Analysis of Marketing Margins under Food Recalls and BSE Outbreaks in the U.S. Beef Industry

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Abstract

It is generally observed that whenever there are cases of disease outbreaks or food recalls, there is a concomitant decline in commodity prices. However, it is still not clear what happens to price spreads among affected agents in the marketing chain. To shed light on this issue, we estimate the collective impact of Bovine Spongiform Encephalopathy (BSE) and food recalls on marketing margins associated with the U.S. beef industry over time. In previous research, the effects of these variables on the market demand of meat were estimated separately. By including these variables together in the same model specification we avoid the possibility of confounding their effects, and we are in position to obtain more precise estimates of elasticities of price transmission along the marketing chain.

Key words: marketing margins, elasticities of price transmission, BSE, food recalls, U.S. beef industry

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Introduction

We analyze the impact of Food Safety Inspection Service (FSIS) recalls and Bovine Spongiform Encephalopathy (BSE) outbreaks on the U.S. beef market, specifically their effects on the marketing margins at farm-wholesale-retail levels of the beef marketing chain. The empirical question is how marketing margins respond to specific market stresses induced by food safety concerns. The two types of food safety variables used in this study are related to food contamination and animal disease. Because the two variables may appear simultaneously in same period of time and some correlation is expected between food contamination and disease outbreaks, it is important to analyze these variables collectively. Since the effect of these two variables may simultaneously appear in some periods of time, this approach will allow us to isolate the impact of each variable on marketing margins associated with the U.S. beef industry using monthly data over the time period of 1982 to 2006. Further, our analysis rests on the use of distributed lag models to take account of the effects of the BSE outbreaks. Our results may aid policy makers to target support to the most vulnerable agents in the marketing channel given the occurrences of food safety incidents.

Marketing margins of the U.S. meat industry have been analyzed rather extensively[4] (Brester and Marsh, 2001). The literature on marketing margins centers attention on the effects of factors such as market concentration, retail demand, farm input supply, and marketing costs (Marsh and Brester, 2004; Armah, 2007). In theory, the structure, conduct, and performance of retail and meat processing sectors may affect farm-wholesale-retail margins, which in turn may affect the level and variability of prices within the marketing channel (Wohlgenant, 1987, Capps et al, 1995). Marsh and Brester (2004) found that increased retail grocery concentration and

[4] See for example marketing margins on USDA website: www.ers.usda.gov .

declining retail grocery productivity significantly increased wholesale-to-retail margins and reduced livestock (cattle and hogs) prices. Schroeter et al. (2000) found little evidence of oligopoly power of meat packing firms but some evidence of oligopsony power by retail grocery firms in the United States. Armah (2007) found that the surge in retail market concentration in 1999 resulted in increased oligopsony power of retailers relative to oligopoly power of wholesalers in the U.S. beef industry. However, variables such as disease outbreaks or food scares rarely have been included in analyses of market margins. To our knowledge, previous works have examined the impacts of food contamination (i.e. food recalls) or disease outbreaks (i.e. mad cow disease or BSE) in isolation, but heretofore, no study relates these market stress variables together in analyzing marketing margins.

The first confirmed cases of BSE in Canada and in the United States had significant effects on trade and prices of U.S. cattle and beef (Coffey et al. 2005; Almas, Collete, and Amosson 2005; Hanrahan and Becker 2006; Mathews, Vaneveer, and Gustafson 2006). Moreover, following BSE outbreaks, the United States announced a series of regulations which required slaughterhouses to remove additional products from cattle and find new ways to dispose of the specified risk materials banned from human or animal consumption (Mathews, Vaneveer, and Gustafson 2006). These new regulations resulted in additional production costs and reduced revenues for beef and beef products. In Figures 1 and 2, we show monthly beef marketing margins at farm-wholesale and wholesale-retail levels from January 1996 to December 2006; the recorded cases of the BSE outbreaks in the United States and Canada; and the beef recalls reported in the United States.

Research on the economic impacts of food safety concerns are mainly focused on demand and food prices. Marsh, Brester, and Smith (2008) examined the two BSE events in the

United States and Canada in 2003 and found minor short-term price effects of BSE events on U.S. cattle prices. They argued that demand for U.S. beef was affected to a much greater extent by the reactions of foreign governments to the BSE announcements in the United States than by the reactions of U.S. consumers. Pigott and Marsh (2004) analyzed the impact of food safety information on the U.S. meat demand. Verbeke, Ward, and Viaene (2000) showed how demographic characteristics, consumption frequency and TV coverage concerning meat safety can negatively impact the consumption of fresh red meat. Marsh, Schroeder, and Mintert (2004) studied the impact of recall events on meat demand in the United States. They found that Food Safety Inspection Service (FSIS) recalls significantly impacted demand. In other instances, Leeming and Turner (2004) found that the 1996 BSE-UK crisis significantly depressed the price of beef. Lloyd et al. (2006) in analyzing the BSE-UK outbreak reported asymmetric responses in the changes in retail and farm prices. That is, BSE events induced prices to fall at the producer level more than double than corresponding prices at the retail level.

There are very few studies which investigate the impacts of food safety concerns on marketing margins, specifically the impact of BSE events on marketing margins of the U.S. beef industry. Saghaian (2007) investigated the impact of the 2003 BSE case in the United States on the dynamics of price adjustment and causality within the U.S. beef marketing channel. He reported that with the discovery of BSE, price transmission was bi-directional and price adjustment was asymmetric with respect to both speed and magnitude. The results indicated differential impacts of the BSE shock on producers and retailers, which led to widening price spreads at different levels of the beef marketing chain. Saghaian (2007) focused solely on the impact of BSE discovered in December 2003 in the United States. Because the beef industries in the United States and Canada are highly integrated and as the Canadian BSE case was

discovered in May 2003 just a few months before the U.S. BSE outbreak, it is possible that the cumulative effects of the Canadian BSE outbreak still persisted within the United States. It would be, therefore, reasonable to model the effect of the Canadian BSE case in analyzing the impact on marketing margins of the U.S. beef industry. Moreover, as reported by Marsh, Schroeder, and Mintert (2004), because food recalls also can significantly affect consumer demand, it is important to analyze the collective impact of these variables on marketing margins for beef.

The Model

Our work primarily is based on the Relative Price Spread (RPS) Model, wherein assuming profit maximization, firms are expected to provide marketing services until the marginal value of such services are equal to marginal cost. Mathematically, this relationship can be represented as $M = K(Q,C)$, where M is the marketing margin or price spread; the function K represents the marginal cost of marketing services, Q represents the quantity of the beef processed and C is the vector of marketing input prices (wages, energy costs). Wohlgenant and Mullen (1987), in investigating the farm-retail price spread associated with the U.S. beef industry, developed the basic specification for price spread or marketing margin as $M = P_r K(Q,C/P_r)$, where $M = P_r - P_f$, P_r is the retail price, and P_f is the price of farm output.

Before Wohlgenant and Mullen (1987), the most common approach to modeling price spreads was based mainly on the Markup Price Model (MPM). The MPM model assumed that the margin is a combination of both percentage and constant absolute amounts. Gardner (1975) pointed out that with this approach, the relationship between farm and retail prices can be depicted accurately only if changes occur solely in supply or demand, not both. Wohlgenant and

Mullen (1987) introduced the RPS model to allow simultaneous changes in both demand and supply.

Wohlgenant and Mullen (1987) posited that in contrast to the markup pricing model, with the RPS there is no fixed relationship between the price spread and the retail price. This relationship is based on the theory that shifts in retail demand and farm supply have two possible avenues of influence on the farm-retail price spread, namely quantity of output and retail price. Increases in output and increases in relative marketing costs lead to higher relative price spreads.

Advancing the RPS model, Capps, Byrne, and Williams (1995) estimated the relative price spread associated with the U.S. lamb industry. Unlike the Wohlgenant and Mullen (1987) model, they decomposed the farm-to-retail relative price spread into slaughter-to-wholesale and wholesale-to-retail segments. Further, they incorporated packer concentration in the slaughter-to-wholesale specification with allowance for economies of scale. In addition, the respective price spread models were estimated as a system of equations (SUR model) to capture gains in efficiency. Capps, Byrne, and Williams (1995) also estimated elasticities of price transmission (EPT) to take account of the responsiveness of downstream prices due to changes in upstream prices along the marketing channel. Using the aforementioned theoretical framework and its extensions, we center attention on how elasticities of price transmission react to incidences of market stress (e.g. food recalls and BSE).

Derived from Capps et al. (1995) and Wohlgenant and Mullen (1987), the empirical analogue of the RPS model can be represented as

(1) $$M_t = b_1 P_{rt} + b_2 P_{rt} Q_t + b_3 IC_t + e_t$$

where M_t is the price spread for beef, P_{rt} is the retail price of beef ($/lb), IC_t is the index of marketing costs for beef, and Q_t is the per capita quantity of beef produced. Following Capps et

al. (1995), the augmented RPS model used for this study includes the effect of beef packer concentration at the farm-to-wholesale level as well at the wholesale-to-retail level; the second adjustment includes the potential effects of seasonal fluctuations in beef demand; and finally, adjustments were made to take account of effects of FSIS food recalls and BSE outbreaks in the United States and Canada. Our empirical Augmented Relative Price Spread (ARPS) model is given by equations (2) and (3).

$$(2)\quad M_{fwt} = \beta_1 P_{wt} + \beta_2 P_{wt} Q_{wt} + \beta_3 ICT_t + \gamma_1 TOP4_{wt} + \phi_1 R_{1t} + \phi_2 R_{2t} + \phi_3 BSE_{usat} + \phi_4 BSE_{cant} + \varepsilon_{wt}$$

$$(3)\quad M_{wrt} = \alpha_1 P_{rt} + \alpha_2 P_{rt} Q_{rt} + \alpha_3 ICT_t + \tau_1 TOP4_{rt} + \theta_1 R_{1t} + \theta_2 R_{2t} + \theta_3 BSE_{usat} + \theta_4 BSE_{cant} + \varepsilon_{rt}$$

With the ARPS model, we analyze the farm-to-wholesale (M_{fw}), wholesale-to-retail (M_{wr}) and farm-to-retail margins ($M_{fr} = M_{wr} + M_{fw}$) in price equivalent retail weight terms (cents/pound). P_{wt} and P_{rt} correspond to wholesale prices and retail prices respectively expressed in cents/ pound; Q_{wt} and Q_{rt} are the monthly per capita disappearance of beef in pounds at the wholesale and retail levels of the marketing chain; ICT is an index of marketing costs associated with the food industry; $TOP4_{wt}$ and $TOP4_{rt}$ are the top 4-firm concentration ratios (%) at the wholesale (beef slaughter plants) and retail (box-beef packing plants) levels of the industry channel. R_1 indicates the number of all recall cases reported by FSIS while R_2 is a dummy variable to indicate "severe" FSIS recall cases. BSE_{usa} and BSE_{can} are indicator variables, which take into account the effect of the BSE outbreak in the United States and in Canada, considering the integration of North America beef market.

Testable hypotheses include: (1) the marketing margins at different levels of the U.S. beef marketing chain are not affected by FSIS recalls and BSE outbreaks, i.e. $H_{01}: \phi_1 = \ldots = \phi_4 =$

0 and; $H_{02}: \theta_1 = \ldots = \theta_4 = 0$; and (2) the impacts of FSIS recalls and BSE outbreaks are the same on the farm-to-wholesale marketing margin and the wholesale-to retail marketing margin, i.e. $H_{03}: \phi_1 = \theta_1$, …, $H_{06}: \phi_4 = \theta_4$,

An ARIMA model was used to account for contemporaneous correlations of the disturbance terms in equations (2) and (3). The adjustment for seasonality was done by the inclusion of monthly indicator variables. Additionally, the potential effects of R_1, R_2, BSE_{usa}, *and* BSE_{can} may not be felt at once, but instead these effects may be distributed over time. To capture such potential responses, we employ a polynomial distributed lag process associated with these respective variables.

Subsequently, we estimate the elasticity of price transmission (EPT) at the wholesale-retail (EPT_{wr}), farm-wholesale (EPT_{fw}) and farm-retail (EPT_{fr}) level. The EPT estimates reflect the degree of price transmission along segments of the marketing channel, that is, the percentage change in a downstream price due to a one-percent change in an upstream price. An EPT close to zero means no transmission of price signals among the segments of the marketing chain, which may be attributed to imperfect competition or non-price competition (Capps et al. 1995).

Data

Our study relies on the use of monthly data from January 1982 to December 2006. Prices and quantities were collected based on the Red Meat Yearbook 2006[5]. Data for BSE and FSIS recalls were taken from official reports of several federal agencies, all of them available on line. Information on marketing cost indices and market concentration variables were taken from related USDA reports. The sources of data as well as details pertaining to the data are presented in the Appendix.

[5] All these data were checked independently with various USDA personnel.

Prices are expressed as cents per pound of retail weight equivalent. All these prices were adjusted for inflation using the Consumer Price Index (CPI) for food and beverages (1982-84 = 100).

The quantities pertain to per capita beef consumption expressed in pounds. Farm quantity is the total weight sold by feeder lots (quantity bought by slaughter plants). Wholesale quantity is the carcass sold by slaughter plants to fabricating plants (or quantity bought by boxed beef packer), and retail quantity is the amount sold by boxed beef packers to retail stores (quantity bought by retail stores, ready to be sold to consumers)[6]. The retail quantity was constructed on the basis of disappearance of beef, given as commercial meat production, plus imports, less exports, plus beginning stocks, less ending stocks. We then multiplied this quantity by a conversion factor to arrive at a retail weight equivalent of beef. The conversion factor used in this study is 0.74, the factor used in USDA reports from 1982 to 2006.

Four-firm concentration ratios were added to the respective specifications of the model. At the wholesale level, concentration is measured as the percentage of the four largest cattle slaughter firms from total commercial slaughter plants. At the retail level, concentration corresponds to the percentage of output associated with the four largest boxed beef fabricating plants relative to total output.

Marketing costs are incurred in paying wages, transportation/fuel, advertising, energy, and other costs. As specific costs indigenous to the U.S. beef industry were not available, a Food Marketing Cost Index[7] developed by ERS, USDA was used as a proxy. This index is presented on a monthly basis for both wholesaling and retail activities.

[6] Beef quantity includes the disappearance of veal as well. It was not possible to disaggregate beef and veal in the data of exports and imports.

[7] Mr. Howard Elitzak, Agricultural Economist, Economic Research Service (ERS), USDA generously provided

FSIS reported meat recalls were taken from the USDA Food Safety and Inspection Service web site[8] and classified by type of meat (beef, pork, chicken, turkey, and others), by class (class I, II and III), type of events (bacterial and others), and by the amount of meat recalled (greater and less than 1,000 kg). These FSIS recalls were used to form two variables: (1) total recalls, which is the sum of recalls of beef per month; and (2) a dummy variable to identify severe recall cases. This dummy takes the value of one if it is a national recall case, a class I[9] case due to bacterial reasons, or if the amount of meat recalled is greater than 1,000 kg. This dummy variable is assigned a value of zero otherwise (regional recalls, class II or III non-bacterial cases, or if amounts recalled <1,000 kg). Previous research provided some basis for the construction of the food recall dummy variable (Salin et al, 2005; and Marsh et al, 2004).

The BSE cases were taken from the USDA and classified as two dummy variables: (1) BSE in the United States (December 2003 in Washington, June 2005 in Texas and March 2006 in Alabama); and (2) BSE in Canada (May 2003, January 2004, January 2006, April 2006, and June 2006). The reason for isolating BSE from recall cases is to avoid any confounding of their effects as well as to ascertain the individual impacts of BSE cases and recalls on marketing margins for beef.

Empirical Results

The parameter estimates pertaining to equations 2 and 3 for the ARPS model are shown in Table 1. The third column refers to empirical results of the farm-to-retail marketing margin. The software package used to obtain these parameter estimates, standard errors, test statistics and

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these data.

[8] Some data input of recall cases from 1982 to 1994 were generously provided by Dr. Schroeder from Kansas State University.

[9] This class includes the more risky cases.

p-values is EVIEWS 6.0. The goodness-of-fits for the respective empirical models were reasonable, ranging from 0.825 to 0.899. The estimated coefficients of the appropriate downstream beef price are significant at the 1 percent level in all marketing margins of beef. The coefficients of the interaction of price-quantity variables are significant at the wholesale-to-retail level and at the farm-to-retail levels. The coefficients related to the marketing cost index are negative but not significant with exception of the farm-retail margin. The coefficient top 4-firm concentration and recall variables are non-significant in all the marketing margin analyses. The impacts of U.S. BSE outbreaks are significant in the analysis of the wholesale-to-retail margin and in the farm-to-retail margin. The impacts of Canadian in BSE cases are significant in the analysis of the farm-to-wholesale margin and in the farm-to-retail margin. Autoregressive and moving average terms associated with the residuals are needed to fix the serial correlation problem.

The joint significance of the recall variables and the BSE variables (F-statistic = 2.89, p-value = 0.022) indicates their importance in affecting the marketing margins at different levels of the U.S. beef marketing channel. Comparing changes in marketing margins at the farm-to-wholesale level with those at the wholesale-to-retail indicates no significant difference due to R_1 and BSE cases in Canada. However, the changes attributed to BSE in the United States and attributed to R_2 are significant, indicating that the effects of these BSE and recall cases have differential impacts in the beef marketing chain.

In Table 2, we show the distributed lag effects of BSE_{USA} and BSE_{CAN} on the respective marketing margins. For BSE cases reported in the United States, the adjustment is done in two months with an estimated effect of up to 18 cents on the wholesale-to-retail margin (around 23 percent of the average wholesale-to-retail marketing margin). BSE cases in Canada have a

significant effect on the farm-to-wholesale margin. The adjustment also is done in two months at the farm-to-wholesale level (around 35 percent of average farm-to-wholesale marketing margin). Interestingly, both the BSE cases in the United States and Canada are significant for farm-to-retail marketing margin relationships. The adjustment is done in four months with a cumulative effect of about 20 cents (around 21 percent of average farm-to-retail marketing margin) for BSE_{USA} and 18 cents (around 19 percent of average farm to retail marketing margin) for BSE_{CAN}. The two-month and four-month lags are in line with the work of Schlenker and Villa-Boas (2008). They found that reductions in beef sales persisted for three months after the U.S. BSE event in 2003.

As exhibited in Table 3, we report the marginal effects and the elasticities associated with the respective U.S. beef marketing margins. Prices and quantities, as expected, have positive marginal effects on the marketing margins. While the marketing cost index and the four-firm concentration ratios were found to be negatively related to the marketing margins, they were generally non-significant. The marginal effects of BSE cases, either in the United States or Canada have positive influences on marketing margins. Similarly, the effects of recalls R_1 were found to have positive, but non-significant influences on marketing margins. But the R_2 effects of the recalls were positive in the farm-to-wholesale margin and negative in the wholesale-to-retail margin.

The results on elasticities indicate that in general marketing margins are inelastic with respect to both recalls and BSE cases (Table 3). Marketing margins are more sensitive to changes in prices than to changes in other determinants.

Finally, following Capps et al. (1995), the elasticity of price transmission (EPT) from the wholesale-to-retail level (EPT_{wr}) can be estimated from equation 3 as follows:

$$\hat{P}_r(1-\hat{\alpha}_1-\hat{\alpha}_2 Q_r)-\hat{P}_w=\hat{\theta}_1 R_1+\hat{\theta}_2 R_2+\hat{\theta}_3 BSE_{USA}+\hat{\theta}_4 BSE_{CAN}+\hat{\alpha}_3 ICT_r+\hat{\gamma}_1 TOP4_r,$$

Hence,

$$\hat{P}_r=[1/(1-\hat{\alpha}_1-\hat{\alpha}_2 Q_r)]*(\hat{P}_w+\hat{\theta}_1 R_1+\hat{\theta}_2 R_2+\hat{\theta}_3 BSE_{USA}+\hat{\theta}_4 BSE_{CAN}+\hat{\alpha}_3 ICT_r+\hat{\gamma}_1 TOP4_r),$$ and

taking the derivative on P_w, it is $\partial\hat{P}_r/\partial\hat{P}_w=1/(1-\hat{\alpha}_1-\hat{\alpha}_2 Q_r)$. Therefore, EPT_{wr} = $\partial\hat{P}_r/\partial\hat{P}_w * P_w/P_r=[1/(1-\hat{\alpha}_1-\hat{\alpha}_2 Q_r)]*P_w/P_r$. Similarly, from equation 2, the EPT from the farm-to-wholesale level is given as follows: $EPT_{fw}=\partial\hat{P}_w/\partial\hat{P}_f * P_f/P_w=[1/(1-\hat{\beta}_1-\hat{\beta}_2 Q_w)]*$ P_f/P_w. Finally, the EPT from the farm-to-retail level is given by $EPT_{fr}=\partial\hat{P}_r/\partial\hat{P}_f * P_f/P_r=$ $[1/(1-\hat{\delta}_1-\hat{\delta}_2 Q_r)]*P_f/P_r$. Alternatively $M_{fr} = M_{fw} + M_{wr}$ since it is an additive identity. Therefore $EPT_{fr}=(\partial\hat{P}_r/\partial\hat{P}_w*\partial\hat{P}_w/\partial\hat{P}_f)*P_f/P_r = EPT_{fw} * EPT_{wr}$. The empirical results associated with the EPT estimates are presented in Table 4.

In Table 4, we present the EPT estimates over the entire sample period as well as for the four-month period immediately before and immediately after the BSE outbreak either in the United States or Canada. This comparison explores the possibility of a change in the elasticity of transmission due to periods before and after the BSE outbreaks. Over the entire sample period, a one-percent increase in farm prices results in a one-percent increase in wholesale prices. That is, at this level of the marketing channel, the EPT is nearly one. However, at the wholesale-to-retail level, the EPT is 0.97, and at the farm-to-retail level the EPT is 0.89. The EPT, however,

decreases before and after the BSE events, at least within this four-month window. This phenomenon is observed in all three levels of marketing chain.

Final Remarks

We examine the effects of FSIS recalls and BSE cases in the United States and Canada on the marketing margins of the U.S. beef industry at various levels of marketing chain. Most of the previous studies on this topic dealt with food recalls or BSE separately. This study assesses combined effects of both variables in a dynamic context; it includes the lagged effects of beef recalls and BSE outbreaks on the marketing margins assuming that adjustments are not made instantaneously to such events.

As expected, the forces of demand and supply represented by prices and quantities have positive influences on the respective marketing margins. For the most part neither marketing costs nor market concentration have any significant effects on the marketing margins over the period January 1982 to December 2006.

Beef recalls have insignificant impacts on the marketing margins at any level. Changes in marketing margins because of BSE are, however, significant. BSE outbreaks in Canada significantly affect the farm-to-wholesale marketing margin and BSE outbreaks in the United States affect the wholesale-to-retail margin. However, BSE outbreaks, both in Canada and in the United States, significantly affect the farm-to-retail level marketing margin. This effect is passed on in two months from one level to other (i.e. farm-to-wholesale or wholesale-to-retail). However, it takes four months for the BSE outbreaks to pass through the beef marketing chain from the farm-to-retail level. During four months before and after the BSE outbreak periods, the magnitude of the elasticities price transmission decreased, indicating a clear effect on marketing margins.

Some limitations are apparent in this analysis. For example, we used the recall information and reported cases of BSE as a measure to analyze changes in marketing margins. However, consumers may not be aware of such reports unless the general media publicizes such information. Media can fabricate or exaggerate such information. As reported by Schlenker and Villas-Boas (2008), the Oprah Winfrey TV show in 1996 on mad cow disease resulted in cattle futures prices dropping substantially more than the drop observed following the first discovery of BSE in the United States. In other cases, under reporting of some incidents by the media also is possible. Because consumer demand and the marketing margins can be affected by the media, one must be cautious concerning the magnitudes of the changes reported. Finally, this study is based on the national level data; therefore, some care must be taken when extrapolating from our results to shed light on changes indigenous to specific states or regions.

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Appendix

BASIC DATA

Prices: Cents per pound. Retail weight equivalent.

- Farm: Net farm value.
- Wholesaler: Wholesale value.
- Retailer: Beef Retail value: Average retail prices for the selected product as reported by BLS

Source : http://www.ers.usda.gov/Data/meatpricespreads/Data/historicalpricespreads.xls

Quantity: Millions of pounds

- Farm: Results of multiply (Average Live Weight of Cattle Slaughtered under Federal Inspection) X (Number of Commercial Cattle Slaughter). Taken from Livestock Slaughter, NASS, USDA
- Wholesaler: Commercial Beef and Veal Slaughter Production. Taken from Livestock Slaughter, NASS, USDA
- Retailer: Estimated Disappearance for beef and veal was estimated with:

Retail Disappearance = (Commercial production + imports – exports + beginning stock – ending stock) * λ .
Where λ is the conversion factor from carcass to retail weight equivalent. The Conversion factor used was λ=0.74 for beef and $\lambda = 0.83$ for veal.
Taken from Livestock Slaughter, NASS, USDA. Tables of Commercial Beef Production, exports and imports on beef and veal and the begging stock table.
Source: Red Meat Yearbook 2006 Economic Research Service.

Concentration Ratios: Concentration is percentage 4 largest firms over the of total of firms

- Wholesaler: For cattle slaughter plants: commercial slaughter
- Retailer: For boxed beef production firms: U.S. boxed beef production

Source: Packers and Stockyards Statistical Report. 1995, 2000 and 2005 Reporting Years. Based in Livestock and Poultry Situation and Outlook, ERS-USDA, various issues; and annual reports filed with GIPSA.

Marketing Cost Index:

- Wholesaler: Total food marketing cost index 1987=100
- Retailer: Total food marketing cost index 1987=100

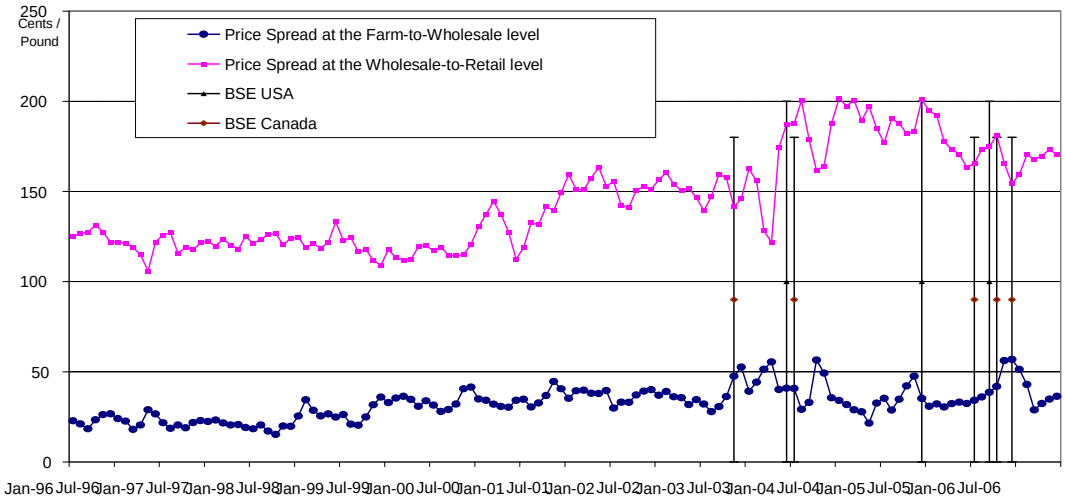
Source: Agricultural Outlook: Statistical Indicators. Several years, Table 9.
http://www.ers.usda.gov/publications/AgOutlook/AOTables/2003/01Jan/table09.xls

Recalls: U.S. Department of Agriculture, Food Safety and Inspection Service (USDA,FSIS). (2007). FSIS Recalls: Recall Case Archive. Updated to September 2007.
URL: http://www.fsis.usda.gov/Fsis_Recalls/Recall_Case_Archive/index.asp

BSE: U.S. Department of Agriculture, Foreign Agricultural Service (USDA, FAS). (2005). Dairy Livestock and poultry Division: Bovine Spongiform Encephalopathy (BSE). Updated to August 2005.
http://www.fas.usda.gov/dlp/BSE/bse.html

CPIF&B: Consumer price index for food and beverages. Index not seasonally adjusted. Source: Bureau of Labor Statistics, Dept. of Labor

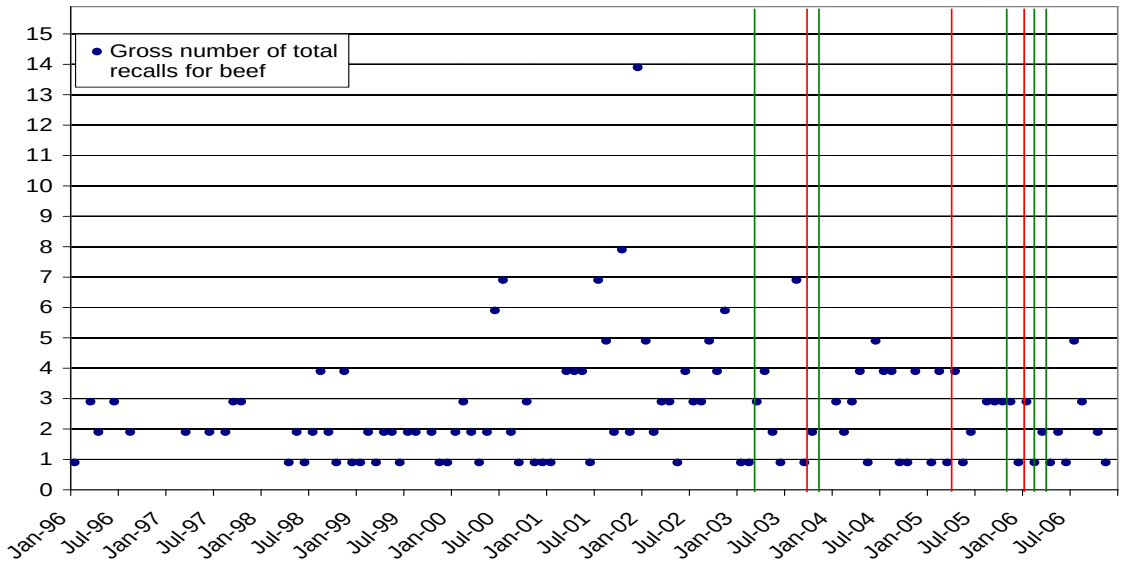
Figure 1



Beef Marketing Margins at the Farm-Wholesale and Wholesale-Retail levels, and BSE outbreak cases in the United States and Canada over the period 1996 to 2006.

Source: USDA Red Meat Yearbook, 2006

Figure 2



Beef recalls in United States, 1996 to 2006.

Source: USDA, Food Safety and Inspection Service (FSIS Recalls), and Foreign Agricultural Service (FAS), Dairy Livestock and poultry Division: Bovine Spongiform Encephalopathy (BSE).

Table 1: Estimates of Marketing Margins

Variables	Farm-to-Wholesale	Wholesale-to-Retail	Farm-to-Retail
Price of Beef (cents/pound)	0.174*	0.323*	0.370*
	(0.027)	(0.057)	(0.015)
Beef Price * Beef Quantity (Per-capita)	0.003	0.007**	0.007**
	(0.002)	(0.003)	(0.002)
Marketing Cost Index (Food & Bev)	-0.006	-0.112	-0.111**
	(0.017)	(0.089)	(0.046)
TOP 4 Firms Concentration Ratio	-0.033	-0.013	0.224
	(0.122)	(0.242)	(0.216)
Beef Recalls (R_1, FSIS gross numbers)	0.076	0.007	0.053
	(0.061)	(0.110)	(0.103)
Beef Recalls (R_2, FSIS severe cases)	0.287	-0.826	-0.178
	(0.360)	(0.665)	(0.612)
PDL1: Lag Distribution of BSE in USA	1.300	7.262*	3.491**
	(1.044)	(2.390)	(1.693)
PDL2: Lag Distribution of BSE in Canada	2.453*	2.243	3.065**
	(0.929)	(2.167)	(1.423)
AR(1)	1.313*	1.582*	0.606*
	(0.160)	(0.091)	(0.115)
AR(2)	-0.321*	-0.583*	0.920*
	(0.157)	(0.089)	(0.029)
AR(3)			-0.540*
			(0.103)
MA(1)	-0.527*	-0.495*	0.487*
	(0.158)	(0.092)	(0.118)
MA(2)	-0.231*	-0.389*	-0.792*
	(0.088)	(0.064)	(0.093)
MA(3)			-0.282*
			(0.069)
R-squared	0.825	0.846	0.899
Adjusted R-squared	0.810	0.833	0.890
S.E. of regression	1.779	3.817	3.398
Sum squared residuals	863.6	3977.2	3094.9
Log likelihood	-578.5	-804.5	-761.1
Mean dependent variable	18.099	78.233	96.339
S.D. dependent variable	4.085	9.343	10.229
Akaike info criterion	4.064	5.591	5.366
Schwarz criterion	4.351	5.878	5.680
Durbin-Watson Stat	1.995	1.992	1.956

Notes: Convergence at 17, 36 and 26 iterations respectively. Monthly dummies are not presented due to space limitations
Standard errors are presented in parentheses. * indicate 1, ** 5, and *** 10 percent significance level.

Table 2: Effects of Lag Distributions of BSE on Marketing Margins

Lag Distribution of BSE_{USA}	Farm-to-Wholesale	Wholesale-to-Retail	Farm-to-Retail
	0.97518	5.44655	2.909
0	(1.24487)	(3.03782)	(2.062)
	1.30024	7.26207	4.655
1	(1.24487)	(3.03782)	(2.062)
	0.97518	5.44655	5.237
2	(1.24487)	(3.03782)	(2.062)
			4.655
3			(2.062)
			2.909
4			(2.062)
	3.2506	18.1552	20.364
Cumulative Effect	(1.24487)	(3.03782)	(2.062)
Lag Distribution of BSE_{CAN}			
	1.83993	1.68228	2.554
0	(2.63916)	(1.03505)	(2.153)
	2.45325	2.24304	4.087
1	(2.63916)	(1.03505)	(2.153)
	1.83993	1.68228	4.598
2	(2.63916)	(1.03505)	(2.153)
			4.087
3			(2.153)
			2.554
4			(2.153)
	6.13312	5.60761	17.881
Cumulative Effect	(2.63916)	(1.03505)	(2.153)

t-statistics are reported in parentheses

Table 3: Marginal Effects and Elasticities Associated with the Farm-to-Wholesale, Wholesale-to-Retail and Farm-to-Retail U.S. Beef Marketing Margins[a]

Variables	Farm-to-Wholesale		Wholesale-to-Retail		Farm-to-Retail	
	Marginal Effects	Elast	Marginal Effects	Elast	Marginal Effects	Elast
Price wholesale	0.201	1.44				
Price retail			0.368	0.97	0.414	0.88
Qty wholesale	0.398	0.19				
Qty retail			1.459	0.12	1.415	0.09
Marketing Cost	-0.006	-0.14	-0.112	-0.59	-0.111	-0.47
TOP-4 Wholesale	-0.033	-0.11				
TOP-4 Retail			-0.013	-0.01	0.224	0.17
R_1	0.076	0.01	0.007	0.00	0.053	0.00
R_2	0.287	0.02	-0.826	-0.01&	-0.178	0.00
BSE_{USA}	1.300	0.21	7.262	0.27&	3.491	0.10
BSE_{Canada}	2.453	0.67	2.243	0.14&	3.065	0.15

[a] Estimated at the sample means of the data.

Table 4: Elasticity of Price Transmission in the Beef Marketing Chain in three periods: entire period average, four-month average before and four-month average after BSE events.

	Entire period average		Average of four months before BSE events		Average of four months after BSE events	
Marketing level	EPT	Std Dev	EPT	Std Dev	EPT	Std Dev
Farm-to-Wholesale	1.07	0.041	1.05	0.028	1.02	0.032
Wholesale-to-Retail	0.97	0.088	0.92	0.043	0.89	0.038
Farm-to-Retail	0.89	0.099	0.83	0.039	0.78	0.031