The Impact of BSE on Japanese Retail Beef Market

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Bovine spongiform encephalopathy (BSE), or mad cow disease, has spread across Europe in the 1990s. Consumption of beef infected by BSE is suspected to cause new variant Creutzfeldt Jacob Disease, which has been associated with about 120 deaths in Europe as of June 2002. The first case of BSE was discovered in a Japanese dairy cow in September of 2001. The Japanese government has spent a budget of over $ 1 billion to restore food security. In particular, all slaughtered cattle have been screened for BSE before market circulation since October 2001, and four additional cases have been discovered as of December 2002.

In the Japanese beef market, there are four main types of beef: Wagyu beef (Japanese native beef cattle), dairy beef (byproduct from the dairy industry), and beef imported from U.S. and Australia. Each is associated with different levels of quality and certain food uses. The Japanese import quota was replaced with tariffs in 1991, and the tariff rate has been lowered by the General Agreements on Tariffs and Trade agreement in the Uruguay Round to 38.5 percent in 2001. Japan is now one of the largest beef importing countries, which receives 5 percent of U.S. annual production. Japanese have strong preferences for domestically produced food, which is believed to be safer and of higher quality. Beef imports have expanded their market shares through away-from-home consumption, while domestic beef has maintained its premium over imports at retail stores. The country of origin labeling for fresh beef was mandated in July 2000.

Japanese per capita consumption of beef in October 2002 dropped 44 percent from the previous month. Sales of all types of beef were affected, and meat consumption shifted toward poultry and pork. In addition to the continuing incidents related to BSE, several illegal activities of Japanese meat companies were revealed during the aftermath, further shaking the consumer confidence in meat retailing. As of May 2002, consumption of all beef appeared to be recovering from the initial shock. U.S. and Australian imports continued to decline through January 2002, but are recovering in 2003.

The objectives in this paper are (1) to examine the nature of structural change in Japanese meat demand due to BSE discovery, if any, and (2) to quantify the impact of BSE on consumption across different origins of beef. Several studies have measured impacts of BSE in the European markets (for example, Burton and Young, 1996; Mangen and Burrell, 2001). To address our objectives, we model a Japanese meat demand system with gradual structural change. Using observations through May 2002, we find strongest empirical evidence that the Japanese meat market went under a transition within five months following the initial BSE discovery. During the transition period, demands for all types of beef became highly responsive to prices. Pork demand was affected but seafood and poultry demands were not.

The next section reviews the background information and literature that has addressed the Japanese meat market and impacts of BSE and similar food scares. Then, the gradual switching demand system is specified for the Japanese meat market. Following a discussion on data sources and empirical implementation, estimation results are presented. In our concluding remarks, we comment on the potential effect of BSE discovery on the Japanese livestock industry.

The Japanese Meat Market and the BSE

The Japanese diet consists of rice and other seasonally available food, where meat plays a relatively small role. For example, an average American obtains 12 percent of food calorie intake from meat and only 0.008 percent from seafood, while the average for Japanese is 6 percent from each category. Japanese on average consume less than one-fourth of the amount of beef consumed by Americans. Beef consumed in Japan can be categorized into four types of beef: Wagyu, dairy, U.S., and Australian beef. Wagyu is Japanese native breed cattle, with heavier marbling than dairy or imported beef, which is fit for Japanese traditional beef dishes that require thinly sliced beef. As new beef dishes that suit leaner beef were introduced to Japan, the Japanese imported beef market was expanded. Most of Australian beef is used for hamburgers in fast food chain stores. Imports increased their shares through away-from-home consumption. While 70 percent of the Japanese beef supply was imported, the share of imported beef consumed at home was less than 33 percent during the late 1990s (for details of the Japanese beef market prior to the BSE discovery, see Peterson). At the retail storefront, country of origin labeling has been mandatory since July 2000.

The substitutability among beef types has been an issue in empirical analysis of Japanese meat demand system. Hayes, Wahl, and Williams (1990) found that Wagyu must be treated as a separate commodity from dairy and imported beef, assuming perfect substitutability between the latter two types.[1] Their results also suggested that not all meats are net substitutes in Japan—in particular, chicken was a net complement to import-quality beef and pork—and that both Wagyu and import-quality beef are luxury goods in Japan. Yang and Koo (1994) examined Japanese meat import demand, accounting for country of origin. Beef sources were distinguished into U.S., Australia, and other (which includes New Zealand and Canada), and aggregation over the three sources was rejected over the sample period 1973 and 1990.

It is common in demand analysis of western nations to consider seafood consumption separately from meat consumption. Hayes, Wahl, and Williams (1990) and Capps et al. (1994) found that fish could be separable from other meats in the Japanese demand system. Eales and

[1] Comeau, Mittelhammer, and Wahl (1994) made a similar assumption in their assessment of the U.S. export enhancement programs.

Wessells (1999) confirmed these previous results prior to 1990, but found support for structural change that occurred between 1990 and 1995 that reversed the results, implying that a more current analysis of Japanese meat demand should include seafood. Seasonality defines another distinct characteristic. Johnson, Durham, and Wessells (1998) examined the seasonality in Japanese household demand for meat and seafood, specifying beef as an aggregate commodity but disaggregating seafood products. They found a distinct seasonal pattern in meat consumption, including an increase in beef and certain seafoods and a decrease in pork during the season of gift-giving in December.

The announcement of the first BSE case in Japan came on September 10, 2001. In response, the Japanese government removed animals older than 30 months from the human food chain and instituted BSE testing of all slaughtered cattle for human consumption. It also banned imports, processing, and distribution of meat and bone meal (MBM) for all uses. A budget of over $1.3 billion included the cost of an income stabilization scheme for cattle farms, incineration costs for MBM, and the cost of a new electronic tagging and traceability system for all livestock that was implemented in October 2002. The government also purchased and incinerated the entire beef inventory prior to the initiation of BSE testing at a cost of over 10 billion yen (approximately $100 million). A fifth case was confirmed on August 22, 2002. All were in dairy cows born in early 1996 or late 1995. Initially, the outbreak was linked to MBM imported from the U.K. in the early 1990's, but the most plausible source is now suspected to be inadequately sterilized MBM imported from Italy between 1995 and 1998.

Figure 1 plots per capita consumption from April 1998 through May 2002. Seasonal patterns for all meats are very regular until in October 2001 when beef consumption plummeted to 55 percent of its September level, which was already a 25 percent lower than the August level, and shifted to pork and poultry. Seafood does not appear to have been affected. Despite the scare, more beef was consumed in December due to the gift-giving tradition. In 2003, beef consumption appears to be recovering.

The impact of BSE discovery differed across beef types. Figure 2 shows monthly consumption of the four types of beef from May 2001 through May 2002. Despite the fact that BSE was discovered in a domestic dairy cow, consumption of Wagyu and U.S. beef both dropped. In contrast, Australian beef consumption at the retail storefront appears to be least affected and expanded its share through the remainder of the sample period. Wagyu consumption recovered during the gift-giving month of December, while U.S. beef consumption remained stagnant through February 2002.

BSE was first recognized in the U.K. in the mid 1980's as a bovine form of transmissible spongiform encephalopathies, and in 1996, the U.K. government announced that consumption of BSE-infected beef is possibly linked to new variant Creutzfeld Jacob Disease, fatal in humans. BSE spread to other countries across Europe, including Ireland, Switzerland, France, Portugal, Belgium, and Netherlands, through trades of infected MBM. The first "homegrown" cases were discovered in 2000 in Germany, Spain, and Demark, followed by Italy in 2001. (See Fox and Peterson for a detailed account of events related to the disease.) Meat demand in Europe was considerably affected by the outbreak. For example, the per capita consumption of beef in the U.K. was decreased during 1986 and 1995, which may be attributed to the increasing concern of BSE, and following the announcement of its link to vCJD in March 1996 caused beef consumption to drop by an additional 40 percent. Consumption began to recover gradually in the following years.

In an econometric model, structural change can be captured by a binary variable, which assumes instantaneous adjustment in the market. Yet, it is more plausible that adjustment takes place more gradually before the market settles to a new equilibrium. One way to account for gradual change is to incorporate a continuous shift variable such as advertising expenditures (e.g., Brester and Schroeder, 1995) or a health awareness index based on media (e.g., Brown and Schrader, 1990). An alternative is to specify a time transition function that allows for a gradual shift from one regime to the next, as in Ohtani and Katayama (1986). Moschini and Meilke (1989) incorporated such a transition function in their AIDS model of U.S. meat demand. Xu and Veeman (1996), in their analysis of Canadian meat demand, incorporated the time transition function in both Rotterdam and AIDS systems (for a detailed review of literature on structural change in meat consumption, see Hsu, 2000).

Studies that examined the impact of BSE on European meat demand have followed these alternate methods.[2] Using quarterly data from 1961 to 1993 in an AIDS system for U.K. meat demand, Burton and Young (1996) found that BSE awareness, measured by the number of newspaper articles regarding BSE, accounted largely for the drop in the beef market share in early 1990s and in the long run, diminished the beef market share by 4.5 percent by the end of 1993. Mangen and Burrell (2001) applied a switching AIDS model to analyze preference shifts for meat and fish in the Netherlands due to the BSE scare. They found strongest evidence for a nonlinear structural shift that lasted for 21 months starting in April 1996. We follow this latter approach by incorporating a gradual switching shift function in a demand system to assess the impacts of BSE on Japanese meat demand.

[2] For other studies on BSE that take different approaches, see Burton and Young (1997) and Lloyd et al. (2001).

Model Specification

In this study, we apply the absolute price version of the Rotterdam model (Theil, 1965) incorporating a gradual shift function, following Xu and Veeman (1996), and seasonal dummy variables to capture seasonality in the Japanese meat consumption (Johnson, Durham, and Wessells, 1998). The Rotterdam model approximates the true demand system, where the model parameters represent the underlying utility maximization process. Structural change can be specified by allowing these parameters to change over time. By assuming a time path, l_t, that affects the system simultaneously, and incorporating trend and seasonal dummy variables, D_k, the ith equation of a Rotterdam model for a system of N goods can be written as:

$$
\begin{aligned}
w_{it} d \ln q_{it} &= \alpha_i \left(1+\kappa_i dl_t\right) + \beta_i \left(1+\lambda_i dl_t\right) \sum_{j=1}^{N} w_{jt} d \ln q_{jt} + \sum_{j=1}^{N} \gamma_{ij} \left(1+\mu_{ij} dl_t\right) d \ln p_{it} \\
&\quad + \sum_{k}^{K} \delta_{ik} \left(1+\nu_{ik} dl_t\right) dD_{ikt} + \xi_i
\end{aligned} \tag{1}
$$

where $(i, j) = 1, \ldots, N$ index the goods, t indexes time periods, $k = 1, \ldots, K$ denotes seasonal clusters; p_i, q_i, and w_i are the price, quantity, and budget share of good i; α, β, γ, δ, κ, λ, μ, and ν are model parameters; and ξ_i is the error term. A transition function of the structural change, l_t, is specified to express a linear time path from one regime to the other, following Moschini and Meilke (1989):

$$
\begin{aligned}
l_t &= 0 && \text{for } t=1,\ldots,t_1 \\
l_t &= \left(t-t_1\right)/\left(t_1-t_2\right) && \text{for } t=t_1+1,\ldots,t_2 \\
l_t &= 1 && \text{for } t=t_2+1,\ldots,T
\end{aligned} \tag{2}
$$

where t_1 is the end of the first regime, t_2 is the end of the transition period, and T is the end of the sample period. The transition path between the two regimes may abrupt or gradual, depending on the size of t_1–t_2.

The properties of adding up, homogeneity, and symmetry require the following restrictions : $\sum_i \beta_i = 1$, $\sum_i \gamma_{ij} = \sum_j \gamma_{ij} = 0$, $\sum_i \alpha_i = \sum_i \delta_i = \sum_i \alpha_i \kappa_i = \sum_i \beta_i \lambda_i = \sum_i \delta_i \nu_i = 0$, $\sum_i \mu_{ij} = \sum_j \mu_{ij}$, and $\sum_i \gamma_{ij} \mu_{ij} = \sum_j \gamma_{ij} \mu_{ij} = 0$. The uncompensated and compensated price elasticities are computed from the model parameters and the value of the transition function for each period as:

$$\varepsilon_{ijt} = \varepsilon_{ijt}^{*} - w_{jt} \varepsilon_{iyt} \text{, and}$$

$$\varepsilon_{ijt}^{*} = \frac{\gamma_{ij} \left(1 + \mu_{ij} dl_t\right)}{w_{it}},$$

respectively, while income elasticities at time t are computed as

$$\varepsilon_{iyt} = \frac{\beta_i \left(1 + \lambda_i dl_t\right)}{w_{it}}.$$

Data and Empirical Implementation

As reviewed above, Wagyu needs to be specified as a separate commodity from dairy and imported beef (Hayes, Wahl, and Williams, 1990), and U.S. and Australian beef need to be distinguished (Yang and Koo, 1994). With the advent of country-of-origin labeling, Japanese consumers can distinguish domestic dairy beef from beef from imported sources at the point of sale. Thus, we treat four types of beef (Wagyu, dairy, U.S., and Australian) as individual commodities, and together with pork, poultry, and seafood, the empirical demand system includes seven meats. The sample consists of 97 monthly observations from April 1994 through May 2002. Monthly per capita consumption of beef, pork, and poultry are reported in the *Meat Statistics*, the Ministry of Agriculture, Forestry, and Fishery (MAFF), based on household consumption data and the number of household members collected from *Family Income and Expenditure Survey* (FIES) administered by the Statistical Bureau, the Ministry of Public

Management, Home Affairs, Posts and Telecommunications (SB). Consumption of the four types of beef is compiled by the Agriculture and Livestock Industries Corporation (ALIC) based on the Nikkei Point-of-Sales (POS) data at 9 retail store chains in 6 major metropolitan areas. Per capita consumption of the four types of beef was computed by weighting total beef consumption by MAFF with the shares of consumption for each type based on the ALIC data. Per capita consumption of seafood was obtained by summing consumption per household for major seafood (tuna fish, horse mackerel, bonito, flounder, yellowtail, and cuttlefish) and dividing by the average number of household members (all from FIES).

The national average retail price for beef is reported for four cuts (chuck, loin, round, and flank) for each type of beef by ALIC. The monthly average retail price for four types of beef is computed as a weighted average of the cut-specific price, where the weights are shares of consumption of four cuts, reported by ALIC based on Nikkei POS data. ALIC also reports the national average retail price for three cuts (loin, shoulder, and butt) for domestic and imported pork, as well as their consumption. To obtain the monthly average pork price, domestic and imported pork prices are computed as a weighted average of the respective cut-specific prices, where the weights are the consumption shares of the three cuts, and then, the two prices are weighted by the consumption shares of domestic and imported pork. The retail price of poultry is available from the *Retail Price Survey* (RPS) administered by SB. The retail price of seafood is a weighted average of the price of the six seafoods for which consumption data were reported, from RPS, where weights are the consumption shares. All prices are deflated by the Japanese Consumer Price Index (1 = 2000) from SB.

The structural break-points (t_1, t_2) can either be set a priori or determined by searching over the sample in order to locate the structural breaks empirically (Mangen and Burrell). There is little doubt that the structural change due to BSE began with the initial discovery in mid-September of 2001. Thus, we set t_1 to August 2001. The empirical question is whether the Japanese meat market has completed its transition to the new structure. Thus, t_2 will be determined from the data by estimating the model for t_2 = September 2001 (immediate change) to May 2002 (still in transition at the end of the sample period), and selecting the one with the highest log likelihood function value.

In addition to the theoretical restrictions noted above, negativity is imposed by replacing the matrix of price coefficients with their Cholesky decomposition. The model without the structural change variables includes 51 parameters. The full model with structural change variable would include 102 parameters and with 97 observations, some restrictions on the coefficients of the structural change variables are necessary. To account for seasonality with the minimum number of regressors, dummy variables were specified in quarters, where the base quarter was September through November. Of the underlying trends, expenditure and price response, and seasonality, seasonality appears to be the least likely impacted by the BSE discovery. Thus, $\nu_{ik} = 0$ for all *i* and *k* were imposed. Also, μ_{ij} was estimated as $\mu_i \mu_j$ to reduce the number of parameters. The final model included 69 parameters.

The system is estimated eliminating the poultry equation. The parameters in the poultry equation are recovered from the imposed restrictions. The system is estimated in Shazam using nonlinear seemingly unrelated regression.

Results

The most likely break point of the transition period was January 2002, implying that costly measures taken by the Japanese government helped educate consumers and rebuild consumer confidence to a certain degree in five months since the initial discovery. Compared to

Mangen and Burrell's estimate for the Netherlands of 21 months, the implied adjustment period in Japan is very short. Japan is the only country among those where BSE has been confirmed that has implemented a screening test of all slaughtered cattle destined for human consumption. The manageable scale of slaughtering facilities in Japan (maximum of 300 to 400 head per day) allows equipment to be cleaned after each animal, eliminating the possibility of contamination. At the same time, we may find a different break point when longer time series after the initial discovery becomes available. Our estimate should be interpreted as the period of a transition to another phase, which may also be temporary.

Table 1 reports average Marshallian demand and expenditure elasticities for the period prior to the BSE discovery (April 1994 through August 2001), the estimated transition period (September 2001 through January 2002), and the period under the new structure (February 2002 through May 2002). Table 2 reports average Hicksian demand elasticities for the same periods. Prior to the BSE discovery (top panel), all meats are inelastic with respect to their own prices. Wagyu demand is the most elastic; since it is a prized good, consumers would willingly purchase it if its price is discounted a little. Demand for imported beef is most inelastic, mainly due to the small expenditure share. Domestic beef (wagyu and dairy) and seafood are luxury goods, while imported beef are unit-elastic with respect to income.

Many meats appear to be complements rather than substitutes. Japanese cuisine often requires multiple types of meat; for example, most hamburger is sold as part pork and part beef. Nonetheless, in compensated terms, wagyu is a net substitute of Australian and dairy beef (Table 2). This extends the conclusions of previous studies regarding the imperfect substitutability across beef types so that domestic dairy beef should be considered a separate commodity. Our results are consistent with the observation that dairy beef is similar to imported beef in quality but distinct from wagyu. Pork is a net complement to wagyu but a net substitute to other beef types, seafood, and poultry. Seafood and poultry are net substitutes to wagyu, pork, and to each other. Our results are consistent with those of Hayes, Wahl, and Williams (1990) who found that not all meats in Japan were net substitutes.

The elasticity estimates during the transition period paints a chaotic picture of consumer responses to the BSE discovery (middle panel in Tables 1 and 2). Demand for beef across all types became highly—even absurdly—sensitive to changes in price, although the BSE was discovered in a domestic dairy cow. Pork demand was affected to a lesser degree, while the changes in seafood and poultry demands were moderate. Large coefficients represent ceteris paribus responses to changes in price, when many consumers ceased to purchase beef. According to a national survey by Asahi newspaper in mid-October, one out of four consumers has stopped eating beef altogether. Only 26 percent indicated that they have not altered their beef consumption. The changes in expenditure elasticities vary widely across meats. Demands for Australian and dairy beef and poultry became more responsive to expenditure changes, while U.S. beef, wagyu, and pork became inferior goods. The wide range of responses is similar to Mangen and Burrell's findings in the Netherlands where beef became more expenditure-elastic while poultry became an inferior good. The unaffectedness of seafood demand is noticeable.

Once the demand structure has moved to a new equilibrium, the parameters are comparable to the initial demand structure. This can mostly be explained by the time-shifting function specified as first differences, in line with the Rotterdam model specification, and by the expenditure shares during the last four months of the sample period not differing significantly from the expenditure shares during the period prior to the BSE discovery. Demand for U.S. and domestic beef types appear to be more responsive to prices and expenditures than prior to the scare. Australian beef, along with pork, seafood, and poultry, appears to be less responsive, suggesting that Australian imports improved their position with Japanese consumers.

Table 3 reports estimated parameters for the underlying trend, structural changes in the trend, and seasonal dummy variables. Over the sample period, expenditure shares of all beef types have been declining except for wagyu, and poultry and seafood increased their expenditure shares. Because the analysis only considers meats purchased at the retail storefront, the statistically significant negative trend for U.S. beef may not be inconsistent with the increase in U.S. beef imports. All parameters for the changes in the trend during the transition period are large and positive. The sign is sensible recalling that the time-shift function is specified as the first differences and thus would be a negative number between zero and one during the transition period. The statistical significance confirms the dramatic changes in consumption observed in Figure 1. Seasonal dummy variables suggest indistinct seasonality in Australian beef and poultry demand. The spike in expenditures on wagyu during the gift-giving season of December is revealed in the statistically significant variable for the December-through-February quarter. Pork seems to be consumed during the time of the year when beef is not as popular.

Concluding Remarks

BSE that shocked Europe was discovered in Japan in September 2001. To examine the change in the Japanese meat demand structure, we applied the Rotterdam model to Japanese meat demand, specifying four specific types of beef as separate commodities and incorporating a time-shifting function. Our estimated demand system appears to depict the Japanese meat demand structure appropriately, where four types of beef are indeed regarded as separate commodities, certain meats are net complements of each other, beef and seafood are luxury goods, and seasonal patterns are significant.

We find that the Japanese meat system made a transition to a new state within five months of the BSE discovery, coinciding with the recovery of U.S. and Australian beef imports to Japan. Although BSE was discovered in a domestic dairy cow and beef is sold with mandatory country-of-origin labeling, all types of beef, including those imported, were affected. Of the non-beef meats, pork was most affected, while seafood and poultry were little affected. Indeed, with the large government budget to regain consumer confidence in the food system, Japanese meat consumption appears to have recovered from its initial shock. Based on our estimates we have yet to compute welfare changes due to the BSE scare in Japan, which can then be extended to draw implications for the case when BSE may be discovered in the U.S.

While our analysis has focused on the impact of BSE on consumer demand, the livestock and feed industries were considerably affected. Several dairy cows were found astray, abandoned by distressed owners who feared that they might be infected with BSE. Despite the government's earlier advice to producers not to use feed containing MBM to cattle, the BSE incident revealed that approximately 0.2 percent of the nation's herd, mainly dairy cows, had been fed poultry feed containing MBM. The government suspended distribution of MBM, even for non-cattle use, after the discovery. The government has included an income stabilization scheme for cattle farms in their budget to alleviate the strain on producers. The severity of the BSE impact on the Japanese beef industry, which has been dwindling since the 1970s, remains to be seen.

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Table 1 Marshallian Demand and Expenditure Elasticities

Average over the period May 1994 through August 2001 (N = 88)

	USbeef	AUbeef	Wagyu	DairyBeef	Pork	Seafood	Poultry
USbeef	-0.044	-0.019	-0.113	-0.147	-0.227	-0.312	-0.103
AUbeef		-0.054	0.258	-0.338	0.021	-0.568	-0.190
Wagyu			-0.835	0.064	-0.802	-0.033	-0.085
DairyBeef				-0.284	-0.131	-0.464	-0.195
Pork					-0.220	-0.027	-0.008
Seafood						-0.660	-0.025
Poultry							-0.520
Expenditure	0.966	0.916	1.751	1.094	0.436	1.257	1.157

Average over the period September 2001 through January 2002 (N = 5)

	USbeef	AUbeef	Wagyu	DairyBeef	Pork	Seafood	Poultry
USbeef	-17.514	24.979	-46.924	24.785	-54.583	-9.936	0.072
AUbeef		-44.095	104.610	-79.274	74.393	6.609	-1.331
Wagyu			-360.550	253.400	-221.040	-27.016	2.406
DairyBeef				-129.620	117.030	5.785	-2.818
Pork					-22.499	-1.395	0.387
Seafood						-1.354	-0.039
Poultry							-0.791
Expenditure	-0.291	8.006	-12.951	15.823	-2.187	1.095	3.214

Average over the period Februrary 2002 through May 2002 (N = 4)

	USbeef	AUbeef	Wagyu	DairyBeef	Pork	Seafood	Poultry
USbeef	-0.045	-0.030	-0.113	-0.150	-0.290	-0.370	-0.135
AUbeef		-0.051	0.245	-0.315	0.017	-0.534	-0.180
Wagyu			-0.919	0.106	-0.934	-0.044	-0.113
DairyBeef				-0.299	-0.169	-0.526	-0.232
Pork					-0.217	-0.027	-0.009
Seafood						-0.659	-0.030
Poultry							-0.509
Expenditure	1.134	0.860	1.969	1.231	0.426	1.250	1.125

Table 2 Hicksian Demand Elasticities

Average over the period May 1994 through August 2001 (N = 88)

	USbeef	AUbeef	Wagyu	DairyBeef	Pork	Seafood	Poultry
USbeef	-0.0005	-0.001	0.009	-0.003	0.009	-0.016	0.003
AUbeef		-0.039	0.388	-0.204	0.238	-0.288	-0.091
Wagyu			-0.673	0.330	-0.352	0.509	0.115
DairyBeef				-0.122	0.138	-0.127	-0.074
Pork					-0.114	0.107	0.040
Seafood						-0.277	0.115
Poultry							-0.393

Average over the period September 2001 through January 2002 (N = 5)

	USbeef	AUbeef	Wagyu	DairyBeef	Pork	Seafood	Poultry
USbeef	-31.513	44.931	-84.496	44.612	-98.471	-18.017	0.012
AUbeef		-78.694	188.940	-141.720	138.690	16.584	-0.032
Wagyu			-648.730	454.420	-405.720	-56.952	0.204
DairyBeef				-231.490	220.190	19.817	-0.228
Pork					-41.758	-3.830	0.022
Seafood						-1.594	0.155
Poultry							-0.255

Average over the period Februrary 2002 through May 2002 (N = 4)

	USbeef	AUbeef	Wagyu	DairyBeef	Pork	Seafood	Poultry
USbeef	-0.001	-0.002	0.017	-0.006	0.016	-0.030	0.006
AUbeef		-0.013	0.130	-0.069	0.080	-0.097	-0.031
Wagyu			-1.261	0.619	-0.660	0.955	0.216
DairyBeef				-0.241	0.273	-0.252	-0.146
Pork					-0.088	0.083	0.031
Seafood						-0.255	0.106
Poultry							-0.291

Table 3 Estimated Parameters for Trend (α), Structural Changes in Trend (κ), and Variables[a]

	USBeef	AUBeef	Wagyu	DairyBeef	Pork	Seafood	Poultry
α	-0.0002 *	-0.00012	0.0005 *	-0.0006 *	0.0004 *	-0.0002	0.0002
	.604E-04)	0.136E-03)	(2.162)	(0.00013)	(0.00014)	(0.00011)	
κ	446.700 *	453.300 *	408.680 *	512.960 *	383.270 *	489.480 *	909.510
	(62.270)	(63.120)	(7.126)	(75.161)	(50.300)	(67.859)	
D1	0.0044 *	0.0005	0.006	0.007 *	-0.012 *	0.0051	-0.011
	(0.0018)	(0.0009)	(0.0038)	(0.0026)	(0.002)	(0.0038)	
D2	0.0027	-0.0008	0.012 *	0.011 *	-0.013 *	-0.0114 *	-0.00002
	(0.0019)	(0.0009)	(0.0038)	(0.0026)	(0.002)	(0.0038)	
D3	0.0074 *	0.0004	-0.002	0.008 *	-0.014 *	0.013 *	-0.012
	(0.0021)	(0.0011)	(0.0043)	(0.0030)	(0.0024)	(0.0046)	

[a] * denotes significance at 5 percent level. D1, D2, and D3 corresponds to binary variables that equals one in June through August, December through following February, and March through May, respectively, and zero otherwise.

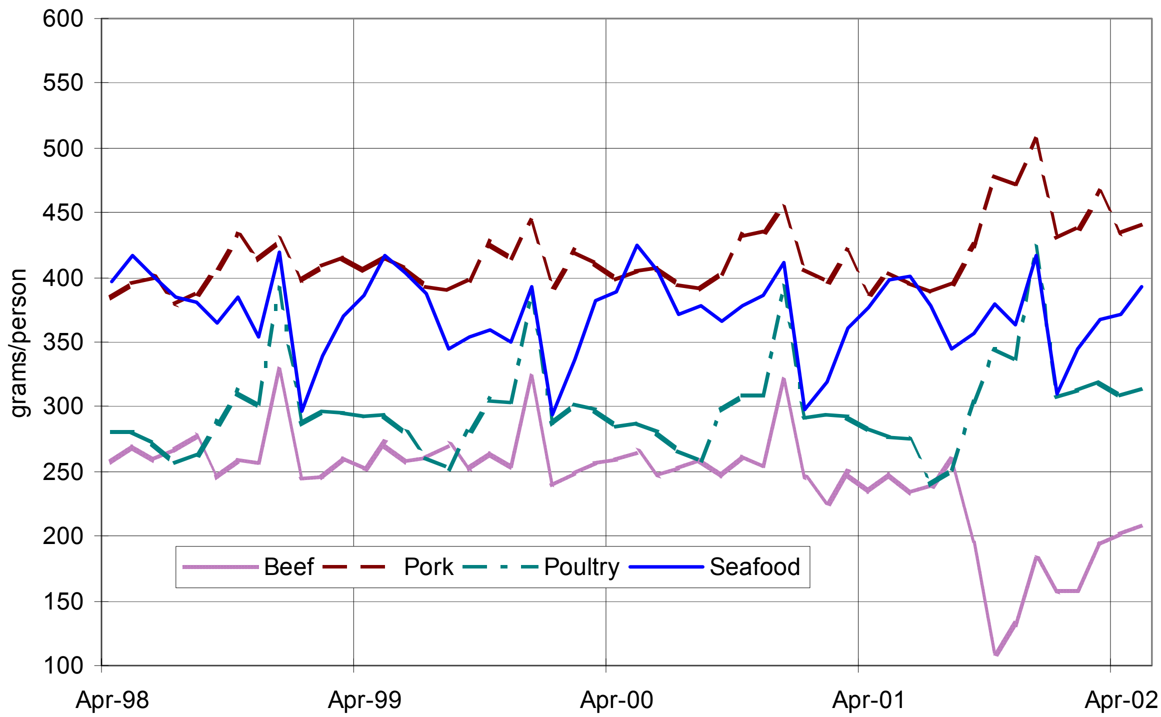

Figure 1 Per Capita Meat Consumption in Japan, April 1998-May 2002

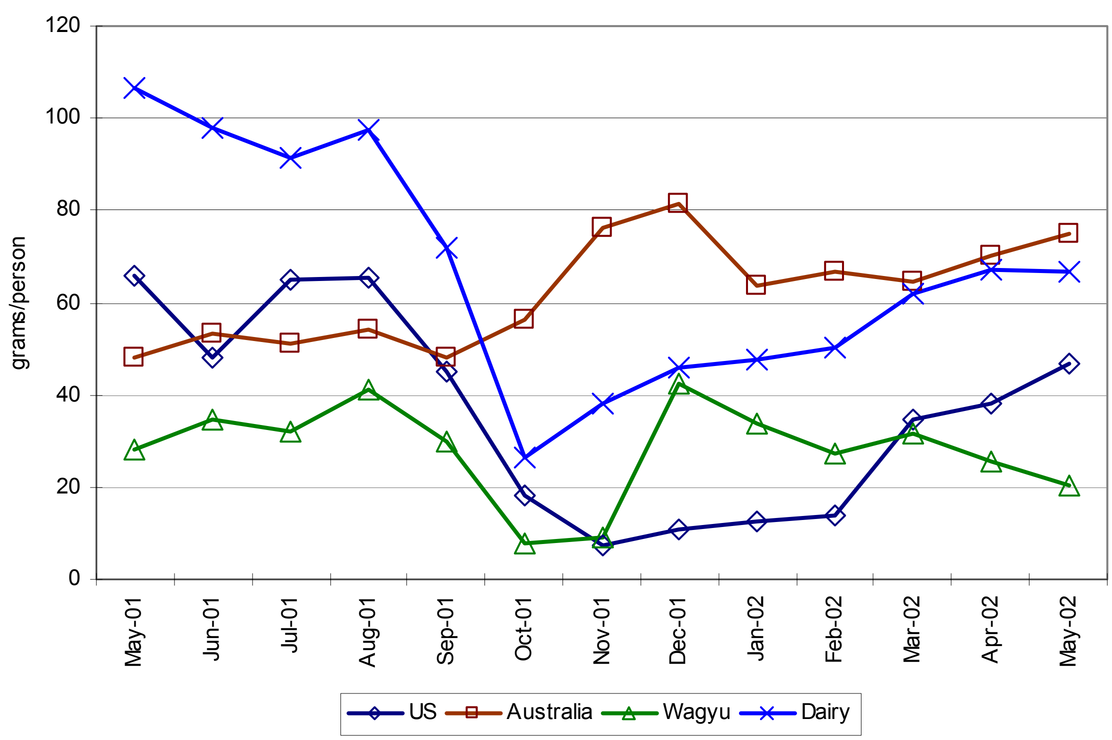

Figure 2 Per Capita Beef Consumption in Japan, May 2001-May 2002.