Agricultural Economics Report No. 439 May 2000

AN ECONOMETRIC ANALYSIS OF DEMAND FOR MEAT AND FISH PRODUCTS IN KOREA

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Acknowledgments

The authors extend appreciation to Dr. Demcey Johnson, Dr. Cheryl Wachenheim, and Dr. Joon Je Park for their constructive comments and suggestions. Special thanks go to Ms. Carol Jensen, who helped to prepare the manuscript.

This research was conducted under the alternative crop program funded by USDA-CSREES (Grant No. 97-34216-3995, ND0517**).**

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Abstract

This study analyzes the structure of Korean meat and fish product demand. The Linear Approximate Almost Ideal Demand System (LA/AIDS) is used to estimate Korean meat and fish demand. Since the expenditure term is endogenous, the three-stage least squares (3SLS) estimator is used to estimate the demand system.

Empirical results indicate that beef imports would increase with increases in per capita income. If imported beef becomes less expensive as a result of the trade liberalization policy adopted by the Korean government, Hanwoo beef would not be competitive and could lose its market share. Pork and chicken would be able to maintain market shares, but most fish products would lose market shares.

Key Words: demand, almost ideal demand system, meat, fish, endogeneity, Rotterdam model, separability, estimator.

Highlights

Korean food demand has increased and diversified as consumers' income has increased. Consumers have changed their consumption patterns by eating more livestock products, vegetables, and fruits rather than cereals.

The demand for meat products has increased from 0.4 million metric tons in 1980 to 1.3 million metric tons in 1996, along with the growth in national income. Meat production in Korea has also grown during recent decades. In 1996, meat production accounted for 25 percent of total agricultural production, rising from 19 percent in 1980.

Fish products are important sources of protein in Korea. Per capita fish product consumption was 28 kg in 1998, which was greater than per capita consumption of all other meat combined (25 kg).

The Korean livestock industry is currently facing the critical challenge of the market liberalization trend under the World Trade Organization (WTO). Imports of frozen pork and chicken were liberalized on July 1, 1997, and the Korean beef market will be fully liberalized on January 1, 2001.

This study analyzes the structure of Korean meat and fish product demand. The Linear Approximate Almost Ideal Demand System (LA/AIDS) is used to estimate Korean meat and fish product demand.

The Hausman endogeneity test indicates that the expenditure term is endogenous. As the result, the three-stage least squares (3SLS) estimator is used to estimate the demand system for meat and fish products in Korea.

The LA/AIDS is estimated using monthly, quarterly, and annual data for the 1980-98 period. Standard errors are larger and t-ratios are smaller when using quarterly and annual data. This result shows that it is better to use disaggregated data to avoid aggregation bias if the data are available.

Empirical results indicate that under trade liberalization, beef imports in Korea will increase in the future. Beef imports would also increase with per capita income. If less expensive and better-quantity imported beef are introduced to Korean consumers, Hanwoo (Korean domestic cattle) beef could not maintain market share.

AN ECONOMETRIC ANALYSIS OF DEMAND FOR MEAT AND FISH PRODUCTS IN KOREA

Jione Jung and Won W. Koo*

Introduction

Korean food demand has increased and diversified as per capita income has increased due to economic growth. Consumption patterns are shifting toward eating more meat, vegetables, and fruits rather than cereals. Meat consumption has increased eight fold, from 165,000 to 1,339,000 metric tons over the 1970-97 period. Pork consumption increased faster than consumption of beef and chicken during this time period (Figure 1).

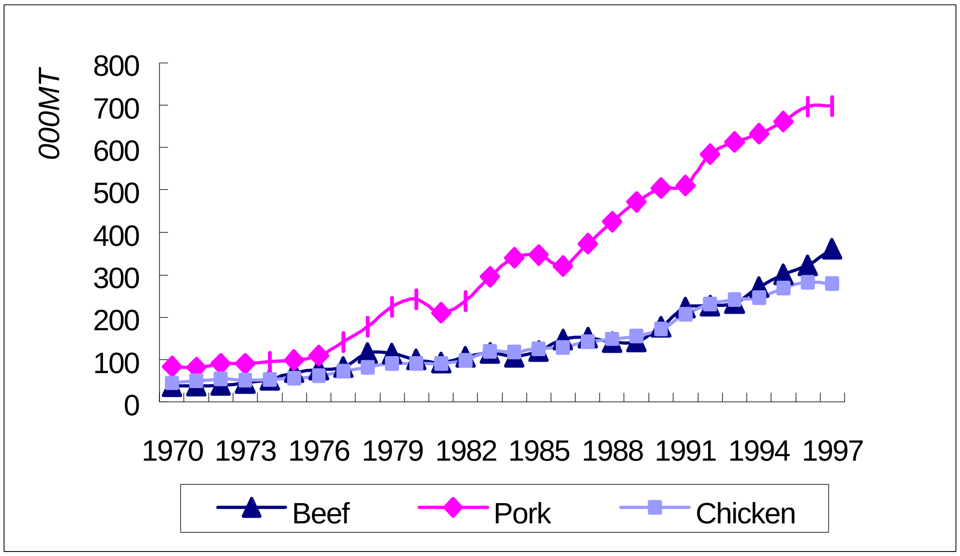

Figure 1. Annual Meat Consumption in Korea: 1970-97.
Source: National Livestock Cooperatives Federation (NLCF), Korea, 1999.

Fish products are important sources of protein in Korea, and their consumption is large compared to meat products in Korea. However, consumption of fish products has declined slightly for the 1980-98 period while meat consumption has increased. In 1996, the Korean people consumed 34.1 kg of fish products per person. When compared to per capita consumption of beef, pork, and chicken in 1996 (25.3 kg), per capita consumption of fish products is greater than all three meat products combined (Figure 2).

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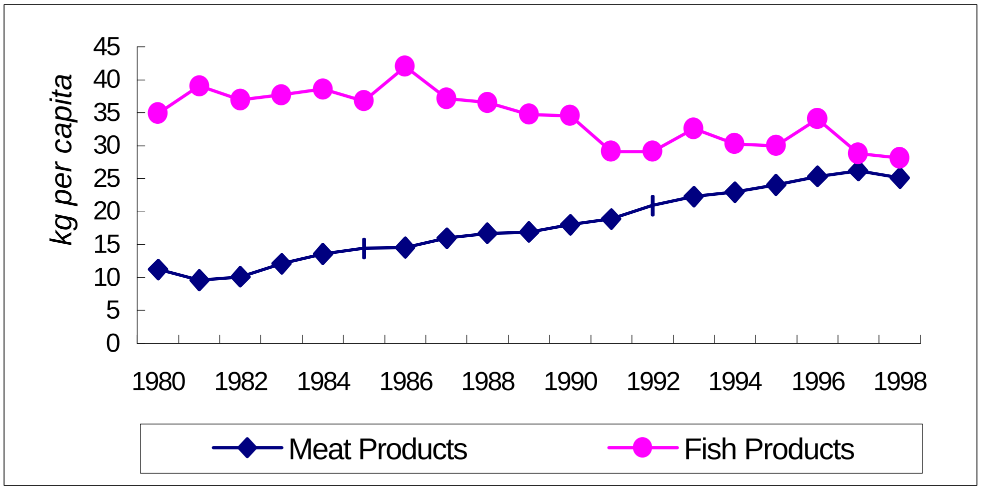

Figure 2. Consumption of Fish Products in Korea: 1980-98.
Source: NLCF and National Fishery Cooperative Federation (NFCF), Korea, 1999.

The Korean meat industry is currently facing a challenge from trade liberalization under the WTO. Imports of frozen pork and chicken were liberalized on July 1, 1997, and the Korean beef market will be fully liberalized on January 1, 2001. The fish industry is also undergoing trade liberalization. From the Asia-Pacific Economic Cooperation (APEC) agreement in 1997, nine fish commodities were liberalized in 1999, and all tariffs in fishery sector should be eliminated by 2007.

The objective of this study is to estimate consumers' behavior in the consumption of meat and fish products in Korea. Special attention is given to fish product consumption as a meat substitute because fish products are important sources of protein in Korea.

The study estimated the meat demand system in Korea using the Linear Approximate Almost Ideal Demand System (LA/AIDS). The F and Likelihood Ratio (LR) tests are used to test separability between meat and fish products. A model specification test developed by Alston and Chalfant (1993) is used to determine an appropriate demand system for the Korean meat and fish industries. The Hausman endogeneity test indicates that the expenditure term is endogenous. Thus, the three-stage least squares (3SLS) estimator is used to estimate the demand system for meat and fish products in Korea.

Most past studies assumed that fish products are separable from meat products, when they estimated the demand for meat products in Korea. Koo et al. estimated Korean meat demand, using a general switching AIDS. In the study, the meat demand system in Korea was estimated without fish products.

Kim and Sa (1994) investigated model specifications for the Korean meat demand system. They used the procedure developed by Alston and Chalfant (1993). Their study chose the LA/AIDS for Korean meat demand analysis.

Shin (1995) analyzed the impact of beef trade liberalization in Korea. Since the price of Hanwoo beef is much higher than the price of imported beef, he suggested that if the quality of Hanwoo beef were similar to high-quality imported beef, Hanwoo beef would lose its price competitiveness. Quality differentiation would induce consumers to pay more for Hanwoo beef than for imported beef.

The paper is organized as follows. The next section reviews the Korean meat and fish industry. A demand model for Korean meat and fish products is developed in the third section. Data and estimation procedures are explained in the fourth section. The fifth section presents empirical results and interpretations. The summary and conclusions are in the last section of the paper.

Korean Meat and Fish Industries

As disposable income has grown, Korean consumers have demanded more meat, stimulating increases in meat production in Korea. The share of the livestock sector grew from 15 percent of total agricultural value in 1970 to 25 percent in 1996 (Table 1).

Table 1. Livestock Share in the Value of Agricultural Products

	Agriculture (A)	Livestock (B)	B/A
Year	*(billion Won)*	*(billion Won)*	(%)
1970	789	118	15
1980	6,415	1,227	19
1990	17,728	3,921	22
1991	19,157	4,405	23
1992	20,405	4,611	23
1993	20,737	5,055	24
1994	23,398	5,304	23
1995	25,855	5,958	23
1996	28,129	6,934	25

Source: Statistical Yearbook of Agriculture and Forestry, Korea, 1997

Meat consumption has increased eight fold, from 165,000 to 1,339,000 metric tons, over the 1970-97 period. Pork consumption increased faster than consumption of beef and chicken during this time period.

Beef is the preferred meat in Korea, but pork has become more popular since it is less expensive. Beef is considered a luxury consumption good. People in high-income groups tend to eat more beef, while low-income consumers generally choose less expensive pork. Pork consumption could decrease in the future as income increases, while beef consumption could increase.

Hanwoo beef production does not cover the increasing trend of higher beef consumption. Beef imports have increased from 7 thousand metric tons in 1988 to 134 thousand metric tons in 1997. The price of Hanwoo beef is generally higher than that of imported beef (Figure 3). In 1998, the price of Hanwoo beef was 13,822 Won/kg, while the price of imported beef was 5,748 Won/kg.

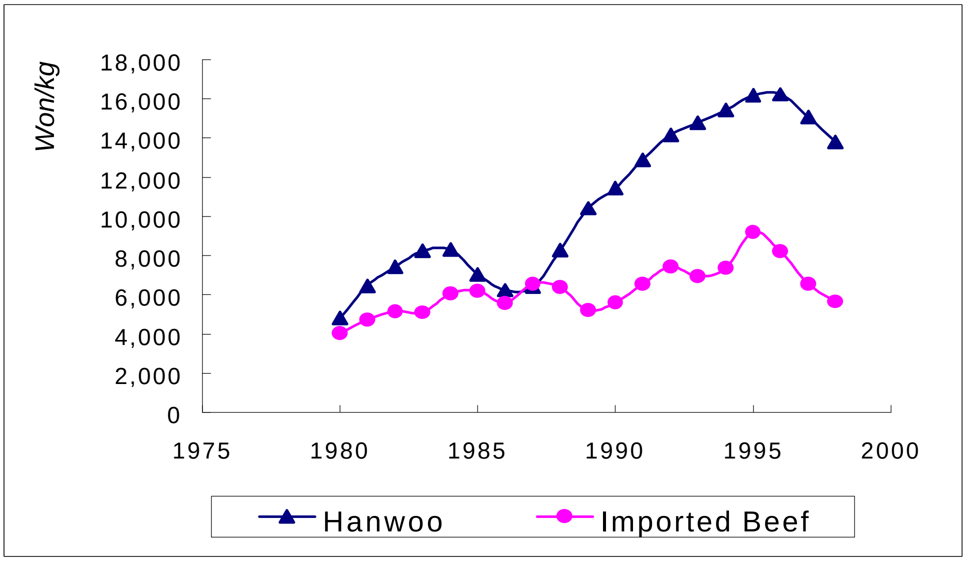

Figure 3. Prices of Hanwoo and Imported Beef in Korea.
Source: NLCF, Korea, 1999.

The major exporting countries of beef to Korea are the United States and Australia (Figure 4). U.S. exports of beef increased from 42 thousand metric tons in 1993 to 83 thousand metric tons in 1997, while other country exports remained the same or increased slightly.

The Korean meat industry is currently facing a market liberalization trend as a result of bilateral and multilateral trade negotiations. Meat imports could increase due to commitments under the Uruguay Round of the GATT, completed in 1993. Imports of frozen pork and chicken were liberalized on July 1, 1997 and beef imports will be liberalized by January 1, 2001.

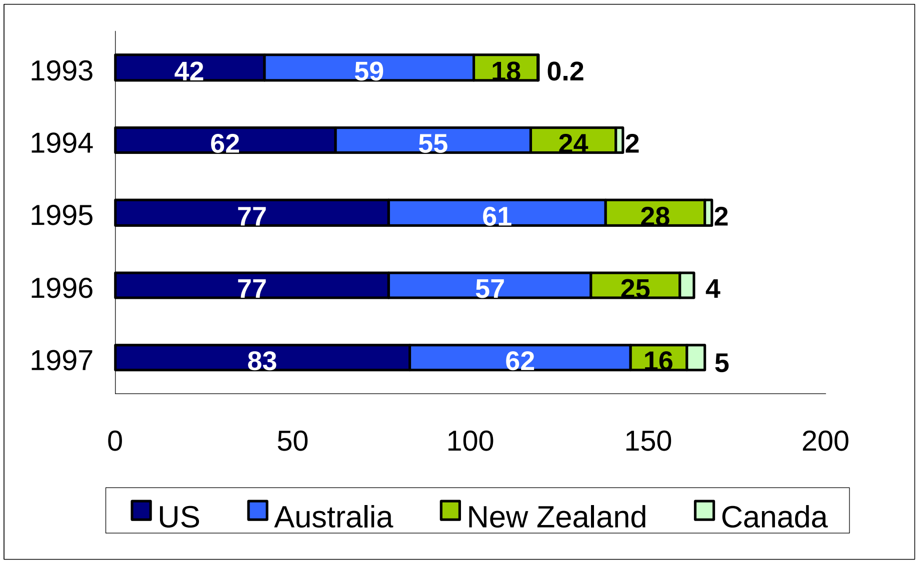

Figure 4. Beef Imports by Country.
Source: NLCF, Korea, 1998.

The Korean fish industry is also undergoing a trade liberalization process. As a member of APEC, Korea is responsible for the early voluntary sectoral liberalization in its fishery sector. From the APEC agreement in 1997, nine fish commodities were liberalized in 1999, and by 2007, all tariffs in the fishery sector should be eliminated (Fishery Working Group, APEC, 1999).

Empirical Model

This section describes the specification of a demand model for meat and fish products in Korea. Theoretical demand models considered in this study are the Rotterdam demand model and the Linear Approximately Almost Ideal Demand System (LA/AIDS).

Separability Between Meat and Fish Products

Consumer theory assumes that a consumer purchases goods and services with limited income. Income is allocated among goods and services to maximize utility.

Consumers allocate total expenditure in two stages (Eales and Wessels, 1999; Goldman and Uzawa, 1964). In the first stage, total expenditure is allocated over broad groups of goods. In the second stage, group expenditures are allocated over individual goods within a group. A necessary and sufficient condition for the second stage of the two-stage budgeting procedure is weak separability of the utility function over broad groups of goods.[1]

[1] The concept of separability is applied in empirical demand studies so that the estimation model is correctly specified and the number of estimated parameters is limited.

Fish products are important sources of protein in the Korean diet. Korean consumers use a large portion of their food budget for fish products. This kind of consumption pattern suggests that consumption of fish products could be related to meat consumption as a complement or substitute.

If fish products are not separable from meat, the demand for meat should be expressed as a function of the prices of all meat and fish products and the budget allocated to the group. On the other hand, if fish and meat products are separable, meat demand should be treated separately from the demand for fish products.

In this study, rather than view fish products as a single homogenous commodity, fish and other seafood are categorized into three groups of products: (1) fish, which includes cod, flounder, pollack, corvinias, anchovy, mackerel, saury, and tuna; (2) crustaceans, which include shrimp and crab; and (3) mollusks, which include abalone, oyster, shell, clam, squid, and octopus. The meat products include domestic (Hanwoo) beef produced in Korea, imported beef, pork, and chicken.

Separability tests are conducted using the LA/AIDS for meat and fish products. The demand system is specified as

(1) $$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_j + \beta_i \log(E / P^*), \qquad i = 1,2,\ldots,n.$$

where w_i is the budget share of the i^{th} good, p_j is the nominal price of the j^{th} good, E is the total expenditure on the group of goods, and $\log P^*$ is the price index. For this test, quarterly data from 1980 to 1998 are used.

The following null hypothesis should be tested for separability between meat and fish products in Korea.

(2) $$\mathbf{H_0}: \gamma_{i,fish} = \gamma_{i,crustacean} = \gamma_{i,mollusk} = 0,$$

where $\gamma_{i,fish}$, $\gamma_{i,crustacean}$, and $\gamma_{i,mollusk}$ are the price parameters of each group of fish products.

The null hypothesis can be tested using either the F-test or the Likelihood Ratio (LR) test. The F-test can be expressed in terms of R^2 obtained from the restricted model which include only meat variables (R_R^2) and the unrestricted model which include both meat and fish product variables (R_{UR}^2).

(3) $$\frac{(R_{UR}^2 - R_R^2)/q}{(1 - R_{UR}^2)/(n-k)} \sim F_{q,n-k}$$

where R_R^2 and R_{UR}^2 are R^2 values of the restricted and unrestricted models, respectively. If the calculated F value is larger than the critical value of the F-statistic, the null hypothesis in Equation (2) is rejected. The null hypothesis of weak separability between meat and fish products is rejected, implying that the demand model should include both meat and fish products (Table 2).

The other separability test is the Likelihood Ratio (LR) test. The Likelihood Ratio can be expressed as follows:

(4) $$LR \equiv 2[L_{UR} - L_R] \sim \chi^2_{k-q}$$

where L_R represents the maximum value of the log-likelihood function when the model contains only meat variables and L_{UR} represents the maximum value when the model includes both meat and fish product variables. If the calculated value of chi-square is larger than the critical value of chi-square with (k-q) degree of freedom at the given critical level, we reject the null hypothesis. The LR test also rejects the null hypothesis at the 5 percent significance level, indicating that the price of fish products should be included in estimating the meat demand model
(Table 2).

Table 2. F- and LR Tests for Separability

Separability	Calculated Value	DF* DF1	DF* DF2	Critical Value (α =.05)
F				
Meat vs. Fish Products	11.050	3	63	3.15
Likelihood Ratio				
Meat vs. Fish Products	1,649.384	10		18.307

* DF denotes Degree of Freedom.

<u>Model Choice Between the LA/AIDS and Rotterdam Model</u>

Once the separability test is performed to determine which goods should be included in a demand model, the appropriateness of a demand model is tested for specified data. The *compound model* approach by Alston and Chalfant (1993) is used to determine an appropriate demand model for this study.

First, the Rotterdam model introduced by Theil (1965) and Barten (1964) is specified with a double-log functional form as

(5) $$\overline{w}_i \Delta \log q_i = \sum_{j=1}^{n} g_{ij} \Delta \log p_j + b_i DQ, \qquad i = 1,2,\ldots,n,$$

where i and j are indexes for goods, q_i is the quantity demanded of the i^{th} good, and p_j is the price of j^{th} good within the group. $\overline{w}_i$ is the average of $w_{i,t}$ and $w_{i,t-1}$, budget shares of i^{th} good on time t and t-1. Δ denotes the first-difference operator ($\Delta \log q_i = \log q_{i,t} - \log q_{i,t-1}$). DQ represents the real income term.

The theoretical restrictions of adding-up, homogeneity, and symmetry, implied by demand theory, are satisfied by the following parametric restrictions on the Rotterdam model.

(6)

Adding-up: $\sum_{i=1}^{n} g_{ij} = 0, \quad \sum_{i=1}^{n} b_i = 1.$

Homogeneity: $\sum_{j=1}^{n} g_{ij} = 0.$

Symmetry: $g_{ij} = g_{ji}.$

More recently, the Almost Ideal Demand System (AIDS) was developed by Deaton and Muellbauer (1980). The AIDS is specified as

(7) $$w_i = a_i + \sum_{j=1}^{n} g_{ij} \log p_j + b_i \log(E / P), \qquad i = 1,2,\ldots,n,$$

where w_i is the budget share of the i^{th} good, E is the total expenditure on the group of goods, and $\log P$ is the price index for the group defined as

(8) $$\log P = a_i + b_i \log p_i + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} c_{ij} \log p_i \log p_j .$$

This price index makes the system nonlinear. To make the model linear in parameters, Deaton and Muellbauer (1980) suggested using Stone's price index defined as

(9) $$\log P^* = \sum_{i=1}^{n} w_{i,t} \log p_{i,t} .$$

The model which uses Stone's price index is called the *Linear Approximate* AIDS (LA/AIDS) as follows

(10) $$w_i = a_i + \sum_{j=1}^{n} g_{ij} \log p_j + b_i \log(E / P^*), \qquad i = 1,2,\ldots,n.$$

However, using Stone’s price index causes a simultaneity problem since the dependent variable w_i appears on the right-hand side of the LA/AIDS. To avoid the simultaneity problem, the lagged share has been used for $P*$, as $\log P* = \sum_{i}^{n} w_{i,t-1} \log p_{i,t}$ (Eales and Unnevehr, 1988). Equation (10) implies that the budget shares of various commodities are linearly related to the logarithm of the real total expenditure and relative prices.

The general demand restrictions of adding-up, homogeneity, and symmetry are satisfied by the following parametric restrictions on the AIDS.

(11) Adding-up: $\sum_{i=1}^{n} a_i = 1, \quad \sum_{i=1}^{n} g_{ij} = 0, \quad \sum_{i=1}^{n} b_i = 0.$

Homogeneity: $\sum_{j=1}^{n} g_{ij} = 0.$

Symmetry: $g_{ij} = g_{ji}.$

Which model fits better for a particular data set is an empirical question. Alston and Chalfant (1993) developed a test procedure for choosing between the AIDS and the Rotterdam model. Suppose we have two alternative models in which the right-hand sides are identical but the dependent variables differ:

(12) Model 1: $y = f(x)$

(13) Model 2: $z = f(x)$

In this case, the Box-Cox transformation can be used to nest both alternatives, and it is possible to test each against the alternative. Equations (12) and (13) are compounded as

(14) $$l y + (1 - l) z = f(x)$$

if $l = 0$, Equation (13) is correct. However, if $l = 1$, Equation (12) is correct. Thus, a model can be determined by testing the null hypothesis, $l = 0$.

The right-hand side of a first-differentiated version of the LA/AIDS is virtually identical to that of the Rotterdam model, even though the dependent variables differ. In several studies, the LA/AIDS has been estimated in the first-differentiated form (e.g., Deaton and Muellbauer 1980, Eales and Unnevehr 1988, Moschini and Meilke 1989, Alston and Chalfant 1993). In the first-differentiated form, the LA/AIDS becomes

(15) $$\Delta w_i = \sum_{j=1}^{n} g_{ij} \Delta \log p_j + b_i \Delta \log(E / P*).$$

The first-differentiated Stone's index, $\Delta \log P^*$, in Equation (15) may be decomposed into three components:

$$(16) \qquad \Delta \log P^* = \sum_{j=1}^{n} w_j \cdot \Delta \log p_j + \sum_{j=1}^{n} \Delta w_j \cdot \log p_j - \sum_{j=1}^{n} \Delta w_j \cdot \Delta \log p_j \ .$$

The second and third term are likely to be quite small since, in the context of time-series data, shares usually do not change much from one observation to the next (Alston and Chalfant 1993). Substituting the first term of $\Delta \log P^*$ from Equation (16) into the first-differentiated LA/AIDS in Equation (15) yields

$$(17) \qquad \Delta w_i \approx \sum_{j=1}^{n} g_{ij} \Delta \log p_j + b_i [\Delta \log X - \sum_{j=1}^{n} w_j \Delta \log p_j] .$$

Equation (17) is similar to the Rotterdam model. Any other difference is in the specification of the income term. Theil and Clements (1987) refer to *DQ* in Equation (5) as *a finite change version of the Divisia volume index* (Alston and Chalfant 1993). It is approximately equal to

$$(18) \qquad DQ^* = \Delta \log X - \Delta \log P^{\circ} \ ,$$

where $\Delta \log P^{\circ} = \sum_{j=1}^{n} \overline{w}_j \cdot \Delta \log p_j$. The similarity of $\Delta \log P^{\circ}$ to the first-differentiated Stone's price index in Equation (16) is evident. It is the same as the first and largest term of $\Delta \log P^*$ except that a moving average of budget shares has been substituted for the current values of budget shares. Substituting *DQ** for *DQ*, the Rotterdam model is re-specified as follows

$$(19) \qquad \overline{w}_i \Delta \log q_i = \sum_{j=1}^{n} g_{ij} \Delta \log p_j + b_i DQ^*$$
$$= \sum_{j=1}^{n} g_{ij} \Delta \log p_j + b_i [\Delta \log X - \sum_{j=1}^{n} \overline{w}_j \cdot \Delta \log p_j] .$$

On the right-hand side, only the real income terms in the first-differentiated LA/AIDS can be distinguished from the Rotterdam model. The differences involve the use of $\overline{w}_j$ instead of w_j in the Rotterdam model, Equation (19) and the deletion of Δw_j terms in the LA/AIDS, Equation (17).

These two models can be combined as

$$(20) \qquad (1 - f) \Delta \overline{w}_i \log(q_i) + f \Delta w_i = \sum_{j=1}^{n} g_{ij} \Delta \log(p_j) + b_i DQ^* , \qquad i = 1, 2, \ldots, n .$$

Equation (20) is a linear combination of the LA/AIDS and the Rotterdam model. If $f = 0$, Equation (20) reduces to the Rotterdam model; if $f = 1$, Equation (20) reduces to the first-differentiated LA/AIDS. A test of the hypothesis that $f = 0$ can be interpreted as a test of the hypothesis that the Rotterdam model is the correct specification.

The LA/AIDS can be tested directly as well. In the alternative compound model,

$$(21) \qquad (1 - l)\Delta w_i + l\,\Delta \overline{w}_i \log(q_i) = \sum_{j=1}^{n} g_{ij} \Delta \log(p_j) + b_i \Delta \log(X / P^*)$$

$l = 0$ implies that the LA/AIDS is correct while l near 1 is evidence against the LA/AIDS in the direction of the Rotterdam model.

To determine an appropriate demand model, two compound models are specified for Korean meat and fish products as follows

$$(22) \qquad (1 - f)\Delta \overline{w}_i \log(q_i) + f\,\Delta w_i = \sum_{j=1}^{7} g_{ij} \Delta \log(p_j) + b_i DQ^* \text{ and}$$

$$(23) \qquad (1 - l)\Delta w_i + l\,\Delta \overline{w}_i \log(q_i) = \sum_{j=1}^{7} g_{ij} \Delta \log(p_j) + b_i \Delta \log(X / P^*),$$

where variables are the same as defined before. Equation (22) is for the Rotterdam model specification, and Equation (23) is for the LA/AIDS specification.

Both Equation (22) and Equation (23) were estimated. In Equation (22), the estimated value of f is 1.2193, with a standard error of 0.0829. The p-value of f is 0.0001. In Equation (23), the estimated value of l is 0.0221, with a standard error of 0.0097. The p-value of l is 0.0237. The p-value of f is less than that of l in the test, indicating that the LA/AIDS fits better for the Korean meat and fish industry than the Rotterdam model.

Data and Procedure

Three sets of time series data are used to estimate a theoretical demand model for the Korean meat and fish industries. They are monthly, quarterly, and annual data for the 1980-98 period.

Quantities of meat consumed and prices were obtained from the National Livestock Cooperatives Federation (NLCF) in Korea (1999). Data for fish products consumption and prices came from Monthly Statistics on Cooperative Sales of Fishery Products published by National Fishery Cooperative Federation (NFCF) of Korea (1999). The consumer price index, disposable income, and population are from the Korean Statistical Information System (KOSIS) published by the National Statistical Office (NSO, 1999).

Estimation Procedure

The empirical model specified for this study is the LA/AIDS including both meat and fish products. Meat is divided into domestic (Hanwoo) beef, imported beef, pork, and chicken; fish products are divided into fish, crustacean, and mollusk.

General demand restrictions are enforced in estimation of the LA/AIDS. The seemingly unrelated regression (SUR) estimator is used to estimate parameters of the model, by enforcing homogeneity and symmetric restrictions directly in estimation. The seventh equation was dropped to meet the adding-up condition.

One concern is whether the expenditure variable in the model is exogenous. If the expenditure variable in the model is endogenous, it is correlated with the random error term, so the SUR estimator is no longer an unbiased estimator (Edgerton, 1993). To test endogeneity of the expenditure variable, the Hausman test suggested by LaFrance (1991) was used.

Let q be a consistent and asymptotically efficient estimator. q^* is a consistent, but inefficient, estimator under the null hypothesis. Then, the Hausman test statistic is

(24) $$m = T(\hat{q}^* - \hat{q})'[Var(\hat{q}^*) - Var(\hat{q})]^{-1}(\hat{q}^* - \hat{q}),$$

which has a chi-square distribution with degrees of freedom equal to the number of unknown parameters in q . If m is larger than the critical value, then the null hypothesis of exogeneity is rejected.

In this study, q is the seemingly unrelated regressions (SUR) estimator, and q^* is the three-stage least squares (3SLS) estimator. Under the exogeneity assumption of right-hand side (RHS) variables of the demand system, the SUR estimator is consistent and asymptotically efficient. If any of the RHS variables are endogenous, the SUR estimator is no longer consistent or efficient, whereas, the 3SLS estimator is inefficient but consistent.

The calculated values of the chi-square for all meat and fish products in the system are larger than the critical value of chi-square with 9 degrees of freedom at the 5 percent significance level. Thus, the null hypothesis that the expenditure variable is exogenous is rejected (Table 3). The result indicates that the expenditure variable in the LA/AIDS should be endogenous.

Therefore, the 3SLS method is used to estimate the LA/AIDS for meat and fish products in Korea. The instruments employed in the estimation are the first lags of all prices and expenditure variables, disposable income, and the consumer price index (Eales, Durham, and Wessells 1997).

Table 3. Endogeneity Test of the Expenditure Variable

	Calculated Test Statistics	DF	Critical Value (a = 0.05)
Hanwoo Beef	1,821.224	9	16.919
Imported Beef	34.603	9	16.919
Pork	126.967	9	16.919
Chicken	2,078.976	9	16.919
Fish	83.557	9	16.919
Crustacean	261.119	9	16.919
System	4,406.447	54	72.136

Estimation Results

Table 4 presents the 3SLS estimates of the LA/AIDS for meat and fish products in Korea using monthly data from 1980 to 1998. The following analysis is based on the estimated model with monthly data.

The system weighted R^2 is 0.554, indicating that independent variables in the LA/AIDS explain 55.4 percent of the data variation. Own price exhibits a significant effect in four equations (Hanwoo beef, pork, chicken, and fish) but is not significant in the remaining equations (imported beef, crustacean, and mollusk). The expenditure variable is significant in the share equations for Hanwoo beef, imported beef, pork, and fish; but not in the share equations of chicken and crustacean.

In the Hanwoo beef equation, parameters of Hanwoo beef, imported beef, chicken, and crustacean prices are statistically significant at the 5 percent significance level, indicating that consumption of beef is sensitive to its own, imported beef, chicken, and crustacean prices. However, in the case of the imported beef model, parameters of all meat (Hanwoo beef, pork, and chicken), crustacean, and mollusk prices are significant at the 5 percent level, indicating that consumption of imported beef is sensitive not only to meat products, but also to fish products.

Seasonal dummy variables of meat (except pork) and fish products are significant at the 5 percent level. The consumption of Hanwoo and imported beef increases in the spring and fall, and decreases during the winter. Pork consumption increases in the winter, but the increase is not statistically significant. The seasonality of chicken is significant at the 5 percent level, especially during the summer and fall. Fish consumption is greatest in winter.

Table 4. Parameter Estimates of the LA/AIDS Using Monthly Data

	Hanwoo	I-Beef	Pork	Chicken	Fish	Crust.	Mollusk
Hanwoo	-0.1156						
	(-4.469)*						
I-Beef	0.0561	-0.0105					
	(4.332)*	(-1.085)					
Pork	0.0167	-0.0335	0.0619				
	(1.340)	(-4.696)*	(5.926)*				
Chicken	0.0132	-0.0235	-0.0310	0.0519			
	(2.110)*	(-5.912)*	(-7.560)*	(10.708)*			
Fish	0.0167	0.0110	-0.0090	-0.0016	-0.0222		
	(1.590)	(1.885)	(-1.477)	(-0.529)	(-3.198)*		
Crust.	0.0113	-0.0081	-0.0034	-0.0036	0.0021	-0.0003	
	(3.284)*	(-3.774)*	(-1.601)	(-2.171)*	(1.228)	(-0.232)	
Mollusk	0.0016	0.0084	-0.0018	-0.0053	0.0030	0.0019	-0.0078
	(0.276)	(2.460)*	(-0.488)	(-3.075)*	(1.019)	(1.928)	
Exp.	0.0753	0.0292	-0.0538	-0.0042	-0.0354	-0.0051	-0.0060
	(4.023)*	(2.490)*	(-4.054)*	(-0.840)	(-3.068)*	(-1.737)	
Spring	0.0539	0.0231	0.0106	0.0030	-0.0538	-0.0103	
	(6.539)*	(4.581)*	(1.829)	(1.409)	(-11.416)*	(-8.001)*	
Summer	0.0530	0.0203	0.0110	0.0161	-0.0688	0.0067	
	(6.045)*	(3.820)*	(1.853)	(7.341)*	(-14.184)*	(5.262)*	
Fall	0.0628	0.0183	-0.0054	0.0198	-0.0590	-0.0070	
	(7.623)*	(3.637)*	(-0.936)	(9.333)*	(-12.483)*	(-5.659)*	
System	Weighted	R^2 =.554					

* Denotes significance at the 5 percent level, and t-ratios are in parentheses.

The same LA/AIDS is estimated using quarterly and annual data for the 1980-98 period. Tables 5 and 6 show the estimation results using quarterly and annual data, respectively. System weighted R^2s are 0.788 with quarterly data and 0.844 with annual data, indicating that the demand system has a higher R^2 with aggregated data.

Table 5. Parameter Estimates of the LA/AIDS Using Quarterly Data

	Hanwoo	I-Beef	Pork	Chicken	Fish	Crust.	Mollusk
Hanwoo	-0.0295						
	(-0.630)						
I-Beef	0.0385	0.0133					
	(1.537)	(0.686)					
Pork	-0.0065	-0.0362	0.1178				
	(-0.288)	(-2.623)*	(6.304)*				
Chicken	-0.0094	-0.0098	-0.0279	0.0485			
	(-1.506)	(-2.298)*	(-6.896)*	(10.210)*			
Fish	0.0103	-0.0098	-0.0258	0.0017	0.0034		
	(0.532)	(-0.846)	(-2.303)*	(0.444)	(0.250)		
Crust.	0.0112	-0.0058	-0.0061	0.0009	-0.0017	0.0031	
	(2.871)*	(-2.242)*	(-2.604)*	(0.488)	(-0.713)	(2.304)*	
Mollusk	-0.0146	0.0098	-0.0153	-0.0040	0.0218	-0.0016	0.0039
	(-1.111)	(1.199)	(-1.847)	(-1.925)*	(3.187)*	(-1.183)	
Exp.	0.0380	0.0884	0.0696	0.0013	-0.1313	0.0066	-0.0725
	(0.896)	(3.067)*	(2.505)*	(1.720)	(-5.201)*	(1.427)	
Spring	0.0487	0.0105	0.0033	0.0030	-0.0359	-0.0124	
	(3.431)*	(1.245)	(0.349)	(1.601)	(-5.016)*	(-10.584)*	
Summer	0.0261	0.0118	0.0157	0.0200	-0.0538	0.0063	
	(1.852)	(1.424)	(1.690)	(11.387)*	(-7.882)*	(5.730)*	
Fall	0.0463	0.0179	0.0024	0.0215	-0.0552	-0.0050	
	(3.579)*	(2.292)*	(0.268)	(13.208)*	(-8.800)*	(-4.843)*	
System Weighted	R^2 = .788						

* Denotes significance at the 5 percent level, and t-ratios are in the parentheses.

Table 6. Parameter Estimates of the LA/AIDS Using Annual Data

	Hanwoo	I-Beef	Pork	Chicken	Fish	Crust.	Mollusk
Hanwoo	-0.1274						
	(-1.701)						
I-Beef	0.0881	-0.0482					
	(2.273)*	(-1.634)					
Pork	0.0353	-0.0506	0.1152				
	(0.814)	(-1.861)	(2.503)*				
Chicken	-0.0152	-0.0078	-0.023	0.0454			
	(-7.872)*	(-7.201)*	(-15.783)*	(33.698)*			
Fish	0.0207	0.0103	-0.0524	0.0088	0.0173		
	(0.560)	(0.524)	(-2.138)*	(6.095)*	(0.590)		
Crust.	0.0038	-0.0001	-0.0075	0.0007	-0.0058	0.0059	
	(0.585)	(-0.028)	(-1.782)	(0.672)	(-1.276)	(2.346)*	
Mollusk	-0.0053	0.0082	-0.0171	-0.009	0.0011	0.003	0.0191
	(-0.361)	(1.019)	(-1.537)	(-7.222)*	(0.110)	(0.999)	
Exp.	0.1227	-0.0297	0.0645	-0.0016	-0.1157	0.0045	-0.0447
	(1.723)*	(-0.657)	(1.014)	(-0.501)	(-2.142)*	(0.497)	
System	Weighted	R^2 = .844					

* Denotes significance at the 5 percent level, and t-ratios are in the parentheses.

Elasticities of Price and Expenditure

Parameter estimates of the LA/AIDS are used to calculate the price and expenditure elasticities. Price elasticity is calculated in two ways. The first is uncompensated elasticity that contains both price and income effects. The second is compensated elasticity which only includes price effects.

Uncompensated and compensated price elasticities of the LA/AIDS are calculated with the following equations, respectively:

(25) $$e_{ij} = -d_{ij} + \frac{\hat{g}_{ij}}{\overline{w}_i} - \hat{b}_i\left(\frac{\overline{w}_j}{\overline{w}_i}\right),$$

(26) $$e_{ij}{*} = e_{ij} + \overline{w}_j + \hat{b}_i\left(\frac{\overline{w}_j}{\overline{w}_i}\right) = -d_{ij} + \frac{\hat{g}_{ij}}{\overline{w}_i} + \overline{w}_j\,, \qquad i, j = 1,2,\ldots,n\,,$$

where $d = 1$ for $i = j$ and $d = 0$ otherwise. $\overline{w}_i$ is the average expenditure share. $\hat{b}_i$ and $\hat{g}_{ij}$ are parameter estimates. The variances of uncompensated and compensated price elasticities are calculated by applying the variance operator as

$$(27) \qquad Var(e_{ij}) = \frac{1}{\overline{w}_i^2} Var(\hat{\gamma}_{ij}) + \frac{\overline{w}_j^2}{\overline{w}_i^2} Var(\hat{\beta}_i) - 2\left(\frac{\overline{w}_j}{\overline{w}_i^2}\right) Cov(\hat{\gamma}, \hat{\beta}),$$

$$(28) \qquad Var(e_{ij}*) = \frac{1}{\overline{w}_i^2} Var(\hat{\gamma}_{ij}) .$$

The estimated variances are used to evaluate the statistical significance of the elasticities. The expenditure elasticity can be computed as

$$(29) \qquad \eta_i = 1 + \frac{\hat{\beta}_i}{\overline{w}_i} .$$

The variance of expenditure elasticity is

$$(30) \qquad Var(\eta_i) = \frac{1}{\overline{w}_i^2} Var(\hat{\beta}_i) .$$

Uncompensated and compensated price and expenditure elasticities and their variances were calculated from the parameter estimates, using Equations (22) to (27). The price and expenditure elasticities were calculated at the mean of the individual meat and fish products expenditure share.

Table 7 shows the calculated uncompensated elasticities at the sample mean. The uncompensated own price elasticities of individual meat and fish products show a negative sign. Own price elasticities of all meat and fish are significant at the 5 percent level.

Among the six meat and fish products (Mollusk was dropped for meeting the adding-up condition.), own-price elasticity of Hanwoo beef is the largest in absolute terms, followed by imported beef, mollusk, fish, crustacean, pork, and chicken. The uncompensated own-price elasticities of Hanwoo and imported beef are -1.5199 and -1.1786, respectively, indicating that beef consumption is sensitive to prices. Chicken is the most price inelastic, implying that chicken consumption is not sensitive to its price. The price elasticities of fish products range between -1.1033 and -1.1297.

Expenditure elasticities for all meat and fish products are positive and statistically significant at the 5 percent significance level, implying that they are normal goods. Expenditure elasticities of Hanwoo beef, imported beef, and mollusks are greater than or equal to one, indicating that beef and mollusk are luxury goods in Korea. Expenditure elasticities of other meat and fish products are inelastic. However, expenditure elasticities of fish and crustaceans are less elastic than other meat products. This result suggests that fish and crustacean are necessities in the Korean diet.

Table 7. Uncompensated Elasticities of Korean Meat and Fish Products: 1980-98 (Monthly)

	HAN	IB	PK	CH	FS	CR	MO	EXP
HAN	-1.5199*	0.1957	-0.0429	0.0304	0.0178	0.0376	-0.0114	1.2898*
	(0.1019)	(0.0489)	(0.0482)	(0.0243)	(0.0463)	(0.0134)	(0.0230)	(0.0720)
IB	0.6938	-1.1786*	-0.6324	-0.3651	0.0899	-0.1237	0.0951	1.4167*
	(0.1964)	(0.1340)	(0.1062)	(0.0575)	(0.0975)	(0.0311)	(0.0515)	(0.1674)
PK	0.0830	-0.0803	-0.7789*	-0.0737	-0.0011	-0.0062	0.0039	0.8547*
	(0.0360)	(0.0190)	(0.0262)	(0.0113)	(0.0199)	(0.0058)	(0.0106)	(0.0358)
CH	0.2041	-0.3317	-0.4210	-0.2544*	-0.0134	-0.0498	-0.0725	0.9393*
	(0.0925)	(0.0557)	(0.0589)	(0.0691)	(0.0497)	(0.0237)	(0.0259)	(0.0723)
FS	0.1617	0.0840	0.0255	0.0054	-1.1033*	0.0177	0.0323	0.7790*
	(0.0652)	(0.0358)	(0.0391)	(0.0197)	(0.0510)	(0.0110)	(0.0197)	(0.0720)
CR	0.6302	-0.3858	-0.0734	-0.1607	0.1467	-1.0081*	0.1091	0.7446*
	(0.1775)	(0.1047)	(0.1052)	(0.0824)	(0.0986)	(0.0575)	(0.0508)	(0.1471)
MO	0.0261	0.1401	-0.0296	-0.0889	0.0507	0.0313	-1.1297	1.0000

*Denotes significance at the 5 percent level, and standard errors are in parentheses.

The compensated elasticities, which compensate for the income effect, are shown in Table 8. The uncompensated and compensated price elasticities are very similar in terms of magnitude and statistical significance. Own-price elasticities of individual meat and fish products carry a negative sign.

Table 8. Compensated Elasticities of Korean Meat and Fish Products: 1980-98 (Monthly)

	HAN	IB	PK	CH	FS	CR	MO
HAN	-1.1845*	0.2860*	0.4344*	0.1207*	0.2241*	0.0634*	0.0660*
	(0.0995)	(0.0499)	(0.0480)	(0.0240)	(0.0403)	(0.0132)	(0.0218)
IB	1.0621	-1.0794*	-0.1082	-0.2659*	0.3166*	-0.0953*	0.1801*
	(0.1852)	(0.1377)	(0.1018)	(0.0568)	(0.0831)	(0.0306)	(0.0488)
PK	0.3052	-0.0205	-0.4627*	-0.0139	0.1357*	0.0109	0.0552*
	(0.0338)	(0.0193)	(0.0282)	(0.0111)	(0.0165)	(0.0057)	(0.0098)
CH	0.4483	-0.2659	-0.0735	-0.1887*	0.1369*	-0.0310	-0.0162
	(0.0892)	(0.0568)	(0.0587)	(0.0692)	(0.0436)	(0.0235)	(0.0247)
FS	0.3642	0.1385	0.3138	0.0599	-0.9787*	0.0332*	0.0790*
	(0.0655)	(0.0363)	(0.0381)	(0.0191)	(0.0433)	(0.0108)	(0.0186)
CR	0.8238	-0.3337	0.2021	-0.1086	0.2658	-0.9932*	0.1537*
	(0.1717)	(0.1070)	(0.1049)	(0.0823)	(0.0862)	(0.0570)	(0.0486)
MO	0.2861	0.2102	0.3404	-0.0189	0.2107	0.0513	-1.0697

* Denotes significance at the 5 percent level, and standard errors are in parentheses.

Cross-price elasticities show competitive or complementary relations among products. Positive cross-price elasticity indicates substitute products while negative cross-price elasticity means that products are complements. Hanwoo beef has the strongest competitive relationship with pork, as indicated by the positive sign and significance at the 95 percent confidence level. Hanwoo beef also has a competitive relationship with all other meat and fish products.

Cross-price elasticity of imported beef with respect to Hanwoo beef (e_{IH} = 1.0621) is greater than that of Hanwoo beef with respect to imported beef (e_{HI} = 0.2860). This implies that the price of imported beef does not have an influence on the consumption of Hanwoo beef while the price of Hanwoo beef affects the consumption of imported beef. This is because consumers in Korea prefer Hanwoo beef to imported beef.

There is a substitute relationship between fish products, but they are not elastic, implying that the consumption of a fish product is not sensitive to prices of other fish products. Meat has a substitute relationship with all fish products and is statistically significant at the 5 percent significance level, indicating that the consumption of meat products is influenced by prices of fish products. However, fish products do not have a good substitute relationship with meat products, indicating that the consumption of fish is not generally sensitive to prices of fish products.

Pork has a competitive relationship with Hanwoo beef while it has a complementary relationship with imported beef. However, the complementary relationship between pork and imported beef is not statistically significant at the 95 percent confidence level. This result could mean that pork and imported beef do not affect each other in the market. Since retail price and supply of imported beef are currently under government control to establish the beef market, the relationship between pork and imported beef may not exist.

Expenditure elasticities are statistically significant at the 5 percent level for all meat and fish products in Korea. The expenditure elasticity for imported beef is the most elastic, indicating that Korea would increase imports of beef as the country increases its expenditure for meat and fish products.

In the case of Hanwoo, the own-price elasticity is larger than the expenditure elasticity of absolute value (e_H=-1.5199 > h_H=1.2898), while the opposite is true for imported beef (e_I=-1.1786 < h_I=1.4167). If price and income (expenditure for meat and fish products) change at the same time, Hanwoo consumption would be more affected by price than income. However, the consumption of imported beef is more sensitive to income than price of imported beef. Consumers buy imported beef when they cannot afford Hanwoo beef. This is the reason why consumers are sensitive to prices of Hanwoo beef. Imported beef is generally consumed by a consumer group with lower income, while Hanwoo beef is consumed by a higher income group. Thus, imported beef is more responsive to expenditure.

Tables 9 and 12 present price and expenditure elasticities using quarterly and annual data. The magnitude of elasticities is similar for all types of data. However, standard errors are larger and t-ratios are smaller when using quarterly and annual data than with monthly data.

Table 9. Uncompensated Elasticities of Korean Meat and Fish Products: 1980-98 (Quarterly)

	HAN	IB	PK	CH	FS	CR	MO	EXP
HAN	-1.1515*	0.1378	-0.0778	-0.0463	0.0164	0.0416	-0.0649	1.1463*
	(0.1867)	(0.0922)	(0.0975)	(0.0253)	(0.0908)	(0.0152)	(0.0532)	(0.1632)
IB	0.2216	-0.8987*	-0.9713	-0.2277	-0.3416	-0.0959	0.0638	2.2622*
	(0.3980)	(0.2611)	(0.2301)	(0.0626)	(0.2087)	(0.0376)	(0.1217)	(0.4115)
PK	-0.0684	-0.1140	-0.7424*	-0.0911	-0.1025	-0.0187	-0.0542	1.1933*
	(0.0671)	(0.0365)	(0.0546)	(0.0122)	(0.0392)	(0.0066)	(0.0244)	(0.0772)
CH	-0.1387	-0.1406	-0.4054	-0.3078*	0.0209	0.0125	-0.0586	1.0179*
	(0.0984)	(0.0576)	(0.0620)	(0.0666)	(0.0644)	(0.0261)	(0.0311)	(0.1045)
FS	0.2780	-0.0036	0.1345	0.0678	-0.8474*	-0.0026	0.1857	0.1794*
	(0.1221)	(0.0682)	(0.0830)	(0.0251)	(0.1048)	(0.0153)	(0.0440)	(0.1578)
CR	0.9480	-0.6288	-0.8412	0.0427	-0.2772	-0.6952*	-0.1971	1.6552*
	(0.4272)	(0.2458)	(0.2385)	(0.1790)	(0.2876)	(0.1360)	(0.1390)	(0.4590)
MO	0.0708	0.2474	0.1792	0.0174	0.5571	-0.0142	-0.8620	-0.2077

Table 10. Compensated Elasticities of Korean Meat and Fish Products: 1980-98 (Quarterly)

	HAN	IB	PK	CH	FS	CR	MO
HAN	-0.8535*	0.2180*	0.3349*	0.0339	0.1998*	0.0530*	0.0039
	(0.1801)	(0.0963)	(0.0874)	(0.0240)	(0.0748)	(0.0150)	(0.0505)
IB	0.8098	-0.7403*	-0.1569	-0.0693	0.0204	-0.0733	0.1996
	(0.3577)	(0.2766)	(0.1971)	(0.0606)	(0.1650)	(0.0371)	(0.1164)
PK	0.2419	-0.0305	-0.3128*	-0.0076	0.0885*	-0.0068	0.0174
	(0.0631)	(0.0383)	(0.0519)	(0.0112)	(0.0311)	(0.0065)	(0.0231)
CH	0.1260	-0.0693	-0.0389	-0.2365*	0.1837*	0.0227	0.0024
	(0.0890)	(0.0606)	(0.0578)	(0.0679)	(0.0535)	(0.0259)	(0.0299)
FS	0.3246	0.0089	0.1991	0.0804	-0.8187*	-0.0008	0.1964*
	(0.1215)	(0.0722)	(0.0699)	(0.0234)	(0.0853)	(0.0151)	(0.0428)
CR	1.3784	-0.5129	-0.2453	0.1586	-0.0124	-0.6786*	-0.0978
	(0.3896)	(0.2600)	(0.2324)	(0.1814)	(0.2417)	(0.1353)	(0.1334)
MO	0.0168	0.2328	0.1044	0.0029	0.5239	-0.0163	-0.8745

* Denotes significance at the 5 percent level, and standard errors are in parentheses.

Table 11. Uncompensated Elasticities of Korean Meat and Fish Products: 1980-98 (Annually)

	HAN	IB	PK	CH	FS	CR	MO	EXP
HAN	-1.1327*	-0.0357	-0.2149	-0.0418	-0.0893	-0.0118	-0.0349	1.5969*
	(0.2956)	(0.1501)	(0.1326)	(0.0228)	(0.1901)	(0.0301)	(0.0673)	(0.2910)
IB	0.1611	-0.9496*	0.2057	0.0373	0.0916	0.0108	0.0330	0.4671
	(0.6126)	(0.4176)	(0.3182)	(0.0515)	(0.3834)	(0.0584)	(0.1439)	(0.6866)
PK	-0.0290	-0.0073	-1.0434*	-0.0089	-0.0188	-0.0025	-0.0073	1.1276*
	(0.1180)	(0.0646)	(0.0782)	(0.0126)	(0.0874)	(0.0136)	(0.0359)	(0.1618)
CH	-0.0289	-0.0078	-0.0412	-1.0078*	-0.0178	-0.0022	-0.0067	1.1114*
	(0.0323)	(0.0172)	(0.0182)	(0.0202)	(0.0297)	(0.0188)	(0.0227)	(0.0561)
FS	0.2160	0.0582	0.2968	0.0554	-0.8663*	0.0160	0.0482	0.2081
	(0.2324)	(0.1295)	(0.1248)	(0.0298)	(0.2656)	(0.0380)	(0.0767)	(0.3928)
CR	0.0076	0.0020	0.0083	0.0015	0.0045	-0.9992*	0.0017	0.9800
	(0.3307)	(0.1763)	(0.1700)	(0.0724)	(0.3271)	(0.1478)	(0.1669)	(0.5493)
MO	-0.0438	0.2165	0.0281	-0.0135	0.4865	-0.0110	-0.8885	0.2333

Table 12. Compensated Elasticities of Korean Meat and Fish Products: 1980-98 (Annually)

	HAN	IB	PK	CH	FS	CR	MO
HAN	-0.7175*	0.0761	0.3760*	0.0700	0.1662	0.0202	0.0609
	(0.2942)	(0.1528)	(0.1517)	(0.0086)	(0.1548)	(0.0269)	(0.0592)
IB	0.2826	-0.9169*	0.3786	0.0700*	0.1663	0.0202	0.0611
	(0.5677)	(0.4331)	(0.3501)	(0.0176)	(0.3001)	(0.0512)	(0.1231)
PK	0.2642	0.0716	-0.6262*	0.0700*	0.1616*	0.0201	0.0603*
	(0.1066)	(0.0662)	(0.1010)	(0.0042)	(0.0665)	(0.0118)	(0.0301)
CH	0.2601	0.0700	0.3700	-0.9300*	0.1600*	0.0200	0.0600*
	(0.0320)	(0.0176)	(0.0224)	(0.0209)	(0.0240)	(0.0181)	(0.0213)
FS	0.2701	0.0728	0.3738	0.0700	-0.8330*	0.0202	0.0607
	(0.2516)	(0.1316)	(0.1537)	(0.0105)	(0.2092)	(0.0323)	(0.0673)
CR	0.2624	0.0706	0.3709	0.0701	0.1613	-0.9796*	0.0605
	(0.3494)	(0.1793)	(0.2179)	(0.0634)	(0.2583)	(0.1413)	(0.1563)
MO	0.0168	0.2328	0.1144	0.0029	0.5239	-0.0063	-0.8745

* Denotes significance at the 5 percent level, and standard errors are in parentheses.

Forecast of Future Consumption

Calculated elasticities are used to forecast the consumption of Korean meat and fish products in the future. The forecasts for meat and fish consumption in Korea are based on the following scenarios: (1) 20 percent and 50 percent increases in per capita income, (2) 10 percent and 20 percent decreases in the price of imported beef under trade liberalization, and (3) both increases in per capita income and decreases in the price of imported beef.

Changes in Per Capita Consumption under Alternative Scenario of Income Increases

Using expenditure elasticities, the change in quantities demanded can be calculated when per capita income increases. Prices of goods are held constant. Table 13 shows increases in meat and fish product consumption when per capita income increases.

Table 13. Changes in Per Capita Consumption of Meat and Fish Products under Alternative Income Growth Scenarios

	H-Beef	I-Beef	Pork	Chicken	Fish	Crust.	Mollusks
				kg per capita			
1998	4.4	1.8	15.1	5.6	18.6	1.0	8.6
20%	5.6 (26)	2.4 (28)	17.7 (17)	6.7 (19)	21.4 (16)	1.1 (15)	10.3 (20)
50%	7.3 (64)	3.1 (71)	21.5 (43)	8.2 (47)	25.8 (39)	1.3 (38)	12.9 (50)

*Numbers in parentheses represent percentage change in meat and fish consumption compared with per capita consumption in 1998.

Expenditures of meat and fish groups increase along with per capita income growth. In general, consumption of meat products increases faster than that of fish products. According to Wharton Econometric Forecasting Associates (WEFA, 1999), Korea's GDP is expected to increase approximately 50 percent from 6,823 dollars to 10,677 dollars in 2008. Under this forecast, the consumption of Hanwoo and imported beef would increase by 64 percent and 71 percent, respectively. Fish product consumption would increase by 38-50 percent.

Changes in Per Capita Consumption under Alternative Scenario of Decreases in Imported Beef Price

In 2001, the Korean beef market will be fully liberalized. Every restriction should be removed. Without government intervention, the price of imported beef might be lower than the current price.

Own-price elasticity of imported beef and cross-price elasticities of other goods were used to analyze the effects of decreases in the price of imported beef on consumption of meat and fish products. Consumption of imported beef increases 11 percent and 22 percent with decreases in prices by 10 percent and 20 percent, respectively. The consumption of Hanwoo beef, fish, and mollusks, which are substitutes for imported beef, would decrease. Hanwoo beef consumption would decrease 6 percent when imported beef price decreased 20 percent (Table 14).

Table 14. Changes in Per Capita Consumption of Meat and Fish Products under Alternative Price Decrease Scenarios

	H-Beef	I-Beef	Pork	Chicken	Fish	Crust.	Mollusks
			Kg per Capita (%)*				
1998	4.4	1.8	15.1	5.6	18.6	1.0	8.6
-10%	4.3 (-3)	2.0 (11)	15.1 (0.2)	5.8 (3)	18.3 (-1)	1.0 (3)	8.4 (-2)
-20%	4.2 (-6)	2.2 (22)	15.2 (0.4)	5.9 (5)	18.0 (-3)	1.0 (6)	8.2 (-4)

*Numbers in parentheses represent percentage change in meat and fish consumption compared with per capita consumption in 1998.

<u>Increases in Per Capita Consumption under Both Increases in Income and Decreases in Price of Imported Beef</u>

Most likely scenarios are considered. One combines a 10 percent decrease in the price of imported beef and a 50 percent increase in per capita income, and the other combines a 20 percent decrease in the price of beef and a 50 percent increase in per capita income. Table 15 shows demand changes in both cases.

Table 15. Changes in Per Capita Consumption under Both Income Growth and Decreases of Imported Beef Price

	H-Beef	I-Beef	Pork	Chicken	Fish	Crust.	Mollusks
			kg per capita				
1998	4.4	1.8	15.1	5.6	18.6	1.0	8.6
Δ -10 % in price, Δ +50 % in income	7.2 (61)	3.3 (82)	21.5 (42)	8.4 (50)	25.5 (37)	1.4 (41)	12.7 (48)
Δ -20 % in price , Δ +50 % in income	7.0 (59)	3.5 (92)	21.6 (43)	8.5 (52)	25.2 (35)	1.4 (44)	12.5 (46)

*Numbers in parentheses represent percentage change in meat and fish consumption compared with per capita consumption in 1998.

Increases in personal income would make consumers eat more meat products than fish products since consumers could afford to buy more expensive meat. When income is assumed to increase by 50 percent, the consumption of Hanwoo beef increases 61 percent and 59 percent, respectively, with 10 percent and 20 percent decreases in the price of imported beef. The lower the price of imported beef, the less would be demand for Hanwoo beef.

Summary and Conclusions

The Korean meat demand system was estimated using the Linear Approximate Almost Ideal Demand System (LA/AIDS). The meat group was divided into Hanwoo beef, imported beef, pork, and chicken. The fish group was categorized into fish, crustacean, and mollusk.

The null hypothesis of separability between meat and fish products was rejected, indicating that meat and fish products should be estimated together. A nested test showed that the LA/AIDS is better than the Rotterdam model in estimating demand for meat and fish products in Korea.

The Hausman endogeneity test indicated that the expenditure term is endogenous. As the result, the three-stage least squares (3SLS) estimator was used to estimate the demand system for meat and fish products in Korea.

The LA/AIDS was estimated using monthly, quarterly, and annual data for the 1980-98 period. The magnitude of parameter estimates and calculated elasticities is similar for all types of data. However, standard errors are larger and t-ratios are smaller when using quarterly and annual data. This result shows that it might be better to use disaggregated data to avoid aggregation bias if the data are available.

To evaluate seasonal effects on meat and fish product consumption with monthly and quarterly data, seasonal dummy variables were included in each equation. The consumption of Hanwoo beef and imported beef increases in the spring and fall and decreases during the winter. Pork consumption increases in the winter, but it is not statistically significant. Chicken consumption increases during the summer and fall. The consumption of fish products is the greatest in winter.

Parameter estimates of the LA/AIDS were used to calculate price and expenditure elasticities. Uncompensated and compensated elasticities were calculated. The uncompensated and compensated price elasticities were similar in terms of magnitude and statistical significance.

All own-price elasticities are negative and statistically significant. The own- price elasticity of Hanwoo beef is most elastic, followed by imported beef, mollusks, fish, crustaceans, pork, and chicken.

Expenditure elasticities for all meat and fish products are positive and significant at the 5 percent significance level. Expenditure elasticities of Hanwoo beef, imported beef, and mollusk are greater than one, indicating that beef and mollusk are luxury goods in Korea. However, expenditure elasticities of fish and crustacean are more inelastic than other meat and fish products. This indicates that fish and crustacean are necessities in the Korean diet.

The expenditure elasticity for imported beef is the most elastic, indicating that Korea will increase beef imports as the country increases its expenditure for meat and fish products.

In the case of Hanwoo beef, the own-price elasticity is larger than the expenditure elasticity in absolute value while it is the opposite for imported beef. If price and income (expenditure for meat and fish products) change at the same time, Hanwoo beef consumption would be more affected by price than income. However, consumption of imported beef is more sensitive to income than the price of imported beef.

Cross-price elasticity shows competitive or complementary relationships among products. Hanwoo beef has a competitive relationship with pork and imported beef. There is a substitute relationship between fish and meat products, indicating that fish is a substitute for meat in Korea. Fish consumption in Korea would increase if prices of meat products increased where prices of fish products remain constant.

Because of trade liberalization, meat imports in Korea will increase in the future. The Korean beef market will be liberalized on January 1, 2001. If per capita income continues to increase, beef imports would also increase since Korean consumers prefer beef to other meat, and Hanwoo beef is in short supply and expensive.

The price of Hanwoo beef is generally two times higher than that of imported beef. Consumers in Korea are willing to pay a premium for Hanwoo beef because they prefer Hanwoo beef to imported beef. However, if cheap and better-quality imported beef were introduced to Korean consumers, then Hanwoo beef would not be able to maintain market share in Korea.

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