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Did BSE Announcements Reduce Beef Purchases?

Fred Kuchler and Abebayehu Tegene

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Fred Kuchler and Abebayehu Tegene

Abstract

This study examines consumers' retail purchases of beef and beef products for evidence of a response to the 2003 U.S. government announcements of finding cows infected with Bovine Spongiform Encephalopathy (BSE). We constructed weekly estimates of quantities of beef products consumers purchased from 1998 through 2004 using ACNielsen Homescan data. While the variance in purchases was large, most could be explained by trend and seasonality. Deviations from established purchase patterns following the BSE announcements varied across beef products, but were limited to no more than 2 weeks in all cases.

Keywords: food safety, Bovine Spongiform Encephalopathy, BSE, retail beef purchases, Government announcements, retrospective analysis

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Summary

In May 2003, several U.S. Government agencies announced that Bovine Spongiform Encephalopathy (BSE—also known as Mad Cow disease) had been found in a cow in Alberta, Canada. The following December, agencies reported that BSE had been found in a cow in Washington State. Both of these sets of announcements had the potential to influence consumers' food choices and retail food markets in the United States.

What Is the Issue?

Knowing how consumers responded to these announcements and, more generally, to news about the safety of the food supply, is important for the design of food policy. Public information programs that effectively communicate risk information could prevent consumers from responding out of proportion to the risks they face. Consumers and food suppliers might both gain if consumers do not avoid foods that are safe. When consumers make informed risk decisions, they create incentives for food suppliers to take cost-effective safety precautions. Also, accurate assessments of consumer responses to food safety risk information will help the public sector gauge the need for industry relief.

Currently, most of the quantitative information about consumers' responses to the BSE announcements has come from consumer opinion surveys. Such surveys allow researchers to quickly gauge consumers' response to announcements. However, survey responses may differ from actual market behavior where consumers have to pay for each of their choices.

The proof of how consumers interpret news about food safety is in the market. Our goal is to see if market data reveal impacts of the BSE announcements, and if so, the magnitude and duration of those impacts.

What Did the Study Find?

Among the three markets examined—fresh beef, frozen beef, and frankfurters—fresh beef provided the strongest case for an impact of the BSE announcements. There is no evidence that the Canadian announcement altered purchase patterns of fresh beef, but purchases during the first 2 weeks after the Washington State announcement were unusually low. Frozen beef purchases fell only for the first week after the Washington State announcement. Frankfurter purchases dropped in the second week following each announcement, but purchases of no-beef frankfurters also fell, suggesting that unrelated events were more likely responsible for the decline.

The magnitude of responses in the market was difficult to estimate precisely, but the duration was clear: within 2 weeks, consumers were behaving exactly as they had before the announcements.

For each of the three commodities, the variation in weekly purchases is large, with seasonal purchasing peaks 2-10 times higher than seasonal troughs. However, about three-quarters of this variation can be explained by trend and seasonality, and, to a lesser extent, retail prices. Having explained

most of the variation in weekly purchases with these factors, large and persistent market impacts related to BSE announcements could be easily detected. In fact, such effects were not detected.

Other food safety announcements could meet with different responses. But, similar responses could reasonably be anticipated in situations where consumers' prior awareness of food safety risks is comparable and where risks have similar characteristics.

How Was the Study Conducted?

The study used purchase records from the ACNielsen Homescan panel (1998-2004) to create nationally representative weekly estimates of U.S. retail purchases. The ACNielsen Homescan panel is a nationally representative panel of households that scan their grocery purchases at home, thereby providing information on each food item purchased. For each item purchased, the data set shows the date of purchase, expenditure, quantity, and attributes of each food (finely differentiating food products). Thus, the researchers were able to construct high-frequency purchase data that were suitable for testing for the presence of even short-lived impacts.

Did BSE Announcements Reduce Beef Purchases?

Fred Kuchler and Abebayehu Tegene

Introduction

In May 2003, several U.S. Government agencies announced that Bovine Spongiform Encephalopathy (BSE—also known as Mad Cow disease) had been found in a cow in Alberta, Canada. The following December, agencies reported that BSE had been found in a cow in Washington State. Both of these sets of announcements and the accompanying media coverage had the potential to influence consumers' food choices and retail food markets in the United States.

Knowing how consumers responded to these announcements and, more generally, to news about the safety of the food supply, is important for the design of food policy. Public information programs that effectively communicate risk information could prevent consumers from responding out of proportion to the risks they face. Consumers and food suppliers might both gain if consumers do not avoid foods that are safe. When consumers make informed risk decisions, they create incentives for food suppliers to take cost-effective safety precautions. Also, accurate assessments of consumer responses to food safety risk information will help the public sector gauge the need for industry relief.

Currently, most of the quantitative information about consumers' responses to the BSE announcements has come from consumer opinion surveys. Researchers at Kansas State University (Coffey et al., 2005) summarized results of five such surveys, each with more than 1,000 respondents, taken by different news media and research organizations. Across all five surveys, between 14 and 29 percent of respondents reported reducing their beef consumption. In three of the surveys, between 3.5 and 7 percent of respondents indicated they stopped eating beef. A survey conducted the following spring (Thilmany et al., 2004) showed similar results, with 13 percent of the surveyed population reporting they reduced their beef purchases. Such surveys allow researchers to quickly gauge consumers' response to announcements. However, survey responses may systematically differ from actual market behavior, where consumers have to pay for each of their choices.

Economists have also used market data to estimate impacts of food safety information on food demand.[1] These studies answer some questions about the likely impacts of BSE announcements, and many proffer smaller impacts than the opinion surveys suggest. Dahlgran and Fairchild (2002) showed that demand for chicken fell in response to news coverage of bacterial contamination, but impacts were small and transitory. Piggott and Marsh (2004) estimated demands for beef, pork, and poultry as functions of prices and publicized food safety information—an index of newspaper articles on food safety concerning meats. They found that the "direct economic effects of the food safety variables were noticeably small in comparison to price and expenditure effects" (p. 169).

[1]Piggott and Marsh (2004) summarize the results of many market-data based studies investigating the impact of food safety information reported in the media and product recall information.

International experience suggests that beef demand can fall significantly with news about BSE. McCluskey et al. (2005) described how BSE changed the retail beef market in Japan in 2001. Japanese beef consumption had been rising rapidly for three decades. After three BSE cases were detected, sales of domestic and imported beef fell by 70 percent. Pennings et al. (2002) reported that German beef consumption traditionally reaches a seasonal peak in November and December each year. When the first case of BSE was detected in Germany on November 26, 2000, purchases declined dramatically; the traditional peak did not occur.

Prior to the U.S. announcements, there was no way to be sure what signal U.S. consumers would receive from government announcements or how consumers' food choices might change. The proof of how consumers interpret such messages is in the market. Our goal is to see if market data reveal impacts, and if so, the magnitude and duration of those impacts.

Here, we retrospectively examine markets that are good candidates for announcement impacts: retail purchases of fresh beef from grocery store meat counters, frozen beef, and frankfurters. Frozen beef is generally more processed than fresh beef at the meat counter, and frankfurters even more so. Together, these three products show the extent of consumer adjustments to BSE announcements.

Retrospective market analysis is challenging. Market data—prices, quantities purchased, and expenditures—summarize what people choose. Market data reveal what did occur, but only rarely make obvious what would have occurred under alternate conditions. With markets, certainty about what might have been is rare. To establish impacts, we need both what we observe and what we would have seen under different conditions.

Our data on beef purchases display complex patterns: long-term trends, strong seasonality, and sensitivity to market prices of beef and other meats. These patterns imply that timing is a major determinant of the measurement of impacts. The patterns, however, are detectable and we can account for their impact, disentangling impacts of BSE announcements from preexisting purchase patterns.

Using ACNielsen Homescan Panel Data To Track Weekly Beef Purchases

This report uses data from the ACNielsen Homescan panel, a nationwide panel of households that use a scanning device to scan the universal product codes (UPCs) on purchased products. Participants scan their food purchases from all retail outlets at home after they finish shopping. The purchase data is uploaded to ACNielsen's computer. Data include detailed product characteristics, date purchased, quantity, and expenditures for each food item purchased by each household. Households scan both fixed-weight products (products with a UPC) and random-weight products (e.g., fresh meat and poultry, fresh fruit and vegetables). The problem associated with products without UPCs is solved by creating a codebook containing product descriptions and a unique code that is scanned.

Homescan Panel Data Is Rich and Detailed

The sample of households in the ACNielsen Homescan panel was selected so that calculations made from the dataset will closely track U.S. food markets. The dataset is a geographically stratified random sample of households. The sample was selected based on both demographic and geographic targets. ACNielsen constructed weights for each household so that the weighted sample would match the U.S. Census along seven variables: household size, income, race, ethnicity (Hispanic or not), female household head's age and education, male household head's education, and the household head's occupation type. That is, the weighted proportion of households in the sample matches the proportions of households in the Census. The weights that make the proportions from the sample equal to proportions from the Census were used in estimation and analysis. Each year, ACNielsen recalculates household weights and adjusts the sample to match annual updates to the Census.

Panel size has varied from 7,124 households in 1999 to a high of 8,833 households in 2003. All purchases in our dataset came from households that participated in the panel for at least 10 out of the 12 months in each year, 1998-2004. This collection procedure leads to millions of purchase records each year.

For our purposes, the data are rich and before-and-after patterns are relatively strong. We examine retail purchase data from the ACNielsen Homescan panel for evidence of changes attributable to the BSE announcements.[2] The dataset is unique because it comes from a nationally representative sample of households, finely differentiates food products and associated expenditures and quantities purchased, and includes exact days when each household purchase was made. Thus, we were able to construct high-frequency purchase data suitable for testing for the presence of even short-lived impacts.

We constructed weekly time series (1998-2004, 364 observations) of fresh beef purchases (i.e., purchases from grocery store meat counters), purchases of frozen beef products, and purchases of frankfurters. To construct each series, we summed the weighted quantities purchased each week. The dataset also includes expenditures for each purchase. To calculate a weekly

[2]The main limitation to using food purchase data to estimate impacts of BSE announcements is that nearly half of what typical consumers spend on food is spent at restaurants (U.S. Department of Agriculture, Economic Research Service). It is possible that consumers made different decisions about beef purchases for meal preparation at home and for restaurant meals.

price, we summed the weighted expenditures and divided the result by the weekly quantity purchased.

Each of the three products may satisfy a different demand. Including all three allows for the possibility that these varying demands might display different responses to the announcements. Our analysis decomposes each time series of purchases into the sum of trend, seasonality, price, and BSE announcement effects.

Income in the United States has been rising and food expenditures as a share of disposable personal income has been declining over many years (U.S. Department of Agriculture, Economic Research Service).[3] It is reasonable to expect that household expenditures for any specific food will be a small fraction of disposable income. When quantities demanded represent small expenditures, demands are likely to be relatively unresponsive to prices. Instead, habit[4] and tradition are likely to be major factors influencing food purchase patterns: for example, demand for some foods will increase before a particular holiday or season. Thus, when we examine purchases of particular foods, we expect to find regularity and patterns across time. Having accounted for observed regularity and patterns means that changes brought about by consumers becoming fearful at particular times should be obvious.

[3]Between 1929 and 2004, expenditures on food as a share of disposable personal income fell from 23.4 percent to 9.5 percent. The trend fell faster for food purchased for consumption at home. In 1929, these expenditures represented 20.3 percent of disposable personal income. By 2004, the share had fallen to 5.4 percent.

[4] Economists often use the term "habit" when describing situations in which consumers take time to fully adjust to changed conditions. Here, we use the term in a conventional way, assuming that consumers adjust quickly, but have preferences that vary over time.

Why Construct Weekly Purchase Data?

We used the purchase record data to estimate quantities of beef products U.S. consumers purchase each week. Evidence indicates that most households make decisions about food purchases on a weekly basis. Also, summarizing data on a weekly basis means each point represents activity over 7 days, thus avoiding trading-day variation that would occur were the data summarized on a monthly basis.

Researchers have examined the shopping frequency question from a variety of perspectives and mostly concluded that weekly grocery shopping is typical. Using a large-scale, nationally representative survey of households, Blaylock (1989) reported that approximately 71 percent of the households in the sample reported that major grocery shopping occurred once a week or more often and 29 percent shopped less than once a week. Bawa and Ghosh (1999) treated the frequency of shopping as an indicator of how households minimize costs—the sum of travel and inventory costs—while meeting food requirements. Their scanner data panel over a 1-year period revealed the number of shopping trips made by households ranged from 23 to 529, with a median of 95 trips. Chiang et al. (2001) found that promotions have little effect in accelerating purchase timing. They concluded that 7-day cycles for shopping are the solution consumers adopt for their time allocation problem. Between 1998 and 2003, the Food Institute (2003) reported that typical shoppers report making 2.2 visits to a supermarket each week, including 1.7 visits to a primary supermarket. Weekly grocery shopping was the primary reason consumers gave for entering a supermarket.

Shopping less than once a week may be related to the timing of income and the costs of reaching a supermarket. Wilde and Ranney (2000), also using nationally representative data, reported that 42 percent of all food stamp

households conduct major grocery shopping trips only once per month (households receive Food Stamps once a month). They found that cash welfare participation, female head of household, urban residence, and increased distance to a "major" grocery store each significantly reduced the probability of shopping frequently among food stamp households. But, the majority of food stamp households shop more frequently than monthly.

Both BSE announcements were made on Tuesdays. We constructed weekly purchase data so that weeks would run from Wednesday through Tuesday, and a week would begin immediately after each announcement. The first week in our dataset begins Wednesday December 31, 1997.

Weekly Purchase Data Display Strong Seasonal Patterns

Fresh Beef Purchases Trend Downward and Have Seasonal Peaks and Troughs

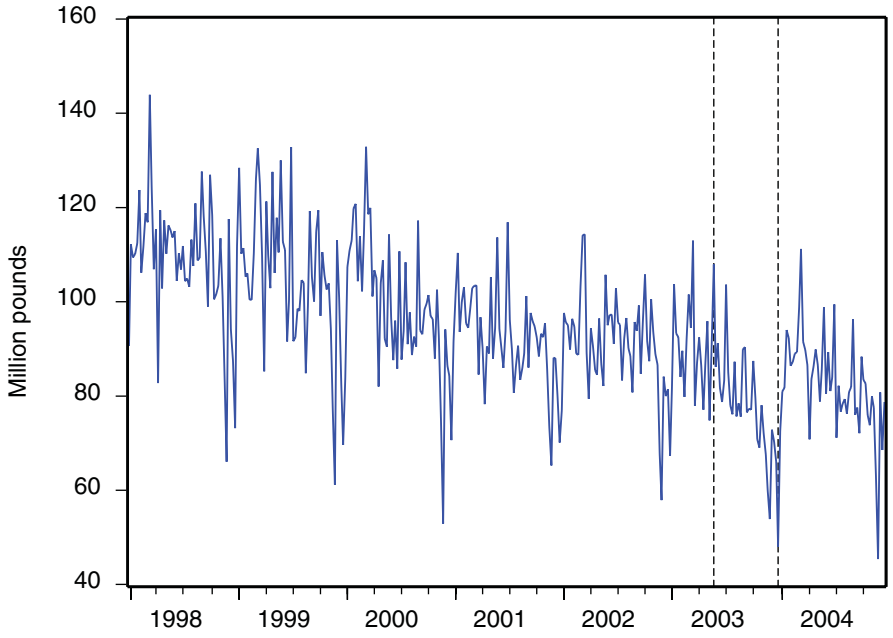
The likely place to look for consumers' adjustments to BSE announcements is in the quantity of beef and veal purchased from grocery store meat counters. At the meat counter, beef and veal packages are individually weighed and labeled with exact, but not uniform, weights. We refer to these purchases as fresh items, distinguishing them from packaged goods bearing UPC codes and having uniform weights. The category of purchases we defined includes beef and veal in a variety of forms: many varieties of roasts, steaks, and chopped meat; ribs; and liver. Since veal is only a very small portion of this category, we refer to the purchases as fresh beef.

Plotting weekly fresh beef purchases reveals two distinctive aspects of the pattern of consumer purchases: trend and seasonality. Figure 1 clearly shows a 7-year downward trend in fresh beef purchases. The rate of decline was 5.2 percent annually, estimated from a linear trend line. Vertical lines

Figure 1

Weekly U.S. purchases of fresh beef, 1998-2004*

Fresh beef purchases declined by 5.2 percent annually between 1998 and 2004



* Weeks immediately following BSE announcements are indicated by vertical lines.
Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

indicate the weeks immediately following the May 20 and December 23, 2003, BSE announcements.

The second feature that can be revealed by time plots is the seasonal pattern of weekly purchases. Figure 2 expands the data from 1998 to show a typical yearly pattern. The figure shows that weekly purchases vary, with purchases at the highest peak approximately twice that of the lowest trough in any year. There are predictable peaks and troughs in each year. Troughs in purchases occur just before several major holidays: Easter, Thanksgiving, and Christmas. Deep troughs occur exactly as other meats peak (turkey at Thanksgiving). Peaks in early March and around summertime holidays (e.g., Labor Day) are typical. The May 20 announcement came just prior to the Memorial Day peak in purchases and the December 23 announcement came just before the trough at Christmas.

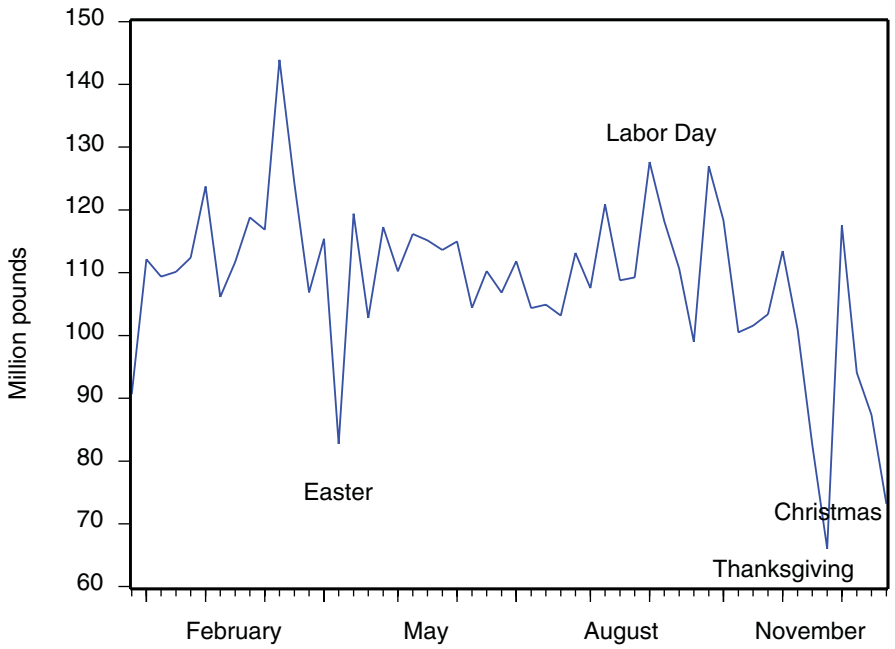
Frozen Beef Purchases Display Rising Seasonal Peaks

Unlike meat sold at the meat counter, frozen beef is packaged in uniform weights and labeled with UPC codes. Mostly, this category consists of steaks and hamburger patties. The frozen product differs from fresh meat at the meat counter in that the frozen is designed to be more quickly prepared.

Figure 2

Weekly U.S. purchases of fresh beef, 1998

Purchases declined at Easter, Thanksgiving, and Christmas



Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

Thus, the demand characteristics of frozen meat may differ from the fresh product. Possibly, impacts of BSE announcements could differ as well.

Figure 3 shows weekly quantities purchased of frozen beef and veal (again referred to as beef) between 1998 and 2004. In contrast to fresh beef, frozen beef purchases show an upward trend, although the pattern is more complex than simply random observations above and below the trendline. Peaks are rising while the troughs are about the same level year after year. (The lowest weekly quantity purchased occurred over Thanksgiving week, 2004.) Further, there is a seasonal pattern to purchases within each year. Figure 4 displays a year of weekly observations. Like every year in the dataset, summertime holidays are peaks and Thanksgiving and Christmas weeks are troughs.

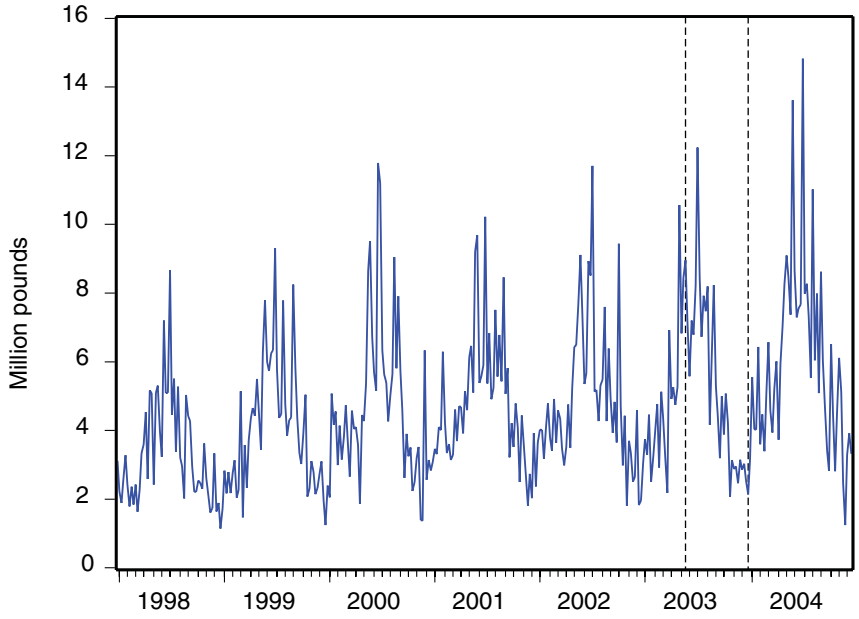
Frankfurter Purchases Are Strongly Seasonal

Weekly purchase data for frankfurters display an obvious seasonal pattern, peaking in the summer months and dipping at the end of the calendar year (fig. 5). In fact, for each year, there are three peaks in the summer. These all occur just before holidays: Memorial Day, July 4th, and Labor Day. The BSE announcements came just before the Memorial Day peak and before the Christmas trough. Figure 6 shows 1 year, 1998, identifying the three

Figure 3

Weekly U.S. purchases of frozen beef, 1998-2004*

Purchases increased between 1998 and 2004, with peaks getting larger and troughs staying about the same

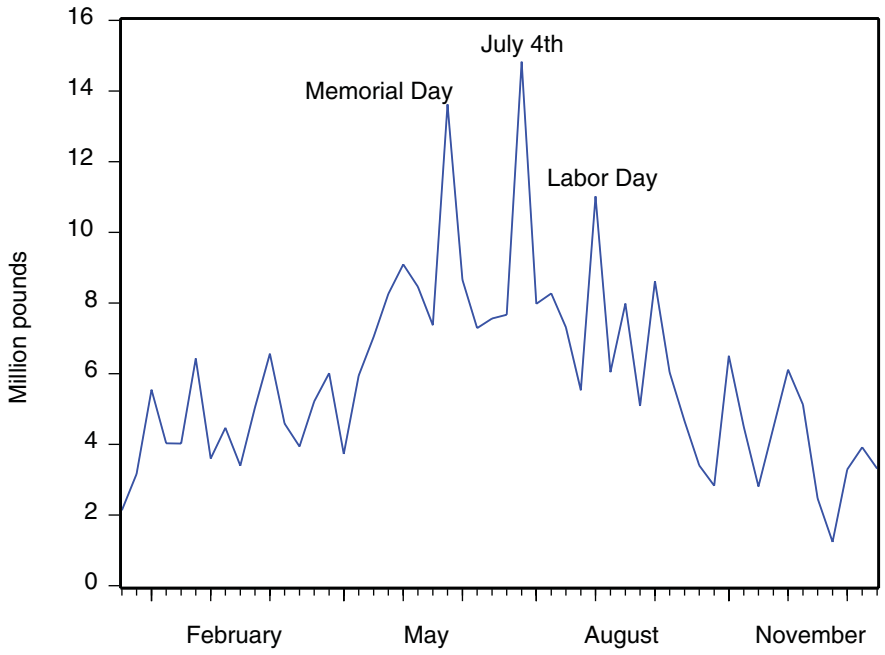


* Weeks immediately following BSE announcements are indicated by vertical lines.
Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

Figure 4

Weekly U.S. purchases of frozen beef, 2004

Purchases hit peaks during Memorial Day, July 4th, and Labor Day

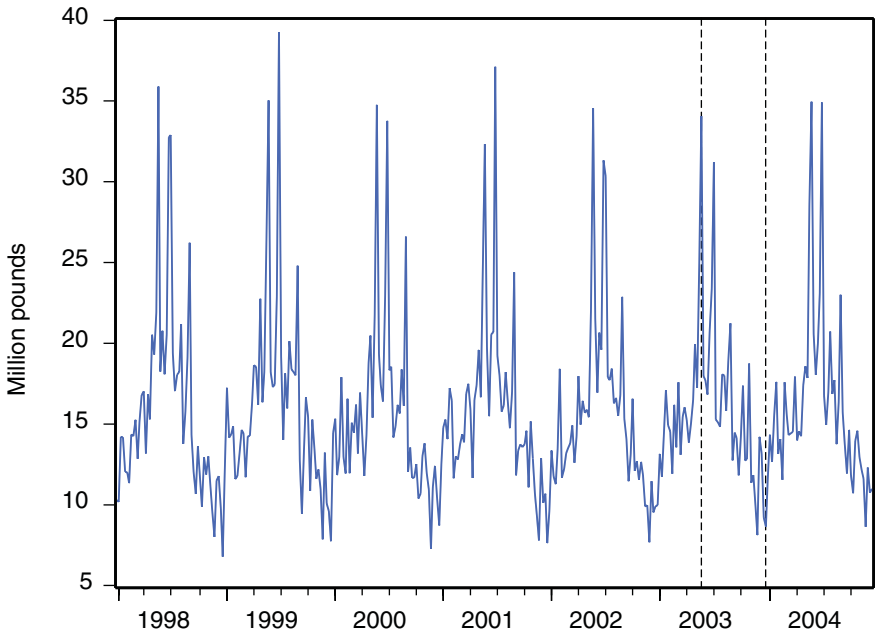


Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

Figure 5

Weekly U.S. purchases of frankfurters, 1998-2004*

Frankfurter purchases were seasonal between 1998 and 2004

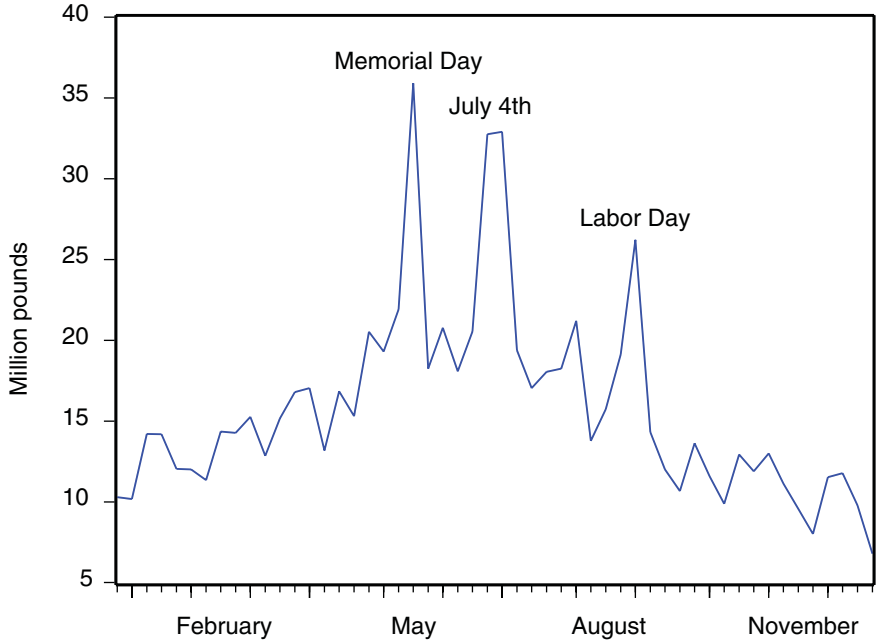


* Weeks immediately following BSE announcements are indicated by vertical lines.
Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

Figure 6

Weekly U.S. purchases of frankfurters, 1998

Frankfurter purchases peaked during summer holidays in 1998



Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

summertime peaks for purchases.

The figures show that variation in purchases throughout the year is large. Weekly purchases were 6.8 million pounds at the deepest trough and 39.3 million pounds at the highest peak. Typically, peaks are five times trough purchases.

Modeling Fresh Beef Purchases

Accounting for Trend and Seasonality Reveals That Impacts Were Short-Lived

Although weekly quantities purchased are variable, 75 percent of the variation in fresh beef purchases over the entire 7-year period can be explained by accounting for the trend and seasonality. We account for the long-term trend in purchases estimating the model

$$y_t = C + \alpha_1 t + \alpha_2 t^2 + \varepsilon_t \quad t = 1, 2, ..., 364$$

where y_t represents pounds of beef purchased in week t, C is a constant, t is a time index, and the error is assumed to have a mean of zero and a constant variance. The time-squared term allows for some bending in the trend. The model, and all others in this report, was estimated with ordinary least squares. Results are in the left-most column of numbers in table 1. By itself, this trend explains 43 percent of the variation (R^2) in quantity purchased.

Seasonality is accounted for by regressing weekly quantities purchased on 52 seasonal 0/1 (dummy) variables, as well as on the time trend. We define 52 seasonal dummy variables as follows:

D1 = 1 for the first week of each year, 0 otherwise.

D2 = 1 for the second week of each year, 0 otherwise…

D52 = 1 for the fifty-second week of each year, 0 otherwise.

The effects of trend and seasonality are captured by

$$y_t = \alpha_1 t + \alpha_2 t^2 + \sum_{i=1}^{52} \gamma_i D_{it} + \varepsilon_t \quad t = 1, 2, ..., 364$$

The middle numerical column of table 1 shows results of this estimation. Again, the time trend is significant, as are all 52 seasonal dummy variables. The Durbin-Watson statistic is very close to 2, indicating the absence of first-order serial correlation in error terms.

The observed patterns in weekly quantities purchased do not completely explain the variation in quantities purchased, but the explanatory power of the estimated model is large enough that the model could be used to provide evidence for the existence of a wide class of possible impacts of the BSE announcements. Impacts that are large and persistent will be most easily identified, while smaller, transitory impacts will be more difficult to detect. Finding that post-announcement quantities purchased are small, relative to quantities predicted by the trend and seasonal model, suggests that some consumers became fearful about consuming beef after hearing the BSE announcements. Of course, as the model does not fully explain the varia-

Table 1
Regression results from trend; trend and seasonal model; and trend, seasonal, and BSE announcement model

Independent variables	Dependent variable: Quantity purchased fresh beef		
	Time trend model	Time trend and seasonal model	Time trend, seasonal, and BSE announcement model
		Estimated coefficient (p value)	
Constant	1.14E+08 (0.0000)		
Time trend	-120543.6 (0.0000)	-117093.8 (0.0000)	-118227.2 (0.0000)
Time squared	65.29080 (0.2989)	71.71246 (0.1094)	79.84719 (0.0740)
52 seasonal dummy variables		All highly significant	All highly significant*
CAN1			8325341 (0.3582)
CAN2			-4954413 (0.5843)
CAN3			6912787 (0.4454)
CAN4			-2482467 (0.7840)
CAN5			-3609573 (0.6902)
WASH1			-23270250 (0.0108)
WASH2			-16680810 (0.0669)
WASH3			-10033931 (0.2696)
WASH4			-5419881 (0.5507)
WASH5			6280924 (0.4893)
Summary statistics			
R^2	0.427850	0.751246	0.762244
Adjusted R^2	0.424680	0.708717	0.712315
Durbin-Watson	1.312908	1.993071	2.028711

* See appendix for details.
Source: Economic Research Service/USDA.

tion in purchases, other unrelated factors could have caused deviations from trend and seasonal patterns.

Our third model is intended to identify impacts of the BSE announcements. We define five new dummy variables to indicate the weeks immediately following the Canadian announcement:

CAN1 = 1 for the week beginning May 21, 2003, 0 otherwise.

CAN2 = 1 for the week beginning May 28, 2003, 0 otherwise…

CAN5 = 1 for the week beginning June 18, 2003, 0 otherwise.

Similarly, we define five dummy variables to indicate weeks immediately following the Washington State announcement.

WASH1 = 1 for the week beginning December 24, 2003, 0 otherwise…

WASH5 = 1 for the week beginning January 21, 2004, 0 otherwise.

The model accounting for trend, seasonality, and the BSE announcements is

$$y_t = \alpha_1 t + \alpha_2 t^2 + \sum_{i=1}^{52} \gamma_i D_{it} + \sum_{j=1}^{5} \delta_j CAN_{jt} + \sum_{k=1}^{5} \delta_k WASH_{kt} + \varepsilon_t \quad t = 1, 2, ..., 364$$

Results are in the right-most column of table 1. Coefficients estimated for the Canadian announcement vary in sign: positive, negative, positive, negative, and negative. This pattern suggests nothing more than white noise. At conventional significance levels (0.05 or 0.10 levels), none of the five variables representing the weeks following the Canadian announcement are significantly different from zero. That is, there is no evidence to suggest the announcement led purchases away from the established trend and seasonal patterns.

The first four variables representing the Washington State announcement are negative. This pattern suggests a temporary decline in purchases. However, only the first two are significantly different from zero at conventional levels of significance (p values are below 10 percent). Thus, there is some evidence suggesting the announcements did lead to reduced purchase levels in the weeks following the announcement. The estimated decline of 23.3 million pounds in the week immediately following the announcement represents 32.6 percent of purchases predicted without the announcement. The share may look large as purchases predicted without the announcement were at a seasonal trough. The estimated decline in the second week, 16.7 million pounds, represents an 18.7-percent decline.

The estimated reductions in purchases are not precise. The 95-percent confidence interval for the reduction during the first week ranges from 5.5 million pounds to 41 million pounds. The 95-percent confidence interval for the second week ranges from an increase of 1.1 million pounds to a reduction of 34.5 million pounds.

Qualitatively, the most one can conclude is that the data suggest a short-lived reduction and some consumers temporarily decided that beef was less safe than it had been. Results from the first week are most compelling as the 95-percent confidence interval is entirely contained in negative numbers. The second week 95-percent confidence interval is less compelling as it extends into positive numbers. The third and fourth weeks show negative coefficients, but of no statistical significance. Still, the results cannot prove an announcement impact as other unrelated factors could account for the deviation from the established trend and seasonal pattern of purchases.

Accounting for Retail Prices Refines Estimates of Duration

For all consumer purchases, retail prices (relative to one another) create incentives that influence purchase decisions. Fresh beef at the meat counter is no exception. Accounting for the influence of prices as well as trend and seasonality could lead to more precise estimates of BSE announcement impacts. If the price of beef were the major determinant of quantity purchased, retailers could have muted consumers' resistance to purchasing beef by lowering price. But, we know from the trend and seasonal dummy model that habit and tradition already explain a large majority of the variation in purchases. So, the influence of price here is necessarily limited.

We estimated the weekly retail price of beef by dividing the weighted weekly total expenditures on beef by the weighted quantity purchased. As such, the price is a unit value for all types of beef. The estimated price does not hold quality constant as it allows for any mix of beef products.

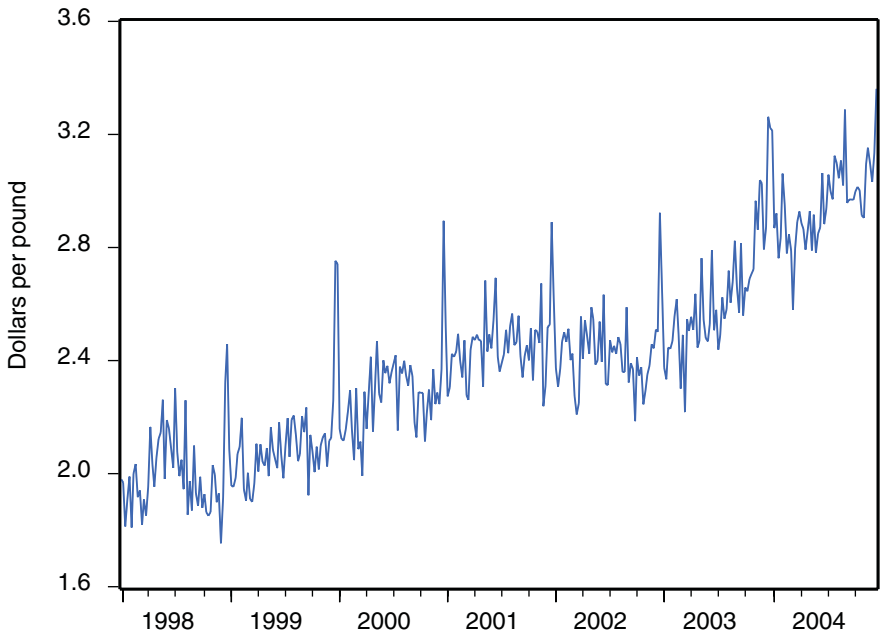
Figure 7 shows an upward trend in the retail price of beef. Over the course of 7 years, retail price has been increasing at an annual rate of 6.4 percent per year.

Before adding a price variable to a regression model, we account for the impact of inflation. Although Federal agencies have not yet developed a

Figure 7

Weekly U.S. retail price of fresh beef, 1998-2004

Prices increased an average of 6.4 percent annually between 1998 and 2004



Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

weekly consumer price index, one can find staple food items that are not subject to much seasonal variation in consumption. These prices could serve the same function as that of the consumer price index in making values comparable across time, albeit in a very imprecise manner. As such, we use the weekly price of bread as a price index, dividing the price of fresh beef by the price of bread. Again, the bread price is a unit value, resulting from dividing weighted weekly expenditures by weighted weekly quantities purchased.

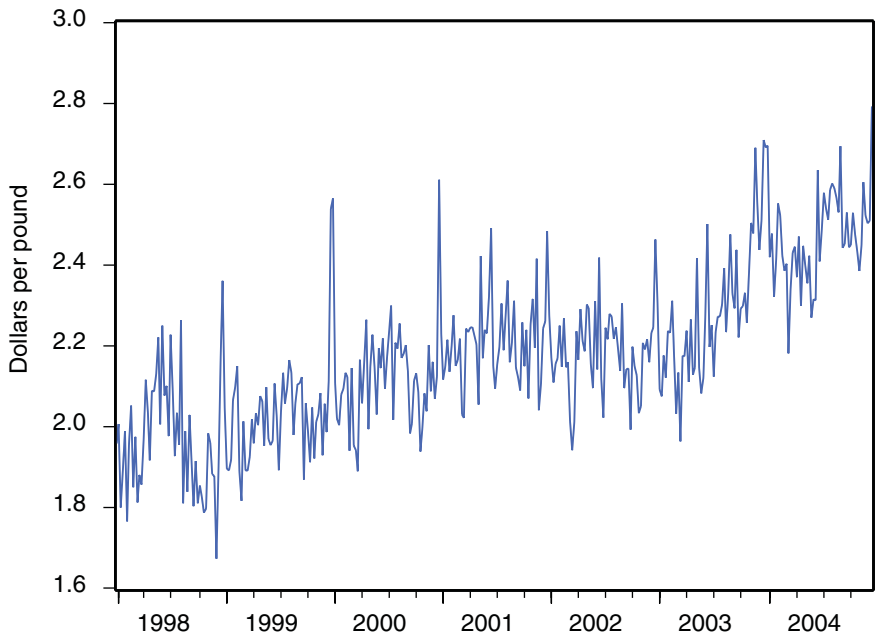
Between 1998 and 2004, our calculated weekly bread price increased at an average annual rate of 2.7 percent. In comparison, the Bureau of Labor Statistics' Consumer Price Index monthly average bread price data increased at an average annual rate of 2.4 percent. The Consumer Price Index for food at home increased at 2.2 percent. So, our bread price index has two desirable features: it is in line with other sources for similar information and is consistent with broader price patterns.

Figure 8 shows the time plot of beef prices deflated by the price of bread. Clearly, as the inflation-adjusted price still shows an upward trend, beef has increased in price more rapidly than has bread.

To show the importance of price to purchase decisions, we estimate a model accounting for trend, seasonality, and inflation-adjusted retail prices of beef and a substitute—poultry (mostly chicken and turkey). Both beef and poultry prices are deflated by the price of bread. The inflation-adjusted

Figure 8

Weekly U.S. inflation-adjusted retail price of fresh beef, 1998-2004
Beef has increased in price more rapidly than other staple foods



Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

price of beef is indicated in the following equation as P^B and the inflation-adjusted price of poultry is indicated by P^P.

$$y_t = \alpha_1 t + \alpha_2 t^2 + \beta_1 P_t^B + \beta_2 P_t^P + \sum_{i=1}^{52} \gamma_i D_{it} + \varepsilon_t \quad t = 1, 2, ..., 364$$

Results are in the left-most numerical column of table 2. Estimation results indicate that both retail prices are significant variables. The coefficient estimate for the beef price variable indicates that if the inflation-adjusted price increased 10 percent from the mean price, quantity purchased would be reduced by 5.1 million pounds, or 5.5 percent of the average quantity. The coefficient for the poultry price is smaller in absolute value than the beef price coefficient and opposite in sign. As expected for a substitute good, a rise in the price of poultry would induce an increase in beef purchases.

To refine our estimates of the BSE announcement impacts, we add 10 announcement impact dummy variables to the trend, seasonality, and price model

$$y_t = \alpha_1 t + \alpha_2 t^2 + \beta_1 P_t^B + \beta_2 P_t^P + \sum_{i=1}^{52} \gamma_i D_{it} + \sum_{j=1}^{5} \delta_j CAN_{jt} + \sum_{k=1}^{5} \delta_k WASH_{kt} + \varepsilon_t$$

t = 1, 2, ..., 364

Results are in the middle numerical column of table 2. Like the corresponding model reported in table 1 (without the price variables), none of the dummy variables representing the weeks following the Canadian announcement are significant. Coefficients change from positive to negative and back several times. The first four dummy variables representing the weeks following the Washington State announcement are negative. However, here prices explain some of the variation in purchases that was formerly captured by the announcement effect dummy variables. Only the first week immediately following the Washington State announcement is significant. Results suggest a decrease of 18.8 million pounds for that one week, or about 28 percent of the quantity forecast to be purchased without the announcement.

The importance of the beef price term in this model is that it could help separate out how much demand diminished from grocers' attempts to maintain sales by lowering prices. Had grocers lowered prices below seasonal levels to reduce the sales loss caused by BSE, there would be less of an impact to explain and the weekly dummy variables would be less significant than in the model without the price term.

There are many ways one could anticipate price levels. In table 3, we report results of four methods: linear trend, trend and seasonal model, and both adjusted for inflation. When we examine price time patterns, observed prices are above prices that are predicted by extending the patterns for the Washington State announcement. Out-of-sample forecasts (weeks beginning December 24, 2003 and December 31, 2003) from the trend model and from the trend and seasonal model are uniformly smaller than observed prices. After adjusting for inflation, out-of-sample forecasts are also below

Table 2
Regression results from combined trend and seasonal models, accounting for price effects and BSE announcements

Independent variables	Dependent variable: Quantity purchased fresh beef		
	Time trend, seasonal, and price model	Time trend, seasonal, price, and BSE announcement model	Time trend, seasonal, and price-BSE announcement interaction model
		Estimated coefficient (p value)	
Time trend	-118510.8	-119359.2	-118482.0
	(0.0000)	(0.0000)	(0.0000)
Time squared	162.2363	162.6403	160.0588
	(0.0006)	(0.0006)	(0.0006)
52 seasonal dummy variables	All highly significant	All highly significant	All highly significant
Beef price/ bread price	-23611554	-22162491	-22139016
	(0.0000)	(0.0000)	(0.0000)
Poultry price/ bread price	12136707	11840466	11156052
	(0.0230)	(0.0283)	(0.0367)
(Beef price/ bread price)xCAN			-1163743
			(0.6936)
(Beef price/ bread price)xWASH			-4867473
			(0.0373)
CAN1		4848199	
		(0.5793)	
CAN2		-9527956	
		(0.2769)	
CAN3		6536046	
		(0.4523)	
CAN4		-1431062	
		(0.8691)	
CAN5		-5905329	
		(0.4977)	
WASH1		-18847852	
		(0.0318)	
WASH2		-7341409	
		(0.4085)	
WASH3		-7093669	
		(0.4164)	
WASH4		-2785781	
		(0.7496)	
WASH5		6502458	
		(0.4562)	
Summary statistics			
R2	0.776348	0.783010	0.779630
Adjusted R2	0.7326675	0.735680	0.738581
Durbin-Watson	2.063951	2.070999	2.077802

Source: Economic Research Service/USDA.

the observed inflation-adjusted prices. Thus, there is little evidence to indicate that retailers used price to mitigate the Washington State BSE announcement impacts. For the Canadian announcement, unadjusted prices were 4 percent lower than trend forecasts for the week beginning May 21, 2003. The following week, prices were as much as 6 percent lower than trend. These deviations could have increased purchases, but not by much, compared with impacts indicated in the announcement dummy variables. That is, none of the models reported here could detect an effect so small.

Table 3
Comparing fresh beef price forecasts with observed prices after the BSE announcements

	Observed price		Forecast price			
Week beginning	Unadjusted	Inflation adjusted	Linear trend	Trend and seasonal model	Linear trend, inflation adjusted	Trend and seasonal model, inflation adjusted
			Dollars per pound			
12/24/03	3.22	2.69	2.68	2.86	2.32	2.44
12/31/03	3.21	2.70	2.69	2.61	2.32	2.27
5/21/03	2.48	2.12	2.58	2.59	2.26	2.23
5/28/03	2.47	2.27	2.58	2.67	2.26	2.35

Source: Economic Research Service/USDA.

The third column in table 2 allows for the possibility that consumers changed the way they responded to inflation-adjusted retail prices just after the BSE announcements. Instead of shifting the average purchase level with BSE announcement dummy variables, we estimate the interaction between the announcements and inflation-adjusted retail prices.

None of the models so far have indicated any response that extended more than 2 weeks. Instead of having five dummy variables representing each of the 5 weeks following the Canadian announcement, we form one variable to distinguish the 2-week period immediately following the announcement. Similarly, we form one variable to distinguish the 2 weeks following the Washington State announcement. Multiplying the announcement variables by the inflation-adjusted retail price allows the price effect to vary over the announcement periods.

CAN = 1 for the weeks beginning May 21 and May 28, 2003, 0 otherwise.

WASH = 1 for the weeks beginning December 24 and December 31, 2003, 0 otherwise.

$$y_t = \alpha_1 t + \alpha_2 t^2 + \beta_1 P_t^B + \beta_2 P_t^P + \sum_{i=1}^{52} \gamma_i D_{it} + \delta_{CAN} CAN_t P_t^B + \delta_{WASH} WASH_t P_t^B + \varepsilon_t$$

t = 1, 2, ..., 364

Results are displayed in the right-most column of table 2. Again, the Canadian announcement variable is insignificant and the Washington State announcement is significant. Evaluated at observed inflation-adjusted prices, estimated impacts from the Washington State announcement are a reduction in purchases of 13.1 million pounds in each of the two post-announcement weeks ($2.69/pound x 4,867,473 pounds).

Collectively, the estimated regressions point to the possibility (but not proof) that the Washington State announcement did reduce fresh beef purchases. There is no evidence that the Canadian announcement influenced purchases.

If the Washington State announcement did influence purchase decisions, the duration of that influence was no more than 2 weeks. Reduced sales over a 1-2 week period do not necessarily mean that grocers were much worse off. Consumers may have been temporarily unsettled by the news, but they probably continued to eat. Demands for many other protein sources likely increased.

Modeling Frozen Beef Purchases

Like fresh beef purchases, the variation in weekly frozen beef purchases is large and can mostly be explained by accounting for trend and seasonality. We account for the increasing seasonal variation through a natural logarithm transformation of the weekly purchase series. Afterward, trend and seasonality explain 71 percent of the variation in (log transformed) purchases. We account for the long-term trend in purchases estimating the model

$$\ln y_t = C + \alpha t + \varepsilon_t \quad t = 1, 2, ..., 364$$

where ln y_t is (log transformed) pounds of frozen beef purchased in week t, C is a constant, t is a time index, and the error is assumed zero mean with constant variance.[5] Figure 3 suggests that the variability of weekly purchases increased over time. We used the logarithm of purchases as our dependent variable rather than the level of purchases because tests for homoscedasticity rejected the assumption of constant variance in levels, but not in logs.

[5] Unlike the fresh beef trend, a quadratic term did not meet conventional tests of significance and was not added to regression equations for frozen beef.

Results are in the left-most numerical column in table 4. By itself, the trend explains 11 percent of the variation (R^2) in quantity purchased. Seasonality is accounted for by regressing weekly quantities purchased on 52 seasonal 0/1 (dummy) variables, as well as on the time trend. The effects of trend and seasonality are captured by the model

$$\ln y_t = \alpha t + \sum_{i=1}^{52} \gamma_i D_{it} + \varepsilon_t \quad t = 1, 2, ..., 364$$

The middle numerical column of table 4 shows results of this estimation. Again, the time trend is significant, as are all 52 seasonal dummy variables. Together the trend and seasonal variables explain 71 percent of the variation in (log transformed) weekly quantity purchased.

The explanatory power of the estimated model is large enough that the model could be used to provide evidence for the existence of a wide class of possible impacts of the BSE announcements. Our third model is intended to identify impacts of the BSE announcements. As with fresh beef, we define five new dummy variables to indicate the weeks immediately following the Canadian announcement and five dummy variables to indicate weeks immediately following the Washington State announcement.

The model accounting for trend, seasonality, and the BSE announcements is

$$\ln y_t = \alpha t + \sum_{i=1}^{52} \gamma_i D_{it} + \sum_{j=1}^{5} \delta_j CAN_{jt} + \sum_{k=1}^{5} \delta_k WASH_{kt} + \varepsilon_t \quad t = 1, 2, ..., 364$$

Results are in the right-most column of table 4. Although estimated coefficients on the first three weekly dummy variables are negative (indicating reduced purchases), none of the five variables representing the weeks

Table 4
Regression results from trend; trend and seasonal model; and trend, seasonal, and BSE announcement model

Independent variables	Dependent variable: Quantity purchased frozen beef		
	Time trend model	Time trend and seasonal model	Time trend, seasonal, and BSE announcement model
		Estimated coefficient (p value)	
Constant	14.98449 (0.0000)		
Time trend	0.001468 (0.0000)	0.001565 (0.0000)	0.001614 (0.0000)
52 seasonal dummy variables		All highly significant	All highly significant*
CAN1			-0.022661 (0.9390)
CAN2			-0.178461 (0.5471)
CAN3			-0.307324 (0.3000)
CAN4			0.021930 (0.9410)
CAN5			-0.268271 (0.3655)
WASH1			-0.547789 (0.0658)
WASH2			-0.228832 (0.4411)
WASH3			0.284611 (0.3381)
WASH4			-0.142814 (0.6306)
WASH5			-0.101990 (0.7312)
Summary statistics			
R^2	0.108821	0.709733	0.716762
Adjusted R^2	0.106359	0.661200	0.658421
Durbin-Watson	0.790331	1.989305	1.997355

Source: Economic Research Service/USDA.

following the Canadian announcement are significant. That is, there is no compelling evidence to suggest the announcement led purchases away from the established trend and seasonal patterns.

The first four variables representing the Washington State announcement are negative. This pattern suggests a temporary decline in purchases, but is likely to be the result of remaining random variation in the data. Only the first week is significantly different from zero at conventional levels of significance (p value is below 10 percent). Thus, there is some evidence suggesting the announcements did lead to reduced purchase levels in the week following the announcement.

The estimated reduction of 55 percent in the week immediately following the announcement appears relatively large, but this estimate is not precise. The 95-percent confidence interval for the reduction ranges from a small increase to a more than 100-percent reduction. Again, like results from fresh beef, the most one can conclude is that there may have been a short-lived reduction as some consumers temporarily decided that beef was not as safe as it had been.

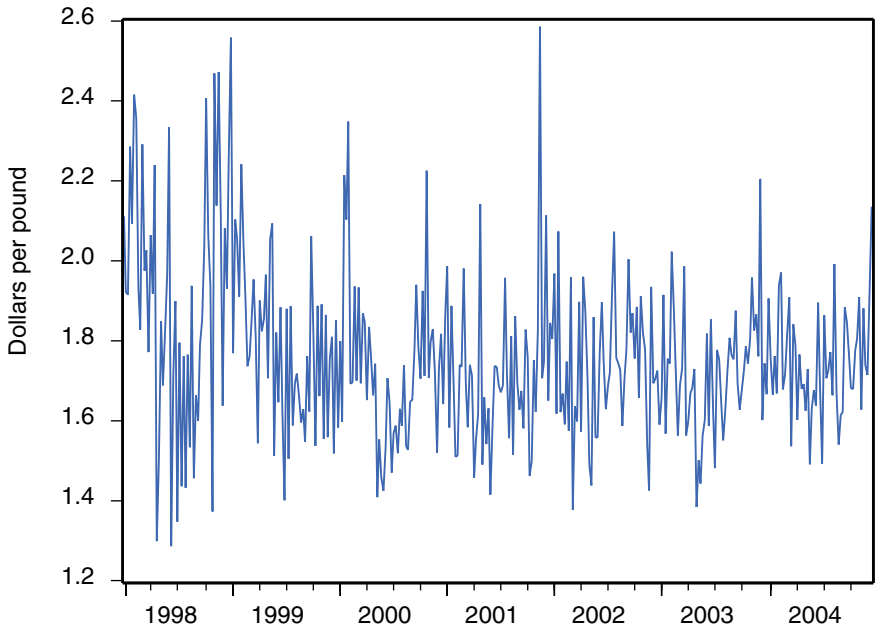
The preceding models do not account for the influence of retail prices. Adding prices may better reveal the magnitude and duration of possible adjustments to BSE announcements. Figure 9 shows the time plot of weekly inflation-adjusted prices for frozen beef, again adjusted by dividing by the corresponding weekly price of bread. Inflation-adjusted prices have been falling at an average of 1.2 percent per year. Contrasting the fresh and frozen beef markets, we see that fresh purchases have been falling and inflation-adjusted prices rising while frozen purchases have been rising (on average) and inflation-adjusted prices falling.

To show how much inflation-adjusted retail prices add to the explanation of the variation in quantity purchased, we estimate the model[6]

$$\ln y_t = \alpha t + \beta \ln P_t + \sum_{i=1}^{52} \gamma_i D_{it} + \varepsilon_t \quad t = 1, 2, ..., 364$$

Figure 9

Weekly U.S. inflation-adjusted retail price of frozen beef, 1998-2004
Inflation-adjusted prices for frozen beef dropped 1.2 percent annually between 1998 and 2004



Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

[6] Paralleling the model for fresh purchases, we also constructed a price for frozen poultry. The frozen poultry price was intended to represent the price of a substitute for frozen beef, since both frozen beef and frozen poultry are more processed than fresh meats. We estimated a regression also including the natural logarithm of the frozen poultry price divided by the price of bread. The estimated coefficient was, as expected, positive and smaller in absolute value than the coefficient for frozen beef. However, the poultry coefficient did not meet conventional significance level tests. Further, we found that estimates of announcement impact coefficients were unaffected by inclusion or exclusion of the poultry price variable.

Both the quantity purchased and the inflation-adjusted retail price are transformed to natural logarithms. Results are in the left-most column of table 5. The (log transformed) price term is highly significant and indicates a price elasticity of -0.9. That is, a 1-percent increase in price typically induces a 0.9-percent decrease in quantity purchased.

We identify the impacts of the BSE announcements by adding 10 dummy variables indicating the 5 weeks following the Canadian announcement and the 5 weeks following the Washington State announcement. The model accounting for trend, seasonality, price, and the BSE announcements is

$$\ln y_t = \alpha t + \beta \ln P_t + \sum_{i=1}^{52} \gamma_i D_{it} + \sum_{j=1}^{5} \delta_j CAN_{jt} + \sum_{k=1}^{5} \delta_k WASH_{kt} + \varepsilon_t \quad t = 1, 2, ..., 364$$

Results are in the right-most column of table 5.

Estimated coefficients for all but 1 of the 10 announcement-effect dummy variables are negative, suggesting that the announcements decreased purchases. However, only one—again, the first week after the Washington State announcement—is different from zero at conventional significance

Table 5
Regression results from combined trend and seasonal models, accounting for price effects and BSE announcements

Independent variables in addition to trend and 52 seasonal dummy variables	Dependent variable: quantity of frozen beef	
	Time trend, seasonal, and price model	Time trend, seasonal, price, and BSE announcement model
	Estimated coefficient (p value)	
Ln(frozen beef price/ bread price)	-0.935291 (0.0000)	-0.950005 (0.0000)
CAN1		-0.017837 (0.9482)
CAN2		-0.195871 (0.4754)
CAN3		-0.147921 (0.5910)
CAN4		-0.053452 (0.8456)
CAN5		-0.192480 (0.4834)
WASH1		-0.633688 (0.0218)
WASH2		-0.163512 (0.5523)
WASH3		0.307697 (0.2635)
WASH4		-0.281413 (0.3076)
WASH5		-0.117712 (0.6685)
Summary statistics		
R^2	0.750452	0.758032
Adjusted R^2	0.707788	0.707218
Durbin-Watson	1.943001	1.946904

Source: Economic Research Service/USDA.

levels. That coefficient suggests purchases were down sharply for 1 week: purchases fell 63 percent. This coefficient is estimated more precisely than the corresponding coefficient in the model without a price variable, but the 95-percent confidence interval is still quite wide. The interval extends from a 9-percent reduction to a more than 100-percent reduction.

Table 6 shows that forecasting prices, either with a linear trend or in combination with the seasonal dummy variables, yields out-of-sample forecasts that are either lower than the observed prices or within the range of forecasts. That is, there is no evidence to suggest that retail prices were especially low immediately after either BSE announcement.

Like the results for fresh beef, the estimated regressions for frozen beef purchases point to the possibility (but not proof) that the Washington State announcement did reduce purchases. There is no evidence that the Canadian announcement influenced purchases. For frozen beef, there is no evidence of impacts beyond 1 week. If some consumers were temporarily fearful of beef, most were convinced that safety was no longer compromised within a short time.

Table 6
Comparing frozen beef price forecasts with observed prices after the BSE announcements

	Observed price		Forecast price			
Week beginning	Unadjusted	Inflation adjusted	Linear trend	Trend and seasonal model	Linear trend, inflation adjusted	Trend and seasonal model, inflation adjusted
			Dollars per pound			
12/24/03	1.99	1.67	1.95	2.13	1.67	1.81
12/31/03	2.27	1.91	1.95	2.00	1.67	1.74
5/21/03	1.86	1.56	1.91	1.77	1.66	1.50
5/28/03	1.86	1.60	1.91	1.82	1.66	1.59

Source: Economic Research Service/USDA.

Modeling Frankfurter Purchases

Beef in various forms is used in many aspects of food processing, making it theoretically possible that consumers might make very far-reaching adjustments in response to the BSE announcements. For example, consumers could have been fearful of gelatin in processed foods. The most processed food we focus on in this report is frankfurters. We focus on purchases of frankfurters and the subset of frankfurters that are made without beef as the latter offers an obvious substitution possibility for consumers trying to avoid beef.

Figure 5 suggests (and statistics confirm) that there is no long-term trend in weekly purchases, but seasonality is obviously present. The first model we explore is a purely seasonal model. Seasonality is accounted for by regressing weekly quantities purchased on 52 seasonal 0/1 (dummy) variables. The dummy variables represent the 52 weeks of the year. The purely seasonal dummy model is

$$y_t = \sum_{i=1}^{52} \gamma_i D_{it} + \varepsilon_t$$

where y_t represents pounds of frankfurters purchased weekly. The left-most numerical column in table 7 shows the results from estimating this model. Although the variation in weekly quantities purchased is large, the purely seasonal dummy model explains nearly 78 percent of the total variation. That is, habit and tradition appear to dominate any possible explanation for the purchase pattern. For our purposes, this result suggests that we may have explained enough of the variation so that additional variables representing BSE announcement impacts could separate out the impacts of the announcements from purchases conditioned by habit and tradition.

Our second model augments the seasonal dummy model by allowing for impacts of the BSE announcements. We add five new dummy variables to indicate the weeks immediately following the Canadian announcement and five dummy variables to indicate weeks immediately following the Washington State announcement.

The model accounting for seasonality and the BSE announcements is

$$y_t = \sum_{i=1}^{52} \gamma_i D_{it} + \sum_{j=1}^{5} \delta_j CAN_{jt} + \sum_{k=1}^{5} \delta_k WASH_{kt} + \varepsilon_t \quad t = 1, 2, \ldots, 364$$

Results of estimating the model appear in the column next to the seasonal dummy model results. The estimated coefficients on all of the variables representing the weeks following BSE announcements are indistinguishable from zero, that is, there is no evidence to reject the zero hypothesis.

Most frankfurters are made with beef, but there are some that are made with turkey, chicken, and/or pork and contain no beef. Federal regulations require labels to indicate which meats are in each package. Generally, frankfurters that do not contain beef say so prominently on labels. Thus, all

Table 7
Regression results from purely seasonal and BSE announcement models

Independent variables in addition to 52 seasonal variables	Dependent variable: Quantity of frankfurters purchased		Dependent variable: Quantity of no-beef frankfurters purchased	
	Seasonal model	Seasonal and BSE announcement model	Seasonal model	Seasonal and BSE announcement model
	Estimated coefficient (p value)			
CAN1		3480717		992063.9
		(0.2396)		(0.2925)
CAN2		-4449059		-1279880
		(0.1331)		(0.1747)
CAN3		86345.90		1140848
		(0.9767)		(0.2262)
CAN4		-2114794		-1117900
		(0.4746)		(0.2357)
CAN5		-2410430		411009.9
		(0.4151)		(0.6625)
WASH1		-2865906		-229410.7
		(0.3327)		(0.8075)
WASH2		-2386278		-1319814
		(0.4198)		(0.1617)
WASH3		1171005		389307.5
		(0.6921)		(0.6793)
WASH4		-858607.6		223711.2
		(0.7715)		(0.8122)
WASH5		121594.7		1504326
		(0.9672)		(0.1109)
Summary statistics				
R^2	0.779342	0.784112	0.587438	0.601742
Adjusted R^2	0.743273	0.740506	0.520000	0.521299
Durbin-Watson	2.256271	2.271388	1.740221	1.711250

Source: Economic Research Service/USDA.

others can be assumed to be wholly or partially beef (usually in a mixture with pork). Consumers are easily alerted to the choice they face when selecting frankfurters: made with beef or made without beef. Thus, there are two possible reasons for failing to find an impact of the BSE announcements. There might not have been an impact, or the impact could have been masked as consumers switched from frankfurters made with beef to no-beef frankfurters.

We constructed weekly quantities purchased of no-beef frankfurters by excluding all products that included beef. Averaging across all weeks, 22.4 percent of frankfurters purchased did not contain beef. Expenditures on no-beef frankfurters averaged 19.7 percent of all frankfurters. If consumer switching masked the BSE impact, then the switching should be easily observable in the no-beef frankfurter market. That is, a small percentage decrease in all frankfurters would show up as a much larger change in no-beef frankfurters.

The third and fourth columns in table 7 repeat the previous exercise for the subset of no-beef frankfurters. Again, the purely seasonal model explains the majority of variation in purchases (59 percent). Introducing variables to represent the 5 weeks after each BSE announcement adds nothing to the explanatory power of the regression. None of the weekly dummy BSE announcement variables are significantly different from zero. This regression offers no evidence that consumers substituted no-beef frankfurters for frankfurters made with beef. Here, there is no indication of any BSE impact.

Lower prices could have muted consumers' resistance to purchasing frankfurters. But, we know from the seasonal dummy model that habit and tradition already explain a large majority of the variation in purchases. So, the influence of price here is necessarily limited. Even so, we want to explain that part of the pattern of purchases to reveal the existence, duration, and magnitude of BSE impacts.

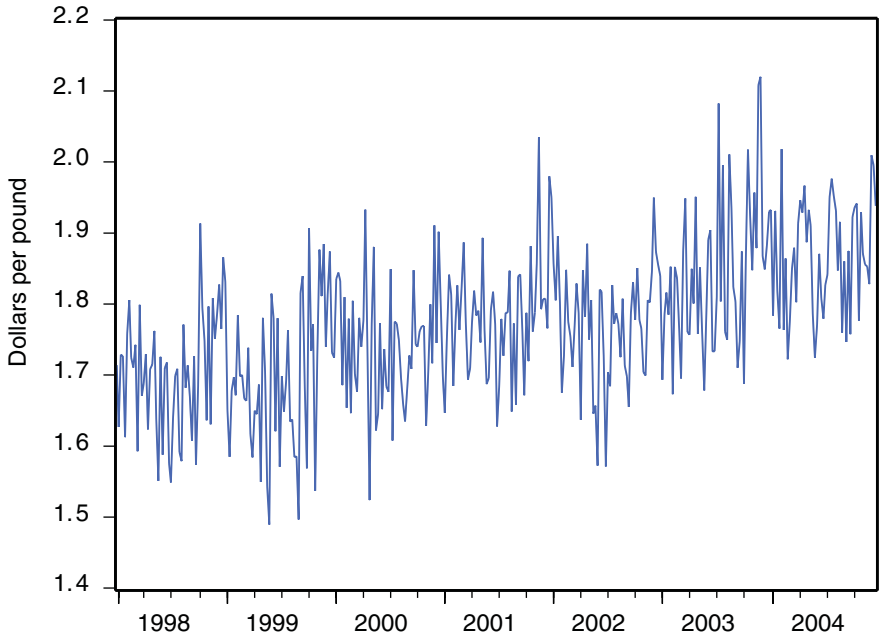
Figure 10 shows that the retail price of frankfurters has not been stationary, but trended upward over 7 years at an annual rate of 1.7 percent per year, estimated from a linear trend. To account for inflation, we use the weekly price of bread as a price index, dividing the price of frankfurters by the price of bread. The result is indicated by P_t. The model accounting for seasonality, price, and the BSE announcements is

$$y_t = \beta P_t + \sum_{i=1}^{52} \gamma_i D_{it} + \sum_{j=1}^{5} \delta_j CAN_{jt} + \sum_{k=1}^{5} \delta_k WASH_{kt} + \varepsilon_t \quad t = 1, 2, ..., 364$$

Figure 10

Weekly U.S. retail price of frankfurters, 1998-2004

Retail prices for frankfurters trended upward at 1.7 percent annually between 1998 and 2004



Source: Economic Research Service/USDA, using data from the ACNielsen Homescan Panel, 1998-2004.

The left-most column in table 8 shows the results of adding contemporaneous inflation-adjusted price to the regression. The price coefficient is clearly significant and the regression's explanatory power is higher than those reported in table 7. Adding the price variable does help reveal potential BSE impacts. In the second week following the Canadian announcement, purchases appear to have been reduced. The coefficient on CAN2 is negative and, at a 10-percent level of significance, differs from zero. Thus, there is some evidence for a short-lived (1 week) reduction in purchases. The negative coefficient suggests that purchases were reduced by 4.8 million pounds, or 21 percent of the purchases forecast without the announcement impact. However, the evidence for an announcement impact is not very strong. The 95-percent confidence interval on the impact ranges

Table 8
Regression results from seasonal models, accounting for price effects and BSE announcements

Independent variables in addition to 52 seasonal dummy variables	Dependent variable: Quantity of frankfurters purchased		Dependent variable: Quantity of no-beef frankfurters purchased	
	Seasonal, price, and BSE announcement model	Seasonal and price-BSE announcement interaction model	Seasonal, price and BSE announcement model	Seasonal and price-BSE announcement interaction model
	Estimated coefficient (p value)			
Frankfurter price/ bread price	-9091536 (0.0000)	-9068182 (0.0000)	-1426983 (0.0000)	-1441923 (0.0000)
(Frankfurter price/ bread price) xCAN		-860321.8 (0.5281)		-223054.3 (0.6636)
(Frankfurter price/ bread price) xWASH		-1755188 (0.1564)		-705898.1 (0.1400)
CAN1	2531014 (0.3742)		880442.1 (0.3359)	
CAN2	-4774498 (0.0936)		-1533646 (0.0947)	
CAN3	989196.8 (0.7281)		1155088 (0.2068)	
CAN4	-1400834 (0.6223)		-1063855 (0.2449)	
CAN5	-3028335 (0.2872)		208287.1 (0.8199)	
WASH1	-3219624 (0.2576)		-300076.1 (0.7427)	
WASH2	-2458096 (0.3871)		-1579544 (0.0853)	
WASH3	-114497 (0.9680)		130542.6 (0.8866)	
WASH4	-1250314 (0.6599)		71666.43 (0.9375)	
WASH5	-630260.8 (0.8246)		1220017 (0.1836)	
Summary statistics				
R^2	0.801425	0.798116	0.626183	0.614650
Adjusted R^2	0.760522	0.762836	0.549184	0.547308
Durbin-Watson	2.274128	2.259880	1.812526	1.852497

Source: Economic Research Service/USDA.

from an increase of 0.8 million pounds to a decrease of 10.3 million pounds. That is, a conclusion of no impact is within the confidence interval.

The second column allows for the possibility that consumers changed the way they responded to retail prices just after the BSE announcements. Again, we include one variable to distinguish the 2-week period immediately following each announcement.

CAN = 1 for the weeks beginning May 21 and May 28, 2003, 0 otherwise.

WASH = 1 for the weeks beginning December 24 and December 31, 2003, 0 otherwise.

The model accounting for seasonality, price, and price-BSE announcement interactions is

$$y_t = \beta P_t + \sum_{i=1}^{52} \gamma_i D_{it} + \delta_{CAN} CAN_t P_t + \delta_{WASH} WASH_t P_t + \varepsilon_t \quad t = 1, 2, ..., 364$$

Results show that the contemporaneous inflation-adjusted retail price is significant. However, here the interaction of the Canadian announcement and price fails a significance test at all reasonable confidence levels. Similarly, the interaction of the Washington State announcement and price is not significant. There is no compelling evidence to suggest that consumers reacted differently to prices after the announcements. The insignificance of the cross of price and the Canadian announcement suggests that the 2-week period was too long, mixing possible impacts in 1 week with no impacts in another. Thus, the previous model with separate variables for each post-announcement week is likely sufficient. That is, the duration of any impact was limited to 1 week.

The third and fourth columns in table 2 report results of estimating announcement impacts on purchases of no-beef frankfurters. Regressing the quantity of no-beef frankfurters on the contemporaneous inflation-adjusted retail price of no-beef frankfurters, 10 announcement-effect dummy variables, and the 52 seasonal dummy variables shows two significant announcement effects. Both second-week dummy variables (Canada and Washington State) indicate reduced purchases for those weeks. In both cases, impacts are limited to the second week after the announcement. Like the results reported for all frankfurters (column one), the regression does not precisely estimate impacts. The mean estimates of impact are a decrease of 1.5 million pounds from the Canadian announcement and a decrease of 1.6 million pounds from the Washington State announcement. However, the 95-percent confidence interval for both announcements extends into positive numbers, indicating increases in purchases. The mean impacts suggest that consumers reacted to the announcements by temporarily reducing purchases of all frankfurters, beef or no-beef. There is no evidence that consumers substituted no-beef frankfurters for frankfurters made with beef.

Table 9 shows that it is unlikely that grocers lowered retail prices to reduce consumers' adjustments to the BSE announcements. Observed prices are either above the range of forecasts (trend, or trend plus seasonal models) or

Table 9
Comparing frankfurter price forecasts with observed prices after the BSE announcements

Week beginning	Observed price: Unadjusted	Observed price: Inflation adjusted	Forecast price: Linear trend	Forecast price: Trend and seasonal model	Forecast price: Linear trend, inflation adjusted	Forecast price: Trend and seasonal model, inflation adjusted
			Dollars per pound			
All frankfurters:						
12/24/03	1.93	1.61	1.84	1.89	1.58	1.60
12/31/03	1.93	1.62	1.84	1.81	1.58	1.57
5/21/03	1.67	1.41	1.81	1.71	1.57	1.46
5/28/03	1.77	1.53	1.81	1.76	1.57	1.53
No-beef frankfurters:						
12/24/03	1.58	1.32	1.56	1.49	1.34	1.25
12/31/03	1.56	1.40	1.56	1.67	1.34	1.46
5/21/03	1.56	1.31	1.56	1.51	1.36	1.29
5/28/03	1.41	1.22	1.56	1.52	1.36	1.33

Source: Economic Research Service/USDA.

within the range. In either case, there is no suggestion that retail prices were especially low in the 2 weeks following announcements. Only the no-beef frankfurter prices in the second week following the Canadian announcement are below the forecast range. There, the prices are 7-10 percent lower than reasonably anticipated, and not large enough to substantially offset calculated coefficients.

The findings for no-beef frankfurters were opposite to expectations that BSE announcements would lead consumers to substitute away from beef frankfurters. A possible explanation is that many consumers were simply confused about the ingredients in no-beef frankfurters and fled no-beef frankfurters more than frankfurters containing beef. This scenario sounds unlikely. A better explanation is that some events unrelated to BSE announcements led consumers to reduce no-beef frankfurter purchases. That is, there is little evidence to indicate BSE announcements influenced consumers' frankfurter purchases.

Generalizing Results to Other Types of Food Safety News

A retrospective analysis may indicate the magnitude and duration of changes in retail purchases of foods in response to a particular food safety news event. It may also help in forecasting impacts of other events when those events have characteristics similar to the studied event. Assuming that consumers always make food choices under some set of assumptions about risks, then they will make different food choices only to the extent that news changes their risk perceptions. That observation suggests a two-way classification scheme for food safety news and a mechanism by which retrospective analyses might point to particular types of consumer responses to other food safety news.

First, news has to be news to consumers before they will revise their subjective risk assessments. If newly released information repeats what consumers have already incorporated in their ideas about risk, the information might not really be news. Information might have to be at odds with what consumers believe to have an impact on risk perceptions. For news to change food choices, it would have to suggest to consumers that they had misjudged the likelihood of illness or had misunderstood health outcomes.

Second, some types of risks will concern consumers more than others. News about risks that consumers dread, like cancer, may provoke relatively large responses. As consumers often overassess very small risks and underassess more substantial risks (Viscusi, 1998), disproportionately large (or small) responses could sometimes be anticipated.

The 2003 BSE announcements are especially useful as benchmarks for classification. Following the logic of the two-way classification scheme, *ex ante*, there was good reason to be uncertain about the announcements' impacts. In terms of news, the announcements informed consumers that a risk they were largely ignoring was negligible. In terms of risk type, human health risks associated with BSE are similar to other risks that have provoked large responses from consumers.

Were the BSE Announcements News?

On May 20, 2003, the Food and Drug Administration (FDA) issued a statement saying that it had learned from the Government of Canada that a cow in Alberta had tested positive for BSE (U.S. Department of Health and Human Services, U.S. Food and Drug Administration, 2003). FDA said meat from the infected cow did not enter the food supply and, although there was no evidence of transmission to other animals, the infected cow's herd mates would be destroyed as a precaution. In its statement, FDA claimed that, "To date, no case of BSE has ever been found in the U.S., despite years of intensive testing for the disease."

FDA described the import prohibitions on cattle and beef from countries that were on the list of BSE-restricted countries (which was immediately amended to include Canada). The agency also highlighted its rule prohibiting mammalian protein from being fed to ruminants; that rule was

designed to limit the spread of BSE within the United States even if it did cross the border.

In December 2003, the Centers for Disease Control and Prevention (CDC) issued a statement after the Washington State finding. CDC described the testing confirming the BSE finding, the beef recall, the epidemiologic investigation into the disease source, and the apparent species barrier protecting humans from BSE (U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, 2003). In its statement, CDC claimed that, "The risk to human health from BSE in the United States is extremely low."

CDC also described its activities related to BSE. These include monitoring the trends and incidence of Creutzfeldt-Jakob disease (CJD) in the United States and conducting followup reviews of clinical and neuropathology records of CJD decedents younger than 55.[7]

[7] British cases of the variant form of CJD (vCJD) occurred among people much younger than the CJD cases.

Following the Washington State finding, the Secretary of Agriculture was interviewed by major media outlets and issued public statements describing new programs USDA was undertaking. For example, on December 30, 2003 (U.S. Department of Agriculture), the Secretary announced an expansion of the ongoing surveillance program, new regulations that would reduce consumer exposure to BSE if BSE were in animals intended to be part of the U.S. food supply, and development of a national animal identification system. New regulations included a ban on the use of downer cattle for food uses; prohibiting tissues most likely to harbor prions—believed to cause BSE—in food; process-control regulations on advanced meat recovery that would prohibit spinal cord tissue; and a regulation prohibiting the use of air injection to stun cattle. A technical team provided daily public statements for several weeks, reporting on testing progress and on tracing the infected animal through the supply chain.

And, like the CDC and FDA statements, the Secretary reminded the public that "…our food supply and the public health remain safe" (U.S. Department of Agriculture, Dec. 30, 2003).

Each of the agencies made unequivocal statements that the U.S. food supply was safe, in effect telling consumers not to be concerned with the BSE findings: the likelihood of exposure to BSE was near zero and likely to fall. The statements also gave agencies an opportunity to highlight programs and activities targeted at managing the risk of BSE.[8]

[8] "The U.S. approach to managing the risk is focused on three primary goals:
- Prevent the agent of BSE from entering the United States and infecting U.S. cattle;
- Prevent the amplification of the agent of BSE throughout the U.S. cattle herd, were it to penetrate the primary firewall at the borders and infect U.S. cattle; and
- Prevent the exposure of Americans to the agent of BSE via food and other products that are fully or partially of bovine derivation" (PL 107-9 Federal Inter-agency Working Group, 2003).

However, for the most part, agencies were not communicating directly with consumers. News media filtered the information agencies provided, summarizing some points and focusing attention to others. News media analyses also drew on nongovernment information sources. Thus, the aggregate message consumers received has to be somewhat uncertain.

Trying to characterize consumer knowledge about the human health risks posed by BSE is a speculative effort. But, some survey information speaks to the issue.

Consumer surveys conducted by the National Cattlemen's Beef Association asked consumers if they had heard about "mad cow" disease in the last month. Results indicated that awareness of BSE increased after both the Canadian announcement and the Washington State announcement. In the latter case, awareness increased from 61 to 96 percent, suggesting that, prior to the announcement, a substantial minority of consumers were not aware of risks related to BSE.

A survey of consumers in the United States, Germany, and the Netherlands conducted by Pennings et al. (2002) in the last week of January and the first week of February 2001 showed that U.S. consumers were the least informed about variant Creutzfeldt-Jakob disease outcomes. Among U.S. consumers, 24.1 percent reported that the illness is fatal and untreatable. More than 58 percent of the Europeans reported similarly.

From a news perspective, prior to the BSE announcements, there would be good reason to suspect that announcements might not have large impacts on food choices. Many consumers were unaware of BSE, and many others considered the exposure risk to be negligible. Government agencies said the risk was negligible. As long as media coverage was consistent with the agencies' messages, news would reinforce pre-existing beliefs. In other words, news would not be "news."

Are Human Health Risks From BSE Like Other Food Safety Risks?

Variant Creutzfeldt-Jakob disease (vCJD) in humans is strongly linked with exposure to BSE through food (World Health Organization, 2002). BSE and vCJD fall into the class of diseases called transmissible spongiform encephalopathy (TSE).[9] All TSE diseases display a prolonged incubation period of months or years and are progressive, debilitating, neurological illnesses. They are always fatal (Detwiler, 1992).

[9] The TSE family of diseases includes (among others) scrapie in sheep, chronic wasting disease in deer and elk, transmissible mink encephalopathy, and classical and variant Creutzfeldt-Jakob disease in humans (Detwiler, 1992).

Two notions about consumers' risk perceptions support anticipating disproportionately large responses to BSE announcements. First, health outcomes from vCJD raise issues of dread and lack of control. The degenerative illness is untreatable and, other than abandoning beef products, there are few defensive actions consumers can take on their own. Unlike bacterial contamination that may be controlled with cooking methods and ordinary hygiene, there are no such safeguards against vCJD. In other countries, vCJD has killed both the young and the elderly, so being healthy might not offer much defense.

Second, while evidence supports the assumption that the likelihood of dietary exposure to BSE is very small, the risk cannot be proven to be zero. As consumers often overestimate small risks, disproportionate responses to news about BSE could have been anticipated.

The Harvard Center for Risk Analysis and Tuskegee University collectively reviewed risks posed by BSE and the effectiveness of government programs at controlling risks (Cohen et al., 2001). The study concluded that several key actions have been particularly effective in achieving these goals:

- The Animal and Plant Health Inspection Service's ban on the import of live ruminants and ruminant meat and bone meal from the United Kingdom (since 1989) and all of Europe (since 1997);

- The FDA's feed ban instituted in 1997 to prevent recycling of potentially infectious cattle tissues to ruminants; and

- Measures instituted in meatpacking plants by the industry and the Food Safety and Inspection Service to reduce the opportunity for infectious tissues (brain and spinal cord) to contaminate human food.

Monitoring data support the conclusion that the risk from BSE is very small. The BSE enhanced surveillance program has tested 775,271 samples from its beginning in 2004 through August 6, 2006 (U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2006b). In that time, two additional infected indigenous animals were identified.

While the historical record makes it easy to argue that the BSE risks to humans in the United States are negligible, USDA will never be able to say that there are no infected animals awaiting slaughter. There are physical limits to what any program can do to guarantee food safety. The enhanced surveillance program allows for the possibility that the agency could make probability statements about the number of infected animals awaiting slaughter.[10] But even the most sophisticated sampling scheme cannot prove that the number is zero.

[10] APHIS issued a draft statement (for review). Findings "support a conclusion that the prevalence of BSE in the United States is less than 1 infected animal per million adults" (U.S. Department of Agriculture, Animal and Plant Health Inspection Service, 2006a).

Certainty that the food supply is BSE-free would require testing all animals with a test that never yields a false negative. Further, for a perfect filter, test results that did confirm BSE would have to lead to 100 percent recall of products derived from infected animals.

From the agencies' perspectives, risks were so small they were justified in reassuring consumers. From their reasoning, consumers who refrain from eating beef out of fear of contracting vCJD have meals that are less satisfying and are no less risky. *Ex ante*, however, it would have been impossible to know if consumers would agree that a risk that cannot be proven zero is effectively zero.

Predictions Need a Benchmark

The two characteristics of the 2003 BSE announcements point in opposite directions. The BSE news involved a negligible risk that consumers were already ignoring. But, the type of risk likely raises issues of dread and lack of control. The first factor suggested no change in food choices, while the second suggested that consumers would shun beef products.

Gauging the consumer response to the 2003 BSE announcements resolves which characteristic of the news was most important to consumers. The measured change in food choices also serves as a benchmark for our classification of food safety news. In this case, the first factor dominated; consumers' risk perceptions before the BSE news were probably very close to their risk perceptions after the news. Consumer response to food safety news with similar characteristics might yield similar changes in food

choices. Of course, consumers may respond to another BSE announcement in an entirely different manner. That is, another BSE announcement might be made in an environment in which consumers' interpretation of both the likelihood of exposure and the health outcomes from becoming ill could differ from the 2003 responses.

References

Bawa, Kapil, and Avijit Ghosh. "A Model of Household Grocery Shopping Behavior." *Marketing Letters*, 10 no. 2 (1999):149-160.

Blaylock, J.R. "An Economic Model of Grocery Shopping Frequency." *Applied Economics*, 21 (June 1989):843-852.

Chiang, Jeongwen, Ching-Fan Chung, and Emily T. Cremers. "Promotions and the Pattern of Grocery Shopping Time." *Journal of Applied Statistics*, 10 (2001):801-819.

Coffey, Brian, James Mintert, Sean Fox, Ted Schroeder, and Luc Valentin. "The Economic Impact of BSE on the U.S. Beef Industry: Product Value Losses, Regulatory Costs, and Consumer Reactions." Kansas State University Agricultural Experiment Station and Cooperative Extension Service, MF-2678, April, 2005.

Cohen, Joshua T., Keith Duggar, George M. Gray, Silvia Kreindel, Hatim Abdelrahman, Tsegaye HabteMariam, David Oryang, and Berhanu Tameru. "Evaluation of the Potential for Bovine Spongiform Encephalopathy in the United States." Harvard Center for Risk Analysis, Harvard School of Public Health and Center for Computational Epidemiology, College of Veterinary Medicine, Tuskegee University, November 26, 2001. http://www.aphis.usda.gov/lpa/issues/bse/bse-riskassmt.html.

Dahlgran, Roger A., and Dean G. Fairchild. "The Demand Impacts of Chicken Contamination Publicity—A Case Study." *Agribusiness*, 18 (2002): 459-474.

Detwiler, Linda A. "Scrapie." *Revue Scientifique et Technique Office International des Epizooties*, 11 (1992):491–537.

The Food Institute. "Food Industry Review 2003." The American Institute of Food Distribution: Elmwood Park, NJ, 2003.

McCluskey, Jill J., Kristine M. Grimsrud, Hiromi Ouchi, and Thomas I. Wahl. "Bovine Spongiform Encephalopathy in Japan: Consumers' Food Safety Perceptions and Willingness to Pay for Tested Beef." *The Australian Journal of Agriculture and Resource Economics*, 49 no. 2 (2005):197-209.

Pennings, Joost M.E., Brian Wansink, and Matthew T.G. Meulenberg. "A Note on Modeling Consumer Reactions to a Crisis: The Case of the Mad Cow Disease." *International Journal of Research in Marketing*, 19 (2002):91-100.

Piggott, Nicholas E., and Thomas L. Marsh. "Does Food Safety Information Impact U.S. Meat Demand?" *American Journal of Agricultural Economics*, 86 (February 2004): 154-174.

PL 107-9 Federal Inter-agency Working Group. *Animal Disease Risk Assessment, Prevention, and Control Act of 2001 (PL 107-9) Final Report, prepared by the PL 107-9 Federal Inter-agency Working Group*, January

2003. http://www.aphis.usda.gov/lpa/issues/bse/risk_assessment/PL107-9_1-03.pdf.

Thilmany, Dawn, Wendy Umberger, and Amanda Ziehl. "Consumer Response to Beef Due to the December 2003 Incident in the U.S." Agricultural Marketing Report, AMR 04-01, Colorado State University Cooperative Extension, June 2004.

U.S. Department of Agriculture. Newsroom—Transcript of Agriculture Secretary Ann M. Veneman Announcing Additional Protection Measure to Guard Against BSE. December 30, 2003. http://www.aphis.usda.gov/hot_issues/bse/bse_news2003.shtml.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. "An Estimate of the Prevalence of BSE in the United States (Draft)." 2006a. http://www.aphis.usda.gov/newsroom/hot_issues/BSE/content/printable_version/BSEprevalence-estimate4-26-06.pdf.

U.S. Department of Agriculture, Animal and Plant Health Inspection Service. "BSE Test Results." 2006b. http://www.aphis.usda.gov/lpa/issues/bse_testing/test_results.html.

U.S. Department of Agriculture, Economic Research Service. Food CPI, Prices, and Expenditures briefing room. http://www.ers.usda.gov/Briefing/CPIFoodAndExpenditures/Data/.

U.S. Department of Health and Human Services, Centers for Disease Control and Prevention. "News and Highlights: BSE, Washington, 2003—Preliminary Investigation Suggests BSE-Infected Cow in Washington State Was Likely Imported from Canada." December, 2003. http://www.cdc.gov/ncidod/dvrd/bse/bse_washington_2003.htm.

U.S. Department of Health and Human Services, Food and Drug Administration. "Statement on BSE Cow in Alberta, Canada." May 20, 2003. http://www.fda.gov/bbs/topics/NEWS/2003/NEW00908.html.

Viscusi, W. Kip. *Rational Risk Policy*. New York: Oxford University Press Inc., 1998.

Wilde, Parke E., and Christine K. Ranney. "The Monthly Food Stamp Cycle: Shopping Frequency and Food Intake Decisions in an Endogeneous Switching Regression Framework." *American Journal of Agricultural Economics*, 82 (February 2000):200-213.

World Health Organization. "Variant Creutzfeldt-Jakob Disease." Revised November, 2002. http://www.who.int/mediacentre/factsheets/fs180/en/.

Appendix

All regressions run with 52 seasonal (weekly) dummy variables were similar in that all the estimated coefficients for the dummy variables were large relative to their standard errors. Hence, t-statistics were large and p-values were all 0.0000. As the dummy variable statistics were substantially the same in each regression, we present results from one regression below. Appendix table 1 presents the estimated coefficients, standard errors, t-statistics, and p-values for all 52 dummy variables indicated in table 1. Estimates were from the regression of quantity of fresh beef purchased on the time variable, time squared, 52 seasonal dummy variables, and 10 BSE announcement variables.

Appendix table 1
Dummy variable statistics

Variable	Estimated coefficent	Standard error	t-statistic	p-value
D1	97262296	3392191	28.67241	0.0000
D2	1.16E+08	3393668	34.23961	0.0000
D3	1.19E+08	3395126	35.06171	0.0000
D4	1.16E+08	3396564	34.11293	0.0000
D5	1.18E+08	3397982	34.78631	0.0000
D6	1.20E+08	3399380	35.31894	0.0000
D7	1.13E+08	3400758	33.26542	0.0000
D8	1.13E+08	3402115	33.25306	0.0000
D9	1.16E+08	3403452	34.22689	0.0000
D10	1.24E+08	3404769	36.53884	0.0000
D11	1.34E+08	3406064	39.31962	0.0000
D12	1.33E+08	3407340	38.89272	0.0000
D13	1.14E+08	3408594	33.46313	0.0000
D14	1.11E+08	3409827	32.42648	0.0000
D15	1.13E+08	3411040	33.26022	0.0000
D16	1.12E+08	3412232	32.68975	0.0000
D17	1.07E+08	3413402	31.20753	0.0000
D18	1.17E+08	3414551	34.18628	0.0000
D19	1.19E+08	3415680	34.92826	0.0000
D20	1.12E+08	3416787	32.84216	0.0000
D21	1.12E+08	3417873	32.86297	0.0000
D22	1.28E+08	3418937	37.41474	0.0000
D23	1.18E+08	3419981	34.40765	0.0000
D24	1.13E+08	3421003	32.90737	0.0000
D25	1.11E+08	3422004	32.50548	0.0000
D26	1.09E+08	3422984	31.91792	0.0000
D27	1.24E+08	3423942	36.30383	0.0000
D28	1.15E+08	3424879	33.65636	0.0000
D29	1.09E+08	3425795	31.75028	0.0000
D30	1.09E+08	3426690	31.84530	0.0000
D31	1.09E+08	3427564	31.83660	0.0000
D32	1.13E+08	3428417	33.07007	0.0000
D33	1.11E+08	3429249	32.23260	0.0000
D34	1.07E+08	3430059	31.13210	0.0000
D35	1.08E+08	3430849	31.56789	0.0000
D36	1.24E+08	3431618	36.05969	0.0000
D37	1.17E+08	3432366	34.04483	0.0000
D38	1.13E+08	3433094	32.78250	0.0000
D39	1.12E+08	3433801	32.57292	0.0000
D40	1.17E+08	3434487	34.17857	0.0000
D41	1.18E+08	3435153	34.40557	0.0000
D42	1.13E+08	3435799	32.77754	0.0000
D43	1.11E+08	3436424	32.23198	0.0000
D44	1.10E+08	3437030	32.01803	0.0000
D45	1.14E+08	3437616	33.24034	0.0000
D46	1.08E+08	3438181	31.32040	0.0000
D47	97154446	3438728	28.25302	0.0000
D48	82445913	3439254	23.97203	0.0000
D49	1.02E+08	3439762	29.54957	0.0000
D50	1.07E+08	3440250	31.10685	0.0000
D51	99386187	3440719	28.88529	0.0000
D52	93292906	3441170	27.11081	0.0000

Source: Economic Research Service/USDA.