The Impact of BSE, FMD, and U.S. Export Promotion Expenditures on Japanese Meat Demand

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Abstract

The study examined Japanese consumer response to the discovery of BSE and discusses implications for the U.S. beef industry following BSE discovery in the U.S. Impacts of FMD and export promotion expenditures were also modeled. Synthetic inverse and ordinary demand systems were used to appropriately specify the demand system.

Background

Japan, with its economic might and high disposable income (2001 GNI per capita of $35,990 (World Bank, 2002)), coupled with relatively low domestic production, has always been seen as a potential market for high quality meat exports. However, in the late 1990's meat imports and consumption decreased considerably in Japan. Among the factors cited was the decline in economic activity and more importantly, the discovery of *Bovine Spongiform Encephalopathy* (BSE) in Japanese herds (Hayes, Wahl and Williams, 1990; Capps et al., 1994; Eales and Wessells, 1999; Peterson and Yun-Ju, 2003).

The main objective of this study is to examine any structural changes in Japanese beef demand, especially due to the 1988 MMA agreement that eliminated quotas and the discovery of BSE in Japanese herds. The study also examines Japanese consumer's response to the discovery of BSE and discusses the implications for U.S. exporters and lessons for the U.S. cattle industry following BSE discovery in the U.S. Finally, the study evaluates United States meat promotion efforts in Japan and its role in expanding U.S. beef demand in Japan.

In empirical analysis, the choice among competing functional forms has mostly been arbitrarily made, as economic theory does not provide a basis for selection. In this case, however, we perform empirical tests to identify the most appropriate functional form for this demand analysis. Studies by Alston and Chalfant (1993), Eales and Wessells (1999), Fousekis and Revell (2000), Ogunyinka and Marsh (2003), among others, have tested for the appropriate specification in demand analysis. An important and related question to the choice of functional form is the choice of specification of the demand model. Fourteen out of seventeen studies reviewed by Smallwood, Haidacher and Blaylock (1989) had used the quantity dependent specification of demand. This has been based on the assumption that prices are predetermined and quantity adjusts to clear the market. However, as noted by Eales and Unnevehr (1994), there are some products for which the notion of predetermined prices is untenable. Perishable products and agricultural produce in particular, are subject to biological lags in production and can be seen as having predetermined quantities.

This study models Japanese demand for beef products with characteristics similar to those described for fish by Eales, Durham and Wessells (1997). These include biological lags in production, import restriction and availability, storability of beef and the existence of both fresh and frozen beef on the Japanese meat market. In Japan, beef cuts sold at the retail level are mainly chilled with the frozen beef being channeled into processing. However, when the premiums on chilled cuts are high, frozen cuts are sold at the retail level. According to Reed and Iswariyadi (2001) this scenario is increasingly observed for U.S. beef imports. Finally, monthly retail data are used in this study, as opposed to the frequently used annual wholesale data in previous studies.

Empirical Model

An ordinary synthetic demand system originally due to Barten (1993) is utilized to select from among four competing ordinary models. The system nests four ordinary demand models; AIDS, Rotterdam, and the Central Bureau of Statistics (CBS) and National Bureau of Research (NBR) models. The four models have identical right-hand-side variables and are related as shown by Barten (1993) and Brown, Lee and Seale (1994). The four models can be regarded as different ways of parameterizing the general synthetic model. The general ordinary synthetic demand system is:

Synthetic model: $w_i d \ln q_i = (d_i + \delta_1 w_i) d \ln Q + \sum_j [e_{ij} - \delta_2 w_i (\delta_{ij} - w_j)] d \ln p_j$ (1)

In all models (and in the inverse models below), *(i, j) = 1,…, N* index the goods, p_i, q_i and w_i are the price, quantity and budget share for good *i*, and β_i, b_i, β_{ij} and b_{ij} are model parameters. In all cases, equations are indexed by *i* and price terms within equation indexed by *j*. For the synthetic model (1), d_i is a weighted average of the expenditure parameters from the differential AIDS and Rotterdam models given as: $d_i = \delta_1 \beta_i + (1 - \delta_1) b_i$, and e_{ij} is the weighted average of the compensated price parameters from the differential AIDS and Rotterdam models given as: $e_{ij} = \delta_2 \beta_{ij} + (1 - \delta_2) b_{ij}$. The Kronecker delta δ_{ij}, is equal to one if *i = j* and zero otherwise.

Similarly, a synthetic inverse model developed by Brown, Lee and Seale (1994) that nests four competing inverse models is utilized to help identify the most appropriate inverse model. The inverse Rotterdam (IRDS), inverse AIDS (IAIDS), inverse Laitinen-

Theil (LTDS) and inverse Rotterdam-AIDS hybrid (RAIDS) comprise the four models that make up the general inverse synthetic demand system:

Synthetic model: $w_i d\ln\pi_i = (d_i - \delta_1 w_i) d\ln Q + \sum_j [e_{ij} - \delta_2 w_i(\delta_{ij} - w_j)] d\ln q_j$ (2)

For the inverse synthetic inverse model (2), d_i is a weighted average of the scale parameters from the differential inverse AIDS and Rotterdam models given as: $d_i = \delta_1 g_i + (1-\delta_1)h_i$, and e_{ij} is the weighted average of the compensated quantity parameters from the differential inverse AIDS and Rotterdam models given as: $e_{ij} = \delta_2 g_{ij} + (1+\delta_2)h_{ij}$. Imposition of the following restrictions on equation (1) and (2) yield the underlying ordinary or inverse models, respectively.

Rotterdam:	$\delta_1 = \delta_2 = 0$	IRDS:	$\delta_1 = \delta_2 = 0$
CBS:	$\delta_1 = 1, \delta_2 = 0$	LTDS:	$\delta_1 = 1, \delta_2 = 0$
AIDS:	$\delta_1 = \delta_2 = 1$	IAIDS:	$\delta_1 = \delta_2 = 1$
NBR:	$\delta_1 = 0, \delta_2 = 1$	RAIDS:	$\delta_1 = 0, \delta_2 = 1$.

Structural change and promotion evaluation

To achieve the objectives of the study, the basic inverse and ordinary synthetic models are modified to account for structural changes, and the impact of BSE, FMD and U.S. beef promotion on Japanese meat demand. To identify any structural changes due to the BSE scare and also account for the influence of the gradual tariff reductions, the approach used by Mangen and Burrell (2001) is adopted. Mangen and Burrell used a switching AIDS model that included a time trend, structural shift and a dummy variable to capture the one-time impact of BSE scare on meat demand in the Netherlands.

In this study it is assumed that the impact of varying tariffs rates are felt through the increased openness of the Japanese economy over time and the general performance of the Japanese economy. Thus, the trend variable will be expected to capture the impact of varying tariff rates, any trend-induced changes in demographics that influence meat consumption (Kinnucan et al., 1997), and the impact of any un-modeled trending variables (Mangen and Burrell, 2001). A BSE dummy variable is included in this study to determine changes that occurred in Japanese beef demand with the discovery of BSE in Japan. A time path r_t is assumed that allows the demand parameters to gradually change over time and is defined below as:

$r_t = 0$, for $t = 1,...t_1$

$r_t = (t - t_1)/(t_2 - t_1)$ for $t = t_1 + 1,.....t_2$

$r_t = 1$ for $t = t_2 + 1,.....T$

where t_1 is the end point of the first regime, t_2 is the end of the transition period and T the end of sample period.

Advertising or promotion is assumed to influence product demand. Two approaches are described by Brester and Schroeder (1995). In the demand shifter approach advertising variables are included as shift variables in demand models either as a linear or auxiliary relationship. The second approach suggested by Theil (1980) assumes that advertising affects demand elasticities of products. Advertising in this case can be seen as acting as a 'taste shifter' that affect the marginal utility of each good (Kinnucan et al., 1997). Based on the observations of Coulibaly and Brorsen (1999), Brester and Schroeder (1995) and Duffy (1995) that similar results are obtained by modeling advertising as a demand shifter or as a scaling variable, and considering the ease of estimation of the former, the demand shifter approach is used in this study.

Misspecification testing, endogeneity testing and functional form selection

The battery of misspecification tests advocated by McGuirk et al. (1995) specifically for systems of equations is used to help identify any econometric violations in the demand systems. The synthetic models purged of econometric violations are subjected to endogeneity testing to select the appropriate specification of demand. The system Durbin-Wu-Hausman test (McGuirk at al., 1995; Maynard and Veeramani, 2003) is used to test for endogeneity in the right-hand-side variables. If parameter estimates are significantly impacted by simultaneity from $d\ln p$, $d\ln q$ and $d\ln Q$, three stage least squares (3SLS) estimation is appropriate.

Dummy variables *D* that take a value of one in July and December and zero all other months of the year capture the gift giving seasons of December and July, when Japanese workers receive annual bonuses.

The resulting empirical models are:

$$w_i d\ln q_i = \alpha_i dr_t + (\sigma_i r_t + d_i + \delta_1 w_i) d\ln Q + \sum_j [\ell_{ij} r_t + e_{ij} - \delta_2 w_i(\delta_{ij} - w_j)] d\ln p_j + f_i D_{BSE} + \sum_j a_{ij} d\ln A_j + \sum_j \sum_k y_{ij} d\ln A_{j-k} + u_i D_{JD} \quad (13)$$

$$w_i d\ln \pi_i = \alpha_i dr_t + (\sigma_i r_t + d_i - \delta_1 w_i) d\ln Q + \sum_j [\ell_{ij} r_t + e_{ij} - \delta_2 w_i(\delta_{ij} - w_j)] d\ln q_j + f_i D_{BSE} + \sum_j a_{ij} d\ln A_j + \sum_j \sum_k y_{ij} d\ln A_{j-k} + u_i D_{JD} \quad (14)$$

Given equation (13) and (14) a test of $\alpha = 0, \ell = 0, \sigma = 0$ is a test of the hypothesis of no structural change. The following demand restrictions apply to equations (13) and (14).

Adding up: $\sum_i \alpha_i = \sum_i f_i = \sum_i \sigma_i = \sum_i u_i = 0$ and $\sum_i \ell_{ij} = \sum_i a_{ij} = \sum_i y_{ij} = 0$ for all j

Homogeneity: $\sum_i \ell_{ij} = \sum_i e_{ij} = 0$ for all i

Symmetry: $\ell_{ij} = \ell_{ji}$ for $e_{ij} = e_{ji}$ all i,j.

Data

Four beef types, U.S., Australian, Japanese Wagyu and dairy, and pork, chicken and fish are evaluated in this study. The sample data for pork, chicken and fish were not distinguished by sources of origin. Previous studies have established that they should be included as part of a separable meat group in modeling Japanese beef demand. The study uses 105 monthly observations from April 1994 to December 2002.

Retail prices for beef and pork were derived from Agriculture and Livestock Industries Corporations (ALIC) data. Beef prices were the weighted prices of four cuts (chuck, loin, round and flank) reported by ALIC based on Nikkei Point-of-Sales (POS). Retail pork prices were the weighted consumption shares of imported and domestic pork weighted by the prices of three cuts (loin, shoulder and butt) reported by ALIC. Retail prices for poultry and fish were both obtained from the Retail Price Survey (RPS) by the Statistical Bureau (SB) Ministry of Public Management, Home Affairs, Post and Telecommunications (MPMHAPT). Fish prices used in the study were the weighted average of five fish types, tuna fish, horse mackerel, flounder, yellow tail and cuttlefish. The fish types selected are composed of high, medium and low-end fish types. The choice of fish types to include in the study reflects the most representative fish series for which data were available and complete.

Quantity data (q_i) represent per capita consumption of meat product *i* in grams. Quantity variables were obtained by dividing aggregate consumption by population or household consumption by the average number of persons per household. Data on beef, pork and poultry quantities were obtained from reported consumption data by the SB, MPMHAPT. Beef consumption data was derived from compiled ALIC data based on retail sales. Fish consumption data was obtained by aggregating consumption data for the five major fish types listed above and reported in the Family Income and Expenditure Survey (FIES) administered by SB MPMHAPT.

Variables A_j and A_{j-k} represent real per capita advertising expenditures reported by the U.S. Meat Export Federation (USMEF) and the lags of real per capita advertising expenditures by *k* periods, respectively. Real per capita advertising expenditures were obtained by converting USMEF advertising expenditures in dollars into Yen using Bank of Japan spot rates and deflating by Japanese CPI and population. Exchange rate data (yen/dollars) were obtained from Bank of Japan long-term time series data. The central rate average monthly Interbank spot yen per dollars rate were used in this study. Monthly Japanese CPI was obtained from the SB, MPMHAPT. Data on the average number of persons per household were obtained from FIES. Average annual population estimates were used as a proxy for average monthly population estimates and were obtained from SB, Ministry of Health, Labor and Welfare (MHLW). The macro variables used as instruments in the test for endogeneity included population, exchange rate, CPI and interest on government bonds defined below. Yield on government bonds was the ten-year yield to subscribers' corporate interest bearing government bonds obtained from the

Bank of Japan long-term time series data. Table 1 below contains descriptive statistics for the meat products used in the study.

<<Table 1 about here>>

Results

The joint conditional and conditional variance system misspecification tests suggested by McGuirk at al. (1995) were rejected in both the ordinary and inverse models. The approach used by Eales and Unnevehr (1988, p. 522) in replacing current budget shares with its lag in computing Stone's price index was adopted in computing the Divisia volume index, after which the joint conditional mean test was not rejected.

The joint conditional variance test pointed to error variance instability as the most likely source for the misspecification in both models as well as dynamic heteroskedasticity in the case of the inverse model. In this study the most likely cause of the unstable error variances will be the variation in consumption introduced by BSE. However, examination of residuals and residual-squared plots over time indicated that the instability in the error variance started much earlier and was concentrated around two specific periods; March 2000 and September 2001-the date for the first outbreak of BSE in Japan. Further literature search revealed that the first outbreak of foot-and-mouth (FMD) in Japan in 90 years was reported in March 2000. Thus, the demand models were re-specified with FMD and BSE dummy variables included among the regressors. Equation-by-equation F-tests for instability in the error variances were not rejected in the ordinary equations and only rejected in Japanese Wagyu in the inverse equations. Thus, the fully specified models with structural change parameters, FMD and BSE variables included were deemed to be statistically adequate and used for model testing.

The fully specified inverse and ordinary demand models were tested for endogeneity of right hand side variables ($d\ln p$, $d\ln q$ and $d\ln Q$). Japanese macro variables as well as first and twelfth order lags were used as instruments. The macro variables used included population, exchange rate (yen/dollar), CPI and interest on Japanese government bonds. The system Durbin-Wu-Hausman tests failed to reject exogeneity in the prices $(d\ln p)$ and the conditional expenditure $(d\ln Q)$ in the ordinary system, and in quantities $(d\ln q)$ and the conditional expenditure $(d\ln Q)$ in the inverse system, respectively. The test results suggest that SUR is appropriate in computing parameters estimates for either the inverse or ordinary systems.

Finally, the fully specified models with structural change parameters, FMD and BSE dummy variables included are used to test for the appropriate functional form after testing for homogeneity and symmetry restrictions. The inverse system rejected several of the symmetry and two of the homogeneity restrictions. In the ordinary system, homogeneity and symmetry restrictions were not rejected at the 0.05 level. Thus, homogeneity and symmetry restrictions were imposed on the ordinary system but not on the inverse system prior to testing for the appropriate functional form.

Based on the LR test results, the fully specified inverse system rejected all four specific functional forms at the 0.01 level of significance. In the case of the ordinary system, the fully specified model with homogeneity and symmetry imposed, failed to reject restrictions corresponding to the Rotterdam demand system while rejecting all other models (AIDS, NBR, CBS).

The primary objective of the study is to identify any structural changes following the discovery of BSE in Japan. Results from the endogeneity tests did not explicitly indicate the best specification to be used in modeling beef demand in Japan. However, the ordinary demand system produced an overall better fit than the synthetic inverse system, conformed to the homogeneity and symmetry restrictions, and lends itself more easily to the objective of evaluating U.S. beef promotional impacts. Advertising or promotion, is expected to influence the purchasing decisions of consumers, and the individual consumer choice variable is quantity. Thus, a quantity dependent specification was used for analyzing advertising impact on quantity demand.

In testing for structural change, the switching regressions utilizing a transition time path described above were used. The start of the transition period was assumed to be September 2001, the month of BSE discovery in Japan. Thus, t_1 is set to August 2001. The results obtained by Peterson and Yun-Ju (2003) were used in determining the end of the transition period as January 2002.

Testing for structural changed entailed testing if there was an instantaneous reversible change in beef demand caused by BSE, as was done by Mangen and Burrell (2001), and also determining if there was a gradual structural change caused by BSE in Japan. The testing procedure follows that of Moschini and Meilke (1989). The results suggested that there was a change in the structure of meat demand in Japan following the discovery of BSE in Japanese beef herds. The test for parameter constancy in the full set of parameters was rejected at the 0.01 level of significance.

As shown in table 2, positive and significant impacts were observed in pork, chicken, fish, Japanese Wagyu and Australian beef while negative impacts were observed for U.S. and Japanese dairy beef in response to BSE discovery in Japan. Incidentally, the results for Japanese dairy beef were not significantly different from zero even though BSE was discovered in Japanese dairy herds. The results did indicate that Japanese consumers reacted negatively towards meat products they perceived as likely to transmit BSE and vice versa. This response was similar to the results obtained by Mangen and Burrell (2001) for Dutch meat consumers in response to the presence of BSE in the Netherlands. These responses represent consumers' interpretation of the potentials of the various beef products to transmit BSE.

<<Table 2 about here>>

The four beef types represented on the Japanese market have distinct qualities that underscore the observed consumer responses. Wagyu beef is the most expensive beef cut in Japan followed by dairy, U.S. and Australian beef, respectively. Wagyu are a native beef breed associated with the heavy marbling preferred by Japanese consumers. Japanese dairy cattle on the other hand are fattened for slaughter after their milk producing life. They are intensively managed to achieve the fattening. This entails feeding them with grains, bone meal and other concentrates. In general, feeding of concentrates containing meat and bone meal (MBM) as protein supplements to livestock, have been associated with the spread of BSE. This husbandry practice was a direct contributor to BSE being found in the United Kingdom and in dairy but not Wagyu cattle in Japan. Thus, Japanese consumers correctly assumed that they were less likely to contract BSE through the Wagyu beef than through dairy beef. The negative response observed for U.S. beef demand may be partly explained by the widely published remarks attributed to a Japanese meat company that imported beef are the most likely sources for the discovery of BSE in Japan (Jin and Koo, 2003).

The study also evaluated the impacts of FMD on the Japanese meat market. The impact of FMD on Japanese meat demand was largely insignificant. FMD had a negative impact on pork, poultry, Japanese Wagyu and U.S. beef demand and positive impacts on fish, Japanese dairy and Australian beef. However, with the exception of fish and Japanese dairy beef that were significant at the 0.10 level, none of the coefficients were significant. The results indicate some level of sophistication among Japanese meat consumers as they reacted negatively against most meat types even though FMD was isolated in cattle. Their reaction indicated that they were very much aware that FMD affects other livestock, unlike BSE that has mainly affected cattle.

As part of evaluating the impact of BSE on Japanese meat demand, elasticities were computed for the various meat products before, during and after the discovery of BSE in Japan. Parameter estimates from the Rotterdam model combined with average expenditure shares for each period were used to compute the elasticity estimates. The income elasticities and associated standard errors are presented below in table 3.

<<Table 3 about here>>

The expenditure elasticities were generally significant and had the expected signs while most of the price elasticities had the expected signs but were largely insignificant. At the height of BSE discovery in Japan, overall expenditure on meat products decreased. The beef products became highly expenditure elastic while chicken and fish experienced slight decreases in their expenditure elasticities. Peterson and Yun-Ju (2003) reported negative income elasticities for pork, Wagyu and U.S. beef in their ‘during phase’. The expenditure elasticities in the ‘after phase’ generally resembled that of the ‘before phase’. The beef products became more expenditure elastic while Australian beef and the non-beef products became slightly less elastic in the aftermath of BSE.

Following the discovery of BSE in Japan, quantity demanded initially decreased for the beef and pork products. Thus, based on the elasticity definition, one would expect that Australian, Japanese dairy and Wagyu beef as well as pork would experience increases in their expenditure elasticities, contrary to what Peterson and Yun-Ju (2003) observed. From the results, fish and poultry were not affected by the discovery of BSE as they both experienced decreases in expenditure elasticity, implying their quantities demanded increased in the ‘during’ phase.

In the case of the price elasticities, the own-price elasticities were mostly inelastic. Japanese Wagyu and dairy beef, as well as fish were the most responsive to price changes with higher own price elasticities. Among the own-price elasticities, only fish was significant before, during and after BSE was discovered. In the ‘during’ phase, the beef products became highly own-price elastic. There was little variation in the prices of meat products during the crisis. This in part explains the lack of significant price elasticities as there was very little variation in the meat prices. From the above, any changes in observed own-price elasticities can most likely be attributed to the changes in consumption following discovery of BSE. See table 4 below for price elasticities and associated standard errors.

<<Table 4 about here>>

The dramatic increases in price elasticities for the meat products in the ‘during phase’ can be attributed to the increased sensitivity of consumers to meat and beef in particular. Meat consumption initially declined following the discovery of BSE. Beef was the most affected as consumers switched from beef consumption at the height of the discovery. Peterson and Yun-Ju (2003) cite a newspaper survey that reported that 75% of consumers had stopped eating beef following BSE discovery in Japan.

The last objective of evaluating promotion or advertising impact is achieved using the fully specified Rotterdam model with structural change parameters, BSE and FMD dummy variables included. Three lag lengths of advertising variables were included to capture the total advertising impacts. Lag length selection was based on LRT for individual and joint lags. In addition, there was no significant individual coefficient beyond lag length three and, finally, overall system misspecification tests (joint conditional mean and variance) favored a maximum lag length of three.

The promotion expenditure data represented only generic promotion expenditures from USMEF and did not include branded promotional expenditures. Similarly, promotion expenditures for Australian, Japanese Wagyu and dairy beef, pork, chicken and fish were not included due to lack of data. Overall, USMEF promotions of U.S. beef in Japan had a positive impact on U.S. beef demand and a negative impact on its main competitor, Australian beef (See table 5). However, these impacts were not statistically significant. USMEF beef promotions also had positive but insignificant impacts on Wagyu and dairy beef and negative and significant impacts on pork and poultry demand.
<<Table 5 about here>>

The own-advertising impact for U.S. beef appears to be rather low. Studies conducted by Brester and Schroeder (1995) and Kinnucan et al. (1997) reported very low and insignificant generic own-promotion and cross advertising elasticities for U.S. beef and pork. They further observed that advertising elasticities were small compared to the price and income elasticities. Kinnucan et al. (1997) concluded that the lack of significant coefficients might be due to the relatively small role advertising plays in meat consumption behavior evident by the small generic advertising intensities. Advertising intensities for U.S. beef in Japan averaged 0.00346 between 1992 and 2002 (intensities were obtained by dividing average promotion expenditure by average value of exports).

The results indicated that a 100% increase in USMEF promotions causes demand for U.S. beef to increase by 6% and Australian beef and pork to decrease by 8% each. Average per capita quantity for U.S. beef was 51 grams while average monthly aggregate USMEF generic promotion expenditure for the study period was $620,000. Thus, from the promotion elasticity, when USMEF promotions increases by $620,000, per capita monthly quantity demanded of U.S. beef is expected to increase by 3.6 grams. This translates to an aggregate monthly increase in U.S. meat demand by 385MT at the retail level. Assuming an average exchange rate of 114, this translates into increased revenue of $8,962,578 and a return on investment of over fourteen times. This return however, is at retail, which involves other marketing and distributing costs not taken into consideration. Based on the results, the decision to expend an additional dollar on promotion should be based on a break even return of 7%. That is, if the promotion dollar will return more than 7% in increased net revenue then the promotion is worthwhile.

Conclusions

The main objectives of the study were to identify and examine the impact of BSE on Japanese beef demand as well as evaluate the impact of U.S. beef promotion on meat demand in Japan. As part of achieving the above objectives, and as objectives in their own right, the study also set out to identify the appropriate specification and functional form to be used in the demand analysis. The current study offers more comprehensive specification and system testing than previous studies.

The differences in specification are potential sources for some of the discrepancies in the results mentioned above. For instance Peterson and Yun-Ju (2003) obtained usually high own-price elasticities (-17.51, -44.09, -360.55 and -129.499 for U.S., Australian, Wagyu and dairy beef respectively) during the BSE crisis. Commeau, Mittlehammer and Wahl (1997) also obtained very high generic promotion coefficients based on their choice of an inverse specification. This contrasts sharply with the low coefficients obtained in this study and in other studies.

The tests of structural change indicated that BSE did impact Japanese beef consumption and also had an overall impact on meat consumption in Japan. The gradual switching Rotterdam specification employed in this study indicated that there were significant changes in the structure of meat demand in Japan occasioned by the discovery of BSE. Japanese consumers reacted negatively to U.S. and Japanese dairy beef. Though BSE had not been reported in cattle herds in the United States and was discovered in a dairy herd in Japan, both were impacted negatively by the discovery of BSE in Japan.

From the observed reaction, Japanese consumers believed that the grain fed U.S. beef could be carriers of BSE, and its close similarities to Japanese dairy beef caused consumers to avoid U.S. beef. Revelations of improper practices by Japanese meat companies, including mislabeling of imported beef as domestic beef, surfaced in the aftermath of BSE discovery in Japan and hurt U.S. beef demand (Peterson and Yun-Ju, 2003; Fox and Peterson, 2002). The grass-fed Australian beef is distinct from the domestic beef, while the grain fed U.S. beef is very similar to the dairy beef in Japan. Thus, any mislabeling would likely affect U.S. beef demand.

Contrary to the observations by Paarlberg, Lee and Seitzinger (2003) that consumers may not understand the difference between the health risks associated with BSE and FMD, the study results indicated otherwise. In this study consumers interpreted the potential impact of FMD and reacted as expected against all the meat products that can be carriers of FMD. Thus, beef, pork and poultry were all affected negatively while fish was affected positively. BSE, on the other hand, initially affected all the meat products with the exception of fish. Overall, however, it negatively affected only Japanese dairy and U.S. beef and positively affected poultry, pork, fish, Japanese Wagyu and Australian beef.

In the aftermath of the BSE discovery in Japan, the Japanese government launched an aggressive marketing campaign on the theme that Japanese beef is the safest in the world (Fox and Peterson, 2002). This was meant to restore consumer confidence in the domestic beef herds. Based on the time it took the beef industry to recover from the crisis (5 months) compared to other countries (21 months in the Netherlands (Mangen and Burrell, 2001)), it appears the campaign was effective. Considering the general suspicion of Japanese consumers to imports, exporters may benefit by promoting their products' safety attributes equally aggressively. Following the worldwide BSE crisis, U.S. meat exports now carry a label designating the U.S. as meeting all international guidelines to be considered free of BSE (Fox and Peterson, 2002). This message may not have yet extended to consumers at the retail level.

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Table 1: Descriptive Statistics for Japanese Meat Products from April 1994 to December 2002

Quantities (g/capita)	Mean	Std. Dev.	Minimum	Maximum
U.S. beef	50.95	13.08	7.39	80.13
Aus. beef	36.34	20.48	14.10	90.47
Wagyu	58.80	34.00	7.83	140.77
Dairy	113.97	28.22	26.43	170.99
Pork	406.70	27.34	352.13	506.10
Poultry	300.09	36.43	241.05	424.32
Fish	349.60	40.59	279.17	572.21
Nominal Prices (Yen/g)	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
U.S. beef	2.56	0.15	2.22	2.83
Aus. beef	1.91	0.11	1.67	2.11
Jap. Wagyu	5.58	0.23	4.99	6.00
Dairy	3.58	0.16	3.15	3.86
Pork	1.38	0.07	1.30	1.78
Poultry	0.93	0.04	0.68	1.01
Fish	2.39	0.19	2.03	2.73
Expenditure Share	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
U.S.	0.05	0.01	0.01	0.08
Aus.	0.03	0.02	0.01	0.07
Wagyu	0.13	0.06	0.02	0.22
Dairy	0.16	0.03	0.04	0.21
Pork	0.22	0.35	0.14	0.33
Poultry	0.11	0.02	0.08	0.16
Fish	0.32	0.03	0.27	0.38

U.S. refers to U.S. beef, Aus. refers to Australian beef, Wagyu refers to Japanese Wagyu beef and Dairy refers to Japanese dairy beef.

Table 2: Estimated Parameters for BSE and FMD Dummies

	U.S.	Aus	Wagyu	Dairy	Pork	Poultry	Fish
D_{BSE}	-0.0098**	0.0045**	0.0284***	-0.0010	0.0098***	0.0120***	0.0155**
	(0.0043)	(0.0023)	(0.0082)	(0.0059)	(0.0039)	(0.0031)	(0.0080)
D_{FMD}	-0.0071	0.0026	-0.0012	0.0112*	-0.0018	-0.0032	0.0044*
	(0.0046)	(0.0024)	(0.0088)	(0.0064)	(0.0041)	(0.0033)	(0.0027)

U.S. refers to U.S. beef, Aus. refers to Australian beef, Wagyu refers to Japanese Wagyu beef and Dairy refers to Japanese dairy beef.
Values in parenthesis are the standard errors
***, ** and * represent statistically significance at the 0.01, 0.05 and 0.10 levels, respectively

Table 3: Expenditure Elasticities 'Before, During and After' the Structural Changes

Product	Before (N=88)	During (N=5)	After (N=11)
U.S. beef	0.7998***	-1.2162	1.0417***
	(0.1703)	(1.5636)	(0.2218)
Australian beef	0.3716*	1.0631***	0.1335*
	(0.2246)	(0.3672)	(0.0807)
Japanese Wagyu	1.3312***	3.9009***	3.1458***
	(0.1310)	(0.9781)	(0.3097)
Japanese dairy	1.0021***	1.4510**	1.7827***
	(0.0746)	(0.6284)	(0.1327)
Pork	0.2834***	0.3629***	0.2119***
	(0.0388)	(0.1222)	(0.0290)
Poultry	1.0080***	0.6788***	0.7654***
	(0.0626)	(0.0838)	(0.0476)
Fish	1.1758***	1.0826***	1.1027***
	(0.0522)	(0.1478)	(0.0489)

Standard errors in parenthesis
***, ** and * represent statistically significance at the 0.01, 0.05 and 0.10 levels, respectively

Table 4: Marshallian Price Elasticities 'Before, During and After' Structural Changes

Before Structural Change: April 1994-August 2001

	U.S.	Aus.	Wagyu	Dairy	Pork	Poultry	Fish
U.S.	-0.0699	0.5211*	-0.6435	-0.6604	0.2137	-0.2764	0.1873
	(0.5697)	(0.2829)	(0.9041)	(0.6045)	(0.3134)	(0.2455)	(0.3104)
Aus.		-0.0438	0.4380	-1.8206	0.6248	0.0782	-0.3263
		(0.9077)	(1.5727)	(1.1375)	(0.5201)	(0.3798)	(0.4119)
Wagyu			-0.6519	0.7821	0.0674	0.0232	0.4215*
			(0.8778)	(0.5489)	(0.2373)	(0.1798)	(0.2357)
Dairy				-0.2561	0.4174***	0.0716	0.5531***
				(0.4157)	(0.1488)	(0.1095)	(0.1393)
Pork					-0.0472	-0.2581***	0.1117*
					(0.0869)	(0.0494)	(0.0667)
Poultry						-0.1310	0.3197***
						(0.1037)	(0.1092)
Fish							-0.3206***
							(0.0445)

During Structural Change: September 2001-January 2002

	U.S.	Aus.	Wagyu	Dairy	Pork	Poultry	Fish
U.S.	-1.4120	-1.5556	-12.6487**	-1.1494	-2.8971	-5.7899**	8.0463***
	(4.8759)	(2.5785)	(6.1536)	(4.7189)	(3.2525)	(2.5678)	(2.6942)
Aus.		-3.2280***	3.4033**	0.7913	2.1569**	-1.3884*	-0.0636
		(1.1974)	(1.4665)	(1.3255)	(1.0558)	(0.7358)	(0.6929)
Wagyu			-3.0359	4.8472*	-1.7193	3.1260**	4.3241***
			(4.5522)	(2.9369)	(1.6256)	(1.2776)	(1.6715)
Dairy				-3.5358	2.0306	0.9996	-1.4262
				(2.5024)	(1.3689)	(0.9497)	(1.1196)
Pork					-0.3160	0.0626	0.2471
					(0.3727)	(0.2094)	(0.1967)
Poultry						-0.0222	0.1505
						(0.1849)	(0.1458)
Fish							-0.7596***
							(0.2467)

Table 4 (continued)

After Structural Change: January 2002-December 2002

	U.S.	Aus.	Wagyu	Dairy	Pork	Poultry	Fish
U.S.	-0.1039	0.7196**	-0.9133	-0.9714	0.1261	-0.4035	-0.0221
	(0.7420)	(0.3687)	(1.1774)	(0.7868)	(0.4102)	(0.3204)	(0.4051)
Aus.		-0.0106	0.1472	-0.6692	0.2044	0.0219	-0.1520
		0.3262	(0.5650)	(0.4086)	(0.1874)	(0.1366)	(0.1483)
Wagyu			-1.7814	1.2175	-0.1954	0.0289	0.2980**
			(2.0741)	(1.2964)	(0.5638)	(0.4257)	(0.5881)
Dairy				-0.5864	0.8670***	0.4381**	0.9138***
				(0.7393)	(0.2659)	(0.1952)	(0.2483)
Pork					-0.0205	-0.1861***	0.0451
					(0.0651)	(0.0370)	(0.0508)
Poultry						-0.0747	0.2588***
						(0. 0788)	(0.0831)
Fish							-0.2776***
							(0.0421)

Standard errors are in parenthesis, U.S. refers to U.S. beef, Aus. refers to Australian beef, Wagyu refers to Japanese Wagyu beef and Dairy refers to Japanese dairy beef.
***, ** and * represent statistically significance at the 0.01, 0.05 and 0.10 levels, respectively

Table 5: Estimated Promotion Elasticities and Standard Errors

	Elasticities	Standard error	t-ratio
U.S. beef	0.0632	0.0884	0.7154
Australian beef	-0.0800	0.0868	-0.9224
Japanese Wagyu	0.0415	0.0697	0.5916
Japanese dairy	0.0597	0.0395	1.5142
Pork	-0.0780***	0.0180	-4.3340
Poultry	-0.0532*	0.0289	-1.8421
Fish	0.0369	0.0254	1.4576

*** statistically significant at the 0.01 level
* statistically significant at the 0.10 level