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The Effects of Mad Cow Disease on U.S. Live Cattle Futures Price

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Due to red meat consumption, bovine spongiform encephalopathy (BSE) disease has been a major human health concern since its discovery in 1986. An event study approach was applied to determine the impact of BSE official events that occurred in the United Kingdom on U.S. live cattle futures prices. When abnormal returns were aggregated during the course of the events, the price series were adversely affected, mainly after the event day. This suggests that market reaction was dissipated quickly and that no leakage of information occurred prior to the event.

Key Words: abnormal returns, bovine spongiform encephalopathy, event study, live cattle futures price

JEL Classifications: Q11, Q13, Q14, Q17

Live cattle futures prices are driven by factors that can, or have the potential to, influence supply and demand of red meat. Concerns about the safety of red meat for humans may play a major role on the demand side. This might cause live cattle futures prices to deviate from the historical price pattern during the period in which a health event is in evidence.

Several studies have investigated the impact of a specific health hazard, linked to red meat consumption, on live cattle futures prices. Kinnucan et al., studying the effects of health information and generic advertising on U.S. meat demand, suggested that meat consumption patterns are influenced by relative prices, total meat expenditures, and health information with no evidence on advertising effects. A similar study done by Capps and Schmitz confirmed that health concerns related to cholesterol could be recognized as a nonprice factor that may have reduced meat consumption over the long term. McKenzie and Thomsen, analyzing effects of U.S. Department of Agriculture (USDA) *Escherichia coli* O157:H7 recalls on wholesale and farm beef prices, found that the recalls reflected in adverse boneless beef price movements had little impact on the price of other wholesale beef and little, if any, impact on live cattle futures prices.

Since 1986, a major health concern that has been observed in the United Kingdom, and then throughout the world, is bovine spongiform encephalopathy ([BSE] mad cow disease) and its linkage to human Creutzfeldt-Jakob disease (CJD) due to the consumption of red meat. Since then, the world has been notified of the development of these fatal diseases in the United Kingdom and further outbreaks in other countries. Using similar approaches to the studies cited above, the objective of this study was to examine the impacts of official events related to the BSE cases that occurred in the United Kingdom on U.S. live cattle futures prices.

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The BSE Story

BSE is a relatively new disease in cattle. It was first recognized in the United Kingdom and defined in November 1986 as transmissible spongiform encephalopathy (TSE). During the next few years, the epidemic grew considerably and affected all parts of the country to different degrees. BSE occurs in adult animals of both sexes, typically in 4 and 5 year olds. It is a neurologic disease involving pronounced changes in mental state and abnormalities in posture, movement, and sensation. The clinical disease usually lasts several weeks and is progressive and fatal (*The BSE Inquiry: The Report*).

Summary of Most Significant BSE Events (The BSE Inquiry: The Report)

November 1986

Pathologists at the Central Vet Laboratory (CVL) identify degenerative changes in brain samples of diseased cattle similar to scrapie-infected sheep brain. Scrapie is another type of TSE that has been endemic in the sheep population of the United Kingdom for nearly 200 years.

May 1987

The same pathology was confirmed in four different herds, but no publicity was given to the event, even within the CVL.

December 15, 1987

Ninety-five cases were confirmed on 87 different farms. The offal of scrapie-infected sheep was confirmed to be the main cause of the disease.

February 24, 1988

BSE was made a notifiable disease.

May 18, 1988

Prohibition was made on feeding ruminant protein to ruminants (The Ruminant Feed Ban, which was introduced on June 14, 1988).

June 21, 1988

The compulsory slaughter of animals showing symptoms of BSE began.

January 13, 1989

By this date, 2,296 cases of BSE had been confirmed on 1,742 farms.

February 9, 1989

An advisory was given to manufacturers of baby foods not to include ruminant offals in their products.

July 28, 1989

The European Union banned the export of U.K. cattle born before July 1988 and of the offspring of affected females.

November 13, 1989

Specified bovine offal (SBO) was banned for use in human food.

March 1, 1990

The European Union restricted U.K. exports of live cattle to those younger than 6 months.

March 27, 1990

The U.K. government announced the first case of the disease in cattle that had been born after the bans (BABs). The likely source of infection of the early BABs was thought to be ruminant feed in which ruminant protein had been incorporated before the bans. Cross-contamination of feeds was also considered.

May 10, 1990

An announcement was made that a Siamese cat had died of a spongiform encephalopathy. This was considered the first case of feline spongiform encephalopathy. The case resulted in a rash of media comment, speculating on the likelihood of human infection.

June 8, 1990

European Union Council Ministers agreed that bone-in-beef products exported from the United Kingdom must come from holdings where BSE had not been confirmed in the previous 2 years, while boneless beef was required to have obvious nervous and lymphatic tissues removed.

September 24, 1990

A pig inoculated with BSE-infected brain tissue succumbed to the disease. An advisement was made that SBOs should not be fed to any animals.

July 14, 1993

The 100,000th case of BSE was confirmed.

July 27, 1994

The European Union commission decided that existing restrictions on the exports of U.K. beef a) should be replaced with a ban on the export of bone-in-beef products except for cattle that had not been on holdings in which BSE had been confirmed in the previous 6 years, and that b) cattle that had been on such holdings in that time should not be exported unless they had been deboned with the adherent tissues removed.

April 1, 1995

A new national Meat and Hygiene Service was created.

March 20, 1996

The government announced the likelihood that recent cases of CJD in young people had resulted from exposure to BSE before 1989.

By this time, 160,000 infected and 30,000 suspected heads had been slaughtered. Since this last date, the U.K. government has not reported any other event in relation to the BSE cases.

Methodology

Standard event study methods were applied to quantify the impacts of BSE-related events on live cattle futures prices, using procedures similar to those of McKenzie and Thomsen to analyze the effects of USDA *E. coli* O157:H7 on wholesale and farm beef prices. The analysis was based on the observed prices for the 18 days surrounding each event. Live cattle futures prices were collected for the April and October contracts from the Chicago Mercantile Exchange by Prophet Information Services. The interval of 18 days was divided into two periods, described as the normal period and the event period. Three normal periods and three event periods were used for each event to increase the accuracy of the analysis. The arrangement of the periods is illustrated in Figure 1.

Normal periods used in this study correspond to the 8 days within the interval (T_1, T_2) as: $(-12, -5)$, $(-10, -3)$, and $(-8, -1)$, where T_1 is the first day and T_2 is the last day of the normal period. The event period is described as the $(T_2 + 1, t = 5)$ interval. In this case, the number of days for each of the event periods will vary according to the corresponding normal period. First, daily returns for each day in the price series are calculated as:

$$(1) \qquad R_{it} = \ln(P_{it}/P_{it-1}) \times 100,$$

where i refers to the ith BSE event, and P_{it} is the observed daily price (settlement price of each day in the live cattle futures price). Normal returns (R_i), which would be expected to occur in the absence of the event, are then calculated as the arithmetic mean of R_{it} during

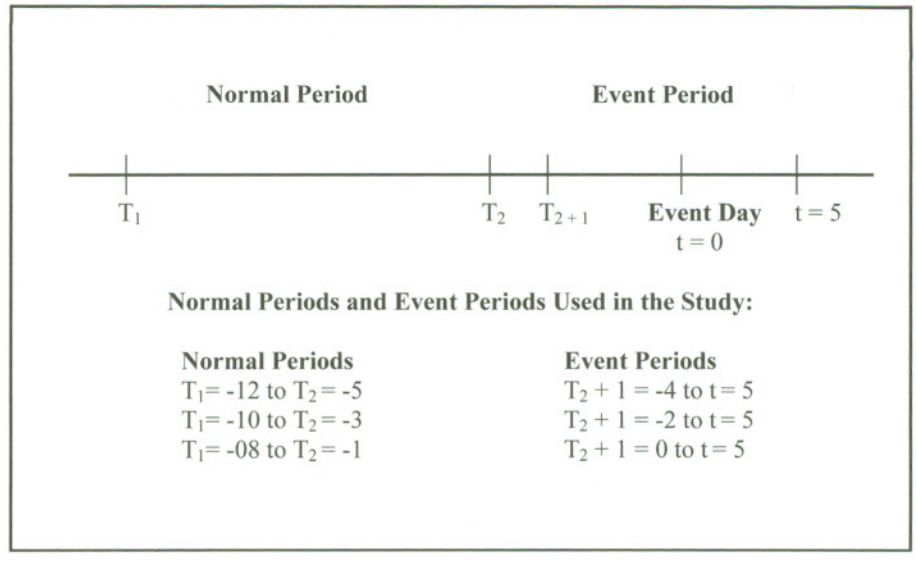

Figure 1. Timeline for the Normal and Event Periods

the 8-day normal period (T_1 to T_2). Abnormal returns, the difference between the actual return (daily return in the event period) and the normal return, are measured for the *i*th event on each day in the event time for each BSE event as:

$$(2) \quad AR_{it} = R_{it} - \bar{R}_i.$$

These abnormal returns are then averaged across the *N BSE* events in the sample to obtain the mean abnormal return for each day in the event time:

$$(3) \quad AR_t = \frac{1}{N}\sum_{i-1}^{N} AR_{it}.$$

To determine the total reaction of a price series to the *BSE* case, we aggregate the abnormal returns over time into a cumulative abnormal return (*CAR*) measure:

$$(4) \quad CAR_{(\tau_1,\tau_2)} = \sum_{t=1}^{\tau_2} AR_t.$$

$CAR(\tau_1, \tau_2)$ reflects the total impact of an event during any given τ_1 to τ_2 interval, where $T_2 + 1 < \tau_1 < \tau_2 < 5$. Thus, *CAR* accounts for the possibility that the impact of the *BSE* events can occur for more than 1 day. This method can account for the possibility of information leakage prior to the official announcement date. When *CAR* is negative, the *BSE* events are assumed to have a negative impact on the live cattle futures prices during the period studied.

The hypothesis:

$$H_O: \quad CAR_{\tau_1,\tau_2} \geq 0$$

$$H_A: \quad CAR_{\tau_1,\tau_2} < 0$$

can be tested using the parametric test statistic (Z_p).

$$(5) \quad Zp = \frac{CAR_{(\tau_1,\tau_2)}}{\sum_{t=\tau_1}^{\tau_2} s_t^2}$$

where

$$s_t^2 = \frac{\sum_{T_2}^{T_2} (AR_t - AR)^2}{7}$$

$$AR = \frac{1}{8}\sum_{t=T_1}^{T_2} AR'_t$$

$$AR'_t = \frac{1}{N}\sum_{i=1}^{N} AR'_{it}.$$

The standard deviation (s_t^2) is calculated for

Table 1. Abnormal Returns and Test Statistics for the $t = -12$ to $t = -5$ Normal Period

	April Contract		October Contract	
Event Day	Abnormal Returns	Z_p Test Statistic	Abnormal Returns	Z_p Test Statistic
−4	−0.0643	−0.3354	−0.1774	−1.0604
−3	0.2118	1.1043	0.2026	1.2112
−2	0.0562	0.2932	−0.1059	−0.6329
−1	0.1905	0.9931	0.0403	0.2407
0	−0.0457	−0.2383	−0.0884	−0.5285
1	−0.1764	−0.9195	−0.2410	−1.4406*
2	0.1844	0.9617	−0.0427	−0.2551
3	−0.2183	−1.1384	0.0374	0.2239
4	0.0658	0.3433	0.2630	1.5724
5	−0.0447	−0.2331	−0.0102	−0.0611

Note: Single asterisks (*) denote significance at the 10% level.

the normal period, where AR'_{it} and AR'_{t} are the abnormal return and the mean abnormal return for the normal period, respectively. If the interval $CAR(\tau_1, \tau_2)$ consists of 2 days, then:

(6) $$\sum s_t^2 = 2 \times s_t^2.$$

Under the null hypothesis, Z_p follows a unit normal distribution as the number of events becomes large. When $\tau_1 = \tau_2 = t$, $CAR(\tau_1, \tau_2) = AR_t$. Hence, Z_p can be used to test the significance of AR_t.

Table 2. Significant Cumulative Abnormal Returns (*CAR*) and Test Statistics for the April Live Cattle Futures Contract Price Series

Normal Period	Interval (τ_1, τ_2)	*CAR*	Z_p Test
−10, −3	0, 5	−0.1503	−4.6311***
−10, −3	0, 4	−0.1197	−3.0732***
−10, −3	0, 3	−0.1996	−4.0999***
−10, −3	0, 1	−0.1939	−1.9910**
−10, −3	1, 5	−0.1187	−3.0472***
−10, −3	1, 4	−0.0881	−1.8089**
−10, −3	1, 3	−0.1680	−2.5877***
−10, −3	3, 5	−0.1550	−2.3865***
−8, −1	0, 5	−0.3590	−10.3741***
−8, −1	0, 4	−0.2936	−7.0702***
−8, −1	0, 3	−0.3388	−6.5257***
−8, −1	0, 2	−0.0997	−1.4409*
−8, −1	0, 1	−0.2635	−2.5376***
−8, −1	1, 5	−0.2926	−7.0459***
−8, −1	1, 4	−0.2272	−4.3768***
−8, −1	1, 3	−0.2724	−3.9348***
−8, −1	2, 5	−0.0956	−1.8408**
−8, −1	3, 5	−0.2593	−3.7461***
−8, −1	3, 4	−0.1939	−1.8674**

Note: Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels, respectively (two-tailed test).

Results

Table 1 describes the average abnormal returns and the Z_p test statistics for each day of the event periods that are based on the (−12, −5) normal period for both April and October live cattle futures contracts. Analyzing these specific data, we can conclude that significant impacts of the *BSE* events on live cattle futures prices are observed only on the first day after the event for the October contract. Although the average abnormal returns are negative for both contracts on the event day ($t = 0$), none of them are statistically significant. Hence, there is little evidence to affirm that the price series analyzed that was based on the (−12, −5) normal period was negatively affected by *BSE* cases.

The negatively significant *CAR* measurements and their respective test statistic (Z_p) are expressed in Table 2 for the April contract price series. *CAR* indicates an aggregation of the average abnormal returns for several days in the event period (interval) for each normal period studied: (−12, −5), (−10, −3), and

Table 3. Significant Cumulative Abnormal Returns (*CAR*) and Test Statistics for the October Live Cattle Futures Contract Price Series

Normal Period	Interval	*CAR*	Z_p Test
−12, −5	1, 1	−0.2410	1.4406*
−10, −3	−2, 3	−0.2087	−8.0754***
−10, −3	−2, 2	−0.2781	−8.9655***
−10, −3	−2, 1	−0.2673	−6.8950***
−10, −3	−1, 3	−0.1348	−4.3454***
−10, −3	−1, 2	−0.2041	−5.2652***
−10, −3	−1, 1	−0.1934	−3.7408***
−10, −3	0, 3	−0.2070	−5.3379***
−10, −3	0, 2	−0.2763	−5.3450***
−10, −3	0, 1	−0.2656	−3.4246***
−10, −3	1, 3	−0.1505	−2.9106***
−10, −3	1, 2	−0.2198	−2.8348***
−10, −3	1, 1	−0.2091	−1.3480*
−8, −1	0, 3	−0.1432	−3.9147***
−8, −1	0, 2	−0.2285	−4.6848***
−8, −1	0, 1	−0.2337	−3.1941***
−8, −1	1, 3	−0.1027	−2.1046**
−8, −1	1, 2	−0.1880	−2.5689***
−8, −1	1, 1	−0.1931	−1.3199*

Note: Single, double, and triple asterisks (*) denote significance at the 10%, 5%, and 1% levels, respectively (two-tailed test).

(−8, −1). This measurement can determine any significant impact of an event on a price series if the market reaction is dissipated. In this case, there were no significant negative values for *CAR* during the event period that was based on the (−12, −5) normal period. However, there is strong evidence to support the impact of the *BSE* events on the April live cattle futures prices during the intervals before and after the event day that were based on the (−10, −3) and (−8, −1) normal periods.

Table 3 expresses the *CAR* and Z_p test statistics for the October live cattle futures contract. As noted in the April contract, negative and significant *CAR* values for the October price series also present strong evidence to support a negative effect of the *BSE* case on the live cattle futures prices during intervals before and after the event day. For the (−12, −5) normal period, only the (1, 1) interval demonstrated a significant impact of *BSE* events.

Overall, the *CAR* and Z_p values support a significant negative impact of *BSE* events on the April and October live cattle price series for intervals corresponding to event periods that were based on (−10, −3) and (−8, −1) normal periods, but these values provide little or no evidence for intervals corresponding to the event period that was based on the (−12, −5) normal period. These results lead to an analysis that is based on the time frame of the intervals studied. The normal period (−12, −5) and its event period (−4, 5) correspond to intervals with the largest number of days prior to the event date (Figure 1). Therefore, any impact of the *BSE* cases in the United Kingdom on the U.S. April and October live cattle futures prices cannot be identified, even in a short period prior to the event day. That is, there is no reason to support any leakage of information or any response from the market before the event day. The geographic distance of the event place and the market analyzed in the study may have contributed to this latter statement. On the other hand, when the price series were analyzed using intervals closer to the event day, there is strong evidence of a negative impact of the BSE events on live cattle prices.

Implications

The BSE situation in the United Kingdom adversely affected U.S. April and October live cattle futures prices during the course of the event. The price series were mainly affected after the event day, showing little evidence of a negative impact before that date. The negative impact of a public health concern on an agriculture commodity price found in this study is similar to that found in previous works on a related topic.

References

BSE Inquiry. *The BSE Inquiry: The Report—The Inquiry into BSE and Variant CJD in the United Kingdom.* Internet site: www.bseinquiry.gov.uk (Accessed March 15, 2002).

Capps, O., Jr., and J.D. Schmitz. "A Recognition of Health and Nutrition Factors in Food De-

mand Analysis." *Western Journal of Agricultural Economics* 16(July 1991):21–35.

Kinnucan, H.W., H. Xiao, C.J. Hsia, and J.D. Jackson. "Effects of Health Information and Generic Advertising on U.S. Meat Demand." *American Journal of Agricultural Economics* 79(February 1997):13–23.

McKenzie, A.M., and M.R. Thomsen. "The Effect of *E. coli* O157:H7 on Beef Prices." *Journal of Agricultural and Resource Economics* 26,2(December 2001):431–44.

Prophet Information Services. *Historical Futures Data, 1959—Present.* Palo Alto, CA: Prophet Financial Systems, 2000.