This approach was selected assuming that traceability will eventually be the imposed baseline standard in both the US and Canada and that WTA would measure what consumers would need to be paid to go back to the old, non-traceable system.

Economic Experiments

Auction experiments were employed to measure US participants' WTA for non-traceable US beef and traceable and non-traceable Canadian beef. Auction experiments have been used to elicit WTP and WTA food product characteristics when publicly available data were not available or were prohibitively costly to gather (e.g., Huffman et al. (2003a) and (2003b); Dickinson and Bailey (2003) and (2002); Shogren, List, and Hayes (2000); Shogren et al. (1994a) and (1994b)).

We follow basically the same design proposed by Shogren et al. (1994a) and used by Dickinson and Bailey (2002) and (2003). However, rather than eliciting bids from participants to "upgrade" a sandwich from a baseline to a different sandwich with enhanced characteristics, we provided participants with a baseline traceable US beef sandwich and then elicited their WTA an alternative sandwich that was non-traceable and/or consisted of imported Canadian beef. This WTA represents the discount in price necessary to entice the participant to accept what they perceive to be an inferior product compared to the baseline.

Subjects were recruited from four different demographic groups at Utah State University in Logan, Utah. These cohorts included faculty members, students, professional employees (non-faculty employees in professional positions such as accounting, human resource management, etc.), and classified employees (groundskeepers, food service workers, staff assistants, etc.). Subjects were recruited by announcements in class (students) and by email and announcement flyers that were distributed around campus. Four different experiments were held (one each for each cohort) with approximately 13-14 participants in each experiment. Experiments were conducted with individuals of similar socioeconomic characteristics (cohorts) in each individual experiment to lower the potential

influence of socioeconomic status barriers within the group and to isolate the potential influence of socioeconomic characteristics on bidding behavior (Dickinson and Bailey (2002)).

The first set of four experiments was held during the first week of December 2003 (pre-*BSE*) . A second set of four experiments was held during the last week of January 2004 (post-*BSE*) . The pre-*BSE* experiments were originally conducted to determine if certifying traceability in Canadian beef would make it more acceptable to American participants after the Canadian *BSE* case in May 2003. The US *BSE* case was announced on December 23, 2003, almost immediately after the first set of experiments had been conducted. Obviously, the December 23rd announcement changed the market landscape for beef in the US. This was the motivation for conducting the post-*BSE* experiments in January 2004. As a result, quite by accident, a data set was developed that measured US participants' WTA almost immediately prior to the American *BSE* case and almost immediately thereafter.

The steps followed in both the pre- and post-*BSE* sets of experiment were the following:

Step 1: Subjects in the experiment were seated and told a lunch sitting in front of them, consisting of the baseline US traceable beef sandwich, chips, dessert, and drink was "free." The participants were also given $15 in cash at the beginning of the one-hour experiment.

Step 2: Subjects were assigned an identification number to ensure anonymity of the data they provided. Participants were informed verbally and also provided with written instructions[7] that indicated they would be allowed to bid for what they would require to be paid to "switch" their baseline sandwich for each of four alternative sandwiches. Subjects were told that for the baseline sandwich "certified information is available that the beef in this sandwich can be traced back to the farm in the US where it originated and this beef has been inspected." The subjects were given the following information about the alternative sandwiches in the experiment: **Sandwich 1** – certified information is available that the beef in this sandwich can be traced back to the farm where it originated. The beef in the sandwich has also been inspected and imported from Canada; **Sandwich 2** – certified information is available that the beef in this sandwich has been inspected and that it was imported from Canada; **Sandwich 3** – certified information is available that the beef in this sandwich has been inspected and that it originated in the USA; and **Sandwich 4** – certified information is available that this sandwich has been inspected.

[7] The written instruction is available from the authors on request.

Step 3: Participants were informed that they would be allowed to place anonymous bids for what they would need to be paid to give up their baseline sandwich for each of the four alternative sandwiches. To ensure that bids would be placed based only on the information provided, the sandwiches were constructed so that the baseline and the four alternatives looked virtually identical and subjects were not allowed to eat until after the auction. There is some discussion in the literature about whether n^{th}-price auctions or 2^{nd}-price (Vickery) auctions elicit more accurate results about consumer demand (Shogren et al. (2001)). Parkhurst, Shogren, and Dickinson (2004) indicate that the average bids using either procedure should be the same and a Vickery (2^{nd}-price) auction is used in our experiments.[8]

Step 4: After all questions had been answered, a trial auction using a baseline candy bar and asking participants to provide anonymous bids regarding the appropriate discount or, conversely, what they would need to be paid (WTA), i.e., the bribe required, to accept a different candy bar. The trial was designed to give participants experience regarding how the actual auctions would operate. There were two rounds of bidding for two candy bars. After both trials' rounds were finished, random numbers were drawn to select the "binding" round and "binding" candy bar. Money and the candy were then exchanged for the binding candy bar.

After answering additional questions following the trial auction, written bids were taken from each participant for Sandwich 1, then Sandwich 2, then Sandwich 3, and finally Sandwich 4. Six total rounds were completed in order for the bid amounts to stabilize (e.g., Hayes et al (1995); Shogren et al. (2001); Dickinson and Bailey (2002) and (2003)). The potential "winner" in any given round for any given sandwich was the person with the lowest bid. However, the potential payoff to the winner was the 2^{nd} lowest bid (Vickery auction style). The "winning" bid for each sandwich (2^{nd} lowest bid) was announced at the end of each round to provide participants with "market" information. Each participant's bid was recorded by an assistant at the end of each round so that data on every bid placed by each participant was preserved.

Step 5: Following the completion of all six rounds, a round was selected at random as the binding round and a sandwich was selected at random as the binding sandwich. This made the participant's every bid in every round a potentially binding bid. Participants were fully aware before the auction rounds commenced

[8] The theoretical reference indicating a 2^{nd}-price auction is demand revealing is found in Vickery (1961). However, there remains discussion about which pricing method in experimental auctions is "best". There are probably other demand-revealing mechanisms as well, and the 2^{nd}-price auction is simply one of them. Parkhurst, Shogren, Dickinson (2004) found that there was some under or over bidding in the 2^{nd}-price auctions (under bidding if you negatively valued the good, overbidding if you positively valued the good). Parkhurst, Shogren and Dickinson(2004) indicated that random n^{th}-price auction did not have this bias, but the variance in bids in n^{th}-price was twice as high as in 2^{nd}-price auctions. Consequently, there is no conclusive evidence that one is better than the other at this point.

that this would be done. The person "winning" the randomly selected alternative sandwich in the binding round was paid the winning amount and the binding alternative sandwich was switched with the winner's baseline sandwich.

Step 6: Participants were asked to complete a survey[9] eliciting not only socioeconomic information (age, gender education, income, etc.) about themselves and their family, but also other information that might influence bids. For example, participants were asked how many servings of beef they consumed each week, the percentage of meals consumed at home, and whether or not a family member had become sufficiently ill from a of a food-borne illness to require hospitalization.

Comparisons of Pre- and Post-BSE Participants

Table 1 presents the set of variables together with their descriptive statistics that was developed from the auctions and the survey responses used in the analysis. Participants in both the pre- and post-*BSE* experimental auctions were also asked a battery of questions to determine their knowledge of specific characteristics relating to the Canadian *BSE* case in May 2003 (e.g., province where *BSE* was found, number of infected animals found, when *BSE* was found, etc.) and were also asked about their general knowledge of *BSE* as a disease (e.g., how humans contract the disease, how *BSE* is diagnosed, etc.). A variable, *BSECAN*, was constructed as the percentage of correct answers the participant gave about the Canadian *BSE* crisis. Another variable, *BSEKNOW*, was constructed as the percentage of correct answers about *BSE* (Table 1).

Although individual participants in the pre- and post-*BSE* sets of experiments were not identical, the same socioeconomic categories (faculty, students, professional employees, and classified employees) were used. Table 2 presents comparisons of the socioeconomic characteristics for the pre- and post-*BSE* groups. Table 2 reveals that only a few statistically significant differences existed between the pre- and post-*BSE* participants. These differences were that post-*BSE* participants were less likely to be married (*MARRIED*), less likely to do their household's grocery shopping (*SHOP*), were less motivated by food safety concerns when purchasing meat (*FSIMP*), and knew more about the Canadian *BSE* case than did pre-*BSE* participants (*BSECAN*) (Table 2).

Whether animal identification in the US should be a voluntary or mandatory program has been a matter of discussion for some time but has become an especially important issue since December 23rd. We asked participants in the post-*BSE* auctions to indicate whether they believed animal identification in the US should be voluntary or mandatory. Most participants (69%) believe animal identification should be a mandatory program. Those believing animal identification should be

[9] The survey instrument is available from the authors on request.

Table 1: Variable Names and Descriptions.

Variable	Description	Mean	Std.Dev.
AVGBID	Average of bid for all six rounds for all sandwiches	2.479	8.236
FEMALE	Female =1, 0 otherwise	49.6%	50.1%
AGE	Age of subject in years	35.319	11.593
MARRIED	Married =1, 0 otherwise	72.3%	44.8%
CHILDREN	Presence of children in household under 18 =1, 0 otherwise	43.4%	49.6%
SERVINGS	Number of times beef products are eaten each week.	3.058	1.810
SHOP	Primary grocery shopper in household = 1, 0 otherwise	62.2%	48.6%
ATHOME	Over 50% of meals prepared at home =1, 0 otherwise	92.0%	27.1%
ILLNESS	In past five years someone in household or immediate family suffered from a food borne illness = 1, 0 otherwise	33.0%	47.1%
PRIMP	Ranked price as first or second (out of 6) most important determinant of meat purchases = 1, 0 otherwise	50.5%	50.1%
FSIMP	Ranked "safety of meat" as first or second (out of 6) most important determinant of meat purchases = 1, 0 otherwise	45.0%	49.8%
TRUSTUS	On a 5 point scale with 5 being "very good assurance" and 1 indicating "no assurance", rated "USDA inspection" as a 4 or above =1, 0 otherwise	82.1%	38.3%
TRUSTCAN	On a 5 point scale with 5 being "very good assurance" and 1 indicating "no assurance", rated "Imported from Canada" as a 4 or above =1, 0 otherwise	20.5%	40.4%
SOMECOL	Less than a bachelors degree has been achieved =1, 0 otherwise	33.6%	47.3%
COLLEGE	Bachelors degree is the highest level of education achieved =1, 0 otherwise	31.9%	46.6%
POSTGRAD	Graduate degree is the highest level of education achieved =1, 0 otherwise	34.5%	47.6%
LOWINC	Household income is < $30,000 =1, 0 otherwise	40.2%	49.1%
MIDINC	Household income is $30,000 - $59,999 =1, 0 otherwise	33.0%	47.1%
HIGHINC	Household income is $60,000+ =1, 0 otherwise	26.8%	44.3%
BSECAN	Score on a test about knowledge of BSE incidence(s) in U.S. and Canada (note: for experiments before outbreak in U.S. questions dealt with the Canadian incidence.)	43.5%	27.0%
BSEKNOW	Score on test about scientific knowledge of BSE	55.6%	27.2%
Sandwich 1 (S_1)	Certified information is available that the beef in this sandwich can be traced back to the farm where is originated and has been inspected and imported from Canada=1, 0 otherwise		
Sandwich 2 (S_2)	Certified information is available that the beef in this sandwich has been inspected and imported from Canada=1, 0 otherwise		
Sandwich 3 (S_3)	Certified information is available that the beef in this sandwich has been inspected and that it originated in the U.S.=1, 0 otherwise		
Sandwich 4 (S_4)	Certified information is available that the beef in this sandwich has been inspected =1, 0 otherwise		
ANIMID	Animal ID system should be mandatory =1, voluntary =0 (note: only asked for groups after BSE in U.S.)	69.1%	46.3%
BEFORE	Subject from experiment before BSE outbreak in U.S.=1, 0 otherwise	51.3%	50.0%

Table 2: Overall Means for Variables Included in the Study Together with Tests for Significant Differences (10% Level of Significance) Between Pre- and Post-*BSE* Experimental Groups and Between Participants in Favor of a Voluntary or Mandatory Animal ID System in the US.

Variable	Mean	Change after BSE in U.S. [a]	Mean for Mandatory vs. voluntary [b]
FEMALE	49.6%	n/c [c]	n/c
AGE	35.32	n/c	n/c
MARRIED	72.3%	-	n/c
CHILDREN	0.43	n/c	n/c
SERVINGS (No.)	3.06	n/c	n/c
SHOP	62.2%	-	n/c
ATHOME	92.0%	n/c	n/c
ILLNESS	33.0%	n/c	n/c
PRIMP	50.5%	n/c	n/c
FSIMP	45.0%	-	n/c
TRUSTUS	82.1%	n/c	n/c
TRUSTCAN	20.5%	n/c	-
SOMECOL	33.6%	n/c	n/c
COLLEGE	31.9%	n/c	n/c
POSTGRAD	34.5%	n/c	n/c
LOWINC	40.2%	n/c	n/c
MIDINC	33.0%	n/c	n/c
HIGHINC	26.8%	n/c	n/c
BSECAN	43.5%	+	+
BSEKNOW	55.6%	n/c	+

[a] + (-) indicates significant increase (decrease) in means for subjects after the BSE incidence in the U.S.
[b] + (-) indicates significant higher (lower) means for subjects favoring mandatory animal ID systems. It should be noted that only subjects after the BSE incidence in the U.S. were asked this question.
[c] n/c indicates no significant change in means of two groups.

mandatory in the US were statistically less certain about the quality of imported Canadian beef (*TRUSTCAN*) and knew more about the Canadian *BSE* case (*BSECAN*) and *BSE* in general (*BSE*) than did those desiring a voluntary program (Table 2).

Regression Analysis

Regression analysis was used to determine the participant characteristics, (age, gender, income, education, knowledge about *BSE*, past illness, etc.) that affected average WTA. Two models were formulated. The first includes a dummy variable

BEFORE which will measure the average change, with all variables considered contemporaneously, in the bribe needed to switch sandwiches before the BSE incidence versus after. The second model instead of using one dummy variable for a before and after effect, includes slope dummies as a change in structure after the American *BSE* case for the variables individually. The two models' forms are the following:

Model 1:

$$AVGBID_{ij} = \alpha_0 + \alpha_1 FEMALE_j + \alpha_2 AGE_j + \alpha_3 MARRIED_j + \alpha_4 CHILDREN_j + \alpha_5 SHOP_j$$
$$\alpha_6 ATHOME\%_j + \alpha_7 ILLNESS_j + \alpha_8 PRIMP_j + \alpha_9 FSIMP_j + \alpha_{10} SERVINGS_j + \alpha_{11} TRUSTUS_j$$
$$+ \alpha_{12} TRUSTCAN_j + \alpha_{13} SOMECOL_j + \alpha_{14} COLLEGE_j + \alpha_{15} POSTGRAD_j + \alpha_{16} MIDINC_j$$
$$+ \alpha_{17} HIGHINC_j + \alpha_{18} BSECAN_j + \alpha_{19} BSEKNOW_j + \alpha_{20} BEFORE_j + \sum_{i=1}^{3} \beta_i S_i + \varepsilon_{ij}$$

Model 2:

$$AVGBID_{ij} = \alpha_0 + \alpha_1 FEMALE_j + \alpha_2 AGE_j + \alpha_3 MARRIED_j + \alpha_4 CHILDREN_j + \alpha_5 SHOP_j$$
$$+ \alpha_6 ATHOME\%_j + \alpha_7 ILLNESS_j + \alpha_8 PRIMP_j + \alpha_9 FSIMP_j + \alpha_{10} SERVINGS_j$$
$$+ \alpha_{11} TRUSTUS_j + \alpha_{12} TRUSTCAN_j + \alpha_{13} SOMECOL_j + \alpha_{14} COLLEGE_j + \alpha_{15} POSTGRAD_j$$
$$+ \alpha_{16} MIDINC_j + \alpha_{17} HIGHINC_j + \alpha_{18} BSECAN_j + \alpha_{19} BSEKNOW_j + \sum_{i=1}^{3} \beta_i S_i$$
$$+ \delta_1 FEMALEB_j + \delta_2 AGEB_j + + \delta_3 MARRIEDB_j + \delta_4 CHILDRENB_j + \delta_5 SHOPB_j$$
$$+ \delta_6 ATHOME\%B_j + \delta_7 ILLNESSB_j + \delta_8 PRIMPB_j + \delta_9 FSIMPB_j + \delta_{10} SERVINGSB_j$$
$$+ \delta_{11} TRUSTUSB_j + \delta_{12} TRUSTCANB_j + \delta_{13} SOMECOLB_j + \delta_{14} COLLEGEB_j$$
$$+ \delta_{15} POSTGRADB_j + \delta_{16} MIDINCB_j + \delta_{17} HIGHINCB_j + \delta_{18} BSECANB_j + \delta_{19} BSEKNOWB_j$$
$$+ \sum_{i=1}^{3} \varphi_i SB_i + \varepsilon_{ij}$$

where variable names and descriptions are given in Table 1. The subscript "*i*" indicates the *i*th sandwich type (*i*=1, 2, 3, 4) and the subscript "*j*" is for the jth participant (*j*= 1, 2, 3, . . .,113).

Many of the variables in equation (1) are binary. The base regression was for WTA Sandwich 4 (S_4), the non-traceable beef of unknown origin, by participants with only a high school education or less (*HIGH SCHOOL*) and in the lowest income category (*LOWINC*). The parameter estimate on *BEFORE* (α_{20}) is a key variable because it is a test for whether or not average WTA alternative sandwiches changed after the US *BSE* case in December 2003. A significant negative value for *BEFORE*'s parameter would indicate that WTA increased following the US *BSE* case. In

equation 2 a positive value for any δ (or φ) would indicate that the participants with that characteristic before the BSE incident in December 2003 would require a larger bribe than participants with that characteristic after December 2003.

Results

Table 3 reports the average bids for WTA alternative sandwiches and an initial statistical analysis for differences in average WTA between pre- and post-*BSE* auctions. The results presented in Table 3 indicate that WTA (S_1, S_2, S_3, and S_4) is non-zero in all cases. This suggests that, on the average, a non-zero amount would need to be paid to participants to entice them to substitute their baseline sandwich for one of the alternative sandwiches. Average WTA was higher for S_1, S_2, and S_3 in the post-*BSE* auctions than in the pre-*BSE* auctions. However, a comparison of pre- and post-*BSE* coefficients of variation (F statistic in Table 3) that variability in WTA increased for S_1, S_2, and S_3 in the post-*BSE* than in the pre-*BSE* experiments. This provides evidence for increased uncertainty regarding the value of certifications for traceability and country of origin after the US *BSE* incident. This may help to explain why average bids to accept S_4 declined as did the variability of bids for S_4 in the post-*BSE* auctions compared to the pre-*BSE* auctions. It is probable that participants in the post-*BSE* experiments were simply less certain as a group about the value of different certifications after December 23rd than they were before December 23rd.

WTA for S_3, the sandwich providing US country-of-origin certification but not traceability, was barely statistically different than zero at the 10% level in the post-*BSE* experiments.[10] A comparison of the pre- and post-*BSE* mean WTA for the alternative sandwiches reveals that, statistically speaking, WTA increased in the post-*BSE* auctions only for S_1 (Pre S_1 – Post S_1 in Table 3), the traceable Canadian beef sandwich. This indicates that subjects in the post-*BSE* auctions needed a larger bribe than subjects in the pre-*BSE* auctions to switch their baseline sandwich for S_1. At the time the post-*BSE* auctions were held, a public announcement had been made reporting that the *BSE* cow in the state of Washington was of Canadian origin. The results suggest that for the participants in these auctions the US *BSE* case likely hurt the reputation of Canadian beef more than it did US beef. This is based on that fact that, as a group, post-*BSE* participants needed larger bribes to accept Canadian beef, even if it was traceable, than did pre-*BSE* participants.

Table 4 reports the parameter estimates for Models 1 and 2. The results for model 1 are random-effects model of average WTA amounts required to entice participants to accept a non-baseline sandwich. Results for Model 2 reported in Table 4 are a

[10] A WTA equaling zero would indicate that subjects would not need to be bribed to switch their baseline sandwich for the alternative sandwich.

Table 3: WTA Average Bids and Statistical Comparisons for Pre- and Post-*BSE* Auctions.

Variable(s)	Mean	Standard Error	F Comparing Variances for Pre- And Post-*BSE* Auctions	t-statistic
Combined Experiments:				
S_1	$1.48	0.258		5.743***
S_2	$3.07	1.023		3.000***
S_3	$1.86	0.795		2.349**
S_4	$3.50	0.804		4.356***
N=113				
Pre-*BSE* Experiments:				
S_1	$1.12	0.250		4.503***
S_2	$1.89	0.525		3.611***
S_3	$1.12	0.378		2.970***
S_4	$3.92	1.473		2.665***
N=58				
Post-*BSE* Experiments:				
S_1	$1.86	0.457		4.064***
S_2	$4.30	2.024		2.126**
S_3	$2.65	1.586		1.673*
S_4	$3.06	0.579		5.284***
N=55				
Comparisons Pre- and Post-*BSE*:				
Pre S_1 – Post S_1	-$0.73	0.513	3.175***	-1.426*[a]
Pre S_2 – Post S_2	-$2.40	2.043	14.114***	-1.179
Pre S_3 – Post S_3	-$1.54	1.591	16.913***	-0.966
Pre S_3 – Post S_4	$0.86	1.614	6.820***[b]	0.536

*** Denotes statistically different than zero at the 1% level.
** Denotes statistically different than zero at the 5% level.
* Denotes statistically different than zero at the 1% level.
[a] One-tailed t-test of significance (see Kmenta, p. 145 (1986)).
[b] The variance in the pre-*BSE* auctions for S_4 was more than the variance for S_4 in the post-*BSE* auctions. The convention for calculating the F statistic places the largest variance as the denominator (Kmenta, p. 148 (1986)).

Table 4: Estimation Results (Dependent Variable = Subject's Average Subject Bid Over Six Auction Rounds).

	Random Effects Model Without slope dummies			Fixed Effects Model With Slope dummies		
Variable	**Coefficient [a]**		**Standard Error**	**Coefficient [a]**		**Standard Error**
Lagrange multiplier test	27.62	***		13.02	***	
Hausman test	31.95					
R2	.152			.514		
Number of observations	416			416		
Constant	7.230	**	3.356			
FEMALE	-0.165		1.229	8.495		6.881
AGE	-0.142	***	0.052	-0.263		0.207
MARRIED	-0.773		1.455	6.111		3.975
CHILDREN	0.456		1.168	1.662		3.242
SHOP	-2.973	**	1.206	-9.304		7.887
ATHOME	2.954	***	1.098	3.059		3.793
ILLNESS	3.230	***	1.045	6.349	*	3.786
PRIMP	1.402		1.186	-1.083		4.029
FSIMP	1.886		1.324	10.299		6.425
SERVINGS	0.152		0.268	-3.963	***	0.910
TRUSTUS	-3.193	**	1.290	2.077		5.512
TRUSTCAN	1.214		1.335	7.917	**	3.993
Education [b]						
SOMECOL	-0.334		1.258	0.332		3.565
COLLEGE	-0.278		1.507	0.491		5.349
POSTGRAD	0.252		2.623	13.072		16.217
Income [c]						
MIDINC	4.819	***	1.275	1.273		4.604
HIGHINC	2.610		1.776	3.254		5.621
BSE Knowledge						
BSECAN	-4.242	**	2.140	15.534		10.177
BSEKNOW	3.634	**	1.845	-3.668		7.802
Meat Characteristics [d]						
Sandwich 1	-2.139	**	1.014	-1.256		1.387
Sandwich 2	-0.433		1.014	1.459		1.387
Sandwich 3	-1.641	[e]	1.014	-0.190		1.387
BEFORE	-0.139		1.031			
Slope changes in variables before						
FEMALEB				-2.169		16.279
AGEB				0.078		0.185
MARRIEDB				-0.409		7.314
CHILDRENB				-7.558		5.841
SHOPB				4.346		13.791
ATHOMEB				0.651		8.169
ILLNESSB				-2.203		7.116
PRIMPB				2.230		7.255
FSIMPB				-12.468	**	5.844
SERVINGSB				7.415	***	2.194

TRUSTUSB	-5.367		6.559
TRUSTCANB	-12.130		8.653
SOMECOLB	-7.789		7.725
COLLEGEB	6.549		8.106
POSTGRADB	-8.392		18.324
MIDINCB	2.536		8.353
HIGHINCB	-6.641		9.712
BSECANB	7.696		14.866
BSEKNOWB	-34.765		25.454
Sandwich 1B	-1.670		1.906
Sandwich 2B	-3.578	*	1.906
Sandwich 3B	-2.742		1.906

[a] ***=.01 significance, **=.05 significance and *=.10 significance.
[b] Base is high school highest education degree.
[c] Base is low income (household income < $30,000).
[d] Base is sandwich 4 (S_4=meat has been inspected).
[e] P-value=0.1056.

fixed effects model. The random effects model for equation 1 follows Dickinson and Bailey (2002) and (2003) and was selected after the Lagrange Multiplier (LM) and Hausman tests revealed that to be the appropriate estimation procedure (Table 4) (Greene (2003)). For Model 2, the variance-covariance matrix could not be inverted so the Hausman test could not be used. The regression analysis was necessary to account for socioeconomic and other participant characteristics that might affect participants' WTA the alternative sandwiches.

Because this is a WTA model, the interpretation of a positive (negative) coefficient is that presence of that characteristic increases (decreases) the bribe that would need to be paid to the subject for them to accept one of the alternative sandwiches as a substitute for the baseline sandwich. Again, the baseline sandwich contains traceable, US beef.

The results in Table 4 indicate that there is no firm statistical evidence to indicate that, on the average, WTA alternative sandwiches changed after the US *BSE* case (insignificant parameter estimate on *BEFORE* (α_{20})). However, the relatively large standard error, compared to the magnitude of the parameter estimate for *BEFORE*, implies a fair amount of variation in average WTA bids between pre- and post-*BSE* participants (see Table 3) and supports the notion that uncertainty about WTA generally increased after December 23rd.

This can be seen in the results of Model 2 where participants concerned about food safety required smaller bribes for switching their sandwich before the December 2003 incident of BSE. This was also true for the bribe needed to purchase the Canadian sandwich which was not traceable. This indicates that consumers may have viewed the December 2003 BSE incident as a Canadian problem. Model 2 also

shows that as servings increased the average bribe needed was larger before the outbreak than it was after the outbreak.

The results reported in Table 4 also indicate that both traceability and country-of-origin information (S_1) (even if the meat is imported) or knowing the beef was produced domestically (S_3) were more acceptable to participants than simply knowing the meat was inspected (S_4). These results confirm both Loureiro and Umberger's findings (2003) that country-of-origin information is valuable to US consumers and Dickinson and Bailey's ((2002) and (2003)) findings that traceability is a valuable market characteristic. This implies that even though the overall reputation of Canadian beef has been damaged among our participants since the US *BSE* case (Table 3), traceability makes Canadian beef more acceptable than if it is non-traceable. This is based on a Wald test of the restriction that the parameter estimates for S_1 and S_2 being equal ($\beta_1 = \beta_2$) which revealed that $\beta_1 < \beta_2$.[11]

Socioeconomic and other participant characteristic played a role in their WTA alternative sandwiches. Participants eating most of their meals at home (*ATHOME*) required more money to give up their baseline sandwich than did participants eating most of their meals away from home, on the average. While person who are the primary shoppers in their household (*SHOP*) required a smaller bribe, on the average, to give up their baseline sandwich than participants who were not the primary shoppers in their households. This might suggest that persons eating away from home expect vendors to provide implicit assurances while those eating mostly at home and who make most of the shopping choices for their household have a greater sense of control when choosing desired assurances. Participants who had experienced a serious food-borne illness in their family (*ILLNESS*) also required higher bribes, on the average, to give up their baseline sandwich than participants not having this characteristic.

Participants with high degrees of trust in the US government inspections (*TRUSTGOV*) were more likely to substitute their baseline sandwich freely among the alternative sandwiches than were participants with less trust of US government inspection. This suggests that certifications beyond simple government inspection (i.e., traceability and country of origin) are simply not as important to this group as they were to people with less trust in the US government.

Similarly, the older the participant (*AGE*) the more willing he/she was to substitute the baseline sandwich for one of the alternative sandwiches. This suggests that traceability and country-or-origin certifications were more important to younger participants than they were to older participants.

[11] $\chi_1^2 = 2.81$ which indicates different values for the parameters at the 10% confidence level.

A participant's education level was not found to significantly affect their WTA alternative baseline sandwiches. However, participants with annual household incomes above $30,000 needed to be paid more, on the average, than participants from low income households indicating that income is a significant determinant of the demand for traceability (see *MIDINC* in Table 4).

Knowledge of the Canadian *BSE* case (*BSECAN*) significantly reduced WTA. This suggests that educating US consumers about the Canadian *BSE* event may increase their willingness to accept (purchase) Canadian beef since those functioning on rumor rather than facts have poorer perceptions of Canadian beef than do those with a knowledge of the Canadian *BSE* case. However, knowledge about *BSE* in general (*BSEKNOW*) required bigger bribes for subjects to give up their baseline sandwich. This suggests that persons with above average knowledge about scientific matters concerning *BSE* valued traceability and country of origin information more than participants with less knowledge about *BSE*. This implies that educating people about *BSE* from a scientific perspective will likely result in more support for traceability and country of origin programs.

Mandatory Animal Identification Program

A logistical regression was used to determine if any of the socioeconomic and other characteristics indicated in equation (1) affected whether or not participants in the post-*BSE* auctions supported voluntary or mandatory animal ID programs in the US (Table 5).

A somewhat surprising result gathered from the logit analysis was that participants having knowledge of the Canadian *BSE* incident and scientific knowledge about *BSE* (*BSECAN* and *BSE*, respectively) were also less likely to support mandatory animal ID than participants without these characteristics. Persons who are knowledgeable about *BSE* realize that an animal ID system will not prevent the disease. However, they should also know that an animal ID system will be a significant aid in tracing a problem should one occur. Unfortunately, the questionnaire did not ask participants directly about how an animal ID system could be useful following a *BSE* episode. Consequently, the level of understanding regarding the necessity of an animal ID to track problems is unknown. This could be contributing to this result and would indicate that while a person may have knowledge about *BSE*, many of them still do not understand why an animal tracking system would be needed following the discovery of a *BSE* case(s) or they may be opposed to a mandatory program for some reason.

TRUSTCAN increased the probability of a participant favoring mandatory ID. This is not surprising because the Canadian animal ID system is mandatory and if a participant trusted the Canadian system, they would likely favor a similar system being implemented in the US.

Table 5: Marginal Effects for Binomial Logit Model Predicting Whether or Not the Participant Supports Mandatory Animal Identification in the United States.

Variable	Coefficient for Marginal effect [a]	Standard error
Correct predictions for 0	11/17	
Correct predictions for 1	27/32	
Number of observations	49	
Constant	1.615***	0.515
FEMALE	-0.093	0.206
AGE	-0.009	0.009
MARRIED	-0.250	0.206
CHILDREN	-0.103	0.184
SHOP	0.050	0.192
ATHOME	-0.221	0.165
ILLNESS	-0.102	0.185
PRIMP	-0.306	0.204
FSIMP	-0.152	0.212
SERVINGS	-0.018	0.043
TRUSTUS	-0.097	0.229
TRUSTCAN	0.569**	0.247
Education [b]		
SOMECOL	0.242	0.194
COLLEGE	0.090	0.218
Income [c]		
MIDHGINC	0.242	0.202
BSE Knowledge		
BSECAN	-0.614*	0.357
BSEKNOW	-0.620*	0.329

[a] ***=.01 significance, **=.05 significance and *=.10 significance.

[b] Base is high school highest education degree. *POSTGRAD* was not included in the regression because of colinearity problems.

[c] Base is low income (household income < $30,000). Because of difficulties in inverting the variance-covariance matrix for the Hausman test, *MIDINC* and *HIGHINC* were combined so that the *MIDINC* is measuring the effect of all incomes above $30,000.

The results indicate that support for mandatory ID among the participants is widespread (69% of participants) and is based, at least to some degree, on their trust in the Canadian government and knowledge of BSE and BSE incidents. Given that average WTA is non-zero, the results provide some evidence for a large number of US consumers being willing to support the implementation of a mandatory

animal ID program with tax dollars. Of course, these results should be confirmed with a broader study.

Conclusions

A series of experimental auctions were conducted immediately preceding and following the announcement on December 23, 2003 that a cow in the state of Washington had been diagnosed with *BSE*. The data set offers some unique insights into the effects of *BSE* on beef demand in the US because it provides a snapshot of demand for a set of American consumers on both sides of a major food safety event.

The results indicate that information about traceability and country of origin is valuable to consumers. They also suggest that greater uncertainty about certifications and assurances for beef existed among the participants after December 23rd than before December 23rd. While this is not surprising, it indicates that US consumers, while not necessarily changing beef buying habits, were subject to some "shock" to their overall perceptions about beef and certifications and assurances about beef.

Perhaps one of the most important findings was that participants' demand for Canadian beef was more adversely affected by the US *BSE* crisis than was the demand for US beef. This implies that US consumers have placed at least some of the "blame" for the US *BSE* incident on Canada because the subject animal was born there.

The results suggest that a large percentage of US consumers would support a mandatory animal ID system in the US and would be willing to pay something for it. Additional work is needed to confirm these results. However, they confirm that the US *BSE* case caused some important changes in American consumer attitudes. Consequently, the US beef industry should not assume that no noticeable change in US consumer attitudes about beef occurred after December 23, 2003. Consumers are more uncertain about beef products than they were prior to December 23rd. Additional *BSE* cases could exacerbate this uncertainty. The movement toward animal ID systems appears to be a good strategic move by the US beef industry and the US government, based on participants' stated support for such systems.

References

Bailey, D., E. C. Jones, and D. L. Dickinson. "Knowledge Management and Comparative International Strategies on Vertical Information Flow in the Global Food System." *American Journal of Agricultural Economics*, 84(December 2002):1337-1344.

Baines, R. N., and W. P. Davies. "Quality Assurance in International Food Supply." Paper presented at the Third International Conference on Chain Management in Agribusiness and the Food Industry, Wageningen University, Wageningen, The Netherlands, 1998.

Baines, R. N., and W. P. Davies. "Meeting Environmental and Animal Welfare Requirements Through On-Farm Food Safety Assurance and the Implications for International Trade." Paper presented at the Agribusiness Forum of the 2000 World Food and Agribusiness Congress, Chicago, IL, June 2000.

Breckendorf, C. Chairman, National Milk Producers Federation. Testimony to the US House of Representatives Committee on Agriculture, Field Hearing on Animal Identification, Houston, TX, March 5, 2004.

Buhr, B. "Electronic Traceability in European and US Meat Supply Chains." Presentation at the National Pork Industry Forum, Denver, CO, 28 February 2002.

Caswell, J. A. "Labeling Policy for GMOs: To Each His Own?" *AgBioForum*, 9(2000):53-57.

Caswell, J. A. "How Labeling of Safety and Process Attributes Affects the Market for Food." *Agricultural and Resource Economics Review*, 27(October 1998):151-158.

Caswell, J. A., and D. I. Padberg. "Toward a More Comprehensive Theory of Food Labels." *American Journal of Agricultural Economics*, 74(May 1992):460-467.

Dickinson, D. L. and D. Bailey. "Meat Traceability: Are US Consumers Willing to Pay for It? *Journal of Agricultural and Resource Economics*, 27(December 2002):348-364.

_____. "Willingness to Pay for Information: Experimental Evidence on Product Traceability from the US A., Canada, the U. K., and Japan." Study paper, Department of Economics, Utah State University, Logan, Utah, August 2003.

Denis, A. H. American Sheep Industry Association. Testimony to the US House of Representatives Committee on Agriculture, Field Hearing on Animal Identification, Houston, TX, March 5, 2004.

Farm Foundation. Food Traceability and Assurance (TA): An Emerging Frontier Driving Developments in the Global Food System. Traceability and Quality Assurance Roundtable issue paper, Oak Brook, IL, April 2004.

Greene, W. H. *Econometric Analysis*, 5th Edition, Upper Saddle River, NJ: Prentice Hall, 2003.

Hayes, D. J., J. F. Shogren, S. Y. Shin, and J. B. Kliebenstein. "Valuing Food Safety in Experimental Auction Markets." *American Journal of Agricultural Economics*, 77(February 1995):40-53.

Hobbs, J. E. "Transaction Costs and Slaughter Cattle Procurement: Processors' Selection of Supply Channels." *Agribusiness: An International Journal*, 12(1996a):509-23.

Hobbs, J. E. "A Transaction Cost Analysis of Quality, Traceability, and Animal Welfare Issues in UK Beef Retailing." *British Food Journal*, 98(1996b):16-26.

Huffman, W. E., M. Rousu, J. F. Shogren, and A. Tegene. "Consumer Willingness to Pay for Genetically Modified Food Labels in a Market with Diverse Information: Evidence from Experimental Auctions." *Journal of Agricultural and Resource Economics*, 28(December 2003a):481-502.

Huffman, W. E., M. Rousu, J. F. Shogren, and A. Tegene. "The Public Good Value of Information from Agribusinesses on Genetically Modified Foods." *American Journal of Agricultural Economics*, 85(December 2003b):1309-1315.

Kmenta, J. *Elements of Econometrics*, 2nd Edition, New York: MacMillan Publishing Company, 1986.

Lewis, S. "Uruguay Establishes Livestock Traceability Commission." *Food Traceability Report*, 1(November 2001):10.

Liddell, S. and D. Bailey. "Market Opportunities and Threat to the US Pork Industry Posed by Traceability Systems." *International Food and Agribusiness Management Review*, 4(2001):287-302.

Loureiro, M. L. "Rethinking New Wines: Implications of Local and Environmentally Friendly Labels." *Food Policy*, 28 (Oct-Dec 2003):547-560.

Loureiro, M. L., and W. J. Umberger. "Estimating Consumer Willingness to Pay for Country-of-Origin Labeling." *Journal of Agricultural and Resource Economics*, 28(August 2003):287-301.

Lusk, J. L., and J. A. Fox. "Consumer Demand for Mandatory Labeling of Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn." *Journal of Agricultural and Applied Economics*, 34(April 2002):27-38.

Lusk, J. L., J. Roosen, and J. A. Fox. "Demand for Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn: A Comparison of Consumers in France, Germany, the United Kingdom, and the United States." *American Journal of Agricultural Economics*, 85(February 2003):16-29.

Lyon, J., President, National Cattlemen's Beef Association. Testimony to the US House of Representatives Committee on Agriculture, Field Hearing on Animal Identification, Houston, TX, March 5, 2004.

Parkhurst, G. M., J. F. Shogren, and D. L. Dickinson. "Negative Values in Vickrey Auctions." *American Journal of Agricultural Economics*, 86(February 2004):222-235.

Philippi, J. National Pork Producers Council. Testimony to the US House of Representatives Committee on Agriculture, Field Hearing on Animal Identification, Houston, TX, March 5, 2004.

Robb, J. Director, Livestock Marketing Information Center, Denver, CO, Personal communication, April 8, 2004.

Rousu, M. W. E. Huffman, J. F. Shogren, and A. Tegene. "Estimating the Public Value of Conflicting Information : The Case of Genetically Modified Foods. *Land Economics*, 80(February 2004);125-135.

Shogren, J. F., M. Margolis, C. Koo, and J. List. "A Random n^{th}-Price Auction." *Journal of Economic Behavior and Organization*, 46(2001):409-421.

Shogren, J. F., J. A. List, and D. J. Hayes. "Preference Learning in Consecutive Experimental Auctions." *American Journal of Agricultural Economics*, 82(November 2000):1016-1021.

Shogren, J. F., J. A. Fox, D. J. Hayes, and J. B. Kliebenstein. "Bid Sensitivity and the Structure of the Vickrey Auction." *American Journal of Agricultural Economics*, 81(November 1994a):1089-1095.

Shogren, J. F., S. Y. Shin, D. J. Hayes, and J. B. Kliebenstein. "Resolving Differences in Willingness to Pay and Willingness to Accept." *American Economic Review*, 84(March 1994b):255-270.

Smith, G. C. Vice Chairman, International Stockmen's Educational Foundation. Testimony to the US House of Representatives Committee on Agriculture, Field Hearing on Animal Identification, Houston, TX, March 5, 2004.

Sparks Companies, Inc. "Linking the Food Chain: Sharing Information and Verifying Sources, Materials and Processes Across Traditional Boundaries." A multi-client study, Memphis, TN, November 2002.

US Animal Identification Plan. Available on line as of April 5, 2004 at http://www.usaip.info.

Vickery, W. "Counterspeculation, Auctions and Competitive Sealed Tenders." *Journal of Finance*, 16(1961):8-37.

Wiemers. J. F. Chairman, USDA/FSIS Interagency Committee on Animal Identification. Presentation at Conference on Attacking Global Food and Agribusiness Barriers, George Mason University, Fairfax, VA.

