

Quality Differences and Price Responsiveness of Wheat Class Demands

William W. Wilson and Paul Gallagher

Price responsiveness and preferences for wheat classes are measured using a Case function specification. Results indicate there have been numerous changes in market shares of wheat classes from different exporters in specific markets. In general, quality differentials are important in some international markets; in others, relative prices are more important in determining market shares.

Key words: export demand, prices, quality, wheat.

As the intensity of competition in wheat trade has increased, so has the importance of differentiation of wheat among exporting countries. There are important differences in the quality of wheat produced and exported from different countries. Consequently, differentiation has the potential to be a competitive factor in international trade. These differences vary by exporting country and result from cumulative effects of tradition in agronomic practices, breeding and variety-release programs, regulations, marketing, trading practices, and climate.

Due to these differences and the intensity of competition, institutions and policies influencing quality have increasingly come under public scrutiny in several wheat-exporting countries. In the United States, as an example, the Grain Quality Improvement Act of 1986 made a number of changes and asked for investigation into specific problem areas. In Canada variety identification and release (Carter, Loyns, and Ahmadi-Esfahani; Ulrich, Furtan, and Schmitz), 3M wheats (i.e., medi-

um strength, protein, and hardness), cleaning policies (Leibfried), and minimal premiums for higher protein have been areas of debate. In the European Community (EC) the administration of the intervention price policy was changed recently, reflecting differences in milling versus feed quality characteristics (Wilson and Hill). In Australia the Industries Assistance Commission (IAC) has questioned whether the costs imposed on the marketing system for quality control (e.g., insect and variety control) are recouped in export sales premiums, and a comprehensive scheme has been introduced in an attempt to avert continuing declines in protein levels (Wilson and Orr).

Perceived in all of these is the notion that quality has an impact on exporters' competitive behavior. Competition in which quality is variable performs much the same function as price competition (Abbott). Providing a superior (inferior) product at equal prices is simply an inverted way of decreasing (increasing) prices. It is difficult, however, to debate quality issues without concurrently recognizing price responsiveness. In some markets the same class of wheat is always imported, or classes are imported in constant proportion. In others the proportions of imported wheat classes vary substantially through time or have important underlying trends.

Variation in imported wheat class shares may be attributable to a number of factors including relative prices. A continuum likely exists re-

The authors are an associate professor of agricultural economics at North Dakota State University and an associate professor of economics at Iowa State University, respectively.

This article is published with the approval of the Director of the North Dakota Agricultural Experiment Station as Journal Article No. 1830.

The authors benefited from Jim Houck's comments on an earlier draft of this paper. Errors and omissions are the responsibility of the authors.

flecting the extent markets are price and quality conscious. At one extreme imports by a price-conscious market would be highly responsive to relative prices. At the other extreme the market could be referred to as quality conscious—one in which substitutability in response to changes in relative price levels is limited. A market may be quality conscious even if it does not import the most expensive wheat. Of particular importance is substitutability which may be limited in some markets due to the products produced or technology used.

The purpose of this article is to analyze variability in wheat class market shares and to identify price responsiveness and substitutability. Important characteristics of this market are differentiation in wheat classes across origins, a potential high degree of substitutability, and a high degree of collinearity among prices. Consequently, a system of market share equations tailored to the analysis of demand for substitutable goods within a market is used to measure price responsiveness and substitutability for different classes and types of wheat in several wheat import markets as well as the domestic U.S. market. Results indicate that the degree of price responsiveness varies substantially across markets, and important differences in underlying preferences exist within markets. In addition, shifts in preferences have been taking place, generally toward stronger wheats or soft wheats.

Sources of Differences in Wheat Quality

There are a number of important differences in wheat quality which influence end-use performance and, consequently, value. These differences are described here briefly—greater detail is available in a number of publications including Hill, Zortman, and Weidner; Wilson and Hill; Wilson and Orr; and U.S. Congress, Office of Technology Assessment.

A multitude of differences exist in the quality of wheat produced and exported from each country. Wheat can be categorized by bran color (either red or white) and habit (planted in spring or winter). These intrinsic differences normally are reflected in a country's classification system, which is part of the grades and standards used to describe quality. Hardness also is important and is highly correlated with protein level and type. Hard wheats are rela-

tively high in protein content and are valuable in bread baking, whereas soft wheats which are low in protein are used in producing unleavened products such as biscuits. Climate, soils, nutrients, and topography influence and cause wide variation in end-use characteristics, such as protein content, test weight, kernel size, and alpha amylase activity. The objectives of plant breeding programs differ to some extent across producing areas and result in different emphases on quality and agronomic characteristics. In addition, there are important differences across countries in controls over variety release. The United States has minimal control over variety release, whereas Canada, Australia, and France have strict controls over the release of varieties. France and Australia also require variety identification (and segregation) at the point of first delivery into the marketing system. In the United States classes are used in the marketing system to demark intrinsic differences.

Besides the intrinsic differences described above, there are numerous other institutions and policies which influence quality across exporting countries. Each country except France has a set of official standards used to categorize wheat by factor limits (e.g., damage, shrunken, and broken kernels).¹ Generally these are purely descriptive and use the least factor approach. Factors included in the standards and limits vary across countries (U.S. Congress, Office of Technology Assessment). Countries also differ in regulations regarding cleanliness (or, as referred to in Australia, hygiene). Both Canada and Australia have strict regulations requiring expenditures within the system to deliver uniform and clean wheat. In the United States and France these activities are largely in response to market incentives. The important point is that there are many dimensions of quality that vary in a number of respects across countries. Quality also is regulated differently within each marketing system. In general, due to the fact that these institutions are very entrenched, quality within a class or grade does not vary through time.

Wheat is used for producing many different products, ranging from animal feed to pasta to

¹ "Official" standards exist in the EC for intervention purposes only. For trading purposes the specifications which are used are contract specific and are not "official." See Wilson and Hill for further discussion.

cookies, biscuits, and breads. Consumption of these products varies around the world depending on many factors including tradition, tastes, and preferences. Different wheat classes are used to produce each of these depending on technical requirements and relative prices. For some end products wheat classes are highly substitutable. In others substitution is very limited due to technical differences. As the composition of countries which import wheat changes, so may the demand for certain characteristics. Developing countries have been responsible for an increasingly larger proportion of total consumption (Woodhams). This is combined with a relative reduction (i.e., relative to total imports) in imports by traditional markets (i.e., EC, Japan). Other factors, which may induce changes in preferences for imported wheats, include changes in products consumed and milling and baking technology, each of which may influence the technical requirements of imported wheat.

Theoretical and Empirical Model

Since the early 1970s the variability of relative prices of different wheat classes has increased (Wilson). Market shares for individual wheat classes respond in part to this variability depending on their substitutability. As indicated above, this substitutability is expected to vary across importing markets, and preferences may change through time. Previous studies addressed substitutability in the wheat market (Capel and Rigaux; Blandford). These applications, specified as single equations, typically treat a good (wheat) from one origin versus an aggregate of the same commodity from all other destinations. However, single-equation specifications ignore important cross-equation relationships among parameters. The specification used in this study is that developed by Case for analysis of demand for differentiated goods within a market. The underlying theory results in a system of market share equations which are specified in a precise functional form with important relationships among the parameters. Information regarding preferences can be derived from these parameters. Consequently, the Case function provides an indirect means to measure relative preferences. The methodology is outlined here briefly. Readers should refer to Case; Sowter, Gator,

and Granger; and to Houck and Ryan for more detail.²

The underlying assumptions of this demand model are that (a) products are close but not perfect substitutes, so that individual competitors sell at different prices, and (b) the probability that an individual buys from a particular supplier is related to the relative prices charged by that supplier and competing suppliers according to the logistic function. Using these assumptions, a system of market share demand equations can be derived with parameters that indicate individuals' preferences towards products and one parameter that indicates the price responsiveness of market shares. Market shares are related to relative prices and preferences. In a simple three-good market the shares for goods 1, 2, and 3 are

$$S_1 = \left[1 + \left(\beta_{12} \frac{P_1}{P_2} \right)^\alpha + \left(\beta_{13} \frac{P_1}{P_3} \right)^\alpha \right]^{-1}$$

$$S_2 = \left[\left(\beta_{21} \frac{P_2}{P_1} \right)^\alpha + 1 + \left(\beta_{23} \frac{P_2}{P_3} \right)^\alpha \right]^{-1}$$

$$S_3 = \left[\left(\beta_{31} \frac{P_3}{P_1} \right)^\alpha + \left(\beta_{32} \frac{P_3}{P_2} \right)^\alpha + 1 \right]^{-1},$$

where $S_1 + S_2 + S_3 = 1$. S_i represents market share and P_i are prices ($i = 1, 2, 3$). The β_{ij} s and α are parameters to be estimated. The functional form is such that as the price of good 1 (P_1) decreases relative to P_2 and P_3 , S_1 approaches one nonlinearly.³

The parameter α indicates the percentage change in relative market shares that occurs when the corresponding relative prices change by 1%. Thus, α is the elasticity of substitution as shown by Houck and Ryan and can be interpreted directly as a summary measure of price responsiveness in the market. Own- and cross-price elasticities in the multiproduct case were derived by Houck and Ryan (p. 6). These

² Houck and Ryan developed linear estimating equations from the Case model which were applied to the edible oils market.

³ These nonlinear market share functions imply the following log-linear relationships between relative market shares and relative prices:

$$\ln \left(\frac{S_2}{S_1} \right) = \alpha \ln \beta_{12} + \alpha \ln \left(\frac{P_1}{P_2} \right)$$

$$\ln \left(\frac{S_3}{S_1} \right) = \alpha \ln \beta_{13} + \alpha \ln \left(\frac{P_1}{P_3} \right).$$

are $N_{ii} = -\alpha(1 - S_i)$ and $N_{ij} = \alpha(S_j)$, respectively.

There are important interrelationships among the β_{ij} s in the equation system. In general these are

$$\beta_{ij} = 1/\beta_{ji} \quad \text{for } i \text{ or } j = 1,$$

and

$$\beta_{ij} = \beta_{1j}/\beta_{1i} \quad \text{for } i \neq 1, j \neq 1.$$

Thus, in a three-good market $\beta_{12} = 1/\beta_{21}$, $\beta_{13} = 1/\beta_{31}$, $\beta_{23} = \beta_{13}/\beta_{12}$, and $\beta_{32} = \beta_{12}/\beta_{13}$. Combining the latter two results in $\beta_{23} = 1/\beta_{32}$. These restrictions are imposed among and between the parameters in the equation system, which assures that market shares sum to unity and that the number of parameters to be estimated is reduced.

The β_{ij} s provide measures of relative preferences between goods i and j . Formally, β_{ij} is the price ratio that must exist between goods i and j for market shares to be equal. If all the β_{ij} s are equal to or close to unity, the goods are undifferentiated. If, in this case, all prices are equal ($P_2/P_1 = P_3/P_1 = 1$), the sellers would have equal market shares. The extent that the β_{ij} s deviate from unity is an indication of the extent that preferences may vary in a particular market.⁴ To illustrate, if $\beta_{12} = 1.10$, then in order to have equal market shares between all goods in the system, the price ratio P_2/P_1 must be 1.10. To meet this condition all other price ratios also must be equal to their respective β_{ij} . In general the extent the β_{ij} deviates from unity is a measure of the implied relative preference. The values of β_{ij} can be interpreted as economic measures of relative preferences, both across combinations of goods of different qualities and through time. For example, the extent that β_{13} exceeds β_{12} is an indication of the preference for good 3 relative to good 1, as compared to the preference of good 2 relative to good 1. If the coefficients differ, then the preferences differ.

The basic model assumes that the parameters and therefore the implied relative preferences are constant through time. To allow for

systematic shifts in implied preferences through time, a trend variable (T) was introduced into the system. In order to maintain consistency in the relationship among parameters, this variable was introduced in a highly specific form:

$$\beta_{ij} = \beta_{ij}^0 T^{\delta_{ij}} \quad j = 2, 3.$$

If the trend variable is indexed so that $T = 1$ at the beginning of the sample period, then β_{ij}^0 indicates the value of the preference parameter at the beginning of the estimation period and δ_{ij} indicates the annual shift in the preference parameter. Note that the market share for good 1 moves inversely with a given β_{1j} , so a positive value for δ_{1j} indicates that good j gains market share relative to good 1.

In general, the specification yields a system of n equations, where n is the number of products within a market, and restrictions are imposed within and between equations on both β_{ij} and α . Adding error terms e_i to the equations results in a system of n equations to be estimated. An example of the system of equations estimated in the three-good case ($n = 3$) follows:

$$S_1 = \left[1 + \left(\beta_{12} \frac{P_1}{P_2} \right)^\alpha + \left(\beta_{13} \frac{P_1}{P_3} \right)^\alpha \right]^{-1} + e_1$$

$$S_2 = \left[\left(\beta_{21} \frac{P_2}{P_1} \right)^\alpha + 1 + \left(\beta_{23} \frac{P_2}{P_3} \right)^\alpha \right]^{-1} + e_2$$

$$S_3 = \left[\left(\beta_{31} \frac{P_3}{P_1} \right)^\alpha + \left(\beta_{32} \frac{P_3}{P_2} \right)^\alpha + 1 \right]^{-1} + e_3.$$

An unrestricted specification of the Case function allows for changes in preference parameters β_{ij} through time. These are incorporated in the relationship among the parameters in the form of the following restrictions:

$$\beta_{12} = \beta_{12}^0 \cdot T^{\delta_{12}},$$

$$\beta_{13} = \beta_{13}^0 \cdot T^{\delta_{13}}, \text{ and}$$

$$\beta_{21} = 1/\beta_{12}, \beta_{31} = 1/\beta_{13}, \beta_{23} = \beta_{13}/\beta_{12},$$

where $T = 1, 2, \dots, n$.

The system of market share equations is nonlinear in parameters and yields direct estimates of the β_{ij} s. This system of equations forms a cross section of time series with cross-equation relationships among the parameters and among the error terms. Thus, the nonlinear market share functions were estimated using Iterative Nonlinear Seemingly Unrelated Regression (ITSUR) with one redundant equation dropped

⁴ Other measures of product differentiation conventionally used are the Hufbauer index, hedonic price functions, and advertising intensity. The advantage of the Case function is that it simultaneously captures price and preference (demand) effects, whereas traditional measures do not.

from each system.⁵ The restrictions were placed on values of parameters across equations to maintain consistency with the Case functional form.

Focus of Study and Data Sources

The system of market share equations was estimated in this study to examine the behavior of wheat class market shares in specific markets. The focus of this study is on shares and, consequently, complications arising from government intervention in domestic markets are avoided. Even if domestic policies influence the "total" quantity of import demand, market shares of classes are impacted to varying degrees by relative wheat price and qualities in the international market.⁶ Analyses of individual regions (markets) are of interest for a number of reasons. First, relatively homogeneous regions with respect to stages of economic development and consumption patterns can be defined. Second, simultaneity problems attributable to supply-side phenomena which potentially would be apparent in more aggregate analyses are avoided. The implicit assumption here is that prices are assumed exogenous and importing countries make choices based on these exogenously determined relative prices.

The system of share equations was estimated for four separate markets. Two are the developing regions of Asia (excluding Japan) and Latin America. These regions provide an interesting contrast. In Asia a multitude of wheat classes are imported, and no one individual class is dominant. In Latin America there are also a multitude of classes imported, but United States Hard Red Winter (HRW) clearly dominates. Countries included in these individual regions are identical to the groupings in the *International Financial Statistics 1986 Yearbook*. The other two markets are the de-

veloped markets of Japan and the domestic United States market.

Time-series data were used for the 24-year period from July/June 1961/62 through June/July 1984/85. The major wheat classes traded in the world market and incorporated in this study include Argentina (ARG), Australia (ASW), Canadian Western Red Spring (CWRS), European Community (EC), and U.S. Wheats—Hard Red Winter (HRW), Hard Red Spring (HRS), Soft Red Winter (SRW), White (WHI), and Durum (DUR). Wheat imports by class were obtained from two sources. Import data for U.S. wheat classes were obtained from various issues of *Grain Market News (GMN)* published by the Agricultural Marketing Service, U.S. Department of Agriculture (USDA). Annual summary reports by U.S. crop year of inspections for export by class and country of destination were used as sources of import figures. Data for wheat and flour imports from Argentina, Australia, the EC, and Canada were obtained from various issues of the International Wheat Council publication *World Wheat Statistics (WWS)*. These import figures were not broken down by class, so all imports from a country were assumed to be of the dominant class.⁷ Durum imports, however, could be identified and consequently were separated from exporter country totals. Wheat class consumption figures for the United States were obtained from *Wheat Situation (WS)* publications by the Economic Research Service, USDA.

Average market shares for each class in the markets included in this study are shown in table 1. Three classes of wheat have about equal importance in Asia: HRW, ASW, and CWRS with 21%, 24%, and 23% market share, respectively. On the other hand, Latin America is clearly dominated by HRW with 45% of the market, followed by ARG with 20%. The Japanese market is dominated by CWRS with 29% followed by HRW, WHI, ASW, and HRS. The U.S. domestic market is dominated by HRW, which accounts for 45% of the market.

Various issues of *WWS* were the sources of

⁵ Alternatively, the relative share equations in footnote 3 are linear in parameters and could be estimated using Seemingly Unrelated Regression (SUR). However, this approach yields only an indirect estimator of the β_j s.

⁶ The distinction here is between factors influencing total market imports versus market shares of imports of specific classes. The former are impacted by a multitude of institutional, public, and economic relationships which in general requires the joint analysis of domestic demand and supply and the residual, import demand. The analysis of market shares allows specific focus on relative prices and qualities of imported wheat.

⁷ Each class of U.S. exports is important and was treated separately. Durum wheat also was deducted from imports of Canadian wheat. For Australia, Argentina, and the EC, class-specific exports are not available for individual importing countries. However, in each of these one class is dominant (normally exceeding 90% of total exports) and consequently the aggregate was used. See Hill, Zortman, and Weidner; Wilson and Hill; and Wilson and Orr for discussion on this point.

Table 1. Average Market Share by Class, Country, and Region, 1961/62-1984/85

Country/Region	United States					ARG	ASW	CWRS	EC
	HRS	HRW	SRW	WHI	DUR				
	----- % -----								
Asia	6	21	9	16	—	—	24	23	—
Latin America	12	45	4	1	2	20	—	13	3
Japan	10	24	—	20	—	—	17	29	—
United States	20	45	21	8	5	—	—	—	—

Key: HRS = Hard Red Spring
 HRW = Hard Red Winter
 SRW = Soft Red Winter
 WHI = White
 DUR = Durum

ARG = Argentina
 ASW = Australia
 CWRS = Canadian Western Red Spring
 EC = European Community

wheat class price data with the exception of U.S. domestic prices which were obtained from selected issues of *WS*. All international prices are international trade year averages. In each country and region FOB prices corresponding to traditional shipping patterns were used with the exception of Japan in which C & F prices were used. In general, FOB prices are more comprehensively available than C & F prices. So long as changes in relative freight costs are minimal, the use of FOB prices should not seriously affect results in the Case function since relative prices are used. Prices used in the analysis of United States consumption were those from the dominant market for each particular class.

Results

Parameter estimates from the nonlinear market share models are presented in table 2. In general, the wheat class with the largest market share in each region (market) is identified as the base class (class 1). Classes included in the model for each market varied according to purchasing patterns in each region. These are shown in table 1 along with average shares for each. All systems converged in a reasonable number of iterations, and to assure global minimums were reached, they were reestimated using different starting values. A weighted R^2 for the system was derived for each market. These were .45, .52, .81, and .34 for Asia, Latin America, Japan, and the United States, respectively.⁸ The statistical results were satis-

factory with all of the price response parameters and most of the β_i^0 s, and δ_i^0 s being significant.

The t -values for the estimates of the price response parameters (or elasticities of substitution) are relatively high for all markets; however, the estimated values vary substantially across markets and reflect the sensitivity of market shares to changes in relative prices. Price response is much greater in Asia than in other markets. The higher degree of price responsiveness in Asia suggests a higher degree of substitutability among wheat classes in this market. The other markets exhibiting relatively low price responsiveness experience less substitutability among imported wheat classes, implying greater rigidity in preferences, and as a result could be referred to as being relatively more quality conscious. In terms of ranking, Asia is the most price conscious followed in order by the United States, Latin America, and Japan. The fact that one market is more price responsive than the others can be explained by two phenomena: (a) the technology used and products produced in Japan, for example, versus Asia allow for only limited substitutability among wheats of different types—in general, Japan has larger mills and greater extraction rates; (b) end users in Japan (i.e., millers and bakers) are insulated from international prices, but yet they request quality specifications from the Japanese Food Agency (JFA). Thus, one would expect less price response and more rigid preferences in Japan compared to the other markets. Market share price elasticities can be calculated from

⁸ The weighted R^2 for the system was defined as: $R^2 = (1 - SS_m/SS_T)$. SS_m is the weighted sum of squares for the complete system presented in table 2. SS_T is defined as the sum of squares for the

system assuming only a constant equal to the mean is included in the model. To be consistent, this was derived using the same S matrix as in the previous stage and estimated using ITSUR.

Table 2. Wheat Class Market Shares: Nonlinear Estimates of Case Function Parameters by Market, 1961/62-1984/85^a

Region	Price Response α	β_{12}^0	β_{13}^0	β_{14}^0	β_{15}^0	β_{16}^0	β_{17}^0	β_{18}^0	δ_{12}^0	δ_{13}^0	δ_{14}^0	δ_{15}^0	δ_{16}^0	δ_{17}^0	δ_{18}^0
Asia	5.53* (6.00)	0.907* (20.82)	0.293* (2.13)	1.134* (19.9)	0.68* (9.27)	1.023* (16.59)			0.0093 (0.48)	0.369* (2.36)	-0.061* (2.50)	0.098* (2.90)	0.060* (2.33)		
Latin America	0.874* (3.98)	0.103 (1.49)	0.338 (1.08)	1.909* (2.18)	0.105 (1.32)	0.183 (1.69)	0.183 (1.65)	0.00256 (0.63)	-0.305* (1.80)	-0.438* (2.03)	-0.681* (2.69)	-0.227 (1.07)	0.115 (0.73)	0.182 (1.16)	0.899* (2.96)
Japan	0.592* (2.19)	0.387 (1.01)	2.392* (2.06)	0.0098 (0.46)	7.06 (1.08)				0.296 (0.83)	-0.178 (1.34)	1.449* (2.18)	-0.491* (1.80)			
United States	1.57* (6.35)	0.648* (12.02)	0.327* (5.21)	0.785* (10.99)	0.270* (3.74)				-0.037* (1.82)	0.018 (0.51)	-0.072* (2.44)	0.036 (0.58)			

^a Asymptotic *t*-ratios are in parentheses.

* Indicates significance at 10% level.

Key: Asia 1 = ASW, 2 = HRW, 3 = SRW, 4 = HRW, 5 = HRS, 6 = CWRS

Latin America 1 = HRW, 2 = EC, 3 = WHI, 4 = ARG, 5 = SRW, 6 = HRS, 7 = CWRS, 8 = DUR

Japan 1 = WHI, 2 = ASW, 3 = HRW, 4 = HRS, 5 = CWRS

United States 1 = HRW, 2 = SRW, 3 = WHI, 4 = HRS, 5 = DUR

values of the α s (from table 2) and market shares (from table 1). The elasticities confirm the price responsiveness parameter, α , and allow traditional economic interpretation. These price elasticities indicate the responsiveness of market share to changes in prices, assuming all else constant. In Asia all own-price elasticities (in absolute value) exceed 3.9, while those in the other markets are considerably smaller.

The intercept (β_{ij}^0) and trend coefficients (δ_{ij}^0) in table 2 indicate levels and changes in the preference parameters. The intercept coefficient, β_{ij}^0 , indicates the preference parameter values at the beginning of the estimation period. These coefficients are significantly different from zero in all but a few cases. Positive trend coefficients indicate a systematic change in β_{ij} (the market share gain of class *j* relative to class 1) and suggest that secular changes in preferences are important for some classes in some markets.⁹ Significant trend variables indicate there are underlying shifts in market shares. These trends are net of price effects and are interpreted as nonneutral shifts in import shares. These shifts are attributable to factors such as composition of importers, products consumed, and processing technology, but the individual effects cannot be segregated. Trend coefficients that are not significant indicate no shifts between those class pairs. The results indicate that shifts in shares, holding price effects constant, are occurring in each of the markets. To illustrate the magnitude of these shifts, the parameters (β_{ij} s) were calculated for different points in time using the estimated coefficients.

The parameters with respect to the base class (also the dominant class) in each market are shown in table 3 for the beginning and end of the estimation period and, as discussed above, could be interpreted as relative preference. Deviations of individual β_{ij} s from unity and their dispersion within a given market are indicators of relative preferences.

In general, the β_{ij} s reflect preferences between pairs of wheat classes. The precise interpretation of the β_{ij} is the value of the price ratio that must exist between classes to achieve equal market shares. If the parameter value is greater than one, then there is a stronger pref-

⁹ The preference parameter relative to the base class (β_{1j}) is expressed as the product of the intercept (β_{1j}^0) and trend multiplier ($T^{t\delta_{1j}^0}$), which identifies the competing classes' preference gains relative to the base class.

Table 3. Preference Parameter Estimates for 1961/62 and 1984/85

Region (Market)	Year	Base Class ^a	β_{12}	β_{13}	β_{14}	β_{15}	β_{16}	β_{17}	β_{18}
Asia		ASW	WHI	SRW	HRW	HRS	CWRS		
	1961/62		0.91	0.30	1.13	0.69	1.02		
	1984/85		0.93	0.95	0.94	0.94	1.24		
Latin America		HRW	EC	WHI	ARG	SRW	HRS	CWRS	DUR
	1961/62		0.10	0.03	1.93	0.10	0.18	0.18	0.003
	1984/85		0.04	0.01	0.22	0.05	0.26	0.33	0.04
Japan		WHI	ASW	HRW	HRS	CWRS			
	1961/62		0.39	2.41	0.01	7.14			
	1984/85		1.00	1.35	1.04	1.44			
United States		HRW	SRW	WHI	HRS	DUR			
	1961/62		0.65	0.33	0.78	0.27			
	1984/85		0.50	0.26	0.53	0.22			

^a For each region (market) the base class is given and preference parameters are shown with respect to each of the other classes.
 Key: ASW = Australia CWRS = Canadian Western Red Spring
 WHI = White EC = European Community
 SRW = Soft Red Winter ARG = Argentina
 HRW = Hard Red Winter DUR = Durum
 HRS = Hard Red Spring

erence for the j th class. For example, the value in the Japan market of β_{15} is 1.44 in 1984/85. With five classes in the market, equal market shares for each class would be 20%. The value 1.44 indicates that the fifth class (CWRS) would have to sell at a 44% premium over the first class (WHI) in order for each of the classes to have a 20% (equal) market share. The fact that β_{15} exceeds one indicates the extent of preference for CWRS relative to WHI, as reflected in the premium the former could command. Care should be taken in interpretation of extreme values of β_{ij} s. These are a result of little price response and/or abnormally large or small shares for either class. Even over the normal range of consumption patterns, shares in these markets differ substantially from equal market shares. Consequently, in these cases there are strong or inveterate preferences for or against one of the classes, and substantial changes in relative prices would be necessary in order to induce a shift in shares.

There is an important consistency between the price response parameters and the value of the β_{ij} s. As an example, in Asia there is a high degree of price responsiveness as indicated by the value of α of 5.53 in table 2. In addition, the relation shown in table 3 between β_{12} , β_{13} , β_{14} , and β_{15} in 1984 values suggests that there is little difference in preferences among these (i.e., $j = 2-5$). However, β_{16} indicates substantial relative preference of CWRS

to ASW. In the case of Japan α indicates less price response and correspondingly strong preferences. This is consistent with the values of the β_{ij} s when compared across the j s. In particular, there is little difference in the preference between WHI and ASW ($j = 1$, and 2), and greater between WHI (and ASW) versus HRW and CWRS. The point is that the values of the price response parameters are consistent with those of the preference parameter. However, comparisons must be made across the β_{ij} s for $j = 2, \dots, n$. If they are similar in value (e.g., Asia), there is little difference in preference; therefore, one would expect greater price response. In addition, if they are close to one, there is little preference difference with respect to product 1.

Besides being informative in and of themselves, β_{ij} s can be compared through time and across class pairs. Changes in preference parameters between the early sixties and the mid-eighties correspond to nonzero trend coefficients (δ_{ij}^0). In Asia HRW has been losing preference relative to ASW, but shifts are not occurring between the two white wheats, ASW and WHI. All of the other classes, SRW, HRS, and CWRS, are gaining relative to ASW in Asia. In Latin America there has been a radical shift in the preference for ARG relative to HRW, favoring the latter. In Japan there are shifts away from the earlier preferred classes, HRW and CWRS, towards HRS and ASW.

Table 4. Complete Preference Parameter Estimates for 1984/85

Asia						
	ASW	WHI	SRW	HRW	HRS	CWRS
ASW	—	0.93	0.95	0.94	0.94	1.24
WHI	1.07	—	1.07	1.01	1.01	1.32
SRW	1.05	0.98	—	0.98	0.99	1.30
HRW	1.07	1.00	1.02	—	1.01	1.32
HRS	1.06	0.99	1.01	0.99	—	1.31
CWRS	0.81	0.76	0.77	0.76	0.76	—

Latin America								
	HRW	EC	WHI	ARG	SRW	HRS	CWRS	DUR
HRW	—	0.04	0.01	0.22	0.05	0.26	0.33	0.04
EC	25.65	—	0.22	5.62	1.31	6.77	8.41	1.14
WHI	1.19	4.64	—	26.06	6.07	31.40	38.99	5.31
ARG	4.57	0.18	0.04	—	0.23	1.20	1.50	0.20
SRW	19.60	0.76	0.16	4.29	—	5.17	6.42	0.87
ARS	3.79	0.15	0.03	0.83	0.19	—	1.24	0.17
CWRS	3.05	0.12	0.03	0.67	0.16	0.81	—	0.14
DUR	22.43	0.87	0.19	4.91	1.14	5.92	7.34	—

Japan					
	WHI	ASW	HRW	HRS	CWRS
WHI	—	1.00	1.35	1.04	1.44
ASW	1.00	—	1.34	1.04	1.44
HRW	0.74	0.75	—	0.77	1.07
HRS	0.96	0.97	1.29	—	1.39
CWRS	0.69	0.70	0.93	—	0.72

United States					
	HRW	SRW	WHI	HRS	DUR
HRW	—	0.50	0.26	0.53	0.22
SRW	2.00	—	0.52	1.05	0.44
WHI	3.88	1.94	—	2.04	0.85
HRS	1.90	0.95	0.49	—	0.41
DUR	4.58	2.29	1.19	—	2.41

Key: ASW = Australia
 WHI = White
 SRW = Soft Red Winter
 HRW = Hard Red Winter
 HRS = Hard Red Spring

CWRS = Canadian Western Red Spring
 EC = European Community
 ARG = Argentina
 DUR = Durum

HRW has maintained dominance in the U.S. market. However, relative preferences have shifted slightly away from SRW and HRS, and slightly towards WHI and DUR.

Interesting comparisons also can be made across class pairs at a particular time. The complete matrix of preference parameters for other pairs of classes was derived using the relationship between β_{ij} s described above. These are shown in table 4 for 1984/85. The value of β_{12} in Japan is one, revealing that

preferences are the same for WHI and ASW. Neither class is preferred over the other to the extent a premium could be commanded. This phenomenon also occurs in Asia among the imported U.S. classes. The 12 β_{ij} s involved including, for example, β_{23} , β_{34} , and β_{53} , range from .98 to 1.02 and indicate very similar preferences among all four U.S. classes.

There is a strong preference in the Latin American market for the dominant class, HRW. This is indicated by all of the β_{1j} s being

substantially less than one in 1984/85, which implies that all the β_{1i} s are substantially greater than one. This even holds true for wheat from Argentina. The second most preferred class is CWRS with a value for β_{17} of .33, the largest in that row. Of particular interest in comparing β_{ij} s across class pairs is where similar types are involved. For example, β_{15} and β_{16} in Asia are .94 and 1.24, respectively, implying the value of β_{56} is 1.31 and indicating the extent that CWRS is preferred relative to HRS. Similarly, there is a minimal preference for HRS relative to HRW (β_{45}) but a significant and growing preference for CWRS relative to HRW (β_{46}). In Japan the results indicate a preference (albeit declining) for CWRS relative to HRS (β_{45}) and that HRS is growing in preference relative to HRW (β_{34}).

Conclusions

This study examined the effects of relative prices on shifts of imported wheat class market shares. In general, the results indicate that quality differentials and prices both are important competitive factors in international markets. Every market to a certain extent is price and quality conscious, and these results indicate the relative importance of these competitive factors. Asia is by far the most price-conscious market. This is supported both by the large price responsiveness parameter and the relatively uniform preference parameters. This is not to preclude quality from being important but indicates that compared to other markets, relative prices are more important in determining shifts in market shares. From an exporting country's perspective, the implication is that in these markets prices should be the critical strategic variable. Latin America and Japan are relatively less price responsive, implying fairly rigid class preferences. This should not be interpreted that these markets necessarily have strong preferences for "high quality" wheat, however defined, but that they have unique preferences for particular wheat qualities. Thus, these markets may be quality conscious in the sense that particular qualities are preferred, not necessarily a high-priced wheat. The implication of this from an exporting country's perspective is that in these markets changes in relative prices would be a less important (i.e., compared to Asia) strategic variable impacting shares.

The results also indicate that preference structures for individual wheat classes are shifting over time. There are strong and relatively stable preferences for HRW in the U.S. domestic market. In Asia there are growing preferences for SRW, HRS, and CWRS relative to ASW, whereas HRW is losing. In Japan HRW and CWRS are both losing preference relative to WHI, whereas ASW and HRS are gaining relative to WHI. On the other hand, the Latin American market has strong preferences for HRW relative to ARG. In many markets the preferences for U.S. wheats are distinctly different from like wheats of competitors. Some quality-conscious markets tend to prefer strong wheats, while others prefer typically cheaper wheats. In the latter case, shares for cheaper markets are very unresponsive to changes in relative prices, indicating unique preferences exist for these particular wheat qualities.

[Received February 1989; final revision received June 1990.]

References

- Abbott, L. *Quality and Competition*. New York: Columbia University Press, 1955.
- Blandford, D. "Market Share Models and the Elasticity of Demand for United States Agricultural Exports." Paper presented at International Trade Research Consortium Conference on "Elasticities in International Trade," Dearborn MI, 30 July 1987.
- Capel, R. E., and L. R. Rigaux. "Analysis of Export Demand for Canadian Wheat." *Can. J. Agr. Econ.* 22(1974):1-14.
- Carter, C. A., R. M. A. Loyns, and Z. F. Ahmadi-Esfahani. "Varietal Licensing Standards and Canadian Wheat Exports." *Can. J. Agr. Econ.* 34(1986):361-77.
- Case, J. "On the Form of Market Demand Functions." *Econometrica* 42(1974):207-10.
- Hill, L., R. Zortman, and T. Weidner. *A Comparison of Grain Production and Marketing Technologies and Grain Grading Practices in Argentina and the United States*. Unpublished report prepared for the Office of Technology Assessment. Washington DC: U.S. Congress, October 1987.
- Houck, J. P., and M. E. Ryan. *Market Share Analysis and the International Market for Fats and Oils*. Econ. Rep. 78-8, Dep. Agr. and Appl. Econ. St. Paul: University of Minnesota, 1978.
- Industries Assistance Commission. *Draft Report on the Wheat Industry*. Canberra, Australia, October 1987.
- International Monetary Fund. *International Financial Statistics*. Yearbook, periodical. Washington DC: International Monetary Fund, 1984-86.

- International Wheat Council. *World Wheat Statistics*. Annual issues, 1960-85. London.
- Leibfried, J. "Grain Handling Efficiency Study." Unpublished report of the Grain Transportation Agency, Winnipeg, 1987.
- Sowter, A. P., A. Gator, and C. Granger. "The Effect of Prices on Choice: A Theoretical and Empirical Investigation." *Appl. Econ.* 3(1971):167-81.
- Ulrich, A., W. H. Furtan, and A. Schmitz. "The Cost of a Licensing System Regulation: An Example From Canadian Prairie Agriculture." *J. Polit. Econ.* 95(1987): 160-78.
- U.S. Congress, Office of Technology Assessment. *Grain Quality in International Trade: A Comparison of Major U.S. Competitors*, OTA-F-402. Washington DC, 1989.
- U.S. Department of Agriculture, Agricultural Marketing Service. *Grain Market News*, various issues.
- U.S. Department of Agriculture, Economic Research Service. *Wheat Situation* (1960-84), various issues.
- Wilson, W. W. "Differentiation and Implicit Prices in Export Wheat Markets." *West. J. Agr. Econ.* 14(1989): 67-77.
- Wilson, W., and L. Hill. "The Grain Marketing System and Wheat Quality in France." North Dakota Res. Rep. No. 110, North Dakota State University, 1989.
- Wilson, W., and D. Orr. "The Grain Marketing System and Wheat Quality in Australia." North Dakota Res. Rep. No. 109, North Dakota State University, 1989.
- Woodhams, R. "Wheat to 1991: Adapting to Oversupply." Special Report No. 1070. London: The Economist Intelligence Unit, 1986.