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THE EFFECTS OF COMPETITION ON U.S. WHEAT MARKET SHARES IN EAST ASIA

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The effects of competition between wheat export countries on the U.S. wheat market shares in ten Asian countries are analyzed. The variables are relative forms of the U.S. against Australian and Canadian variables to incorporate the effects of competition among exporters. From the estimation results, we could not find distinct effects of wheat prices, exchange rates, changes of the prices and currency values, and the U.S. export enhancement program on the U.S. wheat export performance. This implies that further studies are needed to analyze other factors beyond these variables for the Asian wheat import market, such as different protein or type of wheat, importing countries' trading policies, or utilization of the state trading agencies.

Keywords: International Wheat Trade, Market Share, Panel Estimation, Panel Unit-Root Test
JEL classification: C23, F12, Q17

1. INTRODUCTION

The market shares of U.S. wheat in Asian countries have decreased since the early 1980s. During the last decades, the average market share of U.S. wheat in the region has plummeted from 65 percent in the fiscal year 1980/81 to 33 percent in 2006/07.[1] The

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[1] Market shares in individual Asian countries have more dynamic features. South Korea, the Philippines, and Taiwan had been loyal to U.S. wheat with small variations. In recent years, this loyalty has been deteriorating in the Philippines. Malaysia and Indonesia significantly increased their imports from the United States during the period from 1973 through the early 1980s, but they have reduced imports from the United States since the mid-1980s. Thailand and Hong Kong had increased their imports of U.S. wheat until the late 1980s, but they have decreased their imports since the early 1990s. In Indonesia and Hong Kong, the United States has been losing its market share by a large percentage. U.S. market share has been unstable in China

United States competes in the Asian wheat markets with Australia and Canada. The market shares of the three exporting countries in the region range from 80 to 96 percent for the period from 1973/74 to 2006/07.[2] The decreased U.S. market shares are associated with increased sales by competing suppliers. Since the early 1980s, foreign competitors, especially Australia and Canada, have significantly increased their market shares in the Asian countries.

This study examines main factors in changes of the U.S. wheat market shares in the Asian market. In order to incorporate the effects of competition between exporting countries, wheat prices,[3] exchange rates, and their volatilities are formatted as relative forms; the U.S. variables are divided by Australian and Canadian variables, respectively. Using a relative form may help to incorporate, in a parsimonious way, the third country effect into an import demand model. Our analysis focuses exclusively on the floating-rate period, running from 1973 through 2007. 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 check whether the panel data are characterized by nonstationarity and whether there is a cointegration between variables caused by interactions of nonstationary variables.

The remainder of the paper is organized as follows. A model for U.S. market share analysis is specified in the second section. The third section details data used in the study and describes the Maddala and Wu (1999) panel unit-root test and the results from the test. The fourth section presents the method of empirical analysis and shows the estimation results. A summary and conclusion follow in the last section.

2. MODEL SPECIFICATION

A standard market share model is specified, following Cushman (1983), Kenen and Rodrik (1986), Asseery and Peel (1991), and Chowdhury (1993). The relationship can be derived as a solution of behavioral demand and supply functions for a grain trade (Gotur, 1985). The dependent variable is the market shares of U.S. wheat in the ten

and Singapore, with large variations. However, the U.S. wheat market share has been stable at around 50 percent in Japan. The market shares of U.S. wheat in individual Asian countries are plotted but not presented here because of limited space. The figures are obtainable from the authors upon request.

[2] Refer to the *World Agricultural Trade Flows* published by the Foreign Agricultural Service (FAS) of the U.S. Department of Agriculture (USDA).

[3] If export prices in the exporting countries are the same over time, the exchange rate effects are the same as the price effects. However, the countries' export prices are different from one another, due mainly to different types of wheat and quality produced by the countries, and the differences are changing over time, it is important to differentiate the price effects from exchange rate effects.

Asian countries. The explanatory variables are U.S. wheat prices relative to Australian and Canadian wheat prices; relative volatility of the wheat prices; the U.S. dollars values relative to Australian and Canadian dollars; and relative volatility of the dollar values. The equation is written as follows:

$$\begin{aligned} x_{it} = \alpha_0 + \beta_1 p_{at} + \beta_2 p_{ct} + \beta_3 V(p_a)_t + \beta_4 V(p_c)_t + \beta_5 r_{ait} + \beta_6 r_{cit} \\ + \beta_7 V(r_a)_{it} + \beta_8 V(r_c)_{it} + e_{it}, \end{aligned} \quad (1)$$

where *x* denotes the U.S. market shares. p_a and p_c denote U.S. wheat prices divided by Australian and Canadian wheat prices, respectively. Note that the wheat prices are expressed in U.S. dollars to make the relative forms interpretable. r_a and r_c represent U.S. dollar values (R_u) divided by Australian and Canadian dollar values (R_a and R_c), respectively, against the ten Asian markets. These relative forms correspond to U.S. dollar values against Australian and Canadian dollar values, since an Asian country's currency value exists in both the denominator and numerator and is deleted from the relative forms. In a market share model, the exchange rate between the importing country and the exporting country should not matter. All that should matter is the exchange rate between the exporting countries, because it affects the relative import prices of wheat. $V(\cdot)$ denotes the volatility of U.S. wheat prices or currency values relative to the volatility of Australian or Canadian wheat prices or currency values; *e* is an error term; and α_0 and β_i are unknown parameters. Price variables are time-variant but cross-sectional invariant. All other variables are both time and cross-sectional variant. The subscript *i* denotes cross-sectional changes for the ten Asian importing countries. The subscript *t* represents time changes from 1973/74 to 2006/07 by fiscal year.

A rise in the U.S. wheat prices would reduce the demand for U.S. wheat, thus reducing its market share, while competitors' increased wheat prices might encourage the importers to purchase more from the United States. Thus, the expected signs of the coefficients of p_a and p_c are negative. A rise in the U.S. dollar value (against Australian and Canadian dollar values) may result in comparatively higher purchasing costs of U.S. wheat and, therefore, reduced demand for U.S. wheat. The opposite would be true if the relative U.S. dollar value decreases. Thus, expected signs of the coefficients of r_a and r_c are negative. If the volatility of an exporting country's wheat price or currency value increases, the importers would reduce wheat purchases from the country and switch to other exporters to avoid the risk. A higher volatility implies a higher risk for the importers. Expected signs of relative risk variables for prices and exchange rates are negative.

An import demand model usually includes a variable that captures the effects of change in the importing country's income level, if the dependent variable is the quantity imported. However, since the dependent variable is market share rather than quantity imported, a variable representing importing countries' income level is not included in Equation (1). This follows an assumption that changes in income level in an importing country will not affect the market shares of an exporting country unless consumers' preferences for wheat from various exporting countries significantly changes with their income levels.

The trade policies of importing countries, as well as destination-specific transportation costs, can influence trade flows. For importing countries' trade policies, it is assumed that they do not discriminate in favor of one country against other exporting countries.[4] Regarding transportation costs, it is assumed that the freight rates for heavy grain en route from the United States to the Asian countries have not increased or decreased much in comparison to the freight rates for other countries' trade routes. According to *World Grain Statistics*, published by the International Grain Council (IGC), the annual averages of freight rates for heavy grain for major ocean routes have moved together. Therefore, transportation costs may not significantly affect the U.S. market shares, although it may affect the quantity imported.

Gehlhar and Vollrath (1997) analyzed U.S. market shares of agricultural commodities in the world market to determine whether or not a drop in the U.S. agricultural market share is associated with displacement by competing suppliers. They developed a method, called trade share accounting (TSA), which establishes the relationship between trade structure and market share. From their empirical results, four distinct trends were identified: the 1962-72 *early period*, the 1972-81 *expansion period*, the 1981-87 *contraction period*, and the 1987-94 *transition period*.

For the contraction period, they argue that the two farm policies in the early 1980s - increased loan rates and target prices - are responsible for lost market shares. In effect, these farm policies raised prices of U.S. bulk commodities above the world prices,[5] which

[4] One example for supporting the assumption would be Japan's wheat policy. The Food Staple Control Act of 1942 in Japan gave the Japanese Food Agency (JFA) authority to control prices and marketing of wheat, rice, and barley. The JFA has exerted a high degree of monopsony power in the world wheat market. Refer, for example, Love and Murniningtyas (1992). However, the wheat market shares of the three exporting countries have been stable in Japan during the last two decades. This suggests that Japan's wheat policy does not discriminate in favor of one country against other exporting countries. Rather than discriminating different exporting countries, the JFA gained lowest import prices using the monopsony power. According to the information from the director of the U.S. wheat association Japan-branch we contacted, the JFA purchases more than 90% of wheat imported by Japan. The JFA has a weekly tender through the year, announcing the commodity and quantity. The registered wheat importers begin to check the wheat prices and offer the best prices. Then, the JFA selects an offer with the lowest price in Japanese yen at the Japanese port delivery.

[5] The policies increased both loan rates and target prices because of concern about the potentially negative impact that the Soviet grain embargo would have on domestic farm income. The loan rate for wheat increased 36 percent in a single year, rising from \$2.35 in 1979 to \$3.20 per bushel in 1980. Shortly thereafter,

could encourage competitors to increase their production and to gain market shares. The overall U.S. agricultural market share stopped its precipitous decline in 1987, and then began to rise modestly, gaining 1.3 percent between 1987 and 1994. The export enhancement program (EEP) was one of the main boosters for U.S. agricultural exports during the period.[6] The impact of the EEP in terms of additional exports and cost effectiveness has been analyzed in various studies. The results of these studies have varied widely, with the estimated additional exports ranging from 5 to 70 percent (e.g., Seitzinger and Paarlberg, 1989; and Goldberg and Knetter, 1997).

To capture the effects from the U.S. domestic farm policies and the EEP, two dummy variables, D_t^1 and D_t^2, are included in Equation (1). The first dummy represents the increased loan rates and target prices in the early 1980s. The value of D_t^1 is set as one if *t* corresponds to 1980 through 1984, otherwise it is set as zero. The second dummy represents the EEP. The value of D_t^2 is set as one if *t* is from 1985 to 1995, otherwise it is set as zero.

3. DATA AND PANEL UNIT-ROOT TEST

3.1. Data

The data consist of U.S. wheat market shares in ten Asian countries (China, Hong Kong, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan, and Thailand); average wheat export prices of the United States, Australia, and Canada; and real exchange rates between the ten Asian importing and three exporting countries. The data are annual and range from 1973/74 to 2006/07 by fiscal year.

The data for wheat import by the Asian countries are acquired from the *Foreign Agricultural Service PSD online* provided by USDA. Summary statistics of total wheat imports and imports from the United States by the ten Asian importing countries are presented in Table 1. The data on wheat export prices were provided by the *World Grain*

the 1981 Agricultural and Food Act legislated yearly increases in support prices. Since target price or loan rate serves as a floor price, target price or loan price will become domestic (market) price when market price is lower than target price or loan price, meaning increasing export price. Refer Knutson, Penn, and Blinchbaugh (1998) for debates for the effects of the policies.

[6] The EEP was initiated under the Food Security Act of 1985. This program allows exporters to sell U.S. products in targeted markets at prices below their costs by providing cash bonuses. According to the data set of *Foreign Agricultural Trade of the United States*, provided by FAS/USDA, among various commodities, wheat accounts for more than 80 percent of the total value of all EEP-assisted sales. Until 1994, EEP was applied to an average of 50 to 70 percent of U.S. wheat exports.

Table 1. Summary Statistics of Total Wheat Imports and Imports from the United States by the Ten Asian Countries

Country	Total Wheat Imports				Wheat Imports from the United States			
	Mean	*Std. Dev.*	*Max*	*Min*	*Mean*	*Std. Dev.*	*Max*	*Min*
China	7998	4800	15863	195	2686	2532	8698	0
Hong Kong	332	172	707	124	90	42	172	7
Indonesia	2116	1108	4201	576	403	294	902	0
Japan	5756	295	6418	5111	3217	201	3567	2633
Malaysia	782	349	1340	336	65	38	127	13
Philippines	1368	747	3050	503	1118	537	2177	307
Singapore	280	92	513	150	40	19	88	4
South Korea	3000	1159	5647	1584	1691	229	2107	1340
Taiwan	830	173	1138	527	743	161	1018	442
Thailand	386	282	941	68	166	93	353	37

Notes: The wheat imports are denoted by quantity (1,000 metric tons). Data run from 1973/74 through 2006/07 by fiscal year.

Statistics published by the IGC. The wheat prices are measured as freight-on-board, and they are expressed in the U.S. dollars per ton. Wheat price quotations and summary statistics of the average wheat export prices of the United States, Australia, and Canada are presented in Table 2. From the ten series, the average prices of U.S., Australian, and Canadian wheat were calculated, under the implicit assumption that these different types of wheat are substitutable by the importers.

Table 2. Summary Statistics of Wheat Prices of the United States, Australia, and Canada

	U.S. Wheat Prices	Australian Wheat Prices	Canadian Wheat Prices
Wheat Price Quotations	No.2 DNS 14% in Gulf and Pacific Ports No.2 HRWO in Gulf Port No.2 Soft Red Winter in Gulf Port No.2 Western White in Pacific Prot No.2 Hard Winter 13% in Pacific Port	Prime Hard Australian Standard White	Canada Western Red Spring 13.5% in St. Lawrence and Pacific ports
Mean	154.65	176.05	187.92
Std. Dev.	23.17	31.01	27.79
Maximum	215.50	251.50	249.00
Minimum	117.00	120.50	135.00

Notes: The wheat prices are freight-on-board (FOB) and they are expressed in the U.S. dollars per ton. Data run from 1973/1974 through 2000/07 by fiscal year. DNS denotes Dark Northern Spring, and HRWO denotes Hard Red Winter Ordinary.

This study utilizes real exchange rates and volatilities. There are three sets of real exchange rate data: the Asian countries' currency values against the U.S. dollar (R_u); the Asian countries' currency values against the Australian dollar (R_a); and the Asian countries' currency values against the Canadian dollar (R_c). Real exchange rate data were obtained from the *Agricultural Exchange Rate Data Set* of the Economic Research Service (ERS)/USDA. The average and standard deviation of the exchange rates are displayed in Table 3.

Table 3. Summary Statistics of Exchange Rates of Asian Importing Countries against the U.S., Australian, and Canadian Currencies

Country	vs. United States		vs. Australia		vs. Canada	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
China	6.06	2.21	4.73	1.45	4.91	1.66
Hong Kong	6.79	1.61	5.47	1.26	5.63	1.45
Indonesia	6850.03	3405.68	5247.72	2002.80	5450.51	2224.30
Japan	111.97	22.74	92.33	28.25	93.82	25.75
Malaysia	2.67	0.72	2.11	0.37	2.17	0.47
Philippines	42.95	8.10	34.27	4.14	35.30	5.85
Singapore	1.45	0.16	1.17	0.13	1.20	0.15
South Korea	1035.44	143.37	831.81	93.74	851.50	92.54
Taiwan	28.39	3.71	23.02	4.02	23.51	3.72
Thailand	30.68	6.60	24.35	2.63	25.06	3.82

Notes: The exchange rates are average annual real rates. Data run from 1973/74 through 2006/07 by fiscal year. For the reason of space, other statistics such as maximum or minimum are not presented in the table.

3.2. Panel Unit-Root Test

Nonstationarity and cointegration may exist in panel data. The presence of a unit-root process makes the panel data nonstationary, which has the potential to lead to serious errors in inferences and cointegration between nonstationary variables. After the pioneering work of Levin and Lin (1992), the panel unit-root test has been developed theoretically and applied in empirical studies. Notable contributors in theoretical research include Maddala and Wu (1999), Harris and Tzavalis (1999), and Im, Pesaran, and Shin (2003). Empirical applications of panel unit-root tests are found in MacDonald (1996); Frankel and Rose (1996); and Wu (1996).

Among the different panel unit-root tests, the test developed by Maddala and Wu (1999) has several advantages compared to others. It fits with any type of univariate unit-root test derived and allows specification of different lag lengths in the unit-root regression. It works also for unbalanced panel data. For these reasons, this study adopts

Maddala and Wu's methodology, hereafter MWF, for the panel unit-root test of our data. Since their work was on the basis of Fisher (1932), it is called MWF instead of MW.

In the test, there is a linear trend for each of the *N* cross-section units, resulting in *N* separate unit root tests. The test determines the significance of the results from *N* independent tests of a hypothesis, and the power of the test depends on the way of combining observed significance levels from the *N* different tests. Under the assumption of continuous test statistics, the significance levels ($\alpha_i s$) in *N* univariate unit-root tests follow a uniform distribution, $\alpha_i \in (0,1)$, where $i = 1, 2, ..., N$. Fisher (1932) argued that under the additive property of the χ^2 distribution, the sum of the *N* independent tests for a same null hypothesis, $\sum_i \ln \alpha_i$, has χ^2 distribution with $2 \cdot N$ degree of freedom. Therefore, test statistics of the MWF correspond to the sum of *N* independent $-2 \cdot \ln \alpha_i$.

For the empirical test of the MWF on the panel market shares and exchange rate data, the ADF (*p*) test was applied to each time series in the panel data, where the time dimension of each panel data is 35 and the cross sectional dimension is 10. Two ADF models, drift and trend, were constructed. In the MWF test, one needs to perform a Monte Carlo simulation to derive the *p*-values. Using the Dickey-Fuller *t*-distributions, asymptotic *p*-values were generated by 20,000 simulations for the corresponding ADF *t*-test statistics. Lastly, the MWF test statistic was calculated for the panel variables of U.S. market shares and exchange rates, and the ADF test statistic was derived for the univariate variables of wheat prices of the three exporting countries.

Table 4. Results of Panel and Univariate Unit-Root Tests

Test	Variables	Drift	Trend
Maddala-Wu Fisher Test	U.S. Wheat Market Shares	30.870**	57.423**
		(0.051)	(0.000)
	U.S. $ Values in the Asian Countries	22.048	50.182**
		(0.299)	(0.000)
	Australian $ Values in the Asian Countries	12.027	37.258**
		(0.880)	(0.011)
	Canadian $ Values in the Asian Countries	17.376	42.463**
		(0.598)	(0.003)
Augmented Dickey-Fuller Test	U.S. Wheat Export Price	-3.7628**	-3.6735**
		(0.009)	(0.049)
	Canada Wheat Export Price	-2.2725	-2.7642*
		(0.229)	(0.083)
	Australia Wheat Export Price	-1.2347	-3.2404*
		(0.250)	(0.071)

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

Test results are presented in Table 4. Applying the drift model, we could reject the null of a unit-root for market share data, but not for exchange rate data, at the 5 percent significance level. When applying the trend model, the null hypothesis was rejected for all panel data series. For the univariate unit-root test, the null hypothesis was rejected only for the U.S. wheat price series at the 5 percent level under the drift model, but the null was rejected for all price series at the 5 percent level under the trend model. The same tests were repeated for the relative variables, and the results were similar to those for level data. The results suggest that a linear time trend should be included in the empirical model to reduce any erroneous inference from the existence of time trends in the panel data. The test was performed again to permit cross-correlated errors in the panel, and the results were qualitatively the same with those from the test without permitting cross-correlated errors.

4. ESTIMATION AND RESULTS

4.1. Procedure of Empirical Analysis

Each set of real exchange rate panel data is normalized to make each time series equivalent in magnitude. There are three panel exchange rate data sets, i.e., R_u, R_a, and R_c, and in each data set there are ten time series. To rescale each observation, a sample average was calculated for each time series and each observation is divided by the sample average and multiplied by 100. The variances in wheat prices and exchange rates were obtained using the moving sample standard deviation of changes that has been extensively used in literature (e.g., Koray and Lastrapes, 1989; and Chowdhury, 1993). The volatility measure is calculated as follows:

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

where V_t is the volatility and k is the order of moving average. In this study, k is specified as one.

Empirical estimation for Equation (1) is performed using a two-way panel model. To account for any country and time-specific effects that cannot be captured by the explanatory variables, variables for both country and time effects are included in the panel analysis as follows.

$$\begin{aligned} x_{it} &= z'_{it}\beta + e_{it}, \qquad i = 1,\ldots,N; \quad t = 1,\ldots,T, \\ e_{it} &= \phi_i + \omega_t + \varepsilon_{it}, \end{aligned} \tag{3}$$

where z is the matrix of explanatory variables and the subscript it denotes an observation for *i*th cross-sectional unit and *t*th time point, and β is the vector of unknown parameters. The error term, e_{it}, is broken into three components: ϕ_i is a time-invariant cross-section 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. Statistical justification for including both effects is based on a Lagrange multiplier (LM) test (Breusch and Pagan, 1980). In the LM test, the null hypothesis states that no country and time effects exist in the error component model. The LM test was performed and the test statistic was 28.87, which is larger than the critical value of χ^2 distribution with 2 degrees of freedom at the 5 percent level (5.99). Therefore, the null hypothesis of no country and time effects is rejected, indicating that inclusion of the two effects is appropriate and it helps to reduce bias and inconsistency problems caused by omitting relevant variables.

In the estimation, the country and time effects are treated as random, based on a Hausman m-statistic. The Hausman (1978) test was performed and the result showed that the test statistic is 9.45, which is smaller than the critical value of χ^2 distribution with 4 degrees of freedom at the 5 percent level (9.48). The null hypothesis of no correlation between the effect variables and the regressors was not rejected at the 5 percent significance level. This suggests that the random effects model is more appropriate than the fixed effects model.

In the time processes of wheat trade between the United States and the Asian importing countries, a big 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, an autoregressive error component model (Parks, 1967) and the two-way random effect model with a variance-component MA process (Da Silva, 1975) are used in addition to the two-way random effect model (Fuller and Battese, 1974).

In Park's model, the error term, e_{it}, in Equation (3), is broken into two components as follows:

$$e_{it} = \rho_i e_{it-1} + \varepsilon_{it} , \tag{4}$$

where $E[e_{it}^2] = \sigma_{ii}$ denotes heteroscedasticity, and $E[e_{it} e_{jt}] = \sigma_{ij}$ denotes contemporaneously correlated. Therefore, the model is the first-order autoregressive with contemporaneous correlation between cross section.

In the Da Silva model, the residual effect, ε_{it}, in Equation (3), is specified as a finite MA time process of order $m < T - 1$ for each cross-section *i*. It is expressed as follows:

$$\varepsilon_{it} = a_0\theta_t + a_1\theta_{t-1} + ... + a_m\theta_{t-m} , \tag{5}$$

where a_i are unknown constant parameters and θ_t is a white noise process. In this variance-component MA model, the three random variables, ϕ_i, ω_t, and ε_{it}, have normal distributions: $\phi_i \sim N(0,\sigma_\phi^2)$, $\omega_t \sim N(0,\sigma_\omega^2)$, and $\theta_{t-k} \sim N(0,\sigma_\theta^2)$, for $i=1,...,N;\ t=1,...,T;\ k=1,...,m$. The optimal lag, *m*, is determined by a generalized R-square.[7]

The U.S. wheat price is potentially endogenous if there is a simultaneous relationship with the U.S. market shares. If the importers account for the U.S. market shares when purchasing wheat or if the U.S. exporters exert their market power in a destination Asian market based on their market shares, an endogeneity problem might exist in the model. In such cases, the values of price variables may be determined inside or by the model. This could cause price variables to be correlated with the error term, resulting in an inconsistent estimation.

The endogeneity problem is checked using the test suggested by Spencer and Berk (1981). As the first step, we selected instrument variables which are exogenous or predetermined and are strongly correlated with the U.S. wheat prices but not correlated with the error term e_{it} in Equation (1). The instrument variables include operating and opportunity costs in the production of wheat in the United States: costs from fertilizer, chemicals, seed, fuel-lube-electricity, hired labor, and interest rates.[8]

The second step is to run an OLS regression with the chosen instrument variables[9] on the following equation:

$$p_{ust} = \delta IV_t + \upsilon_t\ , \tag{6}$$

where p_{us} denotes U.S. wheat prices; *IV* denotes the vector of instrument variables; δ represents the vector of coefficients to be estimated; and υ is an error term with *i.i.d.*

[7] The conventional R-squared measure is inappropriate since a number outside the 0-to-1 range may be produced in the case of GLS estimation. Thus, a generalized R-squared statistics is reported according to Buse (1973).

[8] In addition to these six factors, there are more potential instruments, such as opportunity cost of unpaid labor, taxes and insurances, or costs for repairs. Because including too many variables might cause multicollinearity between instrument variables, the instruments were chosen based on *t*-value of each variable and the adjusted R^2. All potential instrument variables were at first included into the Equation (6) and then statistically insignificant variables were removed. If the *t*-value of a variable is not statistically significant at the 5 percent level and omitting the variable does not significantly reduce the value of the adjusted R^2, then the variable is removed from the estimation equation for both parsimonious specification and reducing the multicollinearity problem.

[9] The data of the operating and opportunity costs of producing wheat in the United States was obtained from the *commodity costs and returns* published by ERS/USDA.

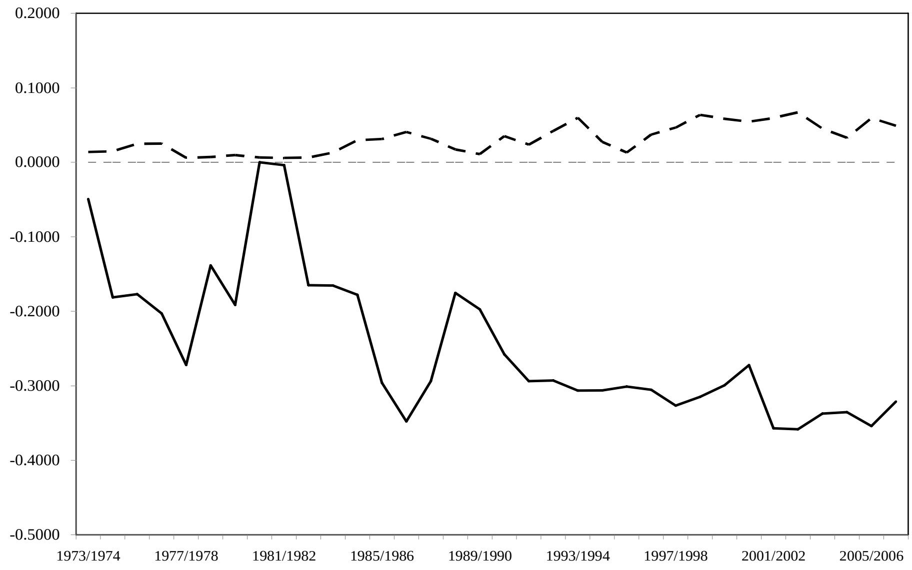
Finally, Equation (1) is estimated with the residual υ_t as an additional independent variable. Under the null hypothesis of no endogeneity, the coefficient of υ_t should be equal to zero. If the test result indicates endogeneity of the U.S. wheat prices, one needs to use the instrument variables instead of the U.S. wheat prices. Estimation results show that the *t*-value of υ_t is 1.23 when we use the model of two-way random effect with variance-component MA process. The null hypothesis of no endogeneity cannot be rejected. Therefore, any potential endogeneity problem of the U.S. price variable would be insignificant in the estimation.

4.2. Estimation Results

As a preliminary step, we tested whether decreased aggregate market share of U.S. wheat in the Asian countries is associated with losses in its market share in individual destination markets or due to any change in the structure of the Asian wheat import market. If markets where an exporting country holds higher market shares grow slower than other markets where the exporting country has lower market shares, the aggregate market share of the country decreases while it maintains constant market shares in individual destination markets. In this case, the aggregate market share does not correctly mirror the country's export performance. Therefore, one needs to test whether the decrease in the aggregate market share was necessarily associated with weakened performance of U.S. sales in individual markets or if it was caused by structural changes in the destination markets. For the test, the structural effect and performance effect were derived using the TSA by Gehlhar and Vollrath (1997).[10] The results are displayed in Figure 1, which shows that changes in the total effect are not mainly from the structural effect and therefore changes in the aggregate market shares are mainly from the performance effect. This clearly indicates that the decreased U.S. market share is associated with losses of its market share in individual destination markets.

The results from the panel estimation of Equation (1) are presented in Table 5 and the results show that most of the variables are not statistically significant. However, there are some exceptions: the relative exchange rates in the case of variance-component MA method; the intercept and time trend in the case of Park's method; and the dummy for U.S. domestic policies in the 1980's and time trend in the case of Fuller and Battese's method.

[10] Based on the trade share accounting by Gehlhar and Vollrath (1997), the following three trade accountings were established: 1) the individual market share for U.S wheat in the Asian countries, 2) the relative size of the individual Asian markets, and 3) the aggregate market share of U.S. wheat in the Asian markets. From the three accountings, the observed market share, the fixed-performance market share, and the base-period market share were estimated by assuming the base year to be 1980. Structural effect and performance effect were then calculated using the three market shares.



Notes: Base year for the accounting is 1980. Dashed line denotes structural effect and bold line denotes total effect.

Figure 1. Trade Share Accounting for U.S. Wheat in the Asian Countries

It implies that if we interpret the results with focus on the variance-component MA method, relative exchange rates are important variables affecting U.S. market shares in the Asian importing countries. This suggests that a strong U.S. dollar compared to its competitors' currencies has a negative effect on U.S. wheat market shares, while strong currency values of its competitors have favorable effects on U.S. market shares. However, results from the other two models say that the variables are not significant.

The price variables are not statistically significant in all estimation methods, which is rather puzzling. This implies that the prices are not important factors in the wheat trade between the three exporting countries and the Asian importing countries.

The dummy variable for the two farm policies in the early 1980s (increased loan rates and target prices) are not statistically significant, except only for the case of Fuller and Battese method. That is, the results from the Fuller and Battese method show that the policies of increased loan rates and target prices had a detrimental effect on the U.S. wheat export performance in the markets. However, the results from the other two estimation methods say differently. The dummy variable for the EEP is not statistically significant in all estimation models, indicating that the subsidy did not have a favorable effect on the U.S. wheat export performance. That is, the EEP was not an effective policy to reverse the downward trend of U.S. wheat exports in the Asian markets after the early 1980s.

Table 5. Panel Estimation Results

Variables	Variable Definition	Expected Sign	Variance-Component MA Method		Park's Method		Fuller and Battese's Method	
α_0	Intercept		0.3703	(0.361)	**0.6642****	(0.000)	0.4096	(0.323)
p_a	U.S. Wheat Price/ Australian Wheat Price	*Negative*	-0.0571	(0.810)	-0.2183	(0.055)	-0.1243	(0.668)
p_c	U.S. Wheat Price/ Canadian Wheat Price	*Negative*	0.1765	(0.571)	0.1345	(0.331)	0.2173	(0.477)
$V(p_a)$	Volatility of p_a	*Negative*	-0.0049	(0.194)	-0.0050	(0.003)	-0.0059	(0.229)
$V(p_c)$	Volatility of p_c	*Negative*	0.0000	(0.199)	0.0000	(0.853)	0.0000	(0.955)
r_a	U.S. $ vs. Australian $	*Negative*	**-0.8775****	(0.000)	0.0447	(0.703)	0.0211	(0.911)
r_c	U.S. $ vs. Canadian $	*Negative*	**-0.8882****	(0.000)	0.0391	(0.626)	0.0289	(0.848)
$V(r_a)$	Volatility of r_a	*Negative*	0.0018	(0.136)	0.0008	(0.020)	0.0003	(0.717)
$V(r_c)$	Volatility of r_c	*Negative*	0.0001	(0.067)	0.0000	(0.515)	0.0000	(0.951)
D_1	Dummy for U.S. Domestic Policies in 1980's	*Negative*	0.0245	(0.507)	-0.0157	(0.429)	**-0.0842****	(0.006)
D_2	Dummy for EEP	*Positive*	0.0499	(0.176)	-0.0463	(0.059)	0.0103	(0.679)
t	Time Trend		-0.0027	(0.449)	**-0.0119****	(0.000)	**-0.0072****	(0.020)
Number of Cross Section			10		10		10	
Length of Time Series			33		33		33	
F test			284.91		2.57		1.59	
(p-value)			(0.000)		(0.005)		(0.108)	

Notes: The values in the parentheses denote p-values. The null hypothesis of F-test is that all variables are insignificant and the values in parentheses are p-values. The symbol ** denotes statistical significance at the 5 percent level.

The variables for the export price volatilities relative to the competitors' price changes and the U.S. dollar volatilities relative to the competitors' currency changes not statistically significant in all estimation models. This implies that the price volatilities and/or currency volatilities are not important factors in the Asian wheat import market. Note that the data are annual, so that the volatility is based on annual changes. Long-range changes of prices and/or exchange rates may not give a significant effect to the decision in the wheat import. However, if one uses quarterly or monthly data, qualitatively different results may be obtained for the price and/or currency volatility variables. This suggests that the volatility variables are not important variables and including them may cause a specification bias in the estimation through a redundant variable problem. Thus, we performed the estimation again without the volatility variables and the results are displayed in Table 6. The results in Table 6 are qualitatively similar to those in Table 5. Most of the variables are not statistically significant.

Table 6. Panel Estimation Results: Without Volatility Variables

Variables	Expected Sign	Variance-Component MA Method		Park's Method		Fuller and Battese's Method	
α_0		0.3218	(0.386)	**0.5867****	(0.001)	0.4089	(0.317)
p_a	*Negative*	-0.0611	(0.757)	-0.1063	(0.300)	-0.0392	(0.886)
p_c	*Negative*	0.3102	(0.268)	0.1056	(0.447)	0.1559	(0.598)
r_a	*Negative*	0.5929	(0.001)	0.0071	(0.950)	0.0110	(0.950)
r_c	*Negative*	**-0.6907****	(0.000)	0.0481	(0.523)	0.0078	(0.955)
D_1	*Negative*	0.0152	(0.642)	-0.0013	(0.946)	0.0947	(0.061)
D_2	***Positive***	0.0228	(0.451)	-0.0273	(0.155)	-0.0064	(0.774)
t		-0.0011	(0.732)	**-0.0104****	(0.000)	**-0.0067****	(0.026)
Number of Cross Section		10		10		10	
Length of Time Series		33		33		33	
F test		5.72		0.73		2.43	
(*p*-value)		(0.000)		(0.627)		(0.026)	

Notes: The values in the parentheses denote *p*-values. The null hypothesis of F-test is that all variables are insignificant and the values in parentheses are *p*-values. The symbol ** denotes statistical significance at the 5 percent level.

Overall results imply that the prices are not important factors (through all different estimation methods) in the wheat trade between the three exporting countries and the Asian importing countries. Story is not much different for the exchange rates. The results only from the variance-component MA method indicate that they are important factors in the Asian wheat import market. This implies that other factors beyond the prices or exchange rates, e.g., quality or type of wheat, importing countries' trading policies, or utilization of the state trading agencies such as the Australian Wheat Board (AWB) and the Canadian Wheat Board (CWB), could be important issues. Thus, future studies should check the qualitative issues to have a insight into the U.S. wheat export performance in the Asian market.

4.3. Reconciliation with Previous Research

This paper has a similarity with Jin, Cho, and Koo (2004) in that both studies analyze similar topics for the same destination markets. The main focus of Jin *et al*. is placed on the effects of price and exchange rate changes of competing suppliers on the U.S. market shares. In order to analyze the impact of competition among the exporting countries, they developed a third country effect model, similar to that by Cushman (1986). Another focus of the paper was given to volatility measures. Four different methods of measuring exchange rate volatility are used to check sensitivity of empirical results to the different measures.

This study differs from Jin *et al*. in the following aspects. 1) This study analyzes the trade share accounting to see whether a drop in the U.S. market share is associated with displacement by competing suppliers. 2) Instead of a third country effect model, this study specifies a standard market share model. 3) This paper uses the relative form of price and exchange rate variables, i.e., the U.S. prices and exchange rate variables were divided by Australian and Canadian variables, respectively. This type of model specification will increase credibility of the analysis since in a market share model, relative prices or relative exchange rates between exporting countries are more important factors than prices or exchange rates of an exporting country alone. 4) This study analyzes the effects of U.S. farm and export policy: increased loan rates and target prices in the 1980s and export enhancement program.

This study finds that the decreased U.S. market share was associated with losses of its market share in individual destination market, but not related to changes in the structure of the Asian wheat import market. It also shows that overall results from three different estimation methods indicate that relative wheat export prices and exchange rates between the United States and both competitors (Australia and Canada) were not important factors affecting the U.S. market shares. While, Jin *et al*. found that Australian wheat price was an important factor on the U.S. market share, but Canadian wheat price was not and that Canadian and Australian currency values were not important factors on the U.S. market shares.

Published works which yield results regarding the effects of the EEP are those of Seitzinger and Paarlberg (1989) and Goldberg and Knetter (1997). Seitzinger and Paarlberg analyzed the effect of the EEP on U.S. wheat exports. Their study shows that the program raised volume, prices, and gross export revenues, but net export revenues rose only slightly. It is important to note that they used sample data from 1985 through 1988, which is only a part of the whole EEP period, so comparing our results to theirs may not provide reliable economic meaning. Goldberg and Knetter analyzed the impacts of the EEP for wheat, with a sample period closer to that of our data. The study shows that overall export shares did not rebound in spite of the implementation of the EEP in the post-1985 period.

5. SUMMARY AND CONCLUSION

This study examines the effects of export competitors on the U.S. wheat market shares in ten Asian markets. We included competition effects between wheat exporting countries in the markets and variables representing U.S. farm and trade policies in addition to prices, exchange rates, and their volatilities. The model was estimated using there different estimation methods.

The results from the three different methods show that relative wheat export prices and exchange rates are not important factors affecting U.S. market shares. However, there were exceptions. The relative exchange rates in the case of Da silva method are statistically significant at the 5 percent level, implying that appreciated U.S. dollar values had detrimental effects on U.S. wheat market shares, while competitors' higher wheat prices and currency appreciation had cross positive effects on U.S. market shares. The variables for the relative volatility of wheat prices and exchange rates are not statistically significant in all cases of estimation models. This implies that importers are not sensitive to annual changes in prices and exchange rates.

The dummy variable for increased loan rates and target prices are not statistically significant, except only for the case of Fuller and Battese's method, indicating that at least a result shows detrimental effect of the policies on the U.S. wheat export performance in the Asian markets. The dummy variable for the EEP is not statistically significant in all estimation models, indicating that the subsidy did not have a favorable effect on the U.S. wheat export performance in the Asian wheat import market.

Overall results imply that the prices are not important factors (in all different estimation methods) in the wheat trade between the three exporting countries and the Asian importing countries. Similar story goes for the exchange rates. The results only from the variance-component MA method indicate that currency values are important factors in the Asian wheat import market. This implies that future studies are needed to analyze other factors beyond the prices or exchange rates, such as different protein or type of wheat, importing countries' trading policies, or utilization of the state trading agencies (e.g., AWB and CWB) for the Asian wheat import market. That is, it suggests that one needs to access the issue through qualitative aspects.

REFERENCES

Asseery, A., and D.A. Peel (1991), "The Effect of Exchange Rate Volatility on Exports: Some New Estimates," *Economics Letters*, 37, 173-177.

Breusch, T.S., and A.R. Pagan (1980), "The Lagrange Multiplier Test and its Application to Model Specification in Econometrics," *The Review of Economic Studies*, 47(1), 239-253.

Buse, A. (1973), "Goodness of Fit in Generalized Least Squares Estimation," *American Statistician*, 27, 106-108.

Chowdhury, A.R. (1993), "Does Exchange Rate Volatility Depress Trade Flows? Evidence from Error-Correction Models," *Review of Economics and Statistics*, 75(4), 700-706.

Cushman, D.O. (1983), "The Effects of Real Exchange Rate Risk on International Trade," *Journal of International Economics*, 15, 45-63.

Da Silva, J.G.C. (1975), *The Analysis of Cross-Sectional Time Series Data*, Department of Statistics, North Carolina State University.

Fisher, R.A. (1932), *Statistical Methods for Research Workers*, 4th ed., Edinburgh: Oliver & Boyd.

Frankel, J.A., and A.K. Rose (1996), “A Panel Project on Purchasing Power Parity: Mean Reversion Within and Between Countries,” *Journal of International Economics*, 40, 209-224.

Fuller, W.A., and G.E. Battese (1974), “Estimation of Linear Models with Crosses-Error Structure,” *Journal of Econometrics*, 2, 67-68.

Gehlhar, M.J., and T.L. Vollrath (1997), “U.S. Export Performance in Agricultural Markets,” Technical Bulletin, 1854, Economic Research Service of U.S. Department of Agriculture, Washington D.C.

Goldberg, P., and M.M. Knetter (1997), “Causes and Consequences of the Export Enhancement Program for Wheat,” *The Effects of US Trade Protection and Promotion Policies*, in R. Feenstra, ed., University of Chicago Press, Chicago, 273-296.

Gotur, P. (1985), “Effects of Exchange Rate Volatility on Trade: Some Further Evidence,” IMF Staff Papers, 32, 475-512.

Harris, R.D.F., and E. Tzavalis (1999), “Inference for Unit Roots in Dynamic Panels Where the Time Dimension is Fixed,” *Journal of Econometrics*, 91, 201-226.

Hausman, J.A. (1978),“Specification Tests in Econometrics,” *Econometrica*, 46(6), 1251-1271.

Im, K.S., M.H. Pesaran, and Y. Shin (2003), “Testing for Unit Roots in Heterogeneous Panels,” *Journal of Econometrics*, 115(1), 53-74.

Jin, H.J., G. Cho, and W.W. Koo (2004), “Third Country Effects on the Market Shares of U.S. Wheat in Asian Countries,” *Journal of Agricultural and Applied Economics*, 36, 797-813.

Kenen, P.B., and D. Rodrik (1986), “Measuring and Analyzing the Effects of Short-Term Volatility in Real Exchange Rates,” *The Review of Economics and Statistics*, 68, 311-315.

Knutson, R., J.B. Penn, and B.L. Flinchbaugh (1998), *Agricultural and Food Policy*, 4th ed., Prentice-Hall, Inc.

Koray, F., and W.D. Lastrapes (1989), “Real Exchange Rate Volatility and U.S. Bilateral Trade: A VAR Approach,” *The Review of Economics and Statistics*, 71, 708-712.

Levin, A., and C.F. Lin (1992), “Unit Root Test in Panel Data: Asymptotic and Finite Sample Properties,” Discussion Paper, 92-93, University of California at San Diego.

Love, H.A., and E. Murniningtyas (1992), “Measuring the Degree of Market Power Exerted by Government Trade Agencies,” *American Journal of Agricultural Economics*, 74(3), 546-555.

MacDonald, R. (1996), “Panel Unit Root Tests and Real Exchange Rates,” *Economics Letters*, 50, 7-11.

Maddala, G.S., and S. Wu (1999), “A Comparative Study of Unit Root Tests with Panel Data and A New Simple Test,” *Oxford Bulletin of Economics and Statistics*, Special Issue, 631-652.

Parks, R.W. (1967), “Efficient Estimation of a System of Regression Equations when

Distributions Are Both Serially and Contemporaneously Correlated," *Journal of the American Statistical Association*, 62, 500-509.

Seitzinger, A.H., and P.L. Paarlberg (1989), "The Export Enhancement Program: How Has it Affected Wheat Exports," Economic Research Service Publication, ERSAIB575, U.S. Department of Agriculture.

Spencer, D.E., and K.N. Berk (1981), "A Limited Information Specification Test," *Econometrica*, 49, 1079-1085.

Wu, Y. (1996), "Are Real Exchange Rates Nonstationary? Evidence from a Panel-Data Test," *Journal of Money, Credit, and Banking*, 28(1), 54-63.

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