Agris on-line Papers in Economics and Informatics

Volume III Number 1, 2011

Consequences of BSE disease outbreaks in the Canadian beef industry

J. Stephen Clark[1], L. Čechura[2]

[1]Nova Scotia Agricultural College Abstract
[2]Czech University of Life Sciences Prague

Abstract

This study examines farm to wholesale prices spreads to measure the impact of the BSE disease outbreak on the Canadian beef industry. The study uses structure break tests developed by Gregory and Hansen (1996) and Hansen (1992) examine possible breaks within co integrating relationships. The study finds evidence that the industry began realignment as a result of the UK BSE disease outbreak, and the Canadian BSE disease outbreak was simply the largest realignment of the process beginning with the UK disease outbreak. However, the only statistically significant break was the BSE disease outbreak itself in May 2003. Stability was not restored until the border was reopened in 2005. Specific results indicated that the processing sector exploited the border closure in May 2003 to enhance its market power and that the system returned to a competitive one after the border re-opened in July 2005.

Key words

Beef industry, price transmission, BSE, market power, parameter instability, cointegration with structural break

Introduction

The BSE disease outbreak was one of the most devastating events in the Canadian beef industry. For the two years when the US market was unavailable to live cattle imports, Canadian beef producers had little choice but to supply cattle to that the Canadian beef local Canadian meat producers. There is much controversy surrounding these events, in particular if the processing industry used the crisis to enhance their profits.

This paper will explore the extent to which the beef processing sector was able to use its market power exploit the ban resulting from the BSE disease outbreak. In general, the extent to which the processing sector was able to do this would depend on its market power. There are two types of ways the processing sector could use market power within the BSE crisis that will be explored in this study:

1) The processing sector could have had pre-existing market power and was able to use this to extract profit from the primary beef industry due to the special circumstances surrounding the BSE crisis; and
2) The processing industry could have used the BSE crisis it enhance its market power.

This study will explore market power in the beef processing industry with special reference to BSE disease outbreaks in the beef industry. Specifically, interest centers not only if the Canadian beef industry was able to exploit BSE disease outbreaks because it did have market power, but also if the beef industry was able to enhance its market power position as a result of the BSE outbreak.

Measuring the extent of market power and testing for the existence of Market power has a long history in the literature. For example, Quagrainie et al. (2003) tested for market power using a structural model and Muth et al. (1999) used a conjectural variation approach.

As an econometric problem, this analysis investigates the extent and timing of structural breaks in the spread of farm to wholesale beef prices in Canada. Interest centres both the existence and timing of a structural break and a possible change in market power resulting from the break. The literature on structural breaks is a large and growing one, beginning with Chow (1960), and Quandt (1960) for the case of stationary data with more modern examples including Hansen (19991a) and Gregory and Hansen (1996), for the case of non-stationary data.

The results of this study indicate that there was a large and striking structural change between farm and wholesale prices in the Canadian beef industry that resulted from the discovery of BSE in Canada in May 2003: There is significant evidence that the Canadian processing industry used the BSE to enhance its market power within the marketing chain. This study also finds that there was also evidence of an, albeit smaller, realignment of market relationships between processing and farm pricing relationships resulted from the earlier BSE disease outbreak in the UK. This latter result is somewhat unique to the literature of the BSE in Canada and gives credence to the argument made by, for example Le Roy and Klein (2005) and Loppacher and Kerr (2004) that the Canadian beef industry could have been better prepared for a disease outbreak. The results of this study indicate that the UK disease outbreak began a process of realignment in the Canadian beef market, with the largest adjustment with the border closure resulting from the Canadian BSE disease outbreak in May 2003 and culminating with the reopening of the border in July 2005.

This study is organized as follows. The next section describes the price spreads within the Canadian beef market. A model of market power is introduced after that. This is followed by a discussion of the econometric specification and testing procedures. Data and data sources are then presented along with empirical results. The final section concludes.

Price spreads within the Canadian beef market

Figure 1a presents a plot of the farm price, wholesale price and the retail price indexes of beef in Canada from 1986:01-2009:12. The sample covers a time period of trade liberalization due to the implementation of CUSTA in 1989 and NAFTA in 1994. The plot indicates that the farm price of beef is somewhat more volatile than the wholesale price. The retail price and the wholesale price indexes tend to track one another fairly consistently. Interest in the BSE concentrates on May 2003 and the plot clearly shows a dramatic shift in the relationship among different levels of the market, with a much greater drop in farm prices than those in the retail and wholesale levels of the market. The wholesale to retail price spread does not display the same dramatic shift during the BSE as the farm to wholesale price spread, indicating that the dramatic effects of the BSE did not seem to extend beyond the wholesale to farm price spread. This study will examine the extent of market power by econometric evaluation of the price spread between farm and wholesale prices. This spread is plotted in figure 1b. The plot is very suggestive of a peculiar relationship during the time period when raw beef imports were banned into the US (between May 2003 and July 2005). The spread is particularly dramatic between farm and wholesale price spreads during the early time period of BSE ban. After the ban ended, there seems to indicate a return to “normal”.

While the informal eyeballing of the data is highly suggestive of a structural break in the Canadian beef industry because of the BSE disease outbreak and the ban on beef exports to the US, such informal techniques are subject to data snooping and measurement without theory. Furthermore, other structural breaks in the series do not seem evident from visual inspection techniques. The following two sections explore a theoretical and empirical apparatus that can formally test the existence of a structural break in the series together with its relationship to the market power of the processing sector.

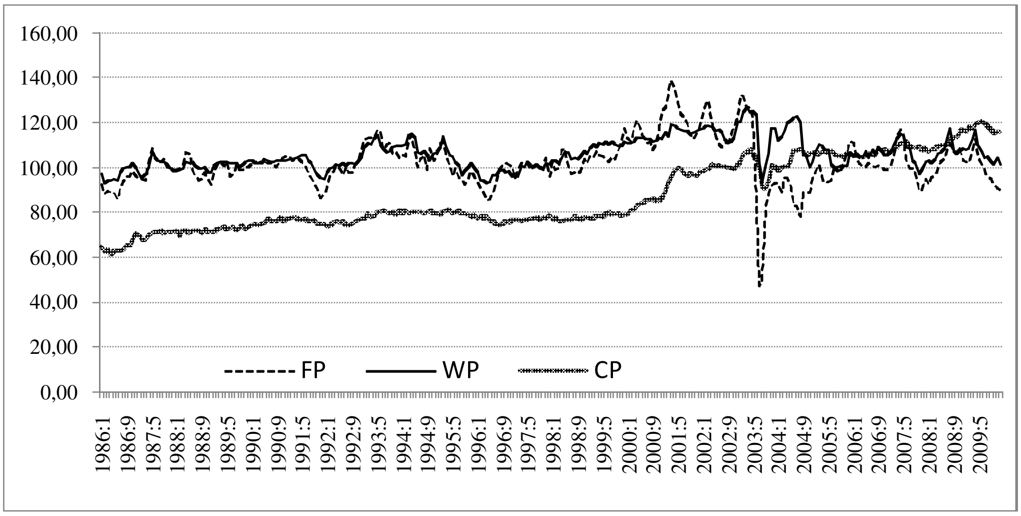
A model of market power in the Canadian beef industry

The model developed in this section is a basic farm to wholesale marketing margin model. Other studies that have used the same theoretical structure include Bakucs and Ferto (2006), Bojnec (2002) and Jumah (2000).

Consider a homogeneous product produced using a constant returns to scale technology (e.g. McCorriston et al. (2001)). Given these assumptions, then it is sufficient to examine the characteristics of the marketing margin to explain market power. The price margin between farm and wholesale prices:

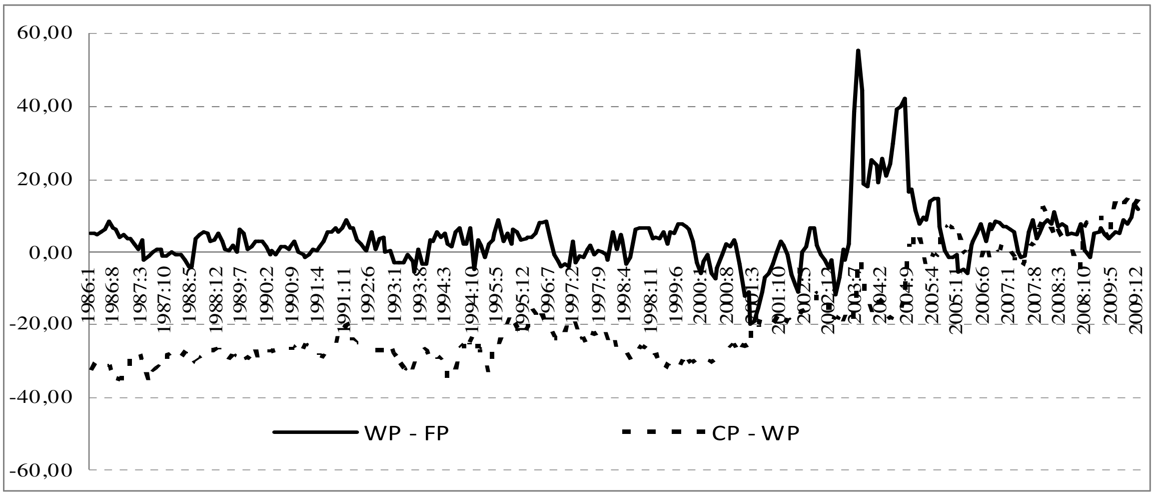
$$M_t = WP_t - FP_t, \quad (1)$$

where M is the marketing margin (price spread), WP for wholesale price and FP is the farm price.



Source: Statistics Canada 2010a, 2010b and 2010c. Notes to table: FP-farm price, WP-Wholesale price, RP-retail price

Figure 1a: Farm Price, Wholesale Price and Consumer price index (1997=100).



Source: Statistics Canada 2010a, 2010b and 2010c. Notes to table: FP-farm price, WP-Wholesale price, RP-retail price

Figure 1b: Changes in price spreads within the Canadian beef market.

Assuming the price is determined by the processor a mark-down rule is defined as:

$M_d = c + dFP,$ (2)

where M_d is the mark-down. The constant term c represents the marginal cost of marketing and slope parameter d ($0 \le d < 1$) indicates the market power of processing sector. The slope d expresses how much the marketing margin can be increased due to their market power.

Substituting (2) for M into (1) and rearranging results in:

$$FP_t = -\frac{c}{1+d} + \frac{1}{1+d} WP_t \ , \qquad (3)$$

If the parameter d is equal to 0, the constant term reduces to c and the slope term is equal to 1. This would indicate a perfect price transmission model and no market power. However, if parameter d is not equal to 0, the slope parameter in (3) is less than 1, indicating that the processing sector has market power over the farm sector. If the prices in equation (3) are in logarithms, the slope parameter in equation (3) is a price transmission elasticity.

Addition assumptions made with respect to equation (3) include that it is a long-run relationship between prices and represents a sub-game perfect equilibrium of a dynamic repeated game. Structural change is measured as a change in the parameters of equation (3) resulting from an event at time t. The change can be in the intercept of the model (3), due to the change in the marketing costs, or in the slope due to a change in market power or both.

Estimation and testing for structural breaks in non-stationary time series

The marketing margin model given by equation (3) is estimated and then tested for a structural break. It has long been known that the estimation strategies and test statistics for structural breaks depend on the time series properties of the data.

The data are tested for a unit roots using an augmented Dickey Fuller (ADF) test (Dickey and Fuller (1979)) to determine the order of integration, I (d). If the time series is non-stationary with a single unit root the next question is if the time series are cointegrated, i.e. if there is a long-run relationship among time series. The empirical section uses two approaches to test for cointegration: The Engle-Granger (1987) two-step approach and the Johansen (1988 and 1991) maximum likelihood approach.

This study will analyze two possible impacts on the retail to farm price spread in the beef industry. First, the processing sector could have used its pre-existing market power to enhance its profits due to border restrictions related to the BSE disease outbreak. Second, the processing sector could have used the border closing as a pretext to change its market power relationship with the beef farm sector. While the former is related to a stable pre-existing relationship in the marketing margin given by equation (3), the latter is related to a change in the marketing margin relationship itself.

From an econometric perspective, interest lies in detecting parameter instability of the marketing margin equation (3). Since analysis deals with the impact of BSE disease outbreak on price transmission and market structure in Canadian beef industry, interest centres on parameter instability. There are several methods by which parameter instability can be examined with an econometric relationship. Early examples include Chow (1960) and Quandt (1960). In the spirit these tests, Hansen (1992) extends the tests to include cases where the break point is unknown (to avoid data snooping) and regressors are I (1). Other methods that detect parameter instability include threshold estimation methods (e.g. Hansen (2000) and Caner and Hansen (2001)). This study uses methods developed by Hansen (1992) and Gregory and Hansen (1996). This approach is superior to classical threshold models because it allows for regime shifts in long-run relationship that allows the study of a change in market power after the structural shock. A maintained hypothesis used in this study is that the relationship can be well approximated by a linear model. Linearity vs. non-linearity of the relationship, is another methodological issue (see e.g. Hansen, 1999) that is not dealt with.

Hansen (1992) proposed three tests – SupF, MeanF, and Lc – for testing parameter instability in cointegrating relationships. All tests have the same null hypothesis; parameter stability, but differ in their choice of alternative hypotheses. Whereas the SupF test has power to detect a one-time regime shift, the MeanF and Lc tests are appropriate to test the stability of the relationship described by the model. The Lc test is a test of the null of cointegration against the alternative of no cointegration. Since the tests are based on Phillips-Hansen fully modified estimator the estimates of cointegrating vectors are asymptotically efficient.

Gregory and Hansen (1996) proposed extension of ADF, Zt and Zα test (we denote the extended versions of the tests – ADF*, Zt* and Zα*) for cointegration with regime shift in either the intercept or the entire coefficient vector. All test the null of no cointegration against the alternative of cointegration in the presence of a possible regime shift and a break of unknown timing. Three forms of structural change are considered:

Level shift model - C

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha^T y_{2t} + e_t, \qquad t = 1, \ldots, \ n. \quad (4)$$

Level shift model with trend – C/T

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \beta t + \alpha^T y_{2t} + e_t, \quad t = 1, \ldots, \ n. \quad (5)$$

Regime shift model – C/S

$$y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha_1^T y_{2t} + \alpha_2^T y_{2t} \varphi_{t\tau} + e_t, \quad t = 1, \ldots, \ n. \quad (6)$$

where y_{1t} is real-valued and y_{2t} is an m-vector of I(1) variables, e_t is I(0). The parameters μ and α describe the m-dimensional hyperplane that the vector process $y_t = (y_{1t}, y_{2t})$ converges over time.

Let the dummy variable, $\varphi_{t\tau}$, be defined as:

$$\varphi_{t\tau} = \begin{cases} 0 & if \quad t \le [n\tau], \\ 1 & if \quad t > [n\tau], \end{cases} \qquad (7)$$

where $\tau \in (0,1)$ is the unknown parameter which denotes the timing of the break point and $[\ ]$ denotes the integer part.

The shift given by equation (4) (C) represents a level shift in the cointegrating relationship, the shift represented by equation (5) allows for a shift in both level and trend (C/T) and the shift represented by equation (6) allows the both a shift in the slope and intercept term (C/S). The last case allows for a shift in both intercept and slope. That is, the structural change is captured either by change in the intercept μ or changes to the slope α or both. The tests statistics (ADF*, Zt* and Zα*) are computed recursively for each data point in the interval $([0.15n],[0.85n])$ from OLS estimates of cointegrating vectors. The smallest value of the test calculated test within the interval is used to evaluate the null hypothesis.

The C/S shift is particularly relevant for examining the impacts of the BSE on the relationship between wholesale and farm prices. Assuming that the smallest value is obtained for the BSE disease outbreak in May 2003 and is statistically significant, then if the shift in the in the slope parameter went from some value close to unity to some value less than unity, this would indicate that the processing sector went from a position of close to competitiveness to one of increasing market power, i.e. it took advantage of the its special control over the market to enhance its profits. If the value before the BSE was less than unity, then this would indicate a level of pre-existing market power that could be used in the event of the crisis like the border closure resulting from the BSE disease outbreak.

The calculations of ADF test, Hansen (1992) instability test and Gregory-Hansen (1996) tests were carried out in GAUSS. The GLS estimates of long-run relationships were run in RATS software.

Data and results

The data used included data on the farm price (FP) index for beef and veal from Statistics Canada CANSIM database (Statistics Canada, 2010a), a wholesale price (WP) index for beef and veal from Statistics Canada CANSIM database (Statistics Canada, 2010b) and a retail price of beef and veal (RP) from Statistics Canada CANSIM database (Statistics Canada, 2010c). The data are monthly prices and run from 1986:1 to 2009:12.

The first step in the process of examining parameter stability is to test the order of integration of farmer (FP) and wholesale price (WP) time series. Table 1 presents the ADF test statistics for different lags and deterministic assumptions. The table indicates that different results for different lags and deterministic assumptions are obtained. The time series seems to be stationary in levels when low lags lengths are used in the ADF test. However, with 12 and 18 lags lengths, the data do not reject unit roots except in the case of FP including an intercept and no trend. Given the monthly nature of the data, we conclude longer lags are more appropriate for these data. Therefore, we conclude that the data are consistent with unit root non-stationarity. Table 1 also indicates that in all cases two unit roots are strongly rejected for all prices.

Subsequent testing for cointegration indicated that using the Dickey-Fuller test for cointegration (the Engle-Granger two steps procedure) the time series are not cointegrated. The Johansen trace test for cointegration using maximum likelihood indicated the existence of a cointegraing relationship. Lack of consistent conclusions between the Johansen approach and the Engel Granger approach could be due to then existence of structural breaks in the series rather than a lack of a contegrating relationship; i.e. the time series may be cointegrated with structural breaks.

All three Hansen (1992) parameter stability tests, SupF (242.56), MeanF (81.05), and Lc (7.674), strongly reject the null hypothesis of a stable relationship between wholesale and farm prices, indicating parameter instability. The results of these tests could support the notion that parameter instability could be due to structural breaks.

The Lc test could be viewed as a test of the null of cointegration against the alternative no cointegration which suggests there is a lack of cointegration between farmer and wholesale price. The SupF test suggests that the regime shifts may have occurred. That is, the Lc test rejects the null hypothesis of cointegration with the maintained hypothesis of long-run stability in the cointegrating vector. However, the SupF test suggests there may be two or more cointegrating regimes which shifted at a particular time in the period under investigation. Hence the rejection of a single cointegrating relationship resulting from the Lc test could be the result of the inappropriate maintained hypothesis of a single cointegrating relationship without any structural break.

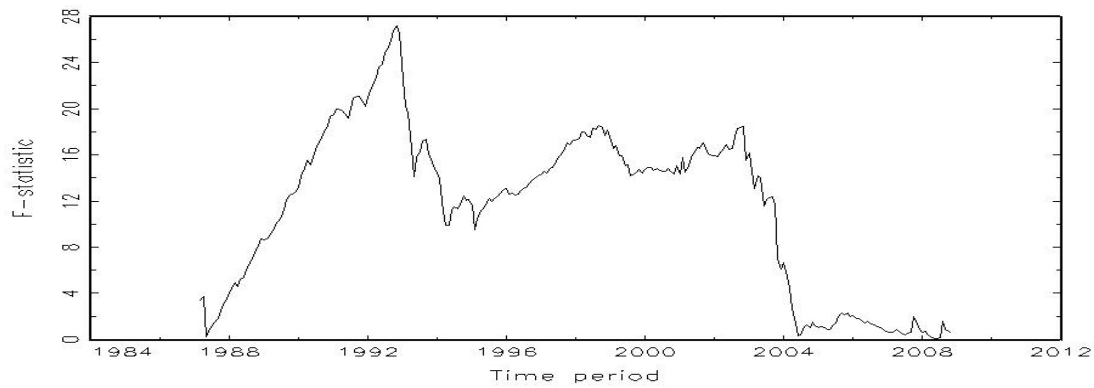
Figure 2 plots the F-statistic for the wholesale to farm marketing margin for each observation in the data. Maximums of this test would indicate the existence of a structural break. The SupF statistic is the largest value attained of the F-statistics, somewhere between 1992 and 1993. This could be related to the implementation of the North American free trade agreement. Other local maximums in the F-statistic may indicate other possible breaks in the processor to farm marketing margin. Time periods of these local maximums revealed in Figure 2 are sometime in the late 1990's and the BSE outbreak in Canada in May 2003.

Table 2 presents test statistics for a cointegrating relationship between wholesale and farm prices with a regime shift using the Gregory-Hansen (1996) approach. All three of the ADF*, Zt* and Zα* indicate cointegration with a regime shift. All three tests strongly reject the null hypothesis of no cointegration. These results are in contrast to the results of Engel Granger ADF test presented above, which indicated no cointegration. These results tend to support the notion that there is a structural break in an otherwise stable wholesale to farm marketing margin equation. The actual breakpoint estimated by all three tests and model specifications was close to or exactly May 2003, the time of the initial ban of beef products entering the US due to the BSE disease outbreak. For example, May 2003 was the estimated time period of the structural break for the C/S model using all three regime shift tests using the Gregory-Hansen approach.

ADF test		FP	dFP	WP	dWP
2 lags	no intercept	-0.45	-10.99***	-0.15	-10.99***
	Intercept	-4.72***	-10.98***	-4.42***	-10.97***
	intercept and trend	-4.70***	-10.97***	-4.83***	-10.97***
6 lags	no intercept	-0.28	-9.27***	0.029	-9.54***
	Intercept	-3.59***	-9.25***	-2.73*	-9.53***
	intercept and trend	-3.55***	-9.26***	-2.77	-9.55***
12 lags	no intercept	-0.20	-5.45***	0.18	-6.37***
	Intercept	-2.90**	-5.47***	-2.14	-6.36***
	intercept and trend	-2.83	-5.49***	-2.01	-6.42***
18 lags	no intercept	-0.26	-4.93***	0.02	-4.36***
	Intercept	-2.57	-4.91***	-2.02	-4.34***
	intercept and trend	-2.53	-4.92***	-2.03	-4.38***

Note: *, ** and *** indicates significance at the 10%, 5% and 1% levels, respectively. FP is farm price, WP is wholesale price, dFP is first differenced farm price, dWP is first differenced wholesale price. Source: own calculations

Table 1: Augmented Dickey-Fuller (ADF) unit root test.



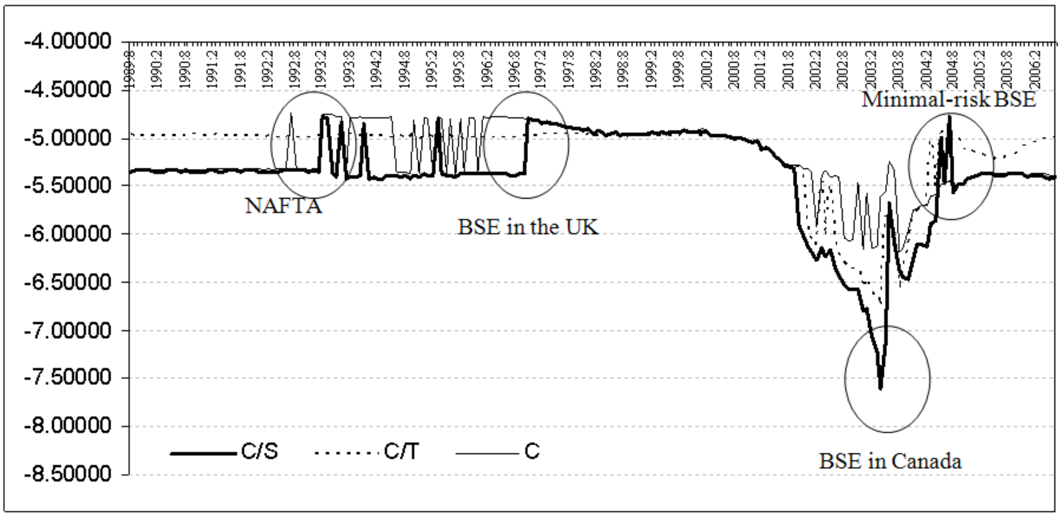
Source: own calculations

Figure 2: Hansen parameter instability test – SupF test – FP and WP regression.

	Test statistic	Breakpoint
ADF*		
C (with 1 lag)	-6.18***	0.74
C/T (with 1 lag)	-6.74***	0.72
C/S (with 1 lag)	-7.61***	0.72
Zt		
C	-5.91***	0.71
C/T	-6.16***	0.71
C/S	-6.68***	0.72
Za		
C	-63.91***	0.71
C/T	-69.49***	0.71
C/S	-78.89***	0.72

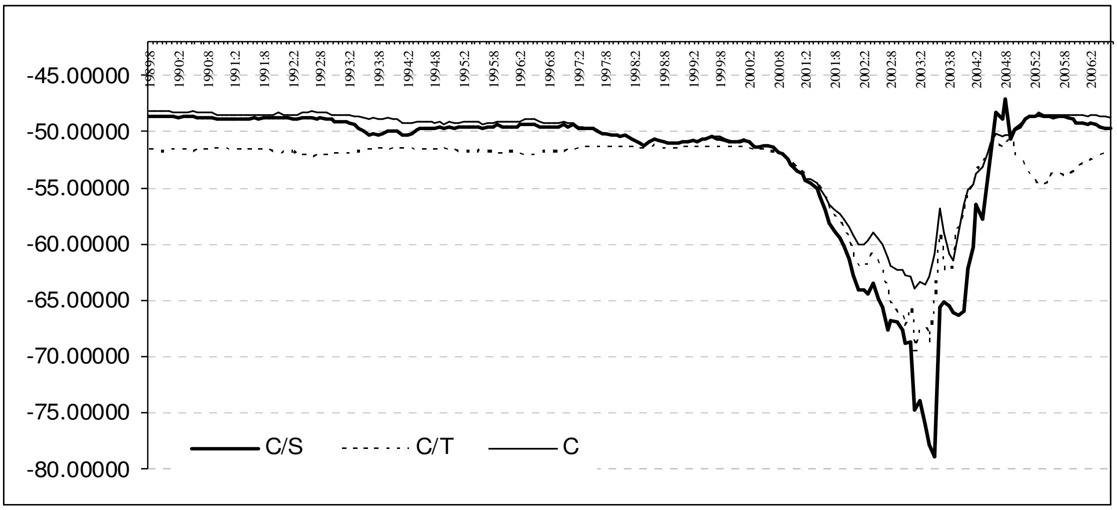
Source: own calculations

Table 2: Gregory-Hansen cointegration test – testing for regime shifts in Canadian beef.



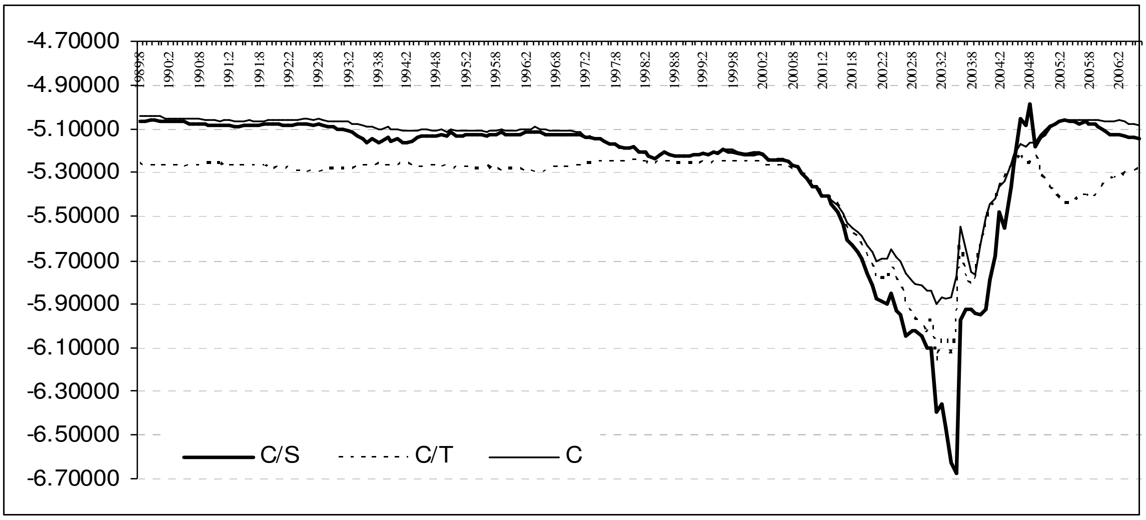
Source: own calculations

Figure 3: Gregory-Hansen cointegration test with break – ADF* test.



Source: own calculations

Figure 4: Gregory-Hansen cointegration test with break – Zα* test.



Source: own calculations

Figure 5: Gregory-Hansen cointegration test with break – Zt* test.

Figures 3 (ADF*), 4 (Zα*) and 5 (Zt*) plot the test statistics for regime shifts of the wholesale to farm marketing margin under the C, C/T and C/S models. All three plots clearly show that the minimum value of these test statistics correspond to the closure of the US border to Canadian imports of live animals into the US that resulted from the discovery of BSE in Canada. All tests also reveal a "return to normal" toward the end of 2004, six months prior to the time the ban was completely lifted in July 2005.

The plot of the Gregory-Hansen ADF* test presented in figure 3 shows a clear drop in the ADF* statistic that began in 1997, which was a time period of the BSE disease outbreak in the UK that lasted from the mid to late 1990's. Beginning in 1997, the ADF* statistic begins a long downward trend, culminating in the BSE outbreak in Canada in May 2003. Thereafter, the ADF* statistic makes a recovery until July 2005, when it returned to pre-UK BSE crisis level. This pattern is repeated, albeit in less dramatic style, with the Zα* and Zt* test statistics. These results indicate that the beginning of realignment in the Canadian beef marketing margin equation may have begun with the initial disease outbreak in the UK rather than the BSE outbreak in Canada. Realignment seems to have been taking place during the whole time period since UK BSE, although the sharpest realignment happened with the closure of the US border in May 2003 resulting from the discovery of BSE in Canada. While these results are suggestive, they are not statistically significant, art from the closure of the border into the US resulting from the discovery of BSE in Canada.

While the analysis until now has focused on test statistics, it does not reveal the nature and extent of market power changes within the Canadian beef marketing system. To undertake this analysis estimates of the marketing margin price markup are examined. Recall from equation (3) that market power implies a coefficient estimate of the slope parameter in the marketing margin to be less than one. Table 3 presents results of estimating the marketing margin model using two sets of Engel Granger cointegrating regression results. The first is the four regime model, with the four regimes being pre UK BSE (1986:01-1997:04), UK BSE (1997:05-2003:05), CDN BSE (2003:05-2004:12) and post CDN BSE (2005:01-2009:12). The table indicates that under both models, the parameter on the slope term fell to 0.88, indicating processors took advantage of the border closure resulting from the BSE disease outbreak to enhance its market power. After the border for Canadian beef was restored, (post CDN BSE), the system was restored to a relatively competitive regime, with the slope coefficient returning to 1.26 under that two regime model or a competitive 0.99 under the four regime model. This indicates that the system was restored to a relatively competitive one as a result of the reopening of the border in 2005, when Canada was declared a minimum risk BSE region by the US.

Four Regime model		Two Regime Model		
Regime	Constant	Slope	Constant	Slope
Pre UK BSE	-22.11	1.20	-29.56	1.26
(1986:01-1997:04)	(9.98)	(0.10)	(15.77)	(0.05)
UK BSE	-45.41	1.42	-29.56	1.26
(1997:05-2003:05)	(11.07)	(0.10)	(15.77)	(0.05)
CDN BSE	-12.40	0.88	-12.40	0.88
(2003:05-2004:12)	(14.93)	(0.13)	(15.77)	(0.14)
Post CDN BSE	-3.40	0.99	-29.56	1.26
(2005:01-2009:12)	(17.07)	(0.16)	(15.77)	(0.05)

Note: Values in parentheses are standard errors

Table 3: Estimates of the parameters of the farm to wholesale marketing margin from Engle- Granger Cointegrating regression.

Conclusions

This study examines farm to wholesale prices spreads to measure the impact of the BSE disease outbreak on the Canadian beef industry. The study finds evidence that the industry began a realignment as a result of the UK BSE disease outbreak, and the Canadian BSE disease outbreak was simply the largest realignment of the process beginning with the UK disease outbreak and ending with the reopening of the border in May 2005. There is also some evidence that realignment began earlier, with the implementation of NAFTA in 1997. However, the only statistically significant break was the BSE disease outbreak itself in May 2003, and not breaks in the series resulting from the implementation of NAFTA or the UK disease outbreak. Stability was not restored until the border was reopened in 2005.

Specific results indicated that the processing sector exploited the border closure in May 2003 to enhance its market power and that a competitive system was resulted after the border re-opened in July 2005

Acknowledgement: The research was supported by the Canadian Agricultural Research Network and by the project No. MSM 6046070906 (project supported by Ministry of Education, Youth and Sports of the Czech Republic).

JEL Classification: C32, D24, Q120

Corresponding authors:
Prof. J. Stephen Clark
Nova Scotia Agricultural College;
e-mail: sclark@nsac.ca

doc. Ing. Lukáš Čechura, Ph.D.
Czech University of Life Sciences Prague, Department of Economics
Kamýcká 129, 165 21 Prague-Suchdol, Czech Republic
Phone: +420 224 382 279, e-mail: cechura@pef.czu.cz

References

[1] Bakucs L.Z., Ferto I.: Marketing and Pricing Dynamics in the Presence of Strutural Breaks – The Hungarian Pork Meat, 98th EAAE Seminar, Chanie, Greece, 2006, p. 16.

[2] Bojnec S.: Price Transmission and Marketing Margins in the Slovenian Beef and Pork Markets During Transition, Xth Congress, Zaragos, Spain, 2002, p. 17.

[3] Caner M.C., B.E. Hansen: Threshold Autoregression with a Unit Root, Econometrica, 69, 2001, pp. 1555-1596.

[4] Chow, G.C.: Tests of Equality Between Sets of Coefficients in Two Linear Regressions, Econometrica, 28, 1960, pp. 591-605.

[5] Dickey D., Fuller W.: Distribution of the Estimators for Autoregressive Time Series with a Unit Root, Journal of the American Statistical Association, 74, 1979, pp. 427-431.

[6] Engle R.F., Granger C.W.J.: Cointegration and error correction: Representation, estimation and testing, Econometrica, 49, 1987, pp. 251-276.

[7] Gregory A.W., Hansen B.E.: Residual-Based tests for cointegration in models with regime shifts, Journal of Econometrics, 70, 1996, pp. 99-126.

[8] Hansen B.E.: Sample Splitting and Threshold Estimation, Econometrica, 68, 2000, 575-603.

[9] Hansen B.E.: Testing for linearity, Journal of Economic Surveys, 13(5), 1999, pp. 551-576.

[10] Hansen B.E.: Tests for Parameter Instability in Regressions With I(1) Processes, Journal of Business & Economic Statistics, 10, 3, 1992, pp. 45-59.

[11] Johansen S.: Estimation and Hypothesis Testing of Cointegrated Vectors in Gaussian VAR Models, Econometrica, 59, 6, 1991, pp. 1551-1580.

[12] Johansen S.: Statistical Analysis of Cointegration Vectors, Journal of Economic Dynamics and Control, 12, 1988, pp. 231-254.

[13] Jumah A.: The Long Run, Market Power and Retail Pricing, Economics Series No. 78, Vienna: Institute for Advanced Studies, 2000, p. 25.

[14] Kwiatkowski D., Phillips P.C.B., Schmidt P., and Shin Y.: Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. Journal of Econometrics, 54, 1992, pp. 159–178.

[15] Le Roy, D.G. and K.K. Klein. (2005). Mad Cow chaos in Canada: Was it bad luck or did policies play a role? Canadian Public Policy 31 (4): 381-99.

[16] Loppacher L.J., Kerr W.A.: The BSE Crisis in Canada: A Trade Perspective on Sanitary Barriers, Estey Centre for Law and Economics in International Trade Saskatoon, Saskatchewan, Canada, 2004, p. 26.

[17] Muth M. K., Wohlgenant M.K.: A Test for Market Power Using Marginal Input and Output Prices with Application to the U.S. Beef Processing Industry, American Journal of Agricultural Economics, 81, 1999, pp. 638-643.

[18] Phillips, P.C.B and P. Perron: Testing for a Unit Root in Time Series Regression, Biometrika, 75, 1988, pp. 335–346.

[19] Quagrainie K., Unterschultz J., Veeman M., Jeffrey S.: Testing for Processor Market Power in the Markets for Cattle and Hogs in Canada. Canadian Journal of Agricultural Economics , 2003, pp. 397–411.

[20] Quandt, R.: Tests of the Hypothesis That a Linear Regression System Obeys Two Separate Regimes, Journal of the American Statistical Association, 55, 1960, pp. 324-30.

[21] Statistics Canada, 2010a. CANSIM database, table no. 329-0040. (Variable V1574572) [Accessed January, 2010].

[22] Statistics Canada, 2010b. CANSIM database, table no. 330-0006. (Variable V1576465) [Accessed January, 2010].

[23] Statistics Canada, 2010c. CANSIM database, table no. 326-0020. (Variable V41690978)[Accessed January, 2010].