EFFICIENCY OF PRICE ADJUSTMENTS OF RICE FOR FARM, WHOLESALE, AND EXPORT MARKETS IN THAILAND

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Abstract

The purpose of this paper is to investigate price efficiency adjustments for farm, wholesale and export markets in Thailand. It is focused on an econometric model which uses a time series of those prices, taking into account the monthly data of the farm prices, wholesale prices, and export prices from January, 1998 – April, 2015, a total of 207 months. There are 3 steps in this study: 1) price causal direction between the markets using Granger causality test, 2) long-run equilibrium between the market prices using EG cointegration test, and 3) short-run dynamic response using ECM test. The results indicate the three unidirectional relationships running from wholesale price to farm and export prices as well as from farm price to export price. Both of the shock adjustments, from wholesale price to farm price and from wholesale price to export price, are similar speed (23.7 percent and 23.8 percent). However, the speed of adjustment from farm price to export price is faster than those two market integration. These findings are important for policy makers who formulate the policies to enhance solving the shock from the drought, flooding, epidemics, the political climate, and other causes.

Keywords: Price, efficiency adjustment, rice, Thailand

Introduction

The gross domestic product (GDP) of Thailand in 2014 at current market prices was 12,141,096 millions bath, of which the agricultural sector contributed 1,412,703 millions. Agricultural and non-agricultural income accounted for 11.64 and 88.36 percent of GDP, respectively (National Economic and Social Development Board, 2014). Agriculture, hunting and forestry contributed 90.82 percent for the agricultural sector. Most agricultural areas grow rice, 69.96 million rai of the total 149.24 million rai, which accounted for 46.88 percent of the total area (Office of Agricultural Economics, 2015).

The major rice planted area in 2014/15 decreased last year due to a change in government policy, declining prices, and the farmers' decision to switch from planting rice to sugarcane which provides higher returns and market certainty. However, the second crop of rice decreased from last year due to lower water levels in major dams which were not sufficient for cultivating rice and declining prices. The yield also slightly

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decreased because of insufficient rainfall (Office of Agricultural Economics, 2015).

In 2014/15, farm holdings planted 3,724.14 and 622.99 households for their first and second crops, respectively. The total area planted with rice was 72.45 million rais and the paddy rice output was 33.81 million tons. The amount of rice moisture (15%), for the first and second crops were equal to 439 and 626 kilograms per rai respectively. The production costs of the first and second rice crops were 10,885 and 9,094 baht per tonne, respectively.

However, rice growers wonder why farm prices are so low compared to wholesale and export prices. This may explain why farmers are so poor compared to other professions.

A General Overview of Rice Marketing in Thailand

In 2014, Thailand exported 10.97 million tons of rice at a total value of 174,853 million baht, compared with 6.61 million tons of rice at a total value of 133,839 million baht in 2013. The volume and value increased by 65.96 percent and 30.64 percent respectively, because the export price of Thai rice was adjusted to that of competitors, such as India and Vietnam, at an average price of 425 US dollars per ton. As a result, some rice importing countries reverted to importing rice from Thailand as before. In 2014, the trading of rice in the world market was 42.91 million tons with a market share of 24 percent of the global market. The average export price was 15,940 baht per tonne (Office of Agricultural Economics, 2015; Customs Department, online, 2015). Thailand's trading partners include the following.

1. For good quality (Jasmine) rice, the United States, Cote d'Ivoire, Senegal, Hong Kong, and Ghana.
2. For white rice 100% and white rice 5% were Iraq, Japan, Angola, Indonesia, and Malaysia.
3. For medium and low quality rice, the Philippines, Cameroon, Mozambique, Indonesia, and the Ivory Coast.
4. For steamed rice, Nigeria, South Africa, Benin, Bangladesh, and Yemen.

Thailand's most important competitors countries were as follows:

1. For good quality rice, the United States, Vietnam, and Australia
2. For medium and low quality rice, Vietnam, China, Pakistan, and Myanmar
3. For steamed rice, the United States and India

For the domestic rice market, the amount of rice used for domestic consumption in 2014 was equal to 10.87 million tons. The wholesale price was 12,277 baht per tonne, while farmers were only able to sell 7,714 baht per tonne (Office of Agricultural Economics, 2015).

Comparisons between the prices of rice that farmers have sold their rice for with wholesale and export prices show a huge difference, even when some costs are included for marketing. Table 1 confirms that there are huge differences between farm, wholesale and export prices for the years 2004 to 2014. Rice growers wonder why farm prices are so low compared to wholesale and export prices. This may explain why farmers are so poor compared to other professions. Moreover, if Thailand experiences any serious unexpected economic problems, such as epidemics, drought or floods, it would be very useful to know how efficient the adjustment of prices between the farm, wholesale, and export markets would be. This was the purpose in undertaking this research study on the price efficiency adjustments of rice for farm, wholesale and export markets in Thailand.

Literature Review

The majority of economic theories are a description of the relationship between economic variables, for which econometrics is an important analysis tool. However, there is a problem if there are two economic variables; which variable will affect the other variables? Therefore, before using econometrics for analysis, the relationships between dependent and independent variables should be examined using a model. Although the dependent variable and independent variable are clearly formulated by the model, the question arises as to whether

a dependent variable is only determined by an independent variable or whether both the dependent variable and the independent variable interact with each other. This question was tested by using causal testing or the Granger causality test, which was proposed by Granger (1969) and Sims (1972). Pindyck and Rubinfield (1998) concluded that the fundamental idea was to confirm whether the addition of a past value for X as an independent variable can conduce significantly to an explanation of the variables in Y.

The time series data which were used for regression analysis were non-stationary, which perhaps accounts for the spurious relationship of the variables in the model. However, the time series data, which were non-stationary, may have a long-run relationship if the deviations from the equilibrium relationship was stationary; that relationship is named cointegration. Therefore, the cointegration test is a stationary test of deviation which comes from an estimate of the long-run equilibrium relationship of the time series variable which is non-stationary. If the time series variables have cointegration, this indicates that the variables have a long-run relationship. The most popular cointegration test is a two-step residual based test (Engel and Granger, 1987; Granger and Newbold, 1974). The Engle and Granger method is a simple test appropriate for testing one equation or a cointegration of equations with only one pair (i.e. two variables). Cointegration testing can be used to show if the time series variables have a long – run equilibrium relationship, if so, then a model of adaptation from short – run to long - run equilibrium can be constructed. Such a model, known as the error correction model (ECM), links the variables between the short–run and the long–run. The most important element of ECM is the speed of the adjustment terms which indicates how dependent variables change in response to a non-equilibrium relationship and the coefficient can be estimated by using the ordinary least square (OLS) technique without spurious regression problem (Engle and Granger, 1987; Li *et al*., 2006).

Granger and Lee (1989) studied the accumulated sum of a stationary series which they described as 'integrated'. If a linear combination of some of the integrated series is stationary, it is said to be cointegrated. This paper presents the empirical results of inventories to consider the possibility of a deeper form of cointegration called multicointegration, which was introduced by Granger and Lee (1989) who used a vector integrated series which is said to be multicointegrated if the accumulated sum

Table 1. The price of rice in farm, wholesale, and export market in Thailand during 2005-2015.

year	Farm Price	Wholesale Price	Export Price
2005	5584	8934	10842
2006	6675	10858	12438
2007	6508	10885	13114
2008	6530	10534	13010
2009	10676	18947	20238
2010	9717	16995	19976
2011	8441	13870	18862
2012	9146	15108	18581
2013	10104	16339	21396
2014	9385	14508	20407
2015	7713	12276	16071

Source: Office of Agricultural Economics, 2015.

of its stationary (cointegrated) linear combinations is again cointegrated with itself. The inventory, which is the accumulated sum of production minus sales, cointegrates production and sales. Such empirical results generally support the presence of multicointegration of production and sales in many U.S. industries and industrial aggregates. The results also favour a non-symmetric error correction model, providing evidence that the strength of attraction is different on both sides of the attractor. A modified rule for inventory control is investigated in the context of a non-symmetric error correction model, and the results generally do not support the rule. Sufficient evidence has been found to conclude that multicointegration is a useful concept in the area of inventory determination. Cramon, Taubadel and Loy (1996) have commented that asymmetric prices in the international Wheat Market from Samarendu Mohanty, E. Wesley F. Peterson, and Nancy Cottrell Kruse (MPK). Their paper analyzes the price linkages between wheat-exporting countries. They discuss three methodical issues which were raised by their analysis. First, the Houck specification used by MPK is inconsistent with an effective test for asymmetricity in the long-run relation between the two wheat prices. They found that this specification is theoretically questionable and is rejected by the data. Second, as an alternative, they propose using the error correction form to test for asymmetric contemporaneous and short-term reactions to deviations from a unique long-run relationship. Using this specification, they find little evidence of asymmetric transmission. Third, MPK use monthly data to analyze wheat price linkages. Weekly data are available, and we demonstrate that data frequency has an important impact on estimates of wheat price transmission. However, the high market concentration is among the major causes of asymmetric price transmission in agricultural market chains. (Meyer and Cramon-Taubadel, 2004)

Khan *et al*. (2005) concluded that cointegration was necessary but not a sufficient condition for Granger causality in that mere correlation did not imply causation. Granger (1988) recommended a useful approach to test for Granger causality between two variables. The fundamental idea was that if a change in X leads to a change in Y, then X could be a cause of Y. This indicates an unlimited regression of Y against past values of Y, with X as the independent variable. A limited regression is also needed in the test regressing Y against past values of Y only. They evaluated the two regressions to test the null hypothesis that X does not cause Y by using the total of square residuals from each regression to compute the F statistic, then they tested whether the group of coefficients was significantly different from zero. The null hypothesis is rejected if they are significantly different from zero, indicating that X causes Y.

Asteriou and Hall (2007) have concluded that if there were important differences between stationary and non-stationary time series, shocks would be temporary and over time their effects would be eliminated as the series revert to their long-run mean values. On the other hand, a non-stationary time series would necessarily contain permanent components. Therefore, the mean and/or the variance of a non-stationary time series would depend on time, which leads to cases where a series (1) has no long-run mean to which the series returns, and (2) the variance would depend on time and would approach infinity as time goes to infinity. The problem with non-stationary or trended data is that the standard OLS regression procedures can easily lead to incorrect conclusions. It can be shown that in these cases the norm is to get very high values of R^2 and very high values of t-ratios while the variables used in the analysis have no interrelationships. These regressions are called spurious regressions. The formal tests for identifying non-stationary processes can be explained by the existence of unit roots when using the ADF test (Augmented Dickey-Fuller test) in order to prevent autocorrelation problems.

Later, Barahona, Trejos, Jai Wei, Chulaphan, and Jatuporn (2013) studied asymmetric price transmission in the artisan dairy industry of Honduras. The data employed includes monthly prices of fluid milk, quesillo (i.e., a local cheese product with a consistency similar to mozzarella),

fresh cheese, and dry cheese between January 1997 to April 2013. Both the Johansen multivariate approach and the Engle-Granger two step analyses confirm that fluid milk prices have a strong cointegration with the price of quesillo, fresh cheese and dry cheese. Furthermore, dairy products that exhibit high market competition such as fresh cheese and dry cheese show negative asymmetric price transmission whereas those that exhibit low market competition such as quesillo show positive asymmetric price transmission. In 2014, a research group also studied a symmetric price transmission in the livestock industry of Thailand. This paper aimed to investigate the farm-retail price transmission for the livestock industry in Thailand employing monthly data from 2002-2012. Using the Engle-Granger two step approach, the study confirmed that farmgate prices were cointegrated with retail price in the poultry and swine industry. Consequently, an asymmetric error correction model (AECM) was used to test for asymmetric price transmission between farmgate and retail prices of chicken and pork. The results show that the pork industry, which focuses on supplying domestic consumption and has heavy export restrictions, was characterized by positive asymmetric price transmission whereas the poultry, which is highly export-oriented, was characterized by symmetric price transmission (Barahona, Trejos, Jai Wei, Chulaphan, and Jatuporn, 2014). In 2016, Soralam (2016) has studied the volatility of the price of rice and linkages between internal market and the global market. She was focused on an econometric model by using the time series of prices, taking into account monthly data of the farm prices of rice, global price of rice, and global food prices from January, 1984 – September, 2015. The data analysis used the unit root test for stationary state of those prices, Granger Causality test, and ECM testing. The results showed that those markets price have been volatile. In addition, the study also found that farm prices and global prices have been causal relationship to each other. Moreover, the farm prices and global prices of rice have no causal relationship with global food prices.

However, there have been less studies that compare the price relationships of rice between farm, wholesale, and export markets by using the Granger causality test (Engle and Granger, 1987). In this study, therefore, the econometric model was applied to the study of price efficiency adjustments of rice between farm, wholesale and export markets in Thailand. This study constructed an econometric model of the rice marketing by using the price level in each market, and estimated the cointegration and error correlation models. The short run error correlation model provided beneficial information on how quickly adjustment occurred among price variables in each market to recover balance in response to short term disturbances of the rice market in Thailand. Finally, we investigate and compare the speed of adjustment between the different market prices in this study.

Methodology

This research adopted a quantitative approach. It focused on an econometric model by using the secondary data of a time series of the prices of rice in Thailand, taking into account the monthly data of the farm prices (P–FG), the wholesale prices (P–WS), and the export prices (P-FOB) from January, 1998 – April, 2015, which totalled 207 months. The data collection was from the Office of Agricultural Economics, Ministry of Agriculture and Cooperatives, and the Department of Customs, Ministry of Finance. The analysis procedure is summarized as follows:

1. The stationary testing of the time series data of monthly prices in the farm, wholesale, and export markets was conducted in order to investigate which of the markets had properties independent of time, because data that changes over time results in an estimation problem of spurious regression. To find out if the time series data yields a statistically stable equilibrium, we tested the data with the Augmented Dickey - Fuller test (ADF - test), and identified the level of integration to be applied in the following analysis in order to test the ADF test by choosing the appropriate lag from the Schwarz Information Criterion (SC) with the lowest possible lag being the most suitable (Dickey and Fuller, 1979; Walter Enders, 2015).

2. An analysis of the linkages between the markets

To analyze the linkages between the market price variables, the Granger causality test for the three markets was carried out the, which tests the relationships between the market prices. In this case, there were six possible forms which show in Figure 1.

It is necessary to test for causality between two variables in order to find the direction of the price relationship between two markets (Engle and Granger, 1987). The fundamental idea is that if a change in X leads to a change in Y, then X could be a cause of Y, and thus the level of the relationship needs to be established. The Vector Autoregressive Model (VAR) was used for the analysis by comparing the calculation for the F-statistic with the referenced F value, then a test was applied to find out whether the group of coefficients was significantly different from zero. The null hypothesis will be rejected if they are significantly different from zero, indicating that X causes Y. Therefore a change in the price of one of the markets would have an impact on the prices in the other market, thus demonstrating that they are interrelated. The Granger Causality test was used for the estimating the parameters estimation by using the Ordinary Least Square (OLS) as follows:

$$\Delta y_t = \alpha_1 + \sum_{i=1}^{p} \beta_1 \Delta y_{t-i} + \sum_{i=1}^{p} \beta_2 \Delta x_{t-i} + \sum_{i-1}^{p} \beta_3 \Delta z_{t-i} + \varepsilon_{t1} \quad (1)$$

$$\Delta x_t = \alpha_1 + \sum_{i=1}^{p} \beta_4 \Delta x_{t-i} + \sum_{i=1}^{p} \beta_5 \Delta y_{t-i} + \sum_{i=1}^{p} \beta_6 \Delta z_{t-i} + \varepsilon_{t2} \quad (2)$$

$$\Delta z_t = \alpha_3 + \sum_{i=1}^{p} \beta_7 \Delta z_{t-i} + \sum_{i=1}^{p} \beta_8 \Delta y_{t-i} + \sum_{i=1}^{p} \beta_9 \Delta x_{t-i} + \varepsilon_{t3} \quad (3)$$

Let y, x, and z be P-FG, P-WS, and P-FOB, respectively, with α as a constant value, β as the coefficient value, and ε as the residual term. The variables are assumed to be stationary at order 1, I(1) process. Δ is a different order.

3. Long – term equilibrium relationship analysis by Engle and Granger

The time series data of rice prices for the farm, wholesale and export markets in Thailand were economic data, was studied and found to have increased over time and to be non-stationary. This illustrates that the mean and variance were not stable and changed over time. The relationship test of the variables by using the ordinary least square (OLS) was most likely to have caused spurious regression problems. However, Engle and Granger (1987) developed this concept and concluded that the data set was analyzed by a regression equation. Although the data set is non-stationary, the variable is not cointegrated. The results of the analysis regression equation do not present a spurious regression problem as in the following test: 1) test stationary of data and estimate the equation by OLS; 2) Consider the residuals which derive from the estimated regression equation. If the residual has a unit root in the stationary I(0) process, then there is a long-term equilibrium relationship between the dependent and the independent variables.

To test the stationary equilibrium of the residuals, this study employs the ADF unit root with no constant and time trend effect (Enders, 2015), as shown in the following equations:

$$\Delta \hat{e}_t = \beta_1 \hat{e}_{t-1} + \sum\nolimits_{i=1}^{p} \beta_2 \Delta \hat{e}_{t-i} + \varepsilon_t \quad (4)$$

P-FG and P-WS
P-FG and P-FOB
P-WS and P-FOB

P-WS and P-FG
P-FOB and P-FG
P-FOB and P-WS

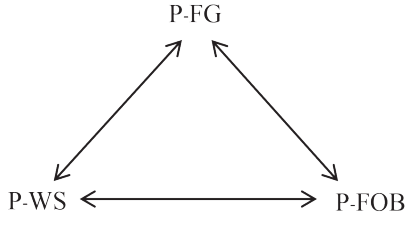

Figure 1. Analyze the linkages between market price variables using Granger Causality test

where $\hat{e}$ is the estimated residual from the regression equation.

4. Short – term adjustment test with Error Correction Model (ECM)

The time series variables, which have long-term equilibrium relationships, were applied to construct a short-term adjustment model to lead to long-term equilibrium. This model was called the Error Correction Model (ECM), which represents short-term and long-term changes simultaneously. This study applied a short-term adjustment model and the estimated coefficient by OLS did not have any spurious regression problems, as the following test shows:

1) Estimate the cointegration equation by using OLS, then calculate the error correction terms.

Accordingly, the previous independent and dependent variables which were found to be stationary tested should have the same or similar integration order.

2) The coefficient of the error correction term must be less than zero which means that there were adjustments from the short-term to the long-term equilibrium. The coefficient of the error correction terms represents the speed of adjustment for equilibrium, as shown by the following equations:

$$\Delta y_t = \alpha_1 + \gamma_y ECT_{t-1} + \sum \alpha_{11}(i)\Delta y_{t-i} + \sum \alpha_{12}(i)\Delta x_{t-i} + \varepsilon_{yt} \quad (5)$$

$$\Delta x_t = \alpha_2 + \gamma_x ECT_{t-1} + \sum \alpha_{21}(i)\Delta y_{t-i} + \sum \alpha_{22}(i)\Delta x_{t-i} + \varepsilon_{xt} \quad (6)$$

where y = speed of adjustment
ECT = error correction term

Results

1. The stationary test for the price of rice in the farm, wholesale, and export markets

The ADF test at the first difference show that the price of rice in the farm, wholesale, and export markets was less than t-statistic at 0.01 significance level. They show that the time series data for the price of rice from the three markets is stationary and that it is also integrated at the first different order, I(1). The test results are shown in Table 2.

2. An analysis of the direction of the linkages between the markets.

2.1 To find out if the price of rice in the farm and wholesale markets are dependent and independent variables, respectively, the data is

Table 2. Stationary test for the price of rice in the farm, wholesale, and export market

Variables	Level		First difference	
	t-statistics	p	t-statistics	p
P-FG	-3.012	1	-10.374***	0
P-WS	-2.719	1	-10.459***	0
P-FOB	-3.060	1	-18.168***	0

Note: *** indicated that the ADF test statistic from calculation was less than t-statistic on the first difference at 0.01 significance level, and p was an optimal lag length from the standard Schwarz Information Criterion

Table 3. Granger causality test

Independent variable (X)	Dependent variable (Y)		
	P-FG	P-WS	P-FOB
P-FG	-	0.622	20.572***
P-WS	16.182***	-	28.506***
P-FOB	0.530	1.625	-

Note: *** indicated a statistical significance at 0.01 level

formed into a logarithm. The results show that there is a unidirectional price causality from the wholesale market to the farm market.

2.2 To find out if the price of rice in the export and farm markets are dependent and independent variables, respectively, the data is formed into a logarithm. The results show that there is a unidirectional price causality from the farm to the export market.

2.3 To find out if the price of rice in the export and wholesale markets are were dependent and independent variables, respectively, the data is formed into a logarithm. The results show that there is a unidirectional price causality from the wholesale to the export market.

An analysis of the directions of the linkages of the price of rice between the markets as calculated above is shown in Table 3 and Figure 2.

3. The long – term equilibrium relationship of variables using Engle and Granger

An analysis of the long-term equilibrium model to test cointegration using Engle and Granger (1987) found that the time series of the residual terms is in a stationary state because the calculation from the ADF was greater than the absolute value of the critical ADF test at a 99% confidence level. Thus the price of farm, wholesale, and export markets are linked, or there is a cointegrated relationship. The details of the analysis are shown in to Table 4.

4. An analysis of adaptations into the equilibrium model using the ECM (Error Correction Model)

From the analysis of a long-term equilibrium model from the past, it can be seen how, if unexpected shocks were to occur in the short term, the price of rice in each of farm, wholesale, and export markets would adapt. An analysis of this issue is presented in Table 5 and can be summarized as follows.

1. The errors in rice prices deviate from the equilibrium over time between the wholesale

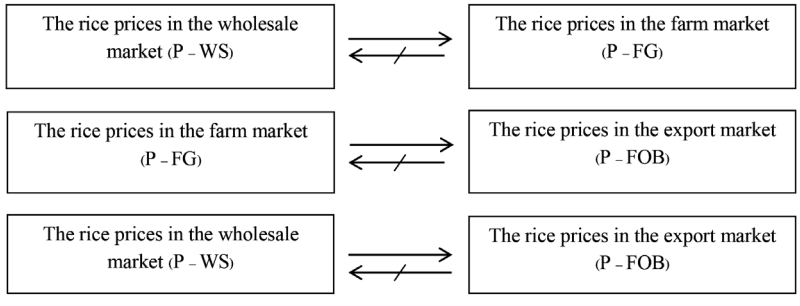

Figure 2. Granger causality test of the linkages direction of rice prices between the markets

Table 4. Long – term equilibrium relationship of variables by Engle and Granger test

Independent variable (X)	Dependent variable (Y)		
	P-FG	**P-FOB**	**P-FOB**
Constant	0.763***	1.421***	0.614***
P-FG	-	-	1.010***
P-WS	0.866***	0.872***	-
R-squared	0.959	0.861	0.906
F-statistics	4826.985***	1282.590***	1991.844***
ADF (Residual)	-5.876***	-6.296***	-7.552***

Note: *** indicated a statistical significance at 0.01 level.

and farm markets, and the adjustment to lower errors or adapting to its original equilibrium takes 23.7 percent of the time from the happened shocks. This means the period of price adjustments of rice in the wholesale to the farm market lasts for a period of adjustment of 4.22 months (1 / 0.237).

2. The errors of rice prices deviate from the equilibrium over time between the wholesale and export markets, and the adjustment to lower errors or adapting to its original equilibrium takes 23.8 percent of the time for change from shocks. This means the period of price adjustments of rice in the wholesale to the export market lasts for a period of adjustment of 4.20 months (1 / 0.238).

3. The errors of rice prices deviate from the equilibrium over time between the farm and export markets, and the adjustment to lower errors or adapting to its original equilibrium takes 47.3 percent of the time for change from shocks. This means the period of price adjustments of rice in the farm to the export markets lasts for a period of 2.11 months (1 / 0.473).

Results from the price adjustments of rice when an unexpected shock occurs show that the price of rice from the wholesale to the farm market lasts for a period of time which is no different form from the adjustment of the prices from the wholesale to the export market, which are 23.7 and 23.8, respectively . For the price adjustment of rice from the farm to the export market when an unexpected shock occurs lasts for a period of time of 47.3 percent of the time for change from shocks. Examples of such shocks are changes in price of rice as a result of government policy to help farmers or exports to international markets, epidemics, drought, and floods. The price adjustment of rice from the wholesale market to the farm and export markets take longer than the price adjustment of rice from the farm to the export markets. A summary of the details described above is shown below in Figure 3.

Conclusions

In this paper, we use cointegration and error correction models to estimate long-term equilibrium relationship and short-run dynamic response for rice market in Thailand for the rice market in Thailand, taking into account the monthly data of the farm prices, the wholesale prices, and the export prices from January, 1998 – April, 2015, which cover a total time of 207 months. The results of the cointegration indicate that there is a long – run relationship between farm and wholesale prices, export and farm

Table 5. Analysis of price adjustment to the rice market equilibrium with ECM

Independent variables (X)	Dependent variables (Y)		
	ΔP-FG	**ΔP-FOB**	**ΔP-FOB**
Constant	5.434x10-4	0.001	3.225x10-4
ΔP-FG	-	-	0.166736*
ΔP-FGt-1	0.184***	-	-
ΔP-WS	0.583***	0.008	-
ΔP-WSt-1	-0.010	0.102	-
ΔP-WSt-2	-	0.324***	-
ΔP-FOBt-1	-	-0.301***	-
ΔP-FOBt-2	-	-0.127**	-
ECTt-1	-0.237***	-0.238***	-0.473***
R-squared	0.610	0.356	0.337
DW	1.983	2.077	2.241
F-statistics	78.886***	18.302***	51.871***

Note: *, ** and *** indicated a statistical significance level at 0.1, 0.05 and 0.01, respectively.

prices, and export and wholesale prices, all of which a unidirectional causality.

The most important results of this research are: (1) changes in the price of rice on the wholesale market cause a change in the price of rice in the farm and export markets. So the wholesale market is important to the farm and export markets. (2) unexpected shocks can occur in the short term, with the result that the error of rice prices deviate from the equilibrium in the wholesale to the farm and export markets, and the adaptation to the original long-run equilibrium takes 23.7 and 23.8 percent of the time for change from shocks, respectively. (3) when unexpected shocks occur in the short term, the error of rice prices deviate from the equilibrium in the farm to the export markets, the adaptation to its original long-run equilibrium takes 43.7 percent of the time for change from shocks.

The research also found that if unexpected shocks occur in the short term, the price adjustment of rice from the wholesale market to farm market and export market adapts efficiently, but did not show any great differences, and it is slower than the period of time adjustment of price from the farm to the export market. Therefore, the price adjustment of rice from the farm to the export market for a long run equilibrium is more effective than the price adjustment of rice from the wholesale to the farm and export markets. Examples of such unexpected shocks are epidemics, drought, and floods. Moreover, the government should focus on the optimization of time adjustments from the wholesale market to the farm and export market because effective adaptation is slow, and also the price of rice is determined by the global market and the impact on rice markets within countries, such as implementing the policy in the form of export support to help wholesalers, or specify the optimal standards of rice for buying and selling between farm and wholesale markets. The government, however, has a policy to reduce the exploitation of farmers by the wholesalers. The government, through the Ministry of Commerce should accelerate its rice sales by expanding export markets to help traders, exporters, local wholesalers and farmers, respectively. Furthermore, the government should carefully study information concerning the issue of the supply chain of the rice market in Thailand which is composed of stakeholders include traders, exporters and local wholesalers, and farmers. There should also be further studies of the various factors related to the supply chain of the rice market, particularly with regard to the prices of rice, and how much of it should be sold and how the price of rice paid to farmers can be maintained in order to ensure fairness. In particular, if there are too many middlemen in the supply chain in Thailand, it will affect the marketing margins, which include marketing costs and greater profits. Such a study of the rice supply chain should lead to a reduction in the marketing margins and ensure greater fairness for farmers.

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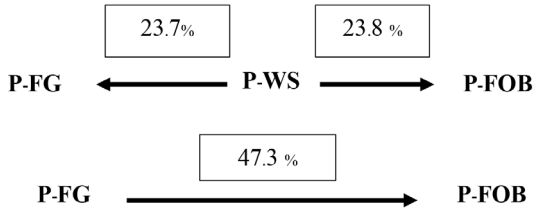

Figure 3. Performance comparison of the price adjustment of rice from farm, wholesale, and export market in Thailand (Source: Table 5)

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