University-Retail Industry Research Partnerships as a Means to Analyze Consumer Response: The Case of Mad Cow Disease

Steven S. Vickner, DeeVon Bailey and Al Dustin[1]

Introduction

Quality data are vital to any empirical inquiry into market behavior. Often the econometrician is unable to investigate natural occurring experiments in real-world markets given limited access to data and must resort to experimental or contingent markets for hypothesis testing and statistical inference. Actual market transactions are preferred as they capture what consumers did, not what they might claim to do in a contrived, sterile setting. Establishing an ongoing partnership with food retailers is a means to work with actual market transactions for a variety of research initiatives. In this paper, we cooperated with Salt Lake City-based Associated Food Stores, Inc. to explore the impact of three separate information shocks related to bovine spongiform encephalopathy (BSE), or Mad Cow Disease, on retail meat consumption.

Markets and Mad Cow Disease

The noun 'market' is so familiar to the economist's vocabulary that it is often ambiguously used in expressions like 'market impact' or 'market response'. But with an issue as headline-worthy and far-reaching as BSE, determining exactly what market is impacted and to what extent requires some careful thought and consideration. Several recent publications (Mathews et al. 2006; Blayney et al. 2006) overview and chronicle the events associated with BSE on import markets, export markets and trade flows. Other markets, such as futures, equities, food away-from-home, institutional and food at-home have different buyers and sellers, and hence one might expect different market outcomes. We analyze the food at-home or grocery store market.

On a Tuesday afternoon, December 23, 2003, the U.S. Secretary of Agriculture, Ann M. Veneman and her advisors met with the media in a historic press conference to discuss the test results of a nonambulatory Holstein cow (USDA Transcript 0433.03). At that time it was thought the cow came from a farm in the state of Washington, but was later traced back to a farm in Canada. The cow tested presumptive positive for BSE using immuno-histo-chemistry. The USDA quarantined the farm in Washington and began to investigate the meat packer, Midway Meats, also located in Washington. Despite federal officials emphasizing the safety of the domestic meat supply, the media frenzy began. News broadcasts, talk shows and newspaper headlines covered the topic exhaustively over the ensuing weeks.

Six months later, Dr. John Clifford, the Deputy Administrator for the USDA's Animal Plant Health Inspection Service (APHIS) held a similar press conference on the evening of June 25, 2004 (USDA Transcript 0263.04). He announced that an inconclusive BSE test result was obtained and re-emphasized the safety and quality assurance of the domestic beef supply. Four days

[1] The authors are Associate Professor and Professor, Department of Economics, Utah State University, and Head, Department of Farm and Ranch Management, Bridgerland Applied Technology College. This project was funded in part by the USDA Rural Business Service Value-Added Producer Grant program and the Utah Agricultural Experiment Station.

later, on the evening of June 29, 2004, Dr. Clifford announced another inconclusive BSE test result (USDA Transcript 0266.04). Again the public was assured that the animal did not enter the food supply. On the morning of November 18, 2004, the Associate Deputy Director of the USDA-APHIS, Andrea Morgan, announced yet another inconclusive BSE test result (USDA Transcript 0501.04). Compared to the December 23, 2003 press conference, the media coverage of the three inconclusive BSE test results was virtually nonexistent. That was not surprising as nearly a year had passed and federal officials underscored the safety of the beef supply in that time. Inconclusive BSE test results do not sell newspapers.

Empirical Model and Estimation

The principal empirical objective of this project is to determine how BSE information affects the demand for fresh meats while controlling for their retail prices, real per capita meat expenditure and seasonality in the grocery store distribution channel. Using detailed, representative point-of-purchase scanner data supplied by Salt Lake City-based Associated Food Stores, Inc. we estimate this consumer demand system. The data spanned the weeks beginning May 9, 2004 to May 1, 2005 for twenty of the stores they own. The twenty stores were spatially dispersed throughout their Utah selling region and well-represent the major population centers in the state (i.e., Logan, Ogden, Layton, Salt Lake City, Orem, Provo and Saint George). The data were then aggregated across store into a time series data set resulting in T = 52 weekly observations. Finally, the individual meat items were aggregated to investigate the retail demand for only fresh beef, pork, chicken and seafood. Within this time frame, the three separate USDA-APHIS inconclusive tests were announced on June 25, 2004, June 29, 2004 and November 18, 2004. The media coverage of each event was the same and practically non-existent based on a detailed analysis of the word count frequency of BSE and related terms in the media. Actually, within two months of the December 23, 2003 event the media coverage was effectively over from a word count perspective. The information regarding those three 2004 announcements will be included in the model using dummy shift variables to assess if BSE news influences purchasing patterns for fresh meats.

We build a theoretically consistent empirical model of demand using an Almost Ideal Demand System (Deaton and Muelbauer 1980; Moschini 1995). It is theoretically consistent because we impose symmetry and homogeneity in the demand equations. There is a separate demand equation for beef, pork and chicken, and we control for the effect of relative prices and real per capita expenditure in each equation. Since expenditure shares sum to one, the parameter estimates in the seafood equation are recovered with the adding up restrictions. In each equation we also incorporate non-price and non-income information shift variables for both BSE and seasonality using a framework similar to that proposed by Teisl, Roe and Hicks (2002). These variables allow the demand curves to shift. For example, ceteris paribus, one might expect the demand curve for beef to shift inward or leftward during the week of one of the three USDA press conferences. Our model allows for that possibility. This test involves restricting parameters across all three equations in the nonlinear demand system so we must use a likelihood ratio test (Gallant 1987). The error terms across demand equations are likely contemporaneously correlated given the interrelated nature of the retail meats so estimation is performed using nonlinear seemingly unrelated regression using PROC MODEL in SAS. Autocorrelation correction in the demand system is given by the Berndt-Savin methodology. There are MT – Ku = (3)(51) – 28 = 125 degrees of freedom in the unrestricted model, since one time series observation was lost due to the Berndt-Savin methodology.

Results and Discussion

The conditional demand system is given in Table 1. It exhibits reasonable properties for the data set and application. Again the parameters in the seafood equation are not presented but may be recovered using the adding up restrictions in the demand system. The fact that only six price parameters are presented reflects symmetry is imposed on the model. Four of the six price parameters are statistically significant ($p<0.10$). It is noted that these parameters relate price and expenditure share, not quantity demanded, and, as such, may not be interpreted as elasticities. They are assembled with other demand parameters and expenditure shares to obtain price elasticities of demand (Moschini 1995). Two of the three parameters on real per capita meat expenditure are statistically significant ($p<0.05$), and all three intercepts are statistically significant as well ($p<0.05$).

As for the non-price and non-expenditure shift variables in the model, four of the six seasonality parameters are statistically significant ($p<0.10$) indicating expenditure shares exhibit seasonal patterns. However, all nine of the parameter estimates on the BSE shift variables are statistically insignificant ($p>0.10$). This finding is not surprising given the lack of media attention to the three inconclusive BSE tests during the study period. While parameter by parameter inspection of asymptotic *t*-tests is telling, a more thorough test of this hypothesis will involve a system-wide likelihood ratio test as discussed in the next section. The Durbin Watson statistics indicate the parsimonious version of the Berndt-Savin autocorrelation correction procedure (i.e., the same rho parameter in each equation) is successful in purging positive serial correlation from the model. Stability or robustness of the parameter estimates and significance of the parameter estimates are quite good for this model.

Table 1. Retail Meat Demand Model Parameter Estimates

	Beef	*Pork*	*Chicken*
Prices			
Beef	-0.0675**	-0.0128	0.0677**
	(0.0284)[1]	(0.0250)	(0.0299)
Pork		-0.1945***	0.0260
		(0.1042)	(0.0316)
Chicken			-0.1141**
			(0.0437)
Expenditure	-0.0854**	-0.0252	0.1068**
	(0.0386)	(0.0287)	(0.0452)
Intercept	0.3700*	0.1518**	0.5230*
	(0.0928)	(0.0645)	(0.1120)
Seasonality1	-0.0968**	0.1365*	-0.0400
	(0.0437)	(0.0299)	(0.0540)
Seasonality2	-0.1077**	0.0163	0.0943***
	(0.0441)	(0.0283)	(0.0544)
BSE1	-0.0003	0.0434	-0.0602
	(0.0455)	(0.0307)	(0.0560)
BSE2	0.0351	0.0093	-0.0289
	(0.0450)	(0.0292)	(0.0555)
BSE3	-0.0133	0.0034	0.0163
	(0.0437)	(0.0282)	(0.0539)
Autocorrelation	0.2503**	0.2503**	0.2503**
	(0.1002)	(0.1002)	(0.1002)
Durbin Watson	1.8435	2.3560	2.2230
Log Likelihood	53.7386		

[1] Standard error in parentheses. Note: *, ** and *** denote statistical significance at the 0.01, 0.05 and 0.10 levels respectively.

Given the model in Table 1, we remove the effects of the BSE announcements by removing those explanatory variables from the demand equations. The model in Table 1 is the unrestricted model whereas the second regression, without the BSE dummies, is the restricted model. Gallant (1987) outlines a procedure to compare the likelihood surface from the unrestricted nonlinear demand system to that of the restricted system. The test is called a likelihood ratio test and under the null hypothesis it is distributed asymptotically chi-square with nine degrees of freedom in this case (i.e., since nine parameters were removed in the restricted model). The likelihood ratio statistic is 4.4199 and the chi-square critical value is 14.6837 for a 10% level of alpha, so we fail to reject the null hypothesis of no BSE announcement effects. In fact, we find no statistical difference between the unrestricted and restricted models at the 1%, 5% and 10% levels of significance (only the 10% level is reported). This test is considered to be far superior to a simple inspection of the parameter by parameter asymptotic *t*-statistics, especially in small samples. Using any single-equation approach, it is not possible to comprehensively test the BSE announcement effects on the demand system overall. We can conclude for this data set and application, the BSE announcements collectively had no impact on consumer response.

Finally, the uncompensated or Marshallian own and cross price elasticities exhibit reasonable direction and magnitude with the only exception being the cross price effect of pork in the beef equation (i.e., indicating complementarity); own price elasticities are negative and all cross price elasticities but one are positive (Table 2). For example, a 1% increase in the price of beef leads to a 1.0305% decrease in the quantity demanded of beef. Similarly, a 1% increase in the price of chicken leads to a 0.1490% increase in the quantity demanded of beef. The Hicksian elasticities too are quite reasonable and similar too. The conditional expenditure elasticities each show the rates of segment growth as the fresh meat category expenditures rise; beef and pork rise proportionally slower, while chicken and seafood rise proportionally faster.

Table 2. Estimated Price and Expenditure Elasticities.

	Beef	*Pork*	*Chicken*	*Seafood*
Marshallian				
Beef	-1.0305	-0.0011	0.1490	0.0291
Pork	0.0130	-2.3402	0.2218	1.2820
Chicken	0.0244	0.0480	-1.6172	0.0670
Seafood	0.2039	3.5260	0.3829	-5.1846
Hicksian				
Beef	-0.5332	0.1205	0.3398	0.0729
Pork	0.4928	-2.2230	0.4059	1.3243
Chicken	0.8855	0.2585	-1.2868	0.1427
Seafood	0.8284	3.6787	0.6226	-5.1297
Expenditure	0.8535	0.8234	1.4778	1.0719

Conclusion

In 2004, the USDA made three press releases regarding inconclusive BSE test results. Based on the data collected by Associated Food Stores, Inc. we were able to isolate our attention on just one retail market, the grocery store distribution channel, which could have been affected by that information. For our data set, the results definitively show that there was no change to the retail demand for fresh meats and those results were not surprising. The media covered the presumptive positive test result from December 23, 2003 in great detail but did not address the

inconclusive tests in 2004. Over the course of 2004, the USDA also took many steps to assure the quality and safety of the domestic beef cattle supply and make these efforts known to domestic consumers.

References

Berndt, E.R. and N.E. Savin. 1975. Estimation and Hypothesis Testing in Singular Equation Systems with Autoregressive Disturbances. Econometrica 43: 937-958.

Blayney, D.P., J. Dyck and D. Harvey. 2006 (April). Economic Effects of Animal Diseases Linked to Trade Dependency. Amber Waves.

Deaton, A. and J. Muelbauer. 1980. An Almost Ideal Demand System. American Economic Review 70: 312-326.

Gallant, A.R. 1987. Nonlinear Statistical Models. New York: John Wiley and Sons.

Mathews, K.H., M. Vandeveer and R.A. Gustafson. 2006 (June). An Economic Chronology of Bovine Spongiform Encephalopathy in North America. USDA-ERS, LDP-M-143-01.

Moschini, G. 1995. Units of Measurement and the Stone Index in Demand System Estimation. American Journal of Agricultural Economics 77: 63-68.

Teisl, M.F., B. Roe and R.L. Hicks. 2002. Can Eco-Labels Tune a Market? Evidence from Dolphin-Safe Labeling. Journal of Environmental Economics and Management 43: 339-359.

USDA Transcripts, Office of Communications, various releases.