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Japanese Meat Import Demand Estimation with the Source Differentiated AIDS Model

Seung-Ryong Yang and Won W. Koo

A source differentiated AIDS model is specified to estimate Japanese meat import demand. Block separability and product aggregation are rejected at conventional levels of significance. The model with the block substitutability restriction explains more than 95% of data variation. The empirical results indicate that the U.S. has the largest potential for beef exports to Japan. Taiwan is in a strong position in the pork market, and Thailand and China are strong in the poultry market. The U.S. competes with Canada and Taiwan in the pork market, but the competition between Taiwan and European countries is the strongest in the market. The U.S. competes with Thailand in the poultry market, where the U.S. is the most vulnerable.

Key words: AIDS, block substitutability, expenditure endogeneity, import demand, product aggregation, separability, source differentiation.

Introduction

Japan is the world's largest meat importing country and one of the largest importers of meat from the U.S. In 1991, about 50% of U.S. beef (including veal) and pork exports, with some 25% of broiler exports, were shipped to Japan [U.S. Department of Agriculture (USDA)]. Japanese meat imports over time are presented in figure 1. Japanese meat imports have been increasing dramatically during the last several years. Under the Beef Market Access Agreement (BMAA) of 1988, import quotas were replaced by an import tariff, beginning 1 April 1991. Japanese beef imports are to be completely liberalized by 1997, and are projected to increase further (Wahl, Hayes, and Williams). In addition, pork and poultry imports have increased steadily over the last two decades.

Policy evaluations and simulations require reliable estimates of demand responsiveness to prices and expenditure (e.g., Wahl, Hayes, and Williams). Spatial equilibrium models and welfare analyses also are based on accurate measures of demand estimates (e.g., Pieri, Meilke, and MacAulay). However, little effort has been made to estimate Japanese meat import behavior in the literature. Hayes, Wahl, and Williams estimated Japanese domestic demand for meat, assuming perfect substitution between import and domestic dairy beef. Yang and Koo estimated Japanese import demand for red meat as an aggregate good.

Trade economists often are more interested in import demand than in domestic demand. For meat industries in exporting countries, import demand elasticities would provide more valuable information. The objective of this study is to provide reliable estimates of Japanese meat import demand elasticities. This study uses an Almost Ideal Demand System (AIDS), in which sources of goods are differentiated and the expenditure is treated as endogenous (LaFrance). Estimates in the present study are more reliable since they do not suffer from aggregation bias over import sources (as in Hayes, Wahl, and Williams)

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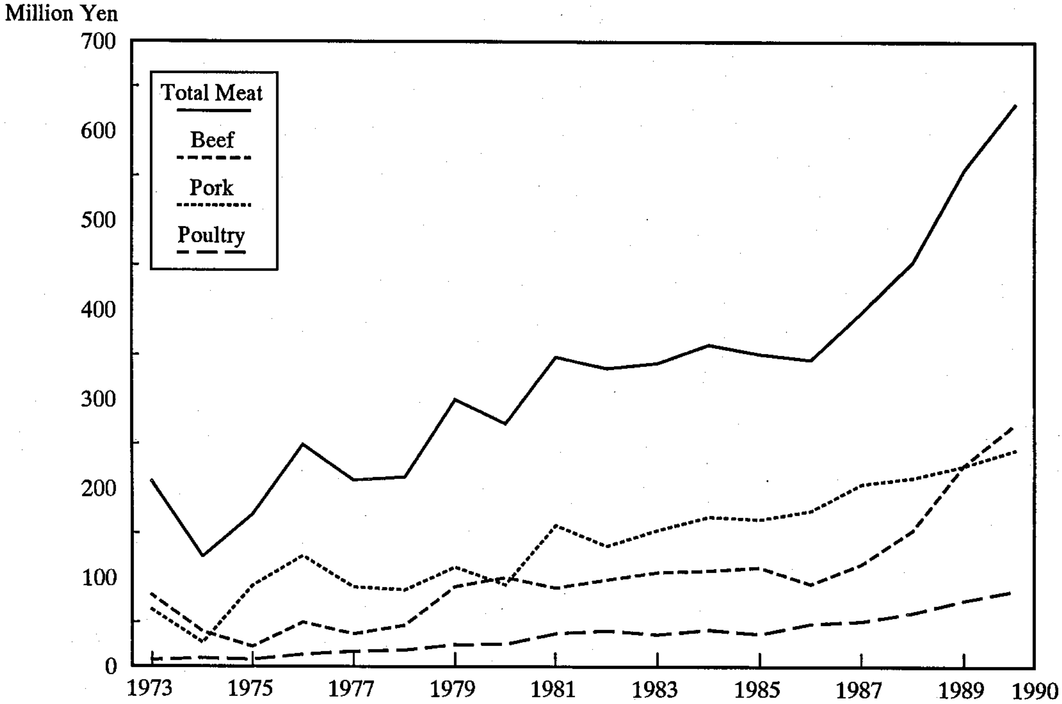

Figure 1. Japanese meat imports, 1973-90

or over goods (as in Yang and Koo), and are estimated using instrumental variable techniques (Edgerton).

The article is organized as follows. In the next section, we discuss models used in previous studies of import demand. The source differentiated AIDS model is specified for this study in the third section. For the model, the expenditure function is rewritten to approximate import behavior that differentiates goods by origin. Data and estimation procedures are explained in the fourth section, followed by a presentation and interpretation of empirical results. Conclusions are presented in the final section.

Model Considerations

In the literature, relatively few models have been used for import demand analyses. The Armington trade model is theoretically consistent and has been widely used (Abbott and Paarlberg; Babula; Penson and Babula; Sarris). One advantage of the Armington model is that it differentiates goods by sources.[1] In other words, the Armington model allows imperfect substitutions among goods from different origins. However, this model suffers from restrictive assumptions of homotheticity and single constant elasticity of substitution (Alston et al.; Winters; Yang and Koo).

Alternatively, Deaton and Muellbauer's AIDS model has been used. Winters suggested using the AIDS model for import demand estimation instead of the Armington model. The AIDS model is flexible, theoretically plausible, and easy to use. However, empirical applications of the AIDS model to import demand typically assume either product aggregation, under which the demand system does not differentiate products by source (e.g., Hayes, Wahl, and Williams),[2] or block separability among goods, which allows the model to consist only of share equations for a good from different origins (e.g., Alston et al.).[3]

Aggregation over products is possible if all prices to be aggregated move together by the same proportion (Hicks). This assumption seems too strong in international agricultural trade. For example, importers may perceive U.S. beef differently from Australian beef because of quality differences. Further, different transaction costs also cause heterogeneous movements of import prices (Johnson, Grennes, and Thursby). Constant relative prices seem practically unlikely. Likewise, block separability among goods in meat imports is often counter-intuitive. This assumption, for example, allows modeling beef demand independently of pork demand. Most empirical research suggests evidence against this assumption. As in the Armington model, block separability may bias elasticity estimates.

Source differentiation is important in import demand analysis. However, block separability should not be required for source differentiation or vice versa. In the Armington model, block separability is inherent since the model is derived under that assumption. This is not true for the AIDS model. Nonetheless, source differentiation and block separability have not been compatible in past research.

This study uses the AIDS model for Japanese meat import demand estimation. The AIDS model is specified such that the product sources are differentiated without imposing block separability. The source differentiated AIDS model includes the conventional AIDS formulations as special cases. Null hypotheses of block separability and product aggregation are tested, and consequences of the restrictions on elasticity estimates also are examined.

The Source Differentiated AIDS Model

The derivation of the AIDS model starts with an expenditure function, representing the Price Independent Generalized Logarithmic (PIGLOG) preference (Deaton and Muellbauer). For the source differentiated AIDS (or simply SDAIDS) model, the expenditure function is rewritten to approximate the importer's behavior that differentiates goods from different origins. The expenditure function given utility u is:

$$\ln[E(p, u)] = (1 - u)\cdot\ln[a(p)] + u\cdot\ln[b(p)], \tag{1}$$

where

$$\ln[a(p)] = \alpha_0 + \sum_i\sum_h \ln(p_{i_h}) + \frac{1}{2}\sum_i\sum_j\sum_h\sum_k \gamma^*_{i_h j_k}\ln(p_{i_h})\ln(p_{j_k}), \tag{2}$$

and

$$\ln[b(p)] = \ln[a(p)] + \beta_0 \prod_i\prod_h p_{i_h}^{\beta_{i_h}}, \tag{3}$$

where α, β, and γ^* are parameters. The subscripts i and j denote goods ($i, j = 1, \ldots, N$), and h and k denote products. The numbers of products are not necessarily the same for all goods. Good i may be imported from m different origins, while good j may have n origins (when $i \neq j$, $h = 1, \ldots, m$, and $k = 1, \ldots, n$).

By substituting equations (2) and (3) into (1), the expenditure function can be rewritten as:

$$\ln[E(p, u)] = \alpha_0 + \sum_i\sum_h \alpha_{i_h}\ln(p_{i_h}) + \frac{1}{2}\sum_i\sum_h\sum_j\sum_k \gamma^*_{i_h j_k}\ln(p_{i_h})\ln(p_{j_k}) + \beta_0 u \prod_i\prod_h p_{i_h}^{\beta_{i_h}}. \tag{4}$$

By Shephard's lemma, the budget share of good i imported from origin h can be obtained by differentiating $\ln[E(p, u)]$ with respect to $\ln(p_{i_h})$. Thus, the budget share (w_{i_h}) is a function of prices and utility as:

(5) $$w_{i_h} = \alpha_{i_h} + \sum_j \sum_k \gamma_{i_h j_k} \ln(p_{j_k}) + \beta_{i_h} u \beta_0 \prod_i \prod_h p_{i_h}^{\beta_{i_h}},$$

where $\gamma_{i_h j_k} = 1/2(\gamma^*_{i_h j_k} + \gamma^*_{j_k i_h})$. Solving equation (4) with respect to u and substituting this into equation (5) results in the SDAIDS in expenditure share form:

(6) $$w_{i_h} = \alpha_{i_h} + \sum_j \sum_k \gamma_{i_h j_k} \ln(p_{j_k}) + \beta_{i_h} \ln\left(\frac{E}{P^*}\right),$$

where

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

Since the price index (P^*) in the share equation (6) is nonlinear and provides difficulties in estimation, Stone's index is used as a linear approximation (Deaton and Muellbauer). Stone's index in this extension is $\ln(P) = \Sigma_i \Sigma_h w_{i_h} \ln(p_{i_h})$. However, this index causes a simultaneity problem since the expenditure share in the index, w_{i_h}, is also the dependent variable. To avoid this, the lagged share (Eales and Unnevehr) or the average share (Haden) has been used.

Marshallian price elasticities with the linear approximation using lagged shares are

(8) $$\epsilon_{i_h j_k} = -\delta_{i_h j_k} + \frac{\gamma_{i_h j_k}}{w_{i_h}} - \beta_{i_h}\left(\frac{w_{j_k}}{w_{i_h}}\right),$$

where $-\delta_{i_h j_k}$ is equal to unity if $i = j$ and $h = k$, and zero otherwise. The expenditure elasticity is

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

The general demand conditions for import behavior also can be imposed or tested as for the AIDS model. The conditions are

Adding-up: $\sum_i \sum_h \alpha_{i_h} = 1; \quad \sum_i \sum_h \gamma_{i_h j_k} = 0; \quad \sum_i \sum_h \beta_{i_h} = 0;$

Homogeneity: $\sum_j \sum_k \gamma_{i_h j_k} = 0;$

Symmetry: $\gamma_{i_h j_k} = \gamma_{j_k i_h}.$

Restricted SDAIDS Models

The SDAIDS model in equation (6) allows different responses of an import country to different goods and their origins. Although the SDAIDS model is more flexible than the previous uses of the AIDS model or Armington model in import demand analyses, it may suffer from a degrees-of-freedom problem in empirical applications. This seems especially true for agricultural commodities, which usually have several nonseparable substitutes from different import origins. Suppose we estimate the SDAIDS model for three goods, each of which has five products. The SDAIDS model includes 17 parameters (3 times 5 prices + intercept + expenditure) to be estimated in each equation.

To reduce the number of parameters, we can introduce the following assumption:

(10) $$\gamma_{i_h j_k} = \gamma_{i_h j}, \qquad \forall\, k \in j \neq i.$$

In other words, 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 (we call this "block substitutability"). For example, this assumption says that Japanese demand for U.S. beef exhibits the same cross-price response to pork from Taiwan and pork from Canada.

The block substitutability assumption enables the SDAIDS model to be rewritten as:

(11) $$w_{i_h} = \alpha_{i_h} + \sum_k \gamma_{i_h k}\ln(p_{i_k}) + \sum_{j \neq i} \gamma_{i_h j}\ln(p_j) + \beta_{i_h}\ln\left(\frac{E}{P}\right),$$

where $\ln(p_j) = \Sigma_k w_{jk}\ln(p_{jk})$. This restricted model (or RSDAIDS) has only nine parameters (prices of 5 products of good i + prices of 2 other goods + intercept + expenditure) compared to 17 for the example above. In general, the RSDAIDS model has $M + (N - 1) + 2$ parameters, while the SDAIDS model has $MN + 2$ parameters in each equation if all goods have the same number of import origins, M. The RSDAIDS model would be a practical alternative for most import demand studies with small samples.

With the same expenditure elasticity as for SDAIDS, the Marshallian price elasticities of the RSDAIDS model are:

(12) $$\epsilon_{i_h i_h} = -1 + \frac{\gamma_{i_h h}}{w_{i_h}} - \beta_{i_h},$$

(13) $$\epsilon_{i_h i_k} = \frac{\gamma_{i_h k}}{w_{i_h}} - \beta_{i_h}\left(\frac{w_{i_k}}{w_{i_h}}\right),$$

(14) $$\epsilon_{i_h j} = \frac{\gamma_{i_h j}}{w_{i_h}} - \beta_{i_h}\left(\frac{w_j}{w_{i_h}}\right).$$

The general demand conditions are rewritten as:

Adding-up: $\sum_i \sum_h \alpha_{i_h} = 1; \quad \sum_h \gamma_{i_h k} = 0; \quad \sum_i \sum_h \gamma_{i_h j} = 0; \quad \sum_i \sum_h \beta_{i_h} = 0;$

Homogeneity: $\sum_k \gamma_{i_h k} + \sum_{j \neq i} \gamma_{i_h j} = 0;$

Symmetry: $\gamma_{i_h k} = \gamma_{i_k h}.$

Because of block substitutability, symmetry conditions among goods are not applicable.

The conventional use of AIDS under the assumption of block separability among goods can be derived by further assuming (on the RSDAIDS model) that

(15) $$\gamma_{i_h j} = w_{i_h}\gamma_{ij}, \qquad \forall\, j \neq i,$$

where γ_{ij} is the cross-price parameter between groups i and j, estimated from an aggregate AIDS model (where sources are not differentiated). For more discussion about this separability test in the AIDS framework, see Hayes, Wahl, and Williams.

Finally, the AIDS model that does not differentiate by origins of goods (i.e., product aggregation) can be obtained by imposing the following assumptions on the SDAIDS (or analogous assumptions on the RSDAIDS):[4]

(16) $$\alpha_{i_h} = \alpha_i, \qquad \forall\, h \in i,$$
$$\gamma_{i_h j_k} = \gamma_{ij}, \qquad \forall\, h, k \in i, j,$$
$$\beta_{i_h} = \beta_i, \qquad \forall\, h \in i.$$

This is the model normally used to estimate domestic demand. However, in some cases, quality differences of agricultural products from the different producing regions may be of interest. Also, to avoid an aggregation bias over commodities, extensive pretesting often is required (e.g., Eales and Unnevehr). The SDAIDS model is general enough to accommodate the restricted cases mentioned above.

Table 1. Summary Statistics for Expenditure Shares of Japanese Meat Imports for 1973-90

Variable	Mean	Std. Dev.	Minimum	Maximum
Beef	.2952	.0787	.1311	.4314
United States	.1004	.0610	.0275	.2367
Australia	.1876	.0561	.1010	.3397
Other Source	.0071	.0076	.0016	.0350
Pork	.4238	.0802	.2171	.5353
United States	.0857	.0431	.0262	.1786
Canada	.0816	.0371	.0274	.1395
Taiwan	.0159	.0612	.0361	.2461
EC	.1372	.0586	.0194	.2181
Other Source	.0132	.0140	.0006	.0493
Poultry	.0991	.0318	.0354	.1403
United States	.0427	.0116	.0140	.0604
Thailand	.0302	.0216	.0001	.0621
China	.0125	.0035	.0047	.0176
Other Source	.0136	.0097	.0015	.0295
Other Meat	.1817	.1034	.0467	.3893

Data and Procedures

Data Description

Annual data for 1973 through 1990 were used for this study. Meat imported by Japan was categorized into four goods: beef, pork, poultry, and other meat. Each good was imported from different sources with a different number of origins. The sample statistics of expenditure shares for each product are summarized in table 1. Among the four meat items, pork was the largest import, accounting for 42% on the average. Beef accounts for 30% of imports, and poultry (mostly frozen chicken) accounts for 10%.

A country was identified as an import origin if it exported over 10% of each meat. Import sources that took less than 10% were combined into "other source" of each meat. Beef was imported mainly from Australia (and New Zealand) and the United States. Before 1988, Australia was the largest beef exporter. The U.S. has emerged as the largest exporter since 1988.

Japan imports pork from the U.S., Canada, Taiwan, and some European countries. Since imports from individual European countries are not large enough, they are combined into "EC" to save degrees of freedom. During the sample period, the competition among pork exporters has been intense. After 1983, however, Taiwan and EC together have taken about 75% of the market, with about 40% apiece.

Major import sources for poultry include the U.S., China, and, recently, Thailand. The U.S. was the largest poultry exporting country until 1985, with more than 40% of the market. However, Thailand has since become the largest exporter, with about 40% of market share, with the U.S. accounting for less than 30%. Other meat includes mutton, lamb, and horse meat, and is not separated by import source. The expenditure share of other meat keeps decreasing from about 30% in 1973 to 5% of total import in 1990.

The data for import quantity and value (in Japanese yen) were obtained from various issues of Japan's Ministry of Agriculture, Forest, and Fisheries (MAFF) publication, *The Meat Statistics in Japan.* Import prices for individual meats by origin are not publicly available. Thus, as a proxy for import price, the unit value obtained by dividing the value by the quantity was used.

Theory does not preclude the domestic production as an import source (Armington; Winters). However, the unit value is not what consumers actually pay. Thus, it is difficult, if not impossible, to construct budget shares using import data with domestic prices. This is especially so when import goods have different marketing channels from their domestic counterparts. Further, during the sample period, quotas have been imposed on beef imports, and most of them were exhausted.[5] Given the quota, beef imports are allocated to each source. This study assumes separability between domestic and import meats.[6]

Estimation Procedures

Since the Japanese import model in this study has four meat items and three origins for beef, five for pork, and four for poultry, the SDAIDS model would have 14 parameters to be estimated in each equation. Given the sample data available (17 observations because of using the lagged Stone index), the degrees-of-freedom problem is serious. We thus estimate the RSDAIDS model with block substitutability as a maintained assumption. This model has eight parameters for beef, 10 for pork, and nine for poultry equations. The equation for other meat was dropped to avoid singularity due to the adding-up condition.

LaFrance showed that conventional least squares estimators applied to conditional demand systems are not consistent or efficient because group expenditure is not exogenous, except for some special cases. Further, standard instrumental variable methods do not yield consistent estimates unless the conditional demands are linear in the expenditure. His findings are important for empirical applications of AIDS models because the expenditure is nonlinear with respect to quantity demanded in the AIDS framework. He suggested using Anderson's iterative instrumental variable method.

Even though the estimation procedure suggested by LaFrance provides efficient estimates, it is computationally complex and burdensome. The AIDS model might have lost one of its nice properties, estimational simplicity. However, Edgerton demonstrated that an alternative stochastic specification allows budget shares to be linear in logarithm of group expenditure and that the standard instrumental variable method yields consistent estimates.

Edgerton suggested using predicted values from the following auxiliary equation for the log of expenditure: $\log(E) = f(p, q, y)$, where p is the price vector of products in the group, q is the price vector of all other goods, and y is total expenditure. To conserve degrees of freedom, this study uses Stone's index for each good for p, consumer price index for q, and per capita private consumption for y. Data for Japanese consumer price index and private consumption are from the International Monetary Fund's *International Financial Statistics Yearbook.* Using the instrument from a linear specification for $f(\cdot)$, the RSDAIDS model is estimated by seemingly unrelated regression (SUR) estimators with homogeneity and symmetry conditions imposed.[7]

Hypotheses of product aggregation over different import sources and block separability are tested with the Wald F-test. These tests are conducted by imposing the restrictions in (15) and (16) on the RSDAIDS model. Elasticities from these restricted models are compared to those from the RSDAIDS model.

Estimated Results

The test results for block separability and product aggregation are presented in table 2. The test statistic for the null hypothesis that beef is separable from all other meats (i.e., pork, poultry, and other meat) is 2.09. Those for pork and poultry are 7.24 and 13.04, respectively. Each of these hypotheses and the joint hypothesis are rejected at less than the 5% level of significance. The null hypothesis of block separability is rejected for the sample data. Likewise, the F-statistic for the aggregation over sources as a whole is 36.96, and rejects the null hypothesis. The same holds for individual hypotheses. The data support differentiating by sources.

Elasticities estimated from AIDS models for individual meats likely are biased due to

Table 2. Wald Test Results for Block Separability and Product Aggregation

Block Separability:

H_0: Beef is separable from all other meats.
 $F = 2.09$*
 df: 9 for numerator and 94 for denominator
H_0: Pork is separable from all other meats.
 $F = 7.24$**
 df: 15 for numerator and 94 for denominator
H_0: Poultry is separable from all other meats.
 $F = 13.04$**
 df: 12 for numerator and 94 for denominator
H_0: All of the above.
 $F = 11.68$**
 df: 36 for numerator and 94 for denominator

Product Aggregation:

H_0: Beef can be aggregated.
 $F = 11.83$**
 df: 10 for numerator and 94 for denominator
H_0: Pork can be aggregated.
 $F = 33.00$**
 df: 28 for numerator and 94 for denominator
H_0: Poultry can be aggregated.
 $F = 29.00$**
 df: 18 for numerator and 94 for denominator
H_0: All of the above.
 $F = 36.96$**
 df: 56 for numerator and 94 for denominator

Note: Single and double asterisks (*) denote significance at the 5% and 1% levels, respectively.

incorrect restrictions imposed on the models. The first three diagonal blocks in table 3 depict the estimated elasticities of the AIDS models that assume block separability among meat items. The separable AIDS model for each meat was estimated independently of the other meats. The last block of table 3 shows the elasticity estimates for the AIDS model that does not differentiate the sources of imports. The rows indicate variables in each model, and the columns indicate models. Presented in table 4 are the elasticities of the source differentiated AIDS model that assumes the same cross-price effects (block substitutability). The elasticities of the separable AIDS models differ from those of the RSDAIDS model. However, the directions of bias do not show any pattern.

Of particular interest are the expenditure elasticities of the AIDS model that does not differentiate by source. The elasticity for beef (aggregated) is 1.529. However, from the RSDAIDS model, the elasticities are 2.872 for U.S. beef, .867 for Australian beef, and 1.830 for beef from other sources. Larger variations in expenditure elasticities can be found for pork and poultry. The same observation holds for price elasticities.

The system R^2 of the RSDAIDS model is .957, while those of individual separable AIDS models are .860 for beef, .689 for pork, and .750 for poultry. The R^2 for the model that did not differentiate by source is .796. The SDAIDS model, with block substitutability imposed, explains the data variation successfully and would appear to provide more valuable information than conventional AIDS models for international trade analysis.

Japanese Meat Import Demand Elasticities

The full matrix of Marshallian demand elasticities from the RSDAIDS model is presented in table 4. Significance tests were conducted, using the method of Chalfant.

Except for U.S. and Canadian pork, all expenditure elasticities are positive, and most of them are significant. Expenditure on U.S. beef is elastic (2.872) and about three times

Table 3. Marshallian Elasticities of Japanese Meat Import Demand Using the Restricted AIDS Models

	Block Separable AIDS Models									Aggregated AIDS Model		
	Beef		Pork				Poultry					
	U.S.	Aust.	U.S.	Can.	Taiwan	EC	U.S.	Thailand	China	Beef	Pork	Poultry
Pbfus	−1.153**	.106*										
Pbfau	−.577**	−.725**										
Pbfos	−.149**	.068**										
Ybf	1.803**	.590**										
Ppkus			−.072	.340*	−1.626*	.319						
Ppkca			.274*	−1.000**	−.328*	.059						
Ppkta			−1.588*	.069	−.314	.383						
Ppkec			.855	.549**	.331	−2.603**						
Ppkos			.104	.049*	.016	−.154**						
Ypk			.280	−.007	1.920**	1.456**						
Pplus							−2.135**	1.232	1.320*			
Ppltl							1.136**	−1.672	−2.239**			
Pplch							.451*	−1.414**	−.601			
Pplos							.085	−.271	.773**			
Ypl							.463**	2.125**	.748**			
Pbeef										−.698	−.796	−.013
Ppork										−1.287*	−.272	.806
Ppoultry										.010	.237	−2.539**
Pother										.446*	−.356*	.068
Y										1.529**	1.188**	1.677**
System R^2		.860				.689			.750			.796

Notes: In column one, P = price and Y = expenditure; *bf* = beef, *pk* = pork, and *pl* = poultry; *us* = United States; *au* = Australia, *ca* = Canada, *ta* = Taiwan, *ec* = EC, *tl* = Thailand, *ch* = China, and *os* = other source. Single and double asterisks (*) denote significance at the 5% and 1% levels, respectively.

Table 4. Marshallian Elasticities of Japanese Meat Import Demand Using the RSDAIDS Model

	Beef			Pork					Poultry			
	U.S.	Aust.	OS	U.S.	Can.	Taiwan	EC	OS	U.S.	Thailand	China	OS
Pbfus	−.090	.100	−1.293**									
Pbfau	−.188	−.482**	−.549									
Pbfos	−.099**	−.014	−.772**									
Ppkus				−1.097	.731**	.112**	−1.422**	.732				
Ppkca				.684**	−1.203**	−1.080**	.381**	−1.231**				
Ppkta				.444	−1.079**	−1.378	3.079**	−2.051*				
Ppkec				−1.972**	.966**	3.896**	−2.561**	1.479**				
Ppkos				.123	−.187**	−.285**	.123*	−1.623**				
Pplus									−2.457**	1.174**	−.610	.204
Ppltl									.886**	−5.600**	−.488	1.321**
Pplch									−.171	−.217	.209	.966**
Pplos									.095	.603**	1.070**	−1.939**
Pbeef				4.392	−1.185	−8.721**	−.299	−9.565**	.369	−1.719**	−1.684	1.311
Ppork	−.011	−.315	6.310						−.136	2.642**	−.232	−1.775
Ppoultry	−2.145**	−.385	−8.038*	−3.139	2.040**	7.079**	−2.163*	14.341**				
Pother	−.336	.229	2.512	.571	.073	−2.507**	.652*	−2.851**	1.024**	.899**	.673	−2.637**
Y	2.872**	.867**	1.830*	−.007	−.155	2.885**	2.209**	.770	.390	2.218**	1.061**	2.548**

System R^2 = .957

Note: Refer to table 3 footnote.

larger than that for Australian beef (.867). This finding is not in agreement with Weatherspoon and Seale, who found that the Japanese expenditure elasticities for U.S. and Australian beef are the same. The finding of our study suggests that, as beef imports increase, Japan imports more from the U.S. than from Australia. This would be consistent with perceived quality differences: the U.S. exports grain-fed beef, which is preferred by Japanese consumers to Australian grass-fed beef.

As expenditures on pork imports increase, Japan imports more from Taiwan (2.885) than from other sources. The EC is the second favorite import source (2.209). Changes in market size seldom affect U.S. and Canadian pork exports to Japan (−.007 and −.155, respectively). In the poultry market, Thailand is the most favored (2.218), followed by China (1.061), while U.S. exports are not affected by import market size (.390).

Own-price elasticities for individual meats from different origins are all negative (with an exception for Chinese poultry), as theory predicts. For beef, own-price elasticities are inelastic (−.090 for U.S. and −.482 for Australia). This may reflect quantity restrictions on beef imports. With large import demand for beef, Japanese imports generally were insensitive to price changes under the quota system.

On the other hand, pork imports are generally price elastic, especially for EC (−2.561) and Canada (−1.203). Pork imports are the least sensitive to U.S. pork prices (−1.097). Poultry imports are also price elastic, with the largest elasticity for Thailand exports (−5.600), followed by U.S. exports (−2.457). However, Japanese imports from China are not price elastic.

Cross-price elasticities reveal competitive relations among products. Cross-price elasticities between U.S. and Australian beef are not significant. This reflects the fact that these two beef products do not substitute for each other in the same segment of the market, mainly because of quality differences (Hahn et al.). However, substitutions in the pork market are intense. The Taiwan–EC substitution is the most strong. Also, the U.S. competes with Canada, and Canada with EC in the pork market. Similarly, the U.S. competes with Thailand in the poultry market. Interestingly, this substitution is asymmetric. Japanese imports from Thailand are more sensitive to the U.S. price (1.174) than imports from the U.S. are sensitive to Thailand's price (.886).

Cross-price elasticities between Canada and Taiwan and between the U.S. and EC in the pork market are significantly negative, indicating complementary relations, contrary to our expectations. Several restrictions imposed on the data (e.g., model and/or homogeneity and symmetry) may account for the apparent complementary relationships. Comovements in exchange rates also may be a factor. Since the unit value was used as a proxy for price, the role of exchange rates may not be negligible.

Complementary relationships between beef and poultry in the beef models and between pork and beef in the pork models are more difficult to explain. These peculiar effects also were found in domestic demands (Hayes, Wahl, and Williams) and are not unusual in demand studies. Pitts and Herlihy showed evidence supporting the fixed expenditure hypothesis. The hypothesis states that when the prices of two products differ substantially and the own-price elasticity of a product is less than one, a decrease in the price may increase the consumption of both products, with a relatively fixed expenditure on the group. During the sample period, the household consumption and expenditure on meat represented near saturation (MAFF). To examine net substitutability, Hicksian elasticities were calculated. However, these provide the same inferences and are not reported.

Summary and Conclusions

The source differentiated AIDS model was specified to estimate Japanese import demand for individual meats. Both block separability and aggregation over product sources were rejected at conventional levels of significance. The test results indicate that using the AIDS model without source differentiation would result in spurious conclusions. Likewise, demand systems confined to an individual meat bias elasticity estimates. The source differentiated AIDS model specified in this study would provide more reliable and detailed information about import demand behaviors.

A country is regarded as having strong export potential in an import market if demand for the product is insensitive to price changes but increases with import expenditure. In the beef import market, the U.S. is in this position. This is consistent with the recent sharp increase in U.S. exports following the 1988 Beef Market Access Agreement. Removal or reduction of trade barriers to the Japanese beef market or increases in total expenditure on meat consumption would stimulate U.S. beef exports to Japan.

Chadee and Mori insist that U.S. exports would not increase under the BMAA as much as many predict, because most import beef is consumed away from home, and thus the reduction in import prices would not be transmitted to consumer prices. The results of this study do not support their allegation: i.e., Japanese are not sensitive to import prices, but to total expenditure on meat in making a decision on beef imports.

Taiwan has the largest expenditure elasticity and insignificant own-price elasticity in the pork market. However, substitutions in the pork market are strong and the Taiwan–EC substitution is the strongest. Canada is in the weakest position in that market.

In the poultry import market, Thailand has the largest expenditure elasticity. However, its own-price elasticity is also the largest. In terms of own-price elasticity, China seems to be in the strongest position, with an expenditure elasticity significantly greater than one. The U.S., which used to be the largest poultry exporter to Japan, is in the least favorable position.

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Notes

[1] Following Armington's terminology, goods from different sources are called products.

[2] Armington loosely defined this as perfect substitutability. Even though perfect substitutability enables product aggregation, nondifferentiation of goods from different sources does not necessarily imply perfect substitution.

[3] This assumption is commonly imposed in import demand analysis. Studies using Rotterdam models under this assumption include Weatherspoon and Seale for Japanese beef imports, and Seale, Sparks, and Buxton for apple demands in four import markets.

[4] Hayes, Wahl, and Williams use these assumptions to test perfect substitutability between Wagyu and import-quality beef (without restriction on the intercept). Perfect substitutability in theory implies infinite cross-price elasticities. These assumptions do not guarantee infinite cross-price elasticities. They test product aggregation between the two products.

[5] During the sample period, the ratio of import to quota is .92 on the average, with .75 in 1973 and .52 in 1975. Without these outliers, the average ratio is .96, with the standard deviation .04.

[6] This assumption usually is imposed on import demand estimations (e.g., Alston et al.; Seale, Sparks, and Buxton; Weatherspoon and Seale). As Winters pointed out, this is mainly because the import data differ in nature from the domestic data.

[7] We conducted the Hausman test for the null hypothesis of no correlation between group expenditure and error terms. The F-statistic for the joint null hypothesis of zero coefficient for predicted value of $\log(E)$ in the RSDAIDS was 5.34 and rejected the null hypothesis at less than the 1% level.

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