Agricultural Economics Report No. 288 July 1992

DEMAND FOR MEAT IN KOREA: ESTIMATION AND TEST FOR STRUCTURAL CHANGE

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Acknowledgments

The authors wish to acknowledge the contribution of the clerical and professional staff of the Department of Agricultural Economics who have participated in the preparation of this report. Special thanks is due to Ms. Lynda Nelson for typing this manuscript. We also express our thanks to Ms. Charlene Lucken for her editorial suggestions.

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Highlights

In the last two decades, meat in Korea has become important in the daily diet. A growth in population and per capita income has increased the meat consumption rapidly in both absolute and relative terms compared to other agricultural products. Pork consumption has increased about four times during the last 20 years. Fish also has been an important source of protein, and its consumption is large compared to other meat. Beef and chicken consumption has increased steadily.

While the demand for meat has increased, its production and marketing activities have not adjusted appropriately. As a result, the prices of meat have fluctuated substantially, mainly because of the imbalance between demand and supply. Poor marketing facilities and inefficient operations of buffer stock escalated variations in demand and supply imbalance. The restrictive trade policy on beef has caused the imbalance between demand and supply of meat. Lack of knowledge about consumer behavior in meat demand could be another cause.

This study estimates the Korean meat demand, using the theoretical AIDS model, and tests if the demand structure has changed over time. The structural change in meat demand would suggest corresponding changes in the Korean meat industry. The demand for beef, pork, chicken, and other meat products is considered, using annual data from 1970 to 1989. The separability test suggests that fish should not be included in this meat demand analysis.

The general switching LA/AIDS model, which allows time-varying parameters, is used to estimate and test for the structural change in meat demand.

The results indicate that structural change in meat consumption has occurred between 1977 and 1989, possibly without termination during the sample period. Significant structural changes are detected in the beef and pork demands, but not in the chicken demand.

Demand responsiveness of each meat differs across types of meat and over the sample period. The income effect of price changes decreases for all types of meat over the sample period. The expenditure elasticity of each meat exceeds unity before the structural change, indicating the meat is a luxury good but became a necessity after the structural change. While price elasticity of beef remains stable before and after the structural change, price elasticities of pork and chicken change substantially. Demand for pork becomes less price elastic and that for chicken more elastic after the structural change.

Except for pork and chicken, none of the cross-price elasticities after structural change are statistically *significant in either the Marshallian or Hicksian measure, indicating insignificant cross-price effects of meat consumption in Korea. Per capita consumption of all individual meat items are predicted to increase until 1996. Pork consumption is predicted to decrease after 1996, while beef and chicken consumption increase at a decreasing rate.*

DEMAND FOR MEAT IN KOREA:
ESTIMATION AND TEST FOR STRUCTURAL CHANGE

Chang-Buhm Lee, Won W. Koo, and Seung-Ryong Yang*

Introduction

Over the past 20 years, per capita meat consumption in Korea has increased substantially (Figure 1). The most striking feature in the Korean meat consumption pattern is the rapid increase in pork consumption. During the last 20 years, pork consumption increased about four times. Fish also has been an important source of protein, and its consumption is large compared to other meat. Beef and chicken consumption also have increased steadily.

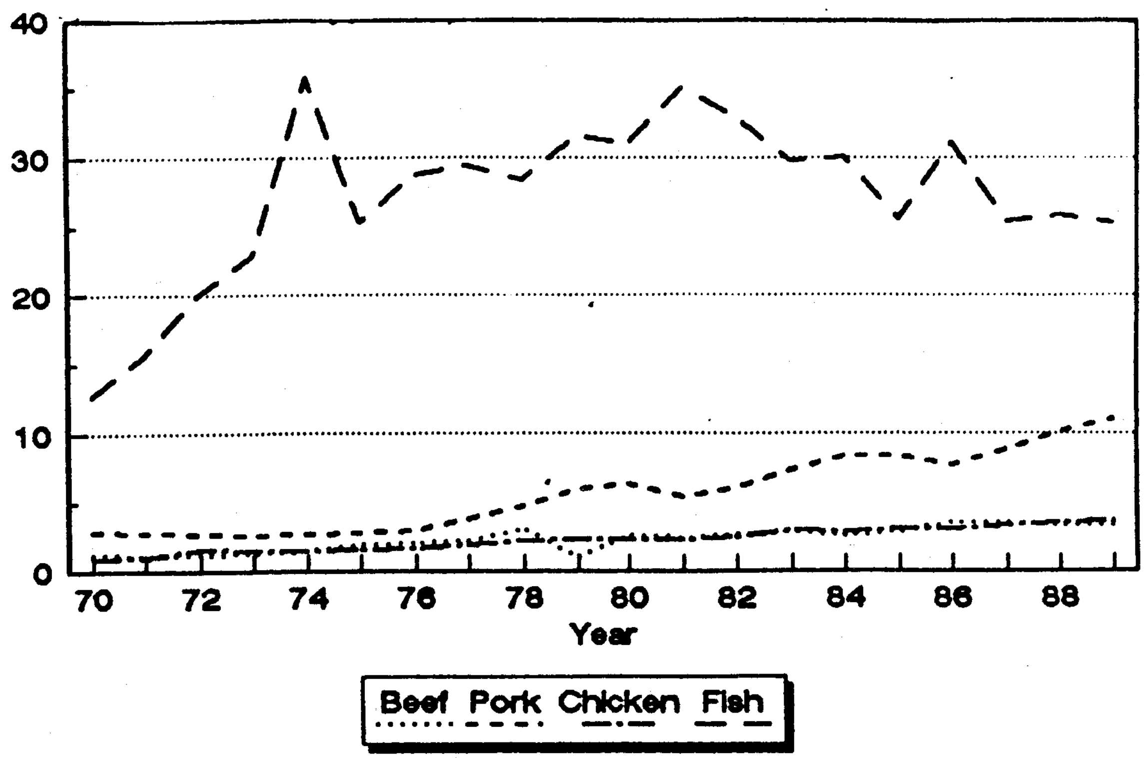

Figure 1. Annual Per Capita Meat and Fish Consumption in Korea

SOURCE: Republic of Korea, National Livestock Cooperative Federation, Materials on Price Demand and Supply of Livestock Products, Seoul, Survey Data, 90-1, 1990.

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Along with the increase in meat consumption, its price, especially for beef and pork, has fluctuated substantially during the last two decades, mainly because of an imbalance between demand and supply. Poor marketing facilities and inefficient operations of buffer stock escalated variations in demand-supply imbalance. In addition, imports of meat (especially beef) in Korea have been limited because of the restrictive policy on beef imports. These have led to volatile meat markets, and producers have faced higher price risks and uncertainty.

Understanding the demand structure for meat would be important for meat producers in production decisions. As consumption patterns and life-styles change, the meat demand structure likely will vary, and producers should be aware of these changes. Knowledge about demand patterns would also be important for policy makers in designing more effective tools to stabilize price variations. In 1990, the Korean government decided to increase the beef import quota and eventually to eliminate its remaining import restrictions. The Korean beef market became important in international meat trade as well.

This study estimates Korean meat demand, using the theoretical AIDS model, and tests if the demand pattern has changed over time. The structural change in meat demand would suggest corresponding changes in the meat industry. Separability between meat and fish products is tested to determine whether fish should be included in the analysis of the meat demand system. This paper is organized as follows: Section 2 reviews past studies on Korean meat demand and the uniqueness of this study compared to previous studies. Section 3 discusses the AIDS model and test procedures for separability and structural change. Section 4 describes the data. Section 5 presents and discusses the empirical results and the last section includes summary and implications of the study.

Review of Korean Meat Demand Studies

Before the 1980s, a limited number of studies were conducted to estimate meat demand in Korea, mainly because meat was not an important portion in the Korean diet. As consumer income grew, however, the demand for meat increased significantly, and meat products became important in food consumption and, accordingly, received more attention from researchers.

Kim estimated the livestock demand in Korea, using a single-equation demand model for beef, pork, chicken, eggs, and milk. He found that income influenced beef, chicken, and milk demand, while prices influenced pork and egg demand. Because the models were specified based on a double-log form in which elasticities are assumed constant with different levels of income, possible changes in demand responsiveness could not be identified.

Similarly, Hu used a double-log model to estimate the demand and supply structure of livestock products in Korea. Six commodities, beef, pork, chicken, eggs, milk, and fish, were used to estimate the demand and supply projections. Koo and Park investigated the Korean meat demand, using the Box-Cox functional form, and reported that income was the dominant factor in livestock demand.

Bae tested for structural change in Korean meat demand, using a dummy variable for changing break points. He hypothesized that factors other than price and income partially explained steep increases in the quantity of meat consumed. Three equations for beef, pork, and chicken were estimated. The results indicate that changes in Korean meat consumption were significant and that consumer preference shifted from chicken to beef and pork.

While the past studies show consistent results for elasticity estimates to some extent, most of them suffer from model specifications that are not theoretically plausible. Few used theoretical demand models that can confirm rational consumer behaviors. With the exception of Bae, none considered structural change that may provide biased and inefficient estimates if ignored (as for the case of misspecification). Bae's study used a dummy variable to capture structural change in meat consumption, but it did not capture smooth transition in demand responsiveness.

The demand for meat in the current study is estimated using a theoretically plausible model with general demand restrictions imposed, and structural change is tested more rigorously than in the previous studies. In addition, separability between meat products and fish is tested for the first time in the Korean meat demand analysis.

Theoretical Model Consideration

This study uses the Almost Ideal Demand System (AIDS) developed by Deaton and Muellbauer. This model has been widely used to estimate the meat demand system in the United States (Eales and Unnevehr; Moschini and Meilke; Nayga and Capps), Canada (Reynolds and Goddard), and Japan (Hayes et al.). This model has considerable advantages over other theoretical models, such as the linear expenditure system, which assumes additivity, and the translog model, which approximates only locally and is nonlinear in parameters.

First, the AIDS model is a first-order approximation to any demand system that satisfies the axioms of preference. Second, it aggregates well over consumers. Third, because of weak separability, two-stage budgeting is possible. Fourth, due to linearity in parameters, it is easy to estimate and interpret parameters. Finally, the AIDS model can be used to test homogeneity and symmetry through linear restrictions on parameters.

From a flexible expenditure function, the AIDS model for n goods in a system is specified as

[1] $w_i = \alpha_i + \sum_j \gamma_{ij} \ln(p_j) + \beta_i \ln(Y/P^*)$, $i,j=1,\ldots,n$,

where w_i is the share of the total expenditure allocated to the i^{th} good, p_j is the price of the j^{th} good within the group, Y is the total expenditure allocated to the group, and P^* is the price index for the group, defined as

[2] $\ln P^* = \alpha_0 + \sum_j \alpha_j \ln(p_j) + 1/2 \sum_i \sum_j \gamma^*_{ij} \ln(p_i) \ln(p_j)$.

This index introduces nonlinearity in parameters and causes difficulties in estimation. Thus, Deaton and Muellbauer suggest the linear Stone index defined as

[3] $\ln P = \sum_j w_j \ln(p_j)$.

The AIDS model that uses the Stone index is called the "linear approximate" AIDS or simply LA/AIDS (Blanciforti and Green). This replacement, however, causes a simultaneity problem since the budget share w_j in the index is also the dependent variable. To avoid this, lagged w_j is often used instead (Eales and Unnevehr).

The price and expenditure elasticities of the LA/AIDS model are

[4] $\varepsilon_{ij} = -\delta_{ij} + \gamma_{ij}/w_i - \beta_i(w_j/w_i)$,
$\varepsilon_{iy} = 1 + \beta_i/w_i$,

where δ_{ij} is the Kronecker delta ($\delta_{ij} = 1$ if $i=j$ and $\delta_{ij} = 0$ otherwise).

The general demand restrictions for this demand model are

[5] Adding up: $\sum_i \alpha_i = 1$, $\sum_i \gamma_{ij} = 0$, $\sum_i \beta_i = 0$,
Homogeneity: $\sum_j \gamma_{ij} = 0$, for all i,
Symmetry: $\gamma_{ij} = \gamma_{ji}$, for all i,j.

Since the dependent variables sum to unity, one equation should be dropped from the estimation. Estimates for the omitted equation can be obtained from the adding up conditions. The AIDS model can be estimated by the seemingly unrelated regression estimator (SURE) with the demand restrictions imposed.

Data Description

Four meat products, beef, pork, poultry, and other meat and fish were considered in this study. Annual data from 1970 to 1989 constitute the estimation period. Per capita consumption of each product is total consumption in kilograms (Kg) divided by total population. The meat consumption data were obtained from Materials on Price, Demand, and Supply of Livestock Products, National Livestock Cooperative Federation of Korea. The price data are expressed as Won/Kg and were taken from Prices of Agricultural and Fishery Products, Korean Ministry of Agriculture, Forestry, and Fisheries (KMAFF). Fish data were from Annual Statistics on Cooperative Sale of Fishery Products, National Federation of Fisheries Cooperatives in Korea. Population data were from Korean Economic Indicators, Economic Planning Board.

Separability Between Meat Products and Fish

Previous studies simply ignored fish in the Korean meat demand model. The underlying assumption of those studies is separability between meat and fish. However, fish in the Korean diet is an important protein source along with meat. Although separability reduces the number of parameters to be estimated, the assumption in Korean meat demand is an important empirical question. Omitting fish, when it should be included, would lead to misspecification of the estimated model. If separability holds, two-stage budgeting implies that the representative consumer's budget allocation on each meat product is not affected by the expenditure on fish.

A utility is separable if the marginal rate of substitution between any two goods in a group is independent of the consumption of any other good in other groups of goods. The separable utility enables the two-stage budgeting. In the first stage, the consumer allocates the total expenditure on several commodity groups. In the second stage, the consumer spends the allocated expenditure for a group on goods in the group without being limited by expenditures allocated for other groups.

Demand functions derived from a separable utility can be expressed as a function of prices of goods in that group and the expenditures for the group. This does not say that the demand for a good in any group is independent of prices of goods in other groups or of total expenditure. Cross-price effects among groups and the total expenditure effect come only through the expenditure allocated to the group under consideration.

Separability can be tested by using parametric restrictions on the AIDS model. Following Hayes et al., the separability restriction in the AIDS model can be written as

[6] $\gamma_{mifj} = w_{mi}w_{fj}\gamma_{mf}$, $i \in m$ and $j \in f$,

where subscripts m and f indicate commodity groups of meat and fish and i and j indicate individual goods in meat and fish groups, respectively. w_{mi} and w_{fj} are the budget shares of the good i in group m and good j in group f, respectively. γ_{mf} is the cross-price parameter between groups m and f, estimated from an aggregate AIDS model of w_m and w_f. If the restriction [6] holds for all i and j, then the two groups, m and f, are separable.

In this study, fish is specified as a single commodity rather than defining several sub-categories of fish. This is mainly because of data availability and technical difficulties in categorizing fish into sub-groups since there are too many species. The separability restriction is respecified as follows:

[7] $\gamma_{mif} = w_{mi}\gamma_{mf}$,

where γ_{mif} is the cross-price parameter between individual meats in the meat group and fish, w_{mi}, is the expenditure share of each good in the meat group.

Individual meat expenditure shares are 0.331 for beef, 0.335 for pork, and 0.096 for chicken. The estimated γ_{mf} is -0.063 with a t-value of -1.74. The joint test of whether each cross-price coefficient of the five-goods AIDS model satisfies the restriction in [7] was conducted, using the Wald-F test. The calculated F-value was 1.0001; and, thus, the hypothesis of separability between meat and fish was not rejected at conventional levels of significance. The meat demand system in Korea can be estimated without including fish. Separability between meat and fish also was found in Japanese meat demand (Hayes et al.).

Gradual Switching Model and Test for Structural Change

As economic and social environments change, consumer behavior changes as well. Consumers' tastes likely vary over time, and preference changes from changing income structure or demographic patterns (Senauer et al.), increasing health concerns (Brown and Schrader), habit formation (Phlips), and/or intensive advertising. These changes often result in fundamental changes in demand structures. Those factors causing structural change usually are excluded from demand models because of unobservability or difficulties in definition. Failure to address structural changes in demand analysis would lead to incorrect estimates and erroneous inferences (Martin and Porter; Moschini and Meilke; Eales and Unnevehr).

Korea has experienced tremendous changes in various dimensions of society during the last two decades. Real GNP in 1988 increased 20 times compared to that in 1961 and 4 times that in 1971. Population increased 50% over the past 20 years. In addition, the traditional diet pattern has changed because of fast economic growth and adoption of the Western culture. Modeling structural change is important for correct estimation of demand elasticities and forecasts.

This study uses Moschini and Meilke's gradual switching AIDS model, which models smooth or abrupt transition of demand structure over time. This model is especially convenient for this study because the test for structural change is based on the AIDS estimation.

Structural change defined as changes in parameters can be modelled, using a specially designed dummy variable, i.e., time path. Let the time path be h_t. The LA/AIDS model in [1] can be reparameterized as

[8] $$w_{it} = \alpha_i+\delta_i h_t + \sum_j(\gamma_{ij}+d_{ij}h_t)\ln(p_{jt}) + (\beta_i+ d_i h_t)\ln(y/P)_t + \varepsilon_{it},$$

with additional general demand restrictions

[9] Adding up: $\sum_i\delta_i = 0,\ \sum_i d_{ij} = 0,\ \sum_i d_i = 0,$
Homogeneity: $\sum_j d_{ij} = 0,$ for all i,
Symmetry: $d_{ij} = d_{ji},$ for all i,j.

The Marshallian elasticities reflecting the effects of the structural change become

[10] $$\varepsilon_{ii} = -1 + (\gamma_{ii}+d_{ii}*h_t)/w_i^a - (\beta_i+d_i*h_t),$$
$$\varepsilon_{ij} = (\gamma_{ij}+d_{ij}*h_t)/w_i^a - (\beta_i+d_i*h_t)(w_j^a/w_i^a),$$
$$\varepsilon_{iy} = (\beta_i+d_i*h_t)/w_i^a + 1,$$

where w_i^a (w_j^a) is the budget share of i^{th} (j^{th}) good after structural change. The Hicksian price elasticities are

[11] $$\eta_{ii} = -1 + (\gamma_{ii} + d_{ii}*h_t)/w_i^a + w_i^a,$$
$$\eta_{ij} = (\gamma_{ij} + d_{ij}*h_t)/w_i^a + w_j^a.$$

The gradually switching time path is constructed as follows:

[12] $$h_t = 0, \text{ for } t = 1,\ldots,\tau_1,$$
$$h_t = (t - \tau_1)/(\tau_2 - \tau_1), \text{ for } t = \tau_1+1,\ldots,\tau_2-1,$$
$$h_t = 1, \text{ for } t = \tau_2,\ldots,T,$$

where τ_1 is the end of the first regime; and, at $t=\tau_1$, the parameters begin to change. τ_2 is the beginning of the second regime; and, at $t=\tau_2$, the structural change completes. If $\tau_2=\tau_1+1$, the change is abrupt. If $\tau_1=0$ and $\tau_2=T$, the structural change occurs throughout the whole sample period.

To determine the gradually changing parameters, τ_1 and τ_2 should be determined jointly with the other parameters in the model. However, h_t is discontinuous with respect to τ_1 and τ_2; thus, estimates of the two parameters are obtained by searching one pair which provides the smallest mean square error among all combinations of τ_1 and τ_2 throughout the sample period (see Moschini and Meilke).

The hypothesis of no structural change is $\delta_i=0$, $d_{ij}=0$, and $d_i=0$ for all i and j. Once the break points, τ_1 and τ_2, are determined by the search, the hypothesis is tested, using the Wald F-test conditional on the estimates of τ_1 and τ_2.

A total of 170 alternative models was estimated to determine τ_1 and τ_2. The mean square error was the lowest when $\tau_1=1977$ and $\tau_2=1989$, indicating that the structural change in Korean meat consumption occurred around 1977. This result seems to be realistic. The Korean economy has been facing tremendous changes since the late 1970s. Since the sample data in this study are from 1970 to 1989, the result does not indicate whether the demand structure has been changing with no termination or was completed in 1989.

The results of the F-test for the null hypothesis of no structural change in meat consumption are reported in Table 1. The hypothesis is rejected at the 1% level. However, the results differ for each meat type. For beef, the null hypothesis of no structural change either in intercept or in price and expenditure parameters is not rejected, while the null hypothesis of no structural change in beef consumption is rejected at a 1% level. Significant structural change is detected for all parameters in pork consumption, while the hypothesis is not rejected for the chicken demand at the 5% level.

Estimated Models and Elasticities

According to the separability test results, fish as a whole was not included in the meat demand system. Since significant structural changes were detected, inferences are based on the estimates of the gradual switching AIDS model.

Tables 2 through 4 present the estimated gradual switching AIDS and conventional AIDS models of beef, pork, and chicken demand, respectively. System-weighted R-squares of the gradual switching AIDS model is 0.94, which is greater than that of the AIDS model, 0.83. For all cases, the structural change coefficients of own price and expenditure terms show negative signs. This means that the coefficients of own price and expenditure terms change in negative directions over time in all equations. In other words, the meat demand became more sensitive to price changes and less sensitive to expenditure changes.

TABLE 1. WALD F-TEST RESULTS FOR STRUCTURAL CHANGE

Null Hypothesis	F-value	Prob>F-value	Results
<u>System</u>			
No structural change in			
all parameters	9.1427	0.0001	Rejected
intercept	8.8012	0.0002	Rejected
prices and expenditure	9.1427	0.0001	Rejected
<u>Beef</u>			
No structural change in			
all parameters	4.1612	0.0048	Rejected
intercept	2.5445	0.1202	Accepted
prices and expenditure	1.3298	0.2795	Accepted
<u>Pork</u>			
No structural change in			
all parameters	8.4158	0.0001	Rejected
intercept	15.4183	0.0004	Rejected
prices and expenditure	10.5093	0.0001	Rejected
<u>Chicken</u>			
No structural change in			
all parameters	2.2651	0.0708	Accepted
intercept	0.1739	0.6794	Accepted
prices and expenditure	2.2065	0.0898	Accepted

In the beef model (Table 2), parameters of beef and chicken expenditure shares are significant at the 5% level. Time-varying parameters of intercept and expenditure terms are significant at the same level. This confirms the structural change in beef consumption. The demand for beef is sensitive to the own price, chicken price, and expenditure.

In Table 3, estimated parameters of pork and chicken prices are significant at the 5% level. The parameter of expenditure term is not significant in the pork model. Time-varying parameters for the intercept and expenditure terms are significant, showing that the structural changes of pork demand are significant. The demand for pork is sensitive to its own and chicken price.

All parameters in the chicken model are significant at the 5% level (Table 4). However, none of the time-varying parameters except for own price are significant. Chicken consumption is

TABLE 2. ESTIMATED DEMAND MODELS FOR BEEF

Variables	Gradual Switching AIDS Model Coefficients	t-value	AIDS Model Coefficients	t-value
INTERCEPT	-0.1032	-1.22	0.1779	2.67
LPB[a]	0.1562	3.57	0.0900	2.66
LPP	-0.0266	-0.86	0.0062	0.22
LPC	-0.0796	-3.16	-0.0280	-1.63
LPO	-0.0499	-7.11	-0.0682	-9.31
LYI[b]	0.1443	3.42	0.0367	1.21
HT[c]	0.7660	1.94	-	-
HLPB[d]	-0.1388	-1.37	-	-
HLPP	-0.0245	-0.43	-	-
HLPC	0.1227	1.55	-	-
HLPO	0.0407	0.94	-	-
HLYI[e]	-0.2860	-2.11	-	-
System Weighted R-square:	0.9382		0.8273	

[a]LPB LPP LPC LPO: Logarithm of price of beef, pork, chicken, and other meat.
[b]LYI: Logarithm of expenditure of meat divided by Stone's index.
[c]HT: Structural change path.
[d]HLPB HLPP HLPC HLPO: Logarithm of beef, pork, chicken, and other meat multiplied by structural change path.
[e]HLYI: LYI multiplied by structural change path.

TABLE 3. ESTIMATED DEMAND MODELS FOR PORK

Variables	Gradual Switching AIDS Model Coefficients	Gradual Switching AIDS Model t-value	AIDS Model Coefficients	AIDS Model t-value
INTERCEPT	0.2355	3.27	0.1926	0.01
LPB[a]	-0.0266	-0.86	0.0062	0.22
LPP	0.0979	3.21	0.0949	3.27
LPC	-0.0545	-2.80	-0.0793	-5.55
LPO	-0.0167	-3.00	-0.0218	-3.07
LYI[b]	0.0287	0.85	0.0448	1.63
HT[c]	1.4649	4.77	-	-
HLPB[d]	-0.0245	-0.43	-	-
HLPP	-0.0017	-0.03	-	-
HLPC	0.0552	1.26	-	-
HLPO	-0.0290	-0.89	-	-
HLYI[e]	-0.4826	-4.34	-	-
System Weighted R-square:	0.9382		0.8273	

[a]LPB LPP LPC LPO: Logarithm of price of beef, pork, chicken, and other meat.
[b]LYI: Logarithm of expenditure of meat divided by Stone's index.
[c]HT: Structural change path.
[d]HLPB HLPP HLPC HLPO: Logarithm of beef, pork, chicken, and other meat multiplied by structural change path.
[e]HLYI: LYI multiplied by structural change path.

TABLE 4. ESTIMATED DEMAND MODELS FOR CHICKEN

Variables	Gradual Switching AIDS Model Coefficients	Gradual Switching AIDS Model t-value	AIDS Model Coefficients	AIDS Model t-value
INTERCEPT	0.0610	1.30	0.1165	3.51
LPB[a]	-0.0796	-3.16	-0.0280	-1.63
LPP	-0.0545	-2.80	-0.0793	-5.55
LPC	0.1490	6.77	0.1226	8.13
LPO	-0.0149	-3.83	-0.0153	-4.54
LYI[b]	0.0715	2.92	0.0254	1.47
HT[c]	0.1545	0.51	-	-
HLPB[d]	0.1227	1.55	-	-
HLPP	0.0552	1.26	-	-
HLPC	-0.1937	-2.06	-	-
HLPO	0.0159	0.70	-	-
HLYI[e]	-0.1493	-1.70	-	-
System Weighted R-square:	0.9382		0.8273	

[a]LPB LPP LPC LPO: Logarithm of price of beef, pork, chicken, and other meat.
[b]LYI: Logarithm of expenditure of meat divided by Stone's index.
[c]HT: Structural change path.
[d]HLPB HLPP HLPC HLPO: Logarithm of beef, pork, chicken, and other meat multiplied by structural change path.
[e]HLYI: LYI multiplied by structural change path.

sensitive to all variables included, but no structural change is indicated.

Table 5 shows the estimated Marshallian elasticities at means. Before structural change, own price elasticities of individual meats, except chicken, are negative, which is consistent with theory. The chicken elasticity is positive but not significant. After the structural change, all own price elasticities become negative; none of them is significant.

Marshallian cross elasticities of individual products before structural change are negative, which imply greater negative income effect than positive substitution effect. After the

TABLE 5. ESTIMATED MARSHALLIAN ELASTICITIES AT SAMPLE MEANS[a]

	Beef	Pork	Chicken	Other Meat	Expenditure
			Before Structural Change		
Beef	-0.6410 (-3.69)	-0.2131 (-2.03)	-0.2565 (-4.26)	-0.1610 (-4.88)	1.4652 (10.78)
Pork	-0.0974 (-0.66)	-0.6709 (-5.84)	-0.1993 (-3.94)	-0.0611 (-2.11)	1.1049 (8.91)
Chicken	-0.7704 (-3.36)	-0.5607 (-3.64)	0.0562 (0.37)	-0.2060 (-4.82)	1.5410 (8.31)
Other	0.0913	0.1766	0.0614	-0.4686	0.1394
			After Structural Change		
Beef	-0.7894 (-1.59)	-0.0473 (-0.10)	0.1814 (0.76)	0.0093 (0.03)	0.4381 (0.81)
Pork	-0.1722 (-0.47)	-0.1984 (-1.02)	-0.1740 (-3.21)	-0.0567 (-0.22)	-0.6415 (-1.58)
Chicken	0.9862 (0.96)	-0.4321 (-0.79)	-1.6263 (-1.13)	0.3512 (0.34)	-0.2237 (-0.16)
Other	-0.6305	-0.5713	-0.1472	-1.5749	3.3702

[a]Numbers in parentheses are t-values.

structural change, however, most t-values of cross-price elasticities are too small to be significant; some are positive. Either increasing the substitution effect or decreasing the income effect may explain these changes in elasticities.

To see net substitution effects, the compensated Hicksian elasticities are calculated in Table 6. Before structural change, beef and pork are net substitutes, while pork-chicken and beef-chicken are net complements. After structural change, however, only pork and chicken are net complements.

The dominant income effects before the structural change are also demonstrated by expenditure elasticities (Table 5). The expenditure elasticity of each individual product, except for

TABLE 6. ESTIMATED HICKSIAN ELASTICITIES AT SAMPLE MEANS[a]

	Beef	Pork	Chicken	Other
		Before Structural Change		
Beef	-0.1864	0.1877	-0.1244	0.1231
	(-1.32)	(1.87)	(-1.53)	(5.46)
Pork	0.2129	-0.3687	-0.0672	0.2230
	(1.87)	(-3.31)	(-0.94)	(10.96)
Chicken	-0.2922	-0.1392	0.2598	0.2318
	(-1.53)	(-0.94)	(1.57)	(7.91)
Other	0.1350	0.2147	0.0798	-0.4290
		After Structural Change		
Beef	-0.6790	0.0738	0.2346	0.2469
	(-1.19)	(0.14)	(1.52)	(1.54)
Pork	0.0673	-0.3758	-0.1136	0.2132
	(0.16)	(-3.18)	(-0.21)	(1.95)
Chicken	0.9298	-0.4940	-1.6405	0.2877
	(1.31)	(-0.96)	(-1.18)	(0.67)
Other	0.2191	0.3605	0.0672	-0.6175

[a]Numbers in parentheses are t-values.

"other" meat, is significant and greater than unity before the structural change. This indicates that beef, pork, and chicken are luxury goods in the early period of the sample data. They, however, become necessities after the structural change. In addition, those elasticities after the structural change are not significantly different from zero.

To summarize these changes in elasticities, Figures 2 through 5 show the evolutions of own price and expenditure elasticities over time. The elasticities before structural change were calculated at the means, while those elasticities after 1977 were calculated at each year's expenditure share. The gap between the Marshallian and Hicksian elasticities represents the income effect. For all three products, the gap is decreasing over time, which indicates decreasing income effects. This implies that, as income grows, the income effect due to price changes becomes negligible.

However, individual patterns of changes in own price elasticity differ across meat types. While the income effect for beef in Figure 2 is getting smaller, the own price effect is increasing; the two opposite movements tend to cancel one another out. As a result, the gross price effect is relatively stable over time. In Figure 3, the Hicksian own elasticity of pork is stable while the income effect is decreasing; thus, the demand is less elastic with respect to price changes. However, the demand for chicken becomes more price elastic because of the decreasing income effect but increasing negative price effect. Figure 4 shows that the demand for each meat product becomes less and less sensitive to the changes in expenditure.

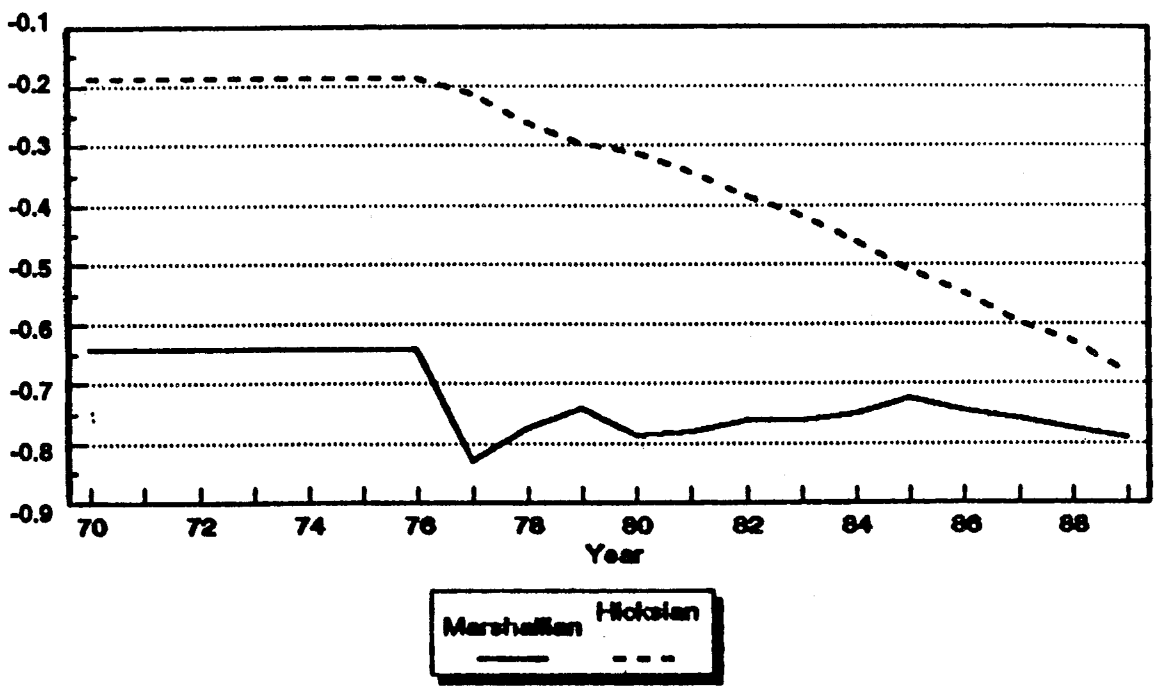

Figure 2. Change of Own Price Elasticity of Beef

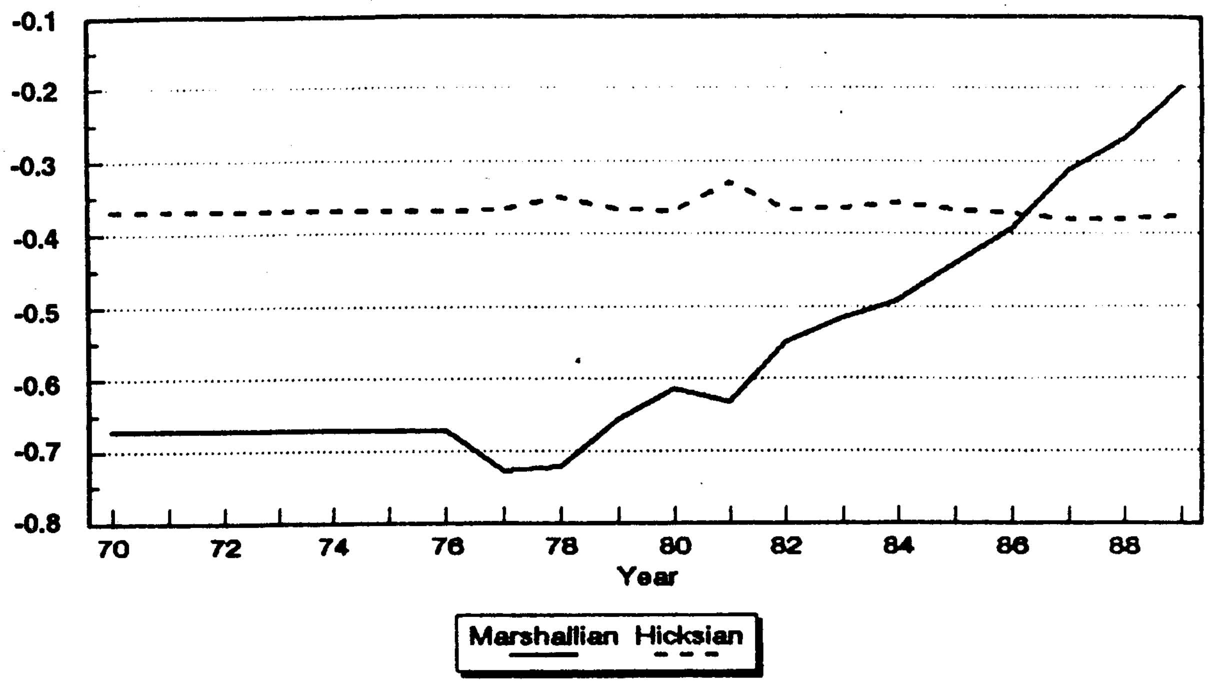

Figure 3. Change of Own Price Elasticity of Pork

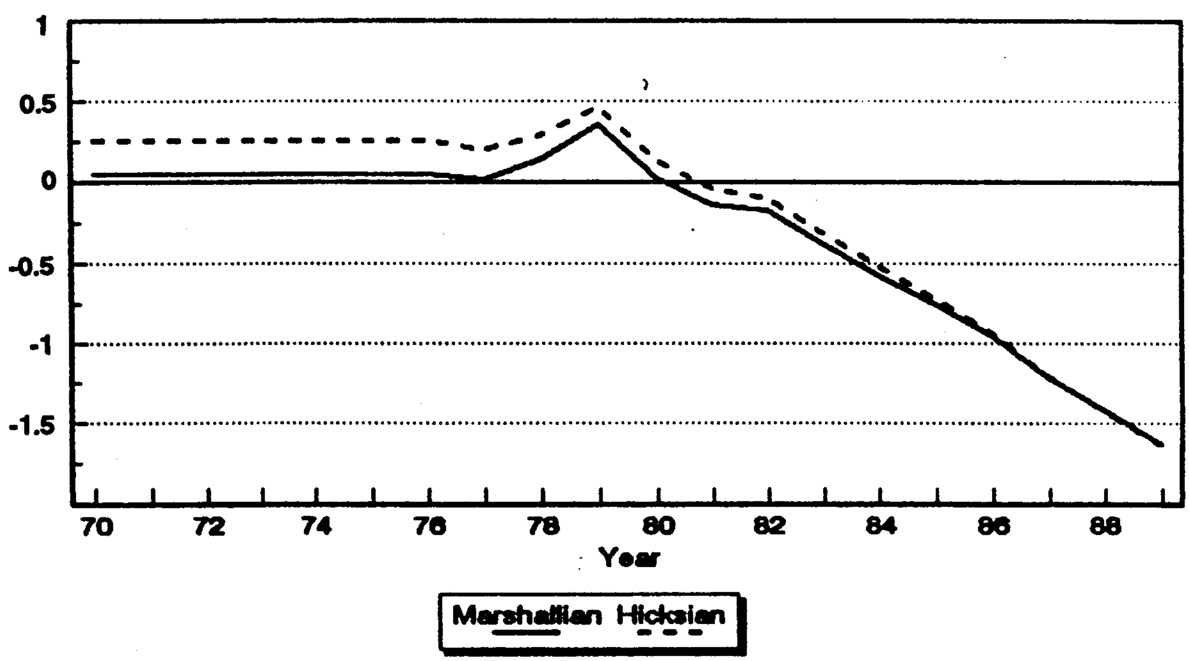

Figure 4. Change of Own Price Elasticity of Chicken

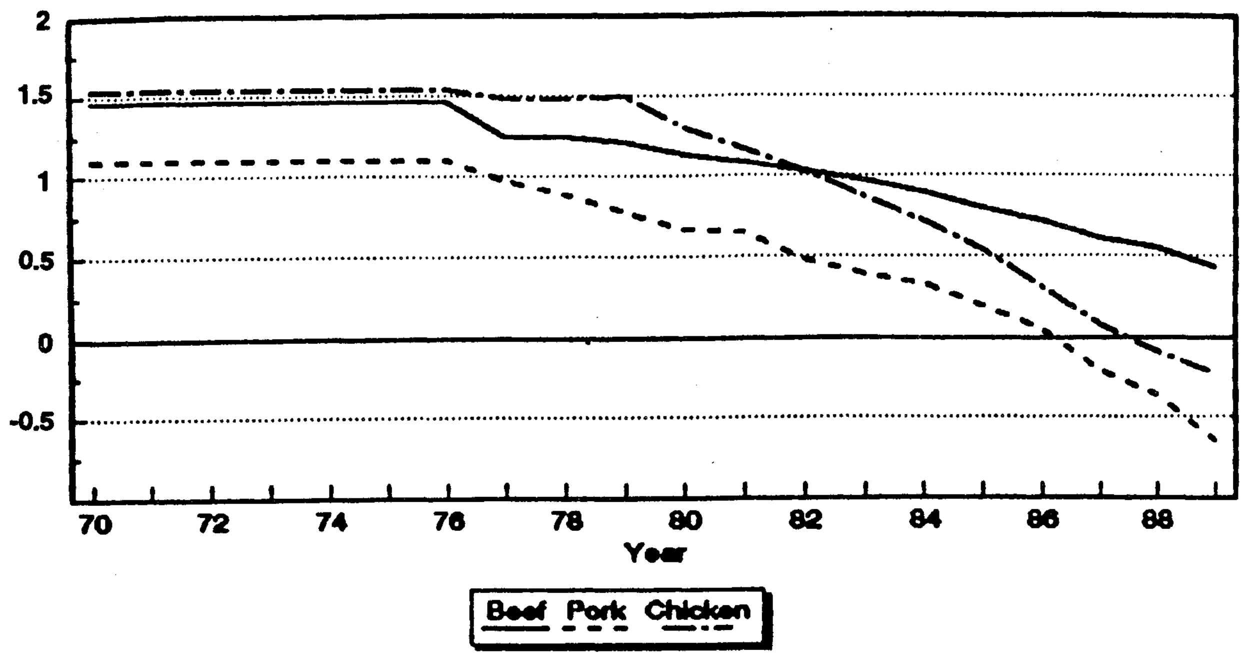

Figure 5. Change of Income Elasticity of Meat

Projections of Demand for Meats

The time-varying AIDS model showed a structural change in the Korean meat demand. As mentioned above, the test could not determine whether the structural change ended in 1989 or it continues. For simplicity, however, we assume no structural change after 1989 and predict per capita meat consumption up to the year 2001. Prediction of per capita meat consumption is based on annual growth rates of 7% in meat price and 11.8% in gross Domestic Products (GDP) (the Seventh Social Economics Development Plan for 1992-1996).

Table 7 shows the actual per capita meat consumption in 1989 and predicted consumption for 1996 and 2001. The demand for each meat is predicted to increase until 1996, i.e., 67% increase for beef, 36% increase for pork, and 68% increase for chicken. However, pork consumption is predicted to decrease after 1996, while beef and chicken consumption are predicted to increase further in 2001, but at a decreasing rate after 1996.

TABLE 7. PROJECTIONS OF PER CAPITA CONSUMPTION OF MEAT[a]

Individual Meat	1989 (actual)	1996 (projection)	2001 (projection)
	----------	kilogram	----------
Beef	3.38 (100)	5.65 (167)	6.57 (194)
Pork	11.13 (100)	15.19 (136)	13.98 (126)
Chicken	3.66 (100)	6.14 (168)	6.52 (178)

[a]Numbers in parentheses are indices (1989=100).

Conclusions

During the last two decades, meat has become important in the daily diet in Korea. A growth in population and per capita income has increased meat consumption rapidly in both absolute and relative terms compared to other agricultural products. While the demand for meat has increased, its production and marketing activities have not adjusted appropriately. Insufficient information on price variations and/or inefficient marketing system may be the reason for market failure. Lack of knowledge about consumer behavior in meat demand could be another cause.

This study analyzed the structure of Korean meat demand, which might be changing over time as social and economic environments change. The demand for beef, pork, chicken, and other meat were considered, using the annual data from 1970 to 1989. The separability test suggested that fish should not be included in this meat demand analysis. Korean consumers allocate the budget on meat consumption to each meat product without being limited by the expenditure on fish.

The gradual switching LA/AIDS model, which allows time-varying parameters, was used to estimate and test for the structural change in meat demand. The results indicated that structural change in meat consumption has occurred between 1977 and 1989, possibly without termination during the sample period. Significant structural changes were detected in the beef and pork demands, but not in the chicken demand.

Demand responsiveness of each meat differs across meat types and over the sample period. The income effect of price changes decreased for all types of meat over the sample period. The expenditure elasticity of each product exceeded unity before the structural change, indicating that meat is a luxury good but became a necessity as a result of the structural change. While price elasticity of beef was relatively stable before and after the structural change, price elasticities of pork and chicken changed substantially. Demand for pork became less price elastic and demand for chicken became more price elastic after the structural change.

Except for pork and chicken, none of the cross-price elasticities after the structural change were statistically significant, in either the Marshallian or the Hicksian measure, indicating insignificant cross-price effects of meat consumption in Korea. Per capita consumption of all individual meat are predicted to increase until 1996. Pork consumption is predicted to decrease after 1996, while beef and chicken consumption are predicted to keep increasing at a decreasing rate.

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