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Consumer Demand for Meat In Alberta, Canada: Impact of BSE

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Abstract

Following the case of bovine spongiform encephalopathy (BSE) in Alberta, Canada, on May 20, 2003, retail beef sales, domestic disappearance of beef, and anecdotal evidence suggest that consumption of beef increased in Alberta. This article investigates fresh meat demand and the impact of BSE on fresh meat demand in Alberta during 2001-2004 through the specification of the linear almost ideal demand system. The model is extended to include a media index of BSE-related newspaper articles and an index to capture the temporary loss of Alberta beef export markets. Estimated coefficients and elasticities are consistent with demand theory. The magnitude of own price elasticities is smaller compared to some other Canadian meat studies which may be due to the nature of this data set. The price during the three-year period could not demonstrate upward or downward trends as clearly as studies which use a much longer data period. The newspaper articles related to BSE had an adverse effect on beef (excluding ground beef) demand while it generated a positive effect on pork demand. The border closure to beef exports increased the demand for beef. However, it had adverse impacts on pork and chicken demand. In addition, total meat expenditure and demand for beef, pork and chicken show strong seasonality trends.

Introduction

The cases of bovine spongiform encephalopathy (BSE) in the United Kingdom and Japan had a major impact on beef consumption in those countries. In the United Kingdom, per capita beef consumption declined steadily between 1986 and 1996 (The BSE Inquiry: The Report 2000). In Japan, beef consumption in October 2001 decreased to 55 per cent of its September level (Peterson and Chen 2003).

On May 20, 2003, the Canadian government announced that one cow from Alberta, Canada tested positive for BSE. Anecdotal evidence suggests, unlike the experience of other countries, after May 20, 2003, beef consumption in Alberta increased. A number of factors may have contributed to the increased demand for beef in Alberta. Immediately following the announcement, the Canadian Food Inspection Agency (CFIA), the government agency responsible for the BSE investigation, announced that the cow did not enter the food system. The cattle/beef industry, retailers and government continually assured consumers that beef was safe. Throughout the BSE investigation, the CFIA disclosed information about the investigation on a regular basis. During the summer, retailers began weekly features of certain beef cuts, particularly the lower priced cuts such as regular ground beef for \$1.70/kg.

During the summer of 2003, retail beef sales, domestic disappearance of beef and anecdotal evidence suggests that consumption of beef increased dramatically in Alberta contrary to expected consumer behaviour after a food scare. The purpose of this article is to apply economic theory of consumer demand to analyze consumer behaviors in meat demand in Alberta, and the impact of BSE on the demand for beef and other meats. In

this preliminary assessment, the demand model will be extended to include non-price variables such as BSE-related newspaper articles and the temporary loss of Alberta beef export markets. This article is unique because it is the first meat demand study in Canada to use weekly retail scan data. It is also unique because no empirical research has been done to estimate the impact of the Canadian case of BSE on consumers meat demand. Recent data from January 2001 to March 2004 that covers the pre- and post- BSE periods are used in this analysis.

Timeline of Selected BSE Events

With the announcement on May 20, 2003, that one cow from Alberta, Canada, tested positive for BSE, the Alberta beef/cattle industry entered a state of uncertainty and turmoil. Immediately after the announcement, governments in 37 countries, including the United States and Mexico, Alberta largest beef export markets, prohibited the import of Canadian ruminant animals and products derived from ruminants. For weeks after May 20, 2003, slaughter levels in Alberta decreased significantly, reducing the domestic supply of beef.

On August 8, 2003, the United States Agriculture Secretary, Ann Veneman, announced that firms could apply for permits to import low risk product including boneless cuts from animals less than 30 months old. On August 11, Mexico announced it would import Canadian boneless beef products from animals under 30 months of age and products (liver, kidney, heart and tongue) still banned by the United States.

During the week ending September 6, 2003, boneless beef was exported from Alberta to the United States and during the week of October 11, 2003, boneless beef was exported from Alberta to Mexico. Between September 6 and October 18, exports increased gradually as the packers slowly increased slaughter rates and regained market share.

On December 23, 2003, the United States government announced a presumptive positive case of BSE from a cow in Washington State. The diagnosis was confirmed on December 25. On January 6, 2004, government officials from the United States and Canada announced jointly that DNA evidence showed that in all likelihood the infected cow had been born in Alberta.

Model Specification

The linearized version of the almost ideal demand system (AIDS) of Deaton and Muellbauer (1980a) is used in this analysis. Following standard procedure, the derived expenditure share equations are applied:

$$w_i = \alpha_i + \sum_j^n \gamma_{ij} \ln p_j + \beta_i (\ln X - \ln P)$$

Where

w_i = expenditure share of the i^{th} goods in the meat demand system;

p_i = price of the i^{th} meat;

$X = \sum_i p_i q_i$ = total meat expenditure in the system;

q_i = quantity purchased of the i^{th} meat;

$\ln P$, the Stone's Price Index, is defined as $\ln P = \sum_{i=1}^n \bar{w}_i \ln p_i$, and

\bar{w}_i = expenditure share of the i^{th} meat at the sample mean.

The demand system includes four meat categories: all other beef, ground beef, pork, and chicken. The segmentation of beef into two groups is based on the assumption that the impact of BSE and the border closure on consumer demand for each beef category would be different.

One stage LAIDS demand system usually assumes goods in the system are weakly separable from goods outside the system and the expenditure variable X is being treated as exogenous. In this study, we assume two-stage budgeting, that is, consumers allocate their total expenditure in two stages (Armington 1969). First, they allocate to broad groups, for example, meat, cereals, fruit and vegetables, etc. In the second stage, meat expenditure is further allocated to products within this group. Therefore, the expenditure variable X in a two-stage demand system format is endogenous and depends on both income and the prices of all consumer goods. Due to data limitation and according to Deaton and Muellbauer's Composite Commodity Theorem (1980b), we assume that X depends on the composite price of all the products in the system, which in this case is a function of the Stone's Price Index for meat: $X = f(P)$.

Both the expenditure function and budget share equations are expanded to include a media variable (media), the temporary loss of export markets (border closure index), seasonality dummy variables, habit formation (one period lagged own quantity in logarithm form), and time trend (t). As it is commonly postulated that the temporary loss

of export markets has caused a downward price effect on the domestic beef market, especially the ground beef, an interaction term between the price of ground beef and border closure index is also included in the model to capture this cross effect.

Data Description

Weekly point-of-purchase scanner data (price and quantity) from AC Nielsen for fresh and refrigerated beef, pork and chicken (bulk and random weight) from Alberta retail stores is used in the analysis. AC Nielsen estimates that the volume of at-home consumption represented by the data set is about 75 per cent. The data excludes all meats sold in fixed weight formats such as frozen boxed meats and processed deli meat. The data covers 168 weeks from January 6, 2001 to March 20, 2004, of which 124 weeks are before the date of the first BSE case and 44 weeks are after the first case of BSE. The descriptive statistics are presented in table 1.

Beef is divided into two groups: ground beef and all other beef. Table 2 contains a complete list of the products that are included in each meat category. Using Alberta population statistics from Statistics Canada (2004) per capita expenditures were calculated for ground beef, all other beef, pork and chicken.

To construct the media variable, Factiva was used to search two Canadian national daily newspapers, the National Post and the Globe and Mail. Using the keywords “mad cow” and “bovine spongiform encephalopathy”, newspaper articles for the 168-week period were searched. Following Teisl, Roe and Hicks (2002), the articles were not

coded based on positive or negative messages. The number of articles found containing these key words was included as the media variable in the model (see figure 5).

The temporary loss of export markets impacted Alberta exports of beef in 2003. Beef exports fell 33.7 per cent in value (\$1.1 billion) and 37.3 per cent in quantity (238,851 tonnes) compared to 2002. Alberta typically exports low-end cuts such as chuck to Mexico and lean and fat trimmings, as well as other cuts to the United States. The temporary closure of the United States and Mexico borders to Alberta beef exports resulted in an increased supply of low priced cuts such as chuck and grinding beef in the domestic market. The chuck that normally would have been exported was ground for the domestic market. The opening of the United States and Mexico borders to Alberta beef in September and October 2003, respectively, created increased competition for chuck and trim.

A border closure index (BCI) is constructed to capture the impact of the temporary loss of export markets and the gradual resumption of export trade on Alberta consumers' demand for beef. The BCI is zero (0) before BSE to represent an open border and one (1) from May 20, 2003 to September 6, 2003 to represent a temporary total loss of beef export markets. Between September 6, 2003 and October 18, 2003, the BCI gradually decreases to 0.3 to represent the gradual increase in beef exports from Alberta to the United States and Mexico. The BCI is constant at 0.3 for the remaining period. The 0.3 was calculated based on exports as a percentage of production. Before May 20, 2003, approximately 60 per cent of production was exported. After October 18, 2003, the level

of exports was approximately 40 per cent of production or about 70 per cent of the pre May 20, 2003 level.

To determine the impact of seasonality on meat demand, the 52 weeks in a year are divided into 13 four-week periods. Using the 13th 4-week period as a base period, twelve dummy variables (DM1-DM12) were constructed and included in the equations.

Meat Consumption Trends

Average retail price and volume sold of all other beef, ground beef, pork and chicken are presented in Figures 1-4, respectively. Over the data period, the average retail price of all other beef, tends to fluctuate between \$11.00/kg and \$14.00/kg. The volume sold of all other beef, varies between 200,000 kg and 300,000 kg with the exception of the period between the middle of July 2003 and the middle of October 2003. During this period, the volume sold of all other beef, increased to 550,000 kg during the first week of August. Sales then decreased over the next three months until they reached more normal sales volume.

Average retail price of ground beef has been relatively stable over the data period. The volume sold of ground beef, varies between 250,000 kg and 350,000 kg. The price of ground beef begins to decrease around the middle of July 2003 and has remained at this lower level for the rest of the data period. The volume of ground beef sold varies between 250,000 kg and 350,000 kg with the exception of the period between the middle of June, 2003 and the first week of August, 2003 when the volume sold increased to approximately 470,000 kg. After reaching this peak, the volume of sales decreased to more normal levels.

Pork average retail prices over the data period are relatively stable. The volume of pork sold varies between 200,000 kg and 275, 000 kg with the exception of the period between November 2002 and May 2003. During this period, pork sales volume was less stable than prior to November 2002.

Average retail chicken prices over the data period are relatively stable. The volume of chicken sold tends to fluctuate between 350,000 kg and 450,000 kg with the exception of a few weeks.

Results and Discussions

The first stage total expenditure equation and the second stage LAIDS model including three budget share equations are estimated simultaneously using SHAZAM's seemingly unrelated regressions (SUR) procedure. The three restrictions - adding up, homogeneity and Slutsky symmetry are imposed to the parameters of the expenditure share equations to satisfy the basic properties of demand theory.

The estimation results for total meat expenditure and budget shares are presented in table 3. Most variables are highly significant. The R^2 and Durbin-Watson statistics for the four equations indicate that the dependent variables are good fits for the model and there is no evidence of serial correlation in the disturbances. Likelihood ratio (LR) tests are utilized to individually test for the null hypothesis of seasonality, media effect, border closure effect, time trend, habit formation and the interaction between ground beef price and BCI. The BCI ground beef price interaction term is constructed as $\log(p_2*BCI+1)$.

The test results presented in table 4 reveal that all the hypothesis are statistically rejected, suggesting that these factors have impacts on Alberta consumer's meat demand.

Estimated results confirm that total meat expenditure is not an exogenous variable. The final function specification, in a logarithm form, is composed of the Stones price index ($\log(P)$), seasonality variables (DM1-DM12) and time trend (t). The border-price interaction variable was excluded from this equation due to a collinearity problem. Consumer spending on meat increases over time and varies depending on the seasons, but is not affected by media or border closure due to BSE. Habit formation is not statistically significant at the aggregate level of total meat expenditure.

The BCI coefficients for the share equations are significant, and are positive for both ground beef and other beef, but negative for pork and chicken. The BCI-price interaction variable shows significant but opposite signs to BCI in all equations, confirming the existence of indirect border closure effects on meat demand through its downward impact on ground beef price. The media coefficients are significant but very small in magnitude. They are negative for ground and other beef and positive for pork. The media coefficient is insignificant for chicken. Time trend is positive for pork, negative for ground beef and chicken and insignificant for other beef. Habit formation exhibits in pork demand only.

Price and Expenditure Elasticities

Marshallian's own price, cross price and expenditure elasticities are calculated at sample mean across the two stages of the demand system and the results are presented in Table 5. Own price elasticities are -0.30, -0.10, -0.20 and -0.18 for other beef, ground beef, pork

and chicken, respectively, although all other beef is the only one that is statistically significant. In addition, their magnitudes are smaller compared with some other Canadian meat studies (Chen and Veeman 1991; Reynolds and Goddard 1991; Moschini and Vissa 1993). This may be due to the nature of this data set. As shown in figures 1-4, meat prices during the three-year period could not demonstrate upward or downward trends as clearly as studies which use a much longer data period. Therefore, the data have limitations in terms of capturing consumers' responses to changes in prices. Cross price elasticity results show strong complement relationship between ground beef and other beef, as well as between pork and chicken. Other beef and pork are substitutes but not statistically significant.

Expenditure elasticities are highly significant and are 0.90, 0.79, 1.15, and 1.12 for all other beef, ground beef, pork and chicken, respectively. The result that beef is a necessity and less income elastic than pork and chicken is consistent with the fact that traditionally, beef has been more common in Albertans diets than other meat products.

Media Elasticities

Media elasticities are calculated to estimate the percentage change in meat quantity demand and meat expenditure in response to a change in the number of BSE related newspaper articles. As shown in Table 5, the elasticity estimates are negative and significant for other beef, positive and significant for pork, and insignificant for ground beef and chicken. Therefore, the newspaper articles related to BSE had adverse effect on the consumption of other beef although the magnitude is very small. On the other hand,

the media has generated a positive effect on the demand for pork. Overall, per capita meat expenditure is not affected by media effect.

These results are similar to other studies in Europe that have investigated how information has impacted consumers' response to BSE. For example, Verbeke and Ward (2001) found, in Belgium, television publicity had a negative impact on beef expenditure in favour of pork. Strak, Euro PA and Associates (1998) conclude that beef market share suffered significantly from BSE publicity in the United Kingdom while pork, lamb and poultry meat gained market share.

Border Closure Index Elasticities

The impact of temporary loss of beef export markets on Alberta consumers' meat demand is quantified by the BCI elasticities. The BCI elasticities estimate the percentage change in meat quantity demand and meat expenditure in response to a change in the BCI as presented in Table 6. The elasticities are significant for all four meat categories. More specifically, the border closure to beef exports has increased Alberta consumer demand for other beef and ground beef 36 per cent and 20 per cent, respectively. However, it has adverse impacts on pork and chicken as consumers have sacrificed 27 per cent and 18 per cent of their demand for these products. The border closure index has no effect on total meat expenditure.

Support for and confidence in Canadian beef is evident in the results of several consumer polls that were conducted following the first case of BSE in Canada. The Consumers' Association of Canada conducted a poll during the first two weeks of June 2003. The Consumers' Association asked consumers, "What impact will the mad cow

issue have on your future consumption of beef?” One third of consumers indicated they would be reducing their beef consumption while 11 per cent said they would significantly reduce or stop eating beef completely. Importantly, 64 per cent of consumers indicated that mad cow disease would have no impact on their beef consumption. Unpublished polling data, from early 2004, suggests that the majority of Canadians are confident in the safety of Canadian beef and two thirds of Canadians say they would buy more beef if it would assist Canada’s beef producers.

Seasonality

Strong seasonality trends exist for all of the meats (figures 6-10). LR test rejects the null hypothesis that seasonality is the same within each quarter. Interestingly, demand for all meats drops slightly during the 4th period (March 25-April 21) and the 11th period (October 7- November 3) when retail sales of turkey for the Easter and Thanksgiving holidays, respectively, would be high.

Demand for all other beef and ground beef exhibit similar seasonality trend. Beef demand is strongest between April and September when consumer demand for beef is between 25 per cent and 30 per cent higher compared to the last four weeks of the year. During the same period, expenditure on all other beef as a percentage of total meat expenditure, or market share, increases. The summer is barbeque season when demand for high priced grilling steaks is strong. Ground beef expenditure share remains relatively unchanged throughout the year.

For most of the year, pork demand is about 20 per cent stronger compared to the last four weeks of the year. Demand increases between May 20 and June 16 and then

decreases until August 11. During the period when pork demand is decreasing, beef demand is at its highest. For the most part, pork's expenditure share throughout the year is consistent with the last four weeks of the year.

Chicken exhibits a similar trend to beef by quantity. Chicken demand is strongest during the summer when demand is about 27 per cent higher compared to the last four weeks of the year. Chicken expenditure share remains relatively stable throughout the year.

Total meat expenditure is highest during between the end of April and the beginning of September when demand for higher priced meat cuts suitable for barbequing, such as loins and chicken breasts, would be strong.

Conclusions and Implications

The purpose of this article is to apply economic theory of consumer demand to analyze consumer behaviours in meat consumption in Alberta, and the impact of BSE on the demand for beef and other meats. The preliminary empirical results suggest that the own price elasticities for all other beef, ground beef, pork and chicken are negative and inelastic. Their magnitudes are smaller compared to some other Canadian meat studies. Cross price elasticity results show a strong complement relationship between ground beef and other beef, as well as between pork and chicken, and a weak substitute relationship between other beef and pork.

Expenditure elasticities are highly significant for all other beef, ground beef, pork and chicken. Beef is less income elastic than pork and chicken.

Media elasticity estimates are negative and statistically significant for other beef, positive and statistically significant for pork, and insignificant for ground beef and chicken. Therefore, the newspaper articles related to BSE had an adverse effect on the consumption of other beef, although the magnitude is very small, while it generated a positive effect on the demand for pork. Overall, per capita meat expenditure is not affected by media.

The border closure to beef exports increased the demand for other beef and ground beef. However, it had adverse impacts on demand for pork and chicken. The border closure index has no effect on total meat expenditure.

Strong seasonality trends exist for all of the meats. Demand for all other beef and ground beef exhibit similar seasonality trend. Overall, demand for meat is strongest during the summer season. Generally, total meat expenditure is highest between the end of April and the beginning of September when demand for meat cuts suitable for barbequing, which tend to be higher priced loins and chicken breasts, would be strong.

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Table 1. Descriptive Statistics

Variable	Mean	St.Deviation	Variance	Minimum	Maximum
Expenditure share- Beef, all other (w_1)	0.334	0.043	0.002	0.229	0.479
Expenditure share - beef, ground (w_2)	0.163	0.017	0.000	0.120	0.200
Expenditure share - Pork (w_3)	0.216	0.032	0.001	0.153	0.361
Expenditure share - Chicken (w_4)	0.287	0.030	0.001	0.214	0.424
Price - Beef, all other (p_1)	12.102	0.936	0.876	9.628	14.373
Price- Beef, ground (p_2)	5.257	0.432	0.187	3.860	6.260
Price - Pork (p_3)	8.187	0.395	0.156	6.910	9.290
Price - Chicken (p_4)	6.725	0.437	0.191	5.626	8.303
Total Expenditure -beef all other, beef ground, pork, chicken (X)	3.142	0.400	0.160	1.939	4.012
Media (media)	3.857	7.269	52.842	0.000	47.000
Border Closure Index (BCI)	0.846	0.308	0.095	0.000	1.000

Table 2. Products/cuts Included in Beef All Other, Beef Ground, Pork and Chicken

Beef all other	Beef ground	Pork	Chicken
Flank	Extra lean ground	Belly	Breast
Front	Lean ground	Leg	Drumsticks
Hip	Hamburger patties	Loin	Legs
Loin	Regular ground	Shoulder	Strips
Rib	Shank		Thighs
			Whole
			Wings

Table 3: Demand System Coefficients

	log(X)	w ₁	w ₂	w ₃
VARIABLE	Coefficient	beef, all other Coefficient	beef, ground Coefficient	pork Coefficient
price-beef all other (p ₁)		0.187**	-0.086**	-0.01
price - beef ground (p ₂)		-0.086**	0.148**	-0.03**
price - pork (p ₃)		-0.01	-0.03**	0.161**
price - chicken (p ₄)		-0.074**	-0.026*	-0.127**
log (P)	0.364*			
log(X/P)		-0.032*	-0.034**	0.033*
DM1 (Jan 1- Jan 27)	0.186**	0.009	-0.009**	0.003
DM2 (Jan28 - Feb 24)	0.194**	-0.001	-0.008*	-0.005
DM3 (Feb 25 - March 24)	0.2**	-0.004	-0.01**	-0.003
DM4 (March 25 - April 21)	0.182**	-0.005	-0.008*	0.004
DM5 (April 22 - May 19)	0.281**	0.03**	-0.011**	-0.021*
DM6 (May 20 - June 16)	0.273**	0.014	0.016**	0.003
DM7 (June 17 - July 14)	0.247**	0.032**	-0.009*	-0.021*
DM8 (July 15 - Aug 11)	0.275**	0.057**	0.016**	-0.033**
DM9 (Aug 12 - Sept 8)	0.276**	0.037**	-0.02**	-0.019*
DM10 (Sept 9- Oct 6)	0.191**	0.022**	-0.016**	-0.006
DM11(Oct 7 - Nov 3)	0.14**	0.004	-0.014**	0.01
DM12 (Nov 4 - Dec 1)	0.179**	-0.008	-0.009**	0.005
Border closure index (BCI)	0.043	0.228**	0.073**	-0.113**
p ₂ *BCI Interaction (log(p ₂ *BCI+1))		-0.091**	-0.035**	0.033*
Media (lgmedia)	0.001	-0.001**	-0.0002*	0.001**
time (t)	0.001**	0	0*	0**
Habit formation (lag(qi))		0.013	0.008	-0.028**
constant term	0.117	0.16**	0.245**	0.141**
R ²	0.45	0.65	0.73	0.44
Raw moment R ²	0.992	0.995	0.997	0.988
Durbin Watson	1.88	1.78	1.92	1.98

** denotes significance at the $\alpha = 0.05$ level *denotes significance at the $\alpha = 0.10$ level

Table 4. Results of Various Hypothesis Tests

	Wald Chi-Square Statistic	P-Value
Quarterly seasonality	78.22 with 36 D.F.	0.00
Border closure effect	48.59 with 4 D.F.	0.00
Ground beef price*border close interaction	32.37 with 3 D.F.	0.00
Lagged media	15.29 with 4 D.F.	0.00
Time trend	35.87 with 4 D.F.	0.00
Habit-lagged quantity in the share equations	10.90 with 3 D.F.	0.01

Table 5. Elasticity With Respect to Prices and Expenditure

Elasticity of:	Price of:				
	beef, all other	beef, ground	pork	chicken	expenditure
beef, all other	-0.298**	-0.361**	0.041	-0.219*	0.904**
beef, ground	-0.308**	-0.103	-0.012	0.078	0.793**
pork	0.061	-0.08	-0.195	-0.357**	1.153**
chicken	-0.1	-0.015	-0.51**	-0.128	1.115**

** denotes significance at the $\alpha = 0.05$ level *denotes significance at the $\alpha = 0.10$ level

Table 6. Elasticity with Respect to Media and Border Closure Index

	media	BCI
beef, all other	-0.002*	0.358**
beef, ground	-0.001	0.202**
pork	0.007**	-0.27**
chicken	0	-0.178**
expenditure	0.001	0.043

** denotes significance at the $\alpha = 0.05$ level
*denotes significance at the $\alpha = 0.10$ level

Figure 1. Consumption Trend: All Other Beef , 2001- 2004

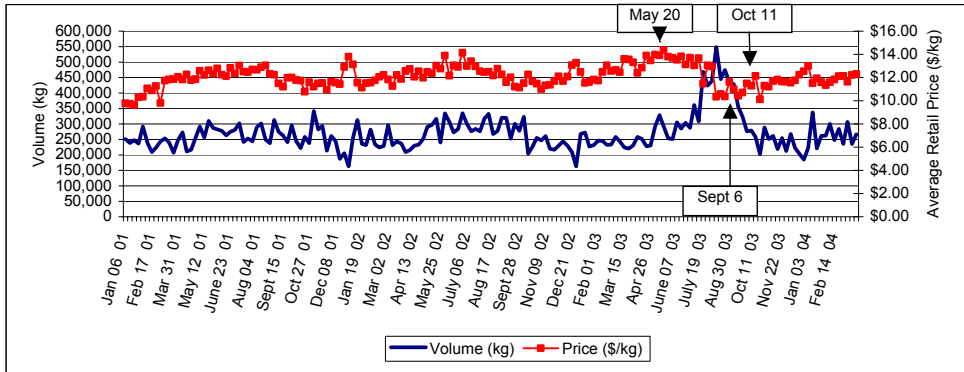


Figure 2. Consumption Trend: Ground Beef , 2001- 2004

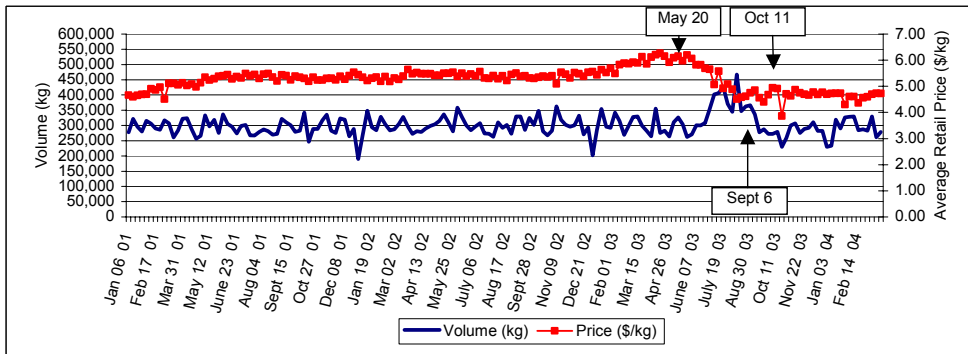


Figure 3. Consumption Trend: Pork , 2001- 2004

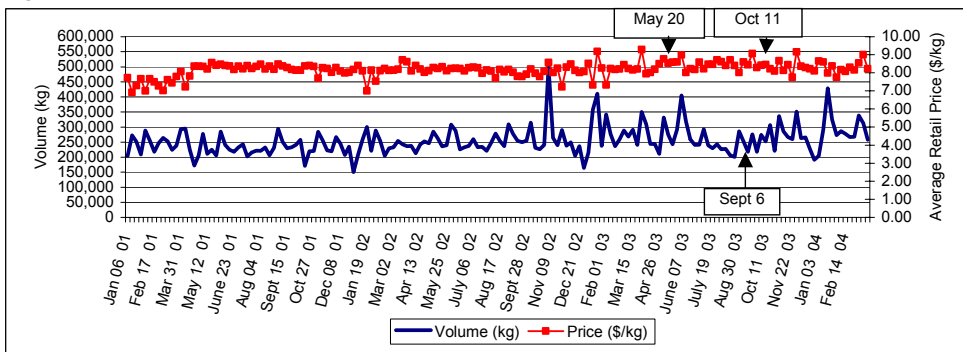


Figure 4. Consumption Trend: Chicken , 2001- 2004

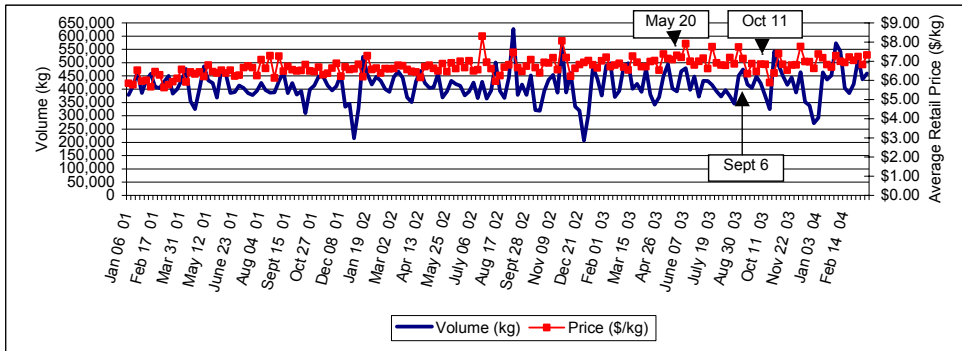


Figure 5. Number of BSE Related Newspaper Articles, 2001-2004

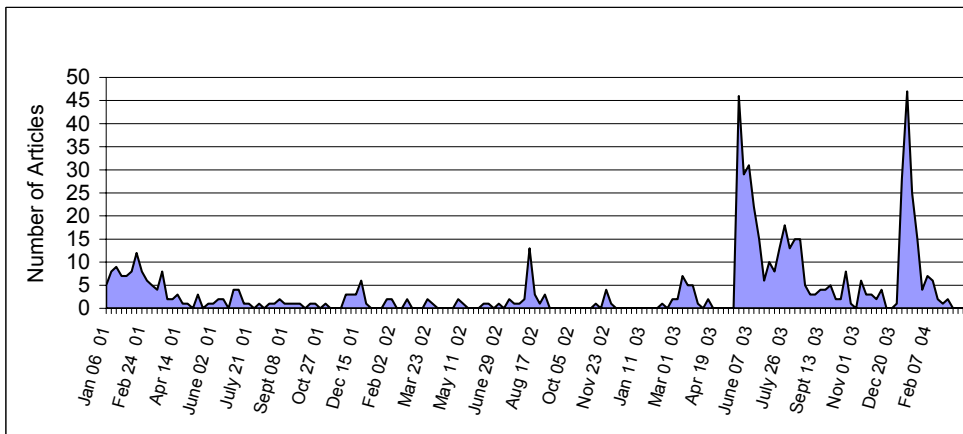


Figure 6. Seasonality Effects on All Other Beef Demand
 % change relative to the last 4-week period of the year

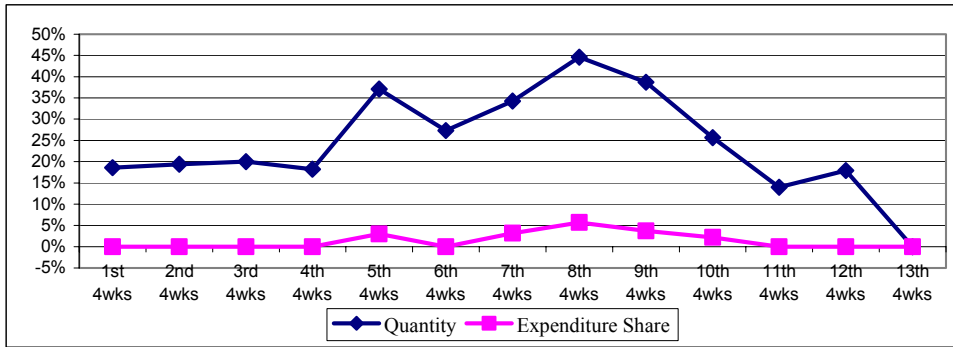


Figure 7. Seasonality Effects on Ground Beef Demand
 % change relative to the last 4-week period of the year

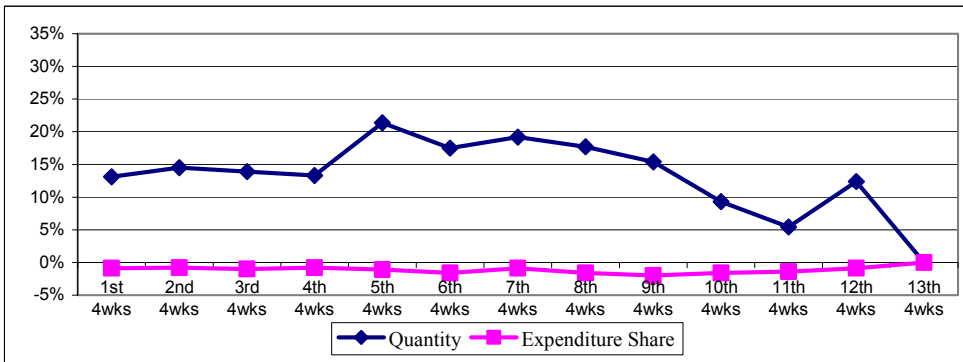


Figure 8. Seasonality Effects on Pork Demand
 % change relative to the last 4-week period of the year

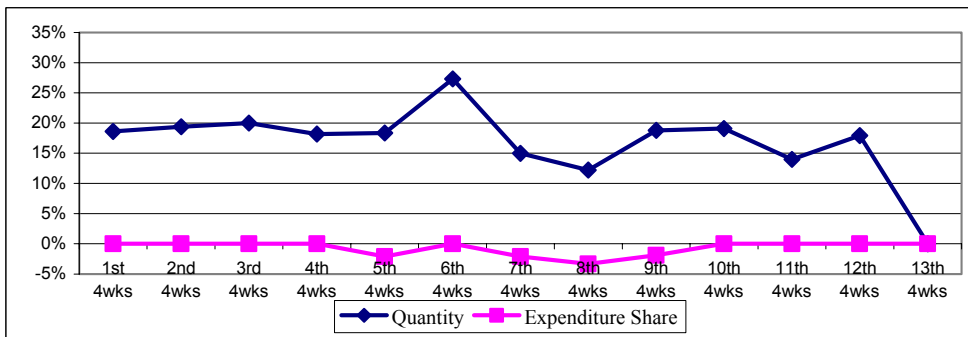


Figure 9. Seasonality Effects on Chicken Demand
 % change relative to the last 4-week period of the year

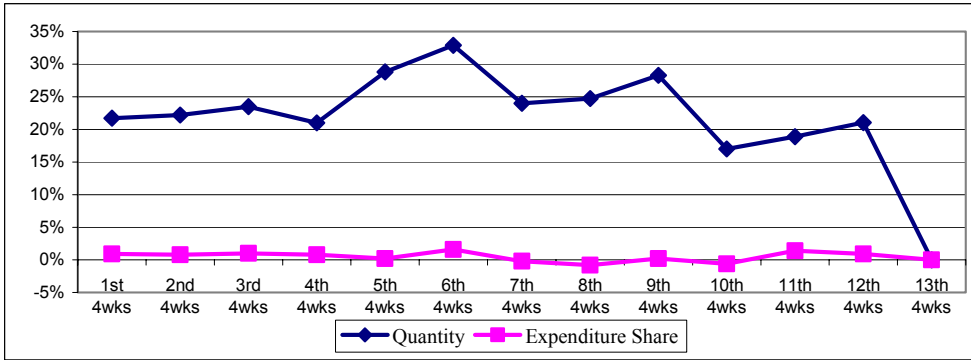


Figure 10. Seasonality Effects on Total Meat Expenditure
 % change relative to the last 4-week period of the year

