AE 97003 **July 1997**

Wheat Import Demand in the Japanese Flour Milling Industry: A Production Theory Approach

Weining Mao
Won W. Koo
Jon P. Suomala
Takeshi Sakurai*

Selected Paper for Presentation at the 1997 AAEA Annual Meetings in Toronto, Canada

***Weining Mao, Won W. Koo, and Jon P. Suomala are postdoctoral research associate, professor, and graduate research assistant, respectively, in the Department of Agricultural Economics at North Dakota State University, Fargo. Takeshi Sakurai is a senior economist at the National Research Institute of Agricultural Economics of the Ministry of Agriculture, Forestry, and Fisheries, Japan.**

Wheat Import Demand in the Japanese Flour Milling Industry: A Production Theory Approach

Weining Mao, Won W. Koo,
Jon P. Suomala, Takeshi Sakurai

Abstract

The translog cost function is used to analyze import demand for wheat differentiated by class and country of origin in the Japanese wheat flour milling industry. Results indicate that U.S. wheat faces strong competition in the Japanese wheat market, but its multiple classes and end-use characteristics enable the United States to preserve the largest market share in Japan.

Key words: import demand, Japan, wheat, production theory, translog cost function

Information on other titles in this series may be obtained from: Department of Agricultural Economics, North Dakota State University, P.O. Box 5636, Fargo, ND 58105. Telephone: 701-231-7441, Fax: 701-231-7400, or e-mail: cjensen@ndsuext.nodak.edu.

Wheat Import Demand in the Japanese Flour Milling Industry: A Production Theory Approach

Weining Mao, Won W. Koo, Jon P. Suomala, Takeshi Sakurai

Japan is one of the largest wheat importing countries in the world, accounting for about 6 percent of world total wheat imports in the early 1990s (International Wheat Council). Japanese wheat imports include both food wheat and feed wheat. The United States, Canada, and Australia are suppliers to the Japanese wheat import market, with 57.7, 23.5, and 18.8 percent of market share, respectively, in 1994. Japanese domestic production only accounts for about 8 percent of its total wheat supply in 1994 (USDA *PS&D View*).

Japanese wheat imports have been controlled by the Japanese Food Agency (JFA). The JFA determines the quotas on wheat imports each year in consultation with private milling companies and wheat trading companies. Each miller prepares a request for quantities of various classes of wheat. The wheat trading companies licensed by the JFA import wheat at world prices and sell the wheat (CIF Japan) to the JFA (Alston, Carter, and Jarvis). The JFA then resells the imported wheat to domestic flour and bran millers at much higher prices. The Japanese government has been using the system of import quotas and high resale prices to protect and to subsidize its domestic wheat production.

Wheat is classified into hard red winter (HRW), hard red spring (HRS), white, soft, and durum wheat on the basis of production practices and end-use characteristics. Importing countries use different classes of wheat depending on their preferences for different end products. In general, wheat is not considered to be a consumer-ready food product, but is mainly used by flour millers to produce wheat flour. Wheat flour is used by food manufacturers to make bread, noodles, pasta, cake, couscous, and other wheat products. Noodles and bread are the most favorite wheat products for Japanese consumers. In Japan, small amounts of wheat are also fed directly to animals or processed for feed use by the bran millers. Following the study by Alston, Carter, and Jarvis, wheat is divided into food and feed wheat in this study. Food wheat is used to produce various types of food products, while feed wheat is used to feed animals. Due to the difficulties in defining feed wheat and in obtaining data, most studies on international wheat trade do not separate trade for food wheat from that for feed wheat. Only a study by Riley, Schwartz, and Ackerman provided a market analysis for world feed wheat trade.

Historically, food wheat accounts for about 80 percent of Japanese total wheat imports (JFA, *Food Control Statistical Yearbook*). Figure 1 shows the shares of food wheat to total wheat in Japanese wheat imports by exporting country from 1983 to 1994. Japanese feed wheat imports are mainly from Australia and the United States. Only small amounts of feed wheat are imported from Canada, mainly because Canadian wheat has the fine baking quality associated with high protein. There are separate quotas for food wheat and feed wheat imports in Japan. Therefore, in estimating Japanese import demand for food wheat, it is more appropriate to separate Japanese food wheat imports from its feed wheat imports and to treat food wheat as an input factor for Japanese wheat flour production.

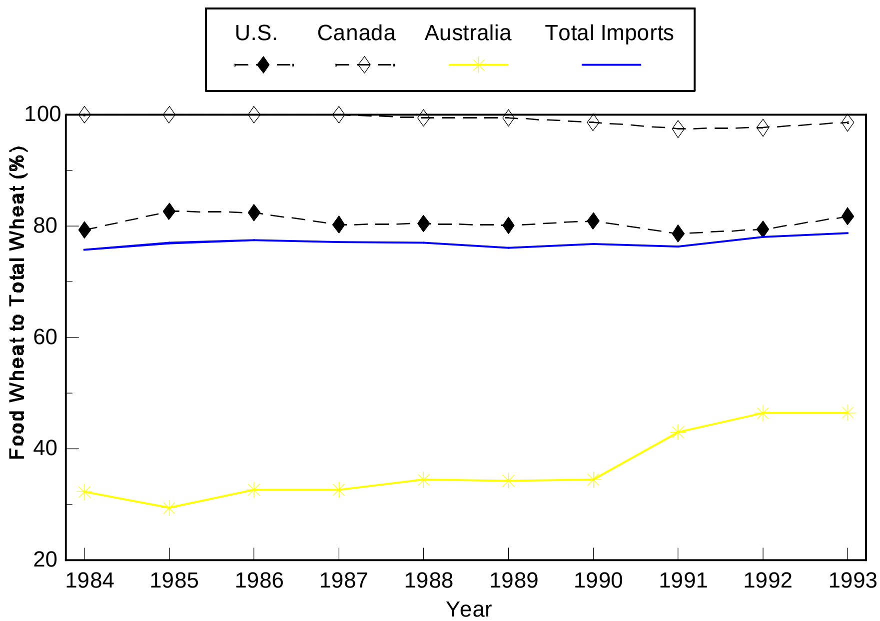

Figure 1. Shares of Food Wheat to Total Wheat in Japanese Wheat Imports by Country

The objective of this study is to estimate Japanese import demand for food wheat differentiated by class and country of origin. Conditional demand for each wheat class is derived from a multiple output - multiple input translog cost function for the Japanese flour milling industry.

Much of the early studies used the traditional methods, such as the direct demand, substitution, and market share models, to analyze wheat import demand under an assumption that wheat is a homogenous commodity (Capel and Rigaux, Greenshields, Gallagher et al.). To identify the substitutability and price responsiveness of wheat classes in import markets, some studies have used the Armington model to analyze trade flows between importing and exporting countries by differentiating wheat by place of production (Honma and Heady). Other analyses have used the complete demand system, such as the almost ideal demand system (AIDS) and the Rotterdam model to analyze import demand for wheat classes (Henning; Alston, Carter, Green, and Pick; Agriculture Canada; Lee, Koo, and Krause). Wilson applied a translog (dual) expenditure model to derive the demand function for wheat by class and country of origin for Pacific Rim countries. However, most previous studies have derived the demand functions for wheat or wheat classes based on consumer demand theory. Since wheat is more generally considered as an input for wheat flour production rather than as a consumer-ready product, it is more appropriate to analyze Japanese import demand for food wheat differentiated by class and country of origin from the perspective of the Japanese wheat flour milling industry using a production theory approach.

This study applied a dual translog cost function to derive wheat import demand in the Japanese flour milling industry. Imported wheat classes from exporting countries are treated as inputs, along with domestic wheat, labor, capital, and other inputs, to produce wheat flours. Duality provides a convenient approach to identify substitutabilities among imported wheat classes and domestic wheat and to measure effects of price changes on import demand for wheat classes in the Japanese flour milling industry.

Model Specification

A translog specification is used to represent the cost function of the Japanese flour milling industry. The translog cost function is well-known for its flexible functional form in terms of the local-order approximation to any arbitrary functional form.

Following Ray's specification, the *m*-output-*n*-input translog cost function for Japanese wheat flour production can be written as

$$\ln C = \ln k + \sum_{r=1}^{m} \alpha_r \ln q_r + \frac{1}{2} \sum_{r=1}^{m} \sum_{s=1}^{m} \lambda_{rs} \ln q_r \ln q_s + \sum_{i=1}^{n} \beta_i \ln w_i$$
$$+ \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \delta_{ij} \ln w_i \ln w_j + \sum_{r=1}^{m} \sum_{i=1}^{n} \gamma_{ri} \ln q_r \ln w_i \,, \tag{1}$$

where C is the total production cost, q_r is the output quantity of product r, and w_i is the price of input i. The translog cost function is positive, symmetric, and linearly homogeneous in input prices. The restrictions on parameters imply that

$$\lambda_{rs} = \lambda_{sr},\ \delta_{ij} = \delta_{ji},\ \sum_{i=1}^{n} \beta_i = 1, \text{ and } \sum_{i=1}^{n} \delta_{ij} = \sum_{j=1}^{n} \delta_{ij} = \sum_{i=1}^{n} \gamma_{ir} = 0, \quad \text{for all } r, s, i, \text{ and } j.$$

Monotonicity and concavity conditions must be checked for each observation after the function has been estimated.

Using Shephard's lemma, the cost share equations can be derived by differentiation of the translog cost function as

$$S_i = \frac{w_i x_i}{C} = \beta_i + \sum_{j=1}^{n} \delta_{ij} \ln w_j + \sum_{r=1}^{m} \gamma_{ri} \ln q_r \,, \qquad i = 1, \ldots, n. \tag{2}$$

With the assumption of marginal cost pricing for the outputs under perfect competition, we obtain the following relationship for each output r

$$\frac{\partial \ln C}{\partial \ln q_r} = \frac{\partial C}{\partial q_r} \frac{q_r}{C} = \frac{p_r q_r}{C}, \qquad r = 1, \ldots, m \tag{3}$$

This leads to the revenue share equations

$$y_r = \frac{p_r q_r}{C} = \alpha_r + \sum_{s=1}^{m} \lambda_{rs} \ln q_s + \sum_{i=1}^{n} \gamma_{ri} \ln w_i \,, \qquad r = 1, \ldots, m. \tag{4}$$

After the parameters of the translog model are estimated, the Allen partial elasticities of substitution (AES) can be calculated from the cost function as

$$\sigma_{ij} = \frac{\delta_{ij} + S_i S_j}{S_i S_j}, \qquad i \neq j, \tag{5}$$

$$\sigma_{ii} = \frac{\delta_{ii} + S_i^2 - S_i}{S_i^2}, \qquad i = j. \tag{6}$$

The price elasticities of conditional demand for individual inputs can be obtained from equations (5) and (6) as

$$\varepsilon_{ij} = \frac{\delta_{ij} + S_i S_j}{S_i}, \qquad i \neq j, \tag{7}$$

$$\varepsilon_{ii} = \frac{\delta_{ii} + S_i^2 - S_i}{S_i}, \qquad i = j. \tag{8}$$

Data Descriptions and Estimation Procedure

According to the Japanese statistical standard, the Japanese milling industry mainly produces three types of wheat flour: weak, standard, and strong flour. Different classes of wheat used by the Japanese millers are domestic soft wheat, U.S. soft wheat, U.S. semi-hard wheat, U.S. hard wheat, Canadian hard wheat, and Australian soft wheat.[1] Because durum wheat imports account for only 1.3 percent of Japanese wheat imports in value, durum wheat was not included in this study. A separability test suggests that labor is not separable from wheat classes in Japanese wheat flour production and, therefore, must be treated as an additional input. The total production capacity of wheat flour, which may be used as a proxy for capital, was first considered as a fixed input. However, the inclusion of the capital input largely reduces the significance of the estimated coefficients for the translog cost function, the estimated Allen elasticities of substitution, and the price elasticities of the demand. This is mainly because production capacity for wheat flour has remained almost the same over the 1967-93 period. Therefore, capital is not included in the final model estimation. Energy and other inputs are simply excluded from the translog cost function because of the unavailability of the data for these variables. A *7*-input-*3*-output translog cost function for the Japanese flour milling industry was finally estimated in this study. The estimated Allen partial elasticities of substitution and price elasticities of demand on different wheat classes were derived from the estimated structural parameters of the translog cost function.

---

[1]Based on the classification system used by the Japanese Food Agency, the imported food wheats are classified into five categories as follows: (1) U.S. Soft (WW), (2) U.S. Semi-Hard (HRW, 11.5% protein), (3) U.S. Hard (HRW, 13% protein; HRS, 14% protein), (4) Canadian Hard (CWRS, 13.5% protein), and (5) Australian Soft (AS).

Annual time series data from 1967 to 1993 were used in this study. All price and quantity data for domestic and foreign wheat were from the *Food Control Statistical Yearbook* (Japanese Food Agency). Data on prices of three wheat flour classes were also taken from the same source. The number of workers employed in the Japanese milling industry and the output quantities of wheat flour by class were collected from the *Wheat Flour and Feed Processors*: *Current Situations* (Japanese Food Agency). The wage index of workers in the Japanese food industry was obtained from the *Japanese Statistical Yearbook* (Statistics Bureau of Japan).

Japanese flour millers purchase domestic and foreign wheat classes used for wheat flour production from the JFA. The prices of domestic and foreign wheat were used as input prices in wheat flour production, while the wholesale prices of wheat flour were used as output prices.

Adding the error term e_i to each equation of (2) and (4) results in a system of cost and revenue share equations for the Japanese wheat flour industry. This system was first estimated with the symmetry and linear homogeneity restrictions imposed. Since the sum of the S_is is equal to unity, the cost share equation for labor (S_7) was dropped to ensure the nonsingularity of the disturbance covariance matrix and the price of labor was used as the *numèraire*. The remaining system was estimated using Zellner's iterative seemingly unrelated regression (ISUR) with parameter restrictions. The parameters associated with the dropped cost share equation were derived from the relationships among the parameters. However, the resulting cost function failed to be concave for some observations of the data. To ensure the concavity restrictions implied by microeconomic theory, the Wiley, Schmidt, and Bramble (WSB) reparameterization procedure outlined by Kohli was used in model estimation. The global concavity was ensured by imposing the concavity restrictions in 1990. This was done by re-estimating the model with input prices and output quantities normalized for 1990. Because of the reparameterization, the model becomes nonlinear in the parameters. The nonlinear system of cost and revenue share equations with the concavity restriction imposed was estimated using the nonlinear seemingly unrelated regression procedure from the *SHAZAM, Version 7.0* (White).

After estimating coefficients of the nonlinear system of cost and revenue share equations, the point estimates for the structural coefficients of the translog cost function were estimated using a Monte Carlo integration illustrated by Chalfant, Grey, and White. Monte Carlo integration is based on the idea that an expectation can be estimated using a random sampling approach. With the consistent coefficient estimates and its variance-covariance matrix from the Zellner's ISUR procedure, a random generator was employed to obtain a random sample for this multivariate normal distribution. From each draw for the parameter vector of the nonlinear system of cost and revenue share equations, the structural parameters of the translog cost function were calculated and the Allen elasticities of substitution and the price elasticities of the import demand were derived by wheat class and by origin of exporting country. The mean values of the derived parameters and elasticities of total draws become the estimated structural parameters and elasticities. The asymptotic standard errors can also be obtained from the Monte Carlo integration through the standard statistical procedure.

Empirical Results

Because of the large number of parameters, the intermediate estimation results for the re-parameterized nonlinear system of cost and revenue share equations are not presented in this study. Instead, the estimates for the structural coefficients of the original cost and revenue share functions are reported in Table 1. Most of the estimated parameters (53 of 87) are significant at the 5 percent level.

With the parameter estimates of the translog cost function, the Allen partial elasticities of substitution (AES) and the price elasticities of conditional demand for wheat classes and labor were calculated and are presented in Tables 2 and 3, respectively. These results also show that most of the elasticities are significant at the 5 percent level.

The positive signs of the AES indicate substitute relationships between any pair of wheat classes. Strong substitution suggests a high level of competition. The negative signs of the off-diagonal AES imply complementary relationships between any pair of wheat classes. This could be mainly because Japanese millers blend different classes of wheat for many different types of wheat flour production. The results indicate that both Japanese soft wheat and U.S. soft wheat are blended with U.S. and/or Canadian hard wheat in Japanese wheat flour production, while Australian soft wheat is only mixed with U.S. semi-hard wheat.

Own-price elasticities are elastic for all wheat classes, but the demands for soft wheat classes are less elastic than those of other classes, indicating that Japanese flour millers are more sensitive to the price of high quality wheat classes. Cross-price elasticities between Japanese soft wheat and U.S. soft wheat are much higher and more significant than those between Japanese soft wheat and Australian soft wheat, indicating a strong competition between U.S. soft wheat and Japanese domestic soft wheat. Strong competition also exists between U.S. hard wheat and Canadian hard wheat and between U.S. semi-hard wheat and Canadian hard wheat. The competition between Australian soft wheat and other wheat classes is relatively less intensive. To see the change in price elasticity of demand for wheat class over time, the estimated price elasticities for six selected years are presented in Table 4.

Alston, Carter, and Jarvis argued that wheat import quotas have been manipulated by the Japanese government to provide preferential treatment to the United States. However, according to the study by Doi, Itoh, and Sawada, wheat flour processed from Canadian hard and U.S. hard wheat is mainly used for bread, while wheat flour processed from U.S. semi-hard wheat is mainly used for Chinese-style noodles. Wheat flour processed from Australian and Japanese soft wheat are used to produce crackers and Japanese-style noodles. Wheat flour processed from U.S. soft wheat goes mainly to produce cake and cookies. These results suggest that U.S. wheat exports to Japan are benefitted primarily from its multiple classes and multiple end-use characteristics. However, Canada has argued that Japan favors the United States over other wheat exporters because of more U.S. influence on Japan.

Table 1. Parameter Estimates of the Translog Cost Function For Japanese Wheat Flour Production, 1967-93

Variable	Cost Share of							Revenue Share of		
	Domestic Soft	U.S. Soft	U.S. Semi-Hard	U.S. Hard	Canadian Hard	Australian Soft	Labor	Weak Flour	Standard Flour	Strong Flour
Intercept	0.1462*	0.1789*	0.0953*	0.2375*	0.2651*	0.0763*	0.0007	0.1226*	0.2240*	0.5476*
	(0.0099)	(0.0114)	(0.0080)	(0.0116)	(0.0115)	(0.0087)	(0.0174)	(0.0084)	(0.0099)	(0.0193)
Input Price of										
Domestic Soft	-0.5628*							-0.6420*	0.8348*	1.2542*
	(0.0685)							(0.0995)	(0.1014)	(0.2752)
U.S. Soft	0.4926*	-0.4900*						0.4943*	-0.0132	0.3013
	(0.0297)	(0.0861)			**(Symmetric)**			(0.0471)	(0.0731)	(0.1803)
U.S. Semi-Hard	0.2213	0.2151*	-0.8236*					-0.2306	-1.5278*	-4.3422*
	(0.0824)	(0.0632)	(0.2620)					(0.2138)	(0.2470)	(0.6568)
U.S. Hard	-0.1273	-0.1739	0.3144	-0.8823*				-1.0347*	0.2452	-0.1376
	(0.1170)	(0.1204)	(0.2519)	(0.4076)				(0.2261)	(0.2725)	(0.6299)
Canadian Hard	-0.0602	-0.1833*	0.3061	0.6688*	-0.8048*			0.6757*	0.7055*	2.6394*
	(0.0777)	(0.0824)	(0.1836)	(0.3111)	(0.2779)			(0.2012)	(0.2273)	(0.5555)
Australian Soft	0.0812	0.1188	-0.2501*	0.2376*	0.0657	-0.3027*		0.8738*	-0.4904*	-0.1126
	(0.0539)	(0.0668)	(0.1133)	(0.1153)	(0.0985)	(0.0863)		(0.0918)	(0.1268)	(0.3136)
Labor	-0.0448*	0.0208	0.0169	-0.0373	0.0077	0.0496*	-0.0129	-0.1944*	0.1983*	0.1984*
	(0.0150)	(0.0140)	(0.0180)	(0.0200)	(0.0165)	(0.0115)	(0.0177)	(0.0189)	(0.0181)	(0.0499)
Output Quantity of										
Weak Flour	0.2264*	0.0211	-0.0993*	0.1087*	-0.1144*	-0.1587*	0.0162	0.4038*		
	(0.0559)	(0.0665)	(0.0275)	(0.0485)	(0.0360)	(0.0350)	(0.0173)	(0.0319)		**(Symmetric)**
Standard Flour	0.2682*	-0.0596	-0.0641	-0.1156	-0.0356	0.0176	-0.0109	-0.1672*	0.2530*	
	(0.0408)	(0.0526)	(0.0218)	(0.0423)	(0.0316)	(0.0296)	(0.0162)	(0.0183)	(0.0184)	
Strong Flour	-0.4946*	0.0385	0.1634*	0.0069	0.1500*	0.1411*	-0.0053	-0.0425	0.0478	0.4997*
	(0.0684)	(0.0827)	(0.0371)	(0.0647)	(0.0444)	(0.0441)	(0.0243)	(0.0344)	(0.0406)	(0.1293)

Note: Concavity was imposed in 1990.
Asymptotic standard errors are in parentheses, and an asterisk (*) indicates significance at the 0.05 level.

Table 2. Estimated Allen Elasticities of Substitution at the Sample Mean, 1967-93

Input Factor	Factor Price of Domestic Soft	U.S. Soft	U.S. Semi-Hard	U.S. Hard	Canadian Hard	Australian Soft	Labor
Domestic Soft	-66.6360 *						
	(7.0679)						
U.S. Soft	25.8887 *	-16.2344 *			**(Symmetry)**		
	(1.5137)	(2.1713)					
U.S. Semi-Hard	19.9609 *	10.1076 *	-66.6312 *				
	(7.0607)	(2.6804)	(18.8364)				
U.S. Hard	-6.3465	-3.9595	16.2072	-33.4398 *			
	(6.7511)	(3.4333)	(12.1829)	(13.2818)			
Canadian Hard	-3.0061	-5.0338	18.0872	26.1360 *	-40.4927 *		
	(5.1697)	(2.7107)	(10.2476)	(11.6942)	(12.0706)		
Australian Soft	7.4161	5.6409 *	-15.5779 *	11.6039 *	4.3825	-25.3304 *	
	(4.2655)	(2.61400	(7.5089)	(5.1459)	(5.0748)	(5.3015)	
Labor	-2.5344 *	1.8125 *	2.1157	-0.6626	1.3936	4.0317 *	-7.5981 *
	(1.1831)	(0.5466)	(1.1952)	(0.8898)	(0.8507)	(0.7092)	(1.1043)

Note: Asymptotic standard errors are in parentheses, and an asterisk (*) indicates significance at the 0.05 level.

Table 3. Estimated Price Elasticities of Factor Demand at the Sample Mean, 1967-93

	Factor Price of						
Demand for	Domestic Soft	U.S. Soft	U.S. Semi-Hard	U.S. Hard	Canadian Hard	Australian Soft	Labor
Domestic Soft	-6.5913 * (0.6991)	5.1806 * (0.3029)	2.3553 * (0.8331)	-1.1121 (1.1830)	-0.4564 (0.7850)	0.9483 (0.5455)	-0.3245 * (0.1515)
U.S. Soft	2.5608 * (0.1497)	-3.2487 * (0.4345)	1.1927 * (0.3163)	-0.6938 (0.6016)	-0.7643 * (0.4116)	0.7213 * (0.3343)	0.2320 * (0.0700)
U.S. Semi-Hard	1.9744 * (0.6984)	2.0226 * (0.5364)	-7.8622 * (2.2226)	2.8400 (2.1348)	2.7463 (1.5560)	-1.9921 * (0.9602)	0.2709 (0.1530)
U.S. Hard	-0.6278 (0.6678)	-0.7923 (0.6870)	1.9124 (1.4375)	-5.8598 * (2.3274)	3.9684 * (1.7756)	1.4839 * (0.6580)	-0.0848 (0.1139)
Canadian Hard	-0.2973 (0.5114)	-1.0073 * (0.5424)	2.1342 (1.2092)	4.5799 * (2.0492)	-6.1483 * (1.8328)	0.5604 (0.6490)	0.1784 (0.1089)
Australian Soft	0.7336 (0.4219)	1.1288 * (0.5231)	-1.8381 * (0.8860)	2.0334 * (0.9017)	0.6654 (0.7705)	-3.2392 * (0.6780)	0.5161 * (0.0908)
Labor	-0.2507 * (0.1170)	0.3627 * (0.1094)	0.2497 (0.1410)	-0.1161 (0.1559)	0.2116 (0.1292)	0.5156 * (0.0907)	-0.9727 * (0.1414)

Note: Asymptotic standard errors are in parentheses, and an asterisk (*) indicates significance at the 0.05 level.

Table 4. Estimated Price Elasticities of Factor Demand for the Selected Years

	Factor Price of					
Demand for	Domestic Soft	U.S. Soft	U.S. Semi-Hard	U.S. Hard	Canadian Hard	Australian Soft
			1968			
Domestic Soft	-3.6804	2.6792	1.2206	-0.5123	-0.1547	0.5600
U.S. Soft	3.2405	-3.8668	1.4189	-0.9365	-0.9804	0.8793
U.S. Semi-Hard	2.6601	2.5566	-10.0822	3.6399	3.5618	-2.6403
U.S. Hard	-0.7244	-1.0948	2.3618	-7.2366	4.9850	1.8622
Canadian Hard	-0.1983	-1.0388	2.0946	4.5182	-6.1175	0.5754
Australian Soft	0.7542	0.9791	-1.6318	1.7738	0.6047	-2.9380
			1972			
Domestic Soft	-14.1697	11.7685	5.3200	-2.8182	-1.2548	2.0741
U.S. Soft	2.4575	-3.1981	1.1793	-0.6816	-0.7411	0.7512
U.S. Semi-Hard	1.8116	1.9230	-7.4588	2.6844	2.6047	-1.8306
U.S. Hard	-0.7025	-0.8136	1.9650	-5.9918	4.0709	1.5594
Canadian Hard	-0.3392	-0.9593	2.0676	4.4145	-5.9487	0.5857
Australian Soft	0.5228	0.9067	-1.3550	1.5769	0.5462	-2.6221
			1979			
Domestic Soft	-8.8564	7.1724	3.2417	-1.6122	-0.6928	1.2438
U.S. Soft	2.1790	-2.8631	1.0449	-0.5629	-0.6299	0.6089
U.S. Semi-Hard	1.8457	1.9583	-7.4803	2.7029	2.6096	-1.9053
U.S. Hard	-0.6314	-0.7255	1.8591	-5.6852	3.8435	1.4113
Canadian Hard	-0.3182	-0.9521	2.1049	4.5072	-6.0508	0.5255
Australian Soft	0.8769	1.4130	-2.3594	2.5410	0.8068	-3.9052
			1983			
Domestic Soft	-5.6395	4.3549	1.9803	-0.8932	-0.3491	0.8125
U.S. Soft	2.7044	-3.3818	1.2385	-0.7297	-0.8029	0.7499
U.S. Semi-Hard	2.1375	2.1527	-8.4054	3.0522	2.9527	-2.1558
U.S. Hard	-0.5768	-0.7588	1.8260	-5.6328	3.8101	1.4235
Canadian Hard	-0.2589	-0.9589	2.0290	4.3762	-5.8860	0.5383
Australian Soft	0.7599	1.1293	-1.8678	2.0616	0.6787	-3.2664
			1988			
Domestic Soft	-4.9163	3.6959	1.7060	-0.7303	-0.2855	0.7308
U.S. Soft	3.4993	-4.1960	1.5785	-0.9992	-1.1026	0.9562
U.S. Semi-Hard	2.1218	2.0736	-8.2687	3.0046	2.8912	-2.0953
U.S. Hard	-0.5418	-0.7829	1.7922	-5.5286	3.7225	1.4161
Canadian Hard	-0.2677	-1.0921	2.1801	4.7060	-6.2895	0.5899
Australian Soft	0.6943	0.9595	-1.6006	1.8135	0.5975	-2.9257
			1993			
Domestic Soft	-6.8297	5.3271	2.4102	-1.1388	-0.4977	1.0567
U.S. Soft	3.5791	-4.3242	1.6016	-1.0283	-1.1609	1.0423
U.S. Semi-Hard	2.8373	2.8062	-11.1255	4.0980	3.9291	-2.8973
U.S. Hard	-0.5366	-0.7213	1.6404	-5.1749	3.4530	1.3811
Canadian Hard	-0.3487	-1.2106	2.3384	5.1337	-6.7992	0.6867
Australian Soft	0.4960	0.7282	-1.1552	1.3756	0.4601	-2.2931

Summary and Conclusions

This study applied a multiple output - multiple input translog cost function for the Japanese flour milling industry to analyze Japanese import demand for food wheat. Unlike previous studies, Japanese import demand for food wheat was separated from that for feed wheat mainly because the JFA sets up separate quotas for food wheat and feed wheat imports. Wheat is considered as an input in Japanese wheat flour production. A duality approach from production theory allows us to derive Japanese import demands for wheat differentiated by class and origin of country.

The system of cost and revenue share equations for Japanese wheat flour production was estimated using the nonlinear seemingly unrelated regression with symmetry, linear homogeneity, and concavity restrictions. The results suggest that Japanese import demand for food wheat is highly elastic, especially for high quality and high protein content wheat classes. U.S. soft wheat mainly competes with Japanese domestic soft wheat in the Japanese wheat market. U.S. hard and semi-hard wheat face strong competition from Canadian hard wheat. Australian soft wheat also competes with U.S. soft and hard wheat, but the competition is less intensive. The multiple classes and the multiple end-use characteristics of U.S. wheat enable the United States to maintain the largest market share in the Japanese wheat market.

References

Agriculture Canada. *Analysis of Strategic Mixes for Canadian Wheat Exports*. Guelph, Ontario: Agriculture Canada. 1987.

Allen, R.G.D. *Mathematical Analysis for Economists*. London: Macmillan & Co. 1938.

Alston, J.M, C.A. Carter, R. Green, and D. Pick. "Whither Armington Trade Model?" *Agr. J. Agr. Econ*. 72(1990):455-67.

Alston, J.M, C.A. Carter, and L.S. Jarvis. "Discriminatory Trade: The Case of Japanese Beef and Wheat Imports." *Can. J. Agr. Econ*. 38(1990):197-214.

Capel, R.E., and L.R. Rigaux. "Analysis of Export Demand for Canadian Wheat." *Can. J. Agr. Econ*. 22(1974):1-14.

Chalfan, J.A., R.S. Gray, and K.J. White. "Evaluating Prior Beliefs in a Demand System: The Case of Meat Demand in Canada." *Amer. J. Agr. Econ.* 73(1991):476-90.

Doi, T., S. Itoh, and M. Sawada. *Agricultural Commodity Prices and Hokkaido Agricultural Production*. Sapporo: The University of Hokkaido Press. 1995.

Gallagher, P., M. Lancaster, M. Bredahl, and T.J. Ryan. "The U.S. Wheat Economy in an International Setting: An Econometric Investigation." ESS/USDA Tech. Bull. No. 1644, U.S. Department of Agriculture. Washington, DC. March 1981.

Greenshields, B.L. *Impact of a Resale Price Increase on Japan's Wheat Imports.* Foreign Agricultural Economic Report No. 128. ERS, USDA. Washington, DC. 1977.

Henning, John C. *An Econometric Model of the World Wheat Market by Class: Evaluating Alternate Canadian Export Regimes.* Unpublished Ph.D. dissertation, University of Guelph. Guelph, Ontario. April 1986.

Honma, Masayoshi, and Earl O. Heady. *An Econometric Model for International Wheat Trade: Exports, Imports, and Trade Flows.* Report No. 124. Iowa State University, Center for Agricultural and Rural Development, Ames. February 1984.

International Wheat Council. *World Wheat Statistics*. London, various issues, 1989-94.

Japanese Food Agency. *Food Control Statistical Yearbook.* Tokyo: various issues, 1967-1994.

Japanese Food Agency. *Wheat Flour and Feed Processors*: *Current Situations*. Tokyo: various issues, 1967-1994.

Kohli, U. *Technology, Duality, and Foreign Trade: The GNP Function Approach to Modeling Imports and Exports*. Ann Arbor: The University of Michigan Press. 1991

Lee, J. H., W.W. Koo, and M. A. Krause. *Japanese Wheat Import Demand*. Fargo: Agr. Econ. Report No. 317. North Dakota State University, Department of Agricultural Economics. April 1994.

Ochsner, G.L. and G.L. Cramer. *An Econometric Analysis of the Export Market for Montana Wheat.* Bulletin No. 679. Montana Agricultural Experiment Station, Montana State University,Bozeman. 1975.

Ray, S.C. "Translog Cost Function Analysis of U.S. Agriculture, 1937-77." *Agr. J. Agr. Econ*. 64(1982):490-98.

Riley, P., S. Schwartz, and K. Ackerman. *World Feed Wheat Trade: A Market Analysis*. Washington, DC: Agr. Inf. Bul. No. 688, U.S. Department of Agriculture, Econ. Res. Serv. February 1994.

Statistics Bureau of Japan. *Japanese Statistical Yearbook*. Tokyo: various issues, 1967-94.

U.S. Department of Agriculture, Econ. Res. Serv. *"PS&D View," Commodity Database*. Washington, DC. 1994.

White, K.J. "SHAZAM Econometrics Computer Program Version 7.0." *Computational Statistics & Data Analysis*. 1993.

Wiley, D.E., Schmidt W.H., and Bramble, W.J. Studies of a Class of Covariance Structure Models." *J. Amer. Stat. Assoc.* 68(1973):317-23.

Wilson, W. W. "Demand for Wheat Classes by Pacific Rim Countries." *J. Int. Agr. Res. Econ*. 19(1994):197-209.

Zellner, A. "An Efficient Method of Estimating Seemingly Unrelated Regressions and Test for Aggregation Bias." *J. Amer. Stat. Assoc.* 57(1962):348-68.