International Journal of Economic Research

ISSN : 0972-9380

available at http: www.serialsjournal.com

Volume 14 • Number 9 • 2017

Market Integration and Price Transmission in Cereals

Dhari Jassim Al Abulhadi

Gulf University for Science and Technology

Abstract: This paper examines price transmission in cereals from the international market to the domestic market. Domestic prices of cereals; wheat, rice, and maize; for the countries Russia, Mexico, Ukraine, Brazil were compared to world prices established by the Unites States. This study uses Augmented Dickey-Fuller (ADF) unit root tests and Johansen's test for Cointegration as well as the Vector Error Correction Model (VECM) to examine both the short and long termrelationship between the two markets. The results of the study found integration between the four countries (Brazil, Mexico, Ukraine and Russia) when paired with each other and with the international prices of the United States. The results show that what matters is not the international prices but the process of elimination and the domestic prices. The strength or significance of cointegration varies with distance, which tends to show that; rather than a single, monolithic World Price taken from the United States, there are natural trade blocs which show more cointegration of prices due to proximity. Thus, in practice the Law of One Price must be modified somewhat, rather than accepted uncritically as in textbooks, since if the Law of One Price does not hold fully in the 'textbook" in the case of cereals, then it is unlikely to hold generally in the cases of all other goods. And the results remind us that it is long-term relation to the domestic prices is what is mainly significant.

JEL Classification: Agriculture in International Trade (Q17); Aggregate Supply and Demand Analysis (Q11); Prices; Empirical Studies of Trade (F14)

Keywords: Price transmission, Cereals, Cointegration

INTRODUCTION

Price transmission from theinternational food market to the domestic market is necessary to pursue comparative advantage and sustainable agricultural production, as well as to ensure domestic production responds to global food scarcity or surplus (World Bank, 2012).The objective of this paper is to examineprice transmission in cereals from the international market to the domestic market. Domestic prices of cereals; wheat, rice, and maize; for the countries Russia, Mexico, Ukraine, Brazilwere compared toworld prices established by the Unites States.

Cereals; wheat rice, and corn or maize; are the staple diet of humankind. Therefore the study of the prices of cereals is an important topic for pragmatic reasons. But for an Economics perspective, the commodity of cereals is important for theory because cereals are homogenous anywhere in the World and serve as the classic example for a perfectly competitive market, which obeys the "Law of One Price, as well as serving as a classic case for one of the most important "Laws" of Economics, namely, the "Law of Comparative Advantage". Therefore, from the point of view of economic theory, it is of crucial importance to investigate empirically, using modern time series econometrics as in the present paper, whether prices in fact follow the Law of One Price in order to provide a mechanism for the Law of Comparative Advantage.

REVIEW OF LITERATURE

Numerous studies have been done to examine themarket integration and degree of price transmission between different markets. These studies are given below.

Meyers, W. and Goychuk, K. (2011) examined the nature of the short run and long run price transmission between Ukraine and Russia and major wheat exporters such as the United States, the European Union (EU) and Canada. The study found that Russian price series werecointegrated with those of the EU, but not with Canadian or U.S. wheat prices. No cointegrationwas found between the Ukraine price series and the other price series. The short run relationship between Russia and theEU was found to be statistically significant.The long run price transmission elasticity between France and Russia was equal to1.07: the Russian wheat price adjusted within six months after the price change occurred in theFrench price.

Shinoj, P *et al.* (2008) analyzed spatial price integration and price transmission among major fish markets in India using monthly retail data. The study found that the degree of integration and rate of price transmission differed according to species. Integration was found to be highest in mackerel because of its affordability to all income classes.Anearfull transmission of price changeswas found in neighboringKerala and Tamil Nadu markets, except in the case of shrimp.The spatial market integration between major shrimp markets in the country was found to be the least, becausemost of it was going outside the country.Lack of integration between important markets of major marine species suggested strategies to bring about greater integration between these markets, so that both the fishermen and the fish consuming community in the country could benefit.

Listorti G. (2008) examined price transmission in the .soft wheat market between the United States and the European Union during the period 1978-2003. In this study, a composite variable equal to the maximum between the intervention and the US price was introduced in a cointegration model in order to study its relation to the EU price. In addition, other models were estimated in which the adjustment coefficients and the parameters of thecointegrating vector were allowed to vary according to the policy regime in place. Results of all models were found to be consistent.The EU price reaction to the long run equilibriumsuggeststhat the role of the US or world price can be understood only if policy regimes are adequately accounted for.Further research is required to measure to what extent the US price adjusts to disequilibria.

Yang, J *et al.* (2003) analysed future price and volatility transmission among threemajor wheat producing and exporting regions - the United States, Canadaand the European Union -for the period 1996-2002. The study found that the US market had a significant impact onthe neighboring Canadian market. The EU market was neither influenced by the US nor the Canadian market. The EU and Canadian pricesaffected the US market prices, but the impact was not large. The EU market was found to be transmitting volatility to theUS and Canada markets, but not vice versa. Moreover, the volatility in wheat prices wastransmitted from Canada to the US, but not vice versa.

Minot, N. (2011) examined the degree to which changes in world food markets influence the price of staple foods in Sub-Saharan Africa over the period 2007-2008. The study found that staple food prices in African countries rose 63 percent between mid-2007 and mid-2008, about three-quarters of world prices.African rice prices were found to be more closely linked to world markets, relative tomaize prices. The global food crisis was unusual in influencing African food prices, probably because of the size of the increase and the fact that it coincided with oil price increases.

Kilima, F (2006) investigated the extent to which world market price changes were transmitted through changes in border prices into local producer prices for four agricultural product markets in Tanzania — sugar, cotton, wheat and rice — for the period 1998-2004.Cointegration and Granger causality techniques were used to test price transmission. The study found thatprices in Tanzania were not well integrated with commodity prices in the world, and there is evidence that border prices were influenced by world market price levels but not vice versa.

Conforti, Piero (2004) examined price transmission in food commodities for sixteen countries during the period 1969 to 2001. These countries were Argentina, Brazil, Chile,Costa Rica, Egypt, Ethiopia, Ghana, India, Indonesia, Mexico, Pakistan, Senegal, Thailand, Turkey,Uganda, and Uruguay.The study found a lower degree of price transmission within African countries compared to that of other countries. Vertical transmission between producers, wholesalers, and retailers within the countrieswas found to be higher than the transmission via changes in the world reference prices. High and fast price transmission appeared for cereals, followed by oilseeds, while it was poorer for livestock products.

Greb, Friederike *et al.* (2012) examined the extent and speed of the transmission ofInternational cereal prices for rice, maize and wheat to local markets in developing countries,with a focus on African countries.The results showed that price transmission to the domestic markets was on an average 73% the strength of an international price changeand half of it occurred within 2.2 months, more than 1 month faster than in other regions. African rice markets were found to have the highest share of cointegrated price pairs, the largest long-run price transmissioncoefficient, and the fastest price reaction compared with other cereal products. In most cases domestic prices adjusted to deviations from the long-run relationship with world prices.

DATA AND METHODOLOGY

The data pertaining to wheat, maize and rice prices (monthly wholesale and retail prices) were collected from FAO GIEWSfor the period January 2000 to August 2014 for the countries Ukraine, Russia, Mexico and Brazil.All price series are in US dollars and are expressed in logs,as in a 'Gravity Model'.

To study the short run and long run relationship between two markets, this study uses Augmented Dickey-Fuller (ADF) unit root tests and Johansen's test forcointegration as well as the Vector Error Correction Model (VECM).

Before continuing it should be noted that modern Time Series Methods are particularly well-suited to testing the Law of One price using international price data as the present paper. Modern Time Series Econometrics is preoccupied with the question of how to measure whether 2 random series are possibly causally related as the Law of 1 price predicts a close relationship between the World Price of a commodity — in the case of cereals this the US Price, due to the productivity of US farmers of the cereal grains — wheat, rice, and maize or corn; and the domestic prices of other countries, up to the price of transaction costs due to distance. This relationship is aptly suited to tests of "cointegration", which test the strength of the relationship between two random variables, which in effect are identical in shape except for a distance between them which is constant, such as the differences in price caused by distance.

Regarding distance this has been repeatedly demonstrated to be a crucial determinate of International Trade. Along with the Law of Comparative Advantage, which is based on a comparison of domestic prices. In fact, models of International Trade which feature distance are known in economics by the term "Gravity Model", since trade between 2 countries depends on the distance between them; similar to how the force of Gravity varies depending on how close they are. The Theory of Gravity as derived by Newton, says that G = M1 * M2 / R-squared, which is a measure of the effect of distance. And taking log of both sides of the equation, we have that ln G = ln(MI) + ln(M2) – ln(R-squared). And in the case of trade, we may say that ln(Trade) = ln(P1) – ln(P2) - ln(Distance), where P=Price. Thus, this paper performs the Time Series tests on natural log of prices, which are hypothesized to be "cointegrated" since in the long run imports=exports such that net trade = 0. And thus the difference between ln(P1) and ln (P2) should be a function of distance.

ADF UNIT ROOT TEST

In order to test for the presence of market integration we use a cointegration test. And a cointegration test requires non-stationarity of the price series. We have applied the ADF test to test the null hypothesis of non-stationarity against an alternative of stationarity. ADF is based on the following equation:

$$\Delta X_t = k + \delta t + (\rho - 1) X_{t-1} + \sum_{i=1}^{N} \varphi \Delta X_{t=1} + \mu_t$$

where X_t is the individual price series under investigation, Δ is the first difference operator, t is a linear time trend, μ_t is a covariance stationary random error, and the number of lags on the augmenting term, N, is determined by Akaike's information criterion to ensure serially uncorrelated residuals. The null hypothesis that X is a non-stationary series is rejected if $(\rho - 1) < 1$ and is statistically significant.

Johansen's Cointegration test

The Johansen (1988) procedure was used to determine the number of cointegrating relationships for each market using only the I(1) variables.

$$P_t = A_1 P_{t-1} + A_2 P_{t-2} + \dots\dots + A_p P_{t-2} + \dots\dots + A_{p-1} P_{t-(p-1)} + A_p P_{t-p} + \varepsilon_t$$

t = 1, 2,..... refer to the data frequency

ε_t = vector of error terms

P = integer, the value of which is to be determined

P_t = (n x 1) vector of prices (p_{1t}, p_{2t}, ..., p_{nt})

A_i = n x (n-s) matrix of coefficients

Cointegration exists if there are n-s cointegrating vectors among the elements of the vector (Granger Representation Theorem described in Engle and Granger, 1987). In this context, the definition of an integrated market requires that s =1 because one reaches for locations that share long-run information.

Vector Error Correction Model (VECM)

An error-correction model is a dynamic model in which the movement of the variables in any periods is related to the previous period's gap from long-run equilibrium. In addition, the ECM provides insight into how the two prices respond to a state of short-run disequilibrium. Specifically, the error correction model allows one to estimate the proportion of the disequilibrium in one period that is corrected in the next period. Thus, the error correction model can be used to examine both short-run and long-run behavior simultaneously. A major result of the Granger Representation Theorem is that a cointegrated system can be written as a vector error correction model (VECM)

$$\Delta P_t = \mu + \Pi P_{t-1} + \Gamma_1 \Delta P_{t-1} + \Gamma_2 \Delta P_{t-2} + \dots\dots\dots + \Gamma_{p-1} \Delta P_{t-p+1} + \varepsilon_t$$

Where Γ_i and Π are matrices and Π has reduced rank *n-s*. The matrix Π can be written where α is an $n \times (n-s)$ matrix of coefficient, and β is an $n \times (n-s)$ matrix of cointegrating vectors. The method proceeds by first testing the hypothesis $r = 0$ that is, there is no cointegrating vector. If this hypothesis can be rejected, it is possible to test the 'hypothesis that there is at most 1 cointegrating vector ($r \leq 1$) and so on.

The regression equation form for a VECM is:

$$p_t^d = \propto + \theta\left(p_{t-1}^d - \beta p_{t-1}^w\right) + \delta p_{t-1}^w + \rho p_{t-1}^d + \in_t$$

where p_t^d is the natural logarithm of the (domestic) prices of maize, rice and wheat in Brazil, Ukraine, Mexico and Russia;e p_t^w is the natural logarithm of the US (world) price of the commodities (maize, rice and wheat), where α is an n x (n-s) matrix of coefficients, where α is an n x (n-s) matrix of coefficients, and β is an n x (n-s) matrix of cointegrating vectors. α, θ, β, δ, and ρ are parameters to be estimated and ε_t is the error term; and theexpression in parenthesis $\left(p_{t-1}^d - \beta p_{t-1}^w\right)$ is the deviation from the long-run equilibrium. Thefollowing two terms measure the short term impact of the lagged increments of thenatural logarithm of international and domestic prices (Conforti, 2004). The error correctioncoefficient (θ) measures the speed of adjustment, expected to fluctuate in the rangebetween $-1<\theta<0$. If the lagged error correction term (the term in parentheses) is positive,the domestic price is too high given the long-term relationship, then the negative valueof θ "corrects" the error by making it more likely that the Δp_t^d is negative. The larger θ is in absolute value (closer to 1), the more quickly the domestic price (p^d) will adjust to thevalue consistent with its long-run relationship to the world price (p^w). The expected value is $0<\delta<\beta$ (Minot, 2011).

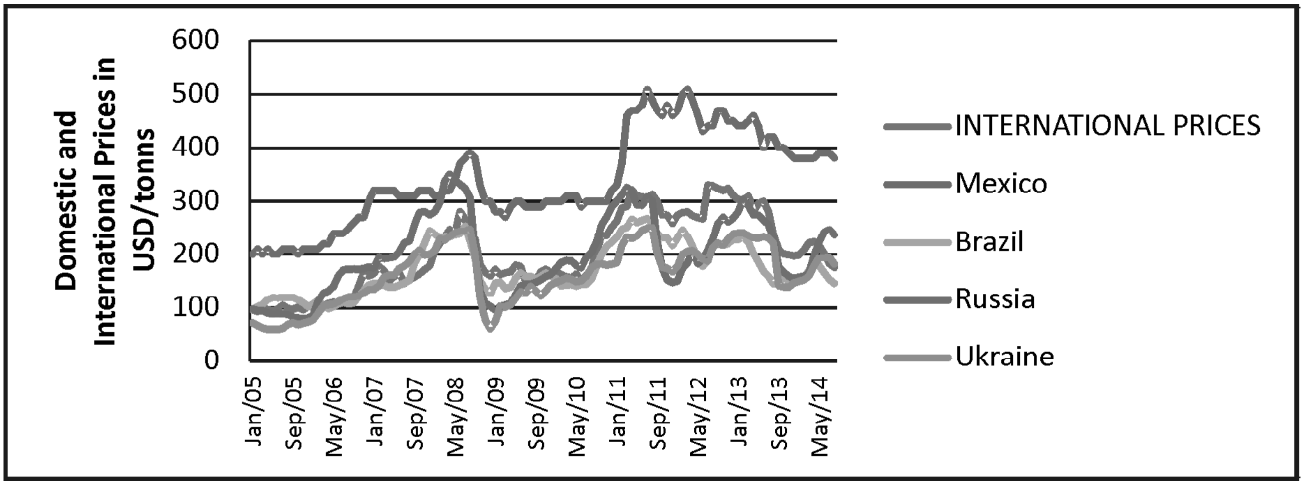

Figure 1: Trends in International and Domestic Prices of Maize appear Cointegrated

Source: Giews FAO

Figure 1 shows trends in international (USA)*maize* prices along with domestic prices of the Brazil, Russia, Ukraine and Mexico. The trend line for international maize prices falls below domestic prices, indicating that international(USA) prices were lower than domestic prices of the Russia and Mexico. Prices were found to be highest in Mexico and were in the range of 200 to 600 USD/ton. International maize prices were found to be in the range of 75 to 330 USD/ton.

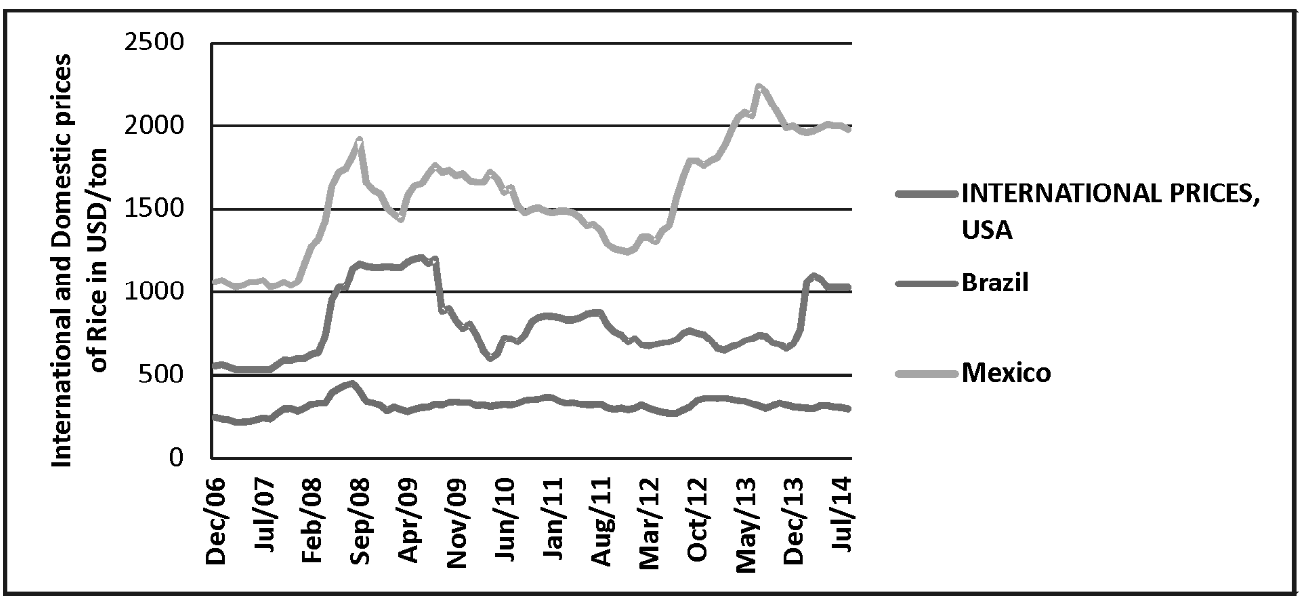

Figure 2: Trends in International and Domestic Prices of Rice appear Cointegrated

Source: Giews FAO

Fig. 2 depicts trends in international (US) *ri*ce prices along with domestic prices for Brazil and the Mexico. Prices of rice were highest in Brazil and were found to be in the range of 340 to 1500 USD/ton. International prices of rice were in the range of 176 to 1208 USD/ton.

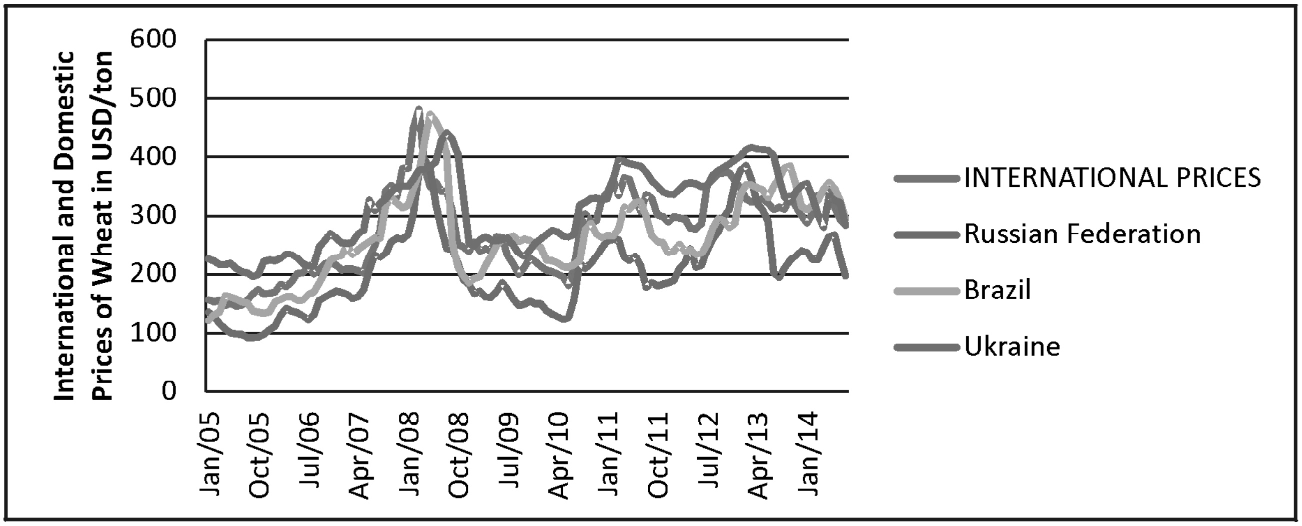

Figure. 3: Trends in International and Domestic Prices of Wheat appcar Cointegrated

Source: Giews FAO

Figure 3 shows trends in international and domestic prices of *wheat*. Theprice of wheat was found to be lowest in Russia. Prices were at the highest level in Brazil and fell in the range of 97 to 473 USD/ton. The world price was found to be in the range 111 to 482 USD/ton.

Table 1 shows descriptive statistics of *wholesale* and *retail* prices for maize, rice, and wheat for the countries Mexico, Ukraine, Brazil,and Russia, as well asthe world (US) price. Average retail pricesand wholesale

Table 1
Descriptive Statistics

Country	*Commodity*	*N*	*Mean*	*Median*	*Min*	*Max*	*Std. Dev.*
Mexico	Maize (Retail Prices)	92	777	780	580	920	84.2
	Maize (Wholesale)	116	306	280	200	600	81.6
	Rice (Wholesale)	176	1325	1260	760	2240	386
Brazil	Rice (Retail Prices)	176	842	840	340	1500	293
	Rice (Wholesale)	93	315	452	216	452	42.8
	Wheat (Retail Prices)	176	806	740	390	1430	308
	Wheat (Wholesale)	176	221	216	97	473	86.8
	Maize (Wholesale)	152	152	146	59	267	57.2
Russia	Wheat (Retail Prices)	116	689	710	430	940	144
	Wheat (Wholesale)	116	205	200	93	396	71.1
	Maize (Wholesake)	119	197	184	80	350	72.5
	Rice (Retail)	119	1214	1260	700	1650	283
Ukraine	Maize (Wholesale)	179	142	131	59	251	55.23
	Wheat (Wholesale)	176	286	270	137	440	72.9
United States	International Prices of Maize	176	166	153	75	330	75.4
	International Prices of Rice	176	568	535	176	1208	302
	International Prices of Wheat	176	228	208	111	482	86.4

prices of maize were found to be highest in Mexico (777 USD/ton and 306 USD/ton respectively). Russia had the highest average retail prices in rice (1214USD/ton), while the Mexico hadthe highest average wholesale prices in rice (1325 USD/ton). Average wholesale and retail prices of wheat were highest in Ukraine and Brazil respectively

Results of Unit Root Test

The Augmented Dicky Fuller (ADF) test is used to test for a unit root, which causes the process to wander unpredictably. A simple example of this a "random walk", in which each term results from the previous term plus an unpredictable white noise error term. A finding of a unit root is necessary to apply tests of cointegration, which mean that two series tend to share the same wandering behavior — or are cointegrated or move together — so that there is a possible causal relationship between the variables.In this paper we expect that the domestic prices of cereals in each country will move in response to changes in the world prices; which are established in the USA since the USA is the major producer of the cereals.The null hypothesis of the ADF is that the variable has a unit root against the alternative that it does not. Table 2 shows the results of unit root test of maize, rice and wheat for the countries Mexico, Ukraine, Brazil and Russia.Time series of prices for wheat, rice and maize were found to be non-stationary for all countries. Rice wholesale prices in Brazil were stationary in mean, but were found to be trend non-stationary.

Table 2
Results of Augmented Dicky Fuller (ADF) Unit Root Test

Country	*Commodity*	*Mean*	*Trend*
Mexico	Maize (Retail Prices)	-1.91	-2.54
	Maize (Wholesale)	-2.8	-3.39
	Rice (Wholesale Prices)	-1.3	-2.2
Ukraine	Maize (Wholesale Prices)	-3.03	-3.38
	Wheat (Wholesale)	-2.26	-2.12
Brazil	Rice (Retail Prices)	-1.17	-2.74
	Rice (Wholesale)	-3.05**	-2.87
	Wheat (Retail Prices)	-2.09	-2.23
	Wheat (Wholesale)	-2.73	-3.05
	Maize (Wholesale)	-2.59	-2.56
Russia	Wheat (Retail Prices)	-1.86	-1.97
	Wheat (Wholesale)	-2.5	-2.68
	Maize (Wholesale)	-3.18	-4.04
	Rice (Retail Prices)	-2.02	-1.04
United States	International Prices of Maize	-1.46	-2.34
	International Prices of Rice	-1.06	-2.2
	International Prices of Wheat	-1.88	-3.04

Notes: AIC was used to determine appropriate lag lengths. The null hypothesis under the ADFtest is nonstationary. * and ** indicate rejection of the null hypothesis at the0.05 and 0.01 significance level respectively

Results of Johansen's Cointegration test

Table 3 presents results for tests of cointegrationafter first-differencing the data. The Johansen trace test and maximum eigenvalue test were used to find cointegration between different markets. Pair-wise analysis was done betweenthe world price as established by the US andthe countries Brazil, Mexico,Ukraine and Russia.

Cointegration in the Maize Market

The trace test and eigenvalue test show that there was one cointegratingvector between the pair USA-Mexico in wholesale maize prices, but no cointegrating vector was foundin maize retail prices. However, two cointegrating vectors were found in the pairs of USA-Brazil, USA-Russia, USA-Ukraine and Russia-Ukraine in maize wholesale prices.

Cointegration in the Rice Market

In the pair USA-Brazil, the trace test and the-eigenvalue test found two and one co-integrating vectors in rice wholesale and retail prices, respectively. In the pair Mexico-Brazil one cointegrating vector was foundin rice wholesale prices. The-eigenvalue test and trace test did not find any co-integrating vectors for rice in thepairs USA-Russia, and USA-Mexico

Cointegration in the Wheat Market

In each of the pairsUSA-Brazil andUSA-Russia two cointegrating vectors were found in wheat wholesale markets as well as retail markets. The trace test and the-eigenvalue test found two cointegrating vectors in the pairsUSA-Ukraine, Russia-Brazil, Ukraine and Ukraine-Russia.The eigenvalue test did not find any cointegrating vector in the pair of Brazil-Russia in the wheat retail market.

Table 3
Johansen's Cointegration test

Markets	*Commodity*	*Vector*	*Trace test*	*5% Level*	*Max-Eigen test*	*5% Level*	*Co-integration Equations*
USA-Mexico	Maize Wholesale	r=0	20.79	15.49	18.37	14.26	Trace test=1Max-Eigen =1
		r ≤ 1	2.42	3.94	2.42	3.84	
	Maize Retail	r=0	11.36	25.87	7.74	19.39	Trace test=0Max-Eigen =0
		r ≤ 1	3.62	12.52	3.62	12.52	
USA-Brazil	Maize Wholesale	r=0	21.62	15.49	17.04	14.26	Trace test=2Max-Eigen =2
		r ≤ 1	4.54	3.84	4.54	3.84	
USA-Russia	Maize Wholesale	r=0	21.33	15.49	15.79	14.26	Trace test=2 Max-Eigen =2
		r ≤ 1	5.54	3.84	5.54	3.84	
USA-Ukraine	Maize Wholesale	r=0	23.33	15.49	18.43	14.26	Trace test=2 Max-Eigen =2
		r ≤ 1	4.89	3.84	4.89	3.84	
Russia-Ukraine	Maize Wholesale	r=0	26.45	15.49	18.17	14.26	Trace test=2 Max-Eigen =2
		r ≤ 1	8.28	3.84	8.28	3.84	

contd. table 3

Markets	*Commodity*	*Vector*	*Trace test*	*5% Level*	*Max-Eigen test*	*5% Level*	*Co-integration Equations*
SA-Mexico	Rice Wholesale	r=0	11.05	25.87	6.18	19.39	Trace test=0 Max-Eigen =0
		r ≤ 1	4.87	12.52	4.87	1252	
USA-Russia	Rice Retail	r=0	14.83	15.49	10.95	14.26	Trace test=0 Max-Eigen =0
		r ≤ 1	3.88	3.84	3.88	3.84	
USA-Brazil	Rice Wholesale	r=0	22.55	15.49	15.15	14.26	Trace test=2Max-Eigen =2
		r ≤ 1	7.40	3.84	7.40	3.84	
	Rice Retail	r=0	12.97	12.97	11.93	11.22	Trace test=1Max-Eigen =1
		r ≤ 1	1.04	4.13	1.04	4.13	
Mexico-Brazil	Rice Wholesale	r=0	18.14	15.49	15.26	14.26	Trace test=1Max-Eigen =1
		r ≤ 1	2.87	3.84	2.87	3.84	
Russia-Brazil	Rice Retail	r=0	15.69	15.49	12.04	14.26	Trace test=1 Max-Eigen =0
		r ≤ 1	3.64	3.84	3.64	3.84	
USA-Ukraine	Wheat Wholesale	r=0	24.70	15.49	19.63	14.26	Trace test=2 Max-Eigen =2
		r ≤ 1	5.07	3.84	5.07	3.84	
USA-Brazil	Wheat Wholesale	r=0	21.51	15.49	16.38	14.26	Trace test=2 Max-Eigen =2
		r ≤ 1	5.13	3.84	5.13	3.84	
	Wheat Retail	r=0	27.64	15.49	21.90	14.26	Trace test=2 Max-Eigen =2
		r ≤ 1	5.74	3.84	5.74	3.84	
USA-Russia	Wheat Wholesale	r=0	23.51	15.49	16.31	14.26	Trace test=2Max-Eigen =2
		r ≤ 1	7.20	3.84	7.20	3.84	
	Wheat retail	r=0	29.50	15.49	22.16	14.26	Trace test=2Max-Eigen =2
		r ≤ 1	7.33	3.84	7.33	3.84	
Ukraine-Brazil	Wheat Wholesale	r=0	21.36	15.49	15.81	14.26	Trace test=2 Max-Eigen =2
		r ≤ 1	5.55	3.84	5.55	3.84	
Russia-Ukraine	Wheat Wholesale	r=0	19.26	15.49	14.30	14.26	Trace test=2Max-Eigen =2
		r ≤ 1	4.96	3.84	4.96	3.84	
Russia-Brazil	Wheat Wholesale	r=0	25.06	15.49	19.31	14.26	Trace test=2Max-Eigen =2
		r ≤ 1	5.75	3.84	5.75	3.84	
	Wheat Retail	r=0	20.81	15.49	11.24	14.26	Trace test=2Max-Eigen =0
		r ≤ 1	9.58	3.84	9.58	3.84	

Vector Error CorrectionModel (VECM)

The Error Correction Models for the cointegrated time series are shown below. Table 4 reports transmission of US maize prices to the domestic prices of maize in Mexico, Brazil, Ukraine and Russia. The speed of adjustment coefficients have the correct sign (negative) for maize andare statistically significant. In USA-Mexico 17 percent of the disequilibrium is removed within a month. While only 9 percent of the disequilibrium is removed after a month in USA-Brazil. In the market USA-Russia and USA-Ukraine 8 percent and 12 percent of the disequilibrium is removed after one month.

Table 4
Results from Vector Error Correction Model for Maize

Variables	*Speed of Adjustment*	*T-value*	*P-value*
USA-Mexico	-0.144*	-3.019	-0.002
USA-Brazil	-0.090*	-1.955	0.027
USA-Russia	-0.084*	-2.858	0.005
USA-Ukraine	-0.125*	-3.060	0.003

Table 5 depicts transmission of international prices of US Rice to the domestic rice pricesof Brazil.14 percent of thedisequilibrium is removed after a month. The speed of adjustment is -0.14.

Table 5
Results from Vector Error Correction Model for Rice

Variables	*Speed of Adjustment*	*T-value*	*P-value*
USA-Brazil	0.138*	-3.910	0.000

Table 6 demonstrates price transmission of prices of wheat in the USA to Brazil, Ukraine and Russia. The speed of adjustment coefficient is -0.228 in Brazil. Thus in Brazil, 23percent of the disequilibrium is removed after a month. In the pair USA-Russia 33 percent of the disequilibrium is removed after a month. While in the pair USA-Ukraine 17 percent of the disequilibrium is removed in each month.

Table 6
Results from Vector Error Correction Model for Wheat

Variables	*Speed of Adjustment*	*T-value*	*P-value*
USA-Brazil	-0.228*	-3.788	0.000
USA-Ukraine	-0.170*	-3.104	0.001
USA-Russia	-0.328*	-4.866	0.000

CONCLUSION

The results of the study found integration between the selected four countries (Brazil, Mexico, Ukraine and Russia) when paired with each other and with the international prices of the United States. In the maize market, thedomestic prices of Mexico, Russia, Ukraine and the Brazil were found to be cointegrated with the international prices of the US. Mexico wholesale maize prices were cointegrated with the US (world) prices, but no such relation was found in the retail maize prices of Mexico. In Brazil,-wholesale and retail rice prices were cointegrated withthe US(world) prices. But no such relation was found in Mexico and Russia. The domestic wheat prices of Brazil, Ukraine and Russia were found to be cointegrated withthe US (world) prices.

Results of VECM found that the speed of adjustment coefficients had the correct sign (negative) for maize and were statistically significant. In the pair USA-Mexico 17 percent of the disequilibrium is removed within a month. While only 9 percent of the disequilibrium is removed after a month in USA-Brazil. In the markets USA-Russia and USA-Ukraine 8 percent and 12 percent of the disequilibrium is removed after one month, respectively. In the pair USA-Brazil 14 percent of the disequilibrium is removed after a month in rice prices. In wheat prices, in the pair USA-Brazil, 23 percent of the disequilibrium is removed after a month. In the pair USA-Russia 33 percent of the disequilibrium is removed after a month, While in the pair USA-Ukraine 17 percent of the disequilibrium is removed in each month.

Results of cointegration show that there is a relationship between ln (P1) and ln (P2) as predicted by the Law of One Price. The Error Correction Model shows that, according to the Law of Comparative Advantage, what matters is not the international prices but the process of elimination and the domestic prices. The strength or significance of cointegration varies with distance, which tends to show that; rather than a single, monolithic World Price taken from the United States, there are natural trade blocs which show more cointegration of prices due to proximity. Thus, in practice the Law of One Price must be modified somewhat, rather than accepted uncritically as in textbooks, since if the Law of One Price does not hold fully in the 'textbook" in the case of cereals, then it is unlikely to hold generally in the cases of all other goods. And the results remind us that it is long-term relation to the domestic prices is what is mainly significant.

REFERENCES

Conforti, Piero (2004), "Price transmission in selected agricultural markets", FAO Commodity and Trade Policy Research Working Paper No. 7. Rome: Food and Agriculture Organisation.

Dickey, D. A., and Fuller, W. A. (1979), Distribution of estimators for time series regressions with a unit root. *Journal of American Statistical Association*, 74: 427-431.

Engle, R.F. and C. W. J. Granger. (1987), "Cointegration and Error-Correction : Representation, Estimation and Testing"; *Econometrica,* 55, pp. 251-76.

Johansen, S. (1988), Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamics and Control* 12, pp. 231-254.

Meyers, W. and Goychuk, K. (2011), "Black Sea Wheat Market Integration with the International Wheat Markets: Some Evidencefrom Co-integration Analysis". Available at: *http://ageconsearch.umn.edu/bitstream/103894/2/Goychuk_Meyeres_AAEA2011-1.pdf*

Shinoj *et al.* (2008), "Spatial Price Integration and Price Transmission among Major Fish Markets in India", *Agriculture Economic Review,* Vol. 21 (Conference number), pp. 327-335.

Listorti G. (2008), "International price transmission on soft wheat markets: which role for policyvariables in cointegration relationships?" Available at: *http://purl.umn.edu/43843*

Yang, J. *et al.* (2003), "Price and Volatility Transmission in International Wheat Futures Markets", *Annals of Economics and Finance,* Vol. 4, pp. 37–50.

Minot, Nicholas (2011), "Transmission of World Price Changes to Markets in Sub-Saharan Africa", International Food policy and Research Institute, FPRI, *IFPRI Discussion Paper 01059*.

Kilima, Fredy T. M. (2006), "Are Price Changes in the World Market Transmitted to Markets in Less Developed Countries? A Case Study of Sugar, Cotton, Wheat, and Rice in Tanzania", Institute for International Integrated Studies, *IIIS Discussion Paper No. 160*.

Greb, Friederike *et al.* (2012), "Cereal Price Transmission from International to Domestic markets in Africa", Paper ID 2012,336, Available at: *www.africaneconomicconference.org/2012/.../Papers/AEC2012-336.pdf*

World Bank (2012), "Transmission of Global Food Prices to Domestic Prices in Developing Countries: Why It Matters, How It Works, and Why It Should Be Enhanced", Contribution to G20 Commodity Markets Sub Working Group. Available at: *http://siteresources.worldbank.org/EXTPREMNET/Resources/489960-1340717984364/WB_CPV_Input_Transmission_of_Global_Food_Prices.pdf*