GLOBAL DEMAND FOR U.S. MEATS

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PREFACE

This dissertation is composed of three chapters. The first chapter (demand for U.S. meats in major U.S. export markets) consists of three essays, about demand for U.S. meats including meats from other sources in the major foreign markets of U.S. produced meats. The first essay, "Competitiveness of Meats from Different Sources in Japan: a Source Differentiated Market Study" estimates a meat demand system for Japan, differentiating meats by type and source of origin and taking into account the impacts of seasonality, the 2000 foot-and-mouth disease (FMD), and 2001 *bovine spongiform encephalopathy* (BSE) outbreaks in Japan. The results of this study show that Japanese beef has the most to gain from an increase in Japanese meat expenditures. in the pork market, the results show that Danish and Canadian pork have a competitive advantage in the Japanese pork market; while poultry from brazil has the most to gain from an increase in Japanese meat expenditures.

The second essay, "Demand for Meats from Different Sources in South Korea: A Source Differentiated Market Study" estimates a meat demand system for South Korea, differentiating meats by type and source of origin and taking into account the impacts of seasonality, the 2001 and 2002 FMD outbreaks in South Korea, and the 2003 U.S. BSE outbreak. The results show that imported beef from the U.S. and Australia have a competitive advantage in the S. Korean meat market. In the pork market, the results indicate that Danish pork has the most to gain from an increase in S. Korean meat expenditures. Regarding the poultry market, the results indicate that poultry from Thailand has the most to gain from an expansion of the S. Korean poultry import market.

The third essay, “Agricultural Trade among the North American Free Trade Agreement (NAFTA) Countries: A Case Study of U.S. Meat Exports” estimates meat demand systems for Canada and Mexico, differentiating meats by type and source of origin and taking into account the impacts of seasonality and the 2003 BSE outbreak in North America. The results show that an increase in Mexican meat expenditures might increase the demand for meats from different sources. For Canadian meat demand, the results indicate that Canadian and U.S. beef have the most to gain from an increase in Canadian meat expenditures; while in the pork market, pork from the U.S. has a competitive advantage in the Canadian pork market. BSE outbreak in North America showed as having small impacts on Canadian and Mexican meat demand, which were not statistically significant in most cases.

The second chapter is entitled “Reworking of the U.S. Meat Demand: A Source Differentiated Analysis.” This essay estimates a meat demand system for the U.S., differentiating meats by type and source of origin and taking into account the impacts of seasonality and the 2003 BSE outbreak in North America. The results show that U.S. fed beef and Canadian beef have a competitive advantage in the U.S. beef market while in the pork market, pork from the rest-of-the world (ROW) has the most to gain from an expansion in U.S. meat expenditures.

The third and final chapter, “Welfare Implications of Selected Supply and Demand Shocks on Producers and Marketers of U.S. Meats” develops an equilibrium displacement model which includes both U.S. meat imports and exports with meat types differentiated by supply source. Importantly, the equilibrium displacement model developed in this study assumes either perfect or imperfect competition of the middle stage (processor-retailer) of meat supply chain. The model is used to estimate the welfare impacts of recent shocks and policy variables (beef and pork promotions, country-of-origin labeling, COOL, and the Japanese and South Korean bans of U.S. beef) on producers and marketers of U.S. meats.

The results indicate that beef and pork promotions increase producer surplus for producers and marketers of U.S. beef and pork and decrease producer surplus for producers and marketers of U.S. poultry. The negative impact of beef and pork promotions on producers and marketers of U.S. poultry is small enough to suggest that producers and marketers of U.S. meat, as a group, benefit from beef and pork promotions. The positive impact of beef and pork promotions is higher in a model with international trade including export promotion, compared to a model without trade. Regarding the impact of COOL, the results indicate that COOL decreases producer surplus of U.S. beef and pork producers unless accompanied with a demand increase of at least 2%. The negative impact of COOL on U.S. beef and pork producers under no demand increase scenario is lower in a model with trade, compared to a model without trade. Furthermore, the results show that retailer oilgopsony market power decreases the welfare of U.S. meat producers. The Japanese and South Korean bans on U.S. beef decrease the producer surplus of producers and marketers of U.S. beef and increase the producer surplus of producers and marketers of competing beef products, which are marketed in Japan and South Korea.

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LIST OF ACRUNYMS

AIDS	Almost Ideal Demand System
BSE	Bovine Spongiform Encephalopathy
CFTA	Canada-U.S. Free Trade Agreement
COOL	Country of Origin Labeling
GATT	General Agreement on Tariffs and Trade
FAO	Food Agricultural Organization
FMD	Foot-and-Mouth Disease
MIL	Meat Import Law
NAFTA	North American Free Trade Agreement
OECD	Organization for Economic Co-operation and Development
ROW	Rest of the World
RSDAIDS	Restricted Source Differentiated Almost Ideal Demand System
TRQs	Tariff-rate quotas
URAA	Uruguay Round Agreement on Agriculture
USDA	United States Department of Agriculture
USDA-AMS	United States Department of Agriculture-Agricultural Market Service
USDA-ERS	United States Department of Agriculture-Economic Research Service
USDA-FAS	United States Department of Agriculture-Foreign Agricultural Service

CHAPTER I

Demand for U.S. Meats in Major U.S. Export Markets

Essay I: Competitiveness of Meats from Different Sources in Japan: A Source Differentiated Market Study

Introduction

Japanese food consumption patterns have shifted from traditional food products (cereals) towards animal protein products such as beef, pork, and poultry. Economic growth and rising per capita incomes along with gradual reductions in meat trade barriers have been reported to be the major underlying factors in the shift of Japanese food consumption patterns (Byrne et al.; and Gorman, Moroi and Lin). For example, from 1980 to 2004, the Japanese per capita meat (beef, pork, and poultry) consumption has increased by 32.5% (OECD). However, the self-sufficiency ratio for meats (beef, pork, and poultry) has decreased from 81% in 1985 to 53% in 2002.

In order to satisfy the increasing meat demand which was accompanied with a decrease in domestic meat self-sufficiency ratio, coupled with an increase in unilateral and bilateral trade agreements, the Japanese government started to liberalize its meat import market to foreign meat suppliers. As a result of trade liberalization, Japan has become the largest market for meat imports, especially for U.S. produced meats. From 2001 to 2003, Japan was the largest international market for U.S. pork and beef, accounting for 37% and 47% of U.S. total pork and beef exports, respectively (USDA-ERS, 2006a).

Considering the significance of Japan as major destination for U.S. produced meats, understanding the economic and non-economic factors that shape the demand for meats from different sources in Japan, are of importance to the U.S. meat producers, marketers, and policy makers in developing effective marketing programs targeted towards expanding sales and market shares of U.S. produced meats. Despite the importance of the topic, studies that have estimated demand for source differentiated meats in Japan are limited. The majority of the past studies have used aggregate consumer data or differentiated only beef by import quality and *wagyu* beef but without differentiating meats by source of origin (Capps et al.; Hayes, Wahl, and Williams; Johnson, Durham, and Wessells; Wahl, Hayes, and Williams; Wahl, Hayes, and Johnson). Yang and Koo; Peterson and Chen; Fabiosa and Ukhova; and Yeboah and Maynard have estimated Japanese demand for meats from different countries. However, none of these studies included Japanese produced meats and differentiated all meat types (beef, pork, and poultry) by country of origin.

Different from past studies, this study utilizes a data set covering a potentially liberalized period during which only import tariffs were in effect in Japan. Furthermore, this study extends the existing source differentiated meat demand studies by including domestically produced meats; differentiating all types of meats by the major sources of supply and including non economic factors such as seasonality and animal diseases, foot-and-mouth disease (FMD) and *Bovine Spongiform Encephalopathy* (BSE), outbreaks.

Hence, the primary objective of this study is to estimate a meat demand system for Japan, differentiating meats by type and source of origin. More specifically, the objective of this study is to estimate 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. To accomplish the objective of this study, a source differentiated meat demand system is specified and estimated. The model differentiates meats by type and by source of origin.

Following a historical overview of the Japanese meat trade policies, a source differentiated meat demand model for the Japanese meat market is presented. Next, the data and estimation methods are outlined followed by a discussion of the results and the summary and conclusion.

An Overview of Meat Trade Policies in Japan

The Japanese meat import market was highly protected since the early 1960s. Among the three meats (beef, pork, and poultry), beef and pork were the most protected. With respect to beef, from 1960 to 1988, the Japanese government used both an import quota and a 25% beef import tariff as means of protecting domestic beef producers. The majority (90%) of the Japanese beef quota was allocated to Livestock Industry Promotion Corporation (LIPC) thorough tender system. The remaining 10% was allocated to the private sector, that is certain Japanese trading companies, through simultaneous buy and sell (SBS) system (Wahl , Hayes, and Williams). The tender system allowed the LIPC to dictate the quality and origin of Japanese beef imports. The LIPC tender system allocated quotas to licensed Japanese owned trade companies to import specific grades of certain meat cuts from any given country. The SBS system allowed Japanese buyers to import beef directly from foreign beef exporters. During this period, each SBS firm specialized in serving a specific segment of the market (grocery stores, restaurants, etc).

Bilateral and multilateral trade agreements between Japan and other countries resulted in liberalization of the Japanese meat import market. Table I-1 presents the liberalization process of the Japanese meat import market. The liberalization of the Japanese meat import market began with the 1988 Beef Market Access Agreement (BMAA). The agreement called for an annual increase in the Japanese beef import quota by 60,000 metric tons beginning in 1988 and the complete removal of beef import quota system by 1991. The BMAA also called for the allocation of most of the LIPC beef quota to SBS system. In 1991, beef imports were totally purchased under SBS system and the Japanese government replaced the beef import quota by 70% beef import tariff. Special safeguard provisions were put in place to limit import surges. Starting in 1991, the safeguard provision allowed an additional 25% tariff in any year that beef imports increase by 20% or more over the previous period (Wahl, Hayes, and Williams).

Regarding the pork import market, before 1971, the Japanese pork import policies were based on a combination of quota and flexible tariff systems (Bredahl et al.). In 1971, this system was replaced by a combination of variable levy and *ad valorem* tariff systems. The variable levy system was based on the difference between the import price and the gate price. The import price is the price, which is determined by the intersection of the excess supply curve and the effective excess demand curve. The gate or "trigger" price was the minimum pork import price, which added to a finite 5% *ad valorem* tariffs was equal to the standard price. The standard price was the politically acceptable level of price of pork in Japan, which was the arithmetic average of the two (upper and lower bound) prices of pork, which were set by the Japanese government (Wahl, Hayes, and Johnson).

For example, in 1989, the Japanese government set the price stabilization band by setting an upper bound of 515 yen/kg and a lower bound of 450 yen/kg. The arithmetic average of the two prices (482.5 yen/kg) determined the standard price, which was intended to support domestic producer profits at a politically acceptable level. Therefore, in 1989, the gate price of 459.5 yen/kg plus a finite 5% *ad valorem* tariff yielded to the standard price of 482.5 yen/kg (459.5 * 1.05). If the import price of pork was lower than the gate price, the importer would have to pay the difference between the gate price and the import price as a duty, the variable levy, in addition to any tariff applied to the gate price.

Since 1995, a significant progress has been made in reducing the Japanese meat import barriers. The Japanese beef import tariff was reduced from 50% in 1995 to 38.5% in 2000 by the Uruguay Round Agreement in Agriculture (URAA) (Dyck and Nelson). The Japanese pork gate price, which was linked to the standard price as described above; was replaced by a new gate price negotiated under URAA. Pork gate prices were reduced from 460 yen/kg in 1995 to 393 yen/kg in 2000 and pork import tariffs were reduced from 5% in 1995 to 4.3% in 2000. Similarly, poultry import tariffs were reduced from their original level in 1995 (table I-1).

Despite a significant progress made towards liberalization of the Japanese meat import market, sanitary and phytosanitary (SPS) measures are still being the major forms of restricting meat imports into Japan. Japan banned beef imports from the U.S. in

December 2003 when BSE was detected in Washington State. On December 12, 2005, Japan agreed to import U.S. beef from cows aged 20 months or younger, which are considered to have less risk of having BSE disease. In late January 2006, Japan banned again beef imports from the U.S. because beef shipments to Japan contained material considered at risk for BSE. The Japanese ban of U.S. beef was resumed on June 21, 2006.

A Model of the Japanese Source Differentiated Meat Demand

The almost ideal demand system (AIDS) is used in this study. This model has been one of the most popular research tools in applied demand analysis. The AIDS model has many desirable properties. The AIDS model is an arbitrary first order approximation of any demand system; it satisfies the axioms of choice, it aggregates over consumers, and it has a functional form consistent with household budget data (Deaton and Muellbauer, 1980a). However, empirical use of the AIDS model in demand estimation typically assumes product aggregation under which the demand system does not differentiate goods by supply source.

In this study, to allow for source differentiation, a version of the AIDS model known as the restricted source differentiated AIDS (RSDAIDS) is used to estimate source differentiated meat demand in Japan. The RSDAIDS allows for source differentiation for various types of meats, while preserving the degrees of freedom and without assuming block separability. The main advantage of RSDAIDS model is that it does not suffer from the aggregation bias over supply sources or goods. The RSDAIDS imposes block substitutability, which assumes that the cross-price effects of 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, p. 399, for the block substitutability restriction). Hence, the prices of other goods from various origins are represented by an aggregate price for that good in the equation of a given source differentiated product. For example; in estimating the Japanese demand for U.S. beef, the prices of pork originating from different sources are represented by one aggregate price of pork. This assumption reduces the number of parameters that need to be estimated and therefore increases the degrees of freedom.

Following Yang and Koo, the RSDAIDS is specified as the following:

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

where subscripts *i* and *j* indicate goods ($i, j = 1, 2, \ldots N$), 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 good, 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 is calculated as the weighted average of source differentiated *j* prices as;

(1.1.2) $$\ln(p_j) = \sum_k w_{j_{k,t-1}} \ln(p_{j_k})$$

P^* is a price index which for source differentiated AIDS is defined as:

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

The RSDAIDS model in (1.1.1) above is nonlinear due to the nonlinear price index in (1.1.3). To make the system linear, Deaton and Muellbauer, 1980a suggest using Stone's price index, here specified as:

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

The budget shares (w_{i_h}), that are used as dependent variables in equation (1.1.1), are also used as independent variables in the aggregate price calculation (equation 1.1.4). Therefore, to avoid simultaneity bias following Eales and Unnevehr, this study uses lagged budget shares ($w_{i_{h,t-1}}$) to compute Stone's price index. Additionally, Moschini; and Lafrance recognizes the lack of invariance of Stone's price index to unit of measurement. Therefore, in order to make the Stone's price index unit-less, as proposed by Moschini and following Dameus et al., in this study 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.

Additionally, a seasonal indicator reflecting seasonal patterns in meat demand in Japan and two indicator variables reflecting BSE and FMD outbreaks in Japan are included. The indicator variables are incorporated as intercept shifters in the RSDAIDS model (Henneberry, Piewthongngam, and Qiang). Therefore, in this study, the intercept term in equation (1.1.1) is defined as:

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

where D represents the three indicator variables (seasonality, BSE, and FMD outbreaks in Japan).

Following Yang and Koo, homogeneity, and symmetry are imposed as shown in equation (1.1.6) and (1.1.7) respectively.

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

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

Due to the inclusion of indicator variables in the RSDAIDS model in (1.1.1), the adding-up property of demand is imposed as:

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

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

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

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

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

Equation (1.1.9) represents own-price elasticities, (1.1.10) represents cross-price elasticities between the same goods from different sources, (1.1.11) represents cross-price elasticities between different goods, that is between good *i* from source *h* and aggregate good *j*. Expenditure elasticity is specified as:

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

The elasticities are calculated at mean level of expenditure shares and the statistical significance of elasticities is determined by the method offered by Mdafri and Brorsen.[1]

Data

Quarterly data from 1994 (quarter 1) to 2003(quarter 3) are used to estimate the parameters of the Japanese demand for source differentiated meats. Three meat categories: beef, pork, and poultry are analyzed in this study. Although fish products are important sources of protein in Japanese diet, in this study fish products are not included in the Japanese meat demand model 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 have been tested and supported in the literature (Capps et al., and Hayes, Wahl, and Williams). Furthermore, this study assumes weak separability between meats and non-meat goods.

Japan imports meats from various sources. A country is identified as a supply source if imports from that country constitute at least 10% of the Japanese total imports of the selected meat. All other countries that supplies less than 10% of the Japanese total imports of selected meats are aggregated as the Rest-of-the-World (ROW). Because retail/wholesale prices for source differentiated meats in Japan are not available, unit-value import prices are used to measure market prices for imported meats. Data on import values (in U.S. dollars) and quantities (in kilograms) are from USDA-ERS, 2002 and USDA-FAS, 2006a. Data on the value of imported meat are converted to Japanese Yen using published exchange rates. Exchange rate data are from USDA-ERS, 2006b. Source differentiated import prices (unit values) of individual meats are calculated by dividing the total import value by the total import quantity.[2]

Data on Japanese domestic meats at wholesale level are from Agriculture & Livestock Industries Corporation (ALIC). Wholesale carcass prices for B-2, and B-3 steers (cross breed steers[3]), are used as the Japanese price of beef. Wholesale price of pork carcass are used as the Japanese pork price. Wholesale price of chicken legs are used as the representative price of broilers.[4]

Seasonal, BSE, and FMD indicator variables are included in the Japanese RSDAIDS model. The seasonal indicator variables takes value of 1 for first (January- March), third (July-September), and fourth (October-December) quarters and zero otherwise. It is hypothesized that there is a seasonal trend into Japanese meat consumption. For example, during the gift giving seasons, Ochugen, in July; Oseibo and Bounenkai, the year-end dinner party, in December; and Osechi, New Year celebration, in January, food items such as meats, are popular gifts (Johnson, Durham, and Wessells).

The FMD indicator variable represents the FMD outbreak in Japan and it takes the value of 1 for the second and third quarters of the year 2000, and zero otherwise. The FMD outbreak in Japan began on March 25, 2000 and lasted through the end of September 2000 (Sugiura et al.) The BSE indicator variable accounts for BSE outbreak in Japan and it takes the value of 1 for the fourth quarter of the year 2001 and the first quarter of the year 2002, and zero otherwise. BSE outbreak in Japan began in September 23, 2001 and lasted through January 2002 (Yeboah and Maynard).[5]

Estimation Procedure and Statistical Tests

The seemingly unrelated regression (SUR) estimation method is used to estimate the model represented by equation (1.1.1); with block substitutability, symmetry, and homogeneity imposed. Due to the adding-up condition, the contemporaneous covariance matrix is singular. Therefore, the last equation (Japanese poultry import demand from the ROW) is dropped from the system for estimation purpose. The parameter estimates for the dropped equations can be calculated using the adding-up restriction. However, in this study, another equation is dropped and the system is re-estimated in order to determine the parameters and the standard errors of the last equation (Henneberry, Piewthongngam, and Qiang). Since the intercept shifters are all dummy variables, the estimated parameters are similar and produce similar elasticities regardless of which equation is dropped. 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, appropriateness of functional form, parameter stability), and joint conditional variance (static and dynamic homoskedasticity, and variance stability) are tested using system misspecification testes proposed by McGuirk et al. Results of the system misspecification tests indicate that estimating the Japanese meat demand model using the model represented by equation (1.1.1) is not appropriate. Dynamics are expected to be particularly important in the analysis of meat demand as consumers are unlikely to respond fully to changes in price, income, or other determinants of demand in the short run. Psychological factors (consumption habits), inventory adjustments, or institutional factors have been given as reasons for the lagged consumer response (Kesavan et al.; Henneberry and Hwang). To allow for lagged effects, the first-difference RSDAIDS model as suggested by Eales and Unnevehr is used here. Therefore, the first-difference of data on continuous variables is used here to estimate the Japanese meat demand system (model 1.1.13 below).

$$(1.1.13) \qquad \Delta w_{i_h} = \sum_k \gamma_{i_{hk}} \Delta \ln(p_{i_k}) + \sum_{j \neq i} \gamma_{i_h j} \Delta \ln(p_j) + \beta_{i_h} \Delta \ln\left(\frac{E}{P^*}\right)$$

Results of misspecification tests for the Japanese meat demand system for both models 1.1.1 and 1.1.13 are presented in table I-2. For model (1.1.13), the results show that the assumption of normality is failed to be rejected at the 1% significance level; except for the equations for pork originating from the ROW.[6] Joint conditional mean and joint conditional variance tests result in the failure to reject the null hypotheses that the conditional mean and the conditional variance are properly specified at the 1% significance level.

Product Aggregation and Block Separability

Product aggregation and block separability tests are performed using model represented by equation 1.1.13. 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 and estimated using nonsource differentiated AIDS model (see Yang and Koo, p. 400, for the product aggregation restrictions). Test results for Japanese meat demand are presented in table I-3. The results indicate that the null hypotheses of nonsource differentiation for all meats are rejected at the 1% significance level. Therefore, the results support estimating the Japanese demand for meats using a source differentiated model.

Additionally, the separability test is used to test block separability within the meat group. The three different blocks in the meat group are beef, pork, and poultry with each block composed of meats from different sources. The block separability test is used to test if consumers' preferences within each block can be described independently of quantities of meats in the other blocks. More specifically, for parsimonious estimation we are interested to know whether each block of meat (e.g. beef from different sources) could be studied separate from meats from other blocks (e.g., pork and poultry from different sources) and without incorporating their prices. This study uses quasi-separability of the cost function to test separability between blocks (for quasi-separability test of the cost function, see Deaton and Muellbauer, 1980b, p. 133; Hayes, Wahl, and Williams, p. 561; and Yang and Koo, p. 400). The null hypothesis is the separability of each block of meat from all other meat blocks (for separability restriction, see Yang and Koo, 1994, p. 400). Test results for the Japanese meat demand system are presented in table I-3. The null hypotheses of whether each meat block in the meat demand system could be studied as a separable category from other blocks of meats; are rejected at the 1% significance level. Therefore, the results support estimating the Japanese demand for meats including the three types of meats.

Endogeneity

Because the expenditure variable (E in equation 1.1.13) is used to compute the budget shares (w_{i_h}), which are the dependent variables, the expenditure explanatory variable might not be truly exogenous. Correlation between the expenditure variable and the error terms that result from expenditure endogeneity, might lead to estimates that are biased and inconsistent. Therefore the 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 of the equation 1.1.13, on a set of instrumental variables (Johnston and DiNardo**)**. The instrumental variables used in this study are: sources differentiated meat prices included in equation 1.1.13, the first-difference of the natural logarithm of the Japanese gross domestic product, and lagged real expenditure variable of the equation (1.1.13). From the OLS regression described above, residuals are recovered. Then we estimate the Japanese meat demand model (equation 1.1.13) with the residuals as an explanatory variable. Jointly, the significance of the coefficients of residuals included in the first-difference RSDAIDS model (equation 1.1.13) are tested. The null hypothesis of this test is that the real expenditure variable in the in equation (1.1.13) is exogenous. Test results show that we fail to reject the null hypothesis at the 1% significance level.

Results

Table I-4 presents the Marshallian demand elasticities with their respective standard errors and the estimates of coefficient for seasonal, FMD, and BSE indicator variables, which were estimated using the first-difference RSDAIDS model (equation

1.1.13).[7] The results of price and expenditure elasticities as well as seasonal, FMD, and BSE indicator variables are described in the following sections.

Expenditure and Price Elasticities

The full matrix of the Marshallian demand elasticities for the Japanese first-difference RSDAIDS model is presented in table I-4. 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).

Regarding imported beef, since the U.S. mostly exports a higher quality (grain-fed beef composed of cuts of choice and prime U.S. grades) to Japan compared to Australian beef (grass-fed beef), it is expected for U.S. beef to carry a higher expenditure elasticity compared to the Australian beef. Nevertheless, in this study, the expenditure elasticity for Australian beef is slightly higher (0.8) compared to U.S. beef (0.7). This result implies that a slightly higher percentage of beef would be imported from Australia compared to the U.S., given a percentage increase in the Japanese meat expenditures. This result is not surprising since Reed and Saghaian report that Japanese consumers prefer fresh beef compared to frozen beef. From 1994 to 2003 (period at 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). Furthermore, the 2003

BSE outbreak in North America could have decreased the perceived high quality of U.S. beef in Japan.

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 the Japanese meat expenditures.

The result that given a percentage increase in the Japanese meat expenditures would increase the demand for Canadian pork by greater percentage compared to U.S. pork seems to be inconsistent with previous expectations because Canada and the U.S. produce and export pork of similar quality. However, Fabiosa and Ukhova also found that a percentage increase in the Japanese meat expenditures would increase the demand for Canadian pork by higher percentage compared to the demand for U.S. pork. The same authors report that the result is particularly true because Canada recently 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 expectation because Danish pork is composed of specific cuts made without bone and fat, which meet quality properties of freshness, color, and texture requirements of the Japanese consumers (Hobbs, Kerr, and Klein). Yang and Koo also found elastic (2.2) expenditure elasticity for 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), poultry from the ROW (0.77), and Japanese domestically produced poultry (0.52). These results show that a percentage increase in the Japanese meat expenditures is expected to increase the demand for poultry from Brazil and Thailand by a higher percentage compared to poultry originated from other sources. These results are consistent with previous expectations because Brazil and Thailand export high quality poultry cuts composed of mechanical de-boned chicken meat and further processed poultry products, which are preferred by Japanese consumers (USDA-FAS, 2006b). Yang and Koo also found that a percentage increase in Japanese meat expenditures would increase the demand for poultry from Thailand and other sources (mainly Brazil) by greater percentage compared to the demand for poultry from other supply sources.

Consistent with what is expected from 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 Japanese source differentiated meat demand by Yang and Koo; and Peterson and Chen. In the pork and poultry markets, similar to Yeboah and Maynard; Peterson and Chen; Wahl, Hayes, and Johnson; and Johnson, Durham, and Wassells, 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 own-price elasticity for poultry from the ROW (-1.9) reported by Yang and Koo.

Marshallian cross-price elasticities indicate gross substitutability or complementary relationships among products from different sources. While a significant positive Marshallian cross-price elasticity between meats from different suppliers indicates substitutability, a significant negative cross-price elasticity may indicate complementarity. Justifying a complementary relationship between meats is difficult since all meats are sources of animal protein and therefore are expected to substitute for one another in human consumption.

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. beef and Japanese. The lack of substitutability relationship between U.S. beef and Japanese beef might be due to difference in 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 beef.

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 hand. These results are consistent with previous expectation since Canada and the U.S. export pork in form of fresh-chilled, which is of comparable quality with the Japanese fresh pork. A strong complementary relationship exists between Danish pork on one hand and U.S. and Canadian pork on the other hand. The lack of competitiveness might be due to difference in pork products and cuts of meat originated from North America and Denmark. Denmark exports frozen pork product in form of 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). Also, complementary relationship exists between pork from Japan and pork from the ROW. The lack of 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, a competitive relationship exists between poultry from Thailand on one hand and poultry originated from China and the ROW (mainly Taiwan) on the other hand. These results are consistent with previous expectations since China, the ROW (mainly Taiwan), and Thailand export same quality of poultry composed of boneless and processed poultry products to Japan. However, 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, a complementary relationship exists between poultry from Japan on one hand and imported poultry from Thailand, Brazil, and the ROW on the other hand. 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 competitive relationship.

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

Effects of Seasonality, FMD, and BSE Outbreaks on Japanese Meat Demand

The parameter estimates of seasonal, BSE, and FMD indicator variables are presented in table I-4. The degree of seasonality in the Japanese meat demand model is considerable. Seasonality is important in quarter I and IV, presumably because of the family New Year celebration (*Osechi*) in the first days of January (quarter I) and the gift giving season (*Oseibo*) and year-end party (*Bounenkai*) in December (quarter IV). The estimated results show that the shares of Japanese beef are higher during the family new year and gift giving celebration periods (quarter I and IV) compared to quarter II while the shares of imported beef are lower during the traditional new year and gift giving periods (quarter I and IV) compared to quarter II. These results are consistent with previous expectation because Japanese consumers demand more highly marbled domestic *wagyu* beef during traditional holiday period (New Year and gift giving periods-quarter I and IV) compared to imported beef. Similar results of seasonal patterns in the Japanese beef demand were obtained by Peterson and Chen.

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 previous expectations as the low income Japanese consumers would increase the demand for relatively cheaper pork products compared to beef during the new year festival in January (quarter I) and during the gift giving celebration (*Ochugen*) in July (quarter III). 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 IV).

FMD outbreak in Japan is shown as having small impact, which is not statistically significant. The BSE outbreak in Japan is shown as having 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; Yeboah and Maynard; and Leuck, Halley, and Harvey).

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. Price and expenditure elasticity estimates are used to evaluate competitiveness among meats from different sources in Japan. Estimates of coefficients of seasonal and animal disease outbreak variables are used to evaluate the impacts of seasonality and animal diseases outbreaks on demand for meats from different sources in Japan.

To assure that the system specification and the estimation procedures are correct, various hypotheses regarding Japanese source differentiated meat demand model are tested. The hypotheses tested are: normality of the error terms, joint conditional mean, joint conditional variance, endogeneity of the real expenditure, separability among included meats, and product aggregation. The results of statistical tests show that the Japanese source differentiated meat demand model is well specified when using the first-difference version of the RSDAIDS model. Also, statistical test results show that it is appropriate to estimate meat demand equations for the three types of meats (beef, pork, and poultry), each meat being differentiated by the supply source.

This study is different from other Japanese meat demand studies since it uses a data set covering a potentially liberalized period during which only import tariffs were in effect in Japan and includes both, imported and domestically produced meats with impacts of seasonality and animal disease outbreaks taken into account. In this study, a country, which supplies high quality and high price meat products to Japan, is considered to have a competitive advantage if the demand for country's meat is expenditure elastic and price inelastic. Moreover, a country, which supplies low quality and low price meat products to Japan, is considered to have a competitive advantage if the demand for country's meat is both expenditure and price elastic.

In the Japanese beef market, the calculated expenditure elasticities indicate that Japanese produced beef has the most to gain from an increase in the Japanese meat expenditures. 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, it can be concluded that Japanese beef has competitive advantage compared to imported beef. Furthermore, based on slightly higher expenditure elasticity of Australian beef compared to U.S. beef, and considering that the price of Australian beef is lower compared to U.S. beef in Japan; Australian beef has competitive advantage in the Japanese beef market compared to U.S. beef.

Japanese beef has the most to gain over the U.S. beef in Japan because Japanese consumers prefer highly marbled beef, Japanese 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 (Gorman, Moroi, and Lin). Australian beef has the most to gain compared to U.S. beef because during the time period considered in this study, Australia exported mainly fresh beef, which is preferred by Japanese consumers, while the U.S. exported mainly frozen beef. Therefore, in order to increase the U.S. beef market share in Japan, the U.S. should consider preventing BSE and other animal disease outbreaks and produce and export to Japan fresh and highly marbled beef products.

In the pork market, the results of expenditure elasticities show that Canada and Denmark have the most to gain from an increase in the Japanese meat expenditures.

Based on 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 competitive advantage in Japanese pork market. Pork from Denmark has the most to gain over U.S. pork because Denmark's pork exports to Japan are composed of pork cuts made without bone and fat, which are preferred by Japanese consumers. In order to increase the U.S. pork market share in Japan, the U.S. should produce, select, and deliver by the entire pork chain, that is from the U.S. farmers to Japanese consumers, boneless pork cuts with low fat content, which meet quality properties of freshness, color, and texture requirements of Japanese consumers.

Regarding the poultry market, Judging by the relatively lower (in absolute value) own-price elasticity and higher and statistically significant expenditure elasticity for Brazilian poultry compared to the poultry from other supply sources, Brazilian poultry can be said to have competitive advantage compared to the poultry from other supply sources. Brazilian poultry has the most to gain in Japan because Brazil's poultry exports to Japan are composed of high quality poultry cuts composed of mechanical de-boned chicken mats, which are preferred by Japanese consumers while the U.S.'s poultry exports to Japan are mainly composed of chicken legs. In order to increase the U.S. poultry market share in Japan, the U.S. should consider exporting boneless and processed poultry products to Japan. Seasonality coefficients indicate that demand for meats is high during the gift giving and New Year celebration periods and BSE outbreak in Japan has affected negatively the demand for U.S. and Japanese produced beef.

Footnotes

1. The equations of own-price, cross-price and expenditure elasticities, equations (1.1.9)-(1.1.12), can be written in matrix form as:

(1.1.14) $$e = Ab$$

where e is the vector of estimated elasticities (ε's, η's), b is the vector of estimated RSDAIDS model parameters (γ's, β's), and A is a matrix of constants (budget shares), The standard errors are calculated by taking the square root of the variance covariance matrix of e, VAR(e), (equation 1.1.15)

(1.1.15) $$\text{VAR}(e) = A\text{VAR}(b)A'$$

where VAR(b) is the variance covariance matrix of b.

2. Although unit values usually reflect perceived differences in intrinsic attributes of imported meats, they may differ from wholesale prices when trade restrictions are in effect.

3. Cross bread steers are steers from cross bread of w*agyu* cattle and other type of Japanese cattle.

4. Price of chicken legs is used as the representative price of broilers because it was the only broiler price that covered the period from 1994 to 2003 in monthly and quarterly basis.

5. Animal disease dummy variables account for the period of time when trade of fresh meat products was banned due to animal disease outbreaks.

6. All the results discussed in this essay refer to the first-difference RSDAIDS model (equation 1.1.13).

7. Hicksian elasticities are not presented here to save space since meats account for a small fraction (1 percent) of the Japanese consumers' disposable income and therefore, Marshallian and Hicksian elasticities are very close.

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Table I-1. Summary of Meat Trade Liberalization in Japan.

Meat Type	Description
Beef	■ In the early 1960s, Japanese government protected domestic beef producers by using import quota system and import tariffs.
	■ In June 1988, the Japanese government signed the Beef Market Access Agreement (BMAA) and the agreement increased Japanese import quota by 60,000 metric tons annually for the first three years. The beef quotas are: 1987=214000MT; 1988=27400MT; 1989=334000MT; 1990=394000MT.
	■ In 1991, beef import quota was removed and import tariff were increased from 25% to 70%.
	■ Tariffs lowered from 50% in 1995 to 38.5% in 2000 by URAA.
	■ Special safeguard provisions were put in place to limit import surges.
Pork	■ Before 1971, Japan was using import quota system and import tariffs for pork import.
	■ Form 1971 to 1994, Japan replaced quota system on pork by variable levy and ad valorem tariffs
	■ In 1995, the URAA agreement replaced Japan's previous variable levy system by gate price system.
	■Tariffs were lowered from 5% in 1995 to 4.3% in 2000 by URAA.
	■ Gate price for carcasses was lowered from 460 yen/kg in 1995 to 393 yen/kg in 2000.
	■Special safeguard provisions were put in place to limit import surges.
Poultry	■ Tariffs on frozen bone-in chicken legs were lowered from 10% in 1995 to 8.25% in 2000 by URAA.
	■ Tariffs in other frozen chicken cuts were lowered from 12% in 1995 to 11.9% in 2000 by URAA.
	■ Tariffs on frozen turkey cuts were lowered from 5% in 1995 to 3% in 2000 by URAA.

Sources: Dyck and Nelson; Wahl, Hayes, and Williams; Wahl, Hayes and Johnson.

Table I-2. Misspecification Test Results for the Japanese Meat Demand Model.

Hypotheses tested	RSDAIDS	First-Difference RSDAIDS
	P-value	P-value
Normality		
Beef from the U.S.	0.011	0.728
Beef from Australia	0.518	0.370
Beef from Japan	0.056	0.891
Beef from the ROW	0.185	0.755
Pork from the U.S.	0.106	0.318
Pork from Denmark	0.917	0.218
Pork from Canada	0.896	0.534
Pork from Japan	0.127	0.142
Pork from the ROW	0.127	0.000
Poultry from the U.S.	0.605	0.539
Poultry from Brazil	0.864	0.714
Poultry from Thailand	0.296	0.113
Poultry from China	0.052	0.897
Poultry from Japan	0.013	0.693
Poultry from the ROW	0.897	0.829
Joint Conditional Mean		
Linear functional form	0.204	0.083
No autocorrelation	0.067	0.339
Parameter stability	0.104	0.369
Overall test	0.013	0.022
Joint Conditional Variance		
Static homoskedasticity	0.000	0.032
Dynamic homoskedasticity	0.025	0.066
Variance stability	0.000	0.435
Overall test	0.000	0.019

Table I-3. Block Separability and Product Aggregation Test Results for the Japanese Meat Demand Model.

Block Separability Test

Ho: Beef is separable from all other meats
F=1.67
df: 8 for numerator and 343 for denominator
Ho: Pork is separable from all other meats
F=7.48**
df: 10 for numerator and 343 for denominator

Ho: Poultry is separable from all other meats
F=164.26**
df: 12 for numerator and 343 for denominator

Ho: All of above
F=68.64**
df:30 for numerator and 343 for denominator

Product Aggregation Test

Ho: Beef can be aggregated
F=21.15**
df: 18 for numerator and 343 for denominator

Ho: Pork can be aggregated
F=6.69**
df: 28 for numerator and 343 for denominator

Ho: Poultry can be aggregated
F=65.40**
df: 40 for numerator and 343 for denominator

Ho: All of above
F=37.02**
df: 86 for numerator and 343 for denominator

Table I-4. Marshallian Elasticites and Parameter Estimates of Coefficients of the Indicator Variables of the Japanese Meat Demand Model.

Explanatory Variables	Beef			
	U.S.	Australia	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	-0.270**	-0.207**	0.088	-0.119
	(0.106)	(0.077)	0.082	(0.170)
Price of poultry	0.092	-0.297	-0.730	0.306
	(0.115)	(0.218)	0.083	(0.242)
Expenditure	0.693**	0.760**	1.369**	0.432
	(0.273)	(0.196)	0.236	(0.397)
Quarter I	-0.043**	-0.012*	0.108**	-0.005**
	(0.009)	(0.004)	(0.019)	(0.001)
Quarter III	0.006	-0.004	-0.001	-0.002*
	(0.005)	(0.003)	(0.012)	(0.001)
Quarter IV	-0.025**	-0.013**	0.055**	-0.004**
	(0.005)	(0.002)	(0.010)	(0.001)
FMD	0.001	0.003	0.003	-2.16401E-05
	(0.007)	(0.004)	(0.016)	(0.001)
BSE	-0.020*	-0.003	-0.030*	-6.84228E-05
	(0.007)	(0.004)	(0.016)	(0.001)

Notes: The system weighted R^2 is equal to 0.832

Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table I-4. Marshallian Elasticites and Parameter Estimates of Coefficients of the Indicator Variables of the Japanese Meat Demand Model.

Explanatory	Pork				
Variables	U.S.	Denmark	Canada	Japan	ROW
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 beef	-0.121	-0.351	-1.141**	-0.376**	-1.113**
	(0.205)	(0.450)	(0.258)	(0.083)	(0.4334)
Price of poultry	-0.097	0.198	-0.935**	-0.625**	-0.326
	(0.269)	(0.452)	(0.255)	(0.085)	(0.353)
Expenditure	1.536**	2.729**	2.827**	1.360**	2.501**
	(0.354)	(0.869)	(0.449)	(0.166)	(0.756)
Quarter I	0.006	-0.015	0.021**	0.079**	-0.008
	(0.008)	(0.018)	(0.005)	(0.016)	(0.018)
Quarter III	-0.002	0.027*	0.002	-0.021*	0.018
	(0.004)	(0.010)	(0.003)	(0.009)	(0.010)
Quarter IV	-0.007	-0.017	0.002	0.015	-0.021
	(0.006)	(0.013)	(0.004)	(0.012)	(0.014)
FMD	-0.006	-0.017	0.005	0.017	-0.012
	(0.005)	(0.013)	(0.003)	(0.012)	(0.012)
BSE	0.006	0.014	2.258E-04	0.009	-0.014
	(0.005)	(0.013)	(0.003)	(0.011)	(0.012)

Notes: The system weighted R^2 is equal to 0.832

Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table I-4. Marshallian Elasticites and Parameter Estimates of Coefficients of the Indicator Variables of the Japanese Meat Demand Model.

Explanatory Variables	Poultry					
	U.S.	Thailand	China	Brazil	Japan	ROW
U.S. price poultry	-0.087	-0.378*	0.117	-0.125	-0.002	0.279
	(0.323)	(0.171)	(0.117)	(0.183)	(0.007)	(0.197)
Thailand price poultry	-0.827*	-0.828*	0.483*	-0.291	-0.078**	0.862**
	(0.379)	(0.412)	(0.215)	(0.298)	(0.012)	(0.325)
China price poultry	0.334	0.618*	-1.809**	0.594	0.080**	-0.601*
	(0.337)	(0.279)	(0.394)	(0.351)	(0.023)	(0.233)
Brazil price poultry	-0.170	-0.184	0.299	-0.873**	-0.032**	0.174
	(0.259)	(0.191)	(0.172)	(0.263)	(0.011)	(0.181)
Japan price poultry	0.247	-1.105**	2.043**	-0.564	-0.412**	-0.079
	(0.306)	(0.274)	(0.419)	(0.377)	(0.038)	(0.207)
ROW price poultry	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	-0.270	-0.729**	-1.102**	-1.149**	0.010	-0.160
	(0.244)	(0.232)	(0.327)	(0.311)	(0.032)	(0.169)
Price of pork	-0.006	-0.252	-0.583*	-0.189	-0.011	-0.050
	(0.175)	(0.164)	(0.233)	(0.229)	(0.028)	(0.120)
Expenditure	0.690	1.166**	0.617	1.384**	0.522**	0.771**
	(0.463)	(0.435)	(0.617)	(0.602)	(0.074)	(0.316)
Quarter I	-0.002	0.007*	-0.012*	0.003	0.016	0.001**
	(0.002)	(0.003)	(0.006)	(0.003)	(0.009)	3.330E-04
Quarter III	0.004	0.001	0.010*	0.003	-0.023	0.001**
	(0.001)	(0.002)	(0.004)	(0.002)	(0.005)	2.080E-04
Quarter IV	0.002*	0.006**	0.001	0.004*	0.049	0.002**
	(0.001)	(0.002)	(0.003)	(0.002)	(0.005)	1.860E-04
FMD	4.655E-04	0.001	-0.002	0.002	0.012	3.367E-04
	(0.001)	(0.002)	(0.005)	(0.002)	(0.007)	2.590E-04
BSE	-0.001	0.003	-0.016*	0.001	0.017	0.001
	(0.001)	(0.003)	(0.005)	(0.002)	(0.007)	2.630E-04

Notes: The system weighted R^2 is equal to 0.832

Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Essay II: Demand for Meats from Different Sources in South Korea: A Source Differentiated Market Study

Introduction

Rapid economic growth and rising per capita incomes along with gradual reductions in meat trade barriers have been given as reasons for the shift in South Korean (S. Korean) consumption patterns away from traditional food products (cereals) and towards animal protein products such as beef, pork, and chicken (Byrne et al.). For example, per capita meat consumption (beef, pork, and chicken) increased from 11.3kg in 1980 to 30.9kg in 2003, an increase of 173%. However, from 1980 to 2003, the self-sufficiency ratios for beef, pork, and poultry decreased from 97.8% to 36.3%, 100% to 93.8%, and 100% to 76.7%, respectively (Henneberry and Hwang).

The S. Korean government has taken major steps towards liberalization of its meat import market. The S. Korean import quotas for pork and chicken were eliminated as of July 1, 1997 and the S. Korean import quotas for beef ended on January 1, 2001 (Dyck and Nelson). As a result of trade liberalization, S. Korea has become an important emerging market for meat imports, especially for U.S. produced meats. From 2001 to 2003, S. Korea was the third and fifth largest international market for U.S. beef and pork, accounting for 21% and 4% of U.S. total pork and beef exports, respectively (USDA-ERS, 2006a).

Considering that S. Korea is an important emerging market for U.S. meats, understanding the economic and non-economic factors that shape the demand for meats from different sources, including U.S. produced meats, in S. Korea, are of importance to the U.S. meat producers, marketers, and policy makers in developing effective marketing programs targeted towards expanding sales and market shares of U.S. produced meats. Source of origin is often considered to be an intrinsic attribute that significantly affects consumer's purchasing decision when more product specific information is not readily available (Kim and Boyd). Beef, pork, and poultry are not uniform products in S. Korea. For example, S. Korean consumers prefer the domestic *Hanwoo* beef compared to imported beef (Kim). Regarding imported beef, the grain-fed beef imported from the U.S. has generally been viewed by S. Korean consumers as having a higher quality than beef imported from other sources (Kim et al., 1997).

Despite the importance of the topic, studies that have estimated meat demand in S. Korea are limited. The majority of the past studies have utilized aggregate consumer data or wholesale-level data, without differentiating meats by source of origin (Koo, Yang, and Lee; Hayes, Ahn, and Baumel; Byrne et al.). Jung and Koo; Kim, Kim, and Veeman estimated demand for meats from different qualities and or sources. However, none of these studies included S. Korean produced meats and differentiated all meat types (beef, pork, and poultry) by country of origin. Henneberry and Hwang estimated S. Korean demand for meats from different countries; however the data used cover a period at which S. Korean meat imports were restricted by a quota system.

Different from past studies, this study uses a data set covering a potentially liberalized period during which only import tariffs were in effect in S. Korea.

Furthermore, this study extends the existing source differentiated meat demand studies by including domestically produced meats; differentiating all types of meats by the major sources of supply and including non economic factors such as seasonality and animal disease outbreaks, that is foot-and-mouth (FMD) disease outbreak in S. Korea and *Bovine Spongiform Encephalopathy* (BSE) outbreak in the U.S.

Hence, the primary objective of this study is to estimate a meat demand system for S. Korea, differentiating meats by type and by source of origin. More specifically, the objectives of this study are: (a) to estimate the impacts of economic factors (meat prices and expenditure) as well as non-economic factors (animal diseases outbreaks and seasonality) on demand for meats from different sources in S. Korea; (b) to access the competitiveness of meats from different sources in the S. Korean meat market; and (c) to provide estimates of the S. Korean demand elasticities for meats originating from various sources including domestically produced meats. To accomplish the objectives of this study, a source differentiated meat demand system is specified and estimated. The model differentiates meats by type and by source of origin.

Following a historical overview of the S. Korean meat trade policies, a source differentiated meat demand model for the S. Korean meat market is presented. Next, the data and estimation methods are outlined followed by empirical results. Finally, the summary and conclusions are given.

An Overview of Meat Trade Policies in South Korea

Prior to 1976, strict import restrictions on meat (beef, pork, and poultry) were in effect in S. Korea. Regarding beef, imports needed to fulfill domestic shortfalls were only allowed from 1976 to 1979 and from 1981 to 1984. In 1985 S. Korean cattle inventory increased and beef prices decreased, which led to a decrease in profit of domestic producers. Consequently, S. Korean farmers lobbied the government for protection by requesting a ban on beef and cattle imports. In response, beef and cattle imports were banned in S. Korea from 1985 to 1987. In 1988, the U.S., Australia, and New Zealand petitioned the General Agreement on Tariffs and Trade (GATT) that S. Korea's ban on beef was illegal. As a result; the S. Korean government removed the ban in July 1988 and instituted a 14,500 metric ton beef import quota instead.

From 1988 through 2001, the S. Korean meat import market operated under a quota system, where imported meat was purchased by a tender system. The tender system allowed the Livestock Products Marketing Organization (LPMO), established in 1988, as the beef import agency (Kim, Kim, and Veeman). LPMO purchased different types of imported meat cuts and distributed to government linked-agencies such as the National Livestock Cooperative Federation (NLCF) and the Korean Cold Storage Company (KCSC). The annual quota was determined by the Ministry of Agriculture, Forestry and Fishery (MAFF) and Economic Planning Board (EPB) (Kim et al., 1996). From 1988 to 2001, significant progress was made in reducing the S. Korean meat import barriers (table I-5). Under GATT negotiations, the S. Korean government gradually replaced the meat tender system by simultaneous buy and sell (SBS). The SBS system allowed S. Korean buyers to import beef directly from foreign beef exporters. During this period, each SBS firm specialized in serving a specific segment of the market (grocery stores, restaurants, etc).

The GATT negotiation called for an increase in the proportion of aggregate import quota to private importing organizations (firms), "supergroups" or SBS, which was established in 1993. The quota allocated to SBS increased from 10% in 1993 to 70% in 1994 (Kim, Kim and Veeman). Following GATT, the Uruguay Round Agreement in Agriculture (URAA) played a significant role in reducing the S. Korean meat import barriers. Under URAA, beef quota was raised from 123,000 tons in 1995 to 225,000 tons in 2000 and beef import tariffs were increased from 20% in 1994 to 44.4% in 1995 and then decreased to 40% in 2004. The absolute beef quota system was eliminated on January 1, 2001, when tariffs became effective and the state trading of beef imports were discontinued.

For pork and chicken, quotas were raised from 1995 through the first half of 1997; and absolute quota ended on July 1, 1997 (Dyck and Nelson). Pork import tariffs were lowered from 37% in 1995 to 25% in 2004 and poultry import tariffs were lowered from 35% in 1995 to 20% in 2004. Despite a significant progress made towards liberalization of the S. Korean meat import market, sanitary and phytosanitary (SPS) measures are still being the major forms of restricting meat imports into S. Korea. S. Korea banned beef imports from the U.S. in December 2003 when BSE was detected in Washington State.

A Model of the South Korean Source Differentiated Meat Demand

The almost ideal demand system (AIDS) is used in this study because it has many desirable properties: The AIDS model is an arbitrary first order approximation of any demand system; it satisfies the axioms of choice, it aggregates over consumers, and it has a functional form consistent with household budget data (Deaton and Muellbauer, 1980a). However, empirical use of the AIDS model in demand estimation typically assumes product aggregation under which the demand system does not differentiate goods by supply source.

In this study, to allow for source differentiation, a version of the AIDS model known as the Restricted Source Differentiated AIDS (RSDAIDS) is used to estimate source differentiated meat demand in S. Korea. The RSDAIDS allows for source differentiation for 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 or goods. The RSDAIDS imposes block substitutability, which assumes that the cross-price effects of 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, p. 399, for the block substitutability restriction). Hence, the prices of other goods from various origins are represented by an aggregate price for that good in the equation of a given source differentiated product. For example; in estimating the S. Korean demand for U.S. beef, the prices of pork originating from different sources are represented by one aggregate price of pork. This assumption reduces the number of parameters that need to be estimated and therefore increases the degrees of freedom.

Following Yang and Koo, the RSDAIDS is specified as the following:

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

where subscripts *i* and *j* indicate goods ($i, j = 1, 2, \ldots N$), 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 good, 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 meat *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 is calculated as the weighted average of source differentiated *j* prices as;

(1.2.2) $$\ln(p_j) = \sum_k w_{j_{k,t-1}} \ln(p_{j_k})$$

and *P** is a price index which for source differentiated AIDS is defined as:

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

The RSDAIDS model in (1.2.1) above is nonlinear due to the nonlinear price index in (1.2.3). To make the system linear, Deaton and Muellbauer, 1980a suggest using Stone's price index, here specified as:

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

The budget shares (w_{i_h}) that are used as dependent variables in equation (1.2.1), are also used as independent variables in the aggregate price calculation (equation 1.2.4). Therefore, in order to avoid simultaneity bias, following Eales and Unnevehr, this study uses lagged budget shares ($w_{i_{h,t-1}}$) to compute Stone's price index (equation 1.2.4).

Moreover, Moschini; and LaFrance recognize the lack of invariance of Stone's price index to unit of measurement. Hence, as proposed by Moschini and following Dameus et al., this study uses scaled meat prices to compute the Stone's price index (equation 1.2.4). Scaled meat prices are source differentiated meat prices divided by their respective means.

Additionally, a seasonal indicator variable reflecting seasonal patterns in meat demand in S. Korea and two indicator variables reflecting BSE and FMD outbreaks in the U.S. and S. Korea, respectively are included. The indicator variables are incorporated as intercept shifters in the RSDAIDS model (Henneberry, Piewthongngam, and Qiang). Therefore, in this study, the intercept term in equation (1.2.1) is defined as:

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

where D represents the three indicator variables (seasonality, BSE, and FMD outbreaks in the U.S. and S. Korea, respectively).

Following Yang and Koo, homogeneity, and symmetry are imposed as shown in equation (1.2.6) and (1.2.7) respectively.

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

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

Due to the inclusion of indicator variables in the RSDAIDS model in (1.2.1), the adding-up property of demand is imposed as:

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

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

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

(1.2.10) $$\varepsilon_{i_h i_k} = \frac{\gamma_{i_{hk}}}{w_{i_h}} - \beta_{i_h} (\frac{w_{i_k}}{w_{i_h}})$$

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

Equation (1.2.9) represents own-price elasticities, (1.2.10) represents cross-price elasticities between the same goods from different sources, (1.2.11) represents cross-price elasticities between different goods, that is between good *i* from source *h* and aggregate good *j*. Expenditure elasticity is specified as:

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

The elasticities and the standard errors of the elasticities are calculated at the mean level of expenditure shares using equations 1.2.9-1.2.12 above. The standard errors of the elasticities are calculated using the method offered by Mdafri and Brorsen.[1]

Data

Monthly data from 2001(month 1)[2] to 2005 (month 5) are used to estimate parameters of the S. Korean RSDAIDS model. Three meat categories studied here are beef, pork, and poultry. Although fish products are important sources of protein in S. Korean diet, in this study fish products are not included in the S. Korean meat demand model because of lack of available fish data. Therefore, weak separability between meats and fish is assumed. Separability between fish and non-fish meats in S. Korea have been tested and supported in the literature (Koo, Yang, and Lee; Bryne et al.; Capps et al.). Furthermore, this study assumes weak separability between meats and non-meat goods.

S. Korea imports meats from various sources. A country is identified as a supply source if imports from that country constitute at least 10% of the total imports of the selected meat. All other countries that supplies less than 10% of S. Korean total imports of selected meat are aggregated as the Rest-of-the-World (ROW). Because retail/wholesale prices for source differentiated meats in S. Korea are not available, unit-value import prices are used to measure market prices for imported meats. Data on import values (in U.S. dollars) and quantities (in kilograms) are from USDA-FAS, 2006. Data on the value of imported meat are converted to S. Korean Won using published exchange rates. Exchange rate data are from USDA-ERS, 2006b. Source differentiated import prices (unit values) of individual meats are calculated by dividing the total import value by the total import quantity.[3] The wholesale-level S. Korean domestic data (quantities and prices) of beef, pork, and broilers are from National Agricultural Cooperative Federation (NACF).

Seasonal, FMD, and BSE indicator variables are included in the S. Korean meat demand model. The seasonal variables correspond to spring (March through May), summer (June through August), and winter (December through February). It is hypothesized that there is seasonal trend into meat consumption. For example, the demand for chicken is high during summer months since chicken is used to prepare traditional soup called *Samgyetang*, which is believed to be healthy food during hot days of summer months. Furthermore, during traditional holiday seasons, that is New Year eve

(February) and gift-giving months (September through October), food items such as meats, are popular gifts in S. Korea.

The FMD indicator variable accounts for FMD outbreak in S. Korea and it takes the value of 1 from April to September of the year 2001 and from June to September of the year 2002 and zero otherwise. FMD outbreak in S. Korea began on March 20, 2000 and lasted through September 2001. Another FMD outbreak in S. Korea began on June 23, 2002 and lasted through August 7, 2002 (Joo et al.; and Sumption). The BSE indicator variable accounts for BSE outbreak in the U.S. and it takes value of 1 from December 2003 to May 2005 and zero otherwise.[4]

Estimation Procedures and Statistical Tests

The seemingly unrelated regression (SUR) estimation method is used to estimate the parameters of model (1.2.1); with block substitutability, symmetry, and homogeneity imposed. Due to the adding-up condition, the contemporaneous covariance matrix is singular. Therefore, the last equation (S. Korean poultry import demand from the ROW) is dropped from the system for estimation purposes. The parameter estimates for the dropped equations can be calculated using the adding-up restriction. However, in this study, another equation is dropped and the system is re-estimated in order to determine the parameters and the standard errors of the last equation (Henneberry Piewthongngam, and Qiang).Since the intercept shifters are all dummy variables, 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, appropriateness of functional form, parameter stability), and joint conditional variance(static and dynamic homoskedasticity, and variance stability) proposed by McGuirk et al. are tested in this study. Results of the system misspecification tests indicate that estimating the S. Korean meat demand model using equation (1.2.1) is not appropriate; mostly due to autocorrelation of the error terms.[5] Kennedy 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 because consumers are unlikely to respond fully to changes in price, income, or other determinants of demand in short term. Psychological habit factors, inventory adjustments, or institutional factors have been reported as reasons for the lagged consumer response (Kesavan et al.; Henneberry and Hwang). To allow for lagged effects, the first-difference RSDAIDS model as suggested by Eales and Unnevehr is used here. Therefore, the first-difference of data on continuous variables is used here to estimate the S. Korean meat demand system (model 1.2.13 below).

(1.2.13)
$$\Delta w_{i_h} = \sum_k \gamma_{i_{hk}} \Delta \ln(p_{i_k}) + \sum_{j \neq i} \gamma_{i_h j} \Delta \ln(p_j) + \beta_{i_h} \Delta \ln\left(\frac{E}{P^*}\right)$$

Results of the misspecification tests for the S. Korean meat demand system, for both models 1.2.1 and 1.2.13 are presented in table I-6. For model (1.2.13), test results indicate that the assumption of normality fails to be rejected at the 1% significance level; except for the equations for pork originating from the ROW.[6] Similarly, joint conditional mean and joint conditional variance tests result in the failure to reject the null hypotheses that the conditional mean and the conditional variance are properly specified at the 1% significance level.

Product Aggregation and Block Separability

The product aggregation and block separability tests are performed using model represented by equation 1.2.13. 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 and estimated using nonsource differentiated AIDS model (see Yang and Koo, p. 400, for the product aggregation test restrictions). The test results for the S. Korean meat demand model are presented in table I-7. The results indicate that the null hypothesis of nonsource differentiation for all meats is rejected at the 1% significance level. Therefore, the results support estimating the S. Korean demand for meats using a source differentiated model.

Moreover, block separability within meat group is tested. 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 if consumers' preferences within each block can be described independently of quantities of meats in the other blocks. More specifically, for parsimonious estimation we are interested to know whether each block of meat (e.g. beef from different sources) could be studied separate from meats of other blocks (e.g., pork and poultry from different sources) and without incorporating their prices. This study uses quasi-separability of the cost function to test separability between blocks (for quasi-separability of the cost function, see Deaton and Muellbauer, 1980b, p.

133; Hayes, Wahl, and Williams, p. 561; and Yang and Koo, p. 400). The null hypothesis is the separability of each block of meat from all other meat blocks (for separability restriction, see Yang and Koo, 1994, p. 400). Test results for the S. Korean meat demand system are presented in table I-7. The null hypotheses of whether each meat block in the meat demand system could be studied as a separable category from other blocks of meats; are rejected at the 1% significance level. Therefore, the results support estimating the S. Korean demand for meats including the three types of meats.

Endogeneity

The expenditure explanatory variable (E in equation 1.2.13) is also used to compute the budget shares, which are independent variables in equation (1.2.13). Therefore, it may not truly exogenous. Correlation between the expenditure variable and the error terms that result from expenditure endogeneity might lead to estimates that are biased and inconsistent. Hence, the endogeneity of the real expenditure variable is tested using Wu-Hausman endogeneity test described by Johnston and DiNardo.

The Wu-Hausman test is performed by regressing the real expenditure variable of the equation 1.2.13, on a set of instrumental variables. The instrumental variables used in this study are: sources differentiated meat prices included in equation 1.2.13, the first-difference of the natural logarithm of the S. Korean gross domestic product, and lagged real expenditure variable of the equation (1.2.13). From the OLS regression described above, residuals are recovered. Then we estimate the S. Korean meat demand (model 1.2.13) with the residuals as an explanatory variable. Jointly, the significance of the coefficients of residuals included in the first-difference RSDAIDS model (equation

1.2.13) are tested. The null hypothesis of this test is that the real expenditure variable in the first-difference RSDAIDS model (equation 1.2.13) is exogenous. The test results show that we fail to reject the null hypothesis at the 1% significance level.

Results

The Marshallian price and expenditure meat demand elasticities along with the standard errors and the parameters estimates for seasonal, FMD, and BSE indicator variables, which were estimated using the first-difference RSDAIDS model (equation 1.2.13) are presented in table I-8.[7] The following sections discuss the results of the expenditure and price elasticities as well as the coefficient estimates of seasonal, FMD, and BSE indicator variables.

Expenditure and Price Elasticities

The Marshallian elasticities for the S. Korean meat demand model are presented in Table I-8. In the beef market, consistent with prior expectation from economic theory, all 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 S. Korean domestic beef. These results suggest that a percentage increase in the S. Korean meat expenditures would increase the demand for imported beef by a higher percentage compared to demand for S. Korean domestic beef.

These results might seem inconsistent with previous expectations since S. Korean consumers prefer S. Korean produced beef (*Hanwoo* beef) compared to imported beef (Henneberry and Hwang). However, since S. Korea is a growing economy country, beef prices might be important feature towards consumers' beef purchase decision. Therefore, because S. Korean *Hanwoo* beef is relatively more expensive than imported beef, S. Korean consumers might increase consumption of beef (relatively cheap imported beef compared to domestic beef) given an increase in their incomes. Similarly, Jung and Koo report 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 S. 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 the Australian beef. Nevertheless, in this study, the expenditure elasticity for Australian beef is slightly higher (1.30) compared to the U.S. beef (1.29). This result implies that a slightly higher percentage of beef would be imported from Australia compared to the U.S., given a percentage increase in the S. Korean meat expenditures. This result is not surprising, as the 2003 BSE outbreak in the U.S. could have negatively impacted the perceptions regarding the safety of U.S. beef in S. Korea.

In the pork market, all the expenditure elasticities are positive and statistically significant. Pork from Denmark has a higher and statistically significant expenditure elasticity (1.04) followed by pork from the ROW (1.0), pork from S. Korea (0.9), pork from Canada (0.85), and pork from the U.S. (0.77). These results suggest that an increase in the S. Korean meat expenditures would increase by a higher percentage the demand for pork from Denmark and the ROW (mainly European Union countries) compared to demand for pork from other supply sources. These results are consistent with S. Korean consumers' general preferences for pork from European Union, which is in the form of *Sam-Gyup-Sal*. This is one of the most preferred parts of the pork belly in S. Korea. *Sam-Gyup-Sal* is composed of alternating meat and fat layers and it is used in traditional S. Korean dishes (Henneberry and Hwang).

For poultry, all expenditure elasticities are positive and statistically significant. Poultry from Thailand has the highest and statistically significant expenditure elasticity (1.40), followed by poultry from the U.S. (1.38), poultry from S. Korea (1.21), and poultry from the ROW (1.07). These results suggest that an increase in the S. Korean meat expenditures would increase by a higher percentage the demand for poultry from Thailand, compared to demand for poultry from other sources. These results are consistent with S. Korean consumers' general preferences for high quality boneless and processed poultry products from Thailand.

Consistent with economic theory, 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; and Capps et al.). Cross-price elasticities between meats from different sources may indicate substitutability/ or complementarity relationships. In the beef market, the majority of cross-price elasticities are not statistically significant. However, the cross price elasticity between U.S. beef and ROW beef and between ROW beef and S. Korean beef are negative and statistically significant. The results indicate complementary relationship between the ROW beef on one hand and beef from the U.S. and S. Korea on the other hand. These results are consistent with prior expectation as ROW (mainly New

Zealand) beef, which is mainly composed of grass-fed beef, is different in quality compared to U.S. beef (grain-fed beef) and S. Korean beef (*Hanwoo* beef).

Similar to beef market, in the pork market, the majority of cross-price elasticities are not statistically significant; except for the cross-price elasticities between Canadian pork on one hand and pork from the U.S., Japan, and the ROW on the other hand. The results show a lack of substitutability relationship between Canadian pork and S. Korean pork. The lack of substitutability relationship between Canadian pork and S. Korean pork might be due to differences in quality between pork from Canada and pork from S. Korea. Canada exports mainly frozen pork to S. Korea while S. Korean pork is mainly in form of fresh. 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 previous expectations as both Thailand and the ROW (mainly China) export boneless and processed poultry products to S. Korea. A complementary relationship is shown between poultry from Thailand and poultry from S. Korea. Difference in quality between frozen boneless and processed poultry products from Thailand and fresh poultry products from S. Korea might explain the lack of substitutability between Thai and S. Korean poultry products.

Results of cross-price elasticities across commodities indicate substitutability relationships between S. Korean beef and aggregate poultry and S. Korean pork and aggregate poultry. The other statistically significant cross-price elasticities across commodities indicate weak complementarity between source differentiated meats and aggregate commodities. In the summary and conclusion section, we will look at the implications of relationships between source differentiated meats and aggregate commodities.

Effects of Seasonality, FMD, and BSE on S. Korean Meat Demand

The parameter estimates of seasonal, FMD, and BSE indicator variables are presented in table I-8. The coefficients of seasonal indicator variables are not statistically significant; except for the equations of beef from the ROW, pork, and poultry from S. Korea. In the beef market, the estimated results show a small increase in the shares of beef from the ROW during spring months (March-May). However, in the pork and poultry market, estimated coefficients of seasonal indicator variables indicate a substantial impact of seasonality on demand for S. Korean pork and poultry.

Regarding S. Korean pork, the results indicate that the shares of S. Korean pork are lower during spring (March-May), summer (June-August), and winter (December-February) compared to fall months (September-November). These results are consistent with seasonal consumption patterns in S. Korea. The winter season (December-February) is associated with S. Korean New Year when S. Koreans consume more beef than pork; and the summer period (June-August) is associated with high temperatures, when S. Koreans consume more poultry than pork.

Regarding S. Korean poultry, the estimated coefficient of seasonal indicator variables show that the shares of S. Korean poultry are higher during spring and summer months compared to fall months. These results are also consistent with seasonal consumption patterns in S. Korea. During summer (June-August) months, which are associated with high temperatures, S. Koreans' demand for poultry is high because poultry (mainly chicken) is used to make a traditional soup called *samgyetang*. *Samgyetang* is believed to have healthy nutrition content, which can help S. Koreans to cope with the high temperatures of the summer months.

The coefficient estimates of FMD indicator variable are not statistically significant; except for the equation of pork from S. Korea and poultry from the U.S. and S. Korea. Interestingly, the results of FMD outbreak in S. Korea show a positive impact on the shares of S. Korean pork and a negative impact on the shares of U.S. and S. Korean poultry. These results may be explained as follows. When FMD was announced in S. Korea, the major importing country of S. Korean pork (Japan) banned imports of pork from S. Korea. Because of bans of S. Korean pork and the S. Korean consumers generally not being worried about FMD as it is not dangers for human's health, the price of pork might have declined in S. 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 S. 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 as S. 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 S. Korea as S. Korea restricted imports of Canadian and U.S. beef.

Summary and Conclusions

The results of this study reveal the preferences of S. Korean consumers for domestically produced meats as well as imported meats from different sources. Specifically, this study provides estimates of own-price, cross-price, and expenditure elasticities for S. Korean source differentiated meat demand. Furthermore, this study estimates the effects of seasonality, FMD, and BSE outbreaks on demand for meats from different sources in S. Korea. The elasticity estimates are used to evaluate the impact of economic factors (meat prices and expenditures) on the S. Korean quantity demanded for source differentiated meats and to evaluate the competitiveness of meats from different sources in S. Korea. The parameter estimates of seasonal and animal disease outbreak variables are used to evaluate the impact of seasonality and animal diseases outbreaks on the demand for meats from different sources in S. Korea.

To assure that the system specification and the estimation procedures are correct, various hypotheses regarding the S. Korean source differentiated meat demand models are tested. The hypotheses tested are: normality of the error terms, joint conditional mean, joint conditional variance, endogeneity of the real expenditure, separability among included meats, and product aggregation. The results of statistical tests show that the S. Korean source differentiated meat demand model is well specified when using the first-difference version of RSDAIDS model. Additionally, the results of statistical tests show that it is appropriate to estimate meat demand equations for the three types of meats (beef, pork, and poultry), each meat being differentiated by the supply source (source differentiated).

This study is different from other S. Korean meat demand studies as it uses a data set covering a potentially liberalized period during which only import tariffs were in effect in S. Korea. Furthermore, it includes both, imported and domestically produced meats with seasonality and animal disease outbreaks taken into account. In this study, a country, which supplies high quality and high price meat products to S. Korea, is considered to have a competitive advantage if the demand for country's meat is expenditure elastic and price inelastic. Moreover, a country, which supplies low quality and low price meat products to S. Korea, is considered to have a competitive advantage if the demand for country's meat is both expenditure and price elastic.

In the S. Korean beef market, the calculated beef expenditure elasticities show that imported beef from different sources has the most to gain from an increase in the S. Korean meat expenditures. Although the S. Korean domestic beef (*Hanwoo* beef) is perceived by S. Korean consumer as possessing high quality, based on higher expenditure elasticity and lower price for imported beef from Australia and the U.S. compared to S. Korean domestic beef, beef from Australia and the U.S. have competitive advantage in the S. Korean beef market.

The grain-fed beef imported from the U.S. has generally been viewed by S. Korean consumers as having a higher quality than beef imported from other sources (Henneberry and Hwang). However, with food safety being the main drivers of beef import demand in S. Korea, a high quality attribute may not be the right signal that will provide a true market advantage. The results of this study show that judging by slightly high expenditure elasticity for Australian beef and relatively lower price of Australian beef compared to U.S. beef, it can be concluded that Australian beef has competitive advantage compared to U.S. beef. Therefore, in order to increase market share of U.S. beef in S. Korea, the U.S. beef producers, marketers, and policy makers should work together in preventing animal diseases outbreak in the U.S. Additionally, the U.S. beef exporters should reverse S. Korean consumers' attitude, particularly on U.S. beef, by positioning U.S. beef as safe high quality product.

In the pork market, the calculated expenditure elasticities indicate that pork from Denmark has the most to gain from an increase in S. Korean meat expenditures compared to pork from other supply sources. Based on high expenditure elasticity and inelastic own-price elasticity for pork from Denmark, Denmark has competitive advantage in the S. Korean pork market. Denmark exports pork belly in form of *Sam-Gyup-Sal*, an alternating meat and fat layers used in traditional S. Korean dishes, which is preferred by S. Korean consumers (Henneberry and Hwang). In order to increase the U.S. pork market shares in S. Korea, the U.S. should produce, select, and deliver by the entire pork chain until retail display centers in S. Korea, pork products that match specific characteristics, which are preferred by S. Korean consumers. Regarding the poultry market, based on inelastic own-price and elastic and statistically significant expenditure elasticities for poultry from Thailand compared to U.S. and S. Korea poultry products, poultry from Thailand has competitive advantage.

Additionally, the results of this study would have implications for market share of meats from different sources in S. Korea. For example, major suppliers of pork and poultry in S. Korea might be interested in knowing by how much they can increase their market share in S. 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, it can be concluded that the major S. 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 of recent Avian Influenza pandemic in Asia that has reduced the consumption of poultry in S. Korea. Based on positive and statistically significant cross-price elasticities between beef from S. Korea and poultry and between pork from S. Korea and poultry, it can be concluded that S. Korean beef and pork might benefit from the Avian Influenza outbreak in S. Korea.

Footnotes

1. For calculating the standard errors of the estimated elasticities, the square root of the variance of a linear transformation of the parameters (equation 1.2.14 below) was calculated.

(1.2.14)
$$e = Ab$$

where e is the vector of estimated elasticities (ε's, η's), b is the vector of estimated RSDAIDS model parameters (γ's, β's), and A is a matrix of constants (budget shares). The variance covariance matrix of e [VAR(e)] was calculated as:

(1.2.15)
$$\text{VAR}(e) = A\text{VAR}(b)A'$$

where VAR(b) is the variance covariance matrix of b.

2. For the S. Korean meat demand, we use monthly data from 2001 because the S. Korean beef import liberalization (the elimination of quotas) started in January 2001. Pork and poultry were previously liberalized in July 1997.

3. Unit values might not be a perfect measure of wholesale prices when trade restrictions are in effect. However, they usually reflect perceived quality differences of imported meats.

4. Restrictions on import of beef from the U.S. were in place in S. Korea from December 2003 to May 2005 because of the 2003 BSE outbreak in the U.S.

5. Results of misspecification test presented in table I-6 for the RSDAIDS model show that we reject the null hypothesis of no autocorrelation at the 1 percent significance level.

6. All the results discussed in this study refer to the first-difference RSDAIDS model.

7. The Hicksian elasticities were not presented here to save space. Moreover, since meats account for a small fraction (4%) of the S. Korean consumers' disposable income and therefore, Marshallian and Hicksian elasticities are very close.

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Table I-5. Summary of Meat Trade Liberalization in South Korea.

Meat Type	Description
Beef	■ From 1976 to 1979 and from 1981 to 1984 beef imports needed to fulfill domestic shortfalls were allowed in Korea. ■ In 1988 Korea's imported beef were operated under quota system were imported beef was purchased by tender. ■ In 1993, Korean government gradual replaced the tender system by simultaneous Buyer and Sellers (SBS) under GATT agreement. ■ Quota raised from 123,000 tons to 225,000 tons by URAA in 1995. SBS share of quota rose from 30 percent in 1995 to 70 percent in 2000 by URAA. Tariffs lowered from 44.4 percent in 1995 to 40 percent in 2004 by URAA. ■ Absolute quota in beef offal ended as of July 1, 1997. ■ Absolute quota system for beef ended as of January 1, 2001.
Pork	■ Quota on frozen pork raised from 21,930 tons in 1995 to 18,275 tons for the first half of 1997 by URAA agreement. ■ Absolute quota ended as of July 1, 1997. ■ Tariffs lowered from 37 percent in 1995 to 25 percent in 2004 by URAA agreement. Tariffs for pork offal lowered from 20 percent in 1995 to 18 percent in 2004 by URAA
Poultry	■ Quota raised from 6,500 tons in 1995 to 7,700 tons for the first half of 1997 by URAA agreement ■ Absolute quota ended as of July 1, 1997. ■Tariffs lowered from 35 percent in 1995 to 20 percent in 2004 by URAA agreement.

Sources: Dyck and Nelson ; Wahl, Hayes, and Johnson; Wahl, Hayes, and Williams; Kim et al. 1997; Byrne et al.

Table I-6. Misspecification Test Results for the South Korean Meat Demand Model.

Hypotheses tested	RSDAIDS	First-Difference RSDAIDS
	P-value	P-value
Normality		
Beef from U.S.	0.9121	0.0096
Beef from Australia	0.7834	0.8768
Beef from the ROW	0.5302	0.9811
Beef from South Korea	0.2869	0.3125
Pork from U.S.	0.0001	0.0001
Pork from Denmark	0.4903	0.6675
Pork from Canada	0.0336	0.7341
Pork from the ROW	0.2261	0.4189
Pork from South Korea	0.7350	0.6558
Poultry from U.S.	0.7354	0.8579
Poultry from Thailand	0.2490	0.7621
Poultry from the ROW	0.0001	0.0827
Poultry from South Korea	0.3857	0.2846
Joint Conditional Mean		
Linear Functional form	0.0557	0.267
No autocorrelation	0.0001	0.267
No structural changes	0.0316	0.648
Overall test	0.0001	0.047
Joint Conditional Variance		
Static homoskedasticity	0.0913	0.368
Dynamic homoskedasticity	0.2303	0.060
No structural changes	0.9013	0.004
Overall test	0.1085	0.027

Table I-7. Block Separability and Product Aggregation Test Results for the South Korean Meat Demand Model.

Block Separability Test

Ho: Beef is separable from all other meats
F=3.23**
df: 8 for numerator and 528 for denominator
Ho: Pork is separable from all other meats
F=26.66**
df: 10 for numerator and 528 for denominator

Ho: Poultry is separable from all other meats
F=3.51**
df: 8 for numerator and 528 for denominator

Ho: All of above
F=12.33**
df: 26 for numerator and 528 for denominator

Product Aggregation Test

Ho: Beef can be aggregated
F=9.68**
df: 18 for numerator and 528 for denominator

Ho: Pork can be aggregated
F=261.97**
df: 28 for numerator and 528 for denominator

Ho: Poultry can be aggregated
F=54.36**
df: 18 for numerator and 528 for denominator

Ho: All of above
F=132.62*
df: 64 for numerator and 528 for denominator

Note: (*) and (**) denote significance at 5% and 1%, respectively

Table I-8. Marshallian Elasticities and Parameters Estimates of Coefficients of the Indicator Variables of the South Korean Meat Demand Model.

Explanatory	Beef			
Variables	U.S.	Australia	Korea	ROW
Price of beef from the U.S.	-0.208	-0.329	-0.010	-0.894**
	(0.239)	(0.293)	(0.061)	(0.361)
Price of 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	-0.350**	-0.094	-0.211	-0.094
	(0.124)	(0.107)	(0.128)	(0.134)
Price of poultry	-0.222	-0.362	0.461**	-0.352
	(0.186)	(0.251)	(0.170)	(0.210)
Expenditure	1.286**	1.298**	0.646*	0.767**
	(0.288)	(0.217)	(0.301)	(0.253)
Spring	0.0029	-0.0006	-0.0388	0.0078*
	(0.0158)	(0.0067)	(0.0311)	(0.0032)
Summer	0.0203	0.0043	-0.0701	0.0043
	(0.0171)	(0.0069)	(0.0370)	(0.0033)
Winter	0.0038	-0.0045	0.0071	0.0049
	(0.0145)	(0.0058)	(0.0330)	(0.0028)
FMD	-0.0158	-0.0111	0.0996	-0.0009
	(0.0182)	(0.0070)	(0.0417)	(0.0033)
BSE	-0.0260**	0.0035	0.0199	0.0024
	(0.0101)	(0.0037)	(0.0229)	(0.0012)

Notes: The system weighted R^2 is equal to 0.846

Notes: Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table I-8. Marshallian Elasticities and Parameters Estimates of Coefficients of the Indicator Variables of the South Korean Meat Demand Model.

Explanatory	Pork				
Variables	U.S.	Denmark	Canada	Korea	ROW
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 beef	0.095	-0.129	-0.129*	-0.125**	-0.285**
	(0.136)	(0.126)	(0.063)	(0.020)	(0.067)
Price of poultry	0.056	-0.043	-0.134	0.057*	-0.274**
	(0.290)	(0.256)	(0.142)	(0.030)	(0.136)
Expenditure	0.768**	1.043**	0.854**	0.900**	0.999**
	(0.283)	(0.260)	(0.130)	(0.043)	(0.138)
Spring	0.0021	-0.0015	0.0008	-0.0558**	0.0014
	(0.0014)	(0.0016)	(0.0008)	(0.0108)	(0.0041)
Summer	0.0003	-0.0011	-0.0003	-0.0814**	0.0049
	(0.0014)	(0.0016)	(0.0008)	(0.0113)	(0.0041)
Winter	0.0027	-0.0009	0.0005	-0.0358**	0.0013
	(0.0014)	(0.0016)	(0.0008)	(0.0105)	(0.0041)
FMD	0.0016	0.0007	0.0003	0.0458**	-0.0021
	(0.0014)	(0.0015)	(0.0007)	(0.0131)	(0.0039)
BSE	0.0024**	0.0008	0.0008*	-0.0058	0.0021
	(0.0008)	(0.0009)	(0.0003)	(0.0074)	(0.0021)

Notes: The system weighted R^2 is equal to 0.8456

Notes: Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table I-8. Marshallian Elasticities and Parameters Estimates of Coefficients of the Indicator Variables of the South Korean Meat Demand Model.

Explanatory Variables	Poultry U.S.	Poultry Thailand	Poultry Korea	Poultry ROW
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**	0.000	0.000
	(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	-0.313**	-0.239**	-0.615**	-0.368
	(0.113)	(0.075)	(0.108)	(0.240)
Price of pork	-0.295	-0.273*	-0.240**	-0.574*
	(0.125)	(0.068)	(0.098)	(0.263)
Expenditure	1.378**	1.403**	1.438**	1.070**
	(0.235)	(0.228)	(0.190)	(0.485)
Spring	-0.0011	-0.0023	0.0374**	0.0007
	(0.0011)	(0.0013)	(0.0087)	(0.001)
Summer	-0.0005	-0.0025	0.0628**	0.0007
	(0.0011)	(0.0012)	(0.0088)	(0.001)
Winter	-0.0010	-0.0013	0.0157	0.0005
	(0.0011)	(0.0012)	(0.0085)	(0.001)
FMD	-0.0030*	-0.0024	-0.0279**	-0.0009
	(0.0012)	(0.0014)	(0.0106)	(0.001)
BSE	-0.0014	-0.0014	-0.0008	0.0018*
	(0.0007)	(0.0008)	(0.0064)	(0.001)

Notes: The system weighted R^2 is equal to 0.846

Notes: Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Essay III: Agricultural Trade among NAFTA Countries:

A Case Study of U.S. Meat Exports

Introduction

The North American Free Trade Agreement (NAFTA), which took effect on January 1, 1994 reduced trade barriers among member countries in the form of import quotas, tariffs, and import licensing and consequently integrated the North American livestock markets (Hahn et al.). Therefore, trade among NAFTA countries (Canada, Mexico, and the U.S.) has resulted in each country specializing in the production of and exporting the types of livestocks and products that it has comparative advantage in compared to other countries. For instance, since Mexico does not have a large feed grain base, the increase in demand for fed beef in this country has been satisfied by imports from its NAFTA partners (Leuck).

In general, the U.S. agricultural exports to Canada and Mexico have increased as result of NAFTA. More specifically, U.S. agricultural exports to Canada have almost doubled from \$5.5 billion in 1994 to \$10.6 billion in 2005 while agricultural exports to Mexico have more than doubled from \$4.6 billion in 1994 to \$9.4 billion in 2005 (USDA-FAS, 2006a). Importantly, the U.S. NAFTA trading partners form an important market for U.S. meat exports. During 2001 to 2005 period, Mexico and Canada accounted for 40% of U.S. total exports of beef, 35% U.S. total exports of pork, and 17% of U.S. total exports of poultry (USDA-FAS, 2006a).

Following NAFTA, the Canadian and Mexican meat markets have become more open to trade by the 1995 Uruguay Round Agreement on Agriculture (URAA) (Dyck and Nelson). Hence, the U.S. has found itself in a more competitive environment in these markets. Additionally, the outbreaks of animal disease and more specifically the 2003 outbreak of U.S. *Bovine Spongiform Encephalopathy* (BSE), has made U.S. meat exports subject to more volatility. Given the increased competitiveness and the restrictions imposed on U.S. meats by its traditional importers, understanding the importance of economic and non-economic factors is crucial in determining the changes in demand for U.S. meats. Published research on the analysis of the Canadian and Mexican meat demand is limited to aggregate meat demand without differentiating meats by supply source (Eales; Dong, Gould, and Kaiser; Golan, Perloff, and Shen; and Gould et al.). Furthermore, a review of literature shows that research on the analysis of demand for meats originating from the U.S. is lacking for U.S. NAFTA trading partners.

Therefore, the primary objective of this study is to analyze import demand for U.S. meats in Canada and Mexico. More specifically, this study estimates the impacts of economic variables (meat prices and expenditures) and non-economic variables (seasonality and BSE outbreak in North America) on the demand for U.S. meats and meats from other sources in Canada and Mexico. To accomplish these objectives, the Canadian and Mexican source differentiated meat demand systems are specified and estimated using data covering a more liberalized period when only import tariffs were in effect in U.S. meat export markets within NAFTA. The models differentiate meats by type and source of origin. The remainder of this study is organized as follows: In the next section the model of the Canadian and Mexican meat demand is presented. Then, data and procedures used to estimate meat demand systems are described. This is followed by a discussion of the empirical results. Summary and conclusions are given in the last part.

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. The AIDS model is an arbitrary first order approximation of any demand system; it satisfies the axioms of choice, it aggregates over consumers, and it has 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 or goods. 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, p. 399, for the block substitutability restriction). Hence, the prices of other goods from various origins are represented by an aggregate price for that good in the equation of a given source differentiated product. This assumption reduces the number of parameters that need to be estimated and therefore increases the degrees of freedom. Following Yang and Koo, in this study, a RSDAIDS model is used to estimate meat demand in Canada and Mexico. Note that meat demand for each country is estimated separately from the other country. The RSDAIDS is specified as the following:

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

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 good, 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 is calculated as the weighted average of source differentiated *j* prices as:

(1.3.2) $$\ln(p_j) = \sum_k w_{j_{k,t-1}} \ln(p_{j_k})$$

P^* in equation (1.3.1) is a price index which for source differentiated AIDS is defined as:

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

The RSDAIDS model in (1.3.1) above is nonlinear due to the nonlinear price index in (1.3.3). To make the system linear, Deaton and Muellbauer, 1980a suggest using Stone's price index, here specified as:

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

The budget shares (w_{i_h}) that are used as dependent variables in equation (1.3.1), are also used as independent variables in the aggregate price calculation (equation 1.3.4). Hence, to avoid simultaneity bias, following Eales and Unnevehr , this study uses lagged budget shares ($w_{i_{h,t-1}}$) to compute Stone's price index. Moreover; Moschini and also LaFrance recognize the lack of invariance of Stone's price index to units of measurement. Therefore, in order to overcome this problem, as proposed by Moschini and following Dameus et al., in this study 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.

Additionally, a seasonal indicator variable reflecting seasonal patterns in meat demand in Canada and Mexico and two indicator variables reflecting the Canadian and the U.S. BSE outbreaks are included in the demand models for each of the U.S. NAFTA trading partners. The indicator variables are incorporated as intercept shifters in the RSDAIDS model (Henneberry, Piewthongngam, and Qiang). Therefore, in this study, the intercept term in equation (1.3.1) is defined as:

(1.3.5) $$\alpha_{i_h} = \alpha^*_{i_h 0} + \sum_{g=1}^{G} \alpha_{i_{hg}} D_g$$

where D represents the three indicator variables (seasonality and the BSE outbreaks in the U.S. and Canada).

Following Yang and Koo, homogeneity, and symmetry are imposed as shown in equation (1.3.6) and (1.3.7) respectively.

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

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

Due to the inclusion of indicator variables in the RSDAIDS model in (1.3.1), the adding-up property of demand is imposed as:

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

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

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

(1.3.10) $$\varepsilon_{i_h i_k} = \frac{\gamma_{i_{hk}}}{w_{i_h}} - \beta_{i_h}(\frac{w_{i_k}}{w_{i_h}})$$

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

Equation (1.3.9) represents own-price elasticities, (1.3.10) represents cross-price elasticities between the same goods from different sources, (1.3.11) represents cross-price elasticities between different goods, that is between good *i* from source *h* and aggregate good *j*. Expenditure elasticity is specified as:

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

The ealsticities are calculated at mean level of expenditure shares. The statistical significance of elasticities are determined by the method offered by Mdafri and Brorsen.[1]

Data

Quarterly data from 1995(quarter I) to 2005(quarter IV) are used to estimate the parameters of the Canadian and Mexican source differentiated meat demand models. For this study, 1995 is chosen for the beginning of data because the Canadian and Mexican meat import markets were totally liberalized (elimination of the quota system) in 1995 and this was also the year that the URAA began to be implemented. The types of meats studied here are: beef, pork, and poultry; with each meat differentiated based on the origin of supply (source differentiated). In addition, this study assumes that meats (beef, pork, and poultry) are weakly separable from other foods and nonfood commodities.

A country is identified as a supply source of imports if imports from that source constitute at least 10% of the total Canadian and Mexican imports of the selected meat. All other sources that supplied less than 10% of Canadian and Mexican 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 Canada and Mexico are not available, unit-value import prices are used to measure market prices for imported meats.[2] Data on import value (in U.S. dollars) and quantity (in kilograms) are from various issues of USDA-ERS, 2002 and USDA-FAS, 2006b. Data on value of imported meats are converted to Canadian dollars and Mexican Pesos using published exchange rates. Exchange rate data are from USDA-ERS, 2006. Import prices (unit values) of individual source differentiated meats are calculated by dividing the total import value by the total import quantity.

Data on domestically produced meats are from various sources. For Canada, wholesale level data on quantity of meat demanded are from Agriculture and Agri-Food Canada. The Montreal wholesale price of beef carcass is used as a proxy of the price of Canadian beef. The weighted average of the Montreal wholesale prices of pork primals and subprimals are used as the price of Canadian pork. The Montreal wholesale price of broilers is used as the price of Canadian poultry. Price data on beef and pork from 1995 to 2000 are from Iowa State University. Price data on beef and pork from 2001 to 2005 and price data on broilers are from Agriculture and Agri-Food Canada. For Mexico, wholesale level data on quantity of meat demanded are from Sistema Integral de

Informacion Agroalimentar y Pesquera (SIAP). Data on wholesale prices of Mexican domestically produced meat are from USDA-FAS, 2006c.

Seasonal and BSE indicator variables are included in the RSDAIDS model of each country. Three seasonal quarterly variables are included for the first, third, and fourth quarters, with the first quarter beginning on January 1. Two BSE indicator variables, one accounting for BSE outbreak in Canada and another accounting for BSE outbreak in the U.S., are included in the model of each country. The Canadian BSE outbreak indicator variable takes the values of 1 for the second, and the third quarters of the year 2003 and zero otherwise. The BSE outbreak in Canada began in May 2003 and lasted through August 2003 when the ban of Canadian beef from cattle younger than 30 months of age was lifted in NAFTA countries (Hahn et al.). The U.S. BSE outbreak indicator variable takes the values of 1 for the fourth quarter of the year 2003 and the first quarter of the year 2004 and zero otherwise. BSE outbreak in the U.S. began in December 2003 and lasted through March 2004 when the ban of U.S. beef from cattle younger than 30 months of age was lifted in NAFTA countries (Hahn et al.).[3]

Estimation Procedures and Statistical Tests

The seemingly unrelated regression (SUR) estimation method is used to estimate the model represented by equation (1.3.1) 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 is dropped for estimation purposes. Poultry import demand from the U.S. and from the ROW are the selected equations to be dropped for the Canadian and Mexican meat demand systems, respectively. The parameter estimates for the dropped equations can be calculated using the adding-up restriction. However, in this study, 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). 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. Results of the system misspecification tests indicates that estimating Canadian meat demand model using the model represented by equation (1.3.1) is not appropriate mostly due to autocorrelation of the error terms.[4] However, misspecification test results indicates that model (1.3.1) is appropriate for the Mexican meat demand system. Kennedy 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 short run. Psychological habit factors, inventory adjustments, or institutional factors have been reported as reasons for lagged consumer response (Kesavan et al.; Henneberry and Hwang). To allow for lagged effects, the first-difference RSDAIDS model as suggested by Eales and Unnevehr is used here for the

Canadian meat demand system (model 1.3.13 below) while the Mexican meat demand is estimated using equation (1.3.1).

$$\Delta w_{i_h} = \sum_{k} \gamma_{i_{hk}} \Delta \ln(p_{i_k}) + \sum_{j \neq i} \gamma_{i_h j} \Delta \ln(p_j) + \beta_{i_h} \Delta \ln\left(\frac{E}{P^*}\right) \tag{1.3.13}$$

Results of the misspecification tests for the Canadian meat demand system for both models 1.3.1 and 1.3.13 are presented in table I-9 and for Mexican meat demand system are presented in table I-10.[5] Results of the misspecification tests for the Canadian meat demand system (model 1.3.13) show that we fail to reject the null hypothesis of normality of the error terms at the 1% significance level. Similarly, joint conditional mean and joint conditional variance tests result in the failure to reject the null hypotheses that the conditional mean and conditional variance are properly specified at the 1% significance levels.

The results of the misspecification tests for the Mexican meat demand system (equation 1.3.1) show that we fail to reject the null hypothesis of normality of the error terms at the 1% significance level; except for the equations of Mexican demand for Canadian beef and U.S. poultry. Joint conditional mean and joint conditional variance tests result in the failure to reject the null hypotheses that the conditional mean and conditional variance are properly specified at the 1% significance levels. Furthermore, various hypotheses regarding Canadian and Mexican consumers' behavior: product aggregation and block separability, and endogeneity of the real expenditure variable are tested in the RSDAIDS model of each country (equation 1.3.13 for Canada and equation 1.3.1 for Mexico).

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 and estimated using nonsource differentiated AIDS model (see Yang and Koo, p. 400, for the product aggregation restrictions). Test results for the Canadian and Mexican meat demand systems are presented in tables I-11 and I-12, respectively. The results indicate that for the Canadian and Mexican 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 Canadian and the Mexican demand for meats using a source differentiated model.

Additionally, this study tests block separability within the meat group. 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 if consumers' preferences within each block can be explained independent of quantities of meats in the other blocks. More specifically, for parsimonious estimation we want to know whether each block of meat (e.g. beef from different sources) could be studied separate from meats of other blocks (e.g., pork and poultry from different sources) and without incorporating their prices. This study uses quasi-separability of the cost function to test separability between blocks (for the quasi-separability of cost function test in AIDS model, see Deaton and Muellbauer, 1980b, p. 133; Hayes, Wahl, and Williams, p. 561; and Yang and Koo, p. 400). The null hypothesis for this test is that each block of meats is separable from all other meat blocks. Test results for the Canadian and Mexican meat demand systems are presented in table I-11 and I-12, respectively. For the two demand models, test results indicate the rejection of the null hypotheisis at the 1% significance level for both Canadian and Mexican meat demand systems. Therefore, test results support estimating the demands for meats including the three types of meats.

Endogeneity

Because expenditure variable E (in equations 1.3.1 for Mexico and 1.3.13 for Canada) 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). The instrumental variables used in this study are: sources differentiated meat prices included in each demand system, the first-difference of the natural logarithm of the Canadian gross domestic product for the Canadian meat demand system and natural logarithm of the Mexican gross domestic product for the Mexican meat demand system, and the lagged real expenditure variable. From the OLS regression described above, residuals are recovered. Then we estimated the Canadian and Mexican meat demand models (equation 1.3.13 and 1.3.1) with the residuals as an explanatory variable. Jointly, the significance of the coefficients of the residuals included in each model is then tested. The null hypothesis of this test is that the real expenditure variable in each meat demand model is exogenous. For the Canadian and

Mexican meat demand models, the results showed that the null hypothesis could not be rejected at the 1% significance level.

Results

Tables I-13 and I-14 present the calculated Marshallian demand elasticities along with the estimated coefficients for seasonal and BSE indicator variables for the Canadian and Mexican meat demand models.[6] Estimation results for the two meat demand systems are presented in the following sections.

Expenditure and Price Elasticities for Canadian Meat Demand Model

Table I-13 presents the calculated Marshallian demand elasticities and the estimated coefficients for seasonal and BSE indicator variables for Canadian meat demand model (equation 1.3.13). In the beef market, all expenditure elasticities are positive and the expenditure elasticities for beef from Canada (1.43) and the U.S. (1.00) are statistically significant. These results confirm the Canadian consumers' general preferences for grain-fed beef from the U.S. and Canada over any imported beef (grass-fed beef) from Australia and the ROW (mainly from New Zealand and South American countries) (Unterschultz, Quagrainie, and Vincent).

In the pork market, all expenditure elasticities are positive and the expenditure elasticity for pork from Canada and the U.S. are statistically significant. Similar to beef, these results are also consistent with the Canadian consumers' strong preferences for fresh pork from Canada and the U.S. compared to frozen pork from the ROW. Consistent with what is expected from economic theory, the results of the Canadian meat demand model show negative Marshallian own-price elasticities for individual meats. The magnitude of all estimated own-price elasticities fall in the range of the Canadian own-price elasticities for (beef, pork, and poultry) reported and estimated by Eales.

Marshallian cross-price elasticities indicate gross substitutability or complementarity relationships among products from different sources. While a significant positive Marshallian cross-price elasticity between meats from different suppliers may indicate substitutability, a significant negative cross-price elasticity may indicate complementarity. The cross-price elasticity between U.S. and Canadian beef are quarter than one and statistically significant. The strong substitution relationship between U.S. and Canadian beef is consistent with prior expectations since Canada and the U.S. both produce beef (grain-fed beef) of similar quality.

In the pork market, a clear relationship between meats from different sources is not evident because none of the cross-price elasticities are statistically significant. However, in the poultry market, a statistically significant and greater than one cross-price elasticity indicates strong substitutability between U.S. and Canadian poultry. This competitive relationship is consistent with prior expectations since both Canada and the U.S. produce poultry products of similar quality. Moreover, most of the cross-price elasticities between source differentiated meats and aggregate meat groups are not statistically significant (table I-13). The exceptions are a significant competitive relationship between Canadian poultry and aggregate beef, and a significant complementary relationship between U.S. pork and aggregate poultry. Applications of these results will be discussed in summary and conclusion section.

Effects of Seasonality and BSE on Canadian Meat Demand

The parameter estimates of seasonal and BSE indicator variables are also presented in table I-13. In general, except in the Canadian demand for the ROW beef, seasonality does not show as having any statistically significant impact on meat demand in Canada. Moreover, the U.S. and Canadian BSE outbreaks show as having only small impacts on Canadian meat demand, which are not statistically significant in most cases. The Canadian BSE outbreak shows as having decreased the share of Canadian beef in Canada. This result is consistent with previous expectations. The BSE outbreak is expected to decrease the demand for beef from the infected country and increase the demand for meats from other sources as well as beef from non-infected countries. Peng, McCann-Hiltz, and Goddard also found a significant negative impact of Canadian BSE outbreak on the demand for beef in Alberta (Canada).

Interestingly, the U.S. and Canadian BSE outbreaks show as having a negative impact on the shares of Australian beef in Canada. The lowered share of Australian beef may be explained by the fact that during the U.S. and Canadian BSE outbreaks, Australia decreased its beef shipments to Canada in order to allow for the increased exports to markets that had banned Canadian and U.S. beef, mainly Japan and South Korea.

Expenditure and Price Elasticities for Mexican Meat Demand

Table I-14 presents the full matrix of the calculated Marshallian demand elasticities with their respective standard errors and the estimated coefficients for seasonal and BSE indicator variables for the Mexican meat demand model (equation 1.3.1). The expenditure elasticities for meats from different sources are positive and all of them are statistically significant, except for Mexican demand for poultry from the ROW. These results confirm the Mexican consumers' preference for meats given an increase in the Mexican meat expenditures reported in past studies (Dong, Gould, and Kaiser; Golan, Perloff, Edward, and Shen). Hence, policies that aim to increase Mexican per capita incomes and consequently increase Mexican meat expenditures are expected to increase the demand for meats in Mexico. Although the magnitude of the source differentiated expenditure elasticities are similar, poultry is the most expenditure elastic meat. Beef and pork from the U.S. and Mexico carry the largest expenditure elasticity compared to the meats from other sources.

Consistent with economic theory, the own-price elasticities for meats from different sources are negative; except for the statistically insignificant own-price elasticity for pork from the ROW. Although it is difficult to compare the results of this study with others, since this study is the first on source differentiated Mexican meat demand, while other studies have analyzed meats on a more aggregate level (nonsource differentiated), the magnitude of own-price elasticities of Mexican produced meats (beef, pork, and poultry) estimated in this study are comparable to own-price elasticities for Mexican meats reported by Sullivan et al.

As mentioned earlier, the cross-price elasticities among meats from different sources may indicate substitutability and complementary relationships. For the Mexican beef market, the majority of cross-price elasticities are positive and statistically significant, indicating substitutability of meats from different sources; except for the lack of substitutability found between Mexican and Canadian beef, pork from the ROW (mainly Canada) and U.S. with pork from Mexico, and Mexican and U.S. poultry. This lack of competitiveness might be explained because of the quality differences and taste preferences for locally produced meats from Mexico compared to beef originating from Canada, pork from the U.S. and the ROW (mainly Canada), and poultry from the U.S.

More specifically, in the pork and poultry markets, the results show competitive relationship between U.S. pork and the ROW pork and between U.S. poultry and the ROW poultry. These results are consistent with previous expectation because U.S. and the ROW (mainly Canada) produce and export pork and poultry products of similar quality to Mexico. A lack of substitutability relationship exists between U.S. pork and Mexican pork, and between Mexican pork and pork from the ROW (mainly Canada). Difference in quality between pork products and cuts of pork from the U.S. and the ROW (mainly Canada) on one hand and Mexican pork on the other hand might explain the results. Furthermore, complementary relationship exists between U.S. poultry and Mexican poultry. Similar to pork, difference in quality between fresh Mexican poultry and frozen and chilled poultry products (mainly composed of turkey cuts, chicken legs, and edible poultry offals) exported from the U.S. to Mexico might explain the relationship. Regarding cross-commodities, the majority of cross-price elasticities are statistically significant. Applications of those results are discussed in summary and conclusion section.

Effects of Seasonality and BSE on Mexican Meat Demand

The parameter estimates for the impacts of seasonal and BSE outbreaks in Canada and the U.S. on the Mexican meat demand are presented in table I-14. The majority of estimated coefficients of seasonal indicator variables are not statistically significant, except in the equations of beef and pork from Mexico. The results show that the shares of Mexican beef are higher in the fourth quarter (October-December) and lower in the first quarter (January-March) compared to the second quarter (April-June). Traditional celebrations such as Christmas in December (fourth quarter) might be the main reason for the increased demand for beef in quarter IV compared to the second quarter.

The estimated parameters of the BSE indicator variable show that BSE outbreak in the U.S. decreased the shares of U.S. beef. The shares of U.S. beef decreased because the Mexican government restricted beef imports from the U.S. during the U.S. BSE outbreak. Results also show that the U.S. BSE outbreak increased the shares of Canadian beef, Mexican beef and U.S. pork. This result is also consistent with previous expectations since the decrease in Mexican consumption of U.S. beef during the U.S. BSE outbreak might have increased the consumption of other meat products such as Canadian beef, Mexican beef, and U.S. pork. Interestingly, the U.S. BSE outbreak decreased the shares of Mexican pork and poultry as well. The decrease in the shares of Mexican pork and poultry might not be due to the U.S. BSE outbreak *per se*, but it might be due to other factors, which are beyond the scope of this study. Pork and poultry related diseases such as classical swine fever, avian influenza, and exotic Newcastle are prevalent in some Mexican states (Hahn et al.). Hence, the decrease in the shares of Mexican pork and poultry might be due to animal (pork and poultry) disease outbreaks in Mexico.

Summary and Conclusions

This is the first study, which estimates the impacts of economic (meat prices and expenditures) and non-economic (seasonality and the U.S. and Canadian BSE outbreaks) variables on the demand for meats from different sources in U.S. NAFTA trading partners of Canada and Mexico. To assure that the specification and estimation procedures of the two meat demand systems are correct, various hypotheses regarding the Canadian and Mexican source differentiated meat demand models are tested. The hypotheses tested for each demand system includes: normality of the error terms, joint conditional mean, joint conditional variance, endogeneity of the real expenditure variable, separability among meats included in each meat demand model, and product aggregation. Results of statistical tests support estimating a set of meat demand equations for the three types of meats (beef, pork, and poultry), each meat being differentiated by supply source, and using RSDAIDS model (equation 1.3.1) for Mexican meat demand while using the first-difference version of the RSDAIDS model (equation 1.3.13) for Canadian meat demand.

The estimated parameters of seasonal and animal disease outbreaks as well as the calculated expenditure and price elasticities are used to access the competitiveness of meats from different sources in the Canadian and Mexican meat markets. In this study, a country, which supplies high quality and high price meat products to Canada and Mexico, is said to have a competitive advantage if the demand for that country's meat is expenditure elastic and price inelastic. Moreover, a country, which supplies low quality and low price meat products to Canada and Mexico, is considered to have a competitive advantage if the demand for country's meat is both expenditure and price elastic.

Regarding the Canadian meat demand model, the calculated expenditure and price elasticities indicate that Canadian beef has a competitive advantage compared to U.S. beef. This is judging by slightly lower own-price elasticity and higher expenditure elasticity of Canadian beef compared to U.S. beef. Unterschultz, Quagrainie, and Vincent also found that Quebec (Canada) consumers prefer high quality beef from Alberta (Canada) compared to U.S. beef. In the pork market, based on the lower (in absolute value) own-price elasticity and slightly higher and statistically significant expenditure elasticity of U.S. pork compared to Canadian pork, pork from the U.S. has a competitive advantage compared to pork from Canada. Seasonality and BSE outbreaks in the U.S. and Canada showed as having small impacts on Canadian meat market share. Nevertheless, Canadian BSE outbreak decreased the Canadian beef market share of Canadian beef in Canada, while it increased the shares of Canadian poultry.

Different suppliers of pork and poultry in Canada might be interested in knowing by how much they can increase their market share in the case of another Canadian BSE outbreak. Results indicate that competitive relationship between aggregate beef and Canadian poultry supports higher poultry consumption in Canada in the case of a BSE outbreak, and might imply benefits to the Canadian poultry producers in terms of increased sales.

Regarding the Mexican meat demand model, based on positive and statistically significant meat expenditure elasticities for source differentiated meats, an increase in the Mexican meat expenditures is expected to increase the demand for meats from different sources. According to Rabobank Group, the Mexican economy is projected to growth 3.3% in 2007. Therefore, Mexican meat expenditures are expected to growth, which will translate into continued strong demand for meats including U.S. produced meats. In the beef market, the results show that Mexican beef has a slight competitive advantage compared to U.S. and Canadian beef. This conclusion is based on the higher expenditure elasticity and lower (in absolute value) own-price elasticity of Mexican beef compared to beef from the U.S. and Canada. Mexican beef has a competitive advantage compared to beef from the U.S. and Canada because the majority of Mexican consumers prefer lean beef from traditionally pasture fatted animals compared to marbled beef from grain fatted animals (Rabbobank Group). However, with growing preference for marbled beef and U.S.-type cuts such as rib eye, especially among more affluent consumers is expected to increase U.S. beef exports in the future.

In the pork and poultry markets, the U.S. is said to have a competitive advantage compared to other pork and poultry products from other supply sources. This is judging by the lower (in absolute value) own-price elasticities and higher and statistically significant expenditure elasticities for pork and poultry from the U.S. compared to other pork and poultry products from other supply sources. Specially, the U.S. is expected to increase poultry exports to Mexico in near future because poultry is the major factor of increase in Mexican per capita meat consumption and by 2008, NAFTA will remove all Mexican poultry import tariffs for poultry from NAFTA partners. Seasonality and BSE outbreaks in the U.S. and Canada showed as having only small and mostly non-statistically significant impacts on Mexican meat demand. However, the U.S. BSE outbreak decreased the shares of U.S. beef and increased the shares of Canadian and Mexican beef and the shares of U.S. pork.

Hahn et al. report that pork and poultry diseases such as classical swine fever, avian influenza, and exotic Newcastle are frequent in some Mexican States. Given that pork and poultry diseases are frequent in Mexico, suppliers of various meats in Mexico might be interested in knowing the implications of outbreaks of those diseases on the demand for their meats. Competition relationship of aggregate pork with Canadian and Mexican beef may indicate that Canadian and Mexican produced beef might benefit from a pork disease (e.g. foot-and-mouth disease and classical swine fever) outbreak in Mexico. Similarly, an outbreak of Avian Influenza (AI) and Exotic Newcastle (EN) is expected to increase the shares of beef from the U.S. and the ROW (mainly Canada); based on the competitive relationships among these meats.

Footnotes

1. The equations of own-price, cross-price and expenditure elasticities, equations (1.3.9)-(1.3.12), can be written in matrix form as:

(1.3.14) $$e = Ab$$

where e is the vector of estimated elasticities (ε's, η's), b is the vector of estimated RSDAIDS model parameters (γ's, β's), and A is a matrix of constants (budget shares), The standard errors are calculated by taking the square root of the variance covariance matrix of e, VAR(e), (equation 1.3.15)

(1.3.15) $$\text{VAR}(e) = A\text{VAR}(b)A'$$

where VAR(b) is the variance covariance matrix of b.

2. Although unit values usually reflect perceived quality differences of imported meats, they may differ from wholesale prices as a result of trade restrictions.

3. Animal disease dummy variables account for the period of time when trade of fresh meat products was banned due to animal disease outbreaks.

4. Results of misspecification test for the RSDAIDS (equation 1.3.1) showed that the null hypothesis of no autocorrelation for the Canadian meat demand is rejected at the 1% significance level.

5. With regard to the Canadian meat demand model, all the results discussed in this study refer to the first-difference RSDAIDS model (equation 1.3.13).

6. Because meats account for a small fraction of Canadian and Mexican consumers' disposable income, which will lead to the Marshallian and Hicksian elasticities to be nearly identical; in order to save space, Hicksian elasticities are not presented.

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Table I-9. Misspecification Test Results for the Canadian Meat Demand Model.

Hypotheses Tested	RSDAIDS	First-Difference RSDAIDS
	P-value	P-value
Normality		
Beef from the U.S.	0.508	0.826
Beef from Australia	0.511	0.055
Beef from Canada	0.822	0.067
Beef from the ROW	0.205	0.512
Pork from the U.S.	0.586	0.465
Pork from Canada	0.714	0.773
Pork from the ROW	0.468	0.199
Poultry from the U.S.	0.020	0.936
Poultry from Canada	0.002	0.211
Joint Conditional Mean		
Linear functional form	0.016	0.512
No autocorrelation	0.000	0.010
Parameter stability	0.943	0.913
Overall test	0.000	0.012
Joint Conditional Variance		
Static homoskedasticity	0.001	0.1942
Dynamic homoskedasticity	0.001	0.0261
Variance stability	0.002	0.1381
Over all test	0.000	0.0504

Table I-10. Misspecification Test Results for the Mexican RSDAIDS Meat Demand Model

Hypotheses Tested	RSDAIDS
	P-value
Normality	
Beef from the U.S.	0.049
Beef from Canada	0.000
Beef from Mexico	0.899
Beef from the ROW	0.934
Pork from the U.S.	0.889
Pork from Mexico	0.775
Pork from the ROW	0.531
Poultry from the U.S.	0.006
Poultry from Mexico	0.125
Poultry from the ROW	0.676
Joint Conditional Mean	
Linear functional form	0.038
No autocorrelation	0.139
Parameter stability	0.010
Overall test	0.011
Joint Conditional Variance	
Static homoskedasticity	0.047
Dynamic homoskedasticity	0.072
Variance stability	0.036
Over all test	0.018

Table I-11. Block Separability and Product Aggregation Test Results for the Canadian Meat Demand Model.

Block Separability Test

Ho: Beef is separable from all other meats
F=0.48
df: 8 for numerator and 241 for denominator
Ho: Pork is separable from all other meats
F=3.24**
df: 6 for numerator and 241 for denominator

Ho: Poultry is separable from all other meats
F=2.55**
df: 4 for numerator and 241 for denominator

Ho: All of above
F=1.86**
df:18 for numerator and 241 for denominator

Product Aggregation Test

Ho: Beef can be aggregated
F=458.25**
df: 18 for numerator and 241 for denominator

Ho: Pork can be aggregated
F=1068.18**
df: 10 for numerator and 241 for denominator

Ho: Poultry can be aggregated
F=1231.21**
df: 4 for numerator and 241 for denominator

Ho: All of above
F=1328.74**
df: 32 for numerator and 241 for denominator

Note: (*) and (**) denote significance at 5% and 1%, respectively

Table I-12. Block Separability and Product Aggregation Test Results for the Mexican Meat Demand Model.

Block Separability Test

Ho: Beef is separable from all other meats
F=13.66**
df: 8 for numerator and 306 for denominator
Ho: Pork is separable from all other meats
F=40.94**
df: 6 for numerator and 306 for denominator

Ho: Poultry is separable from all other meats
F=14.04**
df: 6 for numerator and 306 for denominator

Ho: All of above
F=21.97**
df: 20 for numerator and 306 for denominator

Product Aggregation Test

Ho: Beef can be aggregated
F=296.53**
df: 18 for numerator and 306 for denominator

Ho: Pork can be aggregated
F=195.08**
df: 10 for numerator and 306 for denominator

Ho: Poultry can be aggregated
F=161.06**
df: 10 for numerator and 306 for denominator

Ho: All of above
F=234.18**
df: 38 for numerator and 306 for denominator

Note: (*) and (**) denote significance at 5% and 1%, respectively

Table I-13. Marshallian Elasticities and Parameter Estimates of Coefficients of Indicator Variables of the Canadian Meat Demand Model.

Explanatory	Beef			
Variables	U.S.	Australia	Canada	ROW
Price of beef from the U.S.	-1.649**	-0.159	0.152**	1.067**
	(0.462)	(0.804)	(0.060)	(0.589)
Price of beef from Australia	-0.038	-1.334**	0.006	-0.481
	(0.271)	(0.752)	(0.036)	(0.496)
Price of beef from Canada	1.599**	-0.108	-1.622**	0.235
	(0.637)	(1.390)	(0.231)	(1.021)
Price of beef from ROW	0.513**	-0.743	-0.008	-0.908
	(0.291)	(0.728)	(0.034)	(0.736)
Price of pork	-0.274	-0.808	0.260	-1.246
	(0.669)	(1.230)	(0.204)	(0.845)
Price of poultry	-1.153	0.927	-0.208	0.984
	(0.845)	(1.566)	(0.250)	(1.211)
Expenditure	1.003**	2.226	1.430**	0.350
	(0.511)	(1.612)	(0.279)	(0.998)
Quarter I	0.004	-0.003	-0.030	0.012**
	(0.005)	(0.003)	(0.016)	(0.003)
Quarter III	-0.005	0.001	-0.002	-0.010**
	(0.005)	(0.003)	(0.016)	(0.003)
Quarter IV	0.004	0.003	-0.017	-0.008
	(0.005)	(0.003)	(0.017)	(0.003)
BSE in Canada	0.013	-0.022**	-0.099**	9.064E-05
	(0.010)	(0.005)	(0.026)	(0.005)
BSE in the U.S.	-1.423E-02	-0.012*	0.032	-0.003
	(0.010)	(0.005)	(0.026)	(0.005)

Notes: The system weighted R^2 is equal to 0.59

Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level respectively.

Table I-13. Marshallian Elasticities and Parameter Estimates of Coefficients of Indicator Variables of the Canadian Meat Demand Model.

Explanatory	Pork			Poultry	
Variables	U.S.	Canada	ROW	U.S.	Canada
Price of pork from the U.S.	-0.404**	-0.004	-0.297		
	(0.167)	(1.597)	(0.374)		
Price of pork Canada	-0.142	-1.088**	-0.116		
	(0.167)	(0.153)	(1.207)		
Price of pork from the ROW	-0.035	-0.001	-1.283**		
	(0.042)	(0.008)	(0.253)		
Price of poultry from the U.S.				-1.135**	0.098
				(0.285)	(0.087)
Price of poultry from Canada				1.268**	-0.642**
				(0.734)	(0.289)
Price of beef	-0.278	-0.089	-0.505	0.790	0.424**
	(0.244)	(0.283)	(2.554)	(0.679)	(0.115)
Price of pork				-0.585	0.001
				(0.684)	(0.462)
Price of poultry	-0.526*	0.047	1.059		
	(0.306)	(0.244)	(1.764)		
Expenditure	1.383**	1.134**	1.141	-0.338	0.119
	(0.394)	(0.304)	(2.369)	(0.704)	(0.479)
Quarter I	-9.239E-04	0.019	0.003	-0.001	0.016
	(0.001)	(0.016)	(0.001)	(0.002)	(0.014)
Quarter III	-0.001	0.002	5.023E-04	0.005	0.009
	(0.001)	(0.016)	(0.001)	(0.002)	(0.013)
Quarter IV	-3.360E-04	0.013	0.003	0.005	0.022
	(0.001)	(0.019)	(0.001)	(0.003)	(0.015)
BSE in Canada	-0.001	0.021	0.002	0.007	0.069**
	(0.002)	(0.027)	(0.001)	(0.005)	(0.023)
BSE in the U.S.	0.003	-0.010	-2.214E-04	1.774E-04	-0.002
	(0.002)	(0.029)	(0.002)	(0.005)	(0.023)

Notes: The system weighted R^2 is equal to 0.59

Numbers in parenthesis are asymptotic standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level respectively.

Table I-14. Marshallian Elasticities and Parameter Estimates of Coefficients of Indicator Variables of the Mexican Meat Demand Model.

Explanatory Variables	Beef			
	U.S.	Canada	Mexico	ROW
Price of beef from the U.S.	-2.026**	0.604	0.045**	1.763**
	(0.238)	(0.576)	(0.028)	(0.576)
Price of beef from Canada	0.096	-0.171	-0.059**	0.706**
	(0.092)	(0.353)	(0.011)	(0.254)
Price of beef from Mexico	0.343*	-2.507**	-1.170**	-0.003
	(0.197)	(0.477)	(0.031)	(0.569)
Price of beef from the ROW	0.067**	0.167**	-0.001	-0.754**
	(0.022)	(0.060)	(0.003)	(0.115)
Price of pork	-0.854**	0.815**	0.276**	-3.399**
	(0.130)	(0.440)	(0.017)	(0.311)
Price of poultry	1.429**	0.254	-0.125**	0.857**
	(0.155)	(0.502)	(0.024)	(0.500)
Expenditure	0.947**	0.838**	1.034**	0.812**
	(0.056)	(0.198)	(0.008)	(0.130)
Quarter I	0.006	0.004	-0.016**	-5.721E-06
	(0.004)	(0.002)	(0.004)	(0.0004)
Quarter III	0.003	8.847E-04	-7.120E-05	-2.035E-04
	(0.004)	(0.002)	(0.004)	(0.0003)
Quarter IV	0.012	-1.357E-04	0.011**	-0.001
	(0.004)	(0.002)	(0.004)	(0.0004)
BSE in Canada	-0.004	-4.748E-04	0.014	-1.194E-03
	(0.010)	(0.006)	(0.009)	(0.0008)
BSE in the U.S.	-0.015*	0.018**	0.031**	-3.547E-04
	(0.007)	(0.004)	(0.007)	(0.0006)

Notes: The system weighted R^2 is equal to 0.753

Numbers in parenthesis are standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table I-14. Marshallian Elasticities and Parameter Estimates of Coefficients of Indicator Variables of the Mexican Meat Demand Model.

Explanatory Variables	Pork U.S.	Pork Mexico	Pork ROW
Price of pork from the U.S.	-0.053	0.024	1.426**
	(0.189)	(0.023)	(0.395)
Price of pork from Mexico	-1.221**	-0.838**	-3.631**
	(0.238)	(0.037)	(0.519)
Price of pork from the ROW	0.222	-0.055**	0.437
	(0.189)	(0.008)	(0.284)
Price of beef	-0.260	0.552**	1.402**
	(0.224)	(0.028)	(0.452)
Price of poultry	-1.237**	-0.653**	-0.392
	(0.248)	(0.029)	(0.477)
Expenditure	1.110**	0.970**	0.758**
	(0.070)	(0.008)	(0.143)
Quarter I	0.002	0.003	4.984E-04
	(0.002)	(0.003)	(0.001)
Quarter III	-0.001	-0.003	2.269E-04
	(0.002)	(0.003)	(0.001)
Quarter IV	4.997E-04	-0.019**	-0.001
	(0.002)	(0.003)	(0.001)
BSE in Canada	0.005	-0.019**	0.001
	(0.005)	(0.006)	(0.001)
BSE in the U.S.	0.015**	-0.043**	0.001
	(0.003)	(0.004)	(0.001)

Notes: The system weighted R^2 is equal to 0.753
Numbers in parenthesis are standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table I-14. Marshallian Elasticities and Parameter Estimates of Coefficients of Indicator Variables of the Mexican Meat Demand Model.

Explanatory Variables	Poultry U.S.	Poultry Mexico	Poultry ROW
Price of poultry from the U.S.	-0.165*	-0.033**	4.397**
	(0.088)	(0.008)	(0.573)
Price of poultry from Mexico	-0.384**	-0.831**	0.916
	(0.147)	(0.021)	(0.971)
Price of poultry from the ROW	0.222	0.158**	-1.119
	(0.194)	(0.036)	(1.264)
Price of beef	-0.856**	0.137**	0.053
	(0.260)	(0.044)	(1.590)
Price of pork	0.020	-0.585**	-5.237**
	(0.147)	(0.023)	(0.906)
Expenditure	1.163**	1.154**	0.989
	(0.191)	(0.035)	(1.233)
Quarter I	-0.001	0.009	-1.60E-04
	(0.001)	(0.003)	(0.0003)
Quarter III	-0.002	-0.005	2.38E-04
	(0.001)	(0.003)	(0.0003)
Quarter IV	0.001	-0.028	6.30E-05
	(0.001)	(0.003)	(0.0004)
BSE in Canada	0.002	0.002	-0.001659062
	(0.003)	(0.006)	(0.0008)
BSE in the U.S.	-2.066E-03	-0.022**	-9.30E-05
	(0.002)	(0.005)	(0.0006)

Notes: The system weighted R^2 is equal to 0.753
Numbers in parenthesis are standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

CHAPTER II

Reworking of the U.S. Meat Demand:

A Source Differentiated Analysis

Introduction

The U.S. is one of the major importers in the global meat markets. In 2002, the U.S. was the largest importer of beef accounting for 29.3 percent of the world volume of beef imports; while it was the third largest importer of pork, accounting for 12.7 percent of the world volume of pork imports (USDA-FAS, 2005). Moreover, supply and demand forces have made the meat market highly segmented. For example, the U.S. mainly exports fed beef and imports nonfed beef. In the pork market, the U.S. imports are mostly pork spare ribs, which are preferred by the U.S. consumers (Leuck, 2001; USDA-ERS, 2006c).

U.S. meat imports are expected to grow even further in the future with the increase in market-access resulting from bilateral and multilateral trade agreements. The increase in meat imports by the U.S. is expected to bring about an increase in competition between U.S. produced meats and U.S. imported meats from other countries. Source of origin is considered to be an intrinsic attribute that is expected to affect consumers' purchasing decisions, especially when more product specific information is not readily available (Kim and Boyd). Therefore, recognizing source of origin is important when analyzing the demand for meats in the U.S.

Despite the importance of the topic, most of the studies addressing the competitiveness of U.S. produced meats have focused on the U.S. export markets (mostly on Japan) and not on the U.S. as a meat importer. Moreover, most of the previous studies on U.S. meat demand have focused on aggregate (nonsource differentiated) consumer demand. While some have estimated the demand relationships between various beef cuts, such as table cuts and ground beef (Brester and Wohlgenant; Eales and Unnevehr) or for the United States Department of Agriculture (USDA) graded beef (Lusk et al.), none have differentiated meats by their source of origin. Studies that have estimated source differentiated meat demand in the U.S. are limited to two studies on lamb and mutton (Jones, Hahn, and Davis; Muhammad, Jones, and Hahn). Furthermore, studies on the U.S. domestic impacts of the 2003 Canadian and U.S. outbreaks of *Bovine Spongiform Encephalopathy* (BSE) on the U.S. consumers' preferences for meats from various sources are limited.

Hence, the primary objective of this study is to estimate the U.S. demand for source differentiated meats, including meats that are produced in the U.S. and those that are imported. More specifically, the objective of this study is to analyze the impacts of economic factors (meat prices and expenditures) and non-economic factors (BSE and seasonality) on the U.S. demand for source differentiated meats. Source differentiated meat categories studied here include: U.S. fed beef, U.S. nonfed beef, U.S. pork, U.S. poultry, Australian beef, New Zealand beef, Canadian beef, beef from the rest-of-the world (ROW),[1] Canadian pork, and pork from the ROW.

This study is intended to give a better understanding of U.S. consumer preferences for meats from various sources, including U.S. produced meats, taking into account the 2003 BSE outbreaks in the U.S. and Canada as well as seasonality effects. Results of this study are expected to help the U.S. policy makers, producers, and marketers in developing effective programs targeted towards expanding sales and market shares for U.S. produced meats. More specifically; the U.S. source differentiated meat demand elasticities produced in this study can be used in the analysis of the impacts of various policies and marketing strategies, such as the much debated country-of-origin labeling mandate, or to measure the market impacts of animal and poultry diseases and the resulting policy and regulation changes.

A historical overview of the U.S. meat trade policies is discussed in the first section of this article. Next, a model of the U.S. meat demand is presented followed by a discussion of the results and the summary and conclusions.

An Overview of U.S. Meat Trade Policies

The U.S. government restricted the importation of meats through a quota system under the 1979 Meat Import Law (MIL). The law required the U.S. president to impose quotas on imports of beef, veal, mutton, and goat meat when the aggregate annual quantity supplied of such meats had exceeded a prescribed trigger level (USDHS-CBP). The quota restriction under MIL was allocated to various supplying countries on the basis of their historic shares in the U.S. domestic market. However, the U.S. meat import quotas established under MIL were eliminated subsequent to the bilateral and multilateral trade agreements between the U.S. and other countries, including the Canada-U.S. Free

Trade Agreement (CFTA), the North American Free Trade Agreement (NAFTA), and the Uruguay Round Agreement on Agriculture (URAA). A summary of the U.S. meat trade liberalization is presented in Table II-1.

The U.S. import tariffs for beef, pork, and poultry from Canada and Mexico were totally eliminated in 1993 by CFTA and in 1994 by NAFTA, respectively. Under the URAA, the U.S. replaced the import quota system established under MIL by tariff-rate quotas (TRQs) for U.S. beef imports from non-NAFTA countries (Table II-1). Moreover, special safeguard provisions, which aim to limit import surges by allowing the U.S. to raise tariffs if the volume of imports exceeds a certain amount or if the import prices fall by a certain percentage of a base price, are in effect for U.S. beef imports (Obara, Dyck, and Stout).

Although there has been significant progress towards liberalization of the U.S. meat import market, sanitary and phytosanitary (SPS) measures are currently prevalent and constitute a major form of restricting meat imports. The U.S. banned beef imports from Canada in May 2003 when BSE was detected there. The U.S. lifted the ban of Canadian boneless beef from cattle less than 30 months of age in August 2003 as cattle of this age are considered as having little risk of BSE (Hahn et al.). Furthermore, fresh meats originating from certain countries such as Mexico and South American countries have not been allowed to enter the U.S. due to the prevalence of Classical Swine Fever, Exotic Newcastle (END), Avian Influenza (AI), and foot-and-mouth disease (FMD) in those countries (Hahn et al.; Leuck).

A Model of the U.S. Source Differentiated Meat Demand

The almost ideal demand system (AIDS) is used in this study because of its many desirable properties. The AIDS model is an arbitrary first order approximation of any demand system; it satisfies the axioms of choice, it aggregates over consumers, and it has a functional form consistent with household budget data (Deaton and Muellbauer, 1980a). However, empirical use of the AIDS model in demand estimation typically assumes product aggregation under which the demand system does not differentiate goods by supply source.

In this study, to allow for source differentiation, a version of the AIDS model known as the Restricted Source Differentiated AIDS (RSDAIDS) is used to estimate source differentiated meat demand for the U.S. domestic market. 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 RSDAIDS model is that it does not suffer from the aggregation bias over supply sources or goods. 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, p. 399, for the block substitutability restriction). Hence, the prices of other goods from various origins are represented by an aggregate price for that good in the equation of a given source differentiated product. For example; in estimating the U.S. demand for Canadian pork, the prices of beef originating from different sources are represented by one aggregate price of beef. This assumption reduces the number of parameters that need to be estimated and therefore increases the degrees of freedom.

Following Yang and Koo, the RSDAIDS is specified as the following:

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

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 good, 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 meat *i* from source *h* and nonsource differentiated or aggregated 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 is calculated as the weighted average of source differentiated *j* prices as:

(2.2) $$\ln(p_j) = \sum\nolimits_k w_{j_{k,t-1}} \ln(p_{j_k})$$

*P** in equation (1) is a price index defined as:

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

The RSDAIDS model in (2.1) above is nonlinear due to the nonlinear price index in (2.3). To make the system linear, Deaton and Muellbauer, 1980a suggest using Stone's price index, here specified as:

(2.4) $$\ln P^* = \sum\nolimits_i \sum\nolimits_h w_{i_h} \ln(P_{i_h})$$

It is important to note that budget shares (w_{i_h}) that are used as dependent variables in equation (2.1), are also used as independent variables in the aggregate price calculation (equation 2.4). Therefore, to avoid simultaneity bias following Eales and Unnevehr, this study uses lagged budget shares ($w_{i_{h,t-1}}$) in the computation of Stone's price index. Moreover, Moschini and LaFrance recognize the lack of invariance of Stone's price index to units of measurement. Hence, as proposed by Moschini and following Dameus et al., this study uses scaled meat prices to compute the Stone's price index in equation 2.4. Scaled meat prices are source differentiated meat prices divided by their respective means.

Additionally, a seasonal indicator reflecting seasonal patterns in meat demand in the U.S. and two indicator variables reflecting BSE outbreaks in the U.S. and in Canada are included. The indicator variables are incorporated as intercept shifters in the RSDAIDS model (Henneberry, Piewthongngam, and Qiang). Therefore, in this study, the intercept term in equation (2.1) is defined as:

$$(2.5) \qquad \alpha_{i_h} = \alpha^*_{i_{h0}} + \sum_{g=1}^{G} \alpha_{i_{hg}} D_g$$

where D represents the three indicator variables (seasonality and the BSE outbreaks in the U.S. and Canada).

Following Yang and Koo, homogeneity, and symmetry are imposed as shown in equation (2.6) and (2.7) respectively.

$$(2.6) \qquad \sum_k \gamma_{i_{hk}} + \sum_{j \neq i} \gamma_{i_h j} = 0$$

$$(2.7) \qquad \gamma_{i_{hk}} = \gamma_{i_{kh}}$$

Due to the inclusion of indicator variables in the RSDAIDS model in (2.1), the adding-up property of demand is imposed as:

$$(2.8) \qquad \sum_i \sum_h \alpha_{i_{h0}} = 1; \;\; \sum_i \sum_h \alpha_{i_{hg}} = 0; \; \sum_h \gamma_{i_{hk}} = 0; \; \sum_i \sum_h \gamma_{i_h j} = 0; \; \sum_i \sum_h \beta_{i_h} = 0;$$

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

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

(2.10) $$\varepsilon_{i_h i_k} = \frac{\gamma_{i_{hk}}}{w_{i_h}} - \beta_{i_h} (\frac{w_{i_k}}{w_{i_h}})$$

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

Equation (2.9) represents own-price elasticities, (2.10) represents cross-price elasticities between the same goods from different sources, and (2.11) represents cross-price elasticities between different goods, i.e. between good *i* from source *h* and aggregate good *j*. Expenditure elasticity is specified as:

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

Data

Quarterly data from 1995 (quarter I) to 2005 (quarter IV) are used to estimate the parameters of the U.S. source differentiated meat demand. For this study, 1995 is chosen for the beginning of data because the U.S. meat import market was totally liberalized with the elimination of the quota system in 1995. This is also the year that the URAA began to be implemented. The meats studied here are beef, pork, and poultry. Beef from the U.S. is differentiated by quality (fed and nonfed) and beef and pork are differentiated based on the origin of supply (source differentiated). A country is identified as a supply source if imports from that source constituted at least 10 percent of the total imports of the selected meat. All other sources that supplied less than 10 percent of the U.S. total imports of the selected meat are aggregated as the ROW. Using this criterion, U.S. meat imports are categorized as: beef from Australia, beef from Canada, beef from New Zealand, beef from the ROW, pork from Canada, and pork from the ROW. Poultry is not differentiated by supply source, since more than 95% of U.S. poultry consumption is supplied by U.S. producers. The studied meats (beef, pork, and poultry) are assumed to be weakly separable from other food and nonfood commodities.

Because retail prices for source differentiated meats in the U.S. are not available, unit-value import prices are used to measure market prices for imported meats.[2] Source differentiated import prices (unit values) of individual meats are calculated by dividing the total import values by the total import quantities. Data on import values (in thousand of U.S. dollars) and quantities (in metric tons) are from USDA-FAS, 2006. Data on U.S. domestic meats at the wholesale level are from various sources. For U.S. produced beef and pork, quantity and price data are from USDA-ERS, 2006a and for poultry from USDA-ERS, 2006b. The quantity of fed beef is calculated as the sum of the quantities demanded of beef from steers and heifers. The quantity demanded of nonfed beef is calculated as the sum of the quantity demanded of beef from cows and bulls. Slaughter steer price of choice 2-4 Nebraska Direct is used as the price of fed beef. Slaughter cutter cow price is used for the price of nonfed beef.

Seasonal and BSE indicator variables are included in the RSDAIDS model to measure the impact of seasonality and BSE disease outbreaks on U.S. meat demand. Three seasonal quarterly variables are included for the first (January through March), third (April through June), and fourth (October through December) quarters. Two BSE indicator variables, one accounting for BSE outbreak in Canada and another accounting for BSE outbreak in the U.S., are included in the model. The Canadian BSE outbreak indicator variable takes the values of 1 for the second and the third quarters of the year 2003 and zero otherwise because the U.S. import ban on Canadian beef began in May 2003 and lasted through August 2003 when the ban of Canadian beef from cattle younger than 30 months was lifted (Hahn et al.). The U.S. BSE outbreak indicator variable takes the values of 1 for the fourth quarter of the year 2003 and the first quarter of the year 2004 and zero otherwise because the ban on U.S. beef from major U.S. meat importers including Canada, Japan, Mexico, and S. Korea began in December 2003 and lasted through March 2004 when NAFTA countries lifted the ban of U.S. beef from cattle younger than 30 months of age (Hahn et al.).

Estimation Procedures and Statistical Tests

The Seemingly Unrelated Regression (SUR) estimation method is used to estimate the parameters of model (2.1); with block substitutability, symmetry, and homogeneity imposed. Due to the adding-up condition, the contemporaneous covariance matrix is singular. Therefore, the last equation (poultry from the U.S. equation) in the U.S. meat demand system is dropped from the system for estimation purposes. The parameter estimates for the dropped equation can be calculated using the adding-up restriction. However, in this study, another equation is dropped and the system is re-estimated in order to determine the parameters and the standard errors of the last equation (Henneberry, Piewthongngam, and Qiang). Since the intercept shifters are all dummy variables, the estimated parameters are similar and produce similar elasticities regardless of which equation is dropped. Here the statistical significance of elasticities is determined by the method offered by Mdafri and Brorsen.[3]

System Misspecification Tests

The assumption of normality of the error terms, no autocorrelation, parameter stability, static and dynamic homoskedasticity, and the appropriateness of the functional form are tested using the system misspecification tests as suggested by McGuirk et al. Results of the system misspecification tests for the RSDAIDS model (equation 1) indicate the rejection of the null hypothesis of no autocorrelation at the 1 percent significance level (table II-2). The misspecification of the model's dynamics has been given as one of the sources of autocorrelation (Kennedy).

Dynamics are expected to be particularly important in the analysis of the U.S. meat demand system as meat buyers are unlikely to respond fully to changes in price, income, or other determinants of demand in the short run. Psychological factors (consumption habits), inventory adjustments, or institutional factors have been given as reasons for the lagged consumer response (Kesavan et al.; Henneberry and Hwang). To allow for lagged effects, the first-difference RSDAIDS model as suggested by Eales and Unnevehr is used here. Therefore, the first-difference of data on continuous variables is used here to estimate the U.S. meat demand system (model 2.13 below).

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

Results of misspecification tests for the U.S. meat demand system for both models 2.1 and 2.13 are presented in table II-2. For model (2.13), the test results show that the assumption of normality fails to be rejected at the 1 percent significance level.[4] Similarly, joint conditional mean and joint conditional variance tests result in the failure to reject the null hypotheses that the conditional mean and conditional variance are properly specified at the 1 percent significance level.

Endogeneity

Because the expenditure variable (E in equation 2.13) is used to compute budget shares (w_{i_h}), which are the dependent variables, the expenditure variable might not be truly exogenous. Correlation between the expenditure variable and the error terms that result from expenditure endogeneity might lead to estimates that are biased and inconsistent. Therefore, the endogeneity of the real expenditure variable is tested using the Wu-Hausman endogeneity test, which checks for contemporaneous correlation between regressors and disturbances (Blundell). To test for endogeneity, the equation for $\ln(E/P^*)$ in the first-difference RSDAIDS model is approximated as:

(2.14) $$\Delta \ln(\frac{E}{P^*}) = \alpha_{i_h} + \sum_i \sum_h P_{i_h} \Delta \ln P_{j_{kt}} + \theta_{i_h} \Delta \ln(\frac{E}{P^*})_{t-1} + \rho_{i_h} \Delta \ln(Y_t) + \varepsilon_{i_{ht}}$$

where t = time, Y is total income (GDP is used in this study), E is total meat expenditures, $P_{j_{kt}}$ is the price of meat *j* from source *k*, P* is the Stone's price index, and ε is the error term. The residuals from the single equation OLS model (equation 2.14) are recovered and included as explanatory variables in each equation of the first-difference RSDAIDS (model 2.13). Jointly, the significance of the coefficients of residuals included in the first-difference RSDAIDS model are tested. Here, the null hypothesis is that the real expenditure variable in the first-difference RSDAIDS model (2.13) is exogenous.

Test results show that the exogeneity of the total expenditure variable fails to be rejected at the 1 percent significance level.

Separability

This study tests block separability within the meat group. The three different blocks are beef, pork, and poultry with each group composed of meats from different sources. The block separability test is used to test if consumers' preferences within each block can be described independently of quantities of meats in the other blocks. More specifically, for parsimonious estimation we are interested to know whether each block of meat (e.g. beef from different sources) could be studied separate from meats of other blocks (e.g., pork and poultry from different sources) and without incorporating their prices. This study uses quasi-separability of the cost function to test separability between blocks (for the quasi-separability of cost function test, see Deaton and Muellbauer, 1980b, p. 133; Hayes, Wahl, and Williams, p. 561; and Yang and Koo, p. 400). The null hypothesis is the separability of each block of meat from all other meat blocks (for separability restriction, see Yang and Koo, 1994, p. 400). The results of the separability test are presented in table II-3. The null hypotheses of separability of the individual block of meats in the meat demand system from other meat blocks are rejected at the 1 percent significance level. Therefore, the results support estimating the U.S. demand for meats as a system, including the three types of meats studied here.

Product Aggregation

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 test is used to determine whether source differentiation is necessary with the null hypothesis being that each type of meat can be estimated as an aggregate group using a nonsource differentiated AIDS model (for product aggregation restrictions, see Yang and Koo, p. 400). The test results for the U.S. meat demand system are presented in table 3. Results indicate that the null hypothesis of nonsource differentiation for all meats is rejected at the 1 percent significance level. Therefore, the results support estimating the U.S. demand for meats using a source differentiated model.

Results

Table II-4 presents the Marshallian demand elasticities with their respective standard errors and the parameter estimates for seasonal and BSE indicator variables, which were estimated using first-difference RSDAIDS (equation 2.13).[5] Results of price and expenditure elasticities as well as seasonal and BSE indicator variables are discussed in the following sections.

Price and Expenditure Elasticities

In the beef market; all expenditure elasticities are positive, but only the expenditure elasticities for fed beef from the U.S. and beef from Canada are statistically significant. Moreover, the U.S. demand for Canadian beef carries a much larger expenditure elasticity (2.6) compared to U.S. fed beef (0.96). These results suggest that an increase in the U.S. meat expenditures is expected to increase the demand for U.S. fed beef to some extent, and the demand for Canadian beef to a much greater extent. These results are consistent with the U.S. consumers' general preferences for U.S. and Canadian fed beef because of their perceived superior quality compared to nonfed (grass-fed) beef from the U.S., Australia, New Zealand, and the ROW. The larger expenditure elasticity for Canadian beef compared to U.S. fed beef might be due to the differences in flavor between barley fed Canadian beef and corn fed U.S. beef, noting that Canadian beef accounts for a small percentage of total U.S. consumer fed beef expenditures and the fact that it is channeled to the higher income end of the market (hotels, restaurants, and cruise ships).

Regarding the pork market, all expenditure elasticities are positive and statistically significant. The U.S. demand for pork from the ROW has the highest expenditure elasticity (3.8) followed by Canadian pork (1.4) and U.S. pork (0.9). These results suggest that a significantly higher percentage of pork demanded in the U.S. domestic market would be imported from the ROW compared to the pork originating from Canada and the U.S., given a percentage increase in the U.S. meat expenditures. These results are consistent with the U.S. consumers' preference for high quality pork since U.S. pork imports from the ROW are mainly composed of high quality spare ribs and hams from Denmark, which are preferred by the U.S. consumers (USDA-ERS, 2006c). In the poultry market, the expenditure elasticity for U.S. poultry is positive, greater than one, and statistically significant.

Consistent with economic theory, all source differentiated own-price elasticities are negative and statistically significant. In the beef market, the own-price elasticities for imported beef from Australia and New Zealand are greater than one in absolute value. This result suggests that imported beef from major nonfed beef suppliers is sensitive to own-price in the U.S. domestic market. Moreover, the results support the findings from previous studies that perceived lower quality meats (such as beef imported from Australia and New Zealand) have higher own-price elasticities than perceived higher quality meats (fed beef from the U.S. and Canada) (Lusk et al.; Brester and Wohlgenant; and Eales and Unnevehr). For the pork and poultry markets, results show that own-price elasticities for U.S. produced pork and poultry are less than one in absolute value, while the own-price elasticity for pork from Canada and the ROW are greater than one in absolute value. Similar to the beef market, these results suggest that imported pork is more price sensitive compared to U.S. pork in the U.S. domestic market. Although it is difficult to compare the results of this study with others,[6] the own-price elasticities of U.S. produced meats (fed beef, pork, and poultry) fall within the range of the elasticities estimated by others (Eales and Unnevehr; Lusk et al.; and Piggott and Marsh).

Cross-price elasticities may indicate substitutability or complementary relationships among products from different sources. While a significant positive Marshallian cross-price elasticity between meats from different suppliers indicates substitutability, a significant negative cross-price elasticity may indicate complementarity. Justifying a complementary relationship between meats is difficult since all meats are sources of animal protein and therefore are expected to substitute for one another in human consumption.

For the U.S. beef market, while cross-price elasticities indicate that U.S. fed and nonfed beef are weak substitutes for each other, beef from New Zealand and Australia show a strong competitive relationship. The competitive relationship between the imported beef from Australia and New Zealand is consistent with prior expectations, as both countries supply beef from grass-fed cattle to the U.S. Also, the nonfed beef produced in the U.S. is considered of comparable quality to grass-fed beef from New Zealand; which might explain their competitive relationship. Beef from New Zealand and the ROW also show a competitive relationship. This is consistent with prior expectations as most of the U.S. imports of beef from the ROW are nonfed beef, mainly from South American countries. The results also show a lack of competitiveness between Canadian beef and U.S. nonfed beef. Again, this is consistent with prior expectations since the U.S. imports from Canada are mostly higher quality beef from fed cattle, which are not expected to compete with nonfed beef from cows and bulls in the U.S.

Regarding the pork market, the estimated cross-price elasticities show that U.S. pork competes with pork from Canada and the ROW. However, the complementary relationship that exists between Canadian pork and pork from the ROW might seem odd. The lack of competitiveness might be due to the fact that U.S. imports from the ROW are mainly high quality spare ribs and hams from Denmark which might not necessarily compete with the type of pork that is imported from Canada.

Regarding cross-commodity relationships (e.g., the relationship between source differentiated beef and aggregate pork), interestingly, the majority of cross-price elasticities are not statistically significant. Therefore, from the results of this study the conclusion is that there are no clear relationships between source-differentiated meats and aggregate meat categories. Nevertheless, beef from the ROW shows a strong competitive relationship with aggregate pork. Furthermore; the results show statistically significant negative cross-price elasticities, implying non-substitutability, among source differentiated meats and several of the aggregate meat categories.

Effects of Seasonality and BSE on the U.S. Meat Demand

The parameter estimates of seasonal and BSE indicator variables are presented in table II-4. In the beef market, the coefficients of seasonal indicators show that the budget shares of most of the beef products (U.S. fed beef, Canadian beef, and New Zealand beef) are lower in the fourth quarters compared to the second quarter. These results are consistent with seasonal consumption patterns in the U.S. – the fourth quarter (October-December) is associated with traditional holiday seasons when Americans consume more poultry meat than beef compared to other seasons. In the pork market, the results of the seasonal indicator variables show that the shares of pork from different sources are higher in the first, third, and fourth quarters compared to the second quarter. Since most of the pork consumption in the U.S. is in the form of breakfast meats, the consumption of pork is expected to decrease during the warm summer months as consumers are more likely to eat hot breakfast during the colder seasons.

Regarding BSE impacts, the study by Mathews, Vandeveer and Gustafson indicates that the U.S. and Canadian BSE outbreaks did not decrease the demand for beef in the U.S. domestic market. However, results obtained from this study show the Canadian BSE outbreak had a small negative impact on the budget shares of Canadian beef in the U.S. This result is consistent with prior expectations because from May to August of the year 2003, the U.S. imposed an import restriction on Canadian beef. Moreover, the results of the U.S. BSE outbreak are shown as having a small negative impact on the budget shares of U.S. produced fed and nonfed beef. This result is supported by the data used for this study. More specifically, when graphing the U.S. fed and nonfed beef market shares over time, the graph (not presented here to save space) shows a decrease in the shares during the U.S. BSE outbreak.[7]

Interestingly, the BSE outbreak in Canada is shown as having a negative impact on the U.S. budget share of New Zealand beef. The lowered share of New Zealand beef may be explained by the fact that during the Canadian BSE outbreak New Zealand had decreased its beef shipments to the U.S. in order to allow for increased exports to markets that had banned Canadian beef, mainly Japan and South Korea. Furthermore, results also show a small negative impact on the budget share of U.S. produced pork in the U.S. market as a result of BSE outbreaks in the U.S. and Canada. The negative impact of Canadian and U.S. BSE outbreaks on the shares of U.S. pork is an unexpected result, as BSE is only a cattle related disease. However, this result is supported by the data used in this study that shows that the shares of U.S. pork decreased during the BSE outbreak in Canada and also decreased to some extent during the BSE outbreak in the U.S.[8]

Summary and Conclusions

This study estimates the impacts of economic factors (meat prices and expenditure) and non-economic factors (seasonality and BSE outbreaks in the U.S. and Canada) on the U.S. quantity demanded for source differentiated meats, using the first-difference version of the restricted source differentiated almost ideal demand system. To assure that the system specification and estimation procedures are correct, various hypotheses regarding the U.S. source differentiated meat demand model are tested. The tested hypotheses included: normality, joint conditional mean, joint conditional variance, endogeneity of the total expenditure, separability among meats included in the system, and product aggregation. The results of statistical tests show that the model is well specified when using the first-difference version of RSDAIDS. Furthermore, test results support estimating a set of meat demand equations for the three types of meats (beef, pork, and poultry), each meat being differentiated by the supply source (source differentiated).

This study is one of the first that analyzes source differentiated meat demand in the U.S. domestic market. The results of this study shed light on the U.S. consumer's preferences with regard to meats imported from different sources, including domestically produced meats, during a period of liberalized markets with the impacts of seasonality and BSE outbreaks in the U.S. and Canada taken into account. Moreover, this study accesses the competitiveness of U.S. produced meats in the U.S. domestic market. Given that the U.S. generally is considered to be a supplier of high quality and high price meats in the U.S. domestic market, the U.S. is said to have competitive advantage in the U.S. market if the demand for U.S. meats are price inelastic and expenditure elastic. The same definition of competitive advantage applies to Canadian meats and Danish pork. Canadian meats are comparable in quality and price to U.S. meats, and pork from Denmark is composed of spare ribs and high-end ham products that carry a higher price.

In the beef market, from their statistically significant expenditure elasticities, the results of this study indicate that Canadian beef and U.S. fed beef have most to gain from an increase in the size of the U.S. meat market. Furthermore, the results of this study indicate that U.S. fed beef and Canadian beef have competitive advantage in the U.S.

market, compared to beef from other major supplying sources. This is judging by their relatively low own-price elasticities (in absolute values) and positive and statistically significant expenditure elasticities compared to beef from other major suppliers.

Regarding the pork market, judging by larger (positive) and statistically significant expenditure elasticity for pork from the ROW (3.8) compared to pork from other supply sources, pork from the ROW has the most to gain from an increase in the U.S. meat expenditures. Estimates show that pork products with high own-price elasticities in absolute values also carry high expenditure elasticities. Therefore, accessing which pork product has competitive advantage in the U.S. domestic market is difficult. However, the substitutability among U.S. pork and imported pork, indicates that any increase in the price of imported pork might imply benefits to U.S. pork producers.

The results of this study would have implications for the meat suppliers to the U.S. market. For example, if the increased availability of Australian beef in the U.S. resulting from the 2005 U.S./Australia free trade agreement reduces the relative price of Australian beef and considering the large positive and significant New Zealand/Australia cross-price elasticities, New Zealand producers are expected to have the most to lose in terms of decreased exports and reduced U.S. market shares. Moreover, beef market development activities intended to increase meat consumption in the U.S. are expected to have the most significant impact (in terms of percentage change in sales volume) on Canadian and U.S. fed beef, compared to U.S. nonfed beef and beef from other supplying countries. Finally, competing meat (pork and poultry) price changes are not expected to have a significant impact on U.S. beef producers.

Footnotes

1. In this study, ROW refers to the group of all other countries that export a specific type of meat to the U.S., except those countries which are analyzed in this study and identified as the U.S. competitors. For example, the ROW beef is beef that the U.S. imports from all other countries except Australia, Canada, and New Zealand.

2. Although unit values usually reflect perceived quality differences of imported meats, they may differ from wholesale prices when trade restrictions are in effect.

3. For calculating the standard errors of the estimated elasticities, the square root of the variance of a linear transformation of the parameters (equation 2.15 below) is calculated as:

$$e = Ab \tag{2.15}$$

where e is the vector of estimated elasticities (ε's, η's), b is the vector of estimated RSDAIDS model parameters (γ's, β's), and A is a matrix of constants (budget shares). The variance covariance matrix of e [VAR(e)] was calculated as:

$$\mathrm{VAR}(e) = A\mathrm{VAR}(b)A' \tag{2.16}$$

where VAR(b) is the variance covariance matrix of b.

4. All the results discussed in this study refer to the first-difference RSDAIDS model (equation 2.13).

5. Hicksian elasticities were not presented here because meats account for only a small fraction (2%) of total U.S. consumers' disposable income thus Marshallian and Hicksian elasticities are very similar.

6. This study is the first on source differentiated U.S. meat demand, while other studies have analyzed meats on a more aggregate level (nonsource differentiated).

7. U.S. beef is composed of beef from domestic and imported cattle. The shares of U.S. beef might have decreased due to a decrease in the number of cattle slaughtered in the U.S. since the U.S. banned imports of cattle from its major cattle supplier (Canada). Note that in this study, the quantity of fed beef is the sum of quantity of wholesale beef produced from steers and heifers slaughtered and the quantity of nonfed beef is the sum of wholesale beef produced from cows and bulls slaughtered.

8. The decrease in the shares of U.S. pork can be due to other reasons than just the Canadian and the U.S. BSE outbreaks, which are beyond the scope of this study. However, it is also possible that U.S. consumers decreased the demand for red meats in general during the BSE outbreaks.

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Table II-1. Summary of the U.S. Meat Trade Liberalization.

Trade Partner	Beef	Pork	Poultry
NAFTA Countries	■ Import quotas for beef from Canada and Mexico were eliminated by CFTA and NAFTA agreements as of January 1, 1989 and January 1, 1994, respectively. 4.4 cents tariff per pound of beef originating from Canada was phased-out and eliminated in July 1993.	■ Tariffs of 1.2 cents per kg for sausage and 6.4 cents per kg for canned ham originating from Canada and Mexico were eliminated by CFTA and NAFTA agreements as of January 1, 1989 and January 1, 1994, respectively.	■ Import tariff, which ranged from 2-10.6 cents per kg of the U.S. imports of poultry originating from Canada were supposed to be phased-out over a 10 year period by CAFTA as of January 1, 1989; however, they were eliminated in July 1993.
			■ Import tariff, which ranged from 2-10.6 cents per kg of the U.S. imports of poultry originating from Mexico were eliminated by NAFTA as of January 1, 1994.
Non-NAFTA Countries	■ Import quotas eliminated to TRQs of 378,214 tons/year for Australia, 213,402 tons/year for New Zealand, 200 tons/year for Japan, 20,000 tons/year each for Argentina and Uruguay, and 64,805 tons/year for other countries by URAA in 1995.	■ Tariff on cuts specially prepared for retail lowered from 2.2 cents/Kg to 1.4 cents/Kg by URAA agreement from 1995 to 2000.	■ Tariffs on poultry meat lowered from 22 cents/Kg to 17.6 cents/Kg by URAA agreement from 1995 to 2000.
	■ Tariffs within TRQs on cuts specially prepared for retail ranges from 4% to 10%. Within TRQs tariff otherwise is 4.4 cents/kg.	■ Tariffs for pork offal is zero.	
	■ Over TRQs tariff lowered from 31.1% to 26.5% by URAA agreement from 1995 to 2000.		
	■ Special safeguard provisions to limit import surges on over TRQs are applied.		
	■ Tariff for beef offal is zero.		

Sources: Hahn et al. and Dyck and Nelson .

Table II-2. Misspecification Test Results for the Meat Demand Model.

Hypotheses Tested	RSDAIDS	First-Difference RSDAIDS
	P-value	P-value
Normality		
Fed beef from the U.S	0.4496	0.214
Nonfed beef from the U.S.	0.9116	0.817
Beef from Australia	0.6732	0.522
Beef from Canada	0.1882	0.722
Beef from New Zealand	0.9755	0.524
Beef from the ROW	0.3016	0.417
Pork from the U.S.	0.0034	0.532
Pork from Canada	0.6455	0.787
Pork from the ROW	0.5421	0.688
Poultry from the U.S.	0.9858	0.879
Joint Conditional Mean		
Linear Functional form	0.0127	0.364
No autocorrelation	0.0001	0.031
Parameter stability	0.0001	0.207
Overall test	0.0001	0.012
Joint Conditional Variance		
Static homoskedasticity	0.2472	0.098
Dynamic homoskedasticity	0.074	0.263
Variance stability	0.4655	0.170
Overall test	0.079	0.084

Table II-3. Block Separability and Product Aggregation Test Results for the U.S. Meat Demand Model.

Block Separability Test:

H0: Beef is separable from all other meats.
F=6.07**
df:12 for numerator and 334 for denominator

H0: Pork is separable from all other meats.
F=1.37
df: 6 for numerator and 334 for denominator

H0: Poultry is separable from all other meats.
F=2.93*
df: 2 for numerator and 334 for denominator

H0: All of the above
F=4.34**
df: 20 for numerator and 334 for denominator

Product Aggregation Test

H0: Beef can be aggregated.
F=4.31**
df: 40 for numerator and 334 for denominator

H0: Pork can be aggregated.
F=1.98*
df: 10 for numerator and 334 for denominator

H0: All of above
F=3.86**
df: 50 for numerator and 334 for denominator

Note: (*) and (**) denote significance ant 5% and 1%, respectively.

Table II-4. Marshallian Elasticities and Parameters Estimates of Coefficients of Indicator Variables of the U.S. Meat Demand Model.

Explanatory	Beef					
Variables	Fed U.S	Nonfed U.S	Australia	Canada	New Zealand	ROW
Price of fed beef from the U.S.	-0.664**	0.420*	-0.479	-0.024	0.276	0.420
	(0.150)	(0.209)	(0.944)	(0.582)	(0.645)	(0.572)
Price of non-fed beef from the U.S.	0.041	-0.206*	-0.320	-0.802**	0.628	-0.600*
	(0.026)	(0.097)	(0.385)	(0.226)	(0.349)	(0.280)
Price of beef from Australia	-0.002	-0.054	-2.271**	0.394	3.917**	0.120
	(0.020)	(0.080)	(0.680)	(0.256)	(0.699)	(0.390)
Price of beef from Canada	0.019	-0.189**	0.490	-0.834**	0.064	-0.104
	(0.015)	(0.058)	(0.310)	(0.269)	(0.270)	(0.235)
Price of beef from New Zealand	0.030**	0.101*	2.628**	0.032	-4.361**	0.615*
	(0.009)	(0.049)	(0.467)	(0.150)	(0.715)	(0.305)
Price of beef from ROW	0.004	-0.077*	0.061	-0.062	0.532*	-0.908**
	(0.007)	(0.035)	(0.229)	(0.115)	(0.270)	(0.280)
Price of pork	-0.085	-0.613	-1.448	-1.707	-3.003**	2.005**
	(0.286)	(0.405)	(1.903)	(1.076)	(1.202)	(0.530)
Price of poultry	-0.307	-0.037	-0.825	0.398	-1.101	-2.048*
	(0.293)	(0.412)	(1.837)	(1.061)	(1.216)	(1.128)
Expenditure	0.963**	0.654	2.164	2.605*	1.078	0.501
	(0.331)	(0.468)	(2.019)	(1.185)	(1.320)	(1.211)
Quarter I	-0.022**	0.008**	-0.003	0.001	-0.004**	0.001
	(0.009)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Quarter III	-0.010	-0.001	0.001	-0.002	-0.007**	7.471E-05
	(0.007)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Quarter IV	-0.034**	0.007**	-0.002	-0.002*	-0.011**	0.001
	(0.007)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
BSE in Canada	-0.003	-0.002	-0.002	-0.013**	-0.003**	0.001
	(0.012)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
BSE in the U.S.	-0.025**	-0.010**	3.938E-04	0.005**	-3.453E-04	0.001
	(0.013)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)

Notes: The system weighted R^2 is equal to 0.8742

Numbers in parenthesis are standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

Table II-4. Marshallian Elasticities and Parameters Estimates of Coefficients of Indicator Variables of the U.S. Meat Demand Model.

Explanatory Variables	Pork U.S.	Pork Canada	Pork ROW	Poultry U.S.
Price of pork from the U.S	-0.439**	0.525	0.004	
	(0.059)	(0.359)	(0.515)	
Price of pork from Canada	0.023*	-1.019**	-0.690*	
	(0.012)	(0.352)	(0.341)	
Price of pork from ROW	0.012*	-0.301*	-1.419**	
	(0.006)	(0.154)	(0.302)	
Price of poultry from the U.S.				-0.366**
				(0.103)
Price of aggregate beef	-0.252*	0.167	-0.730	-0.067
	(0.142)	(0.488)	(0.877)	(0.305)
Price of aggregate pork				-1.035**
				(0.313)
Price of aggregate poultry	-0.238	-0.818	-0.964	
	(0.164)	(0.570)	(0.997)	
Expenditure	0.894**	1.446**	3.799**	1.468**
	(0.190)	(0.611)	(1.107)	(0.283)
Quarter I	0.050**	0.002**	0.002**	0.012
	(0.005)	(0.001)	(0.00039)	(0.006)
Quarter III	0.009**	0.001**	6.831E-05	0.001
	(0.003)	(0.0003)	(0.00027)	(0.004)
Quarter IV	0.060**	0.003**	0.001**	0.005
	(0.004)	(0.0004)	(0.000365)	(0.006)
BSE in Canada	-0.015**	-4.680E-04	-1.379E-04	-0.014
	(0.005)	(0.001)	(0.000428)	(0.008)
BSE in the U.S.	-0.010*	-0.001	-1.870E-05	-0.016
	(0.005)	(0.001)	(0.000451)	(0.008)

Notes: The system weighted R^2 is equal to 0.8742
Numbers in parenthesis are standard errors. Single (*) and double (**) asterisks denote significance at 5% and 1% level, respectively.

CHAPTER III

Welfare Implications of Selected Supply and Demand Shocks on Producers and Marketers of U.S. Meats

Introduction

The effects of various supply and demand shocks on U.S. meat prices, quantities, and industry welfare have been widely studied (Mullen, Wohlgenant, and Farris; Unnevehr, Gomez, and Garcia; Chung and Kaiser; Wohlgenant; Kinnucan, Xiao, and Hsia; Brester, Marsh, and Atwood; Lusk and Anderson; and Lusk and Norwood). However, one notable deficiency among these studies is that meats were not differentiated by source of origin and the U.S. international trade was typically not included. Imported meats were ignored for the most part; and if included, meats were not differentiated by source of origin and the U.S. meat export markets were not considered. As a result, none of these previous models were able to evaluate the effects of the U.S. non-price export promotion programs and trade barriers on U.S. meat producers and marketers.

Although nonsource differentiation might have been a realistic assumption for the mentioned studies in the past, this assumption no longer applies to the highly segregated world meat market. The world meat market has been divided into disease-restricted and disease-free countries primarily due to *Bovine Spongiform Encephalopathy* (*BSE*), foot-and-mouth disease (FMD), and avian influenza (AI). For example Japan and South Korea banned U.S. beef after the discovery of BSE in the U.S. in 2003. Therefore, it has become increasingly important to source differentiate meats according to supply sources when estimating the impact of various supply and demand shocks on the U.S. and other countries' meat industries.

Policy makers, producers, and consumers are interested in knowing the impacts of economic and non-economic variables on the meat markets across the globe. This study provides a modeling framework and analyzes the economic impacts of selected non-economic variables on the U.S. meat industry. The non-economic variables whose impacts are studied here include government and industry funded export promotion programs, country of origin labeling (COOL), and animal disease (ban of U.S. beef in Japan and S. Korea). An equilibrium displacement model is developed and used to estimate the impacts of recent shocks and policy variables on the U.S. meat producers and marketers.

This study is organized as follows: The next section develops and describes the equilibrium displacement model and presents the parameters used to simulate the model. This is followed by a discussion of welfare implications of supply and demand shocks due to: (1) beef and pork promotions, (2) country-of-origin labeling (COOL), and (3) the Japanese and S. Korean bans of U.S. beef. When discussing the selected supply and demand shocks, an introductory section is presented followed by simulation methods and the simulated results. Finally, summary and conclusions of each simulated supply and demand shocks are presented.

The Model

This study develops an equilibrium displacement model which includes both U.S. meat imports and exports with meats differentiated by source of origin. The structural specification of supply and demand relationships of meats (beef, pork, and poultry) provides the framework for the equilibrium displacement model. In this study, U.S. produced beef is disaggregated into fed (grain-fed) beef and nonfed (grass-fed) beef. Furthermore, the model includes U.S. domestically produced meats and U.S. meat imports from major countries (Australia, Canada, New Zealand, and the rest-of-the world) as well as U.S. meat exports to major countries (Canada, Japan, Mexico, and S. Korea). The meat model specified here includes two distinct sectors: “retail” (consumer) and “farm” (producer). In addition, in the retail demand side, the model considers relationships (substitution and complementary relationships) between U.S. produced meats and meats from other supply sources in the U.S. domestic and export markets.

The food industry has become more concentrated and imperfectly competitive. For example, four-firm concentration ratio in the U.S. beef packing industry increased from 0.30 in 1978 to 0.86 in 1994 and statistically significant monopoly/monopsony price distortions in slaughter cattle and wholesale beef markets have been reported (Sexton; Schroeter). Therefore, although most equilibrium displacement models have assumed perfect competition as a base meat market structure assumption, the equilibrium displacement model developed in this study assume either perfect or imperfect competition of the middle stage (processor-retailer) of the meat supply chain.

The equilibrium displacement model is based on certain theoretical assumptions (Brester and Wohlgenant; Wohlgenant; and Freebairn, Davis and Edwards). For this study, these assumptions including additional market assumptions for U.S. meats are:

(a) Linearity of all supply and demand curves.

(b) Any shifts in supply and demand curves are parallel. Chung and Kaiser repot that when analyzing the effectiveness of two or more different policies on producer welfare, the type of supply and demand shifts (parallel and pivotal) assumed is important; however, the resulting outcome (gains or loses) does not vary by the type of the shift assumed. Hence, given that this study does not compare the effectiveness of different policies on producer or consumer welfare, a parallel shift appears to be a reasonable assumption.

(c) Fixed proportion production technology at the processors-retailers' market level. Fixed proportion technology means that the elasticity of substitution between market inputs and farm product at the processors-retailers' market level is equal to zero.

(d) Substitution and complementary relationships are modeled on the demand side but not on the supply side. The model does not allow for production relationships (substitution and complementary) among the included meats because it assumes that specialized inputs and different production technologies are used in the production of each type of meat. MacDonald et al. report that meat industry is characterized by a high degree of specialization in production.

(e) On the demand side, this study focuses on the demand for U.S. meats and meats from other sources, including domestically produced meats, in the U.S., Canada, Japan, Mexico, and S. Korea. According to USDA-FAS, 2006a, the majority (more than 90 percent) of U.S. meats (beef and pork) are exported to Canada, Mexico, Japan, and S. Korea. Therefore, in this study, those countries are considered to be the major destinations of U.S. meats.

(f) On the supply side, this study focuses on the meats supplied from the U.S. and other major countries that supply meat to the U.S., Canada, Japan, Mexico, and South Korea including domestically produced meats of the countries included in the model.[1]

(g) The U.S. and Canada are considered as meat importers and exporters while Japan, Mexico, and South Korea are considered as meat importers.

Following the assumptions; the structural supply and demand equations, with error terms omitted are presented below. The meat demand equation is presented as:

(3.1) $$Q_{ijk}^{d} = f(\mathbf{P_k^d})$$ (retail level demand of meats)

where Q_{ijk}^{d} is the quantity of meat of type *i* from country *j* demanded in country *k*. The subscript *i* denotes meat type and $i = 1, \ldots, I$. The subscript *j* denotes the country of origin of meat type *i*, (the supply source of meat of type *i* demanded in country *k* and $j = 1, 2, \ldots, J$). The source differentiated meat of type *i* is called a meat product. The subscript *k* denotes the consuming country (countries in which meat *i* from country *j* is demanded). The *k* destinations are (1) the U.S., (2) Canada, (3) Japan, (4) Mexico, and (5) S. Korea. $\mathbf{P_k^d}$ is a vector of demand prices for source differentiated meats in country *k*. The meat supply equation is presented as:

(3.2) $$Q_{ij}^{s} = f(P_{ij}^{s})$$ (Farm level supply or excess supply of meats) where Q_{ij}^{s} is the quantity supplied of meat of type *i* from country *j*. P_{ij}^{s} is the supply price of meat of type *i* from country *j* (product *ij*).[2] The marketing clearing conditions are given by the respective quantity and price equilibrium conditions.

<u>Quantity Equilibrium Conditions</u>

For meat exporting countries, the quantity equilibrium condition is presented as:

(3.3) $$Q_{ij}^{s} = Q_{ijj}^{d} + \sum_{k \neq j}^{K} Q_{ijk}^{d}$$ (for meat exporters)

where Q_{ijj}^{d} is the quantity demanded of meat *i* in country *j* from its own source (domestically produced), Q_{ijk}^{d} is the quantity demanded of meat *i* from country *j* in country *k* (exported by country *j* to country *k* or foreign demand), and the remaining variables are as previously defined.

For meat importing countries, the quantity equilibrium condition is presented in equation (3.4).

(3.4) $$Q_{ijk}^{s} = Q_{ijk}^{d}$$ (for meat importers)

where Q_{ijk}^{s} is the quantity supplied of meat of type *i* from country *j* to the consuming country *k*. The quantity supplied, Q_{ijk}^{s}, and quantity demanded, Q_{ijk}^{d}, correspond to the domestically produced meats and foreign produced meats when $j = k$ and $j \neq k$, respectively.

Retail-Farm Price Linkages

Given the farm supply and retail demand equations, the retail demand and farm supply equations can be linked with retail-farm price equations to ensure equilibrium across the two vertical channels. Following Sexton, the retail-farm price linkage equations when allowing for imperfect competition at the middle stage (processors-retailers) of the marketing chain is given as follows:[3]

(3.5) $$P_{ijk}^{d}(1+\frac{\xi}{\eta_{ijk}}) = P_{ij}^{s}(1+\frac{\theta}{\varepsilon_{ij}}) + c_{ijk}$$

where c_{ijk} represents retail costs per unit of meat *i* from country *j* demanded in country *k*, η_{ijk} is the own-price demand elasticity of meat *i* from country *j* demanded in country *k*, ε_{ij} is the own-price supply elasticity of meat *i* supplied from country *j*, ξ and θ are market conduct parameters (conjectural elasticities), which measure the extent of retailer marketing power. $\xi \in [0,1]$ measures departure from competition in selling the finished product at retail level, with $\xi = 0$ denoting perfect competition, i.e. the retailers do not have market power in selling the finished product , $\xi = 1$ denoting pure monopoly, and $\xi \in [0,1]$ denotes various degrees of oligopoly market power, where high values denote greater departure from competition; $\theta \in [0,1]$ measures departure of retailers from competition in buying the farm product, with $\theta = 0$ denoting perfect competition i.e. the retailers do not have market power in buying the farm product, $\theta = 1$ denoting pure monopsony, and $\theta \in [0,1]$ denotes various degrees of oligopsony market power, where high values denote greater departure from competition; and the other variables are as previously defined.

Equilibrium Displacement Model

The equilibrium displacement model is derived by totally differentiating equations (3.1) through (3.5) and using log differentials to convert to elasticities. The results produce the following equations, which are used to approximate changes from the initial equilibrium for the U.S. global trade of beef, pork, and poultry.[4] The meat demand equation in relative change form is presented as:

(3.6) $Q_{ijk}^{d*} = \boldsymbol{\eta}\mathbf{P_k^{d*}}$ *(Retail Level Meat Demand)*

where the star (*) represents a relative change operator, so that $Q_{ijk}^{d*} = dQ_{ijk}^{d} / Q_{ijk}^{d} = d\ln(Q_{ijk}^{d})$; $\boldsymbol{\eta}$ represents a vector of own-price and cross-price demand elasticities for meat demanded in country *k*, and the other variables are as previously defined. The meat supply equation in relative change form is presented in equation (3.7).

(3.7) $Q_{ij}^{s*} = \varepsilon_{ij} P_{ij}^{s*}$ *(Farm Level Supply or Excess Supply)*

where ε_{ij} is the own-price supply elasticity and or excess supply elasticity of meat *i* from country *j* , and the other variables are as previously explained. The quantity equilibrium conditions become:

(3.8) $$Q_{ij}^{s*} = \tau_{ijj} Q_{ijj}^{d*} + \sum_{k \neq j}^{K} \lambda_{ijk} Q_{ijk}^{d*} \text{ (for meat exporters)}$$

(3.9) $$\tau_{ijj} = Q_{ijj}^{d} / Q_{ij}^{s}$$

(3.10) $$\lambda_{ijk} = Q_{ijk}^{d} / Q_{ij}^{s}$$

(3.11) $$Q_{ijk}^{s*} = Q_{ijk}^{d*} \text{ (for meat importers)}$$

where τ_{ijj} is the proportion of quantity supplied of meat *i* from country *j* that is demanded in country *j*, λ_{ijk} is the proportion of quantity supplied of meat *i* from country *j* that is demanded in the importing country *k*, and the other variables are as previously defined. The retail-farm price linkage becomes:

$$P_{ijk}^{d*}(1+\frac{\xi}{\eta_{ijk}}) = P_{ij}^{s*}\delta_{ijk}(1+\frac{\theta}{\varepsilon_{ij}}) \tag{3.12}$$

$$\delta_{ijk} = \frac{P_{ij}^{s}}{P_{ijk}^{d}} \tag{3.13}$$

where δ_{ijk} is the ratio between supply price and demand price of meat *i* from country *j* demanded in country *k* and the other variables are as previously defined.

Following Lusk and Anderson; Brorsen et al., Alston and Scobie, and Lemieux and Wohlgenant, the retail level demand and farm level supply shifters are incorporated as parallel shifters in equations (3.6) and (3.7) as follows:

(3.14) $Q_{ijk}^{d*} = \boldsymbol{\eta}\mathbf{P_k^{d*}} - \boldsymbol{\eta}\boldsymbol{\varpi}_{\mathbf{ik}}$ *(Retail Level Meat Demand with Shifter)*

(3.15) $Q_{ij}^{s*} = \varepsilon_{ij}P_{ij}^{s*} + \varepsilon_{ij}\gamma_{ij}$ *(Farm Level Supply or Excess Supply with Shifter)*

where $\boldsymbol{\varpi}_{\mathbf{ik}}$ is a vector of demand shifters of meat *i* demanded in country *k*, γ_{ij} is the supply shifter of meat *i* from country *j*. Following Lusk and Anderson, shifting the supply curve at retail level is performed by shifting the marketing margin equation (equation 3.12) as follows:

(3.16) $P_{ijk}^{d*}(1+\frac{\xi}{\eta_{ijk}}) = P_{ij}^{s*}\delta_{ijk}(1+\frac{\theta}{\varepsilon_{ij}}) - \upsilon_{ijk}$ *(Retail-Farm Price Linkage with Shifter)*

where υ_{ijk} is the retail supply shifter of meat *i* from country *j* demanded in country *k* and the other parameters are as previously defined.

Once the parameters needed in demand and supply equations (3.14) and (3.15), and in equilibrium conditions equations (3.8) and (3.16) are assigned to the model, the values of variables with asterisks can be calculated by solving the equations simultaneously. In matrix notation, equations (3.8), (3.11), (3.14), (3.15), and (3.16) can be written as:

(3.17) $$\mathbf{A} \times \mathbf{Y} = \mathbf{B}$$

where $\mathbf{A}$ is a vector of parameters of endogenous variables in equations (3.8), (3.11), (3.14), (3.15), and (3.16), $\mathbf{Y}$ is a vector of changes in endogenous variables, and $\mathbf{B}$ is a vector of parameter of exogenous shifters. Relative changes in endogenous variables $\mathbf{Y}$ caused by relative changes in exogenous supply and demand shifters are calculated by solving the equation.

(3.18) $$\mathbf{Y} = \mathbf{A}^{-1} \times \mathbf{B}$$

Welfare Measures

Once the values of **Y** have been determined by solving equation (3.18), the changes in producer surplus can be calculated. Changes in producer surplus at farm and retail levels in the case of parallel shifts are calculated from Wohlgenant (equation 10, p. 645) as follows:

(3.19) $$\Delta PS_{ij} = P_{ij}^{s} Q_{ij}^{s} (P_{ij}^{s*} + \gamma_{ij})(1 + 0.5 Q_{ij}^{s*})$$ (Producer surplus at farm level)

(3.20) $$\Delta PS_{ijk} = P_{ijk}^{d} Q_{ijk}^{d} (P_{ijk}^{d*} + \nu_{ijk})(1 + 0.5 Q_{ijk}^{d*})$$ (Producer surplus at retail level)

where ΔPS_{ij} is the change in farm producer surplus of meat *i* from country j, ΔPS_{ijk} is the change in retail producer surplus of meat *i* from country *j* demanded in country *k*, and the other variables are as previously defined.

Parameters Used in the Model

In order to solve the model represented by equation (3.14), (3.15), and (3.16), values are assigned to the model parameters. The parameter values assigned to the model are: own-price and cross-price demand elasticities (η), own-price and excess supply elasticities (ε), quantity proportions (τ) and (λ), price proportions(δ), and the market conduct parameters, i.e. conjectural elasticities, (ξ and θ). In the following sections, an explanation of the source of these parameters is given.

Demand Elasticities

Demand elasticities used in this model were estimated using a restricted source differentiated almost ideal demand system (RSDAIDS). The elasticity estimates reflect conditional elasticities, as the RSDAIDS model is a complete demand system, which assumes weak separability between meats and other goods. Therefore, the estimated elasticities were converted into unconditional demand elasticities. Following Edgerton; and Fan, Wailes, and Cramer, the conditional own-price and cross-price demand elasticities were converted to unconditional elasticities. The own-price elasticities are converted to unconditional elasticities by using equation (3.21).[5]

(3.21) $\eta^{*}_{(m)i,i} = \eta_{(m)i,i} + E_{(m),i}(w_{i,m} + \eta_{mm} w_{i,m})$ (own-price demand elasticities)

where $\eta^{*}_{(m)i,i}$ is the unconditional own-price demand elasticity of meat *i* in meat group *m*, $\eta_{(m)i,i}$ is the conditional own-price demand elasticity of meat *i* in meat group *m*, $E_{(m),i}$ is the conditional expenditure elasticity of meat *i* within meat group *m*, η_{mm} is the unconditional own-price demand elasticity of meat group *m*, and $w_{i,m}$ is the budget share of meat i within meat group m. The own-price elasticity of meat group m (η_{mm}) is from USDA-ERS, 2006.

The cross-price elasticities are converted to unconditional elasticities using the following expression.

(3.22) $\eta^*_{(m)i,h} = \eta_{(m)i,h} + E_{(m),i}(w_{h,m} + \eta_{mm} w_{h,m})$ (cross-price demand elasticities)

where $\eta^*_{(m)i,h}$ is the unconditional cross-price demand elasticity between meat i and meat h in meat group m, $\eta_{(m)i,h}$ is the conditional cross-price demand elasticity between meat i and meat h in meat group m, $w_{h,m}$ is the budget share of meat h within meat group m, and the other variables are as previously defined. The unconditional own-price and cross-price demand elasticities used in this study are presented in table III-1 through table III-5.

<u>Supply and Excess Supply Elaticities</u>

Rather than attempting to estimate the own-price supply elasticities for meats supplied from different sources (countries), following Lusk and Anderson, Wohlgenant, and others, this study relies on preexisting estimates of own-price supply elasticities reported in the literature. This approach is taken because there already exists credible published estimates of own-price supply elasticities. For meat exporting countries, which are not included in the model, excess supply elasticities, i.e. export supply elasticities, were estimated. Following Lemieux and Wohlgenant, the excess supply elasticities were estimated using the following equation:

(3.23) $$\varepsilon^*_{ij} = \frac{\xi^*_{ij}}{S_{ijp}} - \frac{\eta^*_{ij}}{S_{ijc}}$$

where ε_{ij}^{*} is the own-price excess supply elasticity of meat *i* from country *j*, ξ_{ij}^{*} and η_{ij}^{*} are supply and demand own-price elasticities of meat *i* in country *j*, respectively; and S_{ijp} and S_{ijc} are the exports of meat *i* from country *j* as a share of domestic production and consumption, respectively. The supply and excess supply elasticities of meats from each country used in the model as well as the respective sources are presented in table III-6.

Quantity and Price Proportions

The quantity proportions were calculated as the ratio between quantity demanded and the respective quantity supplied of each meat type as shown in equations (3.9) and (3.10). Similarly, the price proportions were calculated as the ratio between supply prices and the respective demand prices as shown in equation (3.13). The calculated quantity and price proportions used in the model are presented in table III-7.

Welfare Impacts of Beef and Pork Promotions

Beef and pork check-off programs have been designed to generate funds for promotion activities, with the objective of enhancing domestic and foreign demand for beef and pork products. For beef, the program is funded by a mandatory assessment of $1-per-head collected each time cattle are sold; and for pork, the program is funded by a mandatory assessment of 0.40 of 1 percent on the market value of all hogs sold in the United States (USDA-AMS, 2006a). In 2001, the national beef and pork check-off programs generated $87.9 million and $54.6 million, respectively (Armbruster and Nichols). From the total dollar amounts generated from each program, 45 percent and 20 percent were allocated to foreign promotion board for export promotion of beef and pork, respectively.

Although the majority of agricultural export promotion expenditures are paid by U.S. producers and a significant amount of beef and pork promotion expenditures are allocated to export promotion, studies that have measured the welfare impacts of meat export promotion programs are limited. Available studies have concentrated on the U.S. domestic market, without including U.S. export markets (Kinnucan, Xiao, and Hsia; Wohlgenant). Considering the relatively significant proportion of total promotion expenditures allocated to export programs; analyzing the impact of beef and pork promotion programs without considering the U.S. export promotion activities, may bias the promotion effectiveness results. Furthermore, a relevant issue is how beef and pork promotion programs benefit U.S. meat producers and marketers and the foreign marketers of U.S. produced meats. Therefore, this study estimates the welfare impacts of the U.S. non-price domestic and export beef and pork promotion programs on U.S. meat producers and marketers.

Methods of Simulating Beef and Pork Promotions

The model described above is used to simulate the welfare impact of beef and pork promotion. Parameter values described above and presented in table III-1 through table III-7 are assigned to the model. The remaining values needed to implement the model are supply and demand shifters. The supply shifters reflect additional costs incurred by beef and pork farmers in order to finance promotion programs and demand shifters reflect demand increase for beef and pork due to promotion programs.

To determine the potential costs of promotion, revenues from mandatory assessment of each program are divided by the respective total farm revenues for each industry (Lusk and Anderson). In 2002, beef and pork check-off programs generated $35.7 million and $27.4 million respectively (USDA-ERS, 2005). In the same period, the total farm revenues for cattle and hogs were $17,437 million and $6,860 million, respectively. Dividing the mandatory assessment of each program by its respective farm revenue shows that in 2002, promotion increased farm production costs by 0.002 and 0.004 in the beef and pork industries, respectively.[6] Therefore, shocks on U.S. beef and pork farm supply are induced by entering the corresponding shifters (0.2 for beef and 0.4 for pork) in the farm supply curve represented by equation (3.15). The farm supply shifters are entered as negative numbers to represent added costs to the system.

On the demand side, the estimated demand shifter parameters of impact of generic advertising on beef and pork demands are mixed. Some studies find the parameters to be positive and statistically significant (Ward and Lambert) while others find the parameters to be insignificant and fragile (Brester and Schroeder; Kinnucan et al.). Studies that have estimated the welfare impacts of beef and pork promotions have used demand shifter parameters that ranges from 0.0005 to 0.057 for beef (Kinnucan; and Wohlgenant) and from 0 to 0.045 for pork (Kinnucan, Xiao, and Hsia; and Wohlgenant). With this in mind, following Wohlgenant, in this study, promotion is assumed to increase the demand for U.S. produced beef and pork by 0.057, and 0.045, respectively. This study uses Wohlgenant demand shifter for comparison purposes since the model used in this study is similar to Wohlgenant model and both this study and Wohlgenant study estimate the impact of beef and pork promotions. The model is simulated by simultaneously shifting the supply and demand curves for beef and pork using 2002 average prices and quantities, and assuming perfect competition and retailer oligopsony market power. Following Zhang, this study uses the value of 0.03 as retailer oligopsony market power parameter.

Results of Welfare Impacts of Beef and Pork Promotions

The estimated welfare measures are presented in table III-8. The results show that beef and pork promotions increase producer surplus for producers and marketers of U.S. beef and pork and decrease producer surplus for producers and marketers of U.S. poultry. These results suggest that an increase in beef and pork demands negatively affects the demand for poultry. Wohlgenant also reports positive impact of beef and pork promotions on U.S. beef and pork producers.

Moreover, the results indicate that although pork has larger supply decrease shifter and lower demand increase shifter compared to beef, producers and marketers of U.S. pork benefit more from beef and pork promotions compared to producers and marketers of U.S. beef. Difference in magnitude of supply and demand elasticities may explain the results. Following Wohlgenant, the model is simulated using relatively high own-price demand elasticities for U.S. beef and pork compared to the respective own-price supply elasticities.[7] The results, which are presented in table III-9, show that similar to Wohlgenant, producer and marketers of U.S. beef gain more from promotion than producers and marketers of U.S. pork.

The results of impact of beef and pork promotions on U.S. beef and pork producers reported in table III-9 are lower than those reported by Wohlgenant. The difference might be due to additional 10 percent reduction in production costs of beef and pork assumed in Wohlgenant study. Therefore, the model is simulated assuming also a 10% decrease in production costs for beef and pork. The results show a $1.84 billion and $0.94 billion as a change in producer surplus of U.S. beef and pork producers, respectively. These results are higher than $1.58 billion and $0.28 billion of change in producer surplus of U.S. beef and pork producers reported by Wohlgenant. Therefore, adding international trade, especially U.S. meat exports and considering export promotion increases the positive impact of beef and pork promotions on U.S. beef and pork producers.

Furthermore, the results show that retailer oligopsony market power reduces the welfare of U.S. meat producers and increase the welfare of U.S. retailers of U.S. meats (table III-8 and table III-9). For example, change in farmers' producer surplus for the overall meat industry decreases from $119.02 million under competitive market to $104.76 million under retailer oligopsony market power (table III-8); while change in U.S. retailers' producer surplus increases from $186.09 million under competitive market to $192.86 million under retailer oligopsony market power. The retailer oligopsony market power affect the allocation of gains from promotion and specifically it is more likely to decrease the total meat industry welfare. For instance, when the own-price demand elasticities are higher compared to absolute values of the respective own-price supply elasticities, the total meat industry welfare decreases from $2,295.71 to $2,277.35.

Welfare Impacts of Country-of-Origin Labeling

The effects of implementing COOL on U.S. meat industry have been widely debated since the publication of the 2002 Farm Security and Rural Investment Act (FSRIA). The Act includes a provision requiring beef, pork, and lamb both ground and muscle cuts as well as fish, fruits and vegetables, and peanuts to be labeled as to their country of origin. The act mandated voluntary COOL on September 30, 2002 and mandatory COOL on September 30, 2004; however, it has been delayed until September 30, 2008 (USDA-AMS, 2006b). Opponents of COOL argue that implementation of COOL will increase production costs in the meat industry because of product blending, the number of ownership exchanges occurring in commodity livestock and meat markets, and the complexity of the meat supply chain, while proponents of COOL suggest that COOL will increase the demand for domestically produced product and improve livestock prices (Brester, Marsh, and Atwood). Due to unknown impacts of COOL on U.S. meat industry, several studies have estimated the costs and welfare impacts of implementing COOL on U.S. meat industry (Sparks Companies; VanSickle et al.; Lusk and Anderson; Brester, Marsh, and Atwood). Available studies that have estimated welfare impacts of COOL have used models that did not include the U.S. meat trade (imports and exports) and the analyzed meats were not differentiated by source of origin.

Although past studies did not include both U.S. meat imports and exports when analyzing the impact of COOL, the U.S. is a major player in the global meat market. In 2002, the U.S. was the first, second, and third largest exporter of poultry, beef, and pork, accounting for 37.9 percent, 17.8 percent, and 19.7 percent of global poultry, beef, and pork exports, respectively. Furthermore, in 2002, the U.S. was the largest importer of beef and third largest importer of pork; accounting for 29.3 percent, and 12.7 percent of the world total volume of beef and pork imports, respectively (USDA-FAS, 2006b).

Considering that the U.S. is a major player in global meat market, it becomes important to re-examine the impact of COOL on U.S. meat producers taking into account both U.S. meat imports and exports. Therefore, the objective of this study is to estimate the impact of COOL on U.S. meat producers using a model, which includes both U.S. meat imports and exports and with meat types differentiated by source of origin.

Methods of Simulating the Welfare Impacts of COOL

The model described above is used to simulate the welfare impacts of COOL. Parameter values described above and presented in table III-1 through table III-7 are assigned to the model. The remaining parameters needed to implement the model are supply and demand shifters. Supply shifters reflect a decrease in beef and pork supply due to implementation of COOL while demand shifters reflect an increase in demand for U.S. beef and pork after implementing COOL.

Regarding farm supply shifters, it is assumed that COOL costs are borne by U.S. beef and pork producers and foreign producers bear none of the costs associated with COOL. Implementation of COOL is reported to decrease the farm supply of U.S. beef within a range from 0.005 to 0.065 and the farm supply of U.S. pork within a range from 0.0025 to 0.03 (Lusk and Anderson). In this study, we use medium values of 0.03 and 0.01 reported by Lusk and Anderson as farm supply shifters of U.S. beef and pork, respectively. Using the 2002 average farm revenues for beef and pork, 0.03 and 0.01 decreases in farm supply for beef and pork correspond to total COOL costs of $17,436.9

million for beef and $68.8 million for pork. These costs fall in the range of COOL costs estimated by VanSickle et al. and Sparks Companies, Inc.

The supply shifters at retail level are computed by dividing the COOL costs reported above by the respective retail revenues. Using this method, retail supply shifter for beef and pork are 0.0173 and 0.0036, respectively. Each meat product that is marketed in the U.S. bears a cost proportional to its aggregate share of the market. Table III-10 presents the supply shifters of each meat product under the examined possibilities of cost incidence. The supply shifters are entered as negative numbers in equation (3.15) and (3.16) presented above to represent added costs to the system.

Following Lusk and Anderson, on the demand side, three scenarios of increases in demand for both U.S. beef and U.S. pork in the U.S. domestic market are examined: (a) no demand increase; (b) 0.02 increases in demand for beef and pork; (c) 0.05 increases in demand for beef and pork. The demand shifters are entered as a positive number in equation (3.14) to represent consumer willingness to pay for the initial quantity of meat due to the new labeling policy. The model is simulated using 2002 average prices and quantities under competitive market and some degree of retailer oligopsony market power, i.e. $\theta = 0.03$.

Four alternatives are examined for incidence of costs: (a) all costs are borne by U.S. meat producers; (b) the costs are equally divided between U.S. meat producers and retailers; (c) one-fourth of the costs are borne by U.S. meat producers and three-forth of the costs are borne by retailers; and (d) all costs are borne by retailers.

Results of Welfare Impacts of COOL

This section discusses the major results of impacts of COOL on U.S. meat producers and compares the results with those reported by Lusk and Anderson. The estimated impacts of COOL on U.S. meat producers are presented in table III-11. Under the assumption of no demand change, results of this study indicate that implementation of COOL decreases producer surplus of U.S. beef and pork producers and increases producer surplus of U.S. poultry producers regardless of who pays for the costs of COOL. U.S. Beef and pork producers lose from COOL implementation when they pay all the costs of COOL because beef and pork demands must increase to make the producer surplus neutral (Lusk and Anderson). Additionally, as proved by Lusk and Anderson, U.S. beef and pork producers lose from COOL when all COOL costs are borne by retailers because in this study, the absolute value of the own-price demand elasticities for beef and pork are greater than the elasticity of substitution between farm product and market input (fixed proportion technology). Poultry producers gains from COOL because COOL does not add additional costs to poultry industry and consequently consumers substitute away from relatively more expensive beef and pork to less expensive poultry.

Moreover, under the assumption of no demand change, the results show that when COOL costs are increasingly borne by retailers, producer surplus of U.S. poultry producers decreases. This result is not because retail COOL costs decrease the retail supply of poultry *per se*, but because of the complementary relationships between U.S. poultry and other meat products covered by COOL. The model is simulated using only positive and relatively large cross-price elasticities between U.S. poultry and other meat products covered by COOL.[8] The results, which are presented in table III-12 indicate that poultry producers are better off when COOL costs are increasingly borne by retailers.

Results presented in table III-11 show that assumptions related to a demand increase clearly have an important impact on affecting producer surplus. If the demands for beef and pork increase by at least 0.02, poultry producers do not benefit from COOL. Poultry producers lose when beef and pork demands increase by at least 0.02 because consumers will increase demand for beef and pork products and consequently negatively affecting the demand for poultry. Although 0.02 increases in the demands for beef and pork increases the producer surplus of U.S. pork producers, it does not increase the producer surplus of U.S. beef producers. Pork producers benefit and beef producers lose when there is 0.02 increase in beef and pork demands because COOL costs for pork are relatively lower than COOL costs for beef. However, if beef and pork demands increase by 0.05, both beef and pork producers benefit from COOL (table III-11).

Finally, the results presented in table III-11 show that retailer oligopsony market power decreases the producer surplus of U.S. beef and pork producers. However, different from previous expectations, results presented in table III-11 also show that under no demand increase, poultry producers gain from retailer oligopsony market power. This result does not mean that retailer oligopsony market power benefits poultry producers *per se*; but the difference in own-price supply and demand elasticities might explain the unexpected result. A one sector model is used to examine the change in producer surplus when there is retailer oligopsony market power. The derivations, which are presented in appendix IV, produce the following equation.

(3.24) $$\Delta PS_i = \frac{\varepsilon_{ii}\gamma_i + \eta_{ii}\nu_i + \eta_{ii}\varpi_i}{\eta_{ii}\delta_i(1 + \frac{\theta_i}{\varepsilon_{ii}}) - \varepsilon_{ii}}$$

where ΔPS_i is the change in producer surplus of meat *i*, η_{ii} is the own-price demand elasticity of meat *i*, ν_i is the retail supply shifter for meat *i*, ε_{ii} is the own-price supply elasticity of meat *i*, δ_i is the farm share of retail dollar for meat *i*, θ_i is the retailer oligopsony market power parameter for meat *i*, γ_i is the farm supply shifter of meat *i*, and ϖ_i is retail demand shifter of meat *i*.

According to equation (3.24), a change in producer surplus depends on own-price demand and supply elasticities, retail and farm supply shifters, retail demand shifter, retailer oligopsony market power parameter, and farm share of the retail dollar. Examining closely equation (3.24), it can be observed that the main parameter that is associated with the retail oligopsony market power is the ratio between the own-price demand and own-price supply elasticities. If the own-price demand elasticity is higher (in absolute value) compared to own-price supply elasticity, the change in producer surplus under retail oligopsony market power might tend to decrease. The model is simulated with greater (in absolute value) own-price demand elasticity for poultry than the respective own-price supply elasticity.[9] The simulated results, which are presented in table III-13 indicate that producer surplus of U.S. poultry producers decreases when retailers have oligopsony market power.

The results obtained in this study are similar to results reported by Lusk and Anderson. Both studies find that under no demand increase scenario, poultry producers benefit from COOL and under 0.05 increases in demand for beef and pork scenario, beef and pork producers benefit from COOL while poultry producers do not benefit from COOL. Some results obtained in this study are different from those reported by Lusk and Anderson. This study finds that under no demand increase scenario, beef and pork producers lose from COOL regardless of who pays the costs of COOL. However, Lusk and Anderson report that under no demand increase scenario, a 50/50 and 25/75 cost shares between U.S. meat producers and marketers, increase the producer surplus for U.S. pork and beef producers respectively. Difference in the elasticity of substitutions between market input and farm product used in the two studies explains the difference in the results.

Furthermore, Lusk and Anderson report that 0.02 increases in demand for beef and pork increases the producer surplus of U.S. beef and poultry producers when COOL costs are both shared and paid by marketers. However, this study finds that 0.02 increases in demand for beef and pork decreases producer surplus of U.S. beef and poultry producers. Finally, different from results reported by Lusk and Andersons, this study finds that meat producers as a whole lose from the implementation of COOL even under 0.02 and 0.05 increase in demand for beef and pork (table III-11). Difference in relative magnitude between supply and demand elasticities may explain the differences in the results. Different from this study Lusk and Andersons uses a model in which own-price supply elasticities of U.S. beef and pork are lower compared to the respective absolute value of own-price demand elasticities.

Following Lusk and Anderson, the model is simulated using relatively low own-price supply elasticities for beef and pork compared to the respective absolute values of own-price demand elasticities.[10] The results, which are presented in table III-14 indicate that similar to results reported by Lusk and Anderson, 0.02 and 0.05 increase in demand for beef and pork benefits U.S. beef and pork producers as well as the whole U.S. meat industry.

Importantly, under no demand increase and all COOL cost being borne by producers, the results of this study indicate that the negative impacts of COOL on U.S. beef and pork producers is largely lower compared to results reported by Lusk and Anderson. Lusk and Anderson also found lower negative impact of COOL on beef and pork producers under a model with U.S. meat imports compared to a model without trade. Therefore, these results suggest that models without trade might overestimate the negative impact of COOL on U.S. beef and pork producers.

Welfare Implications of Japanese and S. Korean Bans on U.S. Beef

After the discovery of *Bovine Spongiform Encephalopathy* (BSE) in the U.S. on December 23, 2003, Japan and S. Korea terminated imports of U.S. beef. The consequences of the Japanese and S. Korean bans of U.S. beef were severe. U.S. beef exports in 2003 were 2.52 billion pounds, but declined by 84 percent to 0.47 billion pounds in 2004 (Marsh, Brester, and Smith). The loss of the major U.S. export markets increased the quantities of beef available in the U.S. domestic market thereby depressing domestic prices below levels they would have attained if exports were possible. For example, Nebraska fed steer prices averaged $97.05 per hundredweight before the U.S. BSE outbreak; however they decreased by 21 percent to $76.27 per hundredweight over the first three weeks after the U.S. BSE outbreak (Marsh, Brester, and Smith).

Although the Japanese and S. Korean bans of U.S. beef is reported to have negatively affected U.S. beef producers, studies that have estimated the welfare impacts of the Japanese and S. Korean bans of U.S. beef on U.S. beef producers are limited. In general, past studies on the impact of BSE outbreak have estimated losses of trade shares, farmers and packers' revenues, and fluctuations in farm prices (Shroeder and Leatherman; Hanrahan and Becker; and Carter and Huie) and the impact of BSE outbreak on consumer meat demand (Jin and Koo; and Mangen and Burrel).

Considering that Japan and S. Korea are important markets for U.S. beef, a study that estimates the welfare impact of the Japanese and S. Korean bans of U.S. beef on U.S. beef producers and marketers is important. Furthermore, another relevant issue is how the Japanese and S. Korean bans of U.S. beef affect the welfare of other beef producers that supply beef in Japan and S. Korea. Therefore, this study estimates the welfare impacts of the Japanese and S. Korean bans of U.S. beef on U.S. beef producers, and marketers, and on other producers and marketers of other beef products that are marketed in Japan and S. Korea.

Methods of Simulating Japanese and S. Korean Bans on U.S. Beef

The model described above is used to simulate the welfare impacts of the Japanese and S. Korean bans of U.S. beef. Parameter values described above and presented in table III-1 through table III-7 are assigned to the model. The remaining values needed to implement the model are shocks necessary to impose the ban on U.S. beef in Japan and S. Korea. The Japanese and S. Korean bans on U.S. beef is imposed by shifting the Japanese and S. Korean demands for U.S. beef so that the change in quantity demanded for U.S. beef in Japan and S. Korea decreases by 100 percent.

Using Excel solver, a percentage decrease in demand for U.S. beef in Japan and S. Korea that yield a 100 percent decrease in the change of quantity demanded was estimated. The solver results indicate that in order to have a ban on U.S. beef in Japan and South Korea, the demands for U.S. beef in Japan and S. Korea should decrease by 466 percent and 825 percent, respectively. Therefore, the Japanese and S. Korean bans on U.S. beef were simulated by shifting the equations of the Japanese and S. Korean demands for U.S. beef by 466 percent and 825 percent, respectively. Three ban alternatives are examined: (a) the Japanese ban on U.S. beef; (b) the S. Korean ban on U.S. beef; and (c) both the Japanese and S. Korean bans on U.S. beef. The model is simulated using 2002 average prices and quantities.

Results of Welfare Implications of the Japanese and S. Korean Bans on U.S. beef

Table III-15 presents the results of welfare impacts of the Japanese, S. Korean, and both the Japanese and S. Korean bans of U.S. beef on U.S. beef producers and marketers and on other producers and marketers of other beef marketed in Japan and S. Korea. Concerning the Japanese ban on U.S. beef, the results show that the ban decreases the producer surplus of U.S. beef producers and marketers and increases producer surplus of Australian and Japanese beef producers and marketers.

The producer surplus of U.S. beef producers and marketers decreases because as the major U.S. beef importer stops importing U.S. beef, the quantities available of U.S. beef in the U.S. domestic market as well as in other U.S. export markets increase and consequently decrease U.S. beef price, which leads to a decrease in producer surplus of producers and marketers of U.S. beef. The producer surplus of Japanese and Australian beef producers and marketers increases because the shares of beef from these sources in the Japanese market increase as Japanese consumers substitute the non-existent U.S. beef with Japanese and Australian beef.

Regarding S. Korean ban on U.S. beef, the results show that the ban decreases producer surplus of U.S., Australian, and S. Korean beef farmers (table III-15). The reduction of producer surplus of Australian and S. Korean beef farmers is an unexpected result. Complementary relationships between U.S. beef and Australian beef in the S. Korean meat market might explain the result. Therefore, the cross-price elasticities between U.S. beef and Australian beef (-0.123 and -0.253 presented in table III-1) are changed to positive values (substitution relationship). The model is simulated and the results are presented in table III-16. The results indicate that similar to Japanese ban on U.S. beef, S. Korean ban on U.S. beef decreases producer surplus of U.S. beef producers and marketers and increases producer surplus of Australian and S. Korean beef producers and marketers (table III-16). Finally, the results indicate that when both Japan and S. Korea ban U.S. beef, U.S. beef producers and marketers lose more while the Australian, Japanese, and S. Korean beef producers and marketers gain more compared to single ban (table III-16).

Summary and Conclusions

This study builds an equilibrium displacement model, which includes both U.S. produced meats, U.S. meat imports from major partners and U.S. meat exports to major partners with meats differentiated by source of origin. Importantly, the model is flexible as it can simulate welfare impacts of supply and demand shocks, assuming perfect and imperfect competition in the meat industry. The model is used to estimate welfare impacts of beef and pork promotions, country-of-origin labeling (COOL), and the Japanese and S. Korean bans on U.S. beef using 2002 average prices and quantities. The major findings of each demand and supply shock analyzed in this study are presented in this section.

Regarding beef and pork promotions, similar to Wohlgenant study, this study finds that an increase in demand for beef and pork due to promotion activities increases producer surplus of U.S. beef and pork farmers. The increase in producer surplus of U.S. beef and pork is higher in a model with trade including export promotion compared to a model without trade. Similarly, the results of this study show that beef and pork promotions increase producer surplus for marketers of U.S. beef and pork and decrease producer surplus for marketers of U.S. poultry. The results also show that the negative impact of beef and pork promotions on poultry producers and marketers is small enough to suggest that U.S. meat producers and marketers as a group gain from beef and pork promotions. The effects of retailer oligopsony market power show that U.S. meat producers do not benefit from retailer oligopsony market power while U.S. retailers of U.S. meat benefit from their oligopsony market power.

Regarding the impact of COOL on U.S. meat producers, similar to Lusk and Anderson, this study finds that if fixed proportion technology is assumed at processor-retailer level of supply chain and there is no demand increase, COOL implementation decreases producer surplus of U.S. beef and pork producers and increases producer surplus of U.S. poultry producers. The negative impact of implementation of COOL on U.S. beef and pork producers when all costs of COOL are borne by producers is lower under a model with trade (U.S. meat imports and exports) compared to a model without trade. Furthermore, the results show that distribution of COOL costs has a major impact on the welfare effects of the legislation. Producer surplus of U.S. beef and pork producers increases when COOL costs are increasingly borne by retailers.

Moreover, the results show that consumers' reaction to COOL has a major impact on the welfare of U.S. meat producers. Beef and pork producers gain while poultry producers lose when there is an increase in demand for U.S. beef and pork. Under beef and pork demand increase scenarios, the net effects of COOL depend mainly on the absolute value of own-price supply and demand elasticities. If the own-price supply elasticities for beef and pork are lower compared to the respective absolute value of the own-price demand elasticities, COOL implementation accompanied with an increase in demand for beef and pork will likely benefit the meat industry. The results of retailer oligopsony market power show that beef, pork, and poultry producers are worse off if retailers have oligopsony market power.

Regarding the Japanese and S. Korean bans on U.S. beef, the results show that the Japanese and S. Korean bans on U.S. beef reduce the welfare of U.S. beef producers and marketers and increase the welfare of other producers of beef that compete with the

U.S. beef in the Japanese and S. Korean markets. The negative impact of the Japanese and S. Korean bans on U.S. beef is severe for the U.S. meat producers followed by the U.S., Mexican, Japanese, S. Korean, and Canadian retailers of U.S. beef. The benefits from the Japanese and S. Korean bans on U.S. beef are high for the Japanese followed by the Australian and S. Korean beef producers. Furthermore, the results show that the negative impact of banning U.S. beef is greater under multiple ban (Japanese and S. Korean bans) compared to single ban.

Footnotes

1. The major export countries are defined here as those that supply at least 10 percent of the quantity of imports of a specified meat type in each country that is included in the model. Those exporters are considered to be the U.S. competitors.

2. The supply price corresponds to the farm price if equation (3.2) is farm supply and it corresponds to export price if equation (3.2) is excess supply. P_{ij}^{s} is supply price for meats originated from the U.S., Canada, Mexico, Japan, and S. Korea, and P_{ij}^{s} is export price for meats from Australia, New Zealand, Denmark, China, Brazil, Thailand, and the ROW.

3. The derivation of the expression 3.5 is presented in appendix I.

4. The derivation of the results is presented in appendix II.

5. The derivation of unconditional own-price and cross-price demand elasticities is presented in appendix III.

6. The distribution of costs of promotion between fed and nonfed beef was done according to aggregate share of the market for each beef product. 85 percent of U.S. beef production is composed by fed beef, therefore the percentage decrease in supply of fed beef is equal to 0.002*0.85=0.0017 and the remaining 0.0003 are the percentage decrease in supply of nonfed beef.

7. The own-price demand elasticities of fed beef, nonfed beef and pork in the U.S. domestic market are changed to -1.357, -2.178, and -1.207, respectively.

8. The negative values of cross-price elasticities between the U.S. poultry and U.S. pork; U.S. poultry and Canadian pork; and U.S. poultry and ROW pork in the U.S. domestic market are changed from their original values of -0.648, -0.887, and -0.892, respectively to 1.648, 1.88, and 1.892, respectively.

9. The farm own-price supply elasticity and the own-price demand elasticity for poultry in the U.S. domestic market are set to be 0.3 and -0.8, respectively.

10. The own-price demand elasticities for fed beef, nonfed beef, pork and poultry in the U.S. domestic market are changed to -1.351, -2.178, -1.207 and -0.33, respectively.

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Appendix I: Derivation of Marketing Margin Equation

Consider two (farm and retail) sectors model of meat market chain where the consumers' inverse demand for the retail product and the inverse farm supply of the raw commodity are expressed as:

(A1) $P_{ijk}^{d} = D(Q_{ijk}^{d})$

(A2) $P_{ij}^{s} = S(Q_{ijk}^{s})$

(A3) $Q_{ijk}^{d} = Q_{ijk}^{s} = Q_{ijk}$

The representative retailer firm's profit function can be expressed as;

(A4) $\pi^{R} = (D(Q_{ijk}^{d})q_{ijk} - c_{ijk}q_{ijk} - S(Q_{ijk}^{s})q_{ijk}$

where q_{ijk} is the representative retailer firm's quantity supplied and demanded, All other variables are defined in the text.

The first-order necessary condition for maximizing equation (A4) is

(A5) $$\frac{\partial \pi^{R}}{\partial q_{ijk}} = D(Q_{ijk}^{d}) + \frac{\partial D(Q_{ijk}^{d})}{\partial Q_{ijk}^{d}} \frac{\partial Q_{ijk}^{d}}{\partial q_{ijk}} q_{ijk} - c_{ijk} - S(Q_{ijk}^{s}) - \frac{\partial S(Q_{ijk}^{s})}{\partial Q_{ijk}^{s}} \frac{\partial Q_{ijk}^{s}}{\partial q_{ijk}} q_{ijk} = 0$$

$$= D(Q_{ijk}^{d}) + \frac{\partial D(Q_{ijk}^{d})}{\partial Q_{ijk}^{d}} \frac{Q_{ijk}^{d}}{Q_{ijk}^{d}} \frac{D(Q_{ijk}^{d})}{D(Q_{ijk}^{d})} \frac{\partial Q_{ijk}^{d}}{\partial q_{ijk}} q_{ijk} = S(Q_{ijk}^{s}) + \frac{\partial S(Q_{ijk}^{s})}{\partial Q_{ijk}^{s}} \frac{Q_{ijk}^{s}}{Q_{ijk}^{s}} \frac{S(Q_{ijk}^{s})}{S(Q_{ijk}^{s})} \frac{\partial Q_{ijk}^{s}}{\partial q_{ijk}} q_{ijk} + c_{ijk}$$

Substituting $D(Q_{ijk}^{d})$ by P_{ijk}^{d} and $S(Q_{ijk}^{s})$ by P_{ij}^{s} yields:

(A6) $$P_{ijk}^{d} + \frac{\partial P_{ijk}^{d}}{\partial Q_{ijk}^{d}} \frac{Q_{ijk}^{d}}{Q_{ijk}^{d}} \frac{P_{ijk}^{d}}{P_{ijk}^{d}} \frac{\partial Q_{ijk}^{d}}{\partial q_{ijk}} q_{ijk} = P_{ij}^{s} + \frac{\partial P_{ij}^{s}}{\partial Q_{ijk}^{s}} \frac{Q_{ijk}^{s}}{Q_{ijk}^{s}} \frac{P_{ij}^{s}}{P_{ij}^{s}} \frac{\partial Q_{ijk}^{s}}{\partial q_{ijk}} q_{ijk} + c_{ijk}$$

Equation (A6) can be written in elasticity form as:

(A7) $$P_{ijk}^{d}(1+\frac{\xi_{ijk}}{\eta_{ijk}}) = P_{ij}^{s}(1+\frac{\theta_{ijk}}{\varepsilon_{ij}}) + c_{ijk}$$

where $\xi_{ijk} = \frac{\partial Q_{ijk}^{d}}{\partial q_{ijk}}\frac{q_{ijk}}{Q_{ijk}^{d}}$ and $\theta_{ijk} = \frac{\partial Q_{ijk}^{s}}{\partial q_{ijk}}\frac{q_{ijk}}{Q_{ijk}^{s}}$ are the conjectural elasticities

Appendix II: Derivation of Equilibrium Displacement Model

The equilibrium displacement model is developed by differentiating and taking log differentials for the structural demand, supply and equilibrium condition equation as shown below:

Demand

(B1) $Q_{ijk}^{d} = f(\mathbf{P_k^d})$

$$dQ_{ijk}^{d} = \frac{dQ_{ijk}^{d}}{d\mathbf{P_k^d}} d\mathbf{P_k^d}$$

$$\frac{dQ_{ijk}^{d}}{Q_{ijk}^{d}} = \frac{dQ_{ijk}^{d}}{d\mathbf{P_k^d}} \frac{\mathbf{P_k^d}}{Q_{ijk}^{d}} \frac{d\mathbf{P_k^d}}{\mathbf{P_k^d}}$$

$$Q_{ijk}^{d*} = \boldsymbol{\eta}\mathbf{P_k^{d*}}$$

where all variables and parameters are explained in the text.

Supply

(B2) $Q_{ij}^{s} = f(P_{ij}^{s})$

$$dQ_{ij}^{s} = \frac{dQ_{ij}^{s}}{dP_{ij}^{s}} dP_{ij}^{s}$$

$$\frac{dQ_{ij}^{s}}{Q_{ij}^{s}} = \frac{dQ_{ij}^{s}}{dP_{ij}^{s}} \frac{P_{ij}^{s}}{Q_{ij}^{s}} \frac{dP_{ij}^{s}}{P_{ij}^{s}}$$

$$Q_{ij}^{s*} = \varepsilon_{ij} P_{ij}^{s*}$$

where all variables and parameters are explained in the text.

Quantity Equilibrium Condition

(B3) $$Q_{ij}^{s} = Q_{ijj}^{d} + \sum_{k \neq j}^{K} Q_{ijk}^{d}$$

$$dQ_{ij}^{s} = dQ_{ijj}^{d} + \sum_{K \neq j}^{K} dQ_{ijk}^{d}$$

$$\frac{dQ_{ij}^{s}}{Q_{ij}^{s}} = \frac{Q_{ijj}^{d}}{Q_{ij}^{s}} \frac{dQ_{ijj}^{d}}{Q_{ijj}^{d}} + \sum_{k \neq j}^{K} \frac{Q_{ijk}^{d}}{Q_{ij}^{s}} \frac{dQ_{ijk}^{d}}{Q_{ij}^{s}}$$

$$Q_{ij}^{s*} = \tau_{ijj} Q_{ijj}^{d*} + \sum_{k \neq 1}^{K} \lambda_{ijk} Q_{ijk}^{d*}$$

(B4) $$Q_{ijk}^{s*} = Q_{ijk}^{d*}$$

where all variables and parameters are defined in the text.

Retail-Farm Price Linkage

(B5) $$P_{ijk}^{d} (1 + \frac{\xi}{\eta_{ijk}}) = P_{ij}^{s} (1 + \frac{\theta}{\varepsilon_{ij}}) + c_{ijk}$$

$$dP_{ijk}^{d} (1 + \frac{\xi}{\eta_{ijk}}) = dP_{ij}^{s} (1 + \frac{\theta}{\varepsilon_{ij}})$$

$$\frac{dP_{ijk}^{d}}{P_{ijk}^{d}} (1 + \frac{\xi}{\eta_{ijk}}) = \frac{dP_{ij}^{s}}{P_{ijk}^{d}} \frac{P_{ij}^{s}}{P_{ij}^{s}} (1 + \frac{\theta}{\varepsilon_{ij}})$$

$$(1 + \frac{\xi}{\eta_{ijk}}) P_{ijk}^{d*} = (1 + \frac{\theta_{ijk}}{\varepsilon_{ij}}) \delta_{ijk} P_{ij}^{s*}$$

where all variables and parameters are defined in the text

Appendix III: Derivation of Unconditional Price and Expenditure Elasticities

The Marshallian elasticities computed in the RSDAIDS model are conditional elasticities given that weak separability between meat products and other commodities was assumed. In order to have the unconditional demand elasticities, a transformation following two-stage budget procedure is presented. Consider the unconditional Marshallian demand given by:

(C1) $\mathbf{q} = f(\mathbf{p}, Y)$

where $\mathbf{q}$ is a vector of quantities of goods, $\mathbf{p}$ is a vector of corresponding nominal prices, and *Y* is total income so that $Y = \mathbf{q}'\mathbf{p}$. Under two stages budgeting (TBS), the allocation of the total income *Y* takes place in two independent stages.

First stage, total income *Y* is allocated between $\mathbf{n}$ vector of commodity groups, such as meats, other food items, and non food items. The total income *Y* is allocated to $\mathbf{n}$ vector of commodity groups as:

(C2) $\mathbf{x} = \psi(\mathbf{p}, Y)$

where **x** is vector of group expenditures and **p** is a vector of group price indices.

The second stage consists of the allocation of group expenditure **x** among each goods within an individual group of commodity so that:

(C3) $\mathbf{q}_{\mathbf{(m),i}} = g_m(\mathbf{p}_{\mathbf{(m),i}}, x_m)$ [1],

[1] Equation (C3) is the conditional demand of meat *i* within commodity group *m*.

where $\mathbf{q}_{\mathbf{(m),i}}$ is a vector of quantities of good i within commodity group m, x_m is the total expenditure in commodity group m. $\mathbf{p}_{\mathbf{(m),i}}$ is a vector of prices of good i within commodity group m.

For the TSB to hold, the conditional and unconditional demand functions should yield the same results so that:

(C4) $f_m(\mathbf{p}, Y) = g_m\left[\mathbf{p}_{\mathbf{(m),i}}, \psi_m(\mathbf{p}, Y)\right]$

From equation (C4) above, we can derive the unconditional expenditure and the unconditional cross-price and own-price demand elasticities from the respective estimated conditional elasticities as follows:

(C5) $$\frac{\partial \ln f_m}{\partial \ln p_{(m),h}} = \frac{\partial \ln g_m}{\partial \ln p_{(m),h}} + \frac{\partial \ln g_m}{\partial \ln \psi_m} \frac{\partial \ln \psi_m}{\partial \ln p_{(m),h}}$$

where $p_{(m),h}$ is the price of good h within commodity group m, and other variables are defined as before.

From equation (C3) above, we know that $g_m = q_{(m),i}$ and $\psi_m = x_m$, therefore, equation (C5) becomes:

(C6) $$\begin{aligned} \frac{\partial \ln f_m}{\partial \ln p_{(m),h}} &= \frac{\partial \ln q_{(m),i}}{\partial \ln p_{(m),h}} + \frac{\partial \ln q_{(m),i}}{\partial \ln x_m} \frac{\partial \ln x_m}{\partial \ln p_{(m),h}} \\ &= \frac{\partial q_{(m),i}}{\partial p_{(m),h}} \frac{p_{(m),h}}{q_{(m),i}} + \frac{\partial q_{(m),i}}{\partial x_m} \frac{x_m}{q_{(m),i}} \frac{\partial x_m}{\partial p_{(m),h}} \frac{p_{(m),h}}{x_m} \\ &= \eta_{(m)i,h} + \eta_{(m),i} \frac{\partial x_m}{\partial p_{(m),h}} \frac{p_{(m),h}}{x_m} \end{aligned}$$

We know that the total expenditure for meat group m is: $x_m = P_m Q_m$, thus

(C7) $$\frac{\partial x_m}{\partial p_{(m),h}} \frac{p_{(m),h}}{x_m} = \frac{\partial p_m}{\partial p_{(m),h}} \frac{p_{(m),h}}{p_m} + \frac{\partial Q_m}{\partial p_m} \frac{p_m}{Q_m} \frac{\partial p_m}{\partial p_{(m),h}} \frac{p_{(m),h}}{p_m}$$

Fan *et al*. suggest that if the true cost of living index is proportional to the cost function, and the derivative $(\partial c / \partial p)(p / c)$ is equal to relevant budget share, we can conclude

(C8) $(\partial p_m / \partial p_{(m),h})(p_{(m),h} / p_m) = w_{h,m}$, thus substituting (C8) in (C7) we have

(C9) $\frac{\partial x_m}{\partial p_{(m),h}} \frac{p_{(m),h}}{x_m} = w_{h,i} + \eta_{mm} w_{h,m}$, substituting (C9) in (C6) we have

(C10) $$\frac{\partial \ln f_m}{\partial \ln p_{(m),h}} = \eta_{(m)i,j} + E_{(m),i}(w_{h,m} + \eta_{mm} w_{h,m})$$

where $\eta_{(m)i,h}$ is the conditional cross-price demand elasticity between meat *i* and meat *h*, in meat group m, $E_{(m),i}$ is the conditional expenditure elasticity of meat *i*, within meat group *m*, $w_{h,m}$ is the budget share of meat *h* within meat group *m*, η_{mm} is the unconditional own-price demand elasticity of meat group *m*.

The derivation of the unconditional own-price demand elasticity is similar to the derivation of the unconditional cross-price elasticity presented above and it produces the following expression.

(C11) $$\frac{\partial \ln f_m}{\partial \ln p_{(m),i}} = \eta_{(m)i,i} + E_{(m),i}(w_{i,m} + \eta_{mm} w_{i,m})$$

where $\eta_{(m)i,i}$ is the conditional own-price demand elasticity of meat *i* in meat group *m*, $w_{i,m}$ is the budget share of meat *i* within meat group *m*.

Appendix IV: Derivation of Producer Surplus for one Sector Model

(D1) $Q_i^{d*} = \eta_{ii} P_i^{d*} - \eta_{ii} \varpi_i$

(D2) $Q_i^{s*} = \varepsilon_{ii} P_i^{s*} + \varepsilon_{ii} \gamma_i$

(D3) $Q_i^{s*} = Q_i^{d*}$

(D4) $P_i^{d*}(1 + \frac{\xi_i}{\eta_{ii}}) = P_i^{s*} \delta_i (1 + \frac{\theta_i}{\varepsilon_{ii}}) - \upsilon_i$

Where Q_i^{d*} is the change in quantity demanded of meat *i*, η_{ii} is the own-price demand elasticity of meat *i*, P_i^{d*} is the change in demand price of meat *i*; ϖ_i is demand shifter of meat *i*, Q_i^{s*} is the change in quantity supplied of meat *i*, ε_{ii} is the own-price supply elasticity of meat *i*, P_i^{s*} is the change in supply price of meat *i*, γ_i is the farm supply shifter of meat *i*, ξ_i is the retailer oligopoly market power parameter for meat *i*, δ_i is the farm retail dollar share for meat *i*, θ_i is the retailer oligopsony market power parameter for meat *i*, ν_i is the retail supply shifter for meat *i*.

Substitute equation (D4) in equation (D1)

(D5) $Q_i^{d*} = \eta_{ii} \left[\delta_i (1 + \frac{\theta_i}{\varepsilon_{ii}}) / (1 + \frac{\xi_i}{\eta_{ii}}) \right] P_i^{s*} - \frac{\nu_i}{(1 + \frac{\xi_i}{\eta_{ii}})} - \eta_{ii} \varpi_i$

Substitute equation (C5) in equation (C2)

$$\eta_{ii}\left[\delta_i(1+\frac{\theta_i}{\varepsilon_{ii}})/(1+\frac{\xi_i}{\eta_{ii}})\right]P_i^{s*}-\frac{\nu_i}{(1+\frac{\xi_i}{\eta_{ii}})}-\eta_{ii}\varpi_i=\varepsilon_{ii}P_i^{s*}+\varepsilon_{ii}\gamma_i$$

Solving for P_i^{s*} we get:

$$\text{(D6)}\quad P_i^{s*}=\frac{\varepsilon_{ii}\gamma_i+\frac{\eta_{ii}\nu_i}{(1+\frac{\xi_i}{\eta_{ii}})}+\eta_{ii}\varpi_i}{\eta_{ii}\delta_i\frac{(1+\frac{\theta_i}{\varepsilon_{ii}})}{(1+\frac{\xi_i}{\eta_{ii}})}-\varepsilon_{ii}}$$

The change in producer surplus is calculated as: $\Delta PS_i=P_i^sQ_i^s(P_i^{s*}+\gamma_i)(1+0.5Q_i^{s*})$

Following Lusk and Anderson, change in producer surplus is characterized by investigating changes in $(P_{ij}^{s*}+\gamma_{ij})$. Substituting equation (D6) in term $(P_{ij}^{s*}+\gamma_{ij})$, we get:

$$\text{(D7)}\quad \Delta PS_i=\frac{\varepsilon_{ii}\gamma_i+\frac{\eta_{ii}\nu_i}{(1+\frac{\xi_i}{\eta_{ii}})}+\eta_{ii}\varpi_i}{\eta_{ii}\delta_i\frac{(1+\frac{\theta_i}{\varepsilon_{ii}})}{(1+\frac{\xi_i}{\eta_{ii}})}-\varepsilon_{ii}}+\gamma_i$$

Considering retailer oligopsony market power only equation (D7) becomes:

$$\text{(D8)}\quad \Delta PS_i=\frac{\varepsilon_{ii}\gamma_i+\eta_{ii}\nu_i+\eta_{ii}\varpi_i}{\eta_{ii}\delta_i(1+\frac{\theta_i}{\varepsilon_{ii}})-\varepsilon_{ii}}$$

Table III-1. Marshallian Unconditional Elasticities for the U.S. Meat Demand Model

	U.S. Source Differentiated Meat Demand Elasticities									
	Fbus	*nfbus*	*ab*	*cb*	*nzb*	*rowb*	*uspk*	*cpk*	*rowpk*	*uspl*
Pfbus	-0.357	0.629	0.212	0.808	0.620	0.580	0.025	0.665	0.711	0.440
Pnfbus	0.082	-0.178	-0.228	-0.692	0.674	-0.579	-0.255	0.400	0.509	0.826
Pba	0.007	-0.048	-2.251	0.417	3.927	0.125	-0.288	0.368	0.485	0.144
Pbc	0.030	-0.182	0.514	-0.805	0.076	-0.099	-0.286	0.370	0.487	0.146
Pbnz	0.036	0.105	2.641	0.048	-4.354	0.618	-0.291	0.365	0.483	0.141
Pbrow	0.010	-0.073	0.073	-0.048	0.538	-0.905	-0.292	0.364	0.482	0.140
Ppkus	0.164	-0.448	-1.870	-1.009	-2.708	2.128	-0.207	0.900	0.989	-0.648
Ppkc	-0.088	-0.707	-1.093	-1.221	-2.659	1.865	0.031	-1.007	-0.657	-0.887
Ppkrow	-0.092	-0.712	-1.097	-1.225	-2.658	1.860	0.015	-0.295	-1.404	-0.892
Pplus	-0.070	0.124	-0.292	1.039	-0.836	-1.925	0.018	-0.462	-0.029	-0.005

Notes: *b*=Beef; *pk*=pork; *pl*=poultry;*P*=price; *fb*=fed beef; *nfb*=nonfed beef; *a*=Australia; *c*=Canada; *nz*=New Zealand; *us*=The U.S.; *row*=rest-of-the world

Table III-2. Marshallian Unconditional Elasticities for the Canadian Meat Demand Model

	Canadian Source Differentiated Meat Demand Elasticities								
	bus	*ba*	*bc*	*brow*	*pkus*	*pkc*	*pkrow*	*plus*	*plc*
Pbus	-1.622	-0.098	0.192	1.076	-0.087	-0.004	-0.417	0.245	0.074
Pba	-0.029	-1.314	0.019	-0.478	-0.103	-0.021	-0.434	0.218	0.051
Pbc	1.880	0.515	-1.222	0.332	0.134	0.237	-0.176	0.607	0.361
Pbrow	0.527	-0.713	0.001	-0.903	-0.099	-0.017	-0.430	0.225	0.056
Ppkus	-0.262	-0.387	0.415	-1.452	-0.388	0.009	-0.284	-1.021	-0.282
Ppkc	-0.026	-0.235	0.622	-1.171	0.201	-0.807	0.167	-0.693	0.015
Ppkrow	-0.271	-0.383	0.410	-1.468	-0.032	0.001	-1.281	-1.045	-0.301
Pplus	-1.135	1.203	-0.100	0.864	-0.428	0.093	1.106	-1.141	0.100
Pplc	-1.007	1.281	0.011	1.020	-0.315	0.216	1.229	1.218	-0.624

Notes: *b*=Beef; *pk*=pork; *pl*=poultry; *P*=price; *a*=Australia; *c*=Canada; *m*=Mexico; *nz*=New Zealand; *us*=The U.S.; *row*=rest-of-the world

Table III-3. Marshallian Unconditional Elasticities for the Mexican Meat Demand Model.

	Mexican Source Differentiated Meat Demand Elasticities									
	bus	*bc*	*bm*	*brow*	*pkus*	*pkm*	*pkrow*	*plus*	*plm*	*plrow*
Pbus	-2.002	0.625	0.070	1.784	-0.193	0.565	1.333	-0.768	0.221	0.074
Pbc	0.099	-0.168	-0.055	0.709	-0.211	0.544	1.307	-0.785	0.204	0.053
Pbm	0.507	-2.362	-0.991	0.138	-0.061	0.718	1.519	-0.645	0.346	0.224
Pbrow	0.067	0.168	0.001	-0.753	-0.214	0.541	1.303	-0.788	0.201	0.050
Ppkus	-0.857	0.789	0.293	-3.414	-0.043	0.033	1.433	0.065	-0.541	-5.229
Ppkm	-0.760	0.897	0.382	-3.304	-1.108	-0.739	-3.554	0.142	-0.464	-5.136
Ppkrow	-0.865	0.780	0.285	-3.424	0.224	-0.054	0.438	0.059	-0.548	-5.237
Pplus	1.424	0.213	-0.099	0.807	-1.186	-0.649	-0.460	-0.148	-0.017	4.411
Pplm	1.578	0.383	0.041	0.981	-1.057	-0.499	-0.278	-0.199	-0.647	1.074
Pplrow	1.410	0.197	-0.112	0.791	-1.198	-0.663	-0.477	0.223	0.159	-1.119

Notes: *b*=Beef; *pk*=pork; *pl*=poultry;*P*=price; *fb*=fed beef; *nfb*=nonfed beef; *a*=Australia; *c*=Canada; *m*=Mexico ; *nz*=New Zealand; *us*=The U.S.; *row*= the rest-of-the world.

Table III-4. Marshallian Unconditional Elasticities for the Japanese Meat Demand Model

	Japanese Source Differentiated Meat Demand Elasticities														
	usb	*ab*	*jb*	*rowb*	*uspk*	*dpk*	*cpk*	*jpk*	*rowpk*	*uspl*	*tpl*	*chpl*	*brapl*	*jpl*	*rowpl*
Pbus	-0.226	0.011	0.190	0.753	0.093	0.156	-0.546	-0.214	-0.614	-0.306	-0.624	-1.159	-0.980	-0.075	-0.172
Pba	0.009	-0.329	0.066	-0.176	0.079	0.070	-0.552	-0.229	-0.622	-0.325	-0.641	-1.178	-0.995	-0.095	-0.190
Pbj	-0.196	0.261	-0.380	0.089	0.159	0.347	-0.515	-0.143	-0.574	-0.217	-0.548	-1.068	-0.909	0.018	-0.085
Pbrow	0.061	-0.010	0.002	-1.183	0.051	0.153	-0.565	-0.259	-0.639	-0.362	-0.673	-1.217	-1.024	-0.135	-0.227
Ppkus	-0.342	-0.256	0.255	-0.284	-0.843	-1.817	-0.325	0.194	0.837	-0.080	-0.157	-0.682	-0.017	-0.144	-0.095
Ppkd	-0.345	-0.258	0.253	-0.287	-1.593	-0.889	-1.301	0.087	1.003	-0.083	-0.160	-0.685	-0.019	-0.147	-0.098
Ppkc	-0.362	-0.275	0.239	-0.306	-0.158	-0.722	-0.880	0.140	0.702	-0.099	-0.174	-0.702	-0.032	-0.165	-0.114
Ppkj	-0.221	-0.137	0.351	-0.154	0.767	-0.070	1.028	-0.193	-0.838	0.041	-0.054	-0.559	0.079	-0.017	0.023
Ppkrow	-0.338	-0.252	0.258	-0.280	0.929	1.555	1.502	-0.214	-2.050	-0.076	-0.154	-0.678	-0.014	-0.140	-0.092
Pplus	0.001	-0.368	-0.607	0.131	0.079	1.284	-0.350	-0.505	0.156	-0.083	-0.371	0.120	-0.118	0.001	0.284
Pplt	0.008	-0.360	-0.602	0.139	0.084	1.362	-0.348	-0.499	0.159	-0.819	-0.814	0.491	-0.274	-0.072	0.872
Pplch	0.012	-0.356	-0.598	0.144	0.087	1.461	-0.346	-0.496	0.161	0.345	0.637	-1.800	0.616	0.088	-0.589
Pplbra	0.003	-0.365	-0.605	0.134	0.081	1.382	-0.349	-0.503	0.157	-0.165	-0.175	0.304	-0.863	-0.028	0.180
Pplj	0.209	-0.165	-0.449	0.359	0.222	-0.230	-0.306	-0.345	0.225	0.378	-0.884	2.160	-0.301	-0.312	0.068
Pplrow	0.134	-0.220	-0.338	0.213	0.382	1.382	0.211	-0.237	0.652	0.227	0.357	0.058	0.316	0.027	-1.041

Notes: *b*=Beef; *pk*=pork; *pl*=poultry; *P*=price; *a*=Australia; *bra*=Brazil; *c*=Canada; *ch*=China; *d*=Denmark; *j*=Japan; *t*=Thailand; *us*=The U.S.; row=rest of the world.

Table III-5. Marshallian Unconditional Elasticities for the South Korean Meat Demand Model

	S. Korean Source Differentiated Meat Demand Elasticities												
	bus	*ba*	*bk*	*brow*	*pkus*	*pkd*	*pkc*	*pkk*	*pkrow*	*plus*	*plt*	*plk*	*plrow*
Pbus	-0.134	-0.253	0.028	-0.850	0.077	-0.057	-0.119	-0.100	-0.227	-0.131	-0.049	-0.156	-0.287
Pba	-0.123	-0.588	0.026	0.543	0.042	-0.086	-0.152	-0.132	-0.257	-0.154	-0.071	-0.181	-0.315
Pbk	0.009	0.064	-0.792	-0.137	0.154	0.009	-0.046	-0.029	-0.160	-0.080	0.001	-0.097	-0.222
Pbrow	-0.178	0.221	-0.012	0.295	0.024	-0.101	-0.169	-0.149	-0.273	-0.166	-0.084	-0.196	-0.331
Ppkus	-0.219	0.043	-0.365	-0.194	-0.442	0.211	-0.264	-0.004	-0.006	-0.123	-0.089	-0.014	-0.539
Ppkd	-0.218	0.043	-0.364	-0.193	0.253	-0.483	-0.100	-0.002	-0.017	-0.122	-0.089	-0.013	-0.538
Ppkc	-0.219	0.043	-0.364	-0.194	-0.287	-0.092	-0.092	-0.008	-0.892	-0.123	-0.089	-0.013	-0.539
Ppkk	-0.025	0.235	-0.075	0.077	-0.199	-0.143	-0.445	-0.565	-0.077	0.057	0.087	0.191	-0.313
Ppkrow	-0.205	0.057	-0.343	-0.174	-0.032	-0.077	0.545	-0.005	-0.174	-0.110	-0.076	0.002	-0.522
Pplus	-0.165	-0.302	0.400	-0.391	0.018	-0.029	-0.156	0.044	-0.270	-0.805	0.028	-0.001	-0.139
Pplt	-0.164	-0.301	0.401	-0.389	0.019	-0.027	-0.155	0.045	-0.269	0.034	-0.843	0.007	0.007
Pplk	-0.152	-0.291	0.485	-0.319	0.089	0.049	-0.095	0.100	-0.225	-0.109	-0.367	-0.833	0.283
Pplrow	-0.166	-0.304	0.397	-0.393	0.015	-0.032	-0.158	0.041	-0.272	0.197	0.380	0.109	-0.564

Notes: *b*=Beef; *pk*=pork; *pl*=poultry; *P*=price; *a*=Australia; *c*=Canada; *ch*=China; *d*=Denmark; *k*=Korea; *t*=Thailand; *us*=The U.S.; *row*=the rest-of-the world.

Table III-6 Supply and Excess Supply Elasticities for Different Meat Products

Products	Supply elasticities		Demand elasticities		Meat Quantities (1000 MT)			
	Value	Source	Value	Source	Supplied	Demanded	Exported	Elasticity
fbus	0.60	Brester & Wohlgenant, 1997						0.60
nfbus	1.41	Brester & Wohlgenant, 1997						1.41
pkus	0.40	Lusk & Anderson, 2004						0.40
plus	0.65	Lusk & Anderson, 2004						0.65
bc	0.50	Tvedt et al. 1991						0.50
pkc	1.50	Tvedt et al. 1991						1.50
plc	0.70	Sullivan *et al.* 1989						0.70
bm	0.30	Tvedt et al. 1991						0.30
pkm	0.55	Tvedt et al. 1991						0.55
plm	0.70	Sullivan *et al.* 1989						0.70
bj	0.40	Tvedt et al. 1991						0.40
pkj	0.83	Tvedt et al. 1991						0.83
polj	1.27	Sullivan *et al.* 1989						1.27
bk	0.50	Tvedt et al. 1991						0.50
pkk	0.70	Tvedt et al. 1991						0.70
plk	0.90	Sullivan *et al.* 1989						0.90
ba	0.70	Tvedt et al. 1991	-0.78	Tvedt et al. 1991	2028	766	1267	1.59
bnz	0.45	Tvedt et al. 1991	-0.60	Tvedt et al. 1991	576	102	493	0.65
pkd	0.80	Sullivan *et al.* 1989	-0.80	Sullivan *et al.* 1989	1759	346	1392	1.21
plbra	0.65	Sullivan *et al.* 1989	-0.80	Tvedt et al. 1991	7239	5522	1718	5.31
plch	0.49	Sullivan *et al.* 1989	-0.60	Tvedt et al. 1991	13604	13586	1135	13.06
plt	0.70	Sullivan *et al.* 1989	-0.80	Sullivan *et al.* 1989	1414	898	490	3.49
brow	0.50	Tvedt et al. 1991/Brazil value	-0.70	Tvedt et al. 1991/Brazil value	12054	10464	1600	8.34
pkrow	0.90	Tvedt et al. 1991/EU value	-0.80	Tvedt et al. 1991/EU value	17845	16720	5373	5.48
plrow	0.80	EC value/Sullivan *et al.* 1989	-0.90	Tvedt et al. 1991/EC value	9018	7958	2811	5.11

Notes: *b*= beef; *fb*=fed beef; *nfb*=nonfed beef; *pk*=pork; *pl*=poultry; *us*=the U.S.; *c*=Canada; *m*=Mexico ;*j*=Japan; *k*=Korea; *a*=Australia; *nz*=New Zealand; *d*=Denmark; *bra*=Brazil; *ch*=China; *t*=Thailand; *row*=the rest-of-the world.

Table III-7. Quantity and Price Proportions for Different Meat Products.

Meat Products	Meat Quantities (1000 MT)		Prices ($/MT)		Proportions	
	Supplied[a]	Demanded[b]	Supply[c]	Demand[d]	Price (P^s/P^d)	Quantity (Q^d/Q^s)
fbus in *us*	10594	9506	1478	2517	0.587	0.897
nfbus in *us*	1799	1799	989	1925	0.514	1.000
ba in *us*	2028	379	1933	2491	0.776	0.187
bc in *us*	1294	390	1468	2880	0.510	0.301
bnz in *us*	576	201	1549	2523	0.614	0.349
brow in *us*	12054	103	952	2805	0.339	0.009
pkus in *us*	8929	8215	770	2219	0.347	0.920
pkc in *us*	1858	382	669	1954	0.342	0.206
pkrow in *us*	17845	73	1350	3778	0.357	0.004
plus in *us*	17311	14805	465	1231	0.378	0.855
bus in *c*	10594	72	1478	3190	0.463	0.007
ba in *c*	2028	93	1933	2014	0.960	0.046
bc in *c*	1294	1040	1468	3070	0.478	0.804
brow in *c*	12054	56	952	1958	0.486	0.005
pkus in *c*	8929	57	770	2148	0.358	0.006
pkc in *c*	1858	1042	669	2231	0.300	0.561
pkrow in *c*	17845	1	1350	2729	0.495	5.604E-05
plus in *c*	17311	114	465	1530	0.304	0.007
plc in *c*	1111	602	727	1470	0.494	0.542
bus in *m*	10594	284	1478	3171	0.466	0.027
bc in *m*	1294	59	1468	2776	0.529	0.046
bm in *m*	1468	1468	1357	2796	0.485	1.000
brow in *m*	12054	13	952	2304	0.413	0.001
pkus in *m*	8929	200	770	1284	0.599	0.022
pkm in *m*	1070	1070	1293	2064	0.626	1.000
pkrow in *m*	17845	39	1350	1415	0.954	0.002
plus in *m*	17311	381	465	679	0.685	0.022
plm in *m*	2123	2123	1269	2203	0.576	1.000
plrow in *m*	9018	8	1527	2199	0.694	0.001

Notes: *b*=beef; *pk*=pork; *pl*=poultry; *fb*=fed beef; *nfb*=nonfed beef; *a*=Australia; *c*=Canada; *m*=Mexico; *nz*=New Zealand; *row*=the rest-of-the world; *us*=the U.S.

All values refers to 2002 annual values; P^d is demand price, P^s is supply price, Q^d is the quantity demanded; and Q^s is the quantity supplied

a: The data are from Food and Agriculture Organization (FAO); USDA-FAS(2006a); USDA-FAS(2006b).

b: The data are from USDA-FAS(2006a).

c: The data are from Organization for Economic Co-Operation and Development (OECD);USDA-FAS (2006b), Agriculture and Agri-Food Canada.

d: The data are from USDA-FAS (2006a).

Table III-7. Quantity and Price Proportions for Different Meat Products.

Meat Products	Meat Quantities (1000 MT)		Prices ($/MT)		Proportions	
	Supplied[a]	Demanded[b]	Supply[c]	Demand[d]	Price (P^s/P^d)	Quantity (Q^d/Q^s)
bus in *j*	10594	227	1478	3150	0.469	0.021
ba in *j*	2028	231	1933	2808	0.688	0.114
bj in *j*	537	537	4963	5713	0.869	1.000
brow in *j*	12054	31	952	2603	0.366	0.003
pkus in *j*	8929	259	770	4485	0.172	0.029
pkd in *j*	1759	241	1350	4500	0.300	0.137
pkc in *j*	1858	181	669	4539	0.147	0.097
pkj in *j*	1246	1246	3420	3606	0.948	1.000
pkrow in *j*	17845	117	1350	4498	0.300	0.007
plus in *j*	17311	51	465	1263	0.368	0.003
plt in *j*	1414	208	1601	1895	0.845	0.147
plch in *j*	13604	161	1560	1767	0.883	0.012
plbra in *j*	7239	169	868	1503	0.577	0.023
plj in *j*	1229	1229	1857	3800	0.489	1.000
plrow in *j*	9018	114	1527	4534	0.337	0.013
bus in *k*	10594	201	1478	3033	0.487	0.019
ba in *k*	2028	83	1933	2314	0.835	0.041
bk in *k*	211	211	6473	7121	0.909	1.000
brow in *k*	12054	32	952	2311	0.412	0.003
pkus in *k*	8929	15	770	1164	0.662	0.002
pkd in *k*	1759	20	1350	1934	0.698	0.011
pkc in *k*	1858	38	669	828	0.808	0.020
pkk in *k*	1005	1005	1467	2185	0.672	1.000
pkrow in *k*	17845	53	1350	2491	0.542	0.003
plus in *k*	17311	68	465	854	0.545	0.004
plt in *k*	1414	31	1601	1660	0.965	0.022
plk in *k*	437	437	952	1769	0.538	1.000
plrow in *k*	9018	161	1527	1767	0.864	0.018

Notes: *b*=beef; *pk*=pork; *pl*=poultry; *a*=Australia; *bra*=Brazil; *c*=Canada; *ch*=China; *d*=Denmark; *j*=Japan; *k*=Korea; *row*=the rest-of-the world; *t*=Thailand; *and us*=the U.S.

All values refers to 2002 annual values; P^d is demand price, P^s is supply price, Q^d is the quantity demanded; and Q^s is the quantity supplied

a: The data are from Food and Agriculture Organization (FAO); USDA-FAS(2006a); USDA-FAS (2006b).

b: The data are from USDA-FAS(2006a).

c: The data are from Organization for Economic Co-Operation and Development (OECD);USDA-FAS (2006b), Agriculture and Agri-Food Canada.

d: The data are from USDA-FAS (2006a).

Table III-8. Results of Welfare Impacts of Beef and Pork Promotions ($ millions).

Description	Beef	Pork	Poultry	Total Meat Industry Producer Surplus
Perfectly competitive market				
Change in producer surplus at farm level in the U.S.	270.09	342.59	-493.66	119.02
Change in producer surplus at retail level in the U.S.	265.79	340.74	-420.44	186.09
Change in producer surplus at retail level in Canada	2.16	2.36	-3.38	1.14
Change in producer surplus at retail level in Japan	6.56	10.83	-1.50	15.90
Change in producer surplus at retail level in Mexico	8.30	8.48	-11.37	5.41
Change in producer surplus at retail level in South Korea	5.78	0.62	-2.02	4.38
Retailer oligopsony Market Power (θ=0.03)				
Change in producer surplus at farm level in the U.S.	265.68	343.00	-503.92	104.76
Change in producer surplus at retail level in the U.S.	275.12	366.69	-448.95	192.86
Change in producer surplus at retail level in Canada	2.24	2.54	-3.61	1.17
Change in producer surplus at retail level in Japan	6.80	11.66	-1.60	16.86
Change in producer surplus at retail level in Mexico	8.56	9.14	-12.15	5.56
Change in producer surplus at retail level in South Korea	6.00	0.66	-2.15	4.51

Table III-9. Results of Welfare Impacts Beef and Pork Promotions ($ millions).

Description	Beef	Pork	Poultry	Total Meat Industry Producer Surplus
Perfectly competitive market				
Change in producer surplus at farm level in the U.S.	877.61	501.49	-256.17	1122.92
Change in producer surplus at retail level in the U.S.	821.27	487.46	-218.63	1090.10
Change in producer surplus at retail level in Canada	5.66	3.35	-1.72	7.29
Change in producer surplus at retail level in Japan	17.48	15.36	-0.77	32.07
Change in producer surplus at retail level in Mexico	21.99	11.92	-5.79	28.12
Change in producer surplus at retail level in South Korea	15.36	0.88	-1.03	15.21
Retailer oligopsony Market Power (θ=0.03)				
Change in producer surplus at farm level in the U.S.	854.86	482.92	-258.39	1079.38
Change in producer surplus at retail level in the U.S.	838.41	505.60	-230.70	1113.31
Change in producer surplus at retail level in Canada	5.79	3.48	-1.82	7.45
Change in producer surplus at retail level in Japan	17.86	15.94	-0.81	33.00
Change in producer surplus at retail level in Mexico	22.42	12.37	-6.11	28.68
Change in producer surplus at retail level in South Korea	15.71	0.91	-1.08	15.53

Note: The own-price demand elasticity for fed beef, nonfed beef, and U.S. pork in the U.S. domestic market are set to be -1.357, -2.178, and -1.207, respectively.

Table III-10. COOL Supply Shifters for Different Meat Products

Meat Product	Share[1]	meat type shifter	meat product shifter
All Costs Borne by Producers (Farm level)			
U.S. fed beef	0.85	0.03	0.02550
U.S. nonfed beef	0.15	0.03	0.00450
U.S. Pork	1	0.01	0.01000
All Costs Borne by Marketers (Retail level)			
U.S. fed beef	0.776	0.017	0.01342
U.S. nonfed beef	0.137	0.017	0.00237
Beef from Australia	0.031	0.017	0.00053
Beef from Canada	0.032	0.017	0.00055
Beef from New Zealand	0.016	0.017	0.00028
Beef from the ROW	0.008	0.017	0.00014
Pork from the U.S.	0.947	0.004	0.00338
Pork from Canada	0.044	0.004	0.00016
Pork from the ROW	0.008	0.004	0.00003
Cost Share by Domestic Producers and Marketers (50/50)			
Producers (Farm Level)			
U.S. fed beef	0.85	0.015	0.01275
U.S. nonfed beef	0.15	0.015	0.00225
U.S. Pork	1	0.005	0.005
Marketers (Retail level)			
U.S. fed beef	0.776	0.009	0.00671
U.S. nonfed beef	0.137	0.009	0.00118
Beef from Australia	0.031	0.009	0.00027
Beef from Canada	0.032	0.009	0.00027
Beef from New Zealand	0.016	0.009	0.00014
Beef from the ROW	0.008	0.009	0.00007
Pork from the U.S.	0.947	0.002	0.00169
Pork from Canada	0.044	0.002	0.00008
Pork from the ROW	0.008	0.002	0.00002
Cost Share by Domestic Producers and Marketers (25/75)			
Producers (Farm Level)			
U.S. fed beef	0.85	0.0075	0.006375
U.S. nonfed beef	0.15	0.0075	0.001125
U.S. Pork	1	0.0025	0.0025
Marketers (Retail level)			
U.S. fed beef	0.776	0.01297	0.01006
U.S. nonfed beef	0.137	0.01297	0.00178
Beef from Australia	0.031	0.01297	0.00040
Beef from Canada	0.032	0.01297	0.00041
Beef from New Zealand	0.016	0.01297	0.00021
Beef from the ROW	0.008	0.01297	0.00011
Pork from the U.S.	0.947	0.00268	0.00254
Pork from Canada	0.044	0.00268	0.00012
Pork from the ROW	0.008	0.00268	0.00002

[1] Refers to the share of each meat product in the U.S. domestic market.

Table III-11. Results of Welfare Impacts of COOL ($ millions)

Description	All Costs Borne by Domestic Producers	Cost Shared by Domestic Producers and Marketers		All Costs Borne by Marketers
		50/50	25/75	
Scenario: No Demand Change				
Perfectly competitive market				
Change in U.S. Beef producer surplus	-90.75	-75.73	-68.21	-60.69
Change in U.S. Pork producer surplus	-35.67	-32.68	-31.18	-29.69
Change in U.S. Poultry producer surplus	76.29	73.81	72.57	71.34
Retailer Oligopsony Power (θ=0.03)				
Change in U.S. Beef producer surplus	-94.02	-76.85	-68.26	-59.66
Change in U.S. Pork producer surplus	-37.53	-33.66	-31.72	-29.78
Change in U.S. Poultry producer surplus	79.57	75.86	74.00	72.14
Scenario 2% Demand Increase for Beef and Pork				
Perfectly competitive market				
Change in U.S. Beef producer surplus	-44.36	-29.31	-21.78	-14.24
Change in U.S. Pork producer surplus	50.69	53.69	55.20	56.70
Change in U.S. Poultry producer surplus	-53.06	-55.51	-56.74	-57.96
Retailer Oligopsony Power (θ=0.03)				
Change in U.S. Beef producer surplus	-48.45	-31.24	-22.64	-14.03
Change in U.S. Pork producer surplus	47.70	51.60	53.55	55.50
Change in U.S. Poultry producer surplus	-51.48	-55.16	-57.00	-58.84
Scenario: 5% Demand Increase for Beef and Pork				
Perfectly competitive market				
Change in U.S. Beef producer surplus	25.38	40.48	48.03	55.59
Change in U.S. Pork producer surplus	181.04	184.06	185.58	187.09
Change in U.S. Poultry producer surplus	-244.55	-246.97	-248.17	-249.38
Retailer Oligopsony Power (θ=0.03)				
Change in U.S. Beef producer surplus	20.07	37.32	45.95	54.58
Change in U.S. Pork producer surplus	176.35	180.27	182.24	184.20
Change in U.S. Poultry producer surplus	-245.47	-249.09	-250.90	-252.71

Table III-12. Results of Welfare Impacts of COOL ($ millions)

Description	All Costs Borne by Domestic Producers	Cost Shared by Domestic Producers and Marketers		All Costs Borne by Marketers
		50/50	25/75	
Scenario: No Demand Change				
Perfectly competitive market				
Change in U.S. Beef producer surplus	-89.40	-74.17	-66.55	-58.93
Change in U.S. Pork producer surplus	-37.62	-34.92	-33.57	-32.22
Change in U.S. Poultry producer surplus	124.66	129.42	131.80	134.18
Retailer Oligopsony Market Power (θ=0.03)				
Change in U.S. Beef producer surplus	-92.54	-75.21	-66.54	-57.86
Change in U.S. Pork producer surplus	-39.60	-35.95	-34.12	-32.30
Change in U.S. Poultry producer surplus	128.83	130.47	131.29	132.11

Note: The cross-price elasticities between U.S. poultry and other meat products are positive

Table III-13. Results of Welfare Impacts of COOL ($ millions).

Description	All Costs Borne by Domestic Producers	Cost Shared by Domestic Producers and Marketers		All Costs Borne by Marketers
		50/50	25/75	
Scenario: No Demand Change				
Perfectly competitive market				
Change in U.S. Beef producer surplus	-88.84	-73.59	-65.96	-58.33
Change in U.S. Pork producer surplus	-38.42	-35.76	-34.42	-33.09
Change in U.S. Poultry producer surplus	144.21	149.70	152.44	155.19
Retailer Oligopsony Market Power (θ=0.03)				
Change in U.S. Beef producer surplus	-92.48	-75.15	-66.48	-57.81
Change in U.S. Pork producer surplus	-40.28	-36.64	-34.82	-33.00
Change in U.S. Poultry producer surplus	142.43	144.24	145.14	146.05

Note: own-price supply and demand elasticities for poultry are 0.3, and -0.8, respectively.

Table III-14. Results of Welfare Impacts of COOL ($ millions)

Description	All Costs Borne by Domestic Producers	Cost Shared by Domestic Producers and Marketers		All Costs Borne by Marketers
		50/50	25/75	
Scenario: No Demand Change				
Perfectly competitive market				
Change in U.S. Beef producer surplus	-218.58	-201.40	-192.81	-184.21
Change in U.S. Pork producer surplus	-40.99	-39.09	-38.13	-37.18
Change in U.S. Poultry producer surplus	32.32	31.16	30.58	30.00
Scenario 2% Demand Increase for Beef and Pork				
Perfectly competitive market				
Change in U.S. Beef producer surplus	58.92	76.26	84.94	93.62
Change in U.S. Pork producer surplus	155.55	157.48	158.45	159.41
Change in U.S. Poultry producer surplus	-23.39	-24.55	-25.12	-25.70
Scenario: 5% Demand Increase for Beef and Pork				
Perfectly competitive market				
Change in U.S. Beef producer surplus	480.89	498.47	507.27	516.08
Change in U.S. Pork producer surplus	454.57	456.53	457.51	458.49
Change in U.S. Poultry producer surplus	-106.48	-107.63	-108.21	-108.78

Note: The own-price demand elasticities for fed beef, nonfed beef, pork and poultry are -1.357, -2.178, -1.207, and -0.33, respectively.

Table III-15. Results of Welfare Impacts of Japanese and South Korean Bans on U.S. Beef ($ millions).

Description	Japanese Ban	South Korean Ban	Both Japanese and South Korean Ban
	Producer Surplus	Producer Surplus	Producer Surplus
Farm Level			
Change in U.S. Beef producer surplus	-220.621	-375.710	-593.118
Change in Australian beef producer surplus	196.101	-183.950	-2.509
Change in Japanese beef producer surplus	2703.821		2767.787
Change in South Korean beef producer surplus		-18.252	27.334
Retail Level			
Change in U.S. Beef producer surplus in the U.S.	-199.227	-340.739	-541.523
Change in U.S. Beef producer surplus in Canada	-1.481	-2.598	-4.054
Change in U.S. Beef producer surplus in Japan	-2.372	-8.725	-6.385
Change in U.S. Beef producer surplus in Mexico	-6.777	-9.737	-17.710
Change in U.S. Beef producer surplus in South Korea	-4.285	-3.587	-5.917
Change in Australian beef producer surplus in Japan	25.997		-0.348
Change in Australian beef producer surplus in S. Korea		0.069	0.002
Change in Japanese beef producer surplus in Japan	2704.684		2768.670
Change in South Korean beef producer surplus in South Korea		-18.253	27.336

Table III-16. Results of Welfare Impacts of Japanese and South Korean Bans on U.S. Beef ($ millions)

Description	Japanese Ban	South Korean Ban	Both Japanese and South Korean Bans
	Producer Surplus	Producer Surplus	Producer Surplus
Farm Level			
Change in U.S. Beef producer surplus	-217.03	-351.23	-565.31
Change in Australian beef producer surplus	195.79	204.77	415.62
Change in Japanese beef producer surplus	2703.79		2681.93
Change in South Korean beef producer surplus		14.45	60.59
Retailer Level			
Change in U.S. Beef producer surplus in the U.S.	-195.97	-317.84	-514.96
Change in U.S. Beef producer surplus in Canada	-1.46	-2.42	-3.84
Change in U.S. Beef producer surplus in Japan	-2.33	-7.60	-6.17
Change in U.S. Beef producer surplus in Mexico	-6.67	-9.74	-17.91
Change in U.S. Beef producer surplus in South Korea	-4.24	-3.38	-5.73
Change in Australian beef producer surplus in Japan	25.96		52.84
Change in Australian beef producer surplus in South Korea		16.48	32.14
Change in Japanese beef producer surplus in Japan	2704.65		2682.79
Change in South Korean beef producer surplus in South Korea		14.45	60.59

Note: Cross-price elasticities between U.S. beef and Australian beef and between Australian and U.S. beef are 0.123 and 0.253, respectively

VITA

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Scope and Method of Study: This study is composed of three chapters. The first and second chapters assess the competitiveness of U.S. meats in the major U.S. export markets and in the U.S. domestic market, respectively, taking into account the effects of seasonality and animal disease outbreaks (*Bovine Spongiform Encephalopathy*-BSE and foot-and-mouth disease-FMD). The restricted source differentiated almost ideal demand system (RSDAIDS) is used to estimate Canadian, Japanese, Mexican, South Korean, and U.S. demand models. The objective of the third chapter is to estimate the welfare impacts of beef and pork promotions, country of origin labeling (COOL), and the Japanese and South Korean bans of U.S. beef on producers and marketers of U.S. meats. An equilibrium displacement model is built and used to estimate welfare measures.

Findings and Conclusions: The results of the first chapter show that Japanese beef, Danish pork and Brazilian poultry have the most to gain from an expansion of the Japanese meat market. BSE outbreak in Japan decreased the shares of U.S. and Japanese beef. The results of South Korean demand model indicate that U.S. and Australian beef, Danish pork, and Thai poultry have a competitive advantage. BSE outbreak in the U.S. decreased the shares of U.S. beef. For the Canadian demand model, the results show that U.S. and Canadian beef, and U.S. pork have a competitive advantage. Canadian BSE outbreak decreased the shares of Canadian beef. Regarding Mexican meat demand, the results suggest that an increase in Mexican meat expenditures is expected to increase demand for meats from all sources. Results of the second chapter indicate that U.S. fed beef and Canadian beef, rest-of-the world pork, and U.S. poultry would benefit from an increase in U.S. meat expenditures. The results of the third chapter indicate that beef and pork promotions increases welfare of meat industry with beef and pork benefiting the most. COOL will decrease welfare of beef and pork industries unless accompanied with an increase in demand. Bans on U.S. beef decrease the welfare of producers and marketers of U.S. beef and increase the welfare of producers and marketers of competing beef products.

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