Demand Trends and Seasonality in Columbia Wheat Import Market: An Econometric Analysis

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Abstract

This study estimates the impact of seasonality on the Colombian wheat import demand from the United States, Canada and the rest-of-the-world, using an almost ideal demand system (AIDS) model. The results suggest that a general positive seasonal trend exits in the first and second quarters as Colombian wheat stocks diminish prior to harvest. In addition, the United States, in particular, has a strong advantage in both the second and third quarters in comparison to the other wheat exporting countries. Canada has negative seasonality all the three quarters, indicating less substantial seasonal effect for Canada. However, the seasonal impact in the second quarter is almost the same across the board for all wheat exporters in general. It is also found that United States' wheat is very competitive in Colombian wheat imports market and provides the most significant competition for Canada and the rest-of-the-world.

Introduction

Colombia, a South American country, with port facilities on both the Pacific Ocean and the Caribbean Sea, has become one of the United States trading partners over the past few decades. The real Gross Domestic Product (GDP) grew in 1998 with a growth of 1.6 in 1999 (USADA, 1999).[1] Per capita income in 1999 was US $2,261 and inflation rate was approximately 30 percent (Table 1). Colombia trade data shows that the US market share of Colombia's total agricultural imports has risen from 29 per cent of total import value in 1991 to 42 percent in 1995 and 45 percent in 1996 (USDA, 1998).

Main United States grain exports to Colombia consist of corn, wheat, and soybeans. Prior to 1991 the Colombian market was restricted to imports of most commodities, especially grains, as the government pressed a basic policy of food self-sufficiency. United States agricultural exports have benefited from virtual elimination of import quotas, a reduction in import tariffs, and improvements in import licensing procedures (USDA, 1998). The long-term sales opportunities are bright for the US grains, particularly wheat with Colombia placing priority on its dairy, livestock, and poultry industries. Colombia's wheat production has declined from 117,000 tons in 1992 to 25,000 in 1999, as there was a shift to more profitable crops, such as fruits, and vegetables. Figure 1.1 shows that Colombia's total imports grew from 1998 through 1999. However, since the partial elimination of trade barriers[2], other countries, Canada, Argentina, and Australia have increased their market share, thereby challenging the United States market share.

The United Stated share of Colombian total wheat import fell from 52 percent in 1966 to 35 percent in 1998, while Canadian share rose from 39 percent to 42 percent. The Colombia wheat imports in marketing years 1995-1998 are estimated at 950,000 tons. This volume is expected to consist of almost 90 percent hard wheat and approximately 10 percent soft wheat (USDA, 1996).

One of the reasons for the reduction of the United States wheat market share in Colombia might be long-term trade agreements between an importer and an exporter. These long-term trade agreements involve shipment periods of two or more seasons (Harwood & Bailey, 1990). Therefore long-term trade agreements can decrease an importer's flexibility to respond immediately to market conditions.

With Colombia placing priority on its dairy, livestock and poultry industries, together with a growing population and a downward trend in grain and oilseed production, long-term sales opportunities are bright for the U.S. grains and particularly wheat (USDA, 1996b). Canadian wheat exports to Colombia have averaged 0.44 million metric tons (MMT) over the past five years. However, Canadian share decreased to 0.25 MMT for 1999-2000, the Canadian wheat prices are higher due to high protein premiums (USDA, 2000).

The Colombia wheat market exhibits a trend that is becoming apparent in terms of wheat export competition in import markets, where the USA and Canada are major exporters of wheat. The Canadian competition on one side and the South American countries on the other, are complicating the environment in which the United States must operate to maintain steady market shares. Hence the main objective of this paper is to determine the impact of economic factors influencing Colombia's total wheat import demand. This paper will attempt to determine how seasonality impacts exporting countries differently. Also differences in own price demand elasticities as a result of seasonality will be determined. Seasonality is a pattern in markets that generally repeats itself each year, although this pattern may drift or change in amplitude over time of import demand (Jaditz, 1994).

Although the Colombian market is expected to grow, United States market share is being challenged by Canada and could face increased competition from other countries such as Argentina and Australia that are likely to receive duty preferences in the years to come as a result of the South American Trade Agreements (Hoffman, Schwartz & Chomo, 1995). The United States share of Colombian total wheat imports fell from 52 percent in 1996 to 35 percent in 1998, while the Canadian share rose from 39 percent to 42 percent. Colombian wheat imports in marketing year 1995-1998 are estimated at 950,000 tons. This volume consisted of almost 90 percent hard wheat and approximately 10 percent soft wheat (USDA, 1996b).

Production of wheat in Colombia is often during the major harvest month of July and is usually due to start in September. Hence, the bulk of the United States wheat is exported to Colombia during the second quarter of every year between June and July. This view of seasonality is at the very core of approach taken by United States Department of Agriculture towards adjustments of their data (Harwood & Bailey, 1990). The seasonality explores the question of the impact of weather, predictable and regular calendar events, transportation, domestic production, and social conventions on seasonal variations on data. There also tends to be more seasonality of demand in some shipping lines due to trade patterns or prevailing conditions in bulk commodity markets particularly for grains (USDA, 1996 a).

Model Considerations

The empirical investigation of the import demand function has been one of the most active research areas in international economics. Perhaps one of the main reasons for its popularity is its application to a wide range of important macroeconomic policy issues (Abdelhak, 1998). More specifically, trade competition is affected by the international transmission of domestic disturbances, where elasticities are crucial links between economies, the degree to which the external balance constraints.

The traditional import demand function is often specified as a log-linear function of relative price of imports and real income. Empirical researchers are generally interested in two statistical properties of their estimates of import demand elasticities. First, they are interested in the magnitude of these elasticities. A relevant question then is how close the small sample estimates are to their true value. Second, they are interested in inference, that is, hypotheses testing, about these estimates. For example, the price and income elasticities are significantly different from one (Green, 1976).

Yang and Koo (1994) specified a source differentiated AIDS model to estimate Japanese meat import demand. In this study, block separability and product aggregation are rejected at conventional levels of significance. The model with the block substitutability restriction explains more than 95 percent of data variation. The empirical results indicated that the U.S. has the largest potential for beef exports to Japan. Taiwan is in a strong position in the pork market, and Thailand and China are strong in the poultry market. The U.S. competes with Canada and Taiwan in the pork market, but the competition between Taiwan and European countries is the strongest in the market. The U.S. competes with Thailand in the poultry market, where the U.S. is the most vulnerable.

Van, De Boer, and Harkema (1993) used a first-order autoregressive scheme in order to introduce dynamics into the AIDS model. They also considered the theoretical restrictions of additivity, homogeneity, and symmetry. They used two different specifications of the covariance matrix. They estimated the models using import allocation data for the U.K. 1952-1979 of five EEC countries and tested different specifications against each other.

In the case of wheat trade, the world wheat market is one of the most widely studied commodity markets (McCalla, 1996; Alaouze, Watson, & Sturgess, 1978 ; Wilson, Koo & Cater, 1990). Despite this, it remains one of the most controversial commodity markets because of its imperfectly competitive structure, including large grain trading companies and state trading enterprises (STES), product heterogeneity, and extensive government intervention in both exporting and importing countries. Among various aspects of the market, estimation of demand including exports and import demand has received significant attention in the past few decades (Mohanty & Peterson, 1999).

Most past studies, estimating demand for wheat, have either ignored or failed to fully recognize two important factors: product differentiation of wheat and dynamics in the wheat demand function. With respect to product differentiation of wheat by source, past studies can be divided into three different groups. First, various studies such as Konandreas, Bushell and Green (1978); Gallagher et al, (1986), have assumed perfect substitutability across classes and origins. The second group of studies has allowed for imperfect substitutability either in terms of origin or end uses (Wang; Chai; and Chang; and Agriculture Canada). The importance of product differentiation of wheat, where trade is the focus has been recognized by Sumner, Alston and Gray (1994). Furthermore, both Larue (1991), and Wilson (1989) argue that wheat should be differentiated also by country of origin. Larue (1991) found that the assumption of one form of differentiation or another would be appropriate if countries specialize in one product type or the given product type is exported by only one country.

Demand Specifications

In the literature, relatively few models have been used for import demand analyses. The Armington trade model is theoretically consistent and has been widely used (Abbott & Paarlberg, 1986; Babula, 1987; Penson & Babula, 1984; Sarris, 1982). The advantage of the Armington trade model is that it differentiates goods by sources; in other words, the model allows for imperfect substitutions among goods from different origins (Armington, 1978). However, this model suffers from the restrictive assumptions of homotheticity[3] and single constant elasticity of substitution (Alston et al, 1993; Winters, 1984; Yang & Koo, 1994) and is no longer a popular model.

A traditional approach to identifying price responses in international trade is to employ the elasticity of substitution model. In this approach, logarithms of relative import ratios are regressed on the logarithms of income and relative prices. The functional form used in the specification has been widely criticized because it is not derivable from an underlying model of optimization behavior (Samarendu & Peterson, 1999).

Alternatively, Deaton and Muellbauer's (1980) AIDS model has an important feature that the expenditure levels are allowed to impact the distribution of shares. It has a flexible functional form, allowing testing of theoretical restrictions on demand equations.

The AIDS model is derived from a cost function representing a PIGLOG[4] class of preferences. These preferences, represented by either a cost or an expenditure function, define the minimum expenditure necessary to attain a specific utility level at a given price (Chalfant, 1987). The cost function $c(u, P)$ for utility u and price vector P can be defined using the PIGLOG class of preferences by

$$\log c(u, P) = (1 - u)\log\{a(p)\} + u \log\{b(P)\}. \tag{1}$$

where u lies between 0 (subsistence) and 1 (bliss) so that the positive linearly homogeneous function $a(P)$ and $b(P)$ can be regarded as the costs of subsistence and bliss, respectively (Theil, 1965). The functional

forms for log $a(P)$ and log $b(P)$ are chosen such that the first and the second order derivatives of the cost function can be set equal to those of an arbitrary cost function, thus satisfying the necessary condition for flexibility of functional form.

$$\log a(P) = \alpha_0 + \sum \alpha_k \log P_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log P_k \log P_j,$$ (2)

$$\log b(P) = \log a(P) + \beta_0 \prod_k P_k^{\beta_k}.$$ (3)

After the selection of a specific functional form, the cost function in the AIDS model can be written as

$$\log c(u, P) = \alpha_0 + \sum \alpha_k \log P_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* \log P_k \log P_j + \beta_0 \prod_k P_k^{\beta_k}.$$ (4)

The demand functions can be derived directly from the cost function equation (4) using Shepherd's lemma because a fundamental property of the cost function is that price derivatives are the quantity demanded $\partial c(u, P)/\partial P_i = q_i$. Multiplying both sides by $P_i/c(u, P)$, the left-hand side may be expressed as a budget share and the right-hand side may be expressed as a function of prices and utility. The cost function is then solved for u and the resulting term is substituted for u in the budget share equation (Theil, 1980). The budget shares as a function of P and X (total expenditure) can be represented as a single equation:

$$\frac{\partial \log c(u, P)}{\partial \log P_i} = \frac{p_i q_i}{c(u, P)} = w_i,$$ (5)

where w_i is the budget share of good i. Hence, logarithmic differentiation of equation (4) gives the budget shares as a function of prices and utility,

$$w_i = \alpha_0 + \sum_j \gamma_{ij} \log P_j + \beta_i u \beta_0 \prod_k P_k^{\beta_k},$$ (6)

where

$$\gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^* + \gamma_{ji}^*\right),$$ (7)

for a utility-maximizing consumer, total expenditure X is equal to $c(u, P)$ and this equality can be inverted to give u as a function of P and X, the indirect utility function. Solving equation (4) and (6) and eliminating u, we obtain the budget shares as a function of P and X. These are AIDS demand functions in budget share form:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \log P_j + \beta_i \log\{X/P\},$$ (8)

where w_i is the expenditure share of commodity i, P_j is the commodity price, X is the total expenditure of the selected goods, and P is overall price index, which is defined by

$$\log P = \alpha_0 + \sum_k \alpha_k \log P_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \log P_k \log P_j,$$ (9)

Homogeneity, Slutsky symmetry and Adding-up can be imposed on the parameters of the AIDS equation (6) by the following (Alston and Chalfant, 1993):
Homogeneity:

$$\sum_{i=1}^{n} \gamma_{ij} = 0.$$ (10)

Adding-up:

$$\sum_{i=1}^{n} \alpha_i = 1 \ ; \ \sum_{i=1}^{n} \gamma_{ij} = 0 \ ; \ \sum_{i=1}^{n} \beta_i = 0 \ . \tag{11}$$

Symmetry:

$$\gamma_{ij} = \gamma_{ji} . \tag{12}$$

If homogeneity, symmetry and adding up are not rejected, the estimated demand functions are homogenous of degree zero in prices and expenditure taken together (Deaton and Muellbauer, 1980). Provided equations (10), (11) and (12) hold, equation (8) represents a system of demand functions which add up to total expenditure $\sum w_i = 1$, and are homogenous of degree zero in prices and total expenditure, thus satisfying Slutsky symmetry. When there is no change in relative price and X/P, the budget shares are constants. Changes in relative prices take effect through γ_{ij}. Changes in expenditure operate through the β_i coefficients, which are summed to zero and are positive for luxuries and negative for necessities (Deaton and Muellbauer, 1980)[5].

An important feature of the AIDS model is that the expenditure levels are allowed to impact the distribution of shares. It is of flexible functional form, allowing testing of theoretical restrictions on demand equations. The AIDS model in share form for a group of n commodities can be written as

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln(X/P), \qquad i = 1, 2, \ldots, n \tag{13}$$

where w_i is budget share of source i, X is total expenditure on imported wheat and P_j is the price from source j in the system. α_i, γ_{ij}, and β_i are parameters. $\ln P$ is defined as:

$$\log P = \alpha_0 + \sum_k \alpha_k \ln P_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln P_k \ln P_j, \tag{14}$$

$\delta_i = 1 + \beta_i / w_i$ In practice, equation (13) is difficult to estimate because of its nonlinearity. A common alternative is to estimate a linear approximation version of the AIDS model. That is, instead of estimating the complete AIDS model in equation (13), its linear approximation is employed by replacing $\ln P$ with $\ln P^*$, where $\ln P^*$ is the Stone's index defined as:

$$\ln P = \sum_i w_i \ln P_i, \qquad i = 1, 2, \ldots, n. \tag{15}$$

therefore, (14) becomes:

$$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln\{X/P\}, \tag{16}$$

Marshallian and Hicksian measures of elasticities were computed from the estimated coefficients of the AIDS model using derivation by Chalfant[6] as follows:

$$\varepsilon_{ii} = -1 + \gamma_{ij}/w_i - \beta_i, \tag{17}$$

$$\varepsilon_{ij} = \gamma_{ij}/w_i - \beta_i(w_j/w_i), \tag{18}$$

$$\delta_{ii} = -1 + \gamma_{ii}/w_i + w_i, \tag{19}$$

$$\delta_{ij} = \gamma_{ij}/w_i + w_j, \tag{20}$$

where ε and denote Marshallian and Hicksian elasticities respectively. The expenditure elasticities can be obtained from the estimated coefficients as well:

$$. \tag{21}$$

Seasonality in a more appropriate manner would be incorporated into the model by interacting each variable in the model with seasonal dummies[7]. In terms of Colombia, the model specification can be expressed:

$$w_{usMcol} = \alpha_{us} + \gamma_{US,uscol} \ln P_{uscol} + \gamma_{US,candcol} \ln P_{candcol} + \gamma_{US,ROWcol} \ln P_{ROWcol} + \beta_{US,usMcol} \ln(X_{col}/P), \tag{22}$$

$$w_{canMcol} = \alpha_{can} + \gamma_{CAN_{uscol}} \ln P_{uscol} + \gamma_{CAN_{candcol}} \ln P_{candcol} + \gamma_{CAN_{ROWcol}} \ln P_{ROWcol} + \beta_{CAN_{canMcol}} \ln(X_{col}/P), \quad (23)$$

$$w_{ROWMcol} = \alpha_{ROW} + \gamma_{ROW_{uscol}} \ln P_{uscol} + \gamma_{ROW_{candcol}} \ln P_{candcol} + \gamma_{ROW_{ROWcol}} \ln P_{ROWcol} + \beta_{ROW_{ROWMcol}} \ln(X_{col}/P). \quad (24)$$

Where w_{usMcol} is the United States' budget share of expenditure of Colombian wheat imports, $w_{canMcol}$ is the Canadian budget share of expenditure of Colombian wheat imports, $w_{ROWMcol}$ is the rest-of-the-world budget share of expenditure of Colombian wheat imports, P_{uscol} is the price of United States imported wheat in Colombia, $P_{candcol}$ is the price of Canadian imported wheat in Colombia, P_{ROWcol} is the price of rest-of-the-world imported wheat in Colombia, X_{col} is the total Colombia's expenditure on imported wheat, and P is the price index. From equation (15) the Stone Price Index could be represented by:

$$\ln P = w_{usMcol} \ln P_{uscol} + w_{canMdcol} \ln P_{candcol} + w_{ROWMcol} \ln P_{ROWcol} \quad (25)$$

However, in the AIDS P, which is the Stone's Price Index implies the sum of lagged share minus weighted log prices. The lagged budget shares are used as weights in constructing Stone's Price Index to avoid simultaneity since the budget shares are also the dependent variables.

Data and Estimation

The wheat import demand system to be estimated is on a per capita basis and includes wheat imports from the United States and Canada. The study uses monthly data from 1980 to 1999 provided by United States Department of Agriculture, Economic Research Service (USDA, 2000). Quantity, price and price index data were obtained from the United States Department of Agriculture.

The systems of equations were estimated with Zellner's Seemingly Unrelated Regression (SUR). Both homogeneity and symmetry restrictions were imposed in the estimation process. The restrictions were not tested individually since the equations were estimated as a system. Instead, overall hypotheses regarding the restrictions were tested using an F-test. The test statistic is defined as follows:

$$\hat{g} = (R\beta - r)^{|}(R[X^{|}(\textstyle\sum^{-1} \otimes I)X]^{-1}R^{|})^{-1}(R\beta - r) \xrightarrow{d} F_{(J, TM-K)}, \text{ where } \hat{g} \text{ is the test}$$

statistic, R is a matrix of restrictions of dimensions J (number of linear restrictions) by K (number of parameters in the system), β is the unrestricted SUR estimate, r is a vector of restriction constants, X is the design matrix, is the cross equation covariance matrix, $\otimes$ is a symbol for Kronecker product, and I is an identity matrix of dimension equaling the number of observations. The elasticity was formulated by different form when Stone's Price Index was defined with lagged budget shares. Since these elasticities are functions of estimated parameters, they can be tested by hypothesis.

The starting values for the coefficients of the models were obtained through the use of Ordinary Least Squares (OLS) on each estimated expenditure share equation. Given that the N expenditure shares must sum to one in a demand system , only N-1 independent expenditure share equations can be estimated; hence one equation was dropped. The adding-up, homogeneity, and symmetry conditions were imposed, implying the following restrictions: $\sum \alpha_i = 1$, $\sum_i \gamma_{ij} = 0$, $\sum \beta_i = 0$, $\sum_j \gamma_{ij} = 0$, and $\gamma_{ij} = \gamma_{ji}$. However, because of high degree of positive serial correlation, the demand systems had to be estimated using first differences (Lafontaine & White, 1986).

LaFrance (1991) indicated that conditional least squares estimators applied to conditional demand systems are not consistent or efficient because group expenditure is not exogenous, except for some special cases. In addition, standard instrumental variable methods do not yield consistent estimates unless the conditional demands are linear in expenditures. These findings are important for empirical applications of the AIDS model because the expenditure is nonlinear with respect to quantity demanded in the AIDS framework. Hence, he suggested using Anderson's iterative instrumental variable method. Even though the estimation procedure suggested by LaFrance provides efficient estimates, it is computationally complex and difficult. The AIDS model might have lost one of its vital properties, estimation simplicity. Therefore, Edgerton

(1993) proved that an alternative stochastic specification allows budget shares to be linear in logarithm of group expenditure and that the standard instrumental variable methods give consistent estimates.

Among the assumptions of the classical linear regression model is that the residuals are mutually independent. The use of time series data may result in high correlation between the successive residuals, a situation known as serial correlation or autocorrelation. In this study, the Durbin Watson d-statistic is used to test for the presence of autocorrelation. The statistic is usually given by:

$$d = \frac{\sum\limits_{t=2}^{n}\left(u_t - u_{t-1}\right)^2}{\sum\limits_{t=1}^{n}u_t{}^2} \;. \tag{26}$$

Where u_t is the residual resulting from OLS regression. The range of d is from zero to four, d is less than two for positive autocorrelation; d is greater than two for negative autocorrelation; and d is about zero for zero autocorrelation. The program that was used in the analysis provides Durbin-Watson d-statistic among other statistical measures of an Ordinary Least Squares regression.

The Durbin-Watson Tables were used to test the hypothesis of zero autocorrelation. These tables provide du and dL as the upper and the lower bound respectively for the significance of the d statistic. The decision criteria for positive autocorrelation are: if d is less than du, reject the hypothesis of zero autocorrelation in favor of the hypothesis; and if $dL < d < du$, the test is inconclusive (Johnson, Marvin & Buse, 1987). The decision criteria for negative autocorrelation are if $d > (4 - dL)$, reject the hypothesis of zero autocorrelation in favor of the hypothesis of negative autocorrelation as the $dL < (4 - du)$, do not reject the null hypothesis and if $(4 - dL) > (4 - du)$, the test is inconclusive. For models whose Durbin Watson d-statistics showed evidence of autocorrelation, the Cochran iterative method was used as a corrective measure for first order autocorrelation.

Colombia Wheat Import Market Estimation Results

Parameter estimates for Colombian wheat imports from the United States, Canada, and the rest-of-the-world with seasonality effect are presented in Table 3 and without seasonality in Table 4. The system R-squared values for all three regressions are within a reasonable range. The results presented in Table 5 show that all the expenditure elasticity estimates are statistically different from zero at $\alpha = 0.05$ level. Including seasonal dummy variables in the AIDS model indicates the influence of seasonality on Colombian import demand for wheat. Several seasonal patterns become evident from the parameter estimates by Table 3. First, a general positive seasonal trend exits in the first and second quarters as Colombian wheat stocks diminish prior to harvest. In addition, the United States in particular, has a strong advantage in both the second and third quarters in comparison to other wheat exporting countries. Second, Canada has negative seasonality for all the three quarters indicating less substantial seasonal effect for Canada. However, the seasonal impact in the second quarter is almost the same across the board for all wheat exporters in general. Third, in the fourth quarter, all three regressions indicate negative seasonal impact, suggesting that wheat imports by Colombia in the fourth quarter are weak.

Marshallian and Hicksian wheat import demand elasticities for Colombia wheat are presented in Table 5. The signs of the Hicksian elasticities are expected to be symmetric throughout each elasticity matrix and significant. In the following discussion of estimation results, only the Marshallian demand elasticities are discussed, while the Hicksian demand elasticities are presented for reference.

The Marshallian cross-price elasticities indicate the type of relationship among exporters in the case of the United States, Canada, and the rest-of-the-world. All the own-price elasticities exhibit the correct sign and are statistically significant. A significant positive cross-price elasticity indicates a competitive relationship between the United States and Canada, while a significant negative cross-price elasticity reveals a complementary relationship between the two main wheat exporters.

The Colombia wheat import demand for the United States, Canada and the rest-of-the-world is elastic with respect to own-price. All expenditure elasticities indicate that wheat import demand is a normal good. The values of expenditure elasticities are consistent with the existing economic theory and perhaps the most interesting result is how small these elasticities are. Hence, the United States, Canada and rest-of-the-world are in a favorable exporting position in wheat because they all have positive expenditure elasticities. This implies that as Colombia's income level increases, the wheat exporting countries such as the United States and Canada will also increase their wheat exports to Colombia. The cross-price elasticities are also positive and significant reflecting a competitive relationship.

In the Colombia wheat market, export competition is between the United States and Canada. Wheat from Canada provides the greatest competition for the United States because it has positive significant cross-price elasticity for the United States. The United States provides the most significant competition for Canada and the rest-of-the-world with cross-price elasticity of 0.0317 and 0.2296 respectively.

The results of this estimation broadly coincide with previous studies where expenditure elasticities ranged from 0.981 to 1.438, and own price elasticities from 0.640 to 2.364 in Algeria, Egypt, and Jordan from previous studies such as Fritz, (1997). The Fritz studies were based on 1970 through 1993 average data in Algeria, Egypt, and Jordan respectively and also employed an RSDAAIDS model. Therefore, it appears that wheat import demand in Colombia in the past decade may, in part, be comparable to that in Algeria, Egypt, and Jordan during 1990s.

Results from this research study have some important policy implications for the United States wheat industry and policy makers. One is that import demand for United States wheat has declined through the 1990s. Consumption needs in Colombia are increasing as the gross domestic product increases (Figure 1.1). Hence, Colombia's wheat import demand is growing rapidly. Thus, there is need to assist Colombia markets achieve economic development and to generate positive political environment that may lead to the development and maintenance of a successful relationship for international trade. This is because markets with price elastic demands are more sensitive to changes in the price of imported wheat and competition. Previous studies such as Dahl and Wilson (2000) and Carter and Wilson (1997) have suggested that policy makers should encourage producers to improve the quality of wheat imports. Furthermore, quality specifications in the wheat markets play an important role in the decision to import (USDA, 1996a). United States wheat farmers may benefit from producing high quality wheat demanded in Colombia's wheat import markets.

Summary and Conclusions

The results from the AIDS models for Colombia's wheat imports provide valuable information about wheat trade and competition among exporters. First, an exporter was considered to have a favorable trading position when expenditure elasticity is elastic. Therefore, according to this criterion, wheat exported by the United States is very competitive in Colombian wheat imports market. Second, the strength of competition between exporters is measured by the magnitude of the cross-price elasticity. The United States provides the most significant competition for Canada and the rest-of-the-world.

However, there are some limitations with the scope of this study that give important implications for further research. The first limitation is the exclusion of domestic production in each import demand AIDS model. Theory suggests that domestic production affects the import decision of a particular market to import any good. Hence, further research to determine the impact of domestic wheat production would be useful to the United States. Another limitation is the use of expenditure for each import demand system. Colombia's total income may be a better explanation of expenditure used for importing goods. Finally, it would be interesting to look at the relationship between United States wheat market share and own-price import demand elasticity in the Colombian wheat import market.

End Notes

[1] Economic growth in Colombia slowed significantly in 1998 and 1999. The downturn is attributed to low oil and coffee prices, the economic slowdown in neighboring countries especially Ecuador and Venezuela, devaluation of the peso, and economic difficulties in Brazil.

[2] Prior to 1992, before the advent of trade pacts such as the Andean Trade Pacts, the Colombian government agency Institute de Mercadeo Agropecuarira (IDEMA) controlled all wheat imports. *Andean Community and Mercosur Merger*: Colombia and the Andean community are hoping to sign a merger agreement during 1999 with the Mercosur trade bloc—Argentina, Brazil, Paraguay and Uruguay that will become effective January 1, 2000. The Government of Colombia (GOC) hopes that the elimination of duties on agricultural products imported from Mercosur countries will be phased in over an extended period for 7 or 8 years (Agriculture Canada, 1997).

[3] A homothetic function is a monotonic transformation of function that is homogenous of degree 1. In other words, $f(X)$ is homothetic if and only if $f(X)$ can be written as $f(X) = g[h(X)]$ where $h(X)$ is homogenous of degree 1 and $g(X)$ is a monotonic function (Varian, 1992).

[4] PiGLOG is a special form of the price-independent, generalized(PIGL) class of preferences.

[5] Deaton and Muellbauer (1980) summarized the advantages of the AIDS model as follows:

(1)   It gives an arbitrary first-order approximation to any demand system

(2)   It satisfies the axioms of choice exactly;

(3)   It aggregates perfectly over consumers without invoking parallel linear Engel curves;

(4)   It has a functional form that is consistent with known household-budget data;

(5)   It is simple to estimate, largely avoiding the need for non-linear estimation; and

(6)   It can be used to test restrictions of homogeneity and symmetry through linear restrictions on fixed parameters.

[6] Green and Alston show that $d \ln P / d \ln P_j = w_j + \sum_k w_k \ln(P_k)\{d \ln(w)/d \ln(P_j)\}$. Since $\sum_k w_k \ln(P_k)\{d \ln(w)/d \ln(P_j)\}$ is small (less than 0.05 in absolute value) Chalfant assumes this tern equal to zero hence $d \ln P / d \ln P_j = w_j$.

[7] $w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln\{X/P\} + Q_1 + Q_2 + Q_3 + Q_4$ Where $Q_1, Q_2, Q_3,$ and Q_4 are seasonal dummy variables.

Table 1: Colombia Economic Statistics, 1996 – 2002

	1996	1997	1998	1999	2000	2001	2002
Population (millions)	39.4	40.1	40.7	41.1	42.1	42.8	43.5
GDP (US$ billions)*	86.4	95.2	141.7	151.9	173.5	195.9	141.7
GDP growth rate (%)	2.1	3.4	0.5	-4.5	3.0	3.8	2.1
GDP per capita (US$)	2,638.2	2,841.9	2,597.1	2,217.3	2,192.5	2,217.6	2,638.3
Exchange rate (pesos/US$)	1,037.0	1,140.0	1,536.0	1,782.0	2,088.0	2,300.0	2,504.0
Inflation rate (%)*	20.8	18.5	18.7	10.9	11.2	8.8	6.2

* International Monetary Fund
Source: FAO

Table 2: Colombia: Wheat Supply and Disposition, 1997-2003f

July-June Marketing Year	1997-1998	1998-1999	1999-2000f	2000-2001	2002-2003f
Harvested Area (000 ha)	23.6	19.1	18.6	19.8	14.8
Yield (hg/ha)	20,497	21,537	21,418	18,552	21,514
……………*Thousand tonnes*………..……					
Carry-in Stock	112	102	127	127	127
Production	30	39	40	43	43
Import	1,048	1,100	1,000	1,000	1,000
Total Supply	**1,190**	**1,227**	**1,152**	**1,152**	**1,152**
Feed Use	20	20	20	20	20
Food, Seed, Industrial Us	1,068	1,100	1,025	1,483	1,785
Total Domestic Use	**1,088**	**1,120**	**1,045**	**1,503**	**1,805**
Carry-out stocks	102	107	107	(351)	(653)

f: forecast, February 2000-2003
Source: FEDEMOL (Colombian Grain Mill Federation) & USDA

**Table 3: Parameter Estimates for Colombian Wheat Imports Using an Almost Ideal
Demand System Models with Seasonality, 1980-1999**

Independent Variables	United States-Colombia	Canada-Colombia	ROW-Colombia
	Dependent Variables (The budget share of per capita wheat import of:)		
Prices of:			
United States-Colombia	0.0082** (0.0513)	-0.0176** (0.0624)	0.0086** (0.0381)
Canada-Colombia	-0.1823** (0.1540)	-0.4621** (0.1874)	-0.2739** (0.1130)
ROW-Colombia	0.0780** (0.0906)	-0.0942* (0.1104)	0.0115** (0.0657)
Expenditure[a]	-0.1072* (0.0431)	-0.0523** (0.0525)	0.1593** (0.0321)
Seasonal Dummies :			
Quarter 2	0.0481* (0.0424)	-0.0573** (0.0516)	0.0126** (0.0296)
Quarter 3	0.1522** (0.0424)	-0.1108** (0.0531)	-0.0378** (0.0010)
Quarter 4	-0.04788* (0.0444)	-0.0528* (0.0541)	-0.0013* (0.0306)
R^2	0.901	0.909	0.900

Note: The numbers in parenthesis are standard errors.
Single (*) and double asterisks (**) denote significance at the 15% and 10% level, respectively.
[a] Expenditure denotes per capital expenditure on total wheat imported to Colombia.

**Table 4: Parameter Estimates for Colombian Wheat Imports Using an Almost
Ideal Demand System Model without Seasonality, 1980-1999**

	Dependent Variables (The budget share of per capita wheat import of:)		
Independent Variables	United States-Colombia	Canada-Colombia	ROW-Colombia
Prices of:			
United States-Colombia	0.0242**	-0.0312*	0.9983*
	(0.0583)	(0.0661)	(0.0378)
Canada-Colombia	-0.0241**	-0.4964**	-0.0255**
	(0.0169)	(0.0193)	(0.1101)
ROW-Colombia	-0.1277**	-0.1243**	-0.0034**
	(0.0973)	(0.0110)	(0.0632)
Expenditure[a]	-0.10546**	-0.0994**	0.1579**
	(0.0486)	(0.0501)	(0.0352)
R^2	0.845	0.893	0.814

Note: The numbers in parenthesis are standard errors.

Single (*) and double asterisks (**) denote significance at the 15% and 10% level, respectively.

[a] Expenditure denotes per capita expenditure on total wheat imported to Colombia

Table 5: Marshallian and Hicksian Demand Elasticities for Colombian Wheat Imports Estimated Using an Almost Ideal Demand System Model, 1980-1999

Independent Variables	Dependent Variables (The budget share of per capita wheat import of:)		
	United States-Colombia	Canada-Colombia	ROW-Colombia
MARSHALLIAN:			
Prices of:			
United States-Colombia	-1.1608**	0.0317*	0.2296*
	(0.0021)	(0.01036)	(0.0231)
Canada-Colombia	0.0638**	-1.04867*	-0.3068*
	(0.0501)	(0.01520)	(0.0821)
ROW-Colombia	0.3277*	-2.1904*	-1.2722*
	(0.0101)	(0.0731)	(0.1027)
Expenditure	0.8150**	0.6686*	0.0563*
	(0.1701)	(0.0451)	(0.0091)
HICKSIAN:			
United States-Colombia	-0.6150*	0.3577*	0.2541*
	(0.0113)	(0.0891)	(0.1409)
Canada-Colombia	0.4921*	-0.7011*	-0.2808*
	(0.0090)	(0.1101)	(0.0917)
ROW-Colombia	0.8977*	0.3149*	-1.0843*
	(0.0130)	(0.0911)	(0.0137)

Note: The numbers in parenthesis are standard errors.
Single (*) and double asterisks (**) denote significance at the 15% and 10% level, respectively.

Figure 1.1: Colombia Total Wheat Imports and GDP Per Capita, 1961-1999.

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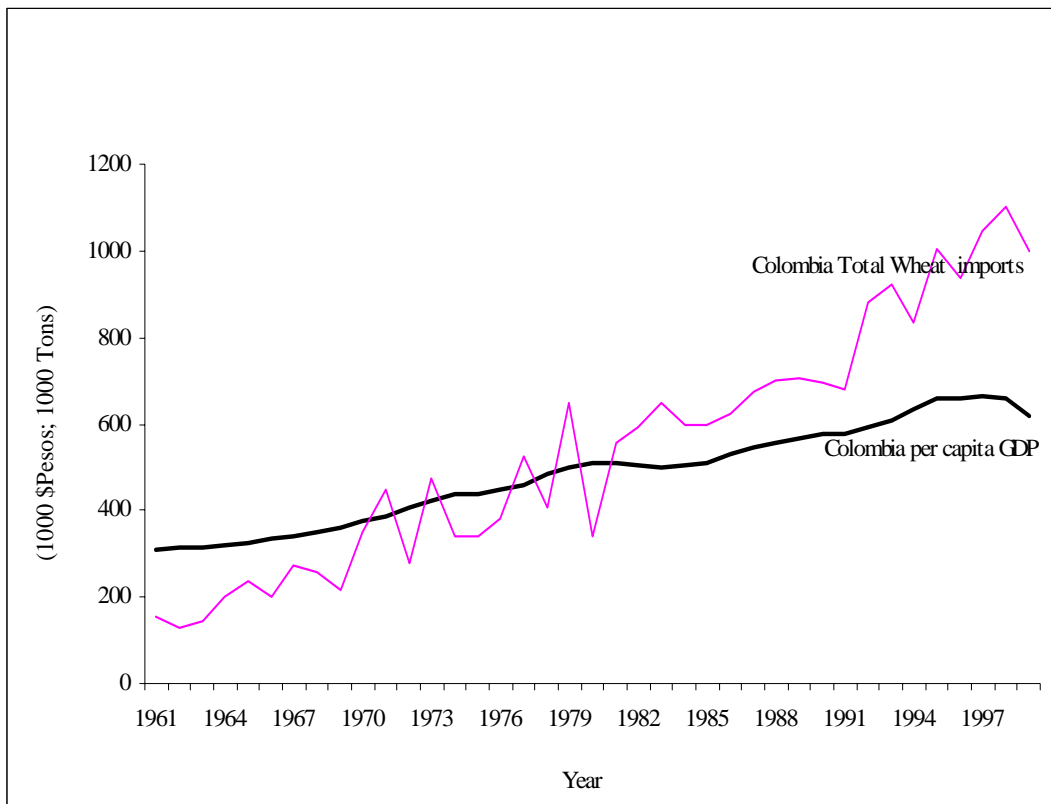
References:

Abdelhak, S. (1998 June). Time-Series Estimation of Structural Import Demand Equations: A Cross-Country Analysis. IMF Staff Papers, 45(2).

Agriculture Canada. (1997). *Analysis of Strategic Mixes for Canadian Wheat Exports*. Guelph, Ontario: Agriculture Canada.

Agriculture and Agri-Food Canada. (2000 February 4). *Wheat: Situation and Outlook*. Market Analysis Division, Policy Branch. *Bi-weekly Bulletin,* 13(3).

Abbott, P. & Paarlberg, P. (1986). Modeling the Impact of the 1980 Grain Embargo. *Embargoes, Surplus Disposal, and U.S. Agriculture*, chap. 11. Staff Rep. No. AGES-860910, USDA/Economic Research Service, Washington DC.

Alaouze, C. M., Watson, A. S. and Sturgess, N. H. (1978). Oligopoly Pricing in the World Wheat Market. *American Journal of Agriculture and Economics.* 60, 173-85.

Alston, J. M., & Chalfant, J. A. (1993 May). The Silence of the Lambda: Test of the Almost Ideal and Rotterdam Models. *American Journal of Agriculture and Economics.* 75, 304-13.

Alston, J. M., Carter, C. A., Green, R. & Pick, D.(1990 May). Whither Armington Trade Model? *American Journal of Agriculture and Economics,* 72, 455-67.

Armington, P. S. (1996). A Theory of Demand for Products Distinguished by Place of Production. *IMF Staff paper* 16, 159-78.

Babula, R. (1987). An Armington Model of U.S. Cotton Exports. *American Journal of Agriculture and Economics.* 39, 12-22.

Carter, C. A. & Wilson, W. W. (1997 May). Emerging Differences in State Grain Trading: Australia and Canada. *American Journal of Agriculture and Economics,* 16(2), 87-98.

Chai, J.(1972) The U.S. Food Demand for Wheat by Classes. Staff Pap. No. P72-14, Department of Agricultural and Applied Economics, University of Minnesota.

Chalfant, J. A. (1987 April). A Globally, Almost Ideal Demand System. *Journal of Business and Economic Statisticss,* 5, 233-42.

Chang, J. (1981). Analysis of Import Demand for Hard Red Spring and Hard Red Winter Wheat in the International Market: Unpublished M.S Thesis, North Dakota State University.

Dahl, B. L. & Wilson, W. W. (2000 Spring Summer). Grades/Classes of Hard Wheats Exported from North America: Analysis of Growth and Market Segments. *Review of Agriculture Economics,* 22(1), 172-91.

Deaton, A & Muellbauer, J. (1980). An Almost Ideal Demand System. *American Economic Review*, 70, 312-326. *Economics Consumer Behavior*. Cambridge University Press.

Edgerton, D. L., (1993 December). On the Estimation of Separable Demand Models. *Journal of Agricultural Resource and Economics,* 18, 141-146.

Fritz, D. D. (1997). Competitiveness of U.S. Wheat and Wheat Flour Industries In Selected Countries. M.S. Thesis, Oklahoma State University.

Gallagher, P., Lancaster, M., Bredahl, M. & Ryan, T. J (1986). The U.S. Wheat Economy in an International Setting: An Econometric Investigation. *ESS/USDA Technical Bulletin,* No. 1644, U.S. Department of Agriculture, Washington DC.

Green, H. A. J. (1976) *Consumer Theory*. New York: MacMillan.

Harwood, L. J., & Bailey, K. W. (1990). *The World Wheat Market-Government Intervention and Multilateral Policy Reforms*. Staff Report AGEX 9007. Commodity Economics Division, Economic Research Services, USDA.

Hoffman, L. A., Schwartz, S., Grace, V., & Chomo, A. (1995). Wheat: Background for 1995 Farm Legislation. USDA ERS. *Agricultural Economic Report,* 712. Washington, DC.

International Monetary Fund (IMF). *International Financial Statistics Yearbook.* Various Issues.

Jaditz, T. (1994 December). Seasonality in Economic Data and Model Estimation. *Monthly Labor Review,* 117(12), 17-22.

Johnson, A. C., Marvin J. B., & Buse, R. C. (1987). *Econometrics: Basic and Applied.* New York: Macmillan, xv480, ISBN: 0-02-360920-6.

Konandreas, P., Bushnell, P. & Green, R. (1978). Estimation of Export Demand Functions for U.S. Wheat. *Western Journal of Agriculture and Economics,* 3, 39-49.

Lafontaine, F., & White, K. J. (1986). Obtaining Any Wald Statistic You Want. *Economic Letters,* 21(1), 35-40.

LaFrance, J. T., (1991). When Is Expenditure 'Exogenous' in Separable Demand Models? *Western Journal of Agriculture Economics,* 16, 49-62.

Larue, B. (1991). Is Wheat a Homogenous Product? *Canadian Journal of Agriculture Economics,* 71, 103-117.

McCalla, A. F. (1966). A Duopoly Model of World Wheat Pricing. *American Journal of Agricultural Economics*, 48, 711-27.

Mohanty, S., & Peterson, E.W.F. (1999). Estimation of Demand for Wheat by Classes for the United States and the European Union. *Agicultural and Resource Economics Review*, 28(2), 154-168.

Penson, J. R., & Babula, R. (1994). Japanese Monetary Policies and U.S. Agricultural Exports. *Journal of Agricultural Resource Economics.* 40, 11-18.

Samarendu M. & Peterson, E.W.F. (1999, October). Estimation of Demand For Wheat by Classes for the United States and the European Union. *Agicultural and Resource Economics Review,* 28, 158-68.

Sarris, A. (1982). European Community Enlargement and World Trade in Fruits and Vegetables. *American Journal of Agriculture And Resource Economics,* 17, 138-49.

Sumner, D. A., Alston, J. M. & Gray, R. (1994). A Quantitative Analysis of the Effects of Wheat Imports on the United States Market for Wheat Including the Impact on Deficiency Payments. Reports Prepared for the Canadian Wheat Board.

Theil, H. (1980). *The System-Wide Approach to Microeconomics*. Chicago: University of Chicago Press.

Theil, H. (1965). The Information Approach to Demand Analysis. *Econometrica,* 33, 67-87.

U.S. Department of Agriculture. (1999 March). *Wheat: Situation and Outlook Yearbook.* USDA/Economic Research Service, WHS-1999.

U.S. Department of Agriculture (USDA), Foreign Agricultural Service, *Grain: World Markets and Trade*, US Department of Agriculture, Washington DC, Various Issues 1995-2000.

———, (1995 August). Trade and Economic Analysis Division, *Unpublished United Nations Calendar Year Trade Data*.

———, (1996 August). Foreign Agricultural Service, *Unpublished Export Credit Guarantee Fiscal Year Export Data,*.

———, (1997 August). Trade and Economic Analysis Division, *Unpublished United Nations Calendar Year Trade Data*.

———, (1998 August). Trade and Economic Analysis Division, *Unpublished United Nations Calendar Year Trade Data*.

———, (1999 August). Trade and Economic Analysis Division, *Unpublished United Nations Calendar Year Trade Data*.

———, (2000 August). Trade and Economic Analysis Division, *Unpublished United Nations Calendar Year Trade Data.*

Van Heeswijk, B. J., de Boer, P. M. C., Harkema, R. (1993). A Dynamic Specification of an AIDS Import Allocation Model. *Empirical Economics* 18(1), 57-73.

Varian, H. R. (1992). *Microeconomic Analysis*. New York: Norton and Company, Inc.

Wang, Y. (1989). The Demand and Price Structure for various Classes of Wheat. Unpublished Ph.D. Dissertation, The Ohio State University. *Western Journal of Agriculture Economics,* 14, 67-77.

Wilson, W. W. (1989). Differentiation in Export Wheat Markets. *Western Journal of Agriculture Economics,* 14, 67-77.

Wilson, W. W., Koo, W.W., & Cater, C. A. (1990). Importer Loyalty in International Wheat Market. *Journal of Agriculture Economics,* 41(1), 94-102.

Winters, L. (1984). Separability and the Specification of Foreign Trade Functions. *Journal of International Economics*, 17, 239-63.

Yang, S. R., & Koo, W.W. (1993). A Generalized Armington Trade Model: Respecification. *Journal of Agricultural and Resource Economics,* 19, 374-76.

Yang, S. R., Koo, W.W. (1994 December). Title: Japanese Meat Import Demand Estimation with the Source Differentiated AIDS Model. *Journal of Agricultural and Resource Economics,* 19(2), 396-408.