Context-Dependent BSE Impacts on Canadian Food-at-Home Beef Purchases

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Abstract

Household-level Canadian scanner data from 2002 – 2005 were used to identify consumer reactions to the early BSE discoveries that severely impacted Canada's beef industry. In all provinces, consumers reacted to the initial BSE event by purchasing more beef, apparently to support struggling ranchers. Subsequent BSE events, however, met with reduced beef purchases. The results were consistent across three measures of monthly beef purchases: participation, units purchased, and beef expenditure share. Failing to account for the context of individual BSE events would have produced little evidence of consumer reaction, a common finding among prior North American BSE studies.

Keywords

BSE, mad cow disease, food safety, consumer behavior, Canada

Introduction

Bovine spongiform encephalopathy (BSE) was first identified in a Canadian-born cow on May 20, 2003, triggering export restrictions that ultimately cost producers billions of dollars (Statistics Canada, 2006a). On December 23, 2003, United States authorities discovered BSE in a Canadian-born cow in Washington state. A third BSE event occurred when two Canadian animals were diagnosed with BSE within two weeks,

on December 30, 2004 and January 11, 2005. This study evaluates the impact of these three BSE events on Canadian retail beef purchases, using ACNielsen Homescan data.

Unlike farm-level impacts, less consensus exists on the severity of BSE-induced consumer demand impacts, but concern remains high among industry members and government agencies. BSE in beef products is linked to variant Creutzfeldt-Jakob Disease (vCJD) in humans, a debilitating and fatal disease receiving broad media coverage. Unlike the European experience, where 164 vCJD deaths occurred in the United Kingdom alone (NCJDSU, 2008), no deaths have been linked to the Canadian-born BSE events.

Maynard, Goddard, and Conley (2008) recently found little evidence that BSE media coverage impacted purchases of beef entrees at Canadian fast food restaurants. The present analysis tests the hypothesis that consumer reaction to BSE evolved as diagnoses mounted. If so, the reaction to each event should be measured separately, allowing for differences in context. Our use of Canadian household-level grocery purchase data for at-home consumption also contributes to the BSE literature with its exceptional sample size, nationwide coverage, and purchase-specific detail.

Background

Based on events in Europe, many observers expected that North American beef consumption would decline abruptly as a result of BSE (Jin, Skripnitchenko, and Koo, 2004). The evidence is mixed. Much of the literature on BSE-related impacts is based on meat demand systems. Burton and Young (1996) used a dynamic Almost Ideal Demand System (AIDS) and BSE media indices, finding economically significant BSE impacts on British beef demand. Mangen and Burrell (2001) and Peterson and Chen

(2005) used switching regressions within AIDS and Rotterdam frameworks, respectively, finding signficant beef demand reductions in both the Netherlands and Japan. Jin and Koo (2003) obtained supporting evidence of Japanese meat demand disruption using nonparametric methods.

Pritchett et al. (2007) used monthly U.S. scanner data and a linearized AIDS model to explore the role of BSE media coverage on retail meat purchases. Event dummy variables produced stronger evidence of BSE impacts than media indices. The authors speculated that variation in media indices was poorly aligned with that of prolonged consumer responses, and that print media indices may be an inadequate measure of total media exposure. Evidence of demand shifts from beef to pork resembled the Canadian results obtained by Peng, McCann-Hiltz, and Goddard (2005), who used similar methods.

Other studies found little evidence of BSE impacts at the consumer level. Piggott and Marsh (2004) found only transitory impacts of BSE media coverage in a Generalized AIDS model of U.S. meat demand, and Vickner, Bailey, and Dustin (2006) found no significant BSE impacts in Utah data using a nested PIGLOG demand system. Maynard, Goddard, and Conley (2008) found little change in the likelihood or quantity of fast food beef entrée purchases following BSE media coverage in the Canadian provinces of Alberta and Ontario.

In addition to the limited human health impact to date, the Canadian government's response was viewed by many as proactive and transparent, and much media coverage after the May, 2003 BSE discovery focused on the ranchers' plight (Boyd and Jardine, 2007). Concurrently, however, Canadian consumers expressed serious

concern about meat safety, with BSE leading the list of meat-related threats (de Jonge et al., 2006).

Empirical Methods

Regression models were developed to test whether consumers at the national level reacted to BSE either by boycotting or reducing beef purchases. The data used in the food-at-home analysis were AC Nielsen Homescan data, purchased by the Consumer and Market Demand Agricultural Policy Research Network, hosted at the University of Alberta's Department of Rural Economy. The data represented household-level meat purchases during calendar years 2002 – 2005. In each year, 9,000 – 10,000 households participated in the panel, often for multiple years.

Each observation provided data on a household's individual meat purchase, including a household ID number, province, primary language, household size, age and presence of children, age of the household head, income, household head education level, purchase date, which of 45 meat types was purchased, quantity purchased, price paid, and codes allowing distinctions among supermarkets, mass merchandise stores, warehouse stores, and other store types.

Selected variable means appear in Table 1, illustrating considerable similarity among study areas. Unit purchases of meat are highest in Alberta and Ontario, and lowest in the prairie provinces of Manitoba and Saskatchewan (abbreviated in tables and figures as Man/Sask). Quebec leads in beef expenditures as a percentage of total meat expenditures. The Maritime provinces feature noticeably lower shares of consumers in the two youngest age groups, which would be consistent with emigration to areas with

strong employment opportunities, such as the oil sands of northern Alberta. Consumers in Ontario and Alberta tend to have higher levels of education, consistent with their relatively younger populations.

The 45 meat type codes were first aggregated into the broader categories of beef, pork, poultry, frozen poultry products, and frozen seafood products. The few remaining meats were game products with exceedingly low purchase frequencies. To provide a temporal basis for comparison across households, purchases were aggregated by household ID and by month, producing over 32,000 observations in Manitoba and Saskatchewan, over 40,000 observations in British Columbia (abbreviated as BC in tables and figures), over 45,000 observations each in Alberta and the Maritimes, over 91,000 Quebec observations and almost 96,000 Ontario observations.

While the data were rich in number of observations, shortcomings include general product designations that prevented distinctions among beef cuts, and a lack of weight data allowing standardization of quantity units, which in turn prevented calculation of meaningful unit prices. To compensate for this ambiguity, the analysis was performed on multiple monthly measures of beef purchases: participation (i.e., positive beef purchases) vs. nonparticipation, number of units purchased, and expenditure share. Thus, a total of 18 regressions were estimated (three regressions for each of 6 provincial areas).

The choice of beef purchase measures also has a statistical rationale. Households may have reacted to BSE discoveries either by ceasing beef purchases entirely, or by altering their level of beef consumption. In many applications, the data generating process for zero observations differs from that of positive observations, typified by distributions with relatively greater probability mass at zero. For example, consumers

who never buy beef would produce zero observations, but so might beef consumers who happened to choose a zero quantity during a given period (Burton, Dorsett, and Young, 1996). Double-hurdle models are often used to test for systematic differences between determinants of "participation" (whether or not to buy beef) and "consumption" (how much beef to buy).

The number of beef units purchased each month is count data left censored at zero, while beef expenditure share is a continuous variable bounded by the unit interval. Cragg (1971) proposed modeling the participation decision as a binary choice model, and the consumption decision as a truncated tobit model. For the current application, a logit model was used to describe the participation decision, a truncated Poisson model was used for quantity (count data) consumption decisions, and a truncated tobit specification was used for expenditure share (continuous data) consumption decisions. Mullahy (1986), Yen (1999), and Maynard et al. (2004) provide examples of count data double-hurdle models.

The general likelihood function for the double-hurdle model is:

$$L = \prod_{q_i=0} \Pr(q_i = 0) \prod_{q_i>0} \left[\Pr(q_i > 0)\, \Pr(q_i \mid q_i > 0)\right] ,$$

where q_i denotes quantity of beef entrees purchased by the i^{th} household.

The specific likelihood function for the count data double-hurdle model is:

$$L = \prod_{q_i=0} \left(\frac{1}{1+\exp(x_i\alpha)} \right) \prod_{q_i>0} \left(\frac{\exp(x_i\alpha)}{1+\exp(x_i\alpha)} \right) \exp\left[1-\exp(x_i\beta)\right] \left(\frac{\exp(q_i x_i \beta)}{q_i!} \right),$$

where α and β are conformable parameter vectors describing participation and consumption behavior, respectively. In the case of the continuous double-hurdle model used to explain expenditure share w_i, the likelihood function is:

$$L = \prod_{q_i=0}\left(\frac{1}{1+\exp(x_i\alpha)}\right)\prod_{q_i>0}\left(\frac{\exp(x_i\alpha)}{1+\exp(x_i\alpha)}\right)\left(\frac{f_i\left(w_i - x_i\beta, \sigma^2\right)}{F_i}\right),$$

where f_i and F_i are respectively the pdf and cdf of the standard normal distribution evaluated at $x_i\beta / \sigma^2$ (Maddala, 1983, p. 152).

While the lack of unit weight data precludes calculation of standardized unit prices, it is possible to measure expenditure per unstandardized unit for each meat category and each month. If one accepts the assumption that average weight per unit within broad meat categories was likely to be stable across time, variation in average per-unit expenditures should correlate highly with average price per kilogram. We used average expenditures per unit, shown in Figure 1, to test anecdotal reports of deep discounting of retail beef products following the first BSE event in May, 2003. Specifically, we regressed monthly national quantity-weighted average beef expenditures on linear and quadratic time trends, monthly dummy variables, and a BSE dummy variable representing various durations beginning with the week of May 23, 2003. The results showed that retail beef prices were not systematically discounted after the first BSE event. Anecdotally, observers have suggested that retail meat managers were reluctant to distort relative meat prices. Therefore, it seems unlikely that consumer response to BSE was confounded by simultaneously and systematically low beef prices.

Three regressions were estimated on beef purchased for at-home consumption, the dependent variables being beef participation (logit model), beef unit quantity consumption (truncated Poisson model), and beef expenditure share (truncated tobit model). In each regression, the independent variables consisted of lagged total meat quantity to control for unobserved household heterogeneity, lagged expenditure shares of the five meat categories (beef, pork, poultry, frozen poultry, and frozen seafood),

household size, dummy variables indicating the presence of children in three age groups (under 6, 6-12, 13-17), four age group dummy variables with the under-35 age group excluded as the base, five income categories with the $70,000+ category excluded as the base, five education categories with university graduates excluded as the base, dummy variables for purchases at mass merchandise stores and warehouse stores, monthly dummy variables excluding August as the base, and 15 BSE event dummy variables.

The BSE discoveries occurring during the study period were treated as three distinct events: one in late May 2003, one in late December 2003, and a pair of BSE diagnoses for which monthly impacts could first be observed in January 2005. For each event, dummy variables were created that separately designated the month of occurrence and four subsequent months.

Results

We obtained qualitatively similar results from all three purchase measures, and to avoid overwhelming readers with tables, Table 2 reports detailed regression results for just one representative measure: number of units purchased. Of course, detailed results for all regressions are available from the authors upon request. For clarity of interpretation, the parameter values from the truncated Poisson model of beef unit purchases are expressed as marginal effects. Many parameter estimates are statistically significant at the .05 or .01 levels, which is not surprising given the large number of observations. Explanatory power in the consumption models was evaluated by the R^2_p statistic for the truncated Poisson model (Greene, 2000, p. 882), and ranged from 0.21 in Alberta to 0.32 in Quebec.

In all provinces, lagged total meat quantity and lagged beef and pork expenditure shares are economically and statistically significant, illustrating the importance of household heterogeneity not explained by the standard demographic variables appearing elsewhere in the regressions. If the lagged beef share rose by one unit (i.e., 100%), it would imply a doubling of lagged beef purchases, and indeed we observe marginal impacts in the following period roughly similar to the mean number of monthly beef purchases in each province. The parameter estimates on lagged total meat quantity and lagged beef share are positive, implying that we are mainly controlling for unobserved heterogeneity (or perhaps habit persistence), as opposed to stockpiling or variety-seeking effects that would produce negative parameters. In the case of beef substitutes, we observe positive coefficients on fresh pork share and fresh poultry share, but negative coefficients on frozen poultry share and frozen seafood share, suggesting that consumer meat preferences are strongly delineated by product form, perhaps more than by product type.

Regarding demographic regressors, household size is predictably positively associated with the number of beef units purchased. The marginal effects are proportionally smaller than implied by mean household size and mean unit purchases, consistent with the interpretation that additional household members are likely to be children who eat smaller quantities. The negative coefficients on dummy variables for children of various ages may at first seem perverse, but note that the model already controls for household size, so the negative child coefficients imply that the presence of children induces fewer beef purchases than the presence of adult household members. In

most provinces, the effect understandably becomes insignificant once children reach the teen years.

Parameters on dummy variables for age of the household head are often statistically significant, but modest in magnitude. The exception is for the two oldest age groups in Quebec, where older consumers purchase considerably more units of beef than consumers in the under-35 age group. Households in the lower income brackets purchased significantly less beef than those earning over $70,000 per year. In most cases, the parameter magnitudes imply that low-income households purchase approximately 10 - 25% fewer units of beef than high-income households. However, higher education levels induce consumers to purchase less beef, presumably due to health concerns. Given the role of education in producing higher incomes, it appears that the competing effects of income and education roughly cancel out.

Households that previously shopped in mass merchandise stores (e.g., Wal-Mart Supercenters) did not purchase significantly different quantities of beef in the current month, but residents of most provinces who previously shopped at warehouse stores (e.g., Costco) purchased significantly fewer beef units in the current month. Consumers can save substantial amounts by purchasing bulk meat products at warehouse stores, and the economically significant parameter magnitudes are consistent with expectations. Regarding seasonality relative to August (late in the grilling season), significantly fewer purchases occurred in December, and consumers tended to purchase more beef in January and May (in which Victoria Day marks the beginning of grilling season).

We now turn to the primary results of the analysis, the BSE-related parameters. Before discussing the dominant pattern of impacts, three items are worth noting. First,

BSE dummy variables are statistically significant in every province, and for each of the three BSE events. Second, the parameter magnitudes often appear to be economically significant. Third, the strongest impacts were often observed one or more months after a given BSE event occurred, and the statistically signficant impacts were almost always distributed across multiple months.

Regardless of which purchase measure was evaluated, the dominant pattern was one of positive impacts after the first BSE event in May 2003, and increasingly negative impacts following the second and third BSE events. While the positive response to the first BSE event may seem surprising, it was accompanied by much media coverage focusing on the closure of borders (especially the U.S. border) to Canadian exports, economic upheaval among ranching communities, and government assurances that beef was safe to eat (Boyd and Jardine, 2007).

Given that Alberta is Canada's dominant producer of beef cattle, one might expect the strongest positive impacts in that province, and in fact, both the strongest short-run and five-month responses occurred in Alberta. After controlling for all other regressors, the first BSE event was associated with a 0.7 unit increase in beef unit purchases in July, 2003 alone, and was associated with a 1.6 unit increase over the span of four months from May – August, 2003. The neighboring provinces of British Columbia, Saskatchewan, and Manitoba also displayed strong positive responses. With each eastward shift, however, the responses grew weaker, with the smallest positive impact occurring in the Maritime provinces.

When the second BSE event occurred in December, 2003, involving an Alberta-born animal diagnosed in Washington State, the initial response in most provinces was

positive, but soon turned negative, producing a net negative response in Alberta and the other prairie provinces. The trend deepened when the third BSE event occurred in January, 2005, with a decidedly negative overall response in all provinces. Interestingly, the strongest negative response was observed in Alberta, with an average five-month impact of 1.2 fewer beef unit purchases per household, holding all else constant. As with the first event, the Maritime provinces in the far-eastern part of the country displayed the weakest response, which was negligible for the second and third events.

The same pattern of initially positive responses followed by increasingly negative impacts was observed in the logit regressions on beef purchase participation and in the truncated tobit regressions on beef expenditure share. Figure 2 illustrates the similarity of the key BSE-related findings across all three purchase measures. For the purpose of constructing Figure 2, a single five-month dummy variable for each event replaced the month-specific dummy variables indicated in Table 2. The uniformly positive response to the first event constrasts sharply with the uniformly negative response to the third event. The magnitude of the impacts is arguably modest on an individual household level, but when aggregated across millions of households implies substantial industry-wide retail-level impacts. For example, the logit regressions suggest that the odds of purchasing any beef were increased by about 15% by the first BSE event, and decreased by about 10% by the third event. Similarly, beef expenditure shares increased about 2 - 4% after the first event, while the third BSE event reduced beef expenditure shares by a similar amount.

Conclusions

The results demonstrate a need to evaluate BSE events individually, rather than measuring an average or net consumer response to BSE. Prior studies that did not distinguish among the context of BSE events in North America (e.g., Maynard, Goddard, and Conley, 2008; Piggott and Marsh, 2004; Vickner, Bailey, and Dustin, 2006) failed to find strong evidence of consumer reactions. Prior findings of negligible net impacts at the retail level were not inconsistent with the present analysis, but they might be a poor basis for policy or management decisions, because the set of contexts that led to offsetting impacts might not be repeated in the future.

Had it not been for the apparently sympathetic and patriotic response of consumers to the first BSE event, consumer reaction to BSE in Canada would likely have appeared much more negative. The response to the second and third BSE events bears some resemblance to the negative consumer reaction in Japan (Peterson and Chen, 2005), where there have also been few explicit human health impacts of BSE. Canadian consumers' unusual positive reaction to the first event was likely a direct consequence of the united government and industry campaign to assuage consumer fears, combined with transparent responses by regulatory agencies that appeared to induce consumer confidence.

Boyd and Jardine (2007) confirmed through an exhaustive media content analysis that the first BSE event was heavily publicized as a trade issue more than a food safety issue. A similar analysis has not yet been completed for subsequent events, but it is possible that the same level of media intensity was difficult to maintain after the initial event. Alternatively, consumers might not respond as fervently to repeated appeals to aid

a struggling industry, or might begin to fear health consequences when BSE discoveries appear to become a pattern rather than an isolated instance.

The primary finding from the present analysis may extend to other food safety and animal health crises, especially those with ambiguous human health impacts. A distinction might be drawn between food safety issues where consumer reaction hinges on the perceived trustworthiness of government and industry decision makers (e.g., salmonella identification in produce), and food safety issues that feature conflicting or confusing scientific knowledge (e.g., mercury levels in certain fish species). In the first case, transparency and principal-agent considerations are paramount, while in the second case, clarity of consumer education is the dominant concern. The sensitivity of consumers to context in surveys and experiments is well-known, thus it is not surprising to find evidence of context-dependence in secondary retail data. Identifying a generalized framework of informational context is a logical next step in future food safety research.

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Table 1. Selected Variable Means from Food-at-Home Scanner Data, 2002-2005

	Alberta	Ontario	Maritimes	Quebec	Man / Sask	BC
# beef purchases / month	2.1	2.1	2.5	3.1	2.4	1.9
# pork purchases / month	1.2	1.3	1.4	1.4	1.3	1.0
# poultry purchases / month	1.1	1.6	1.5	1.4	1.4	1.1
Beef expenditure share	36%	31%	37%	42%	36%	34%
Pork expenditure share	21%	19%	21%	18%	19%	19%
Poultry expenditure share	22%	26%	25%	21%	23%	24%
Frz. poultry expenditure share	8%	9%	7%	9%	9%	9%
Frz. seafood expenditure share	8%	8%	5%	5%	7%	9%
Beef expenditure / month	$39.95	$30.27	$32. 09	$35.40	$26.87	$31.08
Household size	2.6	2.6	2.5	2.5	2.6	2.5
Child under 6	9%	9%	7%	7%	8%	7%
Child age 6-12	14%	13%	11%	11%	14%	11%
Child age13-17	9%	9%	9%	8%	9%	8%
Age: 18-34	9%	7%	4%	7%	6%	4%
Age: 35-44	25%	25%	19%	23%	25%	20%
Age: 45-54	28%	25%	27%	25%	22%	27%
Age: 55-64	20%	21%	25%	22%	21%	21%
Age: 65+	18%	23%	22%	20%	24%	26%
Income < $20K	7%	9%	12%	11%	10%	9%
Income $20-$30K	11%	11%	17%	13%	15%	12%
Income $30-$40K	12%	11%	17%	16%	15%	13%
Income $40-$50K	11%	10%	14%	13%	12%	13%
Income $50-$70K	22%	21%	20%	22%	20%	21%
Income > $70K	37%	38%	20%	24%	27%	33%
Education: < High school	12%	13%	18%	17%	19%	11%
Education: High school	17%	16%	19%	20%	20%	20%
Education: Some college	15%	15%	11%	12%	12%	17%
Education: College	27%	23%	22%	18%	18%	22%
Education: Some university	8%	8%	10%	10%	12%	9%
Education: University	22%	24%	17%	20%	18%	18%

Table 2. Determinants of monthly household beef quantity purchases for at-home consumption [a,b]

Regressor	Alberta	Ontario	Maritimes	Quebec	Man/Sask	BC	RegressorCont)	Alberta	Ontario	Maritimes	Quebec	Man/Sask	BC
Intercept	-0.4319**	-0.7495**	-0.5937**	-0.4863**	-0.9212**	-0.5720**							
Total meat quantity (t-1)	0.1576**	0.1361**	0.1686**	0.2184**	0.1289**	0.1531**	January	0.2696**	0.3896**	0.0951	0.2342**	0.3193**	0.4086**
Beef share (t-1)	1.479**	1.7739**	1.8309**	2.6508**	1.3856**	1.1760**	February	0.0676	0.2268**	0.0765	-0.2109**	0.0477	0.1660**
Pork share (t-1)	0.3603**	0.6899**	0.8966**	0.9553**	0.5578**	0.3200**	March	0.0990*	0.1949**	-0.1117*	-0.1193**	0.0958*	0.0855*
Poultry share (t-1)	0.1399*	0.2181**	0.6101**	0.7679**	0.2780**	0.0031	April	0.0058	0.0689*	-0.0958*	-0.0378	-0.1885**	-0.0990*
Frz. poultry share (t-1)	-0.3449**	-0.6075**	-0.0235	-0.3404**	-0.2332**	-0.3216**	May	0.0855*	0.3469**	0.2012**	0.3193**	0.0818	0.2016**
Frz. seafood share (t-1)	-0.4275**	-0.7673**	-0.4484**	-0.4429**	-0.1050	-0.6053**	June	-0.0194	0.1205**	0.0745	-0.3330**	0.0395	0.0949*
Household size	0.2189**	0.1957**	0.2833**	0.3039**	0.1724**	0.1737**	July	-0.0009	0.0207	0.0157	-0.0765*	-0.0659	0.1616**
Child under 6	-0.3247**	-0.2602**	-0.3185**	-0.3451**	-0.2600**	-0.2949**	September	-0.2498**	0.3171**	-0.1487**	0.0022	-0.1459**	-0.0439
Child age 6-12	-0.0531	-0.2773**	-0.3663**	-0.2816**	-0.1476**	-0.3377**	October	-0.0211**	0.0353	0.1914**	-0.1589**	-0.1371**	-0.0042
Child age 13-17	-0.0397	-0.0213	-0.0681*	-0.1666**	-0.0509	-0.1846**	November	-0.6500	0.2632**	-0.2154**	-0.2611**	-0.0156	0.0883*
Age 35-44	-0.1207**	-0.0526*	-0.1659**	0.0366	-0.0470	-0.0462	December	-0.6500**	-0.3050**	-0.4972**	-0.5021**	-0.4522**	-0.3449**
Age 45-54	0.0237	0.0036	0.0480	0.0976**	-0.0904*	-0.0231	BSE event 1, t+0	0.1542**	0.1243**	-0.0341	0.3122**	0.1664**	0.1453**
Age 55-64	0.1037**	0.0875**	0.0738	0.1775**	0.0760*	0.0486	BSE event 1, t+1	0.2698**	0.0573	-0.0289	0.1769**	0.1620**	0.1917**
Age 65+	0.0968**	-0.1226**	0.1326**	0.4336**	-0.0208	0.0292	BSE event 1, t+2	0.6984**	0.3927**	0.6376**	0.1375**	0.4530**	0.2171**
Income < $20K	-0.1141**	-0.2315**	-0.2766**	-0.4944**	-0.1197**	-0.2280**	BSE event 1, t+3	0.4976**	0.3849**	0.2965**	0.0437	0.5263**	0.6208**
Income $20-$30K	0.0113	-0.1488**	-0.2480**	-0.2682**	-0.1285**	-0.3493**	BSE event 1, t+4	0.0316	-0.0178	-0.2698**	0.4405**	0.0205	0.1398**
Income $30-$40K	-0.0331	-0.1084**	-0.1402**	-0.2051**	-0.1173**	-0.1185**	BSE event 2, t+0	0.2046**	-0.0213	-0.0877	0.1372**	0.1078	0.1915**
Income $40-$50K	-0.2157**	-0.0165	-0.0135	-0.0316	-0.1358**	-0.1071**	BSE event 2, t+1	-0.0235	0.2042**	0.5129**	-0.0177	-0.0604	-0.1518*
Income $50-$70K	-0.0422*	-0.0281*	-0.0113	-0.0195	0.0153	-0.0602**	BSE event 2, t+2	-0.3609**	-0.3634**	-0.7018**	-0.2088**	-0.2434**	-0.1425*
< High school	0.0638*	0.3291**	0.1409**	0.4262**	0.2146**	0.1913**	BSE event 2, t+3	-0.0284	0.3120**	0.4528**	0.5764**	0.0327	0.1097*
High school	0.1335**	0.2167**	0.1563**	0.4343**	0.1798**	0.2452**	BSE event 2, t+4	-0.3381**	0.1792**	-0.1617	-0.2843**	-0.1121	0.0655
Some college	0.2500**	0.1769**	0.107**	0.3983**	0.1880**	0.1723**	BSE event 3, t+0	-0.4887**	-0.0249	0.0076	-0.3674**	-0.4924**	-0.2378**
College	0.0548**	0.0763**	0.0534*	0.2289**	0.0926**	0.1148**	BSE event 3, t+1	-0.1261*	-0.2101**	-0.2806**	0.0908	-0.0126	-0.0622
Some university	0.0638*	0.1082**	0.1955**	0.1800**	0.1052**	0.1148**	BSE event 3, t+2	-0.3439**	-0.1194**	0.2367**	0.0297	-0.2840**	-0.2214**
Mass merchandise store(t-1)	-0.1574	0.1152*	0.1522	-0.0951	-0.1118	0.1557	BSE event 3, t+3	0.1992**	0.3997**	0.2580**	0.2289**	0.4518**	0.2583**
Warehouse store (t-1)	0.0736	0.2196**	-0.3573*	-0.6406**	-0.4301**	-0.6350**	BSE event 3, t+4	-0.4614**	-0.2080**	-0.2448**	-0.4436**	-0.2223**	-0.2308**

[a] values represent Poisson marginal effects, N = 45,146 (Alberta), 95,906 (Ontario), 49,749 (Maritimes), 91,098 (Quebec), 32,906 (Manitoba/Saskatchewan), 40,660(BC)
[b] Poisson R^2 values: 0.21 (Alberta), 0.26 (Ontario), 0.22 (Maritimes), 0.32 (Quebec), 0.27 (Manitoba/Saskatchewan), 0.25 (BC)
* and ** denote statistical significance of the underlying parameter at the .05 and .01 levels, respectively

Figure 1. Retail food-at-home per-unit beef expenditures did not fall dramatically after BSE discoveries in May 2003, December 2003, and January 2005

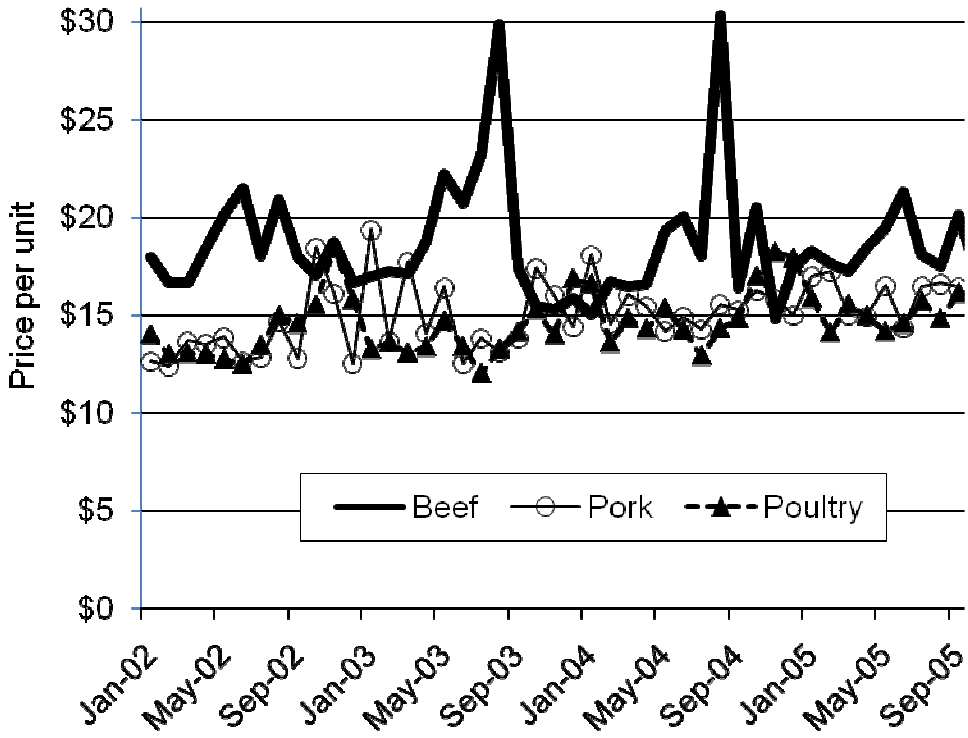

Figure 2. BSE impacts varied across province and BSE occurrence