Competitiveness of U.S. Meats in Japan and South Korea: A Source Differentiated Market Study

Joao E. Mutondo
Graduate Research Assistant,
Department of Agricultural Economics
Oklahoma State University

and

Shida Henneberry, Professor (Contact author)
Department of Agricultural Economics
Oklahoma State University
Contact: srh@okstate.edu

Selected Paper Prepared for Presentation at the American Agricultural Economics Association Annual Meeting, Portland, Oregon, July 29 – August 1, 2007.

**Competitiveness of U.S. Meats in Japan and South Korea:
A Source Differentiated Market Study**

Abstract

The restricted source differentiated almost ideal demand system (RSDAIDS) is used to estimate the parameters of the Japanese and South Korean source differentiated meat demand models. Expenditure and own-price elasticities indicate that Japanese beef, Canadian and Danish pork, and Brazilian and Thai poultry have a competitive advantage in Japan. The BSE outbreak in Japan decreased the shares of Japanese and U.S. beef. Regarding South Korea, the results indicate that imported beef from the U.S. and Australia, Danish pork, and South Korean and Thai poultry have a competitive advantage. The U.S. BSE outbreak decreased the market shares of U.S. beef in the South Korean beef market.

Key words: BSE, competitive advantage, FMD, Japanese meat demand, RSDAIDS, and South Korean meat demand.

Competitiveness of U.S. Meats in Japan and South Korea: A Source Differentiated Market Study

Rapid economic growth and rising per capita incomes, along with gradual reductions in meat trade barriers, have been given as reasons for the increase in Japanese and South Korean meat imports, especially for U.S. meats. Japan was the largest international market from 2001 to 2003 for U.S. beef and pork, accounting for 47% and 37% of U.S. total volume of beef and pork exports, respectively. Regarding South Korea, from 2001 to 2003, South Korea was the third and fifth largest international market for U.S. beef and pork, accounting for 21% and 4% of U.S. total volume of pork and beef exports, respectively (USDA-ERS 2006a).

Although Japan and South Korea are the main international markets for U.S. meats, U.S. meat exports to Japan and South Korea have been negatively affected by competition between U.S. meats and meats from other sources. Moreover, U. S. meat exports to Japan and South Korea have decreased due to animal disease outbreaks such as the 2001 and 2003 *Bovine Spongiform Encephalopathy* (BSE) outbreaks in Japan and in the U.S., respectively. Given the increased competition and the disease driven restrictions imposed on U.S. meats by its traditional importers, understanding and differentiating the importance of economic and non-economic factors is crucial in determining the changes in demand for U.S. meats.

Furthermore, demand elasticities as well as estimated coefficients of non-economic variables (seasonality and animal disease outbreaks) can be used by U.S. policy makers, producers, and marketers when developing effective policies targeted towards expanding sales and market shares for U.S. produced meats. Moreover, evaluation of meat trade policies as well as trade embargos, such as the ban on U.S. beef in Japan and South Korea, relies on accurate measures of source differentiated demand elasticities. Although several published studies have addressed meat import demands in South Korea and Japan, none have included non-economic variables and all of the meats that are differentiated by source of supply (including domestically produced meats). Ignoring the impact of non-economic variables and domestic meats might produce misleading results, which can yield misleading policy recommendations. Hence, this study differs from past studies by including various types of meat (including domestically produced meat), all source differentiated, and by including seasonal and animal disease outbreak variables. In addition, the data for this analysis include a period during which the U.S. meat trade with Japan and South Korea was liberalized (import quotas eliminated).

The general objective of this study is to estimate the Japanese and South Korean demand for meats from different sources, including the U.S. Specifically, this study estimates the impacts of economic variables (meat prices and expenditures) and non-economic variables (seasonality and animal disease outbreaks) on the demand in Japan and South Korea for U.S. meats compared with meats from other sources. The remainder of this study is organized as follows: In the next section, the model of the Japanese and South Korean meat demand is presented. Then, data and procedures used to estimate meat demand systems are described. This section is followed by a discussion of the empirical results. The summary and conclusions are given in the last section.

The Model

To allow for source differentiation, a version of the almost ideal demand system (AIDS) model, known as the restricted source differentiated AIDS (RSDAIDS), is used. The AIDS model has many desirable properties including being an arbitrary first order approximation of any demand system; satisfying the axioms of choice; aggregating over consumers; and possessing a functional form consistent with household budget data (Deaton and Muellbauer 1980a).

The RSDAIDS allows for source differentiation of various types of meats, while preserving the degrees of freedom and without assuming block separability. The main advantage of the RSDAIDS model is that it does not suffer from the aggregation bias over supply sources. Meat types (beef, pork, and poultry) from different sources are not considered homogeneous products with single prices. For parsimonious estimations, the RSDAIDS imposes block substitutability, which assumes that the cross-price effects of source differentiated products in good *j* on the demand for product *h* in good *i*, are the same for all products in good *j*. See Yang and Koo 1994, p. 399, for the block substitutability restriction. Hence, the prices for all products (meat from different sources) in good *j* are represented by a weighted average price for that good in the equation of a given source differentiated product. For example, in the source differentiated beef demand equations, prices of pork and poultry products (pork and poultry from different sources) are represented by weighted average prices of pork and poultry from different sources (p_j in equation 1 below). This assumption reduces the number of parameters that need to be estimated and therefore increases the degrees of freedom. In this study, following Yang and Koo (1994), a RSDAIDS model is used to estimate meat demand in Japan and South Korea. Note that meat demand for each country is estimated separately from the other country. The RSDAIDS is specified as the following:

(1) $$w_{i_h} = \alpha_{i_h} + \sum_k \gamma_{i_{hk}} \ln(p_{i_k}) + \sum_{j \neq i} \gamma_{i_h j} \ln(p_j) + \beta_{i_h} \ln\left(\frac{E}{P^*}\right)$$

where subscripts *i* and *j* indicate goods (*i*, *j* = 1, 2, …N), and *h* and *k* indicate supply sources, w_{i_h} is the budget share of good *i* from source *h*, α_{i_h} is an intercept term for meat *i* from source *h*, $\gamma_{i_{hk}}$ is the price coefficient of source differentiated goods, p_{i_k} is the price of good *i* from source *k* (with *k* including *h*), $\gamma_{i_h j}$ is the cross-price coefficient between source differentiated good *i* from source *h* and nonsource differentiated or aggregated good *j*, β is the real expenditure coefficient, E is group expenditures, p_j is the price of the nonsource differentiated or aggregate good j and it is calculated as the weighted average of source differentiated j prices as:

(2) $$\ln(p_j) = \sum_k \alpha_{i_k} \ln(p_{j_k})$$

P^* in equation (1) is a price index which for source differentiated AIDS is defined as:

(3) $$\ln(P^*) = \alpha_0 + \sum_i \sum_h \alpha_{i_h} \ln(p_{i_h}) + \frac{1}{2} \sum_i \sum_h \sum_j \sum_k \gamma^*_{i_h j_k} \ln(p_{i_h}) \ln(p_{j_k})$$

The RSDAIDS model in equation (1) above is nonlinear due to the nonlinear price index in equation (3). To make the system linear, Deaton and Muellbauer (1980a) suggest using Stone's price index, here specified as:

(4) $$\ln P^* = \sum_i \sum_h w_{i_h} \ln(P_{i_h})$$

The budget shares (w_{i_h}) that are used as dependent variables in equation (1), are also used as independent variables in the aggregate price calculation (equation 4). Hence, to avoid simultaneity bias, this study, following Eales and Unnevehr (1988), uses lagged budget shares ($w_{i_{h,t-1}}$) to compute Stone's price index (equation 4). Moreover; Moschini (1995) and also LaFrance (1998) recognize the lack of invariance of Stone's price index to units of measurement. Therefore, to overcome this problem in this study, as proposed by Moschini (1995) and following Dameus et al. (2002), scaled meat prices are used in the computation of the Stone's price index. Scaled meat prices are calculated by dividing source differentiated meat prices by their respective means and therefore are unit-less. Hence, the index used in equation (4) is the Paasche-like index.

In addition, a seasonal indicator variable that reflects seasonal patterns in meat demand in Japan and South Korea is included in both models. Moreover, two indicator variables, reflecting

BSE and foot-and-mouth disease (FMD) outbreaks in Japan are included in the Japanese demand model. Finally, FMD and BSE indicator variables accounting for the FMD outbreak in South Korea and the BSE outbreak in the U.S. are included in the South Korean meat demand model. The indicator variables are incorporated as intercept shifters in the RSDAIDS model (Henneberry, Piewthongngam, and Qiang 1999). Therefore in this study, the intercept term in equation (1) is defined as:

(5) $$\alpha_{i_h} = \alpha^*_{i_{h0}} + \sum_{g=1}^{G} \alpha_{i_{hg}} D_g$$

where D represents indicator variables (seasonality, FMD outbreak in Japan and South Korea, and BSE outbreaks in the U.S. and Japan).

Following Yang and Koo (1994), homogeneity and symmetry are imposed as shown in equations (6) and (7) respectively.

(6) $$\sum_k \gamma_{i_{hk}} + \sum_{j \neq i} \gamma_{i_h j} = 0$$

(7) $$\gamma_{i_{hk}} = \gamma_{i_{kh}}$$

Due to the inclusion of indicator variables in the RSDAIDS model in equation (1), the adding-up property of demand is imposed as:

(8) $$\sum_i \sum_h \alpha_{i_{h0}} = 1;\ \sum_i \sum_h \alpha_{i_{hg}} = 0; \sum_h \gamma_{i_{hk}} = 0; \sum_i \sum_h \gamma_{i_h j} = 0; \sum_i \sum_h \beta_{i_h} = 0;$$

Marshallian own-price and cross-price elasticities (ε) and expenditure elasticity (η) of the RSDAIDS model are calculated as:

(9) $$\varepsilon_{i_h\, i_h} = -1 + \frac{\gamma_{i_{hh}}}{w_{i_h}} - \beta_{i_h}$$

(10) $$\varepsilon_{i_h\, i_k} = \frac{\gamma_{i_{hk}}}{w_{i_h}} - \beta_{i_h}\left(\frac{w_{i_k}}{w_{i_h}}\right)$$

(11) $$\varepsilon_{i_h j} = \frac{\gamma_{i_h j}}{w_{i_h}} - \beta_{i_h} (\frac{w_j}{w_{i_h}})$$

Equation (9) represents own-price elasticities, (10) represents cross-price elasticities between the same goods from different sources, and (11) represents cross-price elasticities between different goods: between good *i* from source *h* and aggregate good *j*. Expenditure elasticity is specified as:

(12) $$\eta_{i_h} = 1 + \frac{\beta_{i_h}}{w_{i_h}}$$

The elasticities are calculated at mean level of expenditure shares. The statistical significance of elasticities is determined by the method offered by Mdafri and Brorsen (1993).

Data

Quarterly data from 1994 (quarter one) to 2003(quarter three) are used to estimate the parameters of the Japanese meat demand model. Monthly data from 2001(month one) to 2005 (month five) are used to estimate the parameters of the South Korean model. Three meat categories: beef, pork, and poultry are analyzed in this study. Although fish products are important sources of protein in Japanese and South Korean diet, in this study, fish products are not included in the Japanese and South Korean meat demand models because of lack of available fish data. Therefore, weak separability between meats and fish is assumed. Separability between fish and non-fish meats in Japan and South Korea have been tested and supported in the literature (Capps et al. 1994; and Hayes, Wahl, and Williams 1990; Koo, Yang, and Lee 1993; Byrne et al. 1995). Furthermore, this study assumes weak separability between meats and non-meat goods.

A country is identified as a supply source of imports if imports from that source constitute at least 10% of the total Japanese and South Korean imports of the selected meat. All other sources that supplied less than 10% of the Japanese or South Korean total imports of the selected meat are aggregated as the Rest-of-the-World (ROW) category. Because retail/wholesale level prices for source differentiated meats in Japan and South Korea are not available, unit-value import prices are used to measure market prices for imported meats. Source differentiated import prices (unit values) of individual meats are calculated by dividing the total import value by the total import quantity.

For Japan, data on import values (in U.S. dollars) and quantities (in kilograms) are from USDA-ERS (2002) and USDA-FAS (2006a). Regarding South Korea, data on import values (in U.S. dollars) and quantities (in kilograms) are from USDA-FAS (2006a). Data on the value of imported meat are converted to Japanese Yen and South Korean Won using published exchange rates. Exchange rate data are from USDA-ERS (2006b).

Regarding domestic meat data, data on Japanese domestic meats at wholesale level are from Agriculture & Livestock Industries Corporation (ALIC) (1994-2003). Wholesale carcass prices for B-2, and B-3 steers (cross breed steers), are used as the Japanese price of beef. The wholesale prices of pork carcasses are used as the Japanese pork price. The wholesale prices of chicken legs are used as the representative price of broilers. The wholesale level South Korean domestic data (quantities and prices) of beef, pork, and broilers are from National Agricultural Cooperative Federation (NACF) (2005).

The hypothesis is that a seasonal trend exists regarding Japanese and South Korean meat consumption since meats are used as gifts during the Japanese and South Korean gift seasons (Johnson, Durham, and Wessells 1998). Hence, seasonal indicator variables are included in each demand model. For the Japanese meat demand model, the seasonal indicator variables take the value of one for the first (January- March), third (July-September), and fourth (October-December) quarters and zero otherwise. For the South Korean meat demand model, the seasonal variables take the value of one during the spring (March-May), summer (June-August), and winter (December-February) months and zero otherwise.

Regarding animal disease outbreak variables, the FMD outbreak in Japan began on March 25, 2000, and lasted through the end of September 2000 (Sugiura et al. 2001). Hence, the Japanese FMD indicator variable takes the value of one for the second and third quarters of the year 2000 and zero otherwise. According to Yeboah and Maynard (2004), the BSE outbreak in Japan began on September 23, 2001 and lasted through January 2002. Therefore, the Japanese BSE indicator variable takes the value of one for the fourth quarter of the year 2001, the first quarter of the year 2002, and zero otherwise.

For the South Korean meat demand model, Joo et al. (2002) and Sumption (2006) report that the FMD outbreak in South Korea began on March 20, 2000, and lasted through September 2001. Another FMD outbreak began on June 23, 2002, and lasted through August 7, 2002. Consequently, the South Korean FMD outbreak indicator variable takes the value of one from April to September of the year 2001, from June to August of the year 2002, and zero otherwise. Moreover, restrictions on the import of beef from the U.S. were in place in South Korea from December of the year 2003 to May of the year 2005. Hence, the U.S. BSE outbreak indicator variable takes the value of one from December of the year 2003 to May of the year 2005 and zero otherwise.

Estimation Procedures and Statistical Tests

The seemingly unrelated regression (SUR) estimation method is used to estimate the model represented by equation (1) with block substitutability, symmetry, and homogeneity imposed. Due to the adding-up condition of the demand model, the contemporaneous covariance matrix is singular. Hence, the last equation for each demand system (Japan and South Korea) is dropped for estimation purposes. The equations of poultry import from the ROW are the selected equations to be dropped for both meat demand systems. The parameter estimates for the dropped equations can be calculated using the adding-up restriction. In this study however, another equation for each demand model is dropped and re-estimated in order to determine the parameters and the standard errors of the last equation (Henneberry, Piewthongngan, and Qiang 1999). The estimated parameters are similar and produce similar elasticities regardless of which equation is dropped.

System Misspecification Tests

The assumptions of normality of the error terms, joint conditional mean (no autocorrelation, parameter stability, appropriateness of the functional form) and joint conditional variance (static and dynamic homoskedasticity, and variance stability) are tested using system misspecification tests as suggested by McGuirk et al. (1995). Results of the system misspecification tests indicate that estimating Japanese and South Korean meat demand models using the model represented by equation (1) is not appropriate mostly due to the autocorrelation of the error terms. More specifically, the null hypothesis of no autocorrelation is rejected at the 1% significance level in each demand model. Kennedy (2003) reports that one of the sources of autocorrelation is misspecification of the equations' dynamics.

Dynamics are expected to be particularly important in the analysis of meat demand as meat consumers are unlikely to respond fully to changes in price, income, or other determinants of demand in the short run. Psychological habit factors, inventory adjustments, or institutional factors have been reported as reasons for lagged consumer response (Kesavan et al. 1993; Henneberry and Hwang 2007). To allow for lagged effects, the first-difference RSDAIDS model

(model 13 below) as suggested by Eales and Unnevehr (1988) is used here for the Japanese and South Korean meat demand systems.

$$\Delta w_{i_h} = \sum_{k} \gamma_{i_{hk}} \Delta \ln(p_{i_k}) + \sum_{j \neq i} \gamma_{i_h j} \Delta \ln(p_j) + \beta_{i_h} \Delta \ln\left(\frac{E}{P^*}\right) \quad (13)$$

Results of the misspecification tests for the Japanese and South Korean meat demand systems (model 13) fail to reject the null hypothesis of normality of the error terms at the 1% significance level except for the equations of Japanese and South Korean imports of pork from the ROW. Moreover, for the Japanese and South Korean models (model 13), joint conditional mean and joint conditional variance test results fail to reject the null hypotheses that the joint conditional mean and joint conditional variance are properly specified at the 1% significance levels. Furthermore, various hypotheses regarding Japanese and South Korean consumers' behavior including product aggregation and block separability and endogeneity of the real expenditure variable are tested for the RSDAIDS model of each country (equation 13).

Product Aggregation and Block Separability

The product aggregation test is used to test the restrictions that the parameters of the RSDAIDS model are the same as the parameters of the nonsource differentiated AIDS model. The null hypothesis for this test is that each kind of meat can be aggregated (not to be separated by supply source) and estimated using the nonsource differentiated AIDS model (see Yang and Koo 1994, p. 400, for the product aggregation restrictions). The results indicate that for the Japanese and South Korean meat demand models, the null hypothesis of nonsource differentiation for all meats is rejected at the 1% significance level. Therefore, the results support estimating the Japanese and South Korean demand for meats using a source differentiated model.

In addition, this study tests block separability within the meat groups. The three different blocks are beef, pork, and poultry, with each block composed of meats from different sources.

The block separability test is used to test whether consumers' preferences within each block can be explained independent of quantities of meats in the other blocks. More specifically, for parsimonious estimation, the question is could each block of meat (for example, beef from different sources) be studied separately from meats in other blocks (such as pork and poultry from different sources) without incorporating their prices. This study uses quasi-separability of the cost function to test separability between blocks. For the test of quasi-separability of the cost function underlying the AIDS model, see Deaton and Muellbauer (1980b), p. 133; Hayes, Wahl, and Williams (1990), p. 561; and Yang and Koo (1994), p. 400. The null hypothesis for this test is that each block of meats is separable from all other meat blocks. For the two demand models, test results indicate the rejection of the null hypothesis at the 1% significance level. Therefore, the results support estimating the Japanese and South Korean meat demands for meats, including all three types of meats.

Endogeneity

Because expenditure variable E (in equations 13) is used to compute budget shares (w_{i_h}), which is the dependent variable, the expenditure variable might not be truly exogenous. Correlation between the expenditure variable and the error term causes the estimates to be biased and inconsistent. Hence, endogeneity of the real expenditure variable is tested using the Wu-Hausman endogeneity test.

The Wu-Hausman test is performed by regressing the real expenditure variable, on a set of instrumental variables (Johnston and DiNardo 1997). The instrumental variables used in this study are: source differentiated meat prices included in each demand system, the first-difference of the natural logarithm of the Japanese gross domestic product for the Japanese meat demand system and the first difference of natural logarithm of the South Korean gross domestic product for the South Korean meat demand system, and the lagged real expenditure variable of each demand model. From the OLS regression described above, residuals are recovered and used as explanatory variables in estimating the Japanese and South Korean meat demand models (model 13). A joint test was conducted to see whether the coefficients of these residuals equal to zero. If these coefficients are statistically equal to zero, the conclusion is that endogeneity of real expenditure variables does not exist. Test results for both Japanese and South Korean meat demand models fail to reject the null hypothesis that the real expenditure variable is exogenous at the 1% significance level.

Results

The calculated Marshallian demand elasticities (using equation 9-12), along with the estimated coefficients for the seasonal, FMD, and BSE indicator variables for the Japanese and South Korean meat demand models, are presented in tables 1 and 2. Estimation results for each country (using model 13) are presented in the following sections.

Japanese Meat Demand: Expenditure and Price Elasticities

The full matrix of the Marshallian demand elasticities for the Japanese first-difference RSDAIDS model is presented in table 1. In the beef market, all the expenditure elasticities are positive and most of them are statistically significant. Beef from Japan shows the highest expenditure elasticity (1.4) compared to that of imported beef. This result is consistent with the Japanese consumers' general preferences for domestically produced beef over any imported beef, because of the perceived superior quality and consumer health concerns regarding imported beef (Peterson and Chen 2005).

Regarding imported beef, since the U.S. exports mostly a higher quality beef (grain-fed beef composed of cuts graded as prime and choice in the U.S.) to Japan compared to Australian beef (grass-fed beef), U.S. beef is expected to carry a higher expenditure elasticity compared to Australian beef. In this study nevertheless, the expenditure elasticity for Australian beef is slightly higher (0.8) compared to U.S. beef (0.7). This result is not surprising since Reed and Saghaian (2004) report that Japanese consumers prefer fresh beef compared to frozen beef. From 1994 to 2003 (the period during which this study covers); the U.S. exported largely (58.8%) frozen beef, while Australia exported largely (63.5%) fresh or chilled beef to Japan (USDA-ERS 2002; and USDA-FAS 2006a).

For pork, all expenditure elasticities are positive and statistically significant. The expenditure elasticity is high for pork from Canada (2.8) followed by Danish pork (2.7), ROW pork (2.5), U.S. pork (1.5), and Japanese pork (1.4). These results suggest that a significantly higher percentage of pork demanded in Japan would be imported from Canada, Denmark, and the ROW compared to pork from the U.S. and Japan, given a percentage increase in Japanese meat expenditures. Since the U.S. and Canada produce and export pork products of similar quality, U.S. and Canadian pork are expected to carry similar expenditure elasticities. However, the expenditure elasticity of Canadian pork (2.8) is higher than the expenditure elasticity of U.S. pork (1.5). This result was also found by Fabiosa and Ukhova (2000), and they report that the result is particularly true because Canada has expanded its meat processing capacity to allow it to export more meat.

The result, that given a percentage increase in Japanese meat expenditure would increase by greater percentage the demand for Danish pork compared to U.S. pork, is consistent with previous studies because Danish pork exports to Japan are composed of specific cuts made without bone and fat, which meet quality properties of freshness, color, and texture requirements of Japanese consumers (Hobbs, Kerr, and Klein 1998). Yang and Koo (1994) also found elastic

(2.2) expenditure elasticity for the Japanese pork import demand from European Community (mainly Denmark).

Regarding the poultry market, all expenditure elasticities are positive and most of them are statistically significant. Poultry from Brazil shows the largest statistically significant expenditure elasticity (1.4) followed by poultry from Thailand (1.2). These results are consistent with Japanese consumers' preferences because Brazil and Thailand export high-quality poultry products composed of mechanical de-boned chicken meat and further processed poultry products, which are preferred by Japanese consumers (USDA-FAS 2006b). Yang and Koo (1994) also found that a percentage increase in Japanese meat expenditures would increase the demand for poultry from Thailand and other sources (mainly Brazil) by a greater percentage compared to the demand for poultry from other supply sources.

Consistent with economic theory, the results of the Japanese meat demand show negative Marshallian own-price elasticities for individual meats. In the beef market, own-price elasticities for beef from different sources are less than one in absolute values, except for beef imported from the ROW. The inelastic own-price elasticities for beef from different sources are consistent with those reported for the Japanese source differentiated meat demand by Yang and Koo (1994) and Peterson and Chen (2005). In the pork and poultry markets, similar to Yeboah and Maynard (2004), Peterson and Chen (2005), Wahl, Hayes, and Johnson (1992), and Johnson, Durham, and Wassells (1998), the majority of the own-price elasticities are less than one in absolute values; except for own-price elasticity for pork from the ROW (-2.1) and own-price elasticity for poultry from China (-1.8) and the ROW (-1.2). However these elasticities are comparable to the own-price elasticity for pork from the ROW (-1.6) and the own-price elasticity for poultry from the ROW (-1.9) reported by Yang and Koo (1994).

Cross-price elasticities between meats from different sources may indicate substitutability or complementary relationships. In the beef market, most of the cross-price elasticities are not statistically significant except for cross-price elasticities between U.S. beef and Japanese beef and between Australian beef and Japanese beef. The results show a weak complementary relationship between U.S. and Japanese beef. The lack of a substitutability relationship between U.S. and Japanese beef might be due to a difference in the perceived quality between U.S. frozen beef and Japanese fresh beef. Moreover, the results show a weak substitutability relationship between Australian beef and Japanese beef. Similarity in perceived quality between Japanese beef (fresh beef) and Australian beef (fresh-chilled beef) might explain the weak substitutability relationship between the two beefs.

In the pork market, the results show competitive relationships between Japanese pork on one hand and imported pork from the U.S. and Canada on the other. These results are consistent with Japanese consumers' preferences since Canada and the U.S. export fresh-chilled pork, which is of comparable quality with Japanese fresh pork. A strong complementary relationship exists between Danish pork and pork from North America (Canada and the U.S.). The lack of competitiveness might be due to the difference in pork products and cuts of meat originating from North America and Denmark. Denmark exports frozen pork products in cuts made without bone and fat, which meet the preferences of Japanese consumers, while the U.S. and Canada export fresh-chilled pork products to Japan (Fabiosa and Ukhova 2000). Also, a complementary relationship exists between pork from Japan and pork from the ROW. The lack of a substitutability relationship between pork from Japan and the ROW may be explained by the difference in perceived quality between ROW pork (frozen pork) compared to Japanese pork (fresh pork).

In the poultry market, the results show that Chinese and ROW poultry are substitutes for poultry from Thailand. These results are consistent with previous expectations since China, the ROW (mainly Taiwan), and Thailand export to Japan the same quality of poultry products, which are composed of boneless and processed poultry products. However, a complementary relationship exists between poultry from the U.S. and poultry from Thailand. This relationship might be due to differences in quality between U.S. poultry, which is mainly composed of chicken legs compared to the high-quality poultry cuts composed of boneless and processed poultry products from Thailand. Moreover, the results indicate that poultry from Thailand, Brazil, and the ROW have a complementary relationship with poultry from Japan. Again, the perceived quality differences between Japanese domestically produced poultry (fresh poultry) and frozen boneless and processed poultry products from Thailand, Brazil, and the ROW may explain the lack of a competitive relationship.

The estimated results of cross-price elasticities across commodities show a lack of substitutability relationships. In general, beef from various sources complements aggregate pork. Pork from various origins complements aggregate beef and poultry. Poultry from different supply sources complements aggregate beef. The lack of a substitutability relationship between meats from different sources and aggregate commodities may be explained by the difference in quality between meats from different sources and aggregate commodities. Yang and Koo (1994) obtained similar results for the Japanese source differentiated meat demand.

Japanese Meat Demand: Seasonality, FMD, and BSE Effects

The parameter estimates of seasonal, BSE, and FMD indicator variables are presented in table 1. The estimated results show that the shares of Japanese beef are higher during quarter one and four compared to quarter two; while the shares of imported beef are lower during quarter one and four compared to quarter two. These results are consistent with seasonal demand for beef in Japan because Japanese consumers demand more highly-marbled domestic Japanese beef than imported beef during traditional holiday periods such as the family new year celebration (*Osechi*) in January (quarter one), the gift giving season (*Oseibo*) and the year-end party (*Bounenkai*) in December (quarter four) than in quarter two. Similar results of seasonal patterns in Japanese beef demand were obtained by Peterson and Chen (2005).

In the pork market, the estimated results of seasonal variables show that the shares of pork from Canada and Japan are higher in the first quarter compared to the second quarter while the shares of pork from Denmark are higher in the third quarter compared to the second quarter. These results are also consistent with seasonal demand for pork in Japan since the low-income Japanese consumers would increase the demand for relatively cheap pork products compared to beef during the new year festival in January (quarter one) and during the gift giving celebration (*Ochugen*) in July (quarter three). In the poultry market, the estimated results of seasonal indicator variables show that the shares of poultry from different sources are higher in the fourth quarter compared to the second quarter. This result also supports the increase in demand for meats during the Japanese traditional gift giving and year-end dinner party periods (quarter four).

The FMD outbreak in Japan is shown as having small impact, which is not statistically significant. The Japanese BSE outbreak is shown as having a negative impact on Japanese and U.S. beef. These results are consistent with previous findings since the Japanese BSE outbreak decreased the demand for Japanese and imported beef. In particular, the U.S. beef exports to Japan decreased during the Japanese BSE outbreak from 90 million pounds per month during the first 10 months of the year 2001 to 8 million pounds in December of the year 2001, a decrease of

91% (Peterson and Chen 2005; Yeboah and Maynard 2004; and Leuck, Halley, and Harvey 2004).

South Korean Meat Demand: Expenditure and Price Elasticities

The Marshallian elasticities for the South Korean meat demand model are presented in table 2. In the beef market, all of the expenditure elasticities are positive and statistically significant. The results of expenditure elasticities show that in general, imported beef has higher expenditure elasticities compared to South Korean domestic beef. These results suggest that a percentage increase in the South Korean meat expenditures would increase the demand for imported beef by a higher percentage compared to the demand for South Korean domestic beef. These results might seem inconsistent with previous expectations since South Korean consumers prefer South Korean produced beef (*Hanwoo* beef) compared to imported beef (Henneberry and Hwang 2007). However, this result is consistent with findings from previous studies. Jung and Koo (2002) report also higher, elastic, and statistically significant expenditure elasticity for imported beef (2.26) compared to elastic and statistically significant expenditure elasticity for *Hanwoo* beef (1.15).

Among source differentiated imported beef, because South Korean consumers prefer U.S beef (grain-fed beef) over Australian beef (grass-fed beef), the expenditure elasticity for U.S. beef is expected to be higher than for Australian beef. Nevertheless in this study, the expenditure elasticity for Australian beef (1.298) is similar to expenditure elasticity for U.S. beef (1.286). This result is not surprising, since the 2003 BSE outbreak in the U.S. could have negatively impacted the perceptions regarding the safety of U.S. beef in South Korea.

In the pork market, all of the expenditure elasticities are positive and statistically significant. Pork from Denmark has a higher and statistically significant expenditure elasticity

(1.04) compared to pork from other sources. These results are consistent with South Korean consumers' preferences for Danish pork (*Sam-Gyup-Sal*), which is one of the most preferred parts of the pork belly in South Korea. *Sam-Gyup-Sal* pork is composed of alternating meat and fat layers and is used in traditional South Korean dishes (Henneberry and Hwang 2007).

For poultry, all expenditure elasticities are positive and statistically significant. Poultry from South Korea has the highest and most statistically significant expenditure elasticity (1.44), followed by poultry from Thailand (1.40), poultry from the U.S. (1.38), and poultry from the ROW (1.07). These results are consistent with South Korean consumers' general preferences for fresh, domestically-produced poultry and high-quality boneless and processed poultry products from Thailand.

All own-price elasticities are negative; except for the statistically insignificant own-price elasticity for beef from the ROW. All own-price elasticities are less than one in absolute value. Inelastic own-price elasticities reported in this study are consistent with those estimated in past studies (Koo, Yang, and Lee 1993; and Capps et al. 1994). Cross-price elasticities between meats from different sources may indicate substitutability or complementary relationships. In the beef market, the majority of cross-price elasticities are not statistically significant. However, the cross-price elasticities between U.S. beef and ROW beef and between ROW beef and South Korean beef are negative and statistically significant. The results indicate that U.S. and South Korean beef are complement for ROW beef. These results are consistent with prior expectations since the ROW (mainly New Zealand) beef, which is primarily composed of grass-fed beef, is different in quality compared to U.S. beef (grain-fed beef) and South Korean beef (*Hanwoo* beef).

In the pork market, similar to the beef market, the majority of cross-price elasticities are not statistically significant. However, the results show that U.S. and South Korean pork are complement for Canadian pork and ROW pork is a substitute for Canadian pork. Regarding the poultry market, results indicate a statistically significant and positive cross-price elasticity between poultry from Thailand and poultry from the ROW. This result is consistent with Japanese consumers' preferences for poultry since both Thailand and the ROW (mainly China) export boneless and processed poultry products to South Korea. A complementary relationship is shown between poultry from Thailand and poultry from South Korea. The difference in quality between frozen boneless and processed poultry products from Thailand and fresh poultry products from South Korea might explain the lack of substitutability between Thai and South Korean poultry products.

Results of cross-price elasticities across commodities indicate substitutability relationships between South Korean beef and aggregate poultry and South Korean pork and aggregate poultry. The other statistically significant cross-price elasticities across commodities indicate a weak complement between source differentiated meats and aggregate commodities. In the summary and conclusion section, the discussion will address the implications of these relationships.

South Korean Meat Demand: Seasonality, FMD, and BSE Effects

The parameter estimates of seasonal, FMD, and BSE indicator variables are presented in table 2. In the beef market, the estimated results show a small increase in the shares of beef from the ROW during the spring months (March-May). However, in the pork and poultry markets, estimated coefficients of seasonal indicator variables indicate a substantial impact of seasonality on the demand for South Korean pork and poultry products. Regarding South Korean pork, the results indicate that the shares of South Korean pork are lower during the spring (March-May), summer (June-August), and winter (December-February) months compared to the fall months (September-November). These results are consistent with seasonal pork consumption patterns in South Korea. The winter season (December-February) is associated with the South Korean New Year when South Koreans consume more beef than pork; and the summer period (June-August) is associated with warm months, when South Koreans consume more poultry than pork.

Regarding South Korean poultry, the estimated coefficient of seasonal indicator variables shows that the shares of South Korean poultry are higher during the spring and summer months compared to the fall months. These results are also consistent with seasonal poultry consumption patterns in South Korea. During the summer (June-August) months, which are associated with high temperatures, South Koreans' demand for poultry is high because poultry (mainly chicken) is used to make a traditional soup called *samgyetang*. *Samgyetang* is believed to have a healthy nutrition content, which can help South Koreans' poultry consumers cope with the high temperatures of the summer months. The coefficient estimates of the FMD indicator variable are not statistically significant; except for the equation of pork from South Korea and poultry from the U.S. and South Korea. Interestingly, the results of the FMD outbreak in South Korea show a positive impact on the shares of South Korean pork and a negative impact on the shares of U.S. and South Korean poultry. These results may be explained as follows. When the FMD was announced in South Korea, the major importing country of South Korean pork (Japan) banned imports of pork from South Korea. Because of these bans of South Korean pork and the fact that the South Korean consumers were generally not worried about FMD because it is not a danger to human health, the price of pork might have declined in South Korea and consequently consumers shifted from poultry to pork consumption.

Similar to FMD, the estimated coefficients of the U.S. BSE outbreak are not statistically significant; except for the equations of beef from the U.S., pork from the U.S. and Canada, and poultry from the ROW. The U.S. BSE outbreak decreased the shares of U.S. beef in South Korea and increased the shares of pork from the U.S. and Canada as well as the shares of ROW poultry. The decrease in the shares of U.S. beef is consistent with previous expectations since South Korea restricted beef imports from the U.S. after the 2003 U.S. BSE outbreak. The share of pork from the U.S. and Canada increased during the U.S. BSE outbreak because the U.S. and Canada might have increased pork exports to South Korea as South Korea restricted imports of Canadian and U.S. beef.

Summary and Conclusions

This study estimates the impacts of economic factors (meat prices and expenditures) and non-economic factors (seasonality and animal diseases/outbreaks) on the demand for source differentiated meats in Japan and South Korea. This study is different from other Japanese and South Korean meat demand studies because it uses a data set covering a potentially liberalized period during which only import tariffs were in effect in Japan and South Korea. It also includes both imported and domestically produced meats with impacts of seasonality and animal disease outbreaks taken into account. Estimates of coefficients of seasonal and animal disease outbreak variables are used to evaluate the impacts of seasonality and animal diseases outbreaks on the demand for meats from different sources in Japan and South Korea. Calculated price and expenditure elasticities are used to evaluate the competitiveness of U.S. meats in Japan and South Korea.

Competitive advantage may be defined as an advantage over competitors gained by offering consumers a greater value; either by lowering prices or by providing greater benefits and services, such as high-quality products that justify higher prices (Porter 1985). In this study, any meat product that carries a higher and statistically significant expenditure elasticity compared to other meats is assumed to be perceived by consumers as a higher-value product. Furthermore, suppliers that supply higher-valued meat products would be expected to prefer facing an own-price inelastic demand. This is because the higher prices associated with their meats, compared to other meats from other suppliers, will result in an increase in their total revenues (ceteris paribus). Therefore, in this study, a country that supplies higher-priced meat products, such as the U.S., is said to have a competitive advantage in a market that has a price-inelastic and expenditure-elastic demand.

Following the above definition, in the Japanese beef market, based on relatively low (in absolute value) inelastic own-price elasticity and high statistically significant elastic expenditure elasticity for Japanese beef compared to imported beef, the conclusion is that Japanese beef has a competitive advantage compared to imported beef. Japanese beef has the most to gain over imported beef in Japan because Japanese consumers prefer Japanese beef, a highly marbled beef, which is used in popular dishes such as *Sukiyaki*, where it is sliced almost paper thin and boiled in water for a very short time period. In the pork market, based on the higher expenditure elasticity and relatively lower (in absolute value) own-price elasticity for Canadian and Danish pork compared to pork from other supply sources, Canada and Denmark have a competitive advantage in Japanese pork market.

Regarding the poultry market, judging by the relatively lower (in absolute value) own-price elasticities and higher and statistically significant expenditure elasticities for poultry from Brazil and Thailand compared to the poultry from other supply sources, poultry from Brazil and Thailand can be said to have a competitive advantage compared to the poultry from other supply sources. Seasonality coefficients indicate that the demand for meats is high during the gift giving and New Year celebration periods (quarter one and four) and the BSE outbreak in Japan has negatively affected the demand for U.S. and Japanese produced beef.

South Korean domestic beef (*Hanwoo* beef) is perceived by South Korean consumers as being a high-quality product. However, based on higher expenditure elasticity and lower own-price elasticities for imported beef from Australia and the U.S. compared to South Korean domestic beef, beef from Australia and the U.S. have a competitive advantage in the South Korean beef market. The grain-fed beef imported from the U.S. has generally been viewed by South Korean consumers as being a higher-quality product than beef imported from other sources (Henneberry and Hwang 2007). However, with food safety being one of the main drivers of the beef import demand in South Korea, a high-quality attribute may not be the right signal that provides a true market advantage. The results of this study indicate that an increase in South Korean meat expenditures would have the same impact on the demand for U.S. produced beef as it would have on Australian beef.

In the pork market, based on high expenditure elasticity and inelastic own-price elasticity for pork from Denmark, Denmark has a competitive advantage in the South Korean pork market. Regarding the poultry market, based on inelastic own-price and elastic and statistically significant expenditure elasticities for poultry from South Korea and Thailand compared to U.S. poultry, poultry from South Korea and Thailand have competitive advantages.

Additionally, the results of this study would have implications for market share of meats from different sources in South Korea. For example, major suppliers of pork and poultry in South Korea might be interested in knowing how much they can increase their market share in South Korea after the increase in local beef prices due to bans of U.S. and Canadian beef.

Judging from the negative and statistically significant cross-price elasticities between both pork and poultry from different sources and aggregate beef, the conclusion is that the major South Korean meat suppliers do not have much to gain in terms of their pork and poultry. Another current application of this study is the implication that the recent Avian Influenza pandemic in Asia has reduced the consumption of poultry in South Korea. Based on positive and statistically significant cross-price elasticities between beef from South Korea and poultry and between pork from South Korea and poultry, the conclusion is that South Korean beef and pork might benefit from the Avian Influenza outbreak in South Korea.

References

Agriculture & Livestock Industries Corporation (ALIC), Monthly Statistics. 1994-2003. Various Issues.

Byrne, P.J., O. Capps, Jr., R. Tsai, and G.W. Williams. 1995. "Policy Implication of Trade Liberalization: The Case of Meat Products in Taiwan and South Korea." *Agribusiness* 11: 297-307.

Capps, Jr. O., R. Tsai, R. Kirby, and G.W. Williams. 1994. "A Comparison of Demands for Meat Products in the Pacific Rim Region." *Journal of Agricultural and Resource Economics* 19: 210-224.

Dameus, A., F.G-C. Richter, B.W. Brorsen, and K.P. Sukhdial. 2002. "AIDS versus Rotterdam Demand System: A Cox Test with Parametric Bootstrap." *Journal of Agricultural and Resource Economics* 27: 335-347.

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

Deaton, A., and J. Muellbauer.1980b. Economics and Consumer Behavior. Cambridge University Press.

Eales, J.S., and L. J. Unnevehr.1988. "Demand for Beef and Chicken Products: Separability and Structural Change." *American Journal of Agricultural Economics* 70: 521-532.

Fabiosa, J.F., and Y.S. Ukhova. 2000. "New Aggregate and Source-Specific Pork Import Demand Elasticity for Japan: Implication to U.S. Exports." Working Paper, Center for Agricultural and Rural Development., Iowa State University.

Hayes, D.J., T.I. Wahl, and G.W. Williams. 1990. "Testing Restrictions on a Model of Japanese Meat Demand." *American Journal of Agricultural Economics* 72: 556-566.

Henneberry, S.R., and S-K. Hwang. 2007. "Meat Demand in South Korea: An Application of the Restricted Source Differentiated AIDS Model." *Journal of Agricultural and Applied Economics* 39: 47-60.

Henneberry, S., K. Piewthongngam, and H. Qiang. 1999. "Consumer Food Safety Concerns and Fresh Produce Consumption." *Journal of Agricultural and Resource Economics* 24: 98-113.

Hobbs, J.E., W.A Kerr, and K.K. Klein. 1998. "Creating International Competitiveness through Supply Chain Management: Danish Pork." *Supply Chain Management: An International Journa*l 3: 68-78.

Johnson, A.J., C.A. Durham, and C.R. Wessells. 1998. “Seasonality in Japanese Household Demand for Meat and Seafood.” *Agribusiness* 14:337-351.

Johnston, J., and J. DiNardo. 1997. *Econometric MethodSouth* 4th. Ed. New York: McGraw Hill Book Co.

Joo, Y-S, S-H. An, O-K. Kim, J. Lubroth, J-H. Sur. 2002. “Foot and Mouth Disease Eradication Efforts in the Republic of Korea.” *The Canadian Journal of Veterinary Research* 66: 122-124.

Jung, J. and W.W. Koo. 2002. “Demand for Meat and Fish Products in Korea.” Selected Paper, American Agricultural Economics Association.

Kennedy, P. 2003. A Guide to Econometrics. The MIT Press, Cambridge, Massachusetts.

Kesavan, T., Z.A. Hassan, H.H. Jensen, and S. Johnson. 1993. “Dynamic and Long-Run Structure in U.S. Meat Demand.” *Canadian Journal of Agricultural Economics* 41:139-53.

Koo, W.W., S.R. Yang, and C.B. Lee. 1993. “Estimation of Demand for Meat in Korea.” *Journal of Rural Development* 16: 205-222.

LaFrance, J.T. 1998. “The Silence Bleating! of the Lambdas: Comment.” *American Journal of Agricultural Economics* 80: 221-30.

Leuck, D., M. Haley, and D. Harvey. 2004. *US 2003 and 2004 Livestock and Poultry Trade Influenced by Animal Disease and Trade Restrictions.* Washington, DC: U.S. Department of Agriculture/Economic Research Service, Pub.No.LDPM-120-01.

McGuirk, A., P. Dircoll, J. Alwang, and H. Huang. 1995. “System Misspecification Testing and Structural Change in the Demand for Meats.” *Journal of Agricultural and Resource Economics* 20: 1-21.

Mdafri, A., and B.W. Brorsen. 1993. “Demand for Red Meat, Poultry, and Fish in Morocco: An Almost Ideal Demand System.” *Agricultural Economics* 9: 155-163.

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

National Agricultural Cooperative Federation (NACF). Materials on Prices, Supply, Demand of Livestock Products. Internet site: http//nature nonghyp.com/1sp/live/animal/live1.jsp. (Accessed August, 2005).

Peterson, H.H., and Y-J. Chen. 2005.“The Impact of BSE on Japanese Retail Meat Demand.” *Agribusiness* 21: 313-327.

Porter, M. E. 1985."Competitive Advantage. Creating and sustaining superior performance." Macmillan Inc. London.

Reed, M.R., and S. Saghaian. 2004. "Measuring the Intensity of Competition in the Japanese Beef market." *Journal of Agricultural and Applied Economics* 36: 113-121.

Sugiura, K., H. Ogura, K. Ishikawa, K. Hoshino, and K. Sakamoto. 2001. "Eradication of Foot and Month Disease in Japan." *Review of Science and Technology* 20: 701-713.

Sumption, K.L. "Update on the FMD Situation in 2002." Animal Health Services, Food and Agriculture Organization of United Nations. Internet site: http://www.fao.org/ag/againfo/commissions/en/documents/reports/excom68/App01.pdf. (Accessed May 2006).

United States Department of Agriculture-Economic Research Service (USDA-ERS). Internet site: http://www.ers.usda.gov/Briefing/AnimalProducts/trade.htm. (Accessed January 2006a).

____. "Real Country Monthly Average Exchange Rates." Internet site: http://www.ers.usda.gov/Data/exchangerates/Data/RealMonthlyCountryExchangeRateSouthxls. (Accessed May 2006b).

____."The World Trade Atlas." Washington DC, various issues, 2002.

United States Department of Agriculture, Foreign Agricultural Service (USDA-FAS). The World Trade Atlas. "Washington D.C, various issues, 2006a.

____. "World Broiler Overview." Internet site: http://www.fas.usda.gov/dlp2/circular/2004/04-03LP/Broileroverview.pdf#search=%22World%20Broiler%20Overview%2C%20Total%20Broiler%20Meat%20Exports%20Forecast%20to%20Decrease%20Marginally%20in%202004%22. (Accessed September 2006b).

Wahl, T.I., D.J. Hayes, and S. Johnson. 1992. "Impacts of Liberalizing the Japanese Pork Market." *Journal of Agricultural and Resource Economics* 17: 121-137.

Yang, S., and W.W. Koo. 1994."Japanese Meat Import Demand Estimation with the Source Differentiated AIDS Models." *Journal of Agricultural and Resource Economics* 19: 396-408.

Yeboah, G., and L.J. Maynard. 2004."The Impact of BSE, FMD, and U.S. Export Promotion Expenditures on Japanese Meat Demand." Selected Paper, American Agricultural Economics Association.

Table 1. Marshallian Elasticities and Parameter Estimates of Coefficients of the Indicator Variables of the Japanese Meat Demand Model

	Beef				Pork					Poultry					
	U.S.	Australia	Japan	ROW	U.S.	Denmark	Canada	Japan	ROW	U.S.	Thailand	China	Brazil	Japan	ROW
Price of beef from the U.S.	-0.265	-0.031	-0.169**	0.729											
	(0.167)	(0.161)	(0.037)	(0.477)											
Price of beef from Australia	-0.018	-0.358*	0.013	-0.193											
	(0.110)	(0.165)	(0.050)	(0.386)											
Price of beef from Japan	-0.291**	0.158**	-0.566**	0.030											
	(0.102)	(0.053)	(0.078)	(0.166)											
Price of beef from ROW	0.057	-0.013	-0.005	-1.185**											
	(0.038)	(0.043)	(0.005)	(0.358)											
Price of pork from the U.S.					-0.899	-1.833**	-0.428	0.144**	0.746						
					(0.532)	(0.419)	(0.488)	(0.057)	(0.736)						
Price of pork from Denmark					-1.645**	-0.922	-1.396**	0.041	0.919						
					(0.431)	(1.047)	(0.601)	(0.100)	(1.046)						
Price of pork from Canada					-0.186	-0.765*	-0.932*	0.115**	0.655						
					(0.248)	(0.329)	(0.468)	(0.034)	(0.491)						
Price of pork from Japan					0.543	-0.092	0.616*	-0.391**	-1.203**						
					(0.261)	(0.485)	(0.323)	(0.103)	(0.515)						
Price of pork from ROW					0.868	1.036	1.389	-0.268*	-2.149**						
					(0.802)	(1.219)	(1.059)	(0.122)	(1.853)						
Price of poultry from the U.S.										-0.087	-0.378*	0.117	-0.125	-0.002	0.279
										(0.323)	(0.171)	(0.117)	(0.183)	(0.007)	(0.197)
Price of poultry from Thailand										-0.827*	-0.828*	0.483*	-0.291	-0.078**	0.862**
										(0.379)	(0.412)	(0.215)	(0.298)	(0.012)	(0.325)
Price of poultry from China										0.334	0.618*	-1.809**	0.594	0.080**	-0.601*
										(0.337)	(0.279)	(0.394)	(0.351)	(0.023)	(0.233)
Price of poultry from Brazil										-0.170	-0.184	0.299	-0.873**	-0.032**	0.174
										(0.259)	(0.191)	(0.172)	(0.263)	(0.011)	(0.181)
Price of poultry from Japan										0.247	-1.105**	2.043**	-0.564	-0.412**	-0.079
										(0.306)	(0.274)	(0.419)	(0.377)	(0.038)	(0.207)
Price of poultry from ROW										0.088	0.122**	-0.066*	0.037	-0.078**	-1.196**
										(0.062)	(0.047)	(0.026)	(0.041)	(0.024)	(0.080)
Price of beef					-0.121	-0.351	-1.141**	-0.376**	-1.113**	-0.270	-0.729**	-1.102**	-1.149**	0.010	-0.160
					(0.205)	(0.450)	(0.258)	(0.083)	(0.4334)	(0.244)	(0.232)	(0.327)	(0.311)	(0.032)	(0.169)
Price of pork	-0.270**	-0.207**	0.088	-0.119						-0.006	-0.252	-0.583*	-0.189	-0.011	-0.050
	(0.106)	(0.077)	0.082	(0.170)						(0.175)	(0.164)	(0.233)	(0.229)	(0.028)	(0.120)
Price of poultry	0.092	-0.297	-0.730	0.306	-0.097	0.198	-0.935**	-0.625**	-0.326						
	(0.115)	(0.218)	0.083	(0.242)	(0.269)	(0.452)	(0.255)	(0.085)	(0.353)						
Expenditure	0.693**	0.760**	1.369**	0.432	1.536**	2.729**	2.827**	1.360**	2.501**	0.690	1.166**	0.617	1.384**	0.522**	0.771**
	(0.273)	(0.196)	0.236	(0.397)	(0.354)	(0.869)	(0.449)	(0.166)	(0.756)	(0.463)	(0.435)	(0.617)	(0.602)	(0.074)	(0.316)
Quarter one	-0.043**	-0.012*	0.108**	-0.005**	0.006	-0.015	0.021**	0.079**	-0.008	-0.002	0.007*	-0.012*	0.003	0.016	0.001**
	(0.009)	(0.004)	(0.019)	(0.001)	(0.008)	(0.018)	(0.005)	(0.016)	(0.018)	(0.002)	(0.003)	(0.006)	(0.003)	(0.009)	3.330E-04
Quarter three	0.006	-0.004	-0.001	-0.002*	-0.002	0.027*	0.002	-0.021*	0.018	0.004	0.001	0.010*	0.003	-0.023	0.001**
	(0.005)	(0.003)	(0.012)	(0.001)	(0.004)	(0.010)	(0.003)	(0.009)	(0.010)	(0.001)	(0.002)	(0.004)	(0.002)	(0.005)	2.080E-04
Quarter four	-0.025**	-0.013**	0.055**	-0.004**	-0.007	-0.017	0.002	0.015	-0.021	0.002*	0.006**	0.001	0.004*	0.049	0.002**
	(0.005)	(0.002)	(0.010)	(0.001)	(0.006)	(0.013)	(0.004)	(0.012)	(0.014)	(0.001)	(0.002)	(0.003)	(0.002)	(0.005)	1.860E-04
FMD outbreak in Japan	0.001	0.003	0.003	-2.2E-05	-0.006	-0.017	0.005	0.017	-0.012	4.655E-04	0.001	-0.002	0.002	0.012	3.367E-04
	(0.007)	(0.004)	(0.016)	(0.001)	(0.005)	(0.013)	(0.003)	(0.012)	(0.012)	(0.001)	(0.002)	(0.005)	(0.002)	(0.007)	2.590E-04
BSE outbreak in Japan	-0.020*	-0.003	-0.030*	-6.8E-05	0.006	0.014	2.258E-04	0.009	-0.014	-0.001	0.003	-0.016*	0.001	0.017	0.001
	(0.007)	(0.004)	(0.016)	(0.001)	(0.005)	(0.013)	(0.003)	(0.011)	(0.012)	(0.001)	(0.003)	(0.005)	(0.002)	(0.007)	2.630E-04

Notes: System weighted R^2=0.832. Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table 2. Marshallian Elasticities and Parameters Estimates of Coefficients of the Indicator Variables of the South Korean Meat Demand Model

Explanatory	Beef				Pork					Poultry			
Variables	U.S.	Australia	Korea	ROW	U.S.	Denmark	Canada	Korea	ROW	U.S.	Thailand	Korea	ROW
Price beef from the U.S.	-0.208	-0.329	-0.010	-0.894**									
	(0.239)	(0.293)	(0.061)	(0.361)									
Price beef from Australia	-0.159	-0.624	0.008	0.522									
	(0.146)	(0.414)	(0.025)	(0.481)									
Price of beef from Korea	-0.152	-0.099	-0.873**	-0.234**									
	(0.096)	(0.081)	(0.091)	(0.097)									
Price of beef from ROW	-0.194**	0.205	-0.020	0.286									
	(0.073)	(0.203)	(0.012)	(0.433)									
Price of pork from the U.S.					-0.445*	0.207	-0.267*	-0.007	-0.010				
					(0.264)	(0.169)	(0.127)	(0.006)	(0.074)				
Price of pork from Denmark					0.249	-0.488*	-0.104	-0.007	-0.021				
					(0.201)	(0.256)	(0.140)	(0.007)	(0.080)				
Price of pork from Canada					-0.291*	-0.097	-0.096	-0.012**	-0.896**				
					(0.138)	(0.128)	(0.217)	(0.003)	(0.052)				
Price of pork from Korea					-0.383	-0.394	-0.650**	-0.782**	-0.317				
					(0.371)	(0.350)	(0.194)	(0.039)	(0.203)				
Price of pork from ROW					-0.048	-0.100	0.527*	-0.025	-0.195				
					(0.404)	(0.368)	(0.261)	(0.018)	(0.222)				
Price of poultry from the U.S.										-0.812**	0.021	-0.014	-0.144
										(0.084)	(0.074)	(0.018)	(0.174)
Price of poultry from Thailand										0.025	-0.851**	-5.818E-05	2.389E-04
										(0.091)	(0.152)	(0.024)	(0.264)
Price of poultry from Korea										-0.178	-0.437*	-0.743**	0.230
										(0.203)	(0.250)	(0.132)	(0.459)
Price of poultry from ROW										0.194	0.376*	0.219*	-0.567
										(0.201)	(0.213)	(0.129)	(0.428)
Price of beef					0.095	-0.129	-0.129*	-0.125**	-0.285**	-0.313**	-0.239**	-0.615**	-0.368
					(0.136)	(0.126)	(0.063)	(0.020)	(0.067)	(0.113)	(0.075)	(0.108)	(0.240)
Price of pork	-0.350**	-0.094	-0.211	-0.094						-0.295	-0.273*	-0.240**	-0.574*
	(0.124)	(0.107)	(0.128)	(0.134)						(0.125)	(0.068)	(0.098)	(0.263)
Price of poultry	-0.222	-0.362	0.461**	-0.352	0.056	-0.043	-0.134	0.057*	-0.274**				
	(0.186)	(0.251)	(0.170)	(0.210)	(0.290)	(0.256)	(0.142)	(0.030)	(0.136)				
Expenditure	1.286**	1.298**	0.646*	0.767**	0.768**	1.043**	0.854**	0.900**	0.999**	1.378**	1.403**	1.438**	1.070**
	(0.288)	(0.217)	(0.301)	(0.253)	(0.283)	(0.260)	(0.130)	(0.043)	(0.138)	(0.235)	(0.228)	(0.190)	(0.485)
Spring	0.0029	-0.0006	-0.0388	0.0078*	0.0021	-0.0015	0.0008	-0.0558**	0.0014	-0.0011	-0.0023	0.0374**	0.0007
	(0.0158)	(0.0067)	(0.0311)	(0.0032)	(0.0014)	(0.0016)	(0.0008)	(0.0108)	(0.0041)	(0.0011)	(0.0013)	(0.0087)	(0.001)
Summer	0.0203	0.0043	-0.0701	0.0043	0.0003	-0.0011	-0.0003	-0.0814**	0.0049	-0.0005	-0.0025	0.0628**	0.0007
	(0.0171)	(0.0069)	(0.0370)	(0.0033)	(0.0014)	(0.0016)	(0.0008)	(0.0113)	(0.0041)	(0.0011)	(0.0012)	(0.0088)	(0.001)
Winter	0.0038	-0.0045	0.0071	0.0049	0.0027	-0.0009	0.0005	-0.0358**	0.0013	-0.0010	-0.0013	0.0157	0.0005
	(0.0145)	(0.0058)	(0.0330)	(0.0028)	(0.0014)	(0.0016)	(0.0008)	(0.0105)	(0.0041)	(0.0011)	(0.0012)	(0.0085)	(0.001)
FMD outbreak in South Korea	-0.0158	-0.0111	0.0996	-0.0009	0.0016	0.0007	0.0003	0.0458**	-0.0021	-0.0030*	-0.0024	-0.0279**	-0.0009
	(0.0182)	(0.0070)	(0.0417)	(0.0033)	(0.0014)	(0.0015)	(0.0007)	(0.0131)	(0.0039)	(0.0012)	(0.0014)	(0.0106)	(0.001)
BSE outbreak in the U.S.	-0.0260**	0.0035	0.0199	0.0024	0.0024**	0.0008	0.0008*	-0.0058	0.0021	-0.0014	-0.0014	-0.0008	0.0018*
	(0.0101)	(0.0037)	(0.0229)	(0.0012)	(0.0008)	(0.0009)	(0.0003)	(0.0074)	(0.0021)	(0.0007)	(0.0008)	(0.0064)	(0.001)

Notes: System weighted R^2=0.846. The numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.