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INTEGRATION OF RICE MARKET IN ASEAN

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ABSTRACT

Rice, as a trading commodity in the ASEAN, has a pivotal role in economic, social, and political stability. The existence of the ASEAN Economic Community has provided some evidence that shows that market integration in ASEAN becomes apparent. This study analyzes rice import and export trends in the ASEAN, long-term, and short-term relationships among ASEAN rice markets, causality relationships, and impulse response analysis based on ASEAN's rice prices. The data that is used in this research consists of annual rice data of import and export from Thailand, Indonesia, Malaysia, the Philippine, and Vietnam in 1989-2013 as well as monthly data on rice prices in 2012-2016. Trend analysis, Johansen co-integration test, Vector Auto Regression estimation (VAR) with Vector Error Correction Model (VECM), Granger causality, and impulse response analysis are employed to answer the objective of this research. The results show that Indonesia's import trend relatively constant, but export and import trends from Thailand, Vietnam, Malaysia, and the Philippines increase every year. Long-term and short-term relationships exist among rice markets in ASEAN, with the pattern of causality relations as Malaysia affects the Philippines' market, the Philippines' market affects Vietnam's market, and Vietnam's market affects Indonesia's rice market, but there are no reciprocal linkages. In the short run, Indonesia's market is positively influenced by Malaysia and Thailand's markets and negatively influenced by Vietnam's rice market. Malaysia's rice market is influenced by its rice price from the previous first and second months. Malaysia and Thailand's markets positively influence the Philippines' rice market. Indonesia's rice market positively influences Thailand's rice market. Vietnam's rice market is positively influenced by the Philippines' rice market from the first and third months.

Keywords: ASEAN, market integration, rice, VECM

INTRODUCTION

Rice is a commodity whose availability is vital in ASEAN, especially because every ASEAN country has a high need for rice. Rice exporting countries, such as Thailand and Vietnam, derive their income from exporting rice throughout the world. Besides being a net importer and net exporter of the world are in ASEAN, over 40% of world production and consumption rests in ASEAN (ADB, 2012). These things prove that rice is a crucial commodity for its supply of attention.

ASEAN is an association that aims to strengthen each other in various aspects through various cooperation agreements and other strengthening efforts. The creation of the ASEAN Economic Community cannot be separated from ASEAN's noble goal to work together to achieve national independence, one of which is food security. In the end, ASEAN has a close relationship in the economic sector with the realization of free trade, including the rice commodity. In 2011, the World Bank stated that ASEAN member countries agreed to form an Integrated Food Security Framework which consists of two components of cooperation in the field of regional resilience, namely the ASEAN Strategic Plan of Action on Food Security (2009-2013) and the ASEAN Plus Three Emergency Rice Reserve Agreement (APTERR) (Hermanto, 2014). APTERR is an effort to save rice food reserves in a disaster or other phenomenon that causes a food crisis.

Until now, the world rice trade consists only of four to seven percent of total world production. Therefore, the world rice market can be a thin market due to the relatively small trade volume compared to the total world rice production and demand. This phenomenon causes rice prices to be prone to fluctuations due to the small rice volume, while rice demand increases (Julitasari, 2014). Changes in the market price of one can influence the market conditions of other countries. According to Syalsabilla et al. (2010), it has never seriously faced food and rice politics during this country's largest rice importer in Asia. Imports have always overcome the shortage of rice. The average import of Indonesian rice reaches

1.5 million tons from Vietnam and Thailand. Most of Indonesia's population still wants a stable supply and price of rice available at all times, evenly distributed, and at an affordable price.

Edi & Rahmanta (2014) revealed an integration between the domestic rice market and the world rice market with different degrees of integration according to the variety or type of rice. Changes in rice prices in one market will affect other markets. Knowledge of the relationship between one market and another can be used as a consideration in the development of domestic rice commodities. There are a relationship and influence with each other. It is especially so because international rice prices will affect domestic rice prices for net rice importing countries and also affect national income for rice exporting countries. Since rice is considered as an essential commodity in the ASEAN region, therefore, this study aims to determine how the import and export trends of rice in ASEAN, and how to establish long-term and short-term integration between the ASEAN rice market. Furthermore, the objective also tries to determine the causal relationship that that occurs when there is integration between rice prices in the ASEAN market and the impulse from the shock response of prices on the ASEAN rice market.

METHOD

This research's primary method is a quantitative analytical descriptive method, where quantitative research emphasizes objective phenomena and is studied quantitatively. In quantitative analysis, a descriptive method is a research method intended to describe existing phenomena that are taking place at present or in the past (Hamdi, 2014). The descriptive quantitative analysis method is an innovative research method that looks not only from traditional qualitative methodologies but also from a more quantitative lens to provide an overall summary of a study (Seixas et al., 2018).

The type of data used in this research is secondary data from BPS (Central Bureau of Statistics), World Bank, Food and Agriculture Organization (FAO), United Nations Commodities Trade (UN Comtrade), Bureau of Agricultural Statistics (BAS) the Philippines. The trend analysis uses rice imports by Indonesia, Malaysia, and the Philippines and data on rice exports by Thailand and Vietnam during 1999–2013. The data were taken in the VAR analysis covering the monthly data from rice prices in Thailand, Vietnam, Indonesia, Malaysia, and the Philippines in 2012-2016 and other data supporting this research.

There are two models of the analysis method used in this study: the trend analysis method with the least square method and the Vector Auto Regression (VAR) method with the Vector Error Correction Model (VECM) model. Analysis of import and export trend data used Microsoft Excel, while the VAR method analysis used Eviews software.

The VECM model in VAR is used considering the use of time series data in this study. The VECM model is a model capable of analyzing the interdependence of the time series variables (Widarjono, 2013). The rice prices in various countries are not differentiated into the dependent variable or the independent variable. All variables that are believed to be related are included in the model. The VECM model is used in the non-structural VAR method if the time series data is not stationary in level, but stationary in the differentiation delta and is cointegrated to show a theoretical relationship between variables. The VECM specification restricts the long-term behavior relationship between the existing variables to converge into the cointegration relationship but still allow for dynamic changes in the short term (Rosadi, 2011).

Trends Analysis of Import and Export

Trend analysis using time series (time series) is a technique or a method of forecasting using the relationship between the predicted variable and the only independent variable that affects the time variable. The trend analysis in this study uses the Excel 2007 application with the following equation:

$$Y = a + bX \quad \ldots\ldots(1)$$

Description:

- Y = the predicted variable (Rice Imports: Indonesia, Malaysia, Philippines and Rice Exports: Thailand and Vietnam)
- X = time variable
- a = intercept/constants
- b = slope / time modifier regression coefficient, the amount of change in variable Y that occurs at every change of one unit of variable X

Unit Root Test

The unit root test was conducted to determine the stationarity of the data set of the variables to be analyzed (Arifianti et al., 2010). The first unit root test developed by Dickey-Fuller and known as the Augmented Dickey-Fuller test, by the following equation:

$$\Delta LNIND_t = \gamma LNIND_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNIND_{t-i+1} + e_t \quad \ldots\ldots(2)$$

$$\Delta LNMAL_t = \gamma LNMAL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNMAL_{t-i+1} + e_t \quad \ldots\ldots(3)$$

$\Delta LNPHIL_t = \gamma LNPHIL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNPHIL_{t-i+1} + e_t$ ....(4)
$\Delta LNTHAI_t = \gamma LNTHAI_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNTHAI_{t-i+1} + e_t$ ....(5)
$\Delta LNVIET_t = \gamma LNVIET_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNVIET_{t-i+1} + e_t$ ....(6)

$\Delta LNIND_t = \alpha_0 + \gamma LNIND_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNIND_{t-i+1} + e_t$ ....(7)
$\Delta LNMAL_t = \alpha_0 + \gamma LNMAL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNMAL_{t-i+1} + e_t$ ....(8)
$\Delta LNPHIL_t = \alpha_0 + \gamma LNPHIL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNPHIL_{t-i+1} + e_t$ ....(9)
$\Delta LNTHAI_t = \alpha_0 + \gamma LNTHAI_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNTHAI_{t-i+1} + e_t$ ....(10)
$\Delta LNVIET_t = \alpha_0 + \gamma LNVIET_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNVIET_{t-i+1} + e_t$ ....(11)

$\Delta LNIND_t = \alpha_0 + \alpha_1 T + \gamma LNIND_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNIND_{t-i+1} + e_t$ ....(12)
$\Delta LNMAL_t = \alpha_0 + \alpha_1 T + \gamma LNMAL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNMAL_{t-i+1} + e_t$ ....(13)
$\Delta LNPHIL_t = \alpha_0 + \alpha_1 T + \gamma LNPHIL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNPHIL_{t-i+1} + e_t$ ....(14)
$\Delta LNTHAI_t = \alpha_0 + \alpha_1 T + \gamma LNTHAI_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta THAI_{t-i+1} + e_t$ ....(15)
$\Delta LNVIET_t = \alpha_0 + \alpha_1 T + \gamma LNVIET_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta LNVIET_{t-i+1} + e_t$ ....(16)

Description:
IND = Indonesian rice price variable
MAL = Malaysian rice price variable
PHIL = Philippine rice price variable
THAI = Thai rice price variable
VIET = Vietnamese rice price variable
$\Delta IND = IND_t - IND_{t-1}$
$\Delta MAL = MAL_t - MAL_{t-1}$
$\Delta PHIL = PHIL_t - PHIL_{t-1}$
$\Delta THAI = THAI_t - THAI_{t-1}$
$\Delta VIET = VIET_t - VIET_{t-1}$
T = time trend

Equations (2) to (6) are tests without time constants and trends, equations (7) to (11) are tests with the assumption that the observed data has a constant without a time trend, while equations (12) to (16) are test data assuming it has a constant and is influenced by time trends. In the root test used in the study are the three equations above. The hypothesis used in this ADF test is:

H_0: $\gamma = 0$ (there are unit-roots, price data is not stationary)

H_1: $\gamma \neq 0$ (there are no unit-roots, stationary price data)

The value of γ s known by estimating through the least-squares method, and testing is carried out using the t-test. The t-test statistic can be written as follows (Widarjono, 2013):

$t_{statistic} = \frac{\gamma}{\sigma_\gamma}$ ....(17)

H0 is rejected if Augmented Dickey-Fuller t-statistic < critical value, or it means the data is stationary. The value of γ s the coefficient of INDt-1, MALt-1, PHILt-1, THAIt-1, and VIETt-1 while the value of σ_γ is the standard error or standard deviation of γ each of the data above. The stationary test results are compared with the critical value at the confidence α = 5%, H0 is rejected if the probability value α > 5%.

Test Degrees of Integration

The degree of integration test is a further test after the ADF test if it results in a conclusion that the data is not stationary, steps are needed to make the data stationary through the data differentiation process. Knowing to what degree the data will be stationary can be seen by comparing the ADF statistical value obtained with the Mackinnon distribution's critical value. If the DF statistic's absolute value is greater than the critical value at the first level of differentiation, the data is said to be stationary at degree one. However, if the value is smaller than the critical value, the degree of integration test needs to be continued at a higher differentiation to obtain stationary data (Widarjono, 2013)

The formulation of the degree of integration test of the ADF in this study is as follows:

$\Delta DLNIND_t = \gamma DLNIND_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNIND_{t-i+1} + e_t$ ....(18)
$\Delta DLNMAL_t = \gamma DLNMAL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNMAL_{t-i+1} + e_t$ ....(19)
$\Delta DLNPHIL_t = \gamma DLNPHIL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNPHIL_{t-i+1} + e_t$ ....(20)
$\Delta DLNTHAI_t = \gamma DLNTHAI_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNTHAI_{t-i+1} + e_t$ ....(21)
$\Delta DLNVIET_t = \gamma DLNVIET_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNVIET_{t-i+1} + e_t$ ....(22)

$\Delta DLNIND_t = \alpha_0 + \gamma DLNIND_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNIND_{t-i+1} + e_t$ ....(23)
$\Delta DLNMAL_t = \alpha_0 + \gamma DLNMAL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNMAL_{t-i+1} + e_t$ ....(24)
$\Delta DLNPHIL_t = \alpha_0 + \gamma DLNPHIL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNPHIL_{t-i+1} + e_t$ ....(25)
$\Delta DLNTHAI_t = \alpha_0 + \gamma DLNTHAI_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNTHAI_{t-i+1} + e_t$ ....(26)
$\Delta DLNVIET_t = \alpha_0 + \gamma DLNVIET_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNVIET_{t-i+1} + e_t$ ....(27)

$\Delta DLNIND_t = \alpha_0 + \alpha_1 T + \gamma DLNIND_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNIND_{t-i+1} + e_t$ ....(28)

$\Delta DLNMAL_t = \alpha_0 + \alpha_1 T + \gamma DLNMAL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNMAL_{t-i+1} + e_t$ ....(29)
$\Delta DLNPHIL_t = \alpha_0 + \alpha_1 T + \gamma DLNPHIL_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNPHIL_{t-i+1} + e_t$ ....(30)
$\Delta DLNTHAI_t = \alpha_0 + \alpha_1 T + \gamma DLNTHAI_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNTHAI_{t-i+1} + e_t$ ....(31)
$\Delta DLNVIET_t = \alpha_0 + \alpha_1 T + \gamma DLNVIET_{t-1} + \sum_{i=2}^{\rho} \beta_1 \Delta DLNVIET_{t-i+1} + e_t$ ....(31)

Description:

DLNIND	= differences of one Indonesian rice price data
DLNMAL	= differences of one of Malaysian rice price data
DLNPHIL	= differences of one of Philippines rice price data
DLNTHAI	= differences of one of Thai rice price data
DLNVIET	= differences of one of Vietnamese rice price data
ΔDLNIND	= $DLNIND_t - DLNIND_{t-1}$
ΔDLNMAL	= $DLNMAL_t - DLNMAL_{t-1}$
ΔDLNPHIL	= $DLNPHIL_t - DLNPHIL_{t-1}$
ΔDLNTHAI	= $DLNTHAI_t - DLNTHAI_{t-1}$
ΔDLNVIET	= $DLNVIET_t - DLNVIET_{t-1}$
T	= time trend

Equations (18) to (22) are tests without time constants and trends, equations (23) to (27) are tests with the assumption that the observed data has a constant without a time trend, while equations (28) to (31) are test data assuming it has a constant and is influenced by time trends. The root test used in the study is the third equation, where the test used is with time constants and trends. The value of γ known by guessing through the least-squares method, and testing is done using the t-test. The t-test statistic can be written as follows (Widarjono, 2013):

$$t_{statistic} = \frac{\gamma}{\sigma_\gamma} \text{ .... (32)}$$

H_0 is rejected if Augmented Dickey-Fuller t-statistic < critical value, or it means the data is stationary. The value of γ is the coefficient of DLNINDt-1, DLNMALt-1, DLNPHILt-1, DLNTHAIt-1, and DLNVIETt-1, while the value of σ_γ is the standard error or standard deviation of γ of each data different one above. The stationary test results are compared with the critical value at the level of confidence α = 5%, H_0 is rejected if the probability value of α > 5%.

Optimum Lag Test

One of the essential steps in determining the VAR and VECM models is determining the lag of the existing variables. At this stage, the VAR model stability test is also carried out, the optimum lag determination and VAR stability test is carried out first before going through the cointegration test stage. (Nasution, 2015). This lag is determined to eliminate the autocorrelation problem; therefore, it is necessary to know the optimal lag in advance. Determination of optimal lag can be done with several tests of Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), Final Prediction Error (FPE), and Hannan Quin Criterion (HQ) (Usman, 2017). This research uses lag determination based on AIC criteria, with the following formula (Widarjono, 2013):

$$\text{Ln AIC} = \frac{2k}{n} + \ln\left(\frac{SSR}{n}\right) \text{ .... (33)}$$

Description:

k	= number of parameters estimated
n	= number of observations
SSR	= sum of squared residual

The lag to be selected in this study is the model with the smallest AIC value. The smaller the AIC value, the expected value generated by a model will be closer to reality (Widarjono, 2013).

Cointegration Test

In generals, it can be said that if the time series data is not stationary at the level (level) but becomes stationary at the same first level of differentiation, then the data is cointegrated (has a long-term relationship) (Widarjono, 2013). So the cointegration test can only be done on data that determines the integration of the same degree. The cointegration test alternative often used is the cointegration test developed by Johansen (Hjalmarsson & Österholm, 2007). In this study, the degree of integration used is to use level one differentiation, so the Johansen cointegration test model becomes:

$$\begin{bmatrix} DLNIND_t \\ DLNMAL_t \\ DLNPHIL_t \\ DLNTHAI_t \\ DLNVIET_t \end{bmatrix} = \boldsymbol{\mu} + \sum_{i=1}^{\rho-1} \boldsymbol{\Gamma} i \begin{bmatrix} DLNIND_{t-1} \\ DLNMAL_{t-1} \\ DLNPHIL_{t-1} \\ DLNTHAI_{t-1} \\ DLNVIET_{t-1} \end{bmatrix} + \Pi \begin{bmatrix} DLNIND_{t-i} \\ DLNMAL_{t-i} \\ DLNPHIL_{t-i} \\ DLNTHAI_{t-i} \\ DLNVIET_{t-i} \end{bmatrix} + \boldsymbol{\varepsilon}_t \text{ .... (34)}$$

Description:

εt	= residual vector
μ	= intercept vector
Π	= cointegration coefficient matrix (**Π**: αβ‘;

α = adjustment vector, β = cointegration vector, both by nxr order; n = number of variables and r = number of cointegration)
Γi = matrix with the order nxn on the i^{th} endogenous variable

A matrix of ρ variables can explain the long-term relationship (cointegration). When 0 < rank = r < (Π) = r < ρ, then Π consists of a matrix **α** and **β** with r x ρ dimensions, so Π = αβ'. The R matrix consists of r (0 < r < ρ cointegration vector), while the **α** matrix is the error-correction-parameter vector. Whether there is cointegration is based on the likelihood ratio (LR) test. The LR value is calculated based on the following formula (Widarjono, 2013):

$$LR_{count}(Q_t) = -T \sum_{i=r+1}^{k} \log(1-\lambda_i) \text{ ....(35)}$$

Description:
r = cointegration vector, for r = 0,1,…, k – 1
λi = the greatest eingenvalue
Q = statistical test to determine the cointegration vector r
T = number of observations

Then the hypothesis in the cointegration test above is:
H_0: $LR_{count} \geq LR_{critical}$; there are as many cointegration equation r = 0
H_1: $LR_{count} < LR_{critical}$; there are more cointegration equations than r = k

The presence or absence of correlation is explained by looking at the maximum likelihood estimator based on the likelihood ratio (LR) test. If the calculated LR value is higher than the critical value of LR, cointegration exists and is accepted in some variables, and conversely, the calculated LR value is smaller than the critical value, then there is no cointegration (Nurhayati, 2012). The Johansen test provides an alternative LR statistical test known as the maximum eigenvalue statistic, which can be calculated as follows (Widarjono, 2013):

$$LR_{count}(Q_{\max}) = -T(1-\boldsymbol{\lambda}_{i+1}) = Q_t - Q_{t-1} \text{ (36)}$$

H0: $LR_{count} \geq LR_{critical}$; there are as many as r eigenvalue (λ) positive ones indicate cointegration ; r = 0
H1: $LR_{count} < LR_{critical}$; there are as many as r+1 eigenvalue (λ) positive ones indicate cointegration ; r > k

Johansen test on the test results from the value of max-eigen statistic than the critical value at a confidence level of 5% or 1%. H0 is rejected if the t-statistic value> the critical value. The cointegration test determines how the next VAR model will be, where if there is cointegration, then the test uses the VECM estimation.

Estimated Vector Error Correction Model (VECM)

VECM model equations are applied in this study are as follows:

$$\Delta LNDIND_t = \varphi_{IND} + \delta_{IND}t + \lambda_{IND}e_{t-1} + \sum_{i=1}^{\rho} \gamma_{INDi}\, \Delta LNDIND_{t-i} + \sum_{i=1}^{\rho} \omega_{INDi}\, \Delta LNDMAL_{t-i} + \sum_{i=1}^{\rho} \theta_{INDi}\, \Delta LNDPHIL_{t-i} + \sum_{i=1}^{\rho} \pi_{INDi}\, \Delta LNDTHAI_{t-i} + \sum_{i=1}^{\rho} \beta_{INDi}\, \Delta LNDVIET_{t-i} + \varepsilon_{INDt} \text{.............(37)}$$

$$\Delta LNDMAL_t = \varphi_{MAL} + \delta_{MAL}t + \lambda_{MAL}e_{t-1} + \sum_{i=1}^{\rho} \gamma_{MALi}\, \Delta LNDIND_{t-i} + \sum_{i=1}^{\rho} \omega_{MALi}\, \Delta LNDMAL_{t-i} + \sum_{i=1}^{\rho} \theta_{MALi}\, \Delta LNDPHIL_{t-i} + \sum_{i=1}^{\rho} \pi_{MALi}\, \Delta LNDTHAI_{t-i} + \sum_{i=1}^{\rho} \beta_{MALi}\, \Delta LNDVIET_{t-i} + \varepsilon_{MALt} \text{...(38)}$$

$$\Delta LNDPHIL_t = \varphi_{PHIL} + \delta_{PHIL}t + \lambda_{PHIL}e_{t-1} + \sum_{i=1}^{\rho} \gamma_{PHILi}\, \Delta LNDIND_{t-i} + \sum_{i=1}^{\rho} \omega_{PHILi}\, \Delta LNDMAL_{t-i} + \sum_{i=1}^{\rho} \theta_{PHILi}\, \Delta LNDPHIL_{t-i} + \sum_{i=1}^{\rho} \pi_{PHILi}\, \Delta LNDTHAI_{t-i} + \sum_{i=1}^{\rho} \beta_{PHILi}\, \Delta LNDVIET_{t-i} + \varepsilon_{PHILt} \text{ ....(39)}$$

$$\Delta LNDTHAI_t = \varphi_{THAI} + \delta_{THAI}t + \lambda_{THAI}e_{t-1} + \sum_{i=1}^{\rho} \gamma_{THAIi}\, \Delta LNDIND_{t-i} + \sum_{i=1}^{\rho} \omega_{THAIi}\, \Delta LNDMAL_{t-i} + \sum_{i=1}^{\rho} \theta_{THAIi}\, \Delta LNDPHIL_{t-i} + \sum_{i=1}^{\rho} \pi_{THAIi}\, \Delta LNDTHAI_{t-i} + \sum_{i=1}^{\rho} \beta_{THAIi}\, \Delta LNDVIET_{t-i}\, \varepsilon_{THAIt} \text{.................(40)}$$

$$\Delta VIET_t = \varphi_{VIET} + \delta_{VIET}t + \lambda_{VIET}e_{t-1} + \sum_{i=1}^{\rho} \gamma_{VIETi}\, \Delta LNDIND_{t-i} + \sum_{i=1}^{\rho} \omega_{VIETi}\, \Delta LNDMAL_{t-i} + \sum_{i=1}^{\rho} \theta_{VIETi}\, \Delta LNDPHIL_{t-i} + \sum_{i=1}^{\rho} \pi_{VIETi}\, \Delta LNDTHAI_{t-i} + \sum_{i=1}^{\rho} \beta_{VIETi}\, \Delta LNDVIET_{t-i} + \varepsilon_{VIETt} \text{...............(41)}$$

Description:
$e_{(t-1)}$ = $Y_{t-1} - \alpha - \beta X_{t-1}$ (Error Correction Term)
β = cointegration coefficient
ρ = degrees of lag
φ = intercept
δ = trend coefficient
λ = ECT coefficient (speed of adjustment)

The decision on whether each of the variables affects the endogenous variables in the equation is known to calculate the value of F obtained from the following formula:

Description:

SSR_R = residual sum of squares in the restricted equation

SSR_u = residual sum of squares in the equation unrestricted

q = number of lag

n = number of observations

k = number of parameters estimated

The hypothesis in this F test becomes:

H_0: $F_{count} \leq F_{table}$; variables together do not affect endogenous variables

H_1: $F_{count} > F_{table}$; variables together affect the endogenous variables

The partial t-test is carried out to determine how each variable influences the respective lag on endogenous variables. The t-test has done by finding t count by calculating each coefficient of the exogenous variable minus the expected value divided by the standard deviation. If the $t_{count} > t_{table}$ value, H_0 is rejected, where H_0 is no relationship between the exogenous variables at a certain lag to the endogenous variables. If $t_{count} > t_{table,}$ there is a relationship between the exogenous variables at a certain lag and the exogenous variables.

Granger Causality Test

The analysis related to the non-structural VAR system model is to look for a causal relationship or causality test between variables in the VAR system; this causal relationship can be tested using the Granger causality test. Whether or not this causality is tested through the F test or seen from its probability value. Causality is a two-way relationship, so if there is causality in economic behavior, there are no independent variables in the model; all variables are dependent variables (Widarjono, 2013).

Impulse Response Function Analysis

Impulse response analysis tracks the response of endogenous variables in the VAR system due to shocks or changes in the disturbance variable (Widarjono, 2013). Impulse Response Function (IRF) describes how the shock level reacts to another variable's response. IRF also tries to determine the length of the impact of a shock from one variable to another (Usman, 2017). The following is an impulse response testing model (Widarjono, 2013):

$$\begin{bmatrix} X_t \\ Y_t \end{bmatrix} = \begin{bmatrix} \bar{x} \\ \bar{y} \end{bmatrix} + \sum_{i=0}^{\infty} \begin{pmatrix} \Phi_{i1}(i) & \Phi_{i1}(i) \\ \Phi_{i2}(i) & \Phi_{i2}(i) \end{pmatrix} \begin{pmatrix} \varepsilon_{xt-1} \\ \varepsilon_{yt-1} \end{pmatrix} \text{....................(42)}$$

$$X_\tau = \mu \sum_{i=1}^{\infty} \Phi_i \, \varepsilon_{\tau-1} \text{................................(43)}$$

Description:

Xt , **Y**t = vector variables to be measured (LNDIND, LNDMAL, LNDPHIL, LNDTHAI, LNDVIET)

Φ = Impulse response function

X_τ = $\begin{bmatrix} X_t \\ Y_t \end{bmatrix}$

μ = $\begin{bmatrix} X \\ Y \end{bmatrix}$

RESULTS AND DISCUSSION

Based on trend analysis, it is known that rice imports in Indonesia are very dynamic and fluctuate every year with an upward trend even though it looks insignificant.

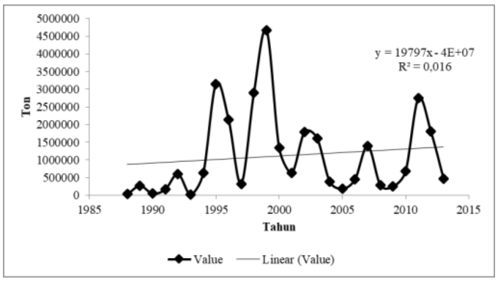

Figure 1. Trends in Rice Imports in Indonesia
Source: FAO Secondary Data Analysis, 2017

The partial t-test on the trend test was performed to give a probability of 0.5178 greater than 5%, so H0 fails to be rejected, where the time trend does not significantly affect rice imports in Indonesia. The trends in rice imports in Indonesia have in the equation below:

$y = 19.797x – 4E+07$, $R^2 = 0,016$ ……………(44)

Each year, there is an increase in rice imports in Indonesia of approximately 19,797 tons of rice.

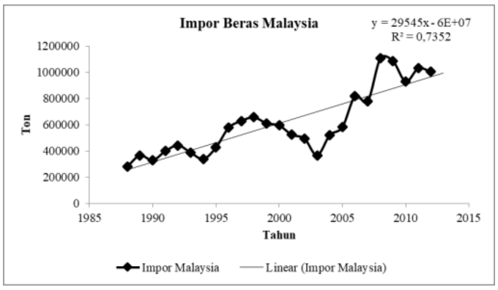

Figure 2. Trends in Imports of Rice in Malaysia
Source: FAO Secondary Data Analysis, 2017

The partial t-test for the trend shows that the t-statistic value of time-variable is greater than the t-table with a probability of less than 0.1% and succeeds in rejecting H0. Therefore, the effect of time or trend is significant on the total imports of Malaysian rice. The trend equation of rice imports in Malaysia is:

$y = 29.545x - 6E+07$, $R^2 = 0.735$ ……………(45)

With each additional year, Malaysia's imports increased by an average of 29,545 tonnes of rice, and were influenced by time. The increase in years is a variable that affects rice imports, amounting to 73.5%, while other variables explain the rest outside of time.

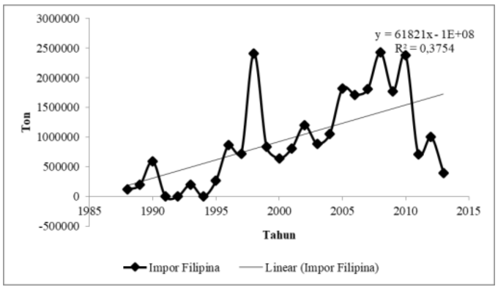

Figure 3. Trends in Imports of Rice in the Philippines
Source: FAO Secondary Data Analysis, 2017

The results of trend analysis in the Philippines show that rice imports in the Philippines fluctuate quite a bit with a significant upward trend. Trends in imports of rice in the Philippines have in the equation below:

$y = 61.821x – 1E+08$, $R^2 = 0,375$ …………(46)

Each year, there is an increase in rice imports in the Philippines of approximately 61,821 tons of rice. This amount is greater than the rice imports carried out by Malaysia and Indonesia each year. Probability significant effect of less than 0.5% lead successful H0 is rejected, then the trend affects the number of imports in the Philippines. The increase in are variables that have an impact of 37.5% while other variables explain the rest outside of time.

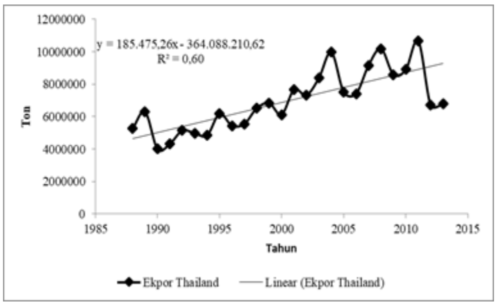

Figure 4. Tren Ekspor Beras di Thailand
Source: FAO Secondary Data Analysis, 2017

Rice exports in Thailand continue to increase steadily every year, as shown by the trend line of Thai rice exports. Thai rice-export-trend is:

$y = 185.475,26x – 364.088.21$, $R^2 = 0.60$…. (47)

The average increase in Thailand's rice exports is 185,475 tonnes per year. The partial t-test results from the trend test of Thai rice exports, where the probability value is smaller than 0.5%, then H0 is successfully rejected so that the effect of time is significant on Thai exports. The year variable affects as much as 60% of rice exports in Thailand, while other variables are explained outside the model.

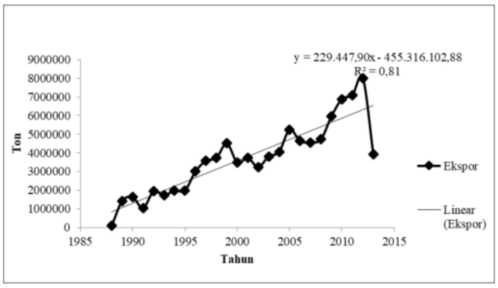

Figure 5. Tren Ekspor Beras di Vietnam
Source: FAO Secondary Data Analysis, 2017

The trend of rice exports in Vietnam continues to increase, although, in 2013, it experienced a significant decline. The t-test results of the Vietnam export trend test with a probability value of less than 0.5% so that it succeeded in rejecting H0 and the trend or time variable had a significant effect on rice exports in Vietnam. The year variable affects as much as 81.0% of rice exports in Vietnam, while other variables are explained outside the model. The equation for Vietnam's export trends is:

$y = 229.447,90x – 455.316.102$, $R^2 = 0,81$….. (48)

The average increase in Vietnam's rice exports was 229,447.90 tonnes per year, more than Thailand's average rice exports in the same period. Vietnam is one of the world's largest exporters by supplying 535,577 tons of rice to Indonesia, 191,401 tons to Malaysia, and 259,296 tons to the Philippines.

Testing the unit root influenced by the constant in it, it was found that only Malaysian rice price data were significant at the 10% level, while the other data were not significant or the ADF t-statistic value was greater than the critical value. Therefore H0 failed to be rejected again, and data for rice other than Malaysian rice had unit-roots. The unit root indicates that the data is not stationary. Although Malaysian rice data is stationary at 10% significance, rice data in other countries is not stationary at the level. Testing in the VAR model requires data that has level equality so that later rice data needs to be transformed into the equivalent in level one differentiation.

In the level one unit root test, taking into account the effect of trends and the presence of constants, the result is that the price of rice in the five countries is stationary at the one percent significance level. The ADF t-statistical value of price data in the five countries is smaller than the critical value of Mac Kinnon, which causes H0 to be rejected, and the data does not contain unit roots or is stationary at the 1st Different level. It is also known that constants and trends do not significantly influence the five countries' rice price variable. The stationarity test results on the first difference show that the data on all variables are stationary. It can be seen from the results of the stationary test above that the t-statistic value is smaller than the critical value of Mac Kinnon, with a probability of zero percent, which means that H0 is rejected. When H0 is rejected, there is no root unit in the data for all variables.

In this study, the AIC criteria were used where the smallest criterion value was the value used in selecting the optimal lag. The asterisk in the table shows the best lag of each criterion. The criteria for the third lag mostly indicate the optimal lag results. Then the model estimation will be carried out at the third lag length. It means that the VAR model variables influence each other in the current period and the previous three periods.

The Johansen cointegration test is carried out by looking at the trace statistical value on the test results. If the trace statistic value is greater than the critical value, H0 is rejected, this means that there is cointegration in the variables in the model. The r or cointegration vector's value shows the number of cointegration equations in the model between variables' relationships. At the 5% and 1% significance level, there is cointegration between variables in the model. The value of r ≥ 1, r ≥ 2, r ≥ 3, r ≥ 4, and r = 5 also shows that at least several more than or equal to one, two, three, four, and or some five cointegration equations between variables with a significance level can be made 5%. Knowing that there is cointegration between variables means that the VAR estimation model to be used is VECM.

Table 1. Results of the Cointegration Equations in the VECM Model

Variable	Cointegration Coefficient
LNIND(-1)	100.000
LNMAL(-1)	0.180904***
LNPHIL(-1)	1.837352***
LNTHAI(-1)	1.045310***
LNVIET(-1)	-1.249762***

Source: Secondary data processed (2017)
Description:
*** significant at the level 1%
** significant at the level 5%
* significant at the level 10%
t-tabel value: t(α=1%)= 2.67779; t(α=5%) = 2.00856; t(α=10%) = 1.67591

Based on table 1, it can be seen that in the long run, the rice price variable in all countries is significant at the one percent real level, which affects the price of rice in Indonesia. The cointegration equation that emerges places Indonesia as the dependent variable whose long-run equilibrium price formation is influenced by four other countries. Rice prices in Malaysia have a positive effect on Indonesian rice prices in the long run. If the Malaysian rice price increases by one percent, the Indonesian rice price will increase by 0.18%. In the long run, if the price in the Philippines increases by one percent, the balance in the Indonesian market towards child equilibrium will increase the price of Indonesian rice by 1.837%. Thai rice prices also affect rice prices in Indonesia with a similar pattern; namely, it positively responds to a one percent increase in Thailand's price, the rice price in Indonesia will increase by 1.045%. This equation fulfills the second hypothesis, where there is a market with a long-term relationship. Causality is a reciprocal relationship or a relationship that affects each other. The purpose of conducting a causality test is to determine whether the existing markets in ASEAN countries influence each other. The decision taken in this test is to find out whether one country affects another country, or is it influenced by another country. The test results of this test are listed in table 2.

The market effect is assumed by the movement of rice price data, which is included in the causality test model of Granger's method. Conclusions can be drawn from each side; there is a possibility that there is no market between two countries that influence each other but can influence or be influenced by the other. The null hypothesis indicates that the independent variable cannot affect the dependent variable if the probability level is less than 1%, 5%, or 10%, then H0 will be rejected, thus concluding that the independent variable significantly affects the dependent variable. If the probability is greater than alpha 0.05, then the market (independent variable) does not significantly influence other markets (dependent variable). Based on the Granger causality analysis, three markets significantly affect other markets, namely Vietnam to Indonesia, Malaysia, to the Philippines, and the Philippines to Vietnam. According to the Granger causality test, there is a 99.22% probability that Vietnamese rice prices affect Indonesia's rice prices. Malaysian rice prices have a 98.23% probability of influencing Vietnamese rice prices.

The most significant influence is that rice prices in the Philippines affect Vietnam's rice price with a probability of 99.75%. The cointegration equation that appears theoretically in the data is used to determine the short-run relationship in VECM, restricting its short-run relationship to its long-run equilibrium. If there is no cointegration, the model used is an ordinary VAR model. In the VECM model, there is a short-term relationship, and the speed of the short-term relationship adjusts to the long-term relationship previously discussed. The VECM model uses a long-term equation with Indonesia as the dependent variable.

Table 2. Results of The Granger Causality Test (*Pairwise Granger Cause*)

Null Hypothesis (H_0)	Obs.	F-calc	Probability
DLNMAL *does not Granger Cause* DLNIND	56	0.06921	0.9761
DLNIND *does not Granger Cause* DLNMAL	56	0.16775	0.9176
DLNPHIL *does not Granger Cause* DLNIND	56	1.09486	0.3602
DLNIND *does not Granger Cause* DLNPHIL	56	0.28546	0.8357
DLNTHAI *does not Granger Cause* DLNIND	56	1.02492	0.3898
DLNIND *does not Granger Cause* DLNTHAI	56	1.09863	0.3587
DLNVIET *does not Granger Cause* DLNIND	56	4.43692***	0.0078
DLNIND *does not Granger Cause* DLNVIET	56	0.52702	0.6658
DLNPHIL *does not Granger Cause* DLNMAL	56	0.29529	0.8286
DLNMAL *does not Granger Cause* DLNPHIL	56	3.69918**	0.0177
DLNTHAI *does not Granger Cause* DLNMAL	56	0.50785	0.6787
DLNMAL *does not Granger Cause* DLNTHAI	56	0.61308	0.6098
DLNVIET *does not Granger Cause* DLNMAL	56	0.11651	0.9500
DLNMAL *does not Granger Cause* DLNVIET	56	0.55541	0.6470
DLNTHAI *does not Granger Cause* DLNPHIL	56	1.30372	0.2838
DLNPHIL *does not Granger Cause* DLNTHAI	56	0.83681	0.4802
DLNVIET *does not Granger Cause* DLNPHIL	56	0.65872	0.5814
DLNPHIL *does not Granger Cause* DLNVIET	56	5.49311***	0.0025
DLNVIET *does not Granger Cause* DLNTHAI	56	1.10934	0.3543
DLNTHAI *does not Granger Cause* DLNVIET	56	0.17208	0.9148

Source: Secondary data processed (2017)
Description:
*** significant at the level 1%
** significant at the level 5%
* significant at the level 10%

The CointEq1 column provides the ECT efficiency results obtained from calculations with the cointegration equation by Johansen in Table 3. Indonesia has an ECT coefficient, which shows a 10% significance speed and is negative. It indicates that the ability to adjust Indonesian rice prices from the short term to the long term is 10.7% closer to the equilibrium point. The Philippines ECT coefficient is also significant in the model, with its adaptability being 15.22% better than Indonesia's. The magnitude of the ECT coefficient in Malaysia, Thailand, and Vietnam is not significant in the model. It indicates that these three countries' price ability to adjust for the short-run effect on equilibrium with the long run is very small or insignificant.

In the short term, the Indonesian market is positively influenced by the Malaysian and Thai markets and is negatively affected by the Vietnamese rice market. The Malaysian rice market was influenced by rice prices in the market itself in the previous one and two months. Malaysia and Thailand positively influence the Philippine rice market. Indonesia positively influences the Thai rice market in the short term. Meanwhile, Vietnam's rice market was positively influenced by the Philippine rice market in the previous first and third months.

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Table 3. Results of the Short-Run Coefficient in VECM

Variable	Dependent Variable Coefficient				
	D(LNIND)	D(LNMAL)	D(LNPHIL)	D(LNTHAI)	D(LNVIET)
CointEq1	-0.107352*	-0.627307	-0.152163***	-0.089001	0.025250
$D(LNIND)_{t-1}$	-0.148840	-1.168501	0.106269	-0.015909	0.102745
$D(LNIND)_{t-2}$	-0.110698	-1.018566	0.054063	-0.071917	-0.094833
$D(LNIND)_{t-3}$	-0.006451	-1.953570	0.197150	0.390164*	-0.062707
$D(LNMAL)_{t-1}$	0.016870	-0.460566**	0.038357***	-0.007670	0.014849
$D(LNMAL)_{t-2}$	0.023478*	-0.397987*	-0.008101	-0.003804	-0.012671
$D(LNMAL)_{t-3}$	0.005846	-0.194101	0.018281	-0.007587	0.012379
$D(LNPHIL)_{t-1}$	-0.101218	0.704816	-0.088736	0.017003	0.625899***
$D(LNPHIL)_{t-2}$	-0.218103	-2.276875	0.033757	0.092742	0.096989
$D(LNPHIL)_{t-3}$	-0.090004	-1.082656	0.178546	0.178273	0.344937*
$D(LNTHAI)_{t-1}$	0.267588**	-1.010601	-0.037628	0.180736	-0.064792
$D(LNTHAI)_{t-2}$	0.048437	1.670370	0.241392*	0.154877	0.128026
$D(LNTHAI)_{t-3}$	0.121709	1.304161	-0.134546	0.097403	-0.174786
$D(LNVIET)_{t-1}$	-0.266351**	0.010902	-0.159257	0.072909	0.304092
$D(LNVIET)_{t-2}$	-0.163520	-1.766362	0.010161	0.045768	-0.021112
$D(LNVIET)_{t-3}$	0.141206	-0.450493	-0.113200	-0.018800	-0.323020*
R-squared	0.362816	0.323641	0.545801	0.259103	0.423408
Adj. R-squared	0.123872	0.070007	0.375476	-0.018733	0.207186

Source: Secondary data processed (2017)
Description:
*** significant at the level 1%
** significant at the level 5%
* significant at the level 10%
t-table value: t(α=1%)= 2.70446 ; t(α=5%) = 2,02108 ; t(α=10%) = 1.68385

If there is a price shock in Malaysia and Thailand, Indonesia's impulse response is positive, while if there are shocks, the Philippines and Vietnam negative. The impulse from Malaysia's rice price response in the event of a price shock in Vietnam is positive, whereas if a price shock occurs in Thailand, Indonesia, and the Philippines, it will give a negative impulse to Malaysia. Indonesia, Thailand, and Malaysia had a negative impact on the impulse of the Philippine rice market's price shock response, where Vietnam was positive. If a shock occurs in Indonesia, Vietnam, and the Philippines, the Thailand rice price will respond positively, while Malaysia's price shock causes Thailand's price to be below equilibrium or negative. The impulse response in Vietnam was negative towards Thailand's price shock while it was positive towards the price shock in Indonesia, Malaysia, and the Philippines.

CONCLUSIONS

Indonesia's rice import trend pattern is constant, while the import trend in Malaysia and the Philippines increases with the Philippines' largest average growth rate. The export trend pattern in Thailand and Vietnam also increases every year. There is a cointegration or long-term relationship between ASEAN rice markets.

In the long run, Malaysia, the Philippines, and Thailand's (Vietnam) markets positively (negatively) affect Indonesia's rice market. In the short term, the Indonesian market is positively influenced by the Malaysian and Thai markets and is negatively affected by the Vietnamese rice market. The Malaysian rice market was influenced by rice prices in the market itself in the previous one and two months. Malaysia and Thailand positively influence the Philippine rice market. Indonesia positively influences the Thai rice market in the short term. Meanwhile, Vietnam's rice market was positively influenced by the Philippine rice market in the previous first and third months.

Based on the causality test, a pattern of market influence is formed as Malaysia affects the Philippine market, the Philippine market affects the Vietnamese market, and the Vietnamese market affects the Indonesian rice market, but there is no reciprocal relationship.

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