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Different Causal Relationships of Export Rice Prices in the International Rice Market

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Abstract: The aim of this paper was to investigate price co-integration and causal relationships of export rice prices among major countries in high- and low- quality rice markets using time series analysis. The result showed the existence of price co-integration or the long-run equilibrium price relationship among export prices in both markets. Results also revealed uni- and bi-directional causality relationships in high- and low- quality rice markets with different speeds of adjustment. The findings provided evidence of the different price relationships across different rice quality in the international rice market. Therefore, the appropriate price reference for each market was proposed and several suggestions were introduced in order to reduce the error when estimates price based models for international rice market.

Key words: International rice market · Export rice price · Vector error correction (VEC) model

INTRODUCTION

Trade share of rice represents about 6.9% of global rice production and only five exporters, namely, Thailand, Vietnam, the United States (USA), Pakistan and India occupy 80 % of the market share in international rice market since 2000 [1]. Thailand is the largest exporter and occupies around 28% of the market share in the international market since 1989 followed by Vietnam (17%), USA (11%) and Pakistan (7%) as shown in Figure 1.

The rice price in the international market is identified by quality and type [2]. According to the FAO rice classification, high-quality rice consists of long grain rice containing less than 20 % of broken kernels. Main exporters of high quality rice include Thailand, USA, Vietnam and India. In turn, low-quality rice contains more than 20 % of broken kernels. In low quality rice markets Thailand, India and Vietnam are major exporters. Smaller exporters can sell as much as they prefer at the price determined by major exporters. Consequentially, the free on board (FOB) prices of rice in the international market always show the same directional trend. This can be confirmed by the FOB prices from major exporters.

Figure 2A shows the movement of the FOB prices of 5% broken long grain rice from USA, Thailand and Vietnam. The FOB prices from the three exporters are similar and seem to converge before 2012. A similar trend is observed in the FOB prices of 25% broken rice from Thailand, Vietnam and Pakistan (Figure 2B). Based on these price movements, we suspect high cross-sectional correlation among the FOB prices of exporters. This implies that the international rice market could be integrated. In other words, the FOB price of a major exporter will not deviate from FOB prices of other exporters if a price changes by one major exporter is used as a reference to determine a price change by the other exporters [3].

Therefore, the key question in this paper is whether the international rice markets are integrated or whether the long-run equilibrium relationship exists among FOB prices of major exporters. If long-run equilibrium relationships

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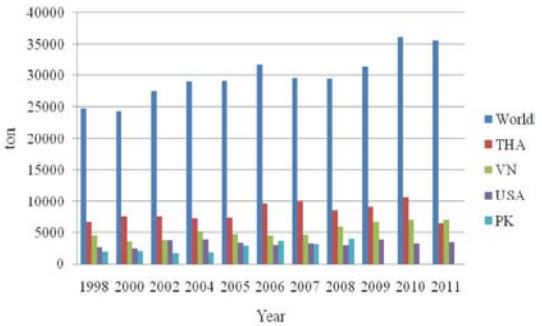

Fig. 1: Export volumes of major exporters from 1998 to 2011

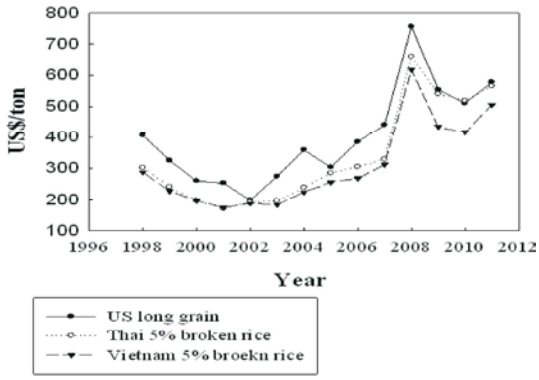

Fig. 2A: The FOB prices of long grain 5 percent broken rice of USA, Thailand, and Vietnam

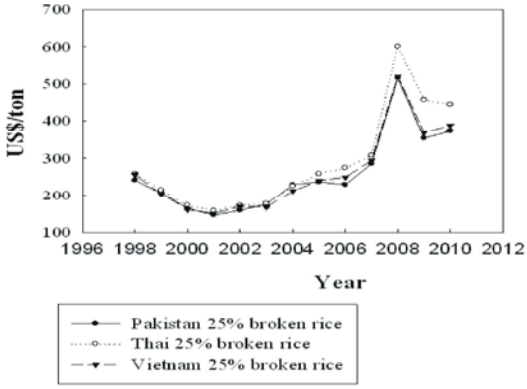

Fig. 2B: The FOB prices of long grain 25 percent broken rice of Thailand, Vietnam, and Pakistan

are evident, then how do the causal relationships perform among FOB prices of major exporters? Examination of price relationships (in terms of co-integration), long-run equilibrium and speeds of adjustment (in terms of short-run price adjustment) can illustrate the flexibility of price in response to unusual shocks. In addition, the causal relationships can assist researchers in identifying the price linkages correctly. Incorrectly specify the price linkages can increase the error of price estimation.

Issues concerning price relationship and market integration in agricultural commodity markets have gained considerable attention. Yovapolkul *et al.* [4] found evidence of long-run equilibrium of long grain rice markets among developing and developed countries. Prices from developed countries are found to influence prices from developing country; furthermore, the changes in rice prices of developed countries have relative impacts on those of developing countries. Later in 2012, Ghafoor and Aslam [5] studied the rice market cointegration among Thailand, USA and internal markets of Pakistan. They found that Pakistan's domestic rice price was not linked to international prices.

Ghoshray [6] found changes of price relationship in different wheat market segments. The idea of different price relationship in the segmented wheat market was utilized by the same author in the rice market. Ghoshray [3] examined the rice price relationship between Thailand and Vietnam by segmented rice market according to quality of rice. They concluded that high-quality rice experienced an asymmetric adjustment. The issue of different price relationships in the international rice market elucidated the fact that different rice quality performs different nature of price dynamics. However, this study did not include other exporters such as USA, India and Pakistan that have increased their presence as major exporters in the international rice market

Thus, this study aimed examine the co-integration and causal price relationship of FOB rice prices from major exporters in high-quality rice market (long grain white rice containing 5% broken) and low-quality rice market (long grain white rice containing 25% broken). The results from this study are expected to correctly verify price linkage of international rice market across different quality of rice markets. The findings will provide the suitable price reference of each market. By using the right price reference, the error in estimates of price based model will reduce.

METERIALS AND METHODS

Data: The data used in this paper was monthly free on board (FOB) price from January 1998 to April 2012. Based on quality, rice markets are divided into two groups (FAO rice classification) which are high- quality rice (white rice containing less than 20 % percent broken rice) and low-quality rice (white rice containing more than 20 % broken rice). Since India abandoned rice export from 2008 to 2010, this study focused on Thailand, Vietnam, USA and

Pakistan. We used the FOB rice price of white rice 5 % broken to represent high-quality rice from Thailand, Vietnam and USA. The low quality-rice was white rice price 25 % broken from Pakistan, Thailand and Vietnam. FOB price data of Thailand, Vietnam, USA and Pakistan were extracted from Osiriz/InfoArroz. All price data in our empirical analysis are in U.S dollar per ton.

The FOB price data of all countries in this study were transformed to natural logarithm and were abbreviated in the following way: 1) the FOB rice prices of Thailand (TH^H), Vietnam (VN^H) and the USA (US^H) in high-quality rice with 5% broken rice; 2) the FOB rice prices of Pakistan (PK^L), Thailand (TH^L) and Vietnam (VN^L) in low-quality rice with 25% broken rice.

Methods: This paper employed four steps of time series techniques to analyze the causal relationship of FOB rice prices of five major exporters. The first step was the unit root test. If the time series were not integrated in the same order, the variable cannot be in a long-run equilibrium relationship [7-9]. Thus, it is vital to conduct the stationary tests in order to ensure that the variables are not integrated in different order. This study employed two unit root tests including the augmented Dickey-Fuller (ADF) tests [10] and Phillips-Perron (PP) test [11] under the null hypothesis that the all price series have a unit root. If the hypothesis of the tests cannot be rejected then the unit root tests were re-estimated of first difference data until stationary. Therefore, all price series contain a single unit root or are I (1).

Then, the second step was the cointegration test. The Johansen cointegration procedure was employed to test whether a long-run relationship among TH^H, VN^H and US^H in high-quality rice market and PK^L, TH^L and VN^L in low-quality rice market exist. The Johansen cointegration procedure is designed to test whether the price series are cointregated by determining the cointegrating rank. Based on theory, the cointegrating rank can be at most one less than the number of endogenous variables in the model. In this study, the cointegrating rank can be at most at two cointegrating ranks from three endogenous variables in high- and low-quality market. We followed Johansen's testing procedure using the trace and maximum eigen value likelihood ratio statistics to indicate the number of cointegrating vectors and using Schwarz criterion to select to optimal lag length.

The third step was to examine the speed of price adjustment. Following [12,7], if the price series is integrated but not co-integrated, a VAR (Vector Autoregressive) model is appropriate to characterize the multivariate relationship among the price series. On the other hand, if the price series is integrated and co-integrated, a vector error correction (VEC) model is more appropriate for such a purpose.

$$\Delta Z_t = \mu_1 + \coprod Z_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \varepsilon_{1t} \quad (1)$$

$$\Delta X_t = \mu_2 + \coprod X_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Z_{t-i} + \varepsilon_{2t} \quad (2)$$

Where ΔZ_t is a (3×1) matrix (ΔZ_{1t}, ΔZ_{2t}, ΔZ_{3t}, are the three FOB price series from Thailand, USA and Vitenam in high-quality rice market), ΔX_t is a (3×1) matrix (ΔX_{1t}, ΔX_{2t}, ΔX_{3t} are the three FOB price series from Thailand, Vitenam and Pakistan in low-quality rice market), μ_1 and μ_2 are a (3×1) matrix vector of constant term, the $\Gamma_i \Delta Z_{t-i}$ terms represent the short-run relationship among elements of the Z_t matrix in high-quality rice market while $\Gamma_i \Delta X_{t-i}$ terms represent the short-run relationship among elements of the X_t matrix in low-quality rice market, $\prod$ captures the long-run relationship among the FOB price series, ρ is a lag length of the model and ε is an error term.

The last step, if the long-run equilibrium relationship exists from the second step then Granger causality test was employed to identify the causal direction among the variables by using VEC model.

RESULTS AND DISCUSSIONS

Properties of Price Time Series: Table 1 shows that both ADF and PP test statistic for prices series of high-quality market (TH^H, VN^H and US^H) and low-quality market (LPK^L, LTH^L and LVN^L) exceed the critical value at 5 % level of significant or fail to reject the null hypothesis of a unit root. Re-estimation of both unit root tests showed that all price variables were stationary at the first order difference.

The results from Johansen's cointegration test using optimal lag length at two indicate the existence of one cointegrating vector in high-quality market and two cointegrating vectors in low-quality market (Table 2). Implying that in high-quality rice market 5% FOB prices of Thailand, Vietnam and USA has a long-run equilibrium relationship as well as 25% FOB prices of Thailand, Vietnam and Pakistan.

The results of ADF and PP in Table 1 confirmed that the price series were both integrated and co-integrated. There fore, the VEC model was applied to examine the

Table 1: The Unit Root Tests

Variable	ADF	PP
High-quality market		
Levels		
TH^H	-0.687	-0.702
VN^H	-1.507	-1.288
US^H	-1.442	-1.292
First differences		
TH^H	-9.201*	-6.265*
VN^H	-8.083*	-6.280*
US^H	-7.849*	-7.849*
Low-quality market		
Levels		
PK^L	-1.821	-3.514
TH^L	-0.607	-0.662
VN^L	-1.399	-1.318
First differences		
PK^L	-13.734*	-30.270*
TH^L	-8.907*	-7.273*
VN^L	-8.192*	-7.588*

The asterisk (*) indicates significance at the 1% level.

Critical value at the 1% level of significance for the ADF is -3.469 and PP is -3.469.

Note: The critical values are obtained from the Mackinnon (1996) table

Table 2: Johansen Cointegration Test

Null	Trace Statistic	Critical values	Maximum eigen value test	Critical values
High-quality market				
$r = 0$	44.993*	29.797	34.506*	21.132
$r \leq = 1$	10.488	15.495	10.020	14.265
$r \leq 2$	0.467	3.841	0.467	3.841
Low-quality market				
$r = 0$	75.703*	29.797	44.895*	21.132
$r \leq 1$	30.807*	15.495	30.222*	14.265
$r \leq 2$	0.584	3.841	0.585	3.841

r denotes the number of cointegration vectors for cointegration test

The asterisk (*) denotes rejection of the null hypothesis of cointegration at the 1% significance level

Table 3: The Speeds of Adjustment Results

		Model diagnostics			
Variable	Speeds of adjustment	R^2	Adjusted R^2	SIC	AIC
High-quality market					
$\Delta\ TH^H$	-0.049*	0.428	0.401	-3.046	-3.194
$\Delta\ US^H$	-0.004***	0.291	0.260	-3.127	-3.276
$\Delta\ VN^H$	-0.251*	0.426	0.403	-2.726	-2.874
Low-quality market					
$\Delta\ TH^L$	-0.026*	0.395	0.369	-2.996	-3.144
$\Delta\ VS^H$	-0.153*	0.297	0.267	-2.579	-2.728
$\Delta\ PK^L$	-0.510	0.395	0.369	-0.138	-0.286

The asterisk (***) indicates significance at the 1% level, (**) is 5% significant and (*) is 10% significant.

Table 4: The Granger causality test

Causality	F-statistic
High-quality market	
US^H does not Granger cause TH^H	0.401
VN^H does not Granger cause TH^H	8.335**
TH^H does not Granger cause US^H	8.575**
VN^H does not Granger cause US^H	6.519**
TH^H does not Granger cause VN^H	12.103***
US^H does not Granger cause VN^H	0.559
Low-quality market	
TH^L does not Granger cause PK^L	0.946
VN^L does not Granger cause PK^L	0.380
PK^L does not Granger cause TH^L	3.069
VN^L does not Granger cause TH^L	21.781***
PK^L does not Granger cause VN^L	5.254*
TH^L does not Granger cause VN^L	1.921

The asterisk (***) indicates significance at the 1% level, (**) is 5% significant and (*) is 10% significant.

speeds of prices adjustment. In high quality market the speed of adjustment of Vietnam (0.251) was higher than that of Thailand (0.049) and USA (0.004). This suggests that after any given shocks in the rice market, Vietnam's prices can return to the long-run equilibrium in a faster pace than Thailand and USA prices do. Similar results were found in low-quality market. The speed of adjustment for Vietnam price in low-quality market was 0.153. In this market, Vietnam can restore rice prices to the long-run equilibrium in a faster pace comparing to Thailand (0.026). In turn, Pakistan price was not statistically significant.

The results of the speed of adjustment are vital for policy markers because it indicates efficiency of price adjustment by comparing to other major exporters. For high-quality, Vietnam price adjust more quickly than Thailand price five times and sixty-two times faster than USA price in response to market shocks. While in low-quality market, Vietnam price also adjusts more quickly than Thailand five times. A deep look at Vietnam's rice policies may explain the high speed adjustment observed in this study. Vietnam's government abolished the rice export quota in May 1, 2001 and the fertilizer import quota. Moreover, all economic agents both state-owned and private who hold the licenses to trade agricultural commodities are allowed to participate in rice export [13]. In addition, the government of Vietnam has implemented an export subsidy. All of these policies increase flexibility of Vietnam's rice trade.

Since 2000, Thailand has implemented rice policies that aim to support rice prices at the farm level: rice procurement program, rice price-pledging scheme and credit assistant [14]. The goal of Thailand rice trade is to maintain stable paddy prices at reasonably high levels [13]. The main objective of the USA rice policy is similar to Thailand in terms of farmer's income support. However, the USA rice policy programs also aim to promote and facilitate purchase of USA rice in foreign markets [15]. Comparing the rice policy of Thailand and USA with that of Vietnam implies the fact that Vietnam utilizes more proactive trade policy programs than Thailand does. Although USA has implemented some programs to support rice exports, the export rice price of USA is higher than Vietnam price.

The results of Granger causality test were reported in Table 4. In high-quality market, four causal direction relationships were found. A bi-directional relationship has been found between Thailand and Vietnam, which implies that changes of Thailand price affects Vietnam price and vice versa. In addition, the direction of causality relationships is found running from Thailand to USA and from Vietnam to USA. In other words, changes of Thailand and Vietnam prices affect USA price but not vice versa. Implying that Thailand and Vietnam prices influence each other and also affect the other exporter in determine its price in high-quality market.

Turning to low-quality market, the result showed two uni-directional relationships. The first uni-directional relationship was found from Vietnam to Thailand. In this market change of Vietnam price affects on Thailand price, but not vice versa. This result is consistent with the finding of Ghoshray [3] that Vietnam price influences Thai price, but not a vice versa. In addition, the other uni-directional relationship was detected from Pakistan price to Vietnam price.

Vietnam's price influenced Thailand's price while Pakistan's price affected Vietnam's price in low-quality market. In this market, Thailand price did not affect the other two prices because Thailand may not realized as a big exporter comparing to Vietnam and Pakistan who gained prominence as a major exporter of low-quality rice [3, 7]. The reason that Vietnam price does not affect Pakistan price may be due to Pakistan itself is a big exporter of 25% broken rice for a long time while Vietnam is well-known as a second largest exporter since 1997 [13]. Therefore, Pakistan depends less on Vietnam price in determine its export prices [5].

CONCLUSIONS AND RECOMMENDATIONS

Long-run relationships were evident among major exporters in high and low quality markets. Vietnam's price

speed of adjustment was highest in response to shocks in both high- and low-quality markets. This implies that rice prices in Vietnam are the most flexible to restore its price to the long-run equilibrium comparing to prices of other exporters. In addition, a bi-directional and two unidirectional relationships were found in high-quality market. It can be concluded that Rice prices from Thailand and Vietnam influenced each other and also affected USA's prices in determining its price in high-quality market. For the low-quality market, Thailand price was affected by Vietnam price while Vietnam price is influenced by Pakistan price. This implies that Pakistan price influence prices of exporters in low-quality market.

Overall the results provided vital evidence of the different price relationships across different quality of rice in the international market. Implying that using Thailand as a price references due to its biggest market share in the international rice market when analyze price based model may cause some estimation errors. Two important suggestions can be drawn in order to reduce the error when estimates price based models for international rice market. Firstly, instead of using only Thailand price as a price reference to study price based models, in high-quality market either Thailand or Vietnam prices can be use for such a study. Using the Vietnam price as a reference, however, researchers must take into consideration Vietnam's price flexibility. For the low-quality rice market, Pakistan price should be utilized as a price reference for econometric price based study. Finally, further studies on agricultural commodities should emphasise on the differentiated of quality grades that may lead to different price dynamic relationships.

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