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Price Responsiveness of Wheat Class Demands*

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Abstract

This paper identifies the price responsiveness and preferences for wheat classes using a "Case" Function specification. Results indicate there have been numerous changes in market shares of wheat classes from the different exporters in specific markets. In general, quality differentials are important in some international markets, whereas others are very price responsive.

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There are many different classes of wheat produced and traded in the world grain market. Differences between classes are due to either indigenous or extraneous characteristics. Color, protein level and quality, strength, and hardness are all indigenous characteristics. Extraneous characteristics include grade factors and nonmillable material or impurities. The quality of wheat which is produced and exported has the potential to be an important competitive factor in international trade. Indeed, as the intensity of competition in wheat trade has increased so has the differentiation of important quality characteristics. These differences vary by exporter country and result from the cumulative effects of tradition in agronomic practices, climate, breeding and variety release programs, regulations, and trading practices. See Wilson, Gallagher, and Reipe for a detailed description of these differences as well as Canada Grains Council (1979).

Of particular importance to exporter competition is the influence of quality on the demand for the different characteristics. In some markets the same class of wheat is always imported, or at least classes are imported in constant proportions. In others, the proportions of wheat classes imported vary substantially through time. Many factors potentially influence the demand for quality characteristics. Relative prices, income, preferences, and domestic production all potentially influence the demand for quality characteristics. Preferences are related to wheat products consumed and as incomes increase, or the mix of importers change, shifts may occur in the demand for characteristics. Income levels have an impact on the ability to pay and/or influence

preferences. The level of domestic production in importing countries may influence the quality requirements of imported wheats, i.e., increases in domestic production may shift requirements from filler wheats to blending wheats. Some markets are highly price conscious, others may be more quality conscious. The latter implies limited substitutability in response to changes in relative price levels.

The purpose of this paper is to analyze variability in wheat class market shares and various factors which may influence the class of wheat purchased. A Case Function was estimated using time series data for selected regions, countries, and the world.

Empirical Methodology

Most previous studies on wheat import demand have note addressed issues related to the heterogeneous nature of wheat, wheat markets, or quality preferences. As such, the focus of most demand studies has been aggregate policy and, therefore, aggregate demand functions were specified. In this study demand behavior is analyzed for individual classes (or types) of wheat and consequently an alternative specification must be used.

The Case Function

Case proposed a functional form for the analysis of demands for differentiated products which is consistent with underlying consumer behavior. However, this functional form has had limited use in empirical analysis. When applied to demands for highly substitutable but differentiated goods, this methodology provides very rich results regarding price responsiveness and preferences. The Case Function is

used in this study to explain variability in imported wheat class market shares and to derive measures of price responsiveness and preferences for different classes and types of wheat. Theoretical foundations of the function are attributable to Case, and Houck and Ryan subsequently derived linear estimable functions in logarithmic form and applied them in the analysis of demands for edible oils.

The underlying assumptions of this demand model are that (1) products are close, but not perfect, substitutes, so that individual competitors can sell at different prices, and (2) 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 a logistic function. Given the products supplied in the market, a system of market share demand equations can be derived with parameters indicating individuals' preferences towards products and one parameter indicating the price responsiveness of market shares. Market shares (S_i) are assumed functionally related to relative prices and preferences. In a simple two good market the shares for goods 1 and 2 are:

$$(1) \qquad S_1 = [1 + (P_1/mP_2)^{\gamma}]^{-1}$$

$$S_2 = [1 + (mP_2/P_1)^{\gamma}]^{-1}$$

$$S_1 + S_2 = 1$$

where P_1 and P_2 are prices (i=1,2) and γ and m are parameters to be estimated. Market shares are inversely related to relative prices. As the price of one good (P_1) decreases relative to P_2, the market share of good 1 increases and asymptotically approaches 1.

The parameter γ indicates the price responsiveness of market shares and can be used to derive own and cross-price elasticities:

(2) $N_{ii} = -\gamma\ (1-S_1)$, $N_{ij} = \gamma(S_j)$

Larger values of γ indicate relatively more price response versus smaller values. The parameter m is a measure of preference, in an economic context, between the two goods and is used to derive measures of relative preference.

In a market with multiple goods the equations system can be expanded to:

(3) $S_i = [\sum_{j \neq i} C_{ij}\ (P_i/P_j)\gamma]^{-1}$

where Ci_j is the ratio of m_i and m_j, and indicates relative preferences. Restrictions apply such that $C_{ij} = 1/C_{ji}$. A system of n equations, where n is the number of goods, can be derived from (3) containing restrictions within and across equations on both C_{ij} and γ.

Other variables can be introduced into the nonlinear equation above through their effect on the C's. In this study a trend variable T was included in the model to capture impacts of changes in tastes and preferences along with changes in other highly correlated variables. In this specification the C's vary through time since $C_{ij} = K_{ij}T^{\delta ij}$ where K_{ij} is $e^{\beta ij/\gamma}$ and β_{ij} and δ_{ij} become parameters. From the estimating equation β_{ij} and δ_{ij} are the intercept and coefficient associated with trend, respectively.

In a multi-good specification C_{ij} becomes a measure of relative preferences. Literally C_{ij} reflects the preference for good i relative to good j. Formally, C_{ij} is the price ratio which must exist between goods i and j for market shares to be equal. To meet this condition all other price ratios must also be equal to their respective C_{ij}. The values of C_{1j} are used in this study as an economic measure of

preferences, both across combinations of wheats of different classes and through time.

Adding error terms e_{it}, to each equation in equation system 3 results in a system of nonlinear equations to be estimated. Coefficients of the model were estimated using Iterative Nonlinear Seemingly Unrelated Regression (ITSUR) with one redundant equation dropped from each system. Values of all other parameters were restricted within and across equations to maintain a consistent preference structure.

Data Dimensions and Sources

The Case Function was estimated to examine wheat class import demand behavior for three regional markets, two countries, and the world. The regions analyzed representing developing countries include Latin America, Asia and Africa. Countries included in these regions are identical to those included in the International Monetary Fund (IMF) groupings for "World Tables" in the International Financial Statistics 1986 Yearbook (IFS). The Japanese market was included as a mature market subject to intense international competition. The United States was included in the analysis because of the importance of the domestic market for wheat. The major wheat classes traded in the world market and considered in this study include: Argentina (Arg), Australia (ASW), Canadian Western Red Spring (CWRS), Amber Durum (CAD), European Community (EC), and U.S. Wheats Hard Red Winter (HRW), Hard Red Spring (HRS), Soft Red Winter (SRW), White (WHI), and Durum (DUR). Data sources for each of the variables and aggregations are explained in detail in Wilson, Gallagher, and Reipe.

Empirical Results

As an introduction to the data, Table 1 shows the historic, average growth rates for imported wheat classes by market. Total wheat imports have risen the fastest in Africa. Within each market the growth rates for individual classes have been highly variable. In Japan, for instance, where the growth rate for total imports has been 3.3 percent, HRS has experienced the highest growth rate by far of 24.6 percent. This figure, however, is relatively high because in early years HRS imports were nil. Other classes with higher than average growth rates over the time period were HRW and ASW. Significantly below average was the growth rate for CWRS, a class normally considered to be a major competitor to HRS. These variations in growth rates within and between markets suggest that underlying demand functions for wheats differ by class and market.

The system of equations was estimated for each market including a number of variables as shifters.[1] The shift variables included trend, per capita real income, per capita domestic production, and concessional imports. The trend variable was used to determine shifts in consumption patterns based on changes in tastes and preferences. Correlations between these variables tended to be quite high, especially those between any combination of trend, income, production and concessional sales. Thus, detection of changes in import behavior attributable to any single one of these variables was very difficult. Since inclusion of trend reflects the cumulative impacts of changes in these variables,

[1]These were estimated for simplicity using the log-linear approximation proposed by Houck and Ryan; estimated using seemingly unrelated regressions with restrictions imposed on the system.

the results presented here only include relative prices and trend. Complete equations including each exogeneous factor individually are contained and discussed in Wilson, Gallagher, and Reipe.

Results of the nonlinear estimation using only relative prices and trend are shown in Table 2. Estimated values of γ reflect the sensitivity of market shares to changes in relative prices. Price response is much greater in Asia than in the other markets. The higher degree of price responsiveness in Asia also suggests a higher degree of substitutability between wheat classes in this market. Markets exhibiting relatively low price responsiveness experience less substitutability between imported wheat classes, more rigidity in tastes and preferences, and are referred to as quality conscious. In terms of ranking, Asia is the most price conscious importing regions followed in order by the U.S., Latin America, Japan, and Africa.[2]

Significant trend variables (G_{jj} in Table 2) indicate that underlying trends are causing shifts in wheat class preferences and consequently market shares. These trends are net of price effects and are interpreted as nonprice shifts in import shares. These shifts could be attributable to variables such as income and/or tastes and preferences, but the individual effects cannot be segregated due to the high degree of collinearity. Trend coefficients which are not

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[2]Market share price elasticities can be calculated from values of the γ's and market shares using Equation 2. The elasticities merely confirm the price responsiveness parameter, γ, and provide a rigorous economic interpretation. These price elasticities indicate the responsiveness of market share to changes in prices assuming all else constant. In the world market all own price elasticities exceed unity. Similar elasticities exist in other markets, but in general the elasticities are smaller with the exception of Asia, which is characterized by quite large elasticities.

significant indicate no shifts in market shares and preferences are occurring between those class pairs.

Preference relationships involving HRW wheat in the world market are either remaining stable or shifting away from the importation of this class. Of particular interest are the shifts toward SRW and EC, both soft wheats, and toward HRS. Other shifts are not statistically significant. A few region or country specific observations can be made from the results. Shifts are occurring, however, between the base class (i=1), either ASW or WHI, and all other classes in Japan and Asia. Most notable in Asia is the shift away from ASW and toward U.S. SRW and to lesser extents toward U.S. HRS and CWRS. In Japan, there are unequal shifts away from HRW and CWRS, but toward HRS. While HRW is already the dominant class in U.S. wheat consumption, preferences are shifting towards increased HRW consumption at the expense of the second and third most important classes, SRW and HRS.

The results presented in Table 2 indicate that preference shifts through time, holding price effects constant, are occurring in many markets.[3] These shifts may be reflective of changes in income, domestic production, or tastes and preferences. In the world market shifts are toward both soft wheats, including SRW and EC, and stronger wheats such as HRS. However, in the U.S. domestic market, both SRW and HRS are decreasing relative to HRW. Patterns of shifts in preferences for imported wheat classes are different in each market as incomes increase and/or tastes and preferences change through time. With the exception

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[3]Wilson, Gallagher, and Reipe provide derivation and detailed discussion of the preference parameters, C_{ij}'s, through time and across classes.

of the U.S. and Latin America, there are nonprice shifts away from HRW, toward either the soft wheats (EC and SRW) or the stronger wheats (HRS and CWRS).

Every market to a certain extent is price and quality conscious and these results do indicate the relative importance of these competitive parameters. Asia is by far the most price conscious market. This is not to preclude quality from being important, but indicates that compared to other markets relative prices are very important determinants market shares. Latin America, Japan, and Africa (in declining order) are relatively less price responsive. This should not be interpreted that those markets have strong preferences for "high quality" wheat, however defined, but indicate unique preferences for particular wheat qualities that are very unresponsive to changes in relative prices. Thus, these markets may be quality conscious in the sense of particular qualities, rather than necessarily a high priced wheat.

Summary

There are unique underlying demands and preferences for wheats of different classes and origins. Of particular interest is that preferences for HRW and HRS are distinctly different in all markets. In addition, there is a significant difference in preferences for HRS and CWRS. Of the markets analyzed, Asia was the most price responsive, the least being Latin America. The impacts of the other variables on import shares are difficult to discern due to the high degree of multi-collinearity between them. However, the results do indicate significant nonprice shifts in underlying functions. The Case Function

specification allows for measurement and comparisons of underlying nonprice shifts in preferences occurring through time. Several shifts of particular interest include: (1) increases in SRW, HRS and CWRS in Asia; (2) increase in SRW and durum in Africa, and decreases in HRW; (3) decreases in SRW in Latin America and increases in HRW and spring wheats. In general the World market is experiencing nonprice shifts in preferences away from HRW and increases in soft wheats (SRW and EC) and in HRS.

TABLE 1. AVERAGE GROWTH RATES[1] OF WHEAT CLASS IMPORTS BY COUNTRY, REGION, AND WORLD, 1961-1962 THROUGH 1984-1985

Country/Region	United States							Canada			Total	
	HRS	HRW	SRW	WHI	DUR	ARG	ASW	CWRS	CAD	EC	Imports	Consumption
	Percent											
Africa		5.2	13.0		19.1			2.9	33.1	9.8	8.9	
Asia	9.2	-3.3	34.8	3.0		5.9	1.1	2.8		3.6	2.4	
Latin America	7.5	6.0	5.7	-0.3	17.2	-1.1		7.6		3.2	5.1	
Japan	24.6	3.6		2.8			4.3	0.20			3.3	
United States	1.4	2.4	1.9	2.1	2.6							2.1
World	8.5	3.0	8.6	3.6		4.3	3.3	2.7		6.0	4.0	

[1]Derived from a simple regression of $\log Q_i = \gamma + \beta \cdot T$ using autoregression techniques. Q_i is annual imports of class i, T is time trend, and β is the growth rate and the reported coefficient.

TABLE 2. NONLINEAR ESTIMATION OF CASE FUNCTION PARAMETERS BY MARKET FOR WHEAT CLASS MARKET SHARES, 1961/62-1984/85

Market	Price Response	Intercepts							Trend Coefficients						
	γ	β12	β13	β14	β15	β16	β17	β18	γ12	γ13	γ14	γ15	γ16	γ17	γ18
Africa	0.48*	-2.76*	0.89*	-0.24	-2.22*	-3.81*			0.44	-0.59*	-0.41*	0.18	0.78*		
	(1.94)	(-2.81)	(2.26)	(-0.76)	(-3.82)	(-3.55)			(1.22)	(-3.50)	(-3.22)	(0.82)	(2.04)		
Asia	5.55*	-0.54*	-6.77*	0.70*	-2.06*	0.12			0.05	2.04*	-0.34*	0.54*	0.33*		
	(6.07)	(-2.27)	(-3.01)	(2.50)	(-4.74)	(0.37)			(0.49)	(2.71)	(-2.58)	(3.26)	(2.36)		
Latin America	0.87*	-1.99*	-2.96*	0.57	-1.97*	-1.48*	-1.48*	-5.22*	-0.27*	-0.38*	-0.60*	-0.20	0.10	0.16	0.79*
	(3.98)	(-6.13)	(-8.13)	(1.52)	(-4.44)	(-4.19)	(-4.28)	(-9.71)	(-1.98)	(-2.40)	(-3.57)	(-1.10)	(0.73)	(1.21)	(4.17)
Japan	0.59*	-0.56	0.52*	-2.74*	1.16*				0.17	-0.11*	0.86*	-0.29*			
	(2.21)	(-1.05)	(3.43)	(-6.45)	(5.85)				(0.88)	(-1.86)	(5.71)	(-3.83)			
United States	1.23*	-0.68*	-1.76*	-0.42*	- 2.15*				-0.05*	0.03	-0.11*	0.08			
	(6.46)	(-8.23)	(-12.90)	(-3.95)	(-11.51)				(-1.67)	(0.50)	(-2.71)	(1.15)			
World	1.27*	-3.36*	- 1.41*	-1.24*	- 0.70*	-1.58*	- 2.24*	0.20	0.74*	0.11*	0.29*	0.10	0.10	0.44*	0.02
	(6.93)	(-6.30)	(-10.04)	(-6.98)	(- 3.79)	(-5.29)	(-10.16)	(1.40)	(3.90)	(1.82)	(4.01)	(1.33)	(0.84)	(5.15)	(0.31)

*Indicates significance at 10 percent level.

Key: Africa 1 = EC, 2 = SRW, 3 = HRW, 4 = CWRS, 5 = DUR, 6 = CAD
Asia 1 = ASW, 2 = WHI, 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
World 1 = HRW, 2= SRW, 3 = WHI, 4 = EC, 5 =ASW, 6 = ARG, 7 = HRS, 8 = CWRS

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