Consumer Responses to Recent BSE Events

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Recent bovine spongiform encephalopathy (BSE, a.k.a. mad cow disease) discoveries in Canadian and U.S. beef cattle have garnered significant media attention, which may have changed consumers' meat-purchasing behavior. Consumer response is hypothesized and tested within a meat demand system in which response is measured using single-period dummy variables, longer-term dummy variables, and media indices that count positive and negative meat-industry articles. Parameters are estimated using retail scanner data, and cross-species price elasticities are calculated. Results suggest that the BSE events negatively impacted ground beef and chuck roasts, while positively impacting center-cut pork chop demand. Dummy variables explained the variation in meat-budget shares better than did media indices.

The announcement of Canada's single case of bovine spongiform encephalopathy (BSE, also known as mad cow disease) on May 20, 2003 was the impetus for a significant new focus on animal health, consumer food-safety perceptions, and animal trade on the North American continent.[1] The European experience with BSE suggests that there is much to learn about the impacts of animal-health concerns on consumer demand (Thompson and Tallard 2003), but little research has been done in the United States since there have been no major animal health outbreaks to analyze in the past. Although the BSE event in North America did not affect the meat system (because of early detection), some impact on consumer demand for beef might still be expected given media attention and any misperceptions among the public.

An empirical exploration of the reaction to the outbreaks might provide interesting results on how the potential threat influenced the beef industry, how the industry's education efforts surrounding the event influenced impacts in the long run and how demand for other meat products was impacted. Thus the current study answers the question, "Have the Canadian and United States announcements of BSE affected U.S. consumers' demand for meat?"

The Canadian event motivated the U.S. to close its border to Canadian beef products and live animal trade. Only seven months after the Canadian BSE event, the United States announced detection of BSE in a single cow in the State of Washington. Subsequently, this event closed borders to trade between the U.S. and its export markets, possibly reinforcing the significance of the event. Beyond interest in seeing the consumer reaction to two countries' BSE events, this research may inform policymakers about how differently the two events were perceived by U.S. consumers (i.e. with a trade partner vs. with a domestic industry).

Against a backdrop of widespread media attention, the secondary research question is whether and to what extent consumer behavior has been altered by the degree and nature of media attention to BSE events. If consumer perceptions and their purchases of beef relative to other meat species have changed considering the amount of printed media coverage given to the event, the effect may be empirically measured with several different approaches and compared to analysis that simply integrates a dummy variable for the time of the event announcement.

This paper begins with the research objectives, followed by a review of the literature related to consumer-demand modeling and event-impact studies. A detailed representation of the methodology, presentation of econometric results, and discussion of the findings on both the primary and secondary research questions are followed by motivation for further research and discussion of the study's limitations.

[1] Canada has experienced seven confirmed cases of BSE since this first event and is investigating another case at the time this article is being written. The U.S. has experienced three confirmed cases. A chronology of these BSE events is found in Mathews, Vandeveer, and Gustafson, 2006.

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Research Objectives

Using a meat demand-system model, this study's objectives are to explore the direct impacts of the Canadian and U.S. beef events on various beef cuts (ribeye, ground beef, boneless loin steaks, and chuck roasts) as well as cross-species impacts on two similar chicken and pork cuts. Emphasis is placed on individual cuts because particular cuts (e.g., ground beef) have been portrayed as having a greater risk of BSE presence relative to other cuts. It is expected that consumers may choose to substitute among cuts based on this risk assessment.

Our secondary objective is to determine if media information about the BSE events had a statistically significant impact on meat-purchase share volumes, and to contrast various proxies for media-information variables including attention to the time element of the impact (persistence, intensity of media coverage across months). Showing myriad approaches and their results may inform future studies that seek to use media as an independent variable in event analyses.

The impact of the Canadian and United States BSE cases on U.S. consumer meat demand have only been explored with more isolated price and quantity data (Crowley and Shimazaki 2005), but the need to examine the impact with a fuller, demand-system approach can provide additional, more-detailed inference. We argue the results of the analysis may be useful to policymakers weighing relative benefits and costs of food-safety measures. For these stakeholders, we seek to quantify the intensity and persistence of food-safety scares on consumer demand, thereby signaling the benefits of food-safety innovations. The demand-systems approach is useful in determining whether a particular meat species or cut actually gains consumer demand during a food-safety scare. These inadvertent benefits also need to be quantified. Retail food- and beef-industry professionals who seek information about consumer responses to perceived food-safety threats may find the study useful, as may those who wish to explore whether the responses to the Canadian and U.S. industries were different (in terms of both absolute demand impacts and the strength of media's influence).

Literature Review

Previous literature related to this research objective falls within two categories: consumer-demand-system models and empirical informational economics. The demand-systems literature addresses how the meat system will be represented in this research, while the empirical-information literature suggests a means to incorporate food-safety information shocks into demand systems. With regard to consumer-demand models, Deaton and Muellbauer (1980) first proposed the Almost Ideal Demand System (AIDS) model that is modified in this study. Pollak and Wales (1981) and Lewbel (1985) proposed various translating and scaling techniques to incorporate shift variables (such as food-safety information) into an expenditure-share system while preserving Closure Under Unit Scaling (CUUS). In this context, CUUS implies that economic effects, such as the demand shift of informational variables, are invariant to scaling data. More recently, a precommitted quantities framework has been advocated as a tractable translation procedure (Bollino 1987; Moschini and Meilke 1989; Alston, Chalfant, and Piggott 2001; Piggott 2003; Piggott and Marsh 2004). In the current study, the linear price index proposed by Moschini (1995) is used to preserve CUUS within the modified AIDS framework.

The conceptual framework and methodology fall from a well established empirical informational economics literature (Swartz and Strand 1981; Smith, van Ravenswaay, and Thompson 1988; Brown and Schrader 1990; Wessells, Miller, and Brooks 1995; Teisl, Roe, and Hicks 2002; Piggott and Marsh 2004; Marks, Kalaitzandonakes, and Vickner 2004; Kalaitzandonakes, Marks, and Vickner 2004, 2005). Like the current research, these studies posit an empirical framework that estimates the impact of non-price information while controlling for price and income/expenditure share differences. The current research uses a similar demand-systems approach so that non-price factors such as food-safety media indices may be integrated appropriately.

A recent Canadian meat demand-system study (Peng, McCann-Hiltz, and Goddard 2004) incorporated a BSE media-index variable into a linear version of the AIDS model while utilizing point-of-purchase scanner data. The authors used weekly point-of-purchase scanner data for fresh and refrigerated beef, pork, and chicken (acquired from AC Nielsen) from Alberta retail stores for its data. The beef products were split into ground beef and "other" beef. Results confirmed the assumption that the newspaper articles addressing BSE had a negative (small in magnitude) and statistically significant impact on the Alberta consumers' demand for beef (cuts other than ground). An interesting finding shows that there was a positive and statistically significant effect on the demand for pork products and insignificant impacts on chicken and ground beef.

A unique contribution of the current study is to examine U.S. consumers' responses to BSE in both the U.S. and Canada (a neighboring trade partner) using a similar model and various media-information variables. While past research has focused on a single own-price or cross-price elasticity for all meat cuts within a species, this research disaggregates consumers' responses to measure intra-species substitution (beef roast versus beef steak versus ground meat) and inter-species substitution (chicken versus beef). In addition, this research aims to compare, contrast, and incorporate multiple forms of media-information variables to proxy the BSE "shock" in a meat demand system.

Methodology

The empirical framework estimates share equations using the Almost Ideal Demand System (AIDS) model (Deaton and Muellbauer 1980), in which the consumer model is separable at the beef, pork, and chicken cut level, but aggregated to the market level for share estimates. More specifically, the expenditure share w_i for the i^{th} retail meat product (i = 1 for ground beef, 2 for boneless beef ribeye steak, 3 for beef chuck roasts, 4 for boneless beef top loin steak, 5 for boneless pork center-cut chops (boneless), and 6 for boneless/skinless chicken breasts) is a function of parameters α_i, γ_{ij}, and β; its own price p_i; the other five meat-product prices p_j; and total meat expenditures M within the system given by

$$(1)\quad w_i = \alpha_i + \sum_{j=1}^{6} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{M}{P}\right),$$

where the unobservable, nonlinear AIDS price index (P) is replaced by the loglinear analog of the Laspeyres price index (Moschini 1995) for constant base-period shares w^0:

$$(2)\quad \ln P = \sum_{j=1}^{6} w_j^o \ln p_j .$$

Any informational-shift variable, such as a BSE event, is incorporated into the α_i parameters as

$$(3)\quad \alpha_i = \varphi_i + \kappa_i ,$$

where κ is a parameter to be estimated.

In the present application, the linear price index in Equation 2 preserves CUUS.[2] In addition, homogeneity and symmetry may be imposed on the model and the adding-up restriction may be tested using standard procedures.

Several approaches have been used to proxy media impact, including both media metrics and a single dummy variable, and these formulations have met with mixed results (Kalaitzandonakes, Marks, and Vickner 2004). The media-index variable found in Equation 3 receives several formulations as described in Table 1, and the system-parameter estimates from each formulation are contrasted in a later section. Simple dummy variables are among those compared and include a variable equal to "1" in the month of the Canadian BSE event (May 2003) and a "0" otherwise, while another places a "1" beginning in May 2003 and extending to the remainder of the data set. In this case, parameter estimates and hypotheses tests will indicate whether the BSE event had a single-month impact or if a longer structural effect is present. Likewise, the U.S. BSE event is given a single month proxy (a "1" in December 2003) and an extended dummy variable (a "1" in December 2003 and beyond).

A second method of capturing consumers' response to the BSE event is an index to capture print-media coverage. A Lexis-Nexis search of articles using the terms "mad cow disease" "BSE" and "bovine spongiform encephalopathy" was performed, and words in each article counted to form a monthly data series ranging from January 2001 to February 2005. Media coverage is coded "Negative" for articles that suggest that beef food safety is ques-

[2] It is possible that the pre-committed quantities framework may not be consistent with our underlying data-generation process and may persistently result in "subsistence" quantities in the negative quadrant, and hence supernumerary expenditures outside the required [0,M] interval. No restrictions can be imposed on the model to ensure that this does not occur.

tionable and "Positive" for articles that described beef food safety in favorable terms. Examples of positive articles could include, but are not limited to, new or more-efficient testing methods to detect the presence of BSE (assuring efficiency with regard to food safety), a suspected case having a negative test result, assurances of the safety of the meat system and how no diseased animal made it into food-marketing channels, or detailed descriptions of the safeguards developed and implemented to prevent BSE incidences. Examples of negative articles are reports of faulty systems or testing methods, negative test results, or descriptions of how the disease could easily occur in the U.S. In addition, media reports of new Food Safety and Inspection Service Rules regarding advanced meat recovery (AMR) practices may negatively influence ground beef demand vis a vis other cuts as the AMR practices are used to mechanically separate meat from bone. The word counts of negative and positive articles are summed in a given month to create the respective data series. A third data series, "Net," is created by subtracting the word count of monthly negative articles from the monthly positive articles.

Five BSE-event variables are created from the previously mentioned series, and the parameter estimates of these variables will be compared after they have been placed in separate demand systems and estimated. First, the "Negative" monthly article sums are used as the informational shift variable. Next, the negative word-count sums are squared, indicating a stronger overall impact on consumer's preferences, and parameters estimated within the system. A third BSE proxy is the "Net" variable that balances the negative word counts against the positive for a given month. The fourth media-index variable squares the monthly net article word-count sums. The final index follows Brown and Schrader (1990) by multiplying the net word count by the ratio of negative word counts to the total word count in each respective month. Table 1 provides a description of all BSE event variables.

Six share equations (ground beef, beef rib eye, beef chuck, beef top loin, pork center-cut chops, and boneless/skinless chicken breasts) comprise the meat-share demand system chosen for this study, and one share equation—beef top loin—is omitted during the estimation procedure. Parameters are estimated using an iterated seemingly unrelated regression (SUR) method on a linear approximation of Deaton and Muellbauer's AID model. A seasonal dummy variable representing the barbecue season (May through September as "1", and "0" otherwise) is also included, given past findings on the importance of accounting for that nonprice aspect of meat demand. Share equations are corrected for a first-order autoregressive process as appropriate.

Data

The United States Department of Agriculture's Economic Research Service (USDA-ERS) purchased monthly retail scanner data for 191 different meat products (beef, veal, poultry, pork, and lamb) sold in U.S. retail grocery stores from January 2001 through February 2005 (fifty months). The retail

Table 1. Description of BSE Event Variables.

Variable	Description
One-month dummy	A "1" in the month of the event, a "0" otherwise.
Extended dummy	A "1" in the event month continuing through subsequent months.
Negative article	Word count of articles coded as "negative."
Negative article squared	Word count of articles coded as "negative" squared (quadratic impact).
Net article	Word count of negative articles subtracted from a word count of positive articles.
Net article squared	Squared "net article" data.
Brown and Schrader	"Net article" variable multiplied by the ratio of the "negative article" variable to the sum of negative and positive word counts.

stores that voluntarily provide the information used to compile the data have $2 million in annual sales, representing approximately 20 percent of supermarket sales in the U.S. This data set is the foundation for the study.

Supermarket scanner data is a continuous record of purchase prices and volumes throughout a month. Average monthly prices are collected for the syndicate (non-discounted price set by the retailer) and the feature (discounted) price. For this analysis, an average weighted feature price that integrates the amount sold during feature promotions at discounted prices is used as the price series. One limitation of the new USDA retail meat scanner data is the lack of access to actual volumes, as a volume index of relative sales movement is reported instead. This may explain why only simple price and volume analyses have been conducted up to this point. Our research questions could not be effectively answered without a systems approach, so a volume and meat-expenditure-share extrapolation exercise was completed. First, a baseline meat-expenditure share for each cut was estimated for the baseline scanner data year, 2001, by taking the volume of retail sales for each cut and multiplying it by the average weighted feature price from the scanner data series. This series was then adjusted with the volume index included in the retail scanner data to more accurately reflect actual sales movements among the retail entities who provided data for this study. This meat-expenditure share can be calculated and reported both as a share of total meat expenditures (if divided by total meat sales) or within the system as the share relative to the cuts included in the system.

The volume index compares the month's volume of sales to the monthly average volume sold in 2001. For example, 500 pounds of ground chuck were sold in June 2001. For all of 2001, the monthly average was 400 pounds. Putting this on an index basis (with 2001 = 100), the index value for ground chuck for June 2001 would be 125 (USDA - ERS 2003). The feature volume is the percentage of total volume sold under featuring. This index is used in the meat-expenditure-share extrapolation exercise described below.

Ziehl et al. (2004) used the same data series to show the importance of disaggregating beef cuts because of differing retail behavior, and given that ground beef is often characterized in the press as a product with relatively greater potential for contamination, beef cuts are also disaggregated in this study. However, not all cuts from the beef carcass could be included, so a representative set of cuts from three major primals (rib, loin, chuck) and the whole carcass (ground beef) were included. These cuts represent approximately 14 percent of total meat expenditures, given the estimation procedure discussed below. In addition, we sought to explore the cross-species demand response to pork and chicken, but to be consistent we included only specific cuts from those species. To maintain a fairly tight system and preserve degrees of freedom, only one cut from each species was chosen: center-cut pork chops and boneless/skinless chicken breasts (considered potential grilling substitutes to steaks and baking substitutes for each other and for roasts). These two cuts represent another 23 percent of total meat expenditures, as they are the highest-value cuts from their respective species. Descriptive statistics on the cuts in each panel are located in Table 2.

Results

The primary objective of this study is to examine U.S. consumers' meat-demand response to the Canadian and U.S. BSE events. A related objective was to explore how the impact of the BSE event could be modeled, ranging from simple dummy variables to more-complex media indices. Results are organized according to the Canadian and U.S. BSE events, with full system-parameter estimates following a discussion of the various BSE event formulations.

Proxies of the Canadian BSE event are considered first, and parameter estimates are found in Table 3. Share equations are found in Table 3's rows, and the various BSE-event parameter estimates are found in columns ranging from the "One Month Dummy" to "Brown and Schrader" following the approaches laid out in Table 1.

Neither the ribeye share nor the chicken breast share indicates a statistically significant impact from any BSE-event formulation. In the chuck, ground beef, and pork equations, the beef products (ground and chuck roast) experience a negative impact, indicating that consumers purchased less of these two beef products. The greater negative impact occurred with ground beef, which in the print media was portrayed as the beef product with the greatest

Table 2. Summary Statistics for Meat Demand System Cuts.

Meat cut	Average feature weighted price ($/lb)	Volume index (2001=100)	Retail volume (Million lbs.)	Average share - all meats	Average share - estimated system
Ribeye	$8.16	120.50	48.01	0.038	0.088
Top sirloin steak	$8.36	106.72	47.22	0.034	0.088
Chuck roast	$3.02	111.50	90.61	0.024	0.061
Ground beef	$2.47	94.04	327.81	0.062	0.181
Center-cut pork loin	$4.40	106.72	322.46	0.120	0.317
Skinless/boneless chicken breast	$3.28	111.36	360.60	0.107	0.264

Table 3. Results of Utilizing Different Canadian BSE-Event Proxies.

Share equation	One-month dummy	Extended dummy variable	Negative article	Negative article squared	Net article	Net article squared	Brown and Schrader
Ribeye share	-1.40E-03	-1.46E-03	-2.66E-13	-5.98E-23	8.84E-09	-3.14E-13	1.62E-08
(t-stat)	(-0.73)	(-1.03)	(-0.65)	(-0.71)	(0.29)	(-0.68)	(0.50)
Chuck share	-1.80E-03*	-1.61E-03	-3.69E-13*	-7.79E-23*	2.19E-08	-4.26E-13*	2.73E-08
(t-stat)	(-1.78)	(-2.02)	(-1.70)	(-1.77)	(1.30)	(-1.74)	(1.53)
Ground share	-5.81E-03*	-4.90E-03*	-1.20E-12*	-2.51E-22*	6.54E-08	-1.36E-12*	8.42E-08
(t-stat)	(-1.98)	(-2.06)	(-1.89)	(-1.96)	(1.33)	(-1.91)	(1.62)
Pork share	1.59E-02*	7.64E-03	3.35E-12*	6.91E-22*	-2.18E-07	3.81E-12*	-2.62E-07*
(t-stat)	(1.86)	(1.09)	(1.82)	(-1.85)	(-1.54)	(1.83)	(-1.74)
Chicken share	-3.05E-03	3.61E-03	-7.27E-13	-1.34E-22	7.00E-08	-7.95E-13	7.38E-08
(t-stat)	(-1.00)	(1.28)	(-1.11)	(-1.00)	(1.42)	(-1.08)	(1.40)

*Statistically significant at the 10% level.

risk of contamination from BSE-infected tissue. Conversely, all but the Net Article and the Brown and Schrader event dummies have a positive impact on the pork share equation, indicating that pork may have been a substitute choice for the beef cuts among those consumers concerned about the events.

The positive impact multiplier on pork shares is generally smaller than the negative impact on chuck and ground beef shares when BSE-event formulations are compared in each column. An exception is the one-month dummy variable, in which pork's positive impact multiplier outweighs the combined negative impact on chuck and ground beef shares.

The event dummy variables (Extended Dummy Variable, One-Month Dummy) have a greater impact on meat shares than do the word-count variables, perhaps because the dummy variables capture more complex information shifters including electronic media, whereas word-count variables are specific to the print media. Furthermore, the media attention on a food-safety event is often focused in a short period, but we are measuring consumer response in a monthly data series. As a result, media word counts may not provide additional information on monthly consumer-demand response, since such events pass out of public attention so quickly.

A similar comparison is attempted with the U.S. BSE-event proxies, but computational difficulty prevented the iterated SUR procedure from providing estimates for the word-count BSE proxies. The results of the demand-system estimation utilizing the dummy variables are presented in Table 4. None of the dummy variables are statistically significant at the ten-percent level. Again, the impact of the one-month dummy is negative for the beef products and positive for the pork share demand equation. In addition, the one-month positive impact on pork shares outweighs the combined negative impact on the chuck and ground beef shares, as was observed in Table 3. These results may suggest that in the month of the BSE event, consumers switch from beef to pork more readily, but the substitution tends to diminish in subsequent months.

Although the event analysis is the primary focus of this study, it is important to know that such estimates are part of a well-behaved demand system that accurately represents consumer behavior. In the next section, parameter estimates from the full demand system are reported when an extended dummy variable is used to capture the BSE event. Parameter estimates are examined, Marshallian price elasticities reported and discussed, and model robustness explored.

The Canadian event is explored first with impact multipliers reported in Table 5 and the Marshallian demand elasticities reported in Table 6. Table 5 lists the share equations in rows, and parameter estimates of explanatory variables are reported in columns. Results indicate that the own-price impact multipliers are positive and significant, and the cross-price

Table 4. Results of Utilizing Different U.S. BSE-Event Proxies.

Share equation	Extended dummy variable	One-month dummy
Ribeye share	0.0004	-0.0024
(t-stat)	(0.26)	(-1.54)
Chuck share	0.0001	-0.0015
(t-stat)	(0.14)	(-1.45)
Ground share	0.0002	-0.0047
(t-stat)	(0.08)	(-1.58)
Pork share	-0.0033	0.0154
(t-stat)	(-0.41)	(1.76)
Chicken share	0.0029	-0.0050
(t-stat)	(0.86)	(-1.66)

Table 5. System Parameter Estimates of Canadian BSE Event - Extended Dummy.

Share equation	constant	Ribeye FWAP[a]	Chuck FWAP	Ground FWAP	Pork FWAP	Chicken FWAP	Loin FWAP	Meat expend	Barbecue	BSE	adj. R^2	DW
Ribeye share	0.0500	0.0095*	0.0002	0.0004	-0.0079*	-0.0045*	-0.0053*	0.0073	0.0031*	-0.0015	0.7563	1.5605
(t-stat)	(0.3977)	(12.1932)	(0.5854)	(0.4604)	(-5.0815)	(-3.9854)	(-3.9834)	(0.4093)	(3.9097)	(-1.0294)		
Chuck share	0.0517	0.0002	0.0181*	-0.0058*	-0.0053*	-0.0053*	-0.0024*	0.0041	0.0021*	-0.0016*	0.6601	1.5237
(t-stat)	(0.7109)	(0.5854)	(42.1162)	(-8.5912)	(-5.5005)	(-8.8420)	(-3.1229)	0.3960	(4.6104)	(-2.0200)		
Ground share	0.1544	0.0004	-0.0058*	0.0573*	-0.0155*	-0.0153*	-0.0073*	0.0113	0.0064*	-0.0049*	0.6447	1.5697
(t-stat)	(0.7059)	(0.4604)	(-8.5912)	(31.6368)	(-5.4112)	(-9.4797)	(-3.2286)	(0.3645)	(4.5724)	(-2.0595)		
Pork share	0.9741	-0.0079*	-0.0053*	-0.0155*	0.0528*	-0.0164*	0.0032	-0.1052	-0.0190*	0.0076	0.5924	1.7392
(t-stat)	(1.4965)	(-5.0815)	(-5.5005)	(-5.4112)	(6.1586)	(-5.4617)	(0.4852)	(-1.1436)	(-4.6205)	(1.0916)		
Chicken share	-0.3492	-0.0045*	-0.0053*	-0.0153*	-0.0164*	0.0516*	0.0037	0.0816*	0.0043*	0.0036	0.8386	1.8502
(t-stat)	(-1.4640)	(-3.9854)	(-8.8420)	(-9.4797)	(-5.4617)	(15.4115)	(1.4948)	(2.4174)	(2.9560)	(1.2793)		

[a]FWAP is the Feature Weighted Average Price.
*Statistically significant at the 10% level.

Table 6. Marshallian Elasticities with Canadian BSE Event – Extended Dummy.

	Ribeye	Chuck	Ground	Pork	Chicken	Loin
Ribeye	-0.8984	-0.0032	-0.0109	-0.1164	-0.0738	-0.0676
Chuck	-0.0030	-0.7090	-0.1068	-0.1077	-0.1046	-0.0450
Ground	-0.0034	-0.0359	-0.6944	-0.1057	-0.1012	-0.0460
Pork	0.0042	0.0036	0.0110	-0.7284	0.0358	0.0394
Chicken	-0.0442	-0.0391	-0.1139	-0.1602	-0.8866	-0.0131
Loin	-0.0607	-0.0279	-0.0849	0.0328	0.0395	-0.9099
Mean share	0.0876	0.0613	0.1809	0.3175	0.2644	0.0883

impact multipliers are also largely significant. The barbecue-season dummy variable (May through September) is significant in each share equation, but the meat-expenditure variable is significant only in the chicken breast share equation. Importantly, the BSE proxy is significant only in the ground beef and chuck roast equations.

The Marshallian elasticities reported in Table 6 are negative, as expected.[3] Ground beef tends to be more price inelastic than the other products, a logical result given that it is considered a staple for many households. Nearly all of the products act as complements to one another (a negative sign on the cross-price elasticity) with the notable exception of the pork product that acts more often as a substitute for ground beef. Interestingly, chicken breasts are not considered a substitute for ground beef in our analysis. We had expected chicken breasts to be substitutes given their use as a barbecue meat during the grilling season, and the proximity of the chicken breast average feature weighted price relative to the ground beef price (Table 2).

In contrast to Tables 5 and 6, Tables 7 and 8 report the demand-system parameter estimates when the U.S. BSE event is modeled with an extended dummy variable rather than assuming the Canadian BSE event was of greater importance. Table 7 focuses on the model that integrates the U.S. BSE dummy variable and indicates a long-term impact of the U.S. BSE event is not observed for any of the meat-price shares. The U.S. event occurred in December 2003, so it may be that too little time has passed (14 observations) to capture a longer-term BSE impact on consumer behavior. Alternatively, U.S. consumers may have lost little confidence in meat safety as a result of the later event, as suggested by a consumer survey conducted in early 2004 (Thilmany et al. 2004).

Elasticity results for the U.S. extended dummy model are reported in Table 8. The own-price elasticities are negative and theoretically consistent. Importantly, these estimates are consistent with those found in Table 6, the Canadian extended dummy event model, indicating the model is robust under alternative BSE event structures.

[3]The Marshallian elasticities for the loin variable are calculated using symmetry and adding-up restrictions of the demand system. The loin own-price parameters could not be estimated directly, as the loin equation was omitted when the system was estimated.

Conclusions

This study explores the impact on U.S. consumers' meat demand of the Canadian and U.S. BSE events. In general, demand for chuck roasts and ground beef declined due to both BSE shocks, and demands for pork increased. This result is consistent with Peng, Hiltz, and Goddard (2004), who explored Canadian consumers' responses to the Canadian outbreak using a similar methodology. The pork substitution effect appears to be strongest in the month of the BSE discovery and diminishes in the longer term. More-expensive beef cuts (e.g., boneless ribeye steak) did not appear to be impacted by the BSE event in a statistically significant manner.

From a methodological perspective, various BSE-event proxies are contrasted against one another. Simple dummy variables tended to generate greater impact multipliers on share equations than did media-index variables, as might be expected. Moreover, the simple dummy variables tended to be statistically significant across more share equations than did the media-index variables. In short, we would conclude that integrating media information into demand systems may be no more useful than including a simple dummy variable to represent the advent of a major event.

This is not to say that construction of media indices and their use in economic studies is without value. In fact, media study may be particularly appropriate when public institutions are perceived to perform inadequately. For instance, when consumers have less assurance that government institutions can respond to food-safety issues, the role of media may be enhanced. After the mishandling of BSE in the United Kingdom, European consumers look to third-party validation, including the media, rather than government to assure them of a safe food supply, whereas a large majority of U.S. consumers still trust the USDA's oversight of the food system. Another instance when media may be an important influencer is when branded products are addressed, an increasing issue with more source-assurance claims being made by private marketers. Media indices may be useful in examining the lost flow of demand for these goods and may also be particularly useful in describing the erosion of brand equity (a stock effect).

A limitation of our study is the use of a monthly data series to capture the impact of a food-safety

Table 7. System Parameter Estimates of U.S. BSE Event-Extended Dummy.

Share equation	constant	Ribeye FWAP[a]	Chuck FWAP	Ground FWAP	Pork FWAP	Chicken FWAP	Loin FWAP	Meat expend.	BBQ	BSE	adj. R^2	DW
Ribeye share	0.0490	0.0093*	-0.0003	-0.0013	-0.0080*	-0.0051*	-0.0057*	0.0093	0.0028*	0.0004	0.7670	1.8665
(t-stat)	(0.3857)	(13.9383)	(-0.7084)	(-1.3650)	(-5.5542)	(-4.7162)	(-4.4025)	(0.5164)	(3.6136)	(0.2644)		
Chuck share	0.0372	-0.0003	0.0185*	-0.0043*	-0.0054*	-0.0046*	-0.0034*	0.0068	0.0020*	0.0001	0.6545	1.7639
(t-stat)	(0.4476)	(-0.7084)	(24.0027)	(-4.5601)	(-5.5639)	(-6.0932)	(-4.0379)	(0.5753)	(3.7771)	(0.1402)		
Ground share	0.1258	-0.0013	-0.0043*	0.0626*	-0.0160*	-0.0133*	-0.0103*	0.0174	0.0057*	0.0002	0.6307	1.8578
(t-stat)	(0.5198)	(-1.3650)	(-4.5601)	(27.7788)	(-5.6963)	(-7.4798)	(-4.2774)	(0.5064)	(3.8230)	(0.0813)		
Pork share	0.8504	-0.0080*	-0.0054*	-0.0160*	0.0544*	-0.0177*	0.0113*	-0.0967	-0.0178*	-0.0033	0.5842	2.1024
(t-stat)	(1.2464)	(-5.5542)	(-5.5639)	(-5.6963)	(6.7591)	(-6.4935)	(1.6964)	(-1.0002)	(-4.2120)	(-0.4112)		
Chicken share	-0.0931	-0.0051*	-0.0046*	-0.0133*	-0.0177*	0.0528*	0.0008	0.0485	0.0046*	0.0029	0.8308	2.2460
(t-stat)	(-0.3667)	(-4.7162)	(-6.0932)	(-7.4798)	(-6.4935)	(14.9365)	(0.3230)	(1.3519)	(3.2574)	(0.8635)		

[a]FWAP is the Feature Weighted Average Price.
*Statistically significant at the 10% level.

Table 8. Marshallian Price Elasticities, U.S. Extended-Dummy Impact.

	Ribeye	*Chuck*	*Ground*	*Pork*	*Chicken*	*Loin*
Ribeye	-0.9033	-0.0096	-0.0337	-0.1255	-0.0859	-0.0750
Chuck	-0.0140	-0.7053	-0.0898	-0.1235	-0.1038	-0.0657
Ground	-0.0154	-0.0295	-0.6714	-0.1190	-0.0987	-0.0656
Pork	0.0014	0.0016	0.0047	-0.7318	0.0249	0.0624
Chicken	-0.0352	-0.0285	-0.0834	-0.1251	-0.8487	-0.0130
Loin	-0.0797	-0.0491	-0.1471	0.0746	-0.0346	-0.9310
Mean share	0.0876	0.0613	0.1809	0.3175	0.2644	0.0883

scare that may be but a week or days in duration. In this case, the demand shock may be muted, as consumption patterns return to normal.

If the USDA - ERS data were available in a weekly time series, we might better be able to match the media exposure of the BSE event to the cycle of consumer purchases. Repeating the analysis with closer attention to these dynamics may provide more statistically significant results vis a vis simple dummy variables. Such is the experience of Kalaitzandonakes, Marks, and Vickner (2004), who first created a daily media-coverage series based on print media, radio transcripts, and television transcripts; counted the number of times that "Starlink" or similar phrases appeared in the coverage; and then summed the daily series to exactly match purchase data in a weekly scanner-data series.

With respect to the general performance of the demand system, all parameter estimates and calculated elasticities are consistent with economic theory. Own-price elasticities are within an expected range, and seasonal variables (i.e. barbecue season) have a statistically significant impact on meat expenditures. These results are consistent regardless of the media-index specification, further reinforcing our confidence in the robustness of the results.

The inclusion of a relatively small set of meat products in the analysis indirectly assumes a degree of separability; however, this assumption has not been statistically tested. The demand model does not take into account a full set of informational shifts due to BSE, such as television reports of the BSE event. Likewise, non-BSE informational shifters, such as beef advertising and recent fad diets like South Beach Diet or Atkins, may have been influencing the underlying demand without being specified in the model. These diets are typically high-protein, low- or no-carbohydrate diets, which have been suspected of increasing the demand for meat products, and there is some evidence that the post–December 2003 period was a high point in the popularity of that diet.

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