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Agribusiness & Applied Economics Report No. 503 January 2003

Third Country Effects on U.S. Wheat Export Performance in Asian Countries

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ACKNOWLEDGMENTS

The authors extend appreciation to Dr. David Lambert, Dr. Eric DeVuyst, Mr. Jeremy Mattson, and Mr. Richard Taylor for their constructive comments and suggestions. Special thanks go to Ms. Beth Ambrosio, who helped to prepare the manuscript.

The research was conducted under the U.S. agricultural policy and trade research program funded by the U.S. Department of the Treasury/U.S. Customs Service (Grant No. TC-01-002G, ND1301).

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Abstract

This study examines third country effects on U.S. wheat export performance in Asian countries. An import demand model is developed to analyze the impacts of price competitiveness, exchange rates, and exchange rate volatilities on U.S. wheat market shares. The United States competes with Australia and Canada in the Asian wheat market. Empirical results show that two factors, Australian wheat price and U.S. dollar values against the Asian countries' currencies, have significant effects on U.S. market shares in this region. Furthermore, exchange rate risks between the exporting and importing countries are found to be important.

Keywords: international grain trade, market share, exchange rate, panel analysis.

Highlights

Market shares of U.S. wheat in Asian countries have decreased since the early 1980s. The decreased market shares may be associated with U.S. sales displaced by competing suppliers, mainly Australia and Canada.

Two factors have received great attention as potential main reasons for reduced U.S. wheat exports: one is the relatively strong U.S. dollar, and the other is the growth and enhanced productivity of foreign agricultural sectors in competition with the United States.

The objective of this study is to test whether these two factors are responsible for the decline in U.S. wheat market shares in Asia. In order to analyze the impact of competition among the exporting countries, a third country effect model is developed.

The dependent variable is the market shares of U.S. wheat in the Asian countries. Explanatory variables include wheat prices of major exporting countries (the United States, Australia, and Canada), exchange rates between the importing and exporting countries, and volatilities in the exchange rates. Four different methods of measuring exchange rate volatility are used to discern the sensitivity of empirical results to different measurements. Our analysis focuses exclusively on the floating-rate period, running from 1973 through 2000. In the estimation procedure, a panel unit-root test is performed to determine whether the panel data are nonstationary and whether there is a cointegration problem.

The results of the panel unit-root test indicate that the cross-sectional time series of market shares, wheat prices, and exchange rates are stationary with a linear trend, suggesting that it is unnecessary to check cointegration between the variables. The empirical results of the panel estimation show that the U.S. currency value and volatility are important factors in determining U.S. wheat shares in the Asian markets. Among the third country variables, Australian wheat price and volatilities in the importing countries' currencies against Canadian and Australian currencies are significant factors affecting U.S. wheat export performance.

Third Country Effects on U.S. Wheat Export Performance in Asian Countries

Hyun J. Jin, Guedae Cho, and Won W. Koo*

INTRODUCTION

U.S. market shares of wheat in Asian countries (China, Hong Kong, Indonesia, Thailand, Taiwan, Singapore, the Philippines, Malaysia, South Korea, and Japan) have decreased since the early 1980s. During the last two decades, the average U.S. market share in this region has fallen from 0.65 to 0.35. Market shares in individual Asian countries have been more dynamic. Importers in South Korea, the Philippines, and Taiwan have traditionally been loyal to the United States. However, in recent years, this loyalty has been deteriorating. Malaysia, Indonesia, Thailand, and Hong Kong increased their imports from the United States from 1973 to 1991, but retreated after 1991. China and Singapore have disturbed the U.S. market share by varying import levels. In Indonesia, the United States has been losing a large percentage of its market share. On the other hand, U.S. wheat market share in Japan has remained stable around 50%.

Decreased U.S. market shares are associated with displaced sales by competing suppliers. Since the early 1980s, foreign competitors, mainly Australia and Canada, have gained their market shares in the Asian countries at the expense of the United States. Australia's wheat export has increased by 100% and Canada's by 40%, according to the Wheat Yearbooks published by the Foreign Agricultural Trade of the United States (FATUS), under the Economic Research Service (ERS) of the U.S. Department of Agriculture.

Two factors have received great attention as main reasons for the reduced U.S. wheat exports: 1) the relatively strong U.S. dollar and 2) increased productivity and the activity of state trading agencies in Australia and Canada.

Exchange rates could be now the single most important variable in determining trade volume of agricultural goods. ERS reported in 1990 that cycles of exchange rate swings have coincided with changes in U.S. agricultural exports since 1969. The average value of the U.S. dollar against the Asian countries' currencies has increased in the last twenty years. The U.S. dollar has appreciated even more against the currencies of its competitors, making U.S. grain exports less competitive. The United States lost 10.5 percentage points of wheat market share between 1992 and 1998 in world markets. Historically, movements in exchange rates have accounted for approximately 25% of the change in U.S. agricultural exports (ERS, 2001). Continuing appreciation has allowed competitors to gain market share and, in turn, expand their production. The growth and enhanced productivity of foreign agricultural sectors is another important factor affecting U.S. market shares.

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The objective of this study is to test whether these two factors are the main causal variables for the decreased U.S. wheat market shares in Asia. In order to analyze the impact of competition among the exporting countries, a third country effect model, similar to that used by Cushman (1986), is developed. Considering the third country effect helps to minimize a specification bias problem that arises from the fact that unilateral trade flows depend not only on the costs of purchasing grain from an exporting country but also on the costs of purchasing grain from competitors of the exporting country.

In this model, the dependent variable is the market share of U.S. wheat in the Asian countries. Explanatory variables include wheat prices of major exporting countries (the United States, Australia, and Canada), exchange rates between the importing and exporting countries, and volatilities in the exchange rates.

Four different methods of measuring exchange rate volatility are used in order to discern the sensitivity of empirical results to different measurements. Our analysis focuses exclusively on the floating-rate period, running from 1973 through 2000. Excluding the pegged-rate period precludes the possibility of specification bias stemming from the change in the exchange-rate regime. In the estimation procedure, a panel unit-root test developed by Maddala and Wu (1999) is performed to determine whether the panel data are nonstationary and whether there is a cointegration problem caused by interactions of nonstationary variables. Most studies have ignored this step in order to simplify empirical procedures.

The results of the panel unit-root test indicate that the cross-sectional time series of market shares, wheat prices, and exchange rates are stationary with a linear trend, suggesting that it is unnecessary to check cointegration between the variables. The empirical results of the panel estimation show that the U.S. currency value and its volatility are important factors in determining U.S. wheat market shares in the Asian countries. Among the third country variables, Australian wheat price and volatility in the importing countries' currencies against Canadian and Australian currencies are significant factors affecting U.S. wheat export performance.

THEORETICAL MODEL

A Third Country Effect Model

Assume that a representative trader in importing country M purchases wheat from two different exporting countries, A and B. Let X be the amount of wheat purchased from country A, and Y from country B. The total cost of purchasing wheat for the importer is

$$TC = c_x \cdot X + c_y \cdot Y, \tag{1}$$

where TC denotes total cost, c_x is the unit cost of purchasing wheat from country A, and c_y is the unit cost of purchasing wheat from country B. The unit costs, c_x and c_y, are stochastic random variables because they change over time. If we divide both sides by the total import, Z, which is the sum of X and Y, then Equation (1) is rewritten as follows:

$$c = c_x \cdot x + c_y \cdot y, \tag{2}$$

where c is *unit* purchasing cost of wheat, and x and y are market shares of the exporting countries A and B, respectively.

The objective of the trader is to maximize unit profit, subject to the risk associated with the profit. Note that without any risk management tools, such as offshore futures hedging or insurance, an equation for unit profit of the trader can be written as the right-hand side of Equation (2) with an additional negative sign. Writing the maximization problem on a *mean-variance utility* framework produces

$$U = E[\pi] - \frac{\gamma}{2} V(\pi), \tag{3}$$

where E is the mathematical expectation operator, π is the unit profit, V is volatility of $(\cdot)$, and γ is the coefficient of risk aversion, assumed to be positive under risk aversion. It is assumed that the utility function of the representative grain importer is continuous, monotonic increasing, and strictly concave.

Substituting Equation (2) into the mean-variance utility equation (3) yields the following objective function:

$$U \equiv -E[c_x]\, x - E[c_y]\, y - \frac{\gamma}{2} \left(x^2\, V(c_x) + y^2\, V(c_y) + 2xy\, Cov(c_x, c_y)\right), \tag{4}$$

where $Cov(\cdot)$ denotes the covariance of variables in parenthesis. Maximizing the objective function (4) with respect to the market shares, x and y, produces the first-order conditions:

$$-E[c_x] - \gamma x V(c_x) - \gamma y Cov(c_x, c_y) = 0\,, \tag{5a}$$

$$- E[c_y] - \gamma y V(c_y) - \gamma x Cov(c_x, c_y) = 0 . \tag{5b}$$

The second-order condition is satisfied by the assumption of strict concavity of the utility function U(·). Solving the first-order conditions with respect to *x* and *y* yields demand functions for market shares as follows:

$$x = \frac{Cov(c_x, c_y)E[c_y] - E[c_x]V(c_y)}{\gamma D}, \tag{6a}$$

$$y = \frac{Cov(c_x, c_y)E[c_x] - E[c_y]V(c_x)}{\gamma D}, \tag{6b}$$

where $D \equiv V(c_x)V(c_y) - Cov(c_x, c_y)^2$. D is greater than zero unless the correlation between c_x and c_y reaches ±1, which would correspond to corner solutions. The effects of expected own-cost, $E[c_x]$, and the volatility of the cost, $V(c_x)$, on its market share *x* are

$$\frac{\partial x}{\partial E[c_x]} = \frac{-V(c_y)}{\gamma D} < 0, \tag{7}$$

$$\frac{\partial x}{\partial V(c_x)} = \frac{-xV(c_y)}{D} < 0. \tag{8}$$

These equations suggest that if the cost and its volatility of exporting country A increase, the importer decreases his demand for country A's wheat.

The effects of the expected exporting cost of country B, $E[c_y]$, and the volatility of the cost, $V(c_y)$, on country A's market share *x* are

$$\frac{\partial x}{\partial E[c_y]} = \frac{Cov(c_x, c_y)}{\gamma D}, \tag{9}$$

$$\frac{\partial x}{\partial V(c_y)} = \frac{yCov(c_x, c_y)}{D}. \tag{10}$$

These equations represent the third country effects. The signs of Equations (9) and (10) depend on the sign of $Cov(c_x, c_y)$. The sign of the correlation between export costs of the two exporting countries is treated as positive in the literature [e.g., Cushman (1986)]. Thus, the signs of Equations (9) and (10) are expected to be positive. This implies that if country B's exporting cost and its volatility rise, the importer reduces his imports from country B; therefore, the market share of country A in the importing country M increases.

The effect of the covariance between the exporting costs of countries A and B on the market share x is

$$\frac{\partial x}{\partial Cov(c_x, c_y)} = \frac{xCov(c_x, c_y) - yV(c_y)}{D}. \tag{11}$$

The sign of Equation (11) remains obscure. Assuming that $Cov(c_x, c_y)$ is positive, the sign of Equation (11) depends on the sizes of $xCov(c_x, c_y)$ and $yV(c_y)$ on the right-hand side. If $xCov(c_x, c_y) > yV(c_y)$, the effect of the covariance on the market share x would be positive. Otherwise, the effect would be negative or zero.

U.S. Market Shares with Multi-Competitors

The major wheat-exporting countries in Asia are the United States, Australia, and Canada. The three exporting countries' market shares range from 86% to 96% in the East and Southeast Asian countries for the period from 1973 to 2000. The objective function (4) needs to be expanded to derive the equation for U.S. market share under multi-competitors as follows:

$$U \equiv - E[c_x]\, x - E[c_y]\, y - E[c_w]\, w - \frac{\gamma}{2} \left(x^2\, V(c_x) + y^2\, V(c_y) + w^2\, V(c_w) + 2xy\, Cov(c_x, c_y) + 2xw\, Cov(c_x, c_w) + 2yw\, Cov(c_y, c_w)\right), \tag{12}$$

where c_w is the exporting cost of another exporting country W, w is the market share of country W, and other variables are previously defined. Maximizing the objective function with respect to the market shares, x, y, and w, produces three first-order conditions. Solving the first-order conditions with respect to the market shares yields the demand functions for x as follows:

$$x = -\{Cov(c_y, c_f)^2\, E[c_x] - Cov(c_x, c_f)\, Cov(c_y, c_f)\, E[c_y] - Cov(c_x, c_y)\, Cov(c_y, c_f)\, E[c_f] + Cov(c_x, c_f)\, E[c_f]\, V(c_y) + Cov(c_x, c_y)\, E[c_y]\, V(c_f) - E[c_x]\, V(c_y)\, V(c_f)\} / \{\gamma(Cov(c_x, c_y)^2\, V(c_f) + Cov(c_x, c_f)^2\, V(c_y) + Cov(c_y, c_f)^2\, V(c_x) - 2\, Cov(c_x, c_y)\, Cov(c_y, c_f)\, Cov(c_x, c_f) - V(c_x)\, V(c_y)\, V(c_f))\}. \tag{13}$$

The demand functions for y and w have the same variables. The demand function (13) shows that the exporting costs of all three exporting countries and variance-covariance of the costs are at play in determining the market share x.

Since wheat is traded in the exporters' currencies, importers face two cost components: wheat prices and exchange rates. Thus, the demand function (13) can be rewritten as an empirical model in which the dependent variable is the level of market shares of U.S. wheat in the Asian markets and the explanatory variables are wheat prices of the United States and other exporting countries, and exchange rates and risks between the importing and the exporting countries. An empirical equation of U.S. market shares in the Asian countries is

$$x_{it} = f(P_{ut}, P_{ct}, P_{at}, R_{uit}, R_{cit}, R_{ait}, V(R_u)_{it}, V(R_c)_{it}, V(R_a)_{it}, Cov(R_u, R_c)_{it}, Cov(R_u, R_a)_{it}, T, \text{ and } e_{it}), \tag{14}$$

where x denotes the natural logarithm of U.S. market shares in the Asian countries; P_u, P_c, and P_a denote the natural logarithms of wheat prices of the United States, Canada, and Australia, respectively; R_u R_c and R_a represent the natural logarithms of U.S., Canadian, and Australian dollar prices, respectively, in terms of importing countries' currencies; V(·) denotes the volatility of the exchange rates; Cov(·) represents covariance between exchange rates; T denotes a time trend; and e is an error term. Price variables are time-variant but cross-sectional invariant. All other variables are both time and cross-sectional variant. *i* denotes cross-sectional changes for the 10 Asian importing countries. *t* represents time changes from 1973/1974 to 1999/2000 by fiscal year.

A rise in the U.S. export price would reduce the import demand for U.S. wheat, thus reducing its market share, while increasing the competitors' export prices would encourage more imports from the United States. If R_u rises, holding R_c and R_a constant, then wheat import price from the United States increases, resulting in comparatively lower purchasing costs from the competitors. The importer, therefore, would import more from Canada and Australia and reduce its imports from the United States. On the other hand, if R_c and/or R_a rises, holding the U.S. dollar prices constant, then the importer increases its import from the United States, while decreasing its imports from Canada and/or Australia.

Inquiries into the effect of exchange-rate volatility on the volume of international trade have been numerous, and much has been written both on the theoretical and empirical sides of this question. Risk variables are thus derived with the exchange rates. According to Equation (13), wheat importers might be concerned about exchange rate risks, $V(R_u)$, $V(R_c)$, and $V(R_a)$, and covariances between exchange rates, $Cov(R_u, R_c)$, $Cov(R_u, R_a)$, and $Cov(R_a, R_c)$. Most international trade studies suggest that uncertainty in exchange rates has a detrimental effect on the volume of trade [for example, see Kenen and Rodrik (1986), Pick (1990), Pozo (1992), Chowdhury (1993), and Bahmani-Oskooee and Ltaifa (1992)]. However, others predict otherwise [De Grauwe (1988) and Hooper and Kohlhagen (1978)]. These divergent views suggest that there is no real consensus about the effects of exchange rate risk on trade volume; there are mixed theoretical and empirical studies for the effect of exchange rate on international trade. Some empirical studies show that the effects of exchange rate risk depend on factors such as the degree of risk aversion and decision maker's objective [Giavazzi and Giovannini (1989), Cushman (1988), Asseery and Peel (1991), and Broll and Eckwert (1999)].

According to Equation (8), we expect that if volatility of an exporting country's exchange rate against an importing country's currency increases, the importer would reduce its purchases from the country and switch to other competitors to avoid the risk. The effect of another competing country's exchange rate volatility on the exporting country's market share is inconclusive, according to Equation (10), depending on the sign of the covariance between competitive exporting countries' currency values. The effects of covariance variables also remain obscure, depending on the sizes of the covariance and variance of exchange rates.

An import demand model generally includes income and trade policies of the importing country. However, these variables are not included in Equation (14) mainly because they will not affect exporting countries' market shares under an assumption that importing countries do not discriminate in favor of one country against other exporting countries.

DATA AND EMPIRICAL PROCEDURE

This study considers 10 Asian importing countries - China, Hong Kong, Indonesia, Thailand, Taiwan, Singapore, the Philippines, Malaysia, S. Korea, and Japan - and three exporting countries - the United States, Canada, and Australia. The data consist of the U.S. wheat market shares in the Asian countries, average wheat export prices of the United States, Canada, and Australia, and real exchange rates between the importing and exporting countries. The data are annual and range from 1973/1974 to 1999/2000 by fiscal year.

Panel Unit-Root Test and Data

The data for wheat imported by the Asian countries are acquired from the data set of FATUS, under the ERS of the U.S. Department of Agriculture. Real exchange rate data are obtained from the International Monetary Fund and the ERS of the U.S. Department of Agriculture. The wheat export price data were drawn from *World Wheat Statistics* published by the International Wheat Council.

The wheat prices are freight-on-board (FOB) and they are expressed in U.S., Canada, and Australia dollars per ton, respectively. For U.S. wheat, No.2 Dark Northern Spring (DNS) 14%, No.2 Hard Red Winter Ordinary (HRWO), and No.2 Soft Red Winter (SRW) in Gulf ports; No.2 DNS 14% in Atlantic ports; and No.2 DNS 14%, No.2 Western White, and No.2 Hard Winter 13% in Pacific ports are selected. For Australian wheat, Prime Hard and Australian Standard White are selected; for Canadian wheat, Canada Western Red Spring (CWRS) 13.5% in St. Lawrence and CWRS 13.5% and No.3 CWRS in Pacific ports are selected. From the 12 series, the average export prices of the United States and its competitors were calculated.

A panel unit-root test developed by Maddala and Wu (1999) has been performed for the data on market shares and exchange rates. Test results are presented in Table 1. The results suggest that observations do not follow a random walk with drift, but they are stationary with a linear trend. This suggests a necessity to detrend the data in the empirical analysis. Thus, a trend variable is included in Equation (14) to track the time trend.

Table 1. Results of Panel Unit-Root Test

Variables	Drift	Trend	Distributions
Market Share	31.99** (0.043)[a]	59.94*** (0.000)	χ^2
Exchange Rate against United States	22.84 (0.297)	51.97*** (0.000)	χ^2
Exchange Rate against Canada	17.88 (0.595)	43.98*** (0.002)	χ^2
Exchange Rate against Australia	12.97 (0.878)	37.71*** (0.010)	χ^2
U.S. Wheat Price[b]	-3.75*** (0.009)	-3.66** (0.048)	*t*
Canadian Wheat Price	-2.25 (0.234)	-2.75* (0.086)	*t*
Australian Wheat Price	-1.22 (0.258)	-3.22* (0.074)	*t*

Note: [a] The values in parentheses represent *p*-values.
[b] Since the price variables are univariate, ADF *t*-statistics are reported instead of MWF χ^2-statistics.
*, **, *** denote rejection of the null hypothesis of unit-root at 10%, 5%, and 1% significance level respectively.

Estimation Procedure

Following Cushman (1983), Pick (1990), Asseery and Peel (1991), Pozo (1992), and Langley, Giugale, Meyers, and Hallahan (2000), this study utilizes real exchange rates and volatilities. The exchange rates of each importing country against exporting countries are normalized to make them equivalent in magnitude. Third country exchange rate variables are given by R_c, R_a, $V(R_c)$, $V(R_a)$, $Cov(R_u, R_c)$, and $Cov(R_u, R_a)$. In the preliminary review of our data, it is found that covariance between R_c and R_a is not independent from other variables, i.e., the covariance is a redundant variable, and thus $Cov(R_c, R_a)$ is not included in the empirical equation (14). The risk variables are not transformed by logarithm, following the empirical model specifications of Kenen and Rodrik (1986), Pick (1990), Asseery and Peel (1991), and Langley, Giugale, Meyers, and Hallahan (2000).

The variances and covariances of exchange rates are obtained from four different types of volatility measures. Two historical volatility measures and two conditional volatility measures are used for the comparison of different implications between *ex post* and *ex ante* volatility measures in the third country model. The first measure is the prediction error, $\{\varepsilon_t\}$, computed from the first-order autoregressive equation, AR(1), as follows:

$$R_t = \alpha + \beta R_{t-1} + \varepsilon_t \,, \tag{15}$$

where R_t is the normalized real exchange rate at time t. The first measure is denoted by $V(1)$. It implicitly assumes that the real exchange rate expected in any year is forecasted by the AR(1) expectation. The Johansen cointegration test is performed, and results indicate that the series of

R_u, R_c, and R_a for each importing country do not have a cointegrating vector. Thus, residual series are derived from univariate AR(1) for R_u, R_c, and R_a, respectively, to make a variance-covariance matrix for each importing country.

The second measure is the moving sample standard deviation of changes in the real exchange rates, and is denoted by *V*(2). This measure has been extensively used in literature [e.g., Koray and Lastrapes (1989) and Chowdhury (1993)], and is calculated as follows:

$$V_t = \sqrt{k^{-1}\sum_{i=1}^{k}(R_{t+i-1} - R_{t+i-2})^2}\,, \tag{16}$$

where V_t is the volatility and k is the order of moving average, specified to be one. It implicitly assumes that the real rate expected in any year is forecasted by the naïve expectation.

The other two measures are conditional volatilities. The third measure is an Autoregressive Conditional Heteroskedasticity (ARCH) process [Engle (1982)], and is denoted by *V*(3). The stochastic error is obtained from an AR(1) conditional mean equation, and the lag p in the ARCH model is specified to be one, resulting in an AR(1)-ARCH(1) process as follows:

$$\begin{aligned} \text{AR(1):}\ R_t &= \delta + \phi R_{t-1} + \upsilon_t\,, \\ \text{ARCH(1):}\ V_t &= \omega + \eta \upsilon_{t-1}^2 + \xi_t\,, \end{aligned} \tag{17}$$

where ν_t and ξ_t are stochastic error terms, the two error terms are independent, and δ, ϕ, ω, and η are unknown parameters. In the ARCH model, the conditional variance is specified to depend upon the past values of the variance itself and upon an exogenous variable.

The fourth measure is the Generalized ARCH (GARCH) process [Bollerslev (1986)], and is denoted by *V*(4). The stochastic error is obtained from an Autoregressive Moving-Average (ARMA(1,1)) conditional mean equation, and the lag p and q in the GARCH model is specified to be one, respectively, resulting in an ARMA(1,1)-GARCH(1,1) process as follows:

$$\begin{aligned} \text{ARMA(1,1):}\ R_t &= a + bR_{t-1} + \theta\upsilon_{t-1} + \gamma_t\,, \\ \text{GARCH(1,1):}\ V_t &= \vartheta + \alpha\gamma_{t-1}^2 + \beta V_{t-1} + \varsigma_t\,, \end{aligned} \tag{18}$$

where γ_t and ς_t are stochastic error terms, the two error terms are independent, and a, b, θ, ϑ, α, and β are unknown parameters. It appears that the GARCH model with a small number of terms performs as well as or better than an ARCH model with many terms [McCurdy and Morgan (1988) and Hsieh (1989)]. In this specification, market participants infer today's variance based upon last period's forecast variance, last period's news about volatility, and an exogenous variable.

Equation (14) is a time-series and cross-section (TSCS) form, and empirical estimation is performed using a two-way panel model. To account for any country-specific effects and time-specific effects that cannot be captured by the explanatory variables in the model, both group and time effects are included in the TSCS analysis. The inclusion of both effects is based on a Lagrange multiplier (LM) test devised by Breusch and Pagan (1980). In the LM test, the null hypothesis is that there are no group and time effects in the following error component model:

$$x_{it} = \mathbf{z}'_{it}\,\beta + e_{it}, \qquad i = 1, \ldots, N; \quad t = 1, \ldots, T, \tag{19}$$
$$e_{it} = \phi_i + \omega_t + \varepsilon_{it},$$

where $\mathbf{z}'_{it}$ is a vector of explanatory variables for the ith cross-sectional unit and tth time point, and β is the vector of unknown parameters. The error term, e_{it}, is decomposed into three components: ϕ_i is a time-invariant and cross-sectional unit effect, ω_t is a cross-sectionally invariant time effect, and ε_{it} is a residual effect unaffected by the explanatory variables and both time and cross-sectional effects.

Following Judge, Griffiths, Hill, and Lee (1980) and Kmanta (1986), the Breusch and Pagan LM test was constructed and the null hypothesis was rejected at the 5% significance level. Thus, inclusion of the two effects is appropriate in the estimation specification. Including the two effects helps to avoid bias and inconsistency problems caused by omitting relevant variables.

In the time processes of wheat trade between the United States and importing countries, a shock may not die out promptly and could have possible lag effects, implying that the first few serial correlations could be substantial and statistically significant. To account for the lag effects, a variance-component moving average (MA) model is used, in which the residual effect, ε_{it}, in Equation (19) is specified as a finite MA time process of order $m < T - 1$, and is expressed as follows:

$$\varepsilon_{it} = a_0\theta_t + a_1\theta_{t-1} + \ldots + a_m\theta_{t-m}, \tag{20}$$

where a is the vector of unknown constants and θ_t is a white noise process. In this variance-component MA model, the three random terms, ϕ_i, ω_t, and ε_{it}, have normal distributions: $\phi_i \sim N(0, \sigma^2_\phi)$, $\omega_t \sim N(0, \sigma^2_\omega)$, and $\theta_{t-k} \sim N(0, \sigma^2_\theta)$, for $i = 1, \ldots, N$; $t = 1, \ldots, T$; $k = 1, \ldots, m$. The estimator of β is a two-step GLS-type estimator, that is, GLS with the unknown covariance matrix replaced by an estimator of the covariance matrix.

In the model, the group and time effects are treated as random, based on a Hausman *m*-statistic that is estimated following Hausman (1978) and Greene (1997). The result of the Hausman test shows that the null hypothesis of no correlation between the effect variables and the regressors was not rejected within the 5% significance level. This suggests that we can treat the group and time effects as random. The third country effect import model performs best when m is specified to be 5, judged by a generalized R-square.

EMPIRICAL RESULTS

Table 2 presents the empirical results with third country variables. Four models are specified with different measures of exchange rate volatility; each model, M(·), is associated with each volatility measure, V(·), respectively. When considering economic sign and statistical significance, the first volatility measure, V(1), seems to perform best in this import demand model.

Table 2. Estimation Results With the Third Country Effect

Variables	Expected Sign	M(1)[a]	M(2)	M(3)	M(4)
U.S. Wheat Price	-	-0.2785	-0.1557	-3.3623	-1.3126
		(-0.14)	(-0.08)	(-1.40)	(-0.52)
Canadian Wheat Price	+	0.2470	0.4382	1.4698	0.7630
		(0.14)	(0.26)	(0.62)	(0.33)
Australian Wheat Price	+	3.8790**	2.8013	7.2374*	1.9411
		(2.10)	(1.52)	(3.11)	(0.81)
Exchange Rate vs. United States	-	-4.3986***	-3.2544	-12.662*	-3.4546
		(-1.72)	(-1.21)	(-3.91)	(-1.07)
Exchange Rate vs. Canada	+	3.2463	2.8506	8.7679*	1.0560
		(1.30)	(1.19)	(2.96)	(0.37)
Exchange Rate vs. Australia	+	2.4837	-2.3594	2.0303	1.3058
		(1.19)	(-1.15)	(0.80)	(0.50)
Volatility of R_u	-	-0.0590***	-0.0010	0.2154*	0.1969*
		(-11.78)	(-0.56)	(28.47)	(60.89)
Volatility of R_c	+	0.0056	0.0242*	0.1372*	0.0506*
		(0.86)	(9.27)	(21.72)	(23.80)
Volatility of R_a	+	0.0007	-0.0351*	-0.1023*	0.0089*
		(0.12)	(-14.51)	(-16.20)	(3.41)
Covariance between R_u and R_c	.	0.0034*	0.0001	-0.0105*	-0.0125*
		(12.01)	(0.67)	(-22.53)	(-47.85)
Covariance between R_u and R_a	.	-0.0038*	-0.0006*	0.0001	0.0016*
		(-12.98)	(-4.32)	(0.01)	(5.79)
Time Trend	-	-0.0495	-0.0487	-0.0618	-0.0388
		(-1.42)	(-1.41)	(-1.53)	(-0.91)
R-squared[b]		0.87	0.74	0.85	0.71
Number of Observations		260	260	260	260
D-W[c]					

Note: [a] M(·) denotes different model specification, changing the volatility measure V(·).
[b] R-squared is a generalized R-squared statistic since the equations are estimated by GLS.
[c] D-W is not reported since the equations are corrected for autocorrelation by the Da Silva method.
The values in the parentheses denote *t*-statistics. *, **, and *** denote statistical significance at the 1, 5, and 10% level, respectively.

The price variables have expected signs: U.S. wheat price has a negative sign, while Canadian and Australian wheat prices have positive signs. However, they are not statistically significant except for the Australian wheat price in models 1 and 3. This implies that U.S. and Canadian wheat prices are not significant in explaining U.S. market shares, while the Australian wheat price has a significant effect on U.S. market shares.

The U.S. exchange rate variable has a negative sign, while the competitors' exchange rates have positive signs, except for the Australian exchange rate in model 2, which is not statistically significant. The U.S. exchange rate is significant in models 1 and 3, and the Canadian exchange rate is significant in model 3. This suggests that a strong U.S. dollar has a negative effect on U.S. market shares, while competitors' exchange rates are not as important factors as the U.S. dollar value. An appreciation of the U.S. dollar against importing countries' currencies makes U.S. agricultural commodities more expensive, and the countries reduce their imports from the United States. However, third country effects are not significant; this may be due to the fact that exporting countries' currencies move in a similar direction.

The volatility of the U.S. exchange rate has a negative sign in models 1 and 2 and a positive sign in models 3 and 4, suggesting that historical and conditional volatility measures have different implications in empirical analysis. This suggests that the expectation and realization of volatility have different nuances in the interaction with grain trade. The volatilities of Canadian and Australian exchange rates are statistically significant in all models except for model 1. The volatility of the Canadian dollar value has a positive sign in all models, indicating that higher uncertainty in Canadian exchange rates increases U.S. wheat market share in the Asian countries. The volatility of the Australian dollar value has a positive sign in models 1 and 4, but a negative sign in models 2 and 3, which is rather puzzling.

A possible explanation for the negative signs is that the AWB may take advantage of exchange rate uncertainty. As Langley, Giugale, Meyers, and Hallahan (2000) found, exchange rate volatility may have a positive effect on exports. When exchange rate risk increases, exporters take advantage of the situation and respond rapidly to deplete their export supply. However, this argument implicitly assumes that the Australian wheat suppliers (hence, the AWB) have market power in the Asian wheat markets. Therefore, this type of argument could be supported through empirical studies on the market power of Australian wheat suppliers in the region.

Covariance terms are statistically significant. A noticeable result is that signs differ between the cases of historical and conditional volatility measures. Covariance between U.S. and Canadian exchange rates has a positive sign in the historical volatility measures, models 1 and 2, and a negative sign in the conditional volatility measures, models 3 and 4. The covariance is significant in all models of conditional volatility, in which it has a negative sign. On the other hand, covariance between U.S. and Australian exchange rates has a negative sign with the historical volatility measures in models 1 and 2 and a positive sign with the conditional volatility measures in models 3 and 4. The covariance is significant in all models of historical volatility measures, in which it also has a negative sign. Overall, the two covariance terms suggest negative effects on U.S. market shares. Theoretically, the negative sign of the covariance term is consistent with significant, positive third country risk effects [Cushman (1986)].

For comparison, Table 3 shows the estimation results without third country variables. U.S. wheat price is significant only in model 1. Positive signs appear in models 2 and 3, but they are not statistically significant. The own exchange rate and risk effects are statistically significant at the 1% level and have negative signs as the theoretical model suggests, except for the exchange rate risk in model 4, which has a positive sign. Note that the R-squared values of all models are relatively low, suggesting that the U.S. wheat market shares are not explained effectively using only own-effect variables.

To see whether adding the third country variables makes a significant contribution in explaining the variation of the dependent variable, a F-test has been performed with the null hypothesis that the additional set of regressors are not jointly significant. From estimations of restricted (without the third country effects) and unrestricted (with the third country effects) equations, R-square values are derived and corresponding F-statistics are calculated. The output from the test shows that F-statistics (6.14 for V(1); 7.37 for V(2); 8.32 for V(3); and 6.48 for V(4)) are larger than the 95% critical value, 3.04, indicating a rejection of the null hypothesis. This suggests that the third country variables are relevant in the model.

Table 3. Estimation Results Without the Third Country Effect

Variables	Expected Sign	M(1)[a]	M(2)	M(3)	M(4)
U.S. Wheat Price	-	-0.2085*	0.0470	0.3671	-0.8863
		(-2.56)	(0.11)	(0.61)	(-1.43)
Exchange Rate vs. United States	-	-1.0980*	-1.0248*	-1.3115*	-7.8145*
		(-10.93)	(-9.35)	(-2.93)	(-48.16)
Volatility of R_u	-	-0.0418*	-0.0410*	-0.0429*	0.0163*
		(-58.18)	(-52.25)	(-2.50)	(9.31)
Time Trend	-	0.0187*	0.0064	-0.0063	-0.0851*
		(6.74)	(0.51)	(-0.36)	(-5.04)
R-squared[b]		0.58	0.49	0.25	0.41
Number of Observations		260	260	260	260
D-W[c]					

Note: [a] M(·) denotes different model specification, changing the volatility measure V(·).
[b] R-squared is a generalized R-squared statistic since the equations are estimated by GLS.
[c] D-W is not reported since the equations are corrected for autocorrelation by the Da Silva method.
The values in the parentheses denote *t*-statistics. * denotes statistical significance at the 1% level.

CONCLUSION

A third country effect model was developed to analyze the impacts of exchange rates between exporting and importing countries and the effects of other competitive exporting countries on U.S. wheat market shares in Asian countries. The empirical model was estimated by a two-way random panel analysis using the Da Silva method.

This study indicates that U.S. market shares are more significantly affected by Australian wheat price than by U.S. and Canadian wheat prices, indicating that Australia is a major competitor in the Asian markets. This may be due to distance advantage of Australian wheat. The U.S. exchange rate against importing countries is significant and negatively affects U.S. market shares, while Canadian and Australian exchange rates positively affect U.S. shares but are insignificant. Exchange rate volatilities in the three exporting countries have significant effects: the U.S. exchange rate risk has a negative effect, while, among the variables of third country effects, Canadian exchange rate risk has a positive effect and Australian exchange risk has mixed effects depending upon model specification. The effect of covariance between the United States and Canada (Australia) is significant and negative with conditional (historical) volatility measures. The negative sign of the covariance term is consistent with positive third country exchange rate risk effects.

The implicit null hypothesis of this study is that U.S. wheat export performance in the ten Asian countries has been affected by a relatively strong U.S. dollar and the third wheat-exporting country effects as well as a traditional economic variable, commodity price. The overall empirical results support the null hypothesis.

By changing the model specification with different volatility measures, the estimation results were affected through the changed values of risk variables. This suggests sensitivity of the import model to specification of volatility measures; therefore, one must derive implications from empirical analyses of the model with several possible volatility measures, not just from an analysis with a volatility measure. Note that, when considering statistical significance, it was found that the first volatility measure, stochastic AR(1) prediction error, performed best in the model.

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