Policy Implications for U.S. Agriculture of Changes in Demand for Food

Helen H. Jensen and James A. Chalfant
Editors

Proceedings of the S-216 Southern Regional Research Committee Symposium
Washington, D.C.
October 7-8, 1991

Sponsored by:
The Economic Research Service, U.S. Department of Agriculture
and
The Farm Foundation

Center for Agricultural and Rural Development
Iowa State University
578 Heady Hall
Ames, Iowa 50011-1070

1994

Demand Analysis for Meat Products in South Korea and Taiwan: Policy Implications for Trade Liberalization

*Oral Capps, Jr., Raymond Kirby, Gary W. Williams, and Refong Tsai**

The fastest growing international markets for meat products are in the Pacific Rim region. The process that brought Japan into the picture began in the late 1960s and will culminate in April 1993 with the removal of most nontariff barriers to beef imports. Japan has become the second largest market for imported beef in the world, behind the United States, and flows of beef from Oceania and North America to Japan have added substantially to total beef demand in the Pacific.

Several events are taking shape that are likely to encourage growth in foreign demand for U.S. beef in other Pacific Rim countries, notably South Korea and Taiwan. First, economic growth in Taiwan and South Korea has induced a notable shift in their food consumption patterns away from traditional, low-value products like rice, toward higher quality, value added products like beef. Second, as Jones and Dyck (1991) note, the marginal costs of market development of entering the markets of South Korea and Taiwan are lower as a consequence of opening the Japanese market. Third, the perceived costs of overcoming explicit trade barriers have decreased. The Japanese and Koreans, for example, agreed to a phased reduction of their longstanding restrictions on beef imports. The Taiwanese government also has consistently lowered their beef import tariff.

*Support for this research comes from the Texas Agricultural Experiment Station.

To understand the potential demands for U.S. beef, as well as those for other meat products, it is essential that we rigorously analyze meat demand in these potentially profitable new Pacific Rim markets. This analysis would provide public and private decision makers with guidelines in ongoing efforts to penetrate Korean and Taiwanese markets. Little work has been done concerning the investigation of meat demands in Taiwan and South Korea. Capps et al. (1994) employed the Rotterdam model to obtain estimates of demand parameters for meat products in Taiwan, South Korea, and Japan. Hayes, Wahl, and Williams (1990) as well as Lambert (1991) used the linear approximate Almost Ideal Demand System (LA/AIDS) model to estimate demand relationships for meat products in Japan. The LA/AIDS model is employed in this paper to explore the demand relationships for meat products, with emphasis on beef, in Taiwan and South Korea.

Objectives

This paper has two related objectives. First, we wish to construct a LA/AIDS demand system model for meat products in Korea and Taiwan. The use of demand systems models permits the exploration of interdependencies among products. In this light, we wish to use the results to analyze the nature and differences of demands for different meat products among these countries. We assume that people living in different regions might cultivate different tastes and

preferences for meat products, and consequently there may be different consumption patterns for meat products among the Pacific Rim countries. Second, given the elasticity estimates, we wish to make projections of consumption and imports for beef for the year 2000 in Taiwan and South Korea under the assumption of trade liberalization.

Historical Trends

This section describes historical trends of consumption of meat products and historical trends in beef imports in the Pacific Rim over the last 20 to 25 years. Although emphasis in this paper centers on Taiwan and South Korea, we include a discussion of trends in Japan to give perspective on the Pacific Rim region. A summary of the average per capita consumption levels of meat products as well as the average budget shares of meat products in recent periods is given in Table 1. Per capita consumption numbers over the period 1960 to 1988 are shown graphically in Figures 1 through 4.

Both the consumption levels and average budget shares for meat products are dissimilar for Taiwan, South Korea, and Japan. Nevertheless, the principal meat product in the Pacific Rim region is unequivocally fish. Marine products make up nearly 85 percent of the meat budget in South Korea, compared to nearly 60 percent of the meat budget in Japan and nearly 45 percent in Taiwan. The Taiwanese spend roughly 40 percent of the meat budget on pork compared to 7 percent in South Korea and 19 percent in Japan. Beef and chicken constitute a relatively small share of the meat budget in the Pacific Rim. The budget shares for beef are slightly less than 4 percent in Taiwan, 6 percent in South Korea, and almost 13 percent in Japan. The relatively small budget share for beef may be attributable in part to import limitations. The budget shares for chicken are 13 percent in Taiwan, 2 percent in South Korea, and roughly 10 percent in Japan.

In Taiwan, pork is the most popular livestock product. On average, over the last 20 years, the per capita consumption of beef and chicken rose 6.2% and 7.3% per year, while per capita consumption of pork and fish grew 2.5% and 2.7% per year respectively.

In South Korea, consumption of meat products has been growing at rapid rates. The higher meat consumption has been attributed to higher rates of personal income and to increasing urbanization in South Korea (Dyck and Sillers 1986). Per capita beef consumption moved from a low of 0.52 kg in 1963 to a high of 3.65 kg in 1987. Per capita pork consumption was at an all-time high of 10.14 kg in 1988, almost triple that of beef. In 1988, per capita consumption of chicken was at an all-time high of 3.55 kg, up from a low of 0.51 kg in 1965. In 1985, Koreans consumed an all-time high of 59.28 kg of marine products. When compared to per capita consumption of beef, pork, and chicken in 1985, per capita consumption of marine products was four times greater than the other three combined.

Over the period 1962 to 1986, the per capita consumption of fish in Japan was on the order of 32 kg. Per capita consumption of pork and chicken over this time period was roughly 7 kg and 5 kg, respectively. Per capita beef consumption averaged slightly less than 3 kg. Although meats make up a small portion of the Japanese diet, consumption is growing due in part to income levels and "westernization" of tastes (Lambert 1991; Hayes, Wahl, and Williams 1990). Fifty years ago, the Japanese consumed almost no meat, and beef consumption in particular was restricted on religious grounds (Gorman, Mori, and Lin 1990).

Beef imports for South Korea and Taiwan over the period 1974 to 1988 are exhibited graphically in Figures 5 and 6. The South Korean government is very involved in protecting the domestic beef industry. Over this period, domestic agricultural policy considerations drove Korea's import policy. Beef imports were allowed in 1976 through 1979, and 1981 through 1984 only to fulfill domestic shortfalls. When imports occurred, they came primarily from Oceania, with 94 percent from Australia and 4 percent from New Zealand. A small but stable trade in grain-fed beef for tourist hotels was filled by U.S. exporters

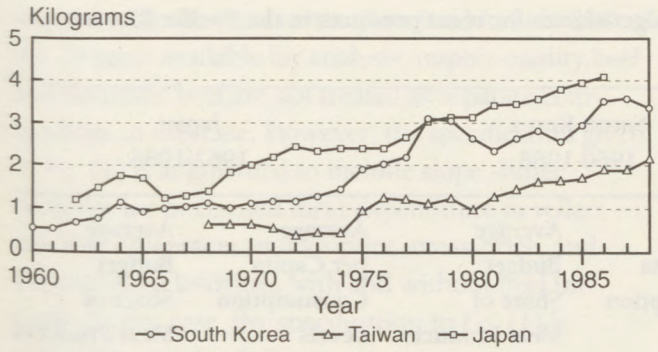

Figure 1. Per capita consumption by country—beef

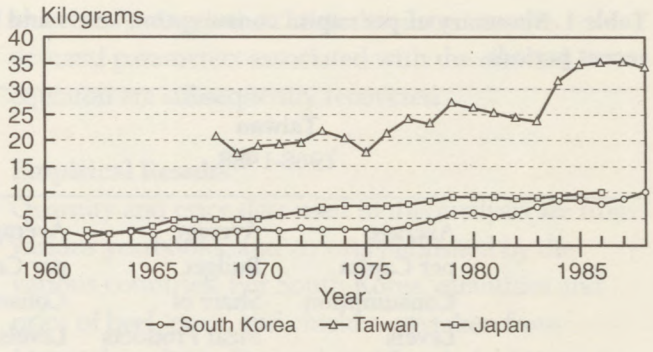

Figure 2. Per capita consumption by country—pork

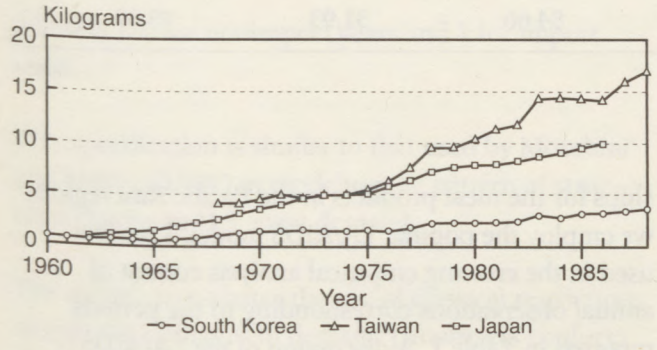

Figure 3. Per capita consumption by country—chicken

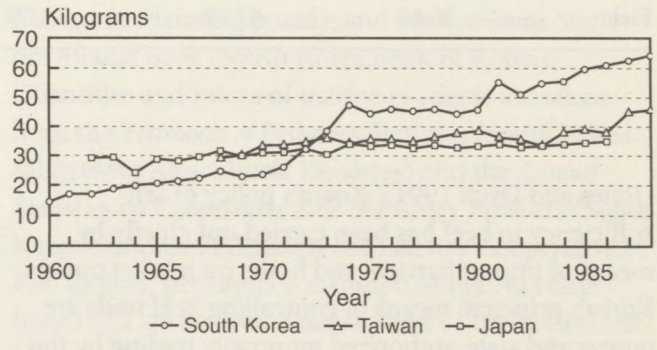

Figure 4. Per capita consumption by country—marine products

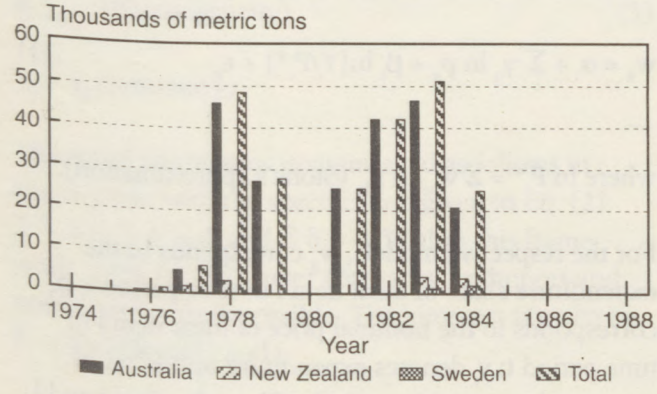

Figure 5. Beef imports for South Korea

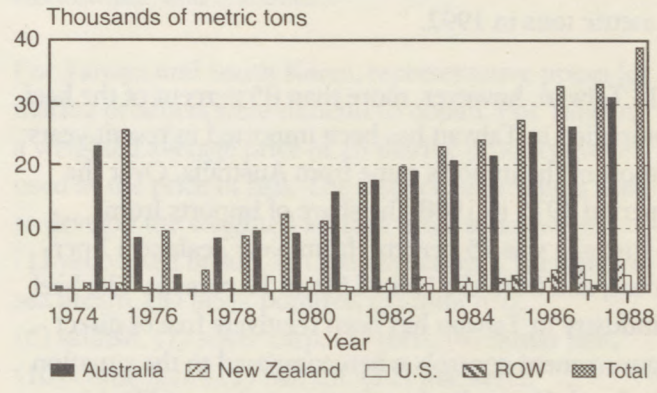

Figure 6. Beef imports for Taiwan

Table 1. Summary of per capita consumption levels and budget shares for meat products in the Pacific Rim in recent periods

	Taiwan 1968-1988		South Korea 1960-1988		Japan 1962-1986	
Commodity	Average per Capita Consumption Levels (kg)	Average Budget Share of Meat Products (%)	Average per Capita Consumption Levels (kg)	Average Budget Share of Meat Products (%)	Average per Capita Consumption Levels (kg)	Average Budget Share of Meat Products (%)
Beef	1.14	3.67	1.92	5.94	2.56	12.60
Pork	24.89	39.74	4.38	7.37	6.79	18.59
Chicken	9.44	13.18	1.81	2.01	5.35	10.40
Fish	36.64	43.39	38.89	84.66	31.93	58.39

(Jones and Dyck 1991). Korea's policy of self-sufficiency in beef has been carried out chiefly by means of import barriers and limits on market outlets. Korea's principal means of controlling beef trade are quotas and state-authorized monopoly trading by the Livestock Product Marketing Organization. Tariff levels are bound at 20 percent (Jones and Dyck 1991). After much negotiation, Korea agreed to allow beef imports from the United States—58,000 metric tons in 1990, 66,000 metric tons in 1991, and 62,000 metric tons in 1992.

In Taiwan, however, more than 85 percent of the beef supplied in Taiwan has been imported in recent years; most of the imports came from Australia. Over the period 1975 to 1988, the share of imports from Australia was 75 percent; from New Zealand 12 percent; and from the United States 12 percent. The beef industry in Taiwan has been relatively free of direct government controls when compared to the situation in South Korea. Beef import controls were lifted in 1972, but import tariffs remain in effect.

On the basis of per capita consumption and budget shares for meat products, we may expect the demands for the various products to differ across Taiwan, South Korea, and Japan. To determine the demand relationships for the meat products in the Pacific Rim region, we employ the popular LA/AIDS model. The data used in the ensuing empirical analysis consist of annual observations corresponding to the periods reported in Table 1. A discussion of the LA/AIDS model is given in the next section.

Demand System Model—LA/AIDS

The currently popular LA/AIDS model (Deaton and Muellbauer 1980) may be written as

$$w_{it} = \alpha_i + \sum_j \gamma_{ij} \ln p_{jt} + \beta_i \ln[Y_t/P_t^*] + \epsilon_{it} \qquad (1)$$

where $\ln P_t^* = \Sigma\, w_{kt} \ln p_{kt}$ (Stone's approximation).

For the respective models, w_{it} corresponds to the expenditure share of meat item i in time period t; p_{jt} corresponds to the nominal price of meat item j in time period t; y_t denotes expenditure on the set of meat products in time period t. The subscripts i and j refer to beef, pork, chicken, and marine (fish) products. Similar to the studies for Japan conducted by Hayes, Wahl, and Williams (1990) and Lambert (1991), import-quality beef and domestic beef are treated as separate commodities in the analysis for Taiwan in this case. However, because of the fact that

imports in South Korea were permitted in only 8 of the 29 years available for analysis, import-quality beef and domestic beef are not treated as separate commodities in this case. However, the specification given in Eq. (1) is augmented to include slope shifter variables for prices and meat expenditure to reflect possible differences in own-price, cross-price, and expenditure elasticities with and without beef imports. In this case, the specification in Eq. (1) is reparameterized as follows:

$$w_{it} = \alpha_i + \sum_j (\gamma_{ij} + \delta_{ij} h_t) \ln p_{jt} + (\beta_i + \delta_i h_t) \ln[Y_t / P_t^*] + \epsilon_{it}, \quad (2)$$

where $h_t = 0$ for nonimport years and 1 for import years.

This specification is similar to that used by Moschini and Meilke (1989) in modeling the pattern of structural change in U.S. meat demand.

The model necessitates the use of classical restrictions so that the estimates of demand parameters conform to theory. For the LA/AIDS, the restrictions accompanying the specification given in Eq. (1) are as follows:

$$\sum_i \alpha_i = 1, \sum_i \gamma_{ij} = 0, \text{ and } \sum_i \beta_i = 1 \text{ (adding up)}$$

$$\sum_j \gamma_{ij} = 0 \text{ (homogeneity)} \quad (3)$$

$$\gamma_{ij} = \gamma_{ji} \text{ (symmetry)}$$

This set of restrictions is augmented as follows in conjunction with the specification given in Eq. (2): $\sum_j \delta_{ij} = 0$; $\sum \delta_{ij} = 0$; and $\sum \delta_i = 0$. Within this framework, a test for parameter constancy for import and nonimport years is possible. The joint test is given by $\delta_{ij} = \delta_i = 0$ for all i and j.

Operationally, when estimating demand systems, one equation must be omitted to avoid singularity of the variance-covariance matrix of disturbance terms. For each model, the omitted equation corresponds to chicken. Through the classical constraints, the demand parameters associated with the omitted equation are subsequently recovered.

Empirical Results

Quantity and price data used in this analysis are from various yearbooks, and reports published by the various countries. For South Korea, quantities and price of beef, pork, and chicken are taken from *Materials on Price, Demand, and Supply for Livestock Products* (South Korea National Livestock Cooperatives Federation), the *Agricultural Cooperative Yearbook* (South Korea Agricultural Cooperative Federation), the *Korea Statistical Yearbook* (South Korea Economic Planning Board), and the *Economic Statistics Annual Book* (South Korea Bank of Korea). Quantities and prices of marine products are taken from the *Yearbook of Fisheries Statistics* (South Korea Ministry of Agricultural Fisheries) and the *Annual Statistics on Cooperative Sale of Fishery Products* (South Korea National Federation of Fisheries Cooperatives). For Taiwan, per capita consumption figures come from the *Taiwan Food Balance Sheet* (Taiwan Council of Agriculture), and retail prices come from *Taiwan Agricultural Prices and Costs Monthly* (Taiwan Department of Agriculture and Forestry). Retail and wholesale price indices come from *Commodity Price Statistics Monthly* (Taiwan Directorate-General of Budget, Accounting, and Statistics).

For Taiwan and South Korea, representative prices for marine products were difficult to obtain. For Taiwan, a weighted average price of 18 marine products was used as the price of fish. The respective products used to develop the weighted average price series were: (1) yellow sea bream, (2) red sea bream, (3) crimson sea bream, (4) black pomfret, (5) milk fish, (6) sailfish, (7) silver carp, (8) tuna, (9) butter fish, (10) cuttle fish, (11) hairtail, (12) mackerel, (13) white croaker, (14) lizard fish, (15) sea eel, (16) nemipterid, (17) striped prawn, and (18) shrimp.

South Korea has thousands of different types of marine products available to consumers. Because of the lack of quantity information for individual marine

species, it was not possible to develop a weighted average price series. The retail price series for marine products in South Korea was constructed by regressing the retail price for marine products in Japan as a function of the wholesale marine price index in South Korea, available annually. The predicted price from this relationship was converted to the retail price of marine products in South Korea by using the exchange rate of won to yen.

Descriptive statistics of per capita consumption, nominal prices, and average budget shares are exhibited in Table 2. In the respective Pacific Rim countries, on average, beef is the most expensive product, generally because of import barriers. As well, beef prices are the most volatile and chicken the least. In Taiwan, on average, fish is the least expensive product; in South Korea, on average, chicken is the least expensive product; import prices for beef in Taiwan are calculated as a weighted average of import prices associated with each exporting country (Australia, New Zealand, and the United States). The weights correspond to the market share of the respective country. Conversion to common monetary units, in this case NT$/kg, is made in the process. The price of imported beef in Taiwan is on average close to 60 percent below the price of domestic beef.

In the respective demand systems analyses for the Pacific Rim countries, real prices are used. Real prices are obtained by dividing the nominal price series by the Consumer Price Index. Estimates of the structural parameters of the demand models are derived by using the method of maximum likelihood in the econometrics package SHAZAM (White et al. 1988). As suggested by Berndt and Savin (1975), the various systems in each Pacific Rim country are corrected for autocorrelation by using the same autocorrelation coefficient ($\hat{\rho}$) for each equation. In the LA/AIDS model, $\hat{\rho}$ corresponds to 0.3988, and 0.2659 for Taiwan and South Korea, respectively. The estimated coefficients and associated standard errors of the parameters in the demand system for the respective countries are exhibited in Tables 3 and 4.

For Taiwan, the goodness-of-fit statistics, as given by R^2, range from 0.52 (chicken) to 0.86 (imported beef). For South Korea, these measures range from 0.71 (pork) to 0.80 (beef). Hence, the LA/AIDS model accounts for a sizable portion of variation in the average budget shares for the respective meat products in each of the Pacific Rim countries.

In the case of South Korea, only 3 of the 14 slope shifter variables associated with price or total expenditures on meats are significantly different from zero. As exhibited in Table 4, the hypotheses that (1) income and price slope shifters jointly are equal to zero, (2) income slope shifters jointly are equal to zero, and (3) price slope shifters jointly are equal to zero cannot be rejected at the .05 level. Consequently, no statistically significant differences in price and income coefficients as a group are evident for importing versus nonimporting years, at least over the period 1960 to 1988. As a result, the model was reformulated, omitting all interaction terms. The parameter estimates and associated t-statistics for this respecification are shown in Table 4.

Given the interest in elasticities, both Marshallian and Hicksian measures are shown in Table 5 (Taiwan) and Table 6 (South Korea). Standard errors of the elasticities are calculated by using the method used by Chalfant (1987). This method assumes that the budget shares are exogenous and hence, the standard errors are only approximations. The resulting t-statistics are given in parentheses. Because expenditure on meats is used rather than total expenditures, the system of demand functions is a conditional set of relationships. The elasticities are therefore second-stage estimates. The estimated elasticities for the Taiwanese, and South Korean, meat demand systems are, in general, in accordance with a priori expectations. All own-price elasticities are negative while most of the compensated cross-price elasticities are positive, indicative of net substitutes.

Taiwan

The own uncompensated (compensated) elasticities for Taiwan are –2.87 (–2.85) for domestic beef, –1.65 (–1.63) for imported beef, –0.75 (–0.22) for

Table 2. Descriptive statistics of variables used in the analysis by Pacific Rim country

Per Capita Consumption	Taiwan (kg) Mean	Std Dev	Min	Max	South Korea Nonimport Years (21) (kg) Mean	Std Dev	Min	Max	South Korea Import Years (8) (kg) Mean	Std Dev	Min	Max
Beef	1.14	0.54	0.37	2.18	1.59	1.01	.51	3.65	2.63	0.36	2.10	3.10
Domestic Beef	0.41	0.19	0.19	0.94								
Imported Beef	0.74	0.66	0.00	1.93								
Pork	24.69	5.86	17.09	34.83	3.81	2.70	1.43	10.13	5.61	1.74	3.04	8.37
Chicken	9.19	4.39	4.02	16.83	1.55	0.98	0.50	3.55	2.38	0.43	1.69	3.00
Fish	36.31	3.80	29.69	45.83	33.60	16.88	13.85	63.99	49.60	4.46	45.00	54.97

Nominal Prices	Taiwan NT$/kg Mean	Std Dev	Min	Max	South Korea Nonimport Years (21) Won/kg Mean	Std Dev	Min	Max	South Korea Import Years (8) Won/kg Mean	Std Dev	Min	Max
Domestic Beef	184.85	86.76	51.63	288.17	1996.2	2701.3	116.0	8276.0	5331.5	2552.3	2126.0	8316.0
Imported Beef	76.21	24.33	36.43	109.80								
Pork	87.43	28.22	41.67	128.74	1012.8	1282.6	67.0	3838.0	2428.7	914.7	1332.0	3526.0
Chicken	80.44	15.47	50.95	98.94	520.2	536.1	63.0	1563.0	1209.5	338.3	821.0	1629.0
Fish	65.42	27.25	25.18	100.47	2030.7	3265.6	38.0	10092.0	2958.4	1383.1	1101.0	4581.0

Average Budget Shares	Taiwan Mean	Std Dev	Min	Max	South Korea Nonimport Years (21) Mean	Std Dev	Min	Max	South Korea Import Years (8) Mean	Std Dev	Min	Max
Domestic Beef	.0133	.0050	.0064	.0260	.0527	.0117	.0341	.0769	.0791	.0101	.0614	.0949
Imported Beef	.0084	.0071	.0000	.0187								
Pork	.4064	.0246	.3615	.4651	.0782	.0354	.0413	.1990	.0775	.0081	.0670	.0885
Chicken	.1330	.0164	.1071	.1707	.0229	.0125	.0064	.0582	.0176	.0035	.0138	.0230
Fish	.4387	.0261	.3886	.4835	.8460	.0546	.6657	.9170	.8256	.0152	.7997	.8479

Table 3. Parameter estimates and associated t-statistics for the LA/AIDS Model—Taiwan[a]

	Parameter Estimate	t-Statistic	DW	R^2
Domestic Beef				
$\alpha 1$	0.0268	0.85	1.6959	0.82
$\gamma 11$	–0.0248*	–5.79		
$\gamma 12$	0.0022	1.10		
$\gamma 13$	0.0162*	2.46		
$\gamma 14$	–0.0003	–0.07		
$\gamma 15$	0.0066	1.07		
$\beta 1$	0.0014	0.20		
Imported Beef				
$\alpha 2$	–0.0219	–0.59	1.4286	0.86
$\gamma 22$	–0.0054*	–2.13		
$\gamma 23$	0.0158*	2.38		
$\gamma 24$	–0.0209*	–3.92		
$\gamma 25$	0.0083	1.16		
$\beta 2$	0.0069	0.83		
Pork				
$\alpha 3$	–0.1657	–0.88	1.8632	0.56
$\gamma 33$	0.1490*	4.03		
$\gamma 34$	0.0172	0.78		
$\gamma 35$	–0.0984*	–5.70		
$\beta 3$	0.1169*	2.80		
Chicken				
$\alpha 4$	0.0521	0.31	2.2087	0.52
$\gamma 44$	–0.0208	–0.87		
$\gamma 45$	0.0248	0.87		
$\beta 4$	0.0197	0.52		
Fish				
$\alpha 5$	1.1086*	4.45	1.7365	0.52
$\gamma 55$	0.1586*	3.46		
$\beta 5$	–0.1451*	–2.60		
ρ	0.3988*	2.76		

[a]Asterisk indicates significance at the 0.05 level.

Table 4. Parameter estimates and associated t-statistics for the LA/AIDS Model—South Korea[a]

		With Interaction Terms		Without Interaction Terms	
		Parameter Estimates	t-statistic	Parameter Estimates	t-statistic
Beef	α	0.0099	0.38	0.0010	0.03
	γ11	0.0227*	2.94	0.0314*	4.22
	γ12	–0.0042	–0.48	0.0061	0.81
	γ13	0.0125*	3.37	0.0060	1.55
	γ14	–0.0311*	–3.56	–0.0435*	–5.30
	β1	0.0123	1.61	0.0144	1.56
	D11	0.0165	0.55	—	—
	D12	0.0092	0.52	—	—
	D13	–0.0184*	–1.93	—	—
	D14	–0.0073	–0.25	—	—
	Dβ1	–0.0025	–0.47	—	—
	DW	1.6499		1.4865	
	R^2	0.8024		0.7276	
Pork	α2	0.1213*	2.56	0.0743	1.56
	γ22	0.0102	0.68	0.0208*	1.68
	γ23	0.0024	0.45	–0.0016	–0.35
	γ24	–0.0084	–0.55	–0.0253*	–2.01
	β2	–0.0131	–0.96	–0.0009	–0.07
	D22	–0.0057	–0.23	—	—
	D23	–0.0138	–1.35	—	—
	D24	0.0103	–0.34	—	—
	Dβ2	–0.0008	–0.23	—	—
	DW	2.1519		2.0656	
	R^2	0.71		0.64	
Chicken	α3	0.0437*	3.22	0.0347*	2.28
	γ33	0.0018	0.37	0.0096*	1.93
	γ34	–0.0169*	–4.58	–0.0139	–4.49
	β3	–0.0068	–1.54	–0.0029	–0.59
	D33	0.0179*	2.26	—	—
	D34	0.0143	1.36	—	—
	Dβ3	0.0048*	2.24	—	—
	DW	0.9985		1.0114	
	R^2	0.8814		0.8782	
Fish	α4	0.8249*	12.48	0.8898*	13.63
	γ44	0.0565*	2.49	0.0827*	4.48
	β4	0.0076	0.40	–0.0106	–0.61
	D22	–0.0173	–0.33	—	
	Dβ4	–0.0014	–0.25	—	
	DW	1.7608		1.6574	
	R^2	0.7688		0.7419	
	ρ	0.3046*	1.90	0.4853*	4.03

χ^2 Tests

H_0: income and price slope shifters jointly equal to zero (x^2_9) 15.75

H_0: income and slope shifters jointly equal to zero (x^2_3) 5.59

H_0: price slope shifters jointly equal to zero (x^2_6) 7.59

[a]Asterisk indicates significance at the 0.05 level.

Table 5. Uncompensated and compensated price elasticities and expenditure elasticities for meat products in Taiwan—LA/AIDS Model

Taiwan					
Uncompensated Price Elasticities					
	Domestic Beef[a]	Imported Beef	Pork	Chicken	Fish
Domestic Beef	–2.8708	0.1655	1.1788	–0.0374	0.4532
	(–8.86)	(1.10)	(2.65)	(–0.08)	(0.70)
Imported Beef	0.2506	–1.6528	1.5424	–2.5817	0.6205
	(1.06)	(–5.49)	(2.02)	(–4.65)	(0.52)
Pork	0.0363	0.0367	–0.7502	0.0042	–0.6146
	(2.26)	(2.23)	(–9.30)	(0.08)	(–5.03)
Chicken	–0.0042	–0.1587	0.0692	–1.1764	0.1213
	(–0.09)	(–4.11)	(0.48)	(–5.72)	(1.62)
Fish	0.0196	0.0217	–0.3179	0.1006	–0.4932
	(1.43)	(1.34)	(–4.48)	(1.84)	(–2.94)
Compensated Price Elasticities					
	Domestic Beef	Imported Beef	Pork	Chicken	Fish
Domestic Beef	–2.8560	0.1749	1.6302	0.1104	0.9405
	(–8.85)	(1.17)	(3.28)	(0.23)	(2.02)
Imported Beef	0.2749	–1.6374	2.2825	–2.3394	1.4194
	(1.17)	(–5.42)	(2.90)	(–3.84)	(1.68)
Pork	0.0534	0.0476	–0.2269	0.1755	–0.0496
	(3.28)	(2.90)	(–2.50)	(3.25)	(–0.58)
Chicken	0.0111	–0.1490	0.5361	–1.0235	0.6254
	(0.23)	(–3.84)	(3.25)	(–5.58)	(2.94)
Fish	0.0285	0.0274	–0.0459	0.1897	–0.1997
	(2.02)	(1.68)	(–0.58)	(2.94)	(–1.57)
Expenditure Elasticities					
	Domestic Beef	Imported Beef	Pork	Chicken	Fish
	1.1108	1.8209	1.2877	1.1488	0.6691
	(2.07)	(1.85)	(12.56)	(34.74)	(8.24)
Income Elasticities					
	Domestic Beef	Imported Beef	Pork	Chicken	Fish
	0.8442	1.3838	0.9786	0.8730	0.5085

[a]t-statistics, estimated following Chalfant (1987), are reported in parentheses.

Table 6. Uncompensated and compensated price elasticities and expenditure elasticities for meat products in South Korea—LA/AIDS Model

	South Korea			
	Uncompensated Price Elasticities			
	Beef[a]	Pork	Chicken	Fish
Beef	–0.4862	0.0846	0.0959	–0.9362
	(–3.84)	(0.69)	(1.51)	(–4.25)
Pork	0.0834	–0.7168	–0.0215	–0.3329
	(0.81)	(–4.41)	(–0.36)	(–1.22)
Chicken	0.3053	–0.0689	–0.5230	–0.5709
	(1.53)	(–0.31)	(–2.17)	(–1.98)
Fish	0.0506	–0.0290	–0.0162	–0.8916
	(–5.66)	(–2.03)	(–4.54)	(–26.79)
	Compensated Elasticities			
	Beef	Pork	Chicken	Fish
Beef	–0.4124	0.1762	0.1210	0.1152
	(–3.30)	(1.40)	(1.87)	(0.84)
Pork	0.1421	–0.6437	–0.0016	0.5034
	(1.40)	(–3.85)	(–0.03)	(2.96)
Chicken	0.3563	–0.0057	–0.5057	0.1551
	(1.87)	(–0.03)	(–2.06)	(1.01)
Fish	0.0081	0.0438	0.0037	–0.0556
	(0.84)	(2.96)	(1.01)	(–2.55)
	Expenditure Elasticities			
	Beef	Pork	Chicken	Fish
	1.2419	0.9878	0.8575	0.9875
	(8.04)	(5.64)	(3.56)	(47.86)
	Income Elasticities			
	Beef	Pork	Chicken	Fish
	1.5523	1.2347	1.0718	1.2343

[a]t-statistics, calculated following Chalfant (1987), are reported in parentheses.

pork, –1.17 (–1.02) for chicken, and –0.49 (–0.20) for fish. The demand for beef and chicken in Taiwan is price elastic, but the demand for pork and fish is price inelastic. The demand for beef is the most sensitive to own-price changes and fish the least. The expenditure elasticities are 1.11 for domestic beef, 1.82 for imported beef, 1.28 for pork, 1.14 for chicken, and 0.67 for fish.

Except for imported beef and chicken as well as for fish and pork, the meat products are net substitutes. Pork in particular, is a strong substitute for domestic and imported beef. Importantly, domestic and imported beef are substitutes. However, the compensated cross-price elasticities for the beef products are not particularly large; the compensated cross-price elasticity of domestic beef with respect to imported beef is 0.1749. The compensated cross-price elasticity of imported beef with respect to domestic beef is 0.2749. This result suggests that domestic and imported beef are net substitutes but not perfect substitutes. To test the hypothesis of perfect substitutability among beef products, we use the χ^2 test statistic as described by Hayes, Wahl, and Williams (1990). The null hypothesis of perfect substitutability of domestic and imported beef is rejected at the 0.01 level of significance ($\chi^2_6 = 228.8$).

Lambert estimated the uncompensated own-price elasticity for beef in Japan to be –1.05 for Wagyu (domestic) beef and –0.58 for imported beef (from the United States, New Zealand, and Australia). Hayes, Wahl, and Williams (1990) estimated the own-uncompensated (compensated) elasticity for Wagyu beef in Japan to be –1.89 (–1.78) and for import-quality beef to be –0.46 (–0.29). The uncompensated own-price elasticities for beef reported for Taiwan thus fall outside the intervals reported by Lambert (1991) and by Hayes, Wahl, and Williams (1990).

South Korea

The respective elasticities measures for South Korea are based on the LA/AIDS model without the interaction terms given the nonsignificance of those terms' associated coefficients. In South Korea, the own uncompensated (compensated) elasticities are –0.48 (–0.41) for beef, –0.71 (–0.64) for pork, –0.52 (–0.50) for chicken, and –0.89 (–0.05) for fish. The demand for the respective meat products in South Korea are price inelastic. The demand for fish is the most sensitive to own-price changes, and beef the least, both the reverse of the situation in Taiwan. The expenditure elasticities are 1.24 for beef, 0.98 for pork, 0.85 for chicken, and 0.98 for fish. Except for pork and chicken, the meat products are net substitutes.

Intercountry Comparisons

Beef and pork, beef and fish, and chicken and fish are net substitutes in the Pacific Rim nations. Pork and chicken appear to be net substitutes in Taiwan, but net complements in South Korea. However, the compensated cross-price elasticities between pork and chicken in South Korea are not statistically different from zero. Imported beef and chicken appear to be net complements in Taiwan, but beef and chicken are net substitutes in South Korea. This net complementary relationship in Taiwan is, however, statistically different from zero. Pork and fish are net substitutes in South Korea, but net complements in Taiwan. However, this net complementary relationship in Taiwan is not statistically different from zero. Thus, the only statistically significant net complementary relationship among meat products in the Pacific Rim is between imported beef and chicken in Taiwan. One could impose net substitutability econometrically as done by Hayes, Wahl, and Williams (1990), but in light of our compensated cross-price elasticities, this restriction may not be necessary.

Finally, all the meat products are normal goods. However, the magnitudes of the expenditure elasticities differ, in some cases substantially. The income elasticity of total meat expenditures in South Korea was estimated to be 1.25 by Kim (1977). No prior information is available regarding the income elasticity of total meat expenditure in Taiwan. However, using an auxiliary regression of real total meat expenditure as a function of real per capita disposable income, we estimated this elasticity to be 0.76 for Taiwan. Multiplying these figures by the various expenditure elasticities for the meat products in Taiwan and South Korea gives rise to income elastici-

ties for the individual commodities in these countries (Blanciforti and Green 1983). Therefore, a 10 percent increase in real income in South Korea leads to a 15.5 percent increase (8.4 percent for domestic beef and 13.8 percent for imported beef in Taiwan) in the demand for beef; a 12.3 percent increase (9.7 percent in Taiwan) in the demand for pork; a 10.7 percent increase (8.7 percent in Taiwan) in the demand for chicken; and a 12.3 percent increase (5.0 percent in Taiwan) in the demand for fish.

Scenarios for Trade Liberalization

Given income and price elasticities of demand, we construct scenarios of consumption and trade over time. Emphasis in this exercise is centered on beef. For simplicity, the domestic supply of beef is assumed to be held constant at 1988 levels. Given this assumption, the scenarios for trade liberalization are dependent on four conditions: (1) own-price effects as beef prices fall to world levels; (2) cross-price effects of pork, chicken, and fish; (3) income effects due to continued economic growth; and (4) population growth. The scenarios focus attention on market size for beef in the year 2000, arbitrarily assuming liberalization in 1996. The scenarios use the elasticities previously derived from the LA/AIDS model.

Growth rates, in percentage changes, for population, real per capita gross domestic product, and real prices of meat products over the 1968 through 1988 period for Taiwan and over the 1960 through 1988 period for South Korea are exhibited in Table 7. These growth rates were derived from the relationship $\ln Y = b_0 + b_1 t$, where Y corresponds to population, income, or price and t corresponds to time. The first scenario for trade liberalization employs half the historical growth rates of these exogenous variables. The second scenario is similar to the first except that percentage changes of real prices of pork, chicken, and fish are assumed to be zero. Under trade liberalization, beginning by design in 1996, real price changes of domestic beef are assumed to be the same as real price changes of imported beef. Of course, it is unrealistic to assume complete adjustments of the Pacific Rim markets from domestic to world prices over a short period of time. The price change of beef, given full liberalization, entails a drop from current retail domestic prices to import prices plus tariff, processing charges, and retail-wholesale margins. Current processing charges and import duties are, however, assumed to remain the same. It seems likely that free trade will force Taiwanese and Korean beef to sell at the price of imported beef. Although this assumption constitutes an imperfect representation of prices that might prevail after liberalization, it nonetheless indicates the order of magnitude by which Taiwanese and Korean beef prices could drop.

Table 7. Growth rates for population, real per capita income, and real prices used in the scenarios for trade liberalization.

	Country	
Growth Rate	Taiwan 1968-1988	South Korea 1960-1988
Population	1.8794	1.8942
Real Per Capita GNP	6.2899	9.3921
Real Beef Price		4.0520
Domestic	1.6691	
Imported	–4.1322	
Real Pork Price	–2.2895	2.5981
Real Chicken Price	–4.4424	–0.3946
Real Fish Price	–0.0821	6.2306

The results of the two scenarios to determine the impacts on consumption and imports of beef in Taiwan and South Korea are given in Table 8. Both scenarios include full liberalization in 1996, with full adjustment to the same retail price change. Both scenarios maintain domestic beef production at 1988 levels, at 4700 metric tons for Taiwan and 141,500 metric tons for South Korea. The only difference in scenarios is the absence of real retail price changes for pork, chicken, and fish. Importantly, both scenarios represent rather conservative assumptions.

Table 8. Results of two scenarios for analysis of consumption and imports of beef in Taiwan and South Korea for selected years

Taiwan		Preliberalization		Postliberalization	
	1988	1989	1995	1996	2000
Change in Beef Consumption/Person (%)		10.5[c] (7.9)[d]	10.5 (7.9)	18.1 (15.5)	18.1 (15.5)
Consumption/Person (Kilograms/Year)	2.18	2.41 (2.35)	4.40 (3.71)	5.19 (4.28)	10.10 (7.62)
Population (000)[a]	19904	20091	21250	21450	22268
Consumption 1,000 Metric Tons	43.4	48.4 (47.2)	93.5 (78.8)	111.3 (91.8)	225.1 (169.7)
Production 1,000 Metric Tons	4.7	4.7	4.7	4.7	4.7
Imports 1,000 Metric Tons	38.7	43.7 (42.5)	88.8 (74.1)	106.6 (87.1)	220.4 (165.0)

South Korea		Preliberalization		Postliberalization	
	1988	1989	1995	1996	2000
Change in Beef Consumption/Person (%)		3.5[c] (6.3)[d]	3.5 (6.3)	5.5 (17.3)	5.5 (17.3)
Consumption/Person (Kilograms/Year)	3.37	3.48 (3.58)	4.28 (5.17)	4.51 (6.06)	5.59 (11.50)
Population (000)[b]	41975	42372	44838	45262	47002
Consumption 1,000 Metric Tons	141.5	147.5 (151.7)	191.9 (231.8)	204.1 (274.3)	262.7 (540.5)
Production 1,000 Metric Tons	141.5	141.5	141.5	141.5	141.5
Imports 1,000 Metric Tons	0	6.0 (10.2)	50.4 (90.3)	62.6 (132.8)	121.2 (399.0)

[a]Assuming population growth rate of 0.9397 percent.
[b]Assuming population growth rate of 0.9471 percent.
[c]Assuming half the historical growth rates of real per capita income and real prices of meat products.
[d]Assuming half the historical growth rates of real per capita income and real price of beef, no changes in real prices of pork, chicken, and fish.

For Taiwan, per capita consumption of beef is projected to grow from 2.18 kg in 1988 to 7.62 to 10.10 kg by the year 2000. Imports are projected to rise from 38,700 metric tons in 1988 to 165,000 to 220,400 metric tons by the year 2000. For South Korea, per capita beef consumption is expected to increase from 3.37 kg in 1988 to 5.59 to 11.50 kg in 2000. Imports are expected to grow from 0 metric tons in 1988 to 121,200 to 399,000 metric tons in 2000.

The volume of imports to Taiwan by the year 2000 amounts to 9 to 12 percent of the 1989 level of North American and Oceania exports of beef to all destinations. Similarly, the volume of imports to South Korea under trade liberalization by the year 2000 amounts to 6 to 21 percent of the 1989 level of North American and Oceania beef exports. Consequently, Taiwanese and South Korean beef imports are notable relative to current beef trade from the United States, Australia, and New Zealand.

Historically, Australia has been the major supplier of beef to Taiwan and to South Korea. This situation may be primarily due to the fact that Australian grass-fed beef is cheaper than U.S. grain-fed beef. However, because the overall size of the Taiwanese and Korean beef markets is potentially large, there are indeed incentives for U.S. firms and the U.S. government to develop prospects for export of grain-fed beef to these Pacific Rim nations as well as to encourage the removal of trade barriers.

Conclusions

Developing marketing programs for meat products in international markets is currently of great interest to U.S. domestic producers. In a recent survey of livestock and meat industry leaders, nearly 75 percent of the respondents believed that events in international markets are now as important as events in domestic markets in determining potential profitability. Nearly 90 percent of the respondents believed that this scenario will hold in the future (Special Report to Texas Beef Industry 1989). Under seemingly conservative assumptions we demonstrate that Taiwanese and Korean beef imports are potentially large under trade liberalization. Elasticities derived from the LA/AIDS model were crucial to this analysis.

Both the United States and Australia may be in position to capture a sizable share of these imports. Historically, Australia has been the chief supplier of beef to Taiwan and South Korea. The costs, especially to U.S. firms selling beef to the Pacific Rim, have fallen in the last decade because of the development of the Japanese market. To secure a foothold in the Pacific Rim trade, U.S. firms and the U.S. government need to develop marketing efforts for grain-fed beef as well as to encourage the removal of trade barriers.

Admittedly, the range of possible trade outcomes is wide. A next step is to integrate the estimates of the LA/AIDS model with livestock supply models in Taiwan and South Korea. Future research efforts are likely to pay dividends to U.S. firms and the U.S. government in trade opportunities with Pacific Rim nations.

References

Berndt, E. R., and H. E. Savin. "Estimation and Hypothesis Testing in Singular Equation Systems with Autoregressive Disturbances." *Econometrica* 43(1975):937-57.

Blanciforti, L., and R. Green. "The Almost Ideal Demand System: A Comparison and Application to Food Groups." *Agri. Econ. Res.* 35(1983):1-10.

Capps, O., Jr., R. Tsai, R. Kirby, and G. W. Williams. "A Comparison of Demands for Meat Products in the Pacific Rim Region." *J. Agri. Res. Econ.* (1994): forthcoming.

Chalfant, J. A. "A Globally Flexible, Almost Ideal Demand System." *J. Bus. Econ. Stat.* 5 (April 1987): 233-47.

Deaton, A., and J. Muellbauer. "An Almost Ideal Demand System." *Amer. Econ. Rev.* 70(1980):312-26.

Dyck, J. H., and D. Sillers. *South Korea: An Export Market Profile.* Economic Research Service, U.S. Department of Agriculture, May 1986.

Gorman, W. D., H. Mori, and B. H. Lin. "Beef in Japan: The Challenge for U.S. Exports." *J. of Food Dist. Research* 21(1990):17-29.

Hayes, D. J., T. I. Wahl, and G. W. Williams. "Testing Restrictions on a Model of Japanese Meat Demand." *Amer. J. of Agri. Econ.* (1990):556-66.

Jones, J., and J. H. Dyck. "Korea's Beef Market in a Pacific Context." Selected paper at the AAEA Annual Meeting, Manhattan, Kansas, Aug. 1991.

Kim, C. S. "A Study of Supply and Demand for Livestock Products in Korea." Korea Institute for Science and Technology, Seoul, South Korea, June 1977.

Lambert, B. *Demand Estimates for U.S. Beef in Japan.* Department of Agricultural Economics and Agribusiness, Louisiana State University, Feb. 1990.

Moschini, G., and K. D. Meilke. "Modeling the Pattern of Structural Change in U.S. Meat Demand." *Amer. J. Agri. Econ.* 71(2)(1989):253-61.

South Korea. Agricultural Cooperative Federation. *Agricultural Cooperative Yearbook.* Seoul, South Korea (various issues).

South Korea. Bank of Korea. *Economic Statistics Annual Book.* South Korea (various issues).

South Korea. Economic Planning Board. *Korea Statistical Yearbook.* South Korea (various issues).

South Korea. Ministry of Agricultural Fisheries. *Yearbook of Fisheries Statistics.* Seoul, South Korea (various issues).

South Korea. National Federation of Fisheries Cooperatives. *Annual Statistics on Cooperative Sale of Fishery Products.* Seoul, South Korea (various issues).

South Korea. National Livestock Cooperatives Federation. *Materials on Price, Demand, and Supply for Livestock Products.* Seoul, South Korea (various issues).

Taiwan. Department of Agriculture & Forestry. *Taiwan Agricultural Prices and Costs Monthly.* Taiwan: Provincial Government (various issues).

Taiwan. Department of Agriculture & Forestry. *Taiwan Agricultural Yearbook.* Taiwan: Provincial Government (various issues).

Taiwan. Council of Agriculture. *Taiwan Food Balance Sheet.* Taipei, Taiwan: Executive Yuan, (various issues).

Taiwan. Directorate-General of Budget, Accounting and Statistics. *Commodity-Price Statistics Monthly, Taiwan Area,* Taipei, Taiwan: Executive Yuan (various issues).

Texas Beef Industry Council. "Survey of U.S. Livestock Procedures on International Livestock and Meat Marketing," Special Report, Fall 1989.

White, K. J., S. A. Haun, N. G. Horsman, and S. D. Wong. *SHAZAM User's Reference Manual,* New York: McGraw-Hill, 1988.