ANALYSIS OF IMPORT-EXPORT TRENDS AND MARKET INTEGRATION OF RICE IN ASEAN-5 IN 2017.1 - 2021.12

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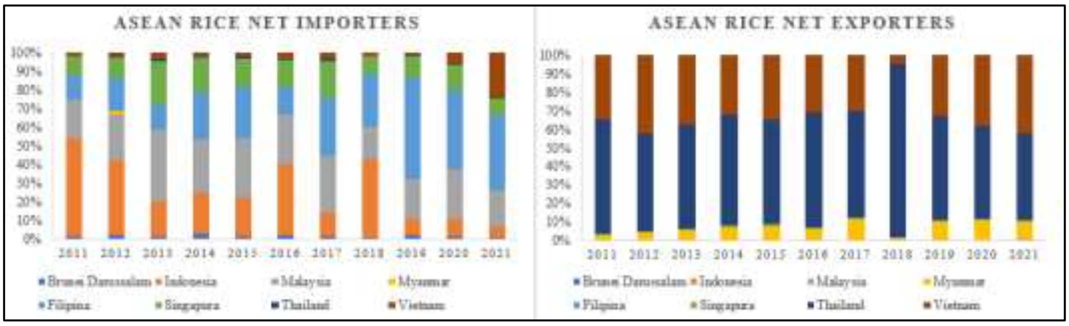
Abstract: *Rice plays an important role in the economic, social, and political stability of ASEAN. The presence of the ASEAN Economic Community (AEC) in 2015 shows that market integration in ASEAN is becoming more real. The objective of this study is to analyze trends in rice imports and exports in ASEAN, integration of rice markets, causality relationships, and impulse response based on rice prices in the ASEAN. Data used include annual data on import and export of rice from Indonesia, Malaysia, the Philippines, Thailand, and Vietnam in 2000-2021 as well as monthly data on rice price in 2017.1 - 2021.12. The methods used are trend analysis, Johansen cointegration test, Vector Autoregression (VAR) estimate with Vector Error Correction Model (VECM), Granger causality test, and impulse response analysis. The result is that the trend pattern of rice imports in Indonesia tends to decrease, while the trend of imports to Malaysia and the Philippines as well as exports to Thailand and Vietnam rises every year. There is integration of the rice market in ASEAN as well as a pattern of coherent and reciprocal inter-national causal relations.*
Keyword: Rice, Market Integration, ASEAN, VECM

INTRODUCTION

Indonesia's staple food, known as “rice”, has not been replaced by any other food, especially in the Asian region. For Indonesians and other ASEAN countries, rice is not only about economics or politics, but also includes politics and security. (Widodo, 2014) identifies the reasons why rice is a politically incorrect commodity, namely because the general public is aware of the existence of stable rice prices, as well as the fact that rice is distributed fairly and at competitive prices. The Asia Development Bank (ADB) notes that total rice consumption in ASEAN in 2013 amounted to almost 22% of global consumption and it is estimated that this percentage will continue to increase by around 1% per year. ADB also predicts that this year's consumption will continue to increase to reach 111.3 million tons by 2021. Rice is of interest to the ASEAN population not only because it is grown in areas suitable for cultivation, but also because the majority of the population consumes it. At the end of 2018, Indonesia reported a target consumption participation rate that exceeded 97.27 percent with a total national consumption of 29.57 million tons (Hairani, 2014). As a result of this consumption trend, Asian countries including Thailand, India, Bangladesh, China and Vietnam as the world's largest producers have identified Indonesians as the world's largest consumers (Sari, 2014).

Figure 1. ASEAN Rice Trade



Data source: Asian Development Bank (ADB), 2012

Looking at the export data in Figure 1, it can be seen that the countries that export the most are Thailand, Vietnam, and Myanmar. According to ADB (2012), in the early term, ASEAN's combined rice exports are projected to grow by 3.3% per year, from 15.5 million tons in 2011 to 21.5 million tons in 2021. On average, ASEAN rice exports have accounted for 53.3% of the total volume globally over the past decade and are expected to increase to around 54.8% above baseline. Thailand and Vietnam are two of the top five exporting countries globally and account for 48.0% of all ASEAN exports (Chulaphan et al., 2012). Nonetheless, there is strong competition from major exporters above the baseline (Syamsuddin & Abubakar Hamzah, 2013).

ASEAN as the center of global rice production and consumption is one of the most important strategic topics to establish the relationship between one market and another in each country. Knowledge of the relationship between one market and another can be used as a consideration in the development of rice commodities in a country. Given that rice imports are not going to stop anytime soon, Indonesia needs knowledge about the international rice market that will also impact the domestic rice market, either directly or indirectly. In addition, as other ASEAN countries have long used rice as a major food commodity, it is important to identify ASEAN market integration models. More specifically, international trade prices will affect domestic trade prices for all importing countries as well as affect the national income of each rice exporting country (Paramita et al., 2015).

This research is a study developed from previous studies. This study is different from previous studies, each of which focuses on the use of variables, scope, time, and methods. Differences with previous studies such as research conducted by Edi (2014) with the title "Analysis of Integration and Volatility of ASEAN Regional Rice Prices on the Indonesian Rice Market" can be explained that the use of scope is only limited to the countries of Indonesia, Philippines, Thailand, and Vietnam and the analysis method carried out using the Revealed Comparative Advantages (RCA) approach and rice price volatility. Based on the results of market integration analysis, it is found that net importers (Indonesia and the Philippines) and net exporters (Thailand and Vietnam) have integration patterns with other countries according to their market conditions. In addition, based on the Impulse Response Function (IRF) results, it is known that in the short to long term, the price of Thai and Vietnamese rice will increase the price of Indonesian rice, while the Philippines and Vietnam result in a decrease in the price of rice in Thailand.

THEORETICAL REVIEW

The demand and supply of goods and services is related to the interaction between buyers and sellers in the market, which will determine the price level of goods and services in the market and the amount of goods and services that will be traded in the market. These interactions can be explained by the theory of demand and supply. Demand theory explains the nature of buyer demand for a commodity (goods and services) and also explains the relationship between the quantity and price demanded and the formation of the demand curve. On the other hand, supply theory explains the nature of sellers who offer commodities for sale. The combination of buyer demand and seller supply can show how the interaction between buyers and sellers will determine the equilibrium price or market price as well as the quantity of commodities traded (Hermawan & Budiyanti, 2020).

The theory of international trade is the Heckscher Ohlin (H-O) theory. Ohlin's quote of his trade pattern states: "*Commodities which in the process of production demand more abundant and less abundant factors will be exported in exchange for commodities which in the process of production demand factors in the opposite proportion. Thus indirectly, factors in excess supply will be exported and factors in scarce supply will be imported*". The H-O theory predicts that each country will export commodities that it produces in excess and import commodities that it lacks (Lindert, 2020).

The process of economic integration is always characterized by the process of market integration among participating countries. Meanwhile, the definition of a market refers to an institution that is generally not physically tangible that brings together sellers and buyers of a commodity of goods or services. The interaction that occurs between sellers and buyers will determine the price level of a commodity being traded (Sugiarto, 2007, Arifianti, 2009). One important effort to achieve market integration is to integrate policies among countries. Market integration is a concept in which market participants in different regions or member countries in the union are driven by supply and demand conditions. This condition is indicated by the rapidly increasing movement of goods, services and production factors within a union (Winantyo et al., 2008). The market can be known to be integrated by calculating using the VECM model in the non-structured VAR method. The following model of the Vector Error Correction Model (VECM) estimation is used (Rosadi, 2011):

$$\Delta Y_t = \varphi_1 + \delta_{1t} + \lambda_1 e_{t-1} + y\Delta Y_{t-1} + \dots + y_{1p}\Delta Y_{t-p} + \omega_{11}\Delta X_{t-1} + \dots + \omega_{1q}\Delta X_{t-q} + \varepsilon_t$$

Description:

ΔY_t : $Y_t - Y_{t-1}$

e_{t-1} : $Y_{t-1} - \alpha - \beta X_{t-1}$ (*Error Correction Term*)

β : cointegration coefficient

p : lag degree

Y : observed variable

X : deterministic variable

VECM is one of the time series models that can directly estimate the rate at which a variable can be brought back to equilibrium after a shock to the other variable. VECM is very useful for estimating short-term effects for both variables and long-term effects of time series data (Usman et al., 2017).

The analysis related to the non-structural VAR system model is to find the causal relationship or causality test between variables in the VAR system (Nasution, 2015). This causal relationship can be tested using the Granger causality test. The presence or absence of causality is tested through the F test or seen from the probability value. Causality is a two-way relationship, so if there is causality in economic behavior, then in the model there are no independent variables, but all variables are dependent variables (Widarjono, 2013). The Granger causality equation model can be written as follows (Akbar et al., 2016):

$$\Delta Y_t = \sum_{j=1}^{m} \alpha_j \Delta Y_{t-1} + \sum_{j=1}^{m} \beta_j \Delta X_{t-1} + \varepsilon_1 t$$

$$\Delta X_t = \sum_{j=1}^{m} \lambda_j \Delta X_{t-1} + \sum_{j=1}^{m} \delta_j \Delta Y_{t-1} + \varepsilon_2 t$$

Where X_{t-1} and Y_{t-1} are lags of the x and y variables, t indicates time while e is the disturbance variable of the regression. Causality tests can be used to determine whether variables statistically affect each other and even have a unidirectional relationship or no relationship at all (Akbar et al., 2016).

Rice as a basic need of the ASEAN community has an important role in the conditions of economic, social and political stability. ASEAN as an association of countries in Southeast Asia has similar conditions where its people consume rice as the main food commodity. The AEC, which has been initiated and implemented since 2015, has made ASEAN an association of countries that has taken one step higher in economic integration, marked by the Free Trade Area (FTA) agreement. This has led to the rice market in ASEAN also taking a step towards greater market integration, with rice becoming a commodity that is both offered and needed in ASEAN. This is evidenced by the fact that ASEAN consists of the largest rice importing and exporting countries in the world. Therefore, knowledge of the development of exports and imports as well as inter-market integration is necessary so that each country can understand the price behavior influenced by other countries in the market (Purba, 2014).

The condition of the rice market can be known by conducting two analyses, namely trend analysis to determine the development of imports and exports and analysis of inter-market relations (integration) based on the price of rice in each country. The rice price used is adjusted to the characteristics of each country, where there are importing countries and exporting countries. In the market integration analysis, a cointegration test is conducted first to determine the appropriate model to use. In this study, rice price data from the selected countries experienced cointegration or long-term equilibrium, so the model used is the Vector Error Correction Model model in VAR analysis. The VECM model used can show the corrected short-run relationship towards its long-run relationship. In addition, the VECM also provides several analyses such as impulse responses that are used to determine the response to price shocks that occur and the Eagel Granger causality test that shows the causality or reciprocal relationship between rice markets in ASEAN countries.

Based on the underlying theory, the research hypothesis can be formulated, namely H1) it is suspected that the import trend in Indonesia, Malaysia, and the Philippines and the export trend in Thailand and Vietnam are increasing or positive; H2) it is suspected that there is integration between ASEAN rice markets; H3) it is suspected that there is a causality relationship between ASEAN rice markets; and H4) it is suspected that there is a response to price shock impulses that occur in the

ASEAN rice market.

RESEARCH METHODS

The type of research used in this research is quantitative analytical descriptive method, where quantitative research emphasizes objective phenomena and is studied quantitatively. This research uses secondary time series data. In the trend analysis, data on rice imports by Indonesia, Malaysia, and the Philippines as well as data on rice exports by Thailand and Vietnam from 2000 to 2021 are used. The data taken in the analysis using the Vector AutoRegression (VAR) method with the Vector Error Correction Model (VECM) model which includes monthly data from the price of rice in Indonesia, Malaysia, the Philippines, Thailand, and Vietnam in 2017-2021 sourced from: 1) United Nation Commodities Trade (UN Comtrade), 2) World Bank, 3) Central Bureau of Statistics (BPS), and 4) Philippine Statistics Authority.

Trend Analysis of Imports and Exports

Trend analysis in this study uses trend analysis with the time series method with IBM SPSS Statistics 26 software. There are several forecasting methods that are analyzed using time series models as follows.

a. Linear Model: $Y_t = \beta_0 + \beta_1 T$
b. Logarithmic Model: $Y_t = \beta_0 + \beta_1 \ln(T)$
c. Quadratic Model: $Y_t = \beta_0 + \beta_1 T + \beta_2 T^2$
d. Cubic Model: $Y_t = \beta_0 + \beta_1 T + \beta_2 T^2 + \beta_3 T^3$
e. Compound Model: $Y_t = \beta_0 \beta_1^T$ atau $\ln Y = \ln\beta_0 + \ln\beta_1 T$
f. S Model: $Y_t = e^{(\beta 0+\beta 1/T)}$ atau $\ln Y = \beta_0 + \beta_1/T$
g. Growth Model: $Y_t = e^{(\beta 0+\beta 1T)}$ atau $\ln Y = \beta_0 + \beta_1 T$
h. Exponential Model: $Y_t = \beta_0 e^{(\beta 1T)}$ atau $\ln Y = \ln\beta_0 + \beta_1 T$

Description:

Y_t : predicted variable (rice imports: Indonesia, Malaysia, Philippines and rice exports: Thailand and Vietnam)
β0, β1, β2, β3 : parameter estimates
ln : natural logarithm
e : number 2.718282
T : time variable

Rice Market Integration Analysis

The analysis of rice market integration in this study uses the Vector Autoregression (VAR) method with the Vector Error Correction Model (VECM) model. The VECM model equation applied in this study is as follows.

$$\Delta DIND_t = \varphi_{IND} + \delta_{IND}\, t + \lambda_{IND}\, e_{t-1} + \sum_{i=1}^{\rho} \gamma_{INDi}\, \Delta DIND_{t-I} + \sum_{i=1}^{\rho} \omega_{INDi}\, \Delta DMAL_{t-I} + \sum_{i=1}^{\rho} \theta_{INDi}\, \Delta DPHIL_{t-I} + \sum_{i=1}^{\rho} \pi_{INDi}\, \Delta DTHAI_{t-I} + \sum_{i=1}^{\rho} \beta_{INDi}\, \Delta DVIET_{t-I} + \varepsilon_{INDt}$$

$$\Delta DMALt = \varphi MAL + \delta MAL\ t + \lambda MAL\ et\text{-}1 + \sum_{i=1}^{\rho} \gamma MALi\ \Delta DINDt\text{-}I + \sum_{i=1}^{\rho} \omega MALi\ \Delta DMALt\text{-}I + \sum_{i=1}^{\rho} \theta MALi\ \Delta DPHILt\text{-}I + \sum_{i=1}^{\rho} \pi MALi\ \Delta DTHAIt\text{-}I + \sum_{i=1}^{\rho} \beta MALi\ \Delta DVIETt\text{-}I + \varepsilon_{MALt}$$

$$\Delta DPHIL_t = \varphi_{PHIL} + \delta_{PHIL}\, t + \lambda_{PHIL}\, e_{t-1} + \sum_{i=1}^{\rho} \gamma_{PHILi}\, \Delta DIND_{t-I} + \sum_{i=1}^{\rho} \omega_{PHILi}\, \Delta DMAL_{t-I} + \sum_{i=1}^{\rho} \theta_{PHILi}\, \Delta DPHIL_{t-I} + \sum_{i=1}^{\rho} \pi_{PHILi}\, \Delta DTHAI_{t-I} + \sum_{i=1}^{\rho} \beta_{PHILi}\, \Delta DVIET_{t-I} + \varepsilon_{PHILt}$$

$\Delta DTHAI_t = \varphi_{THAI} + \delta_{THAI}\ t + \lambda_{THAI}\ e_{t-1} + \sum_{i=1}^{\rho} \gamma_{THAIi}\ \Delta DIND_{t-I} + \sum_{i=1}^{\rho} \omega_{THAIi}\ \Delta DMAL_{t-I} + \sum_{i=1}^{\rho} \theta_{THAIi}\ \Delta DPHIL_{t-I} + \sum_{i=1}^{\rho} \pi_{THAIi}\ \Delta DTHAI_{t-I} + \sum_{i=1}^{\rho} \beta_{THAIi}\ \Delta DVIET_{t-I} + \varepsilon_{THAIt}$

$\Delta DVIET_t = \varphi_{VIET} + \delta_{VIET}\ t + \lambda_{VIET}\ e_{t-1} + \sum_{i=1}^{\rho} \gamma_{VIETi}\ \Delta DIND_{t-I} + \sum_{i=1}^{\rho} \omega_{VIETi}\ \Delta DMAL_{t-I} + \sum_{i=1}^{\rho} \theta_{VIIETi}\ \Delta DPHIL_{t-I} + \sum_{i=1}^{\rho} \pi_{VIETi}\ \Delta DTHAI_{t-I} + \sum_{i=1}^{\rho} \beta_{VIETi}\ \Delta DVIET_{t-I} + \varepsilon_{VIETt}$

Description:

$e_{t-1} = Y_{t-1} - \alpha - \beta X_{t-1}$ (*error correction term*); β = cointegration coefficient

ρ : lag degree

φ : intercept

δ : trend coefficient

λ : ECT coefficient (speed of adjustment)

The analysis related to the non-structured VAR system model is to find the causal relationship or causality test between variables in the VAR system. This causal relationship can be tested using the Granger causality test. The presence or absence of causality is tested through the F test or seen from the probability value. Causality is a two-way relationship so that if there is causality in economic behavior, then in the model there are no independent variables, but all variables are dependent variables. The Granger causality equation model can be written as follows (Widarjono, 2013).

$DIND_t = \sum_{i=1}^{n} \alpha_{1i} DIND_{t-1} + \sum_{i=1}^{n} \beta_{1i} DMAL_{t-1} + e_{1t}$

$DMAL_t = \sum_{i=1}^{m} \delta_{1i} DMAL_{t-1} + \sum_{i=1}^{m} \varphi_{1i} DIND_{t-1} + e_{2t}$

$DIND_t = \sum_{i=1}^{n} \alpha_{2i} DIND_{t-1} + \sum_{i=1}^{n} \beta_{2i} DPHIL_{t-1} + e_{3t}$

$DPHIL_t = \sum_{i=1}^{m} \delta_{2i} DPHIL_{t-1} + \sum_{i=1}^{m} \varphi_{2i} DIND_{t-1} + e_{4t}$

$DIND_t = \sum_{i=1}^{n} \alpha_{3i} DIND_{t-1} + \sum_{i=1}^{n} \beta_{3i} DTHAI_{t-1} + e_{5t}$

$DTHAI_t = \sum_{i=1}^{m} \delta_{3i} DTHAI_{t-1} + \sum_{i=1}^{m} \varphi_{3i} DIND_{t-1} + e_{6t}$

$DIND_t = \sum_{i=1}^{n} \alpha_{4i} DIND_{t-1} + \sum_{i=1}^{n} \beta_{4i} DVIET_{t-1} + e_{7t}$

$DVIET_t = \sum_{i=1}^{m} \delta_{4i} DVIET_{t-1} + \sum_{i=1}^{m} \varphi_{4i} DIND_{t-1} + e_{8t}$

$DMAL_t = \sum_{i=1}^{n} \alpha_{5i} DMAL_{t-1} + \sum_{i=1}^{n} \beta_{5i} DPHIL_{t-1} + e_{9t}$

$DPHIL_t = \sum_{i=1}^{m} \delta_{5i} DPHIL_{t-1} + \sum_{i=1}^{m} \varphi_{5i} DMAL_{t-1} + e_{10t}$

$DMAL_t = \sum_{i=1}^{n} \alpha_{6i} DMAL_{t-1} + \sum_{i=1}^{n} \beta_{5i} DTHAI_{t-1} + e_{11t}$

$DTHAI_t = \sum_{i=1}^{m} \delta_{6i} DTHAI_{t-1} + \sum_{i=1}^{m} \varphi_{6i} DMAL_{t-1} + e_{12t}$

$DMAL_t = \sum_{i=1}^{n} \alpha_{7i} DMAL_{t-1} + \sum_{i=1}^{n} \beta_{7i} DVIET_{t-1} + e_{13t}$

$DVIET_t = \sum_{i=1}^{m} \delta_{7i} DVIET_{t-1} + \sum_{i=1}^{m} \varphi_{7i} DMAL_{t-1} + e_{14t}$

$DPHIL_t = \sum_{i=1}^{n} \alpha_{8i} DPHIL_{t-1} + \sum_{i=1}^{n} \beta_{8i} DTHAI_{t-1} + e_{15t}$

$DTHAI_t = \sum_{i=1}^{m} \delta_{8i} DTHAI_{t-1} + \sum_{i=1}^{m} \varphi_{8i} DPHIL_{t-1} + e_{16t}$

$DPHIL_t = \sum_{i=1}^{n} \alpha_{9i} DPHIL_{t-1} + \sum_{i=1}^{n} \beta_{9i} DVIET_{t-1} + e_{17t}$

$DVIET_t = \sum_{i=1}^{m} \delta_{9i} DVIET_{t-1} + \sum_{i=1}^{m} \varphi_{9i} DPHIL_{t-1} + e_{18t}$

$DTHAI_t = \sum_{i=1}^{n} \alpha_{10i} DTHAI_{t-1} + \sum_{i=1}^{n} \beta_{10i} DVIET_{t-1} + e_{19t}$

$DVIET_t = \sum_{i=1}^{m} \delta_{10i} DVIET_{t-1} + \sum_{i=1}^{m} \varphi_{10i} DTHAI_{t-1} + e_{20t}$

Description:

αi, δi : autoregression coefficient

βi, φi : coefficient describing causality

Hypothesis:

H_0 : $\beta i = 0, \forall i$

(βi = 0, there is no causal relationship between variable Y and X)

H_1 : $\beta i \neq 0, \exists i$
($\beta i \neq 0$, there is a causal relationship between variable Y and X)
H_0 : $\varphi i = 0, \forall i$
($\varphi i = 0$, there is no causal relationship between variables X and Y)
H_1 : $\varphi i \neq 0, \exists i$
($\varphi i \neq 0$, there is a causal relationship between variables X and Y)

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

$$\frac{Xt}{Yt} = \frac{x}{y} + \sum_{i=0}^{\infty} \begin{pmatrix} \Phi i1\ (i) & \Phi i1(i) \\ \Phi i2\ (i) & \Phi i2(i) \end{pmatrix} \begin{pmatrix} \varepsilon xt-1 \\ \varepsilon yt-1 \end{pmatrix}$$

$$X_r = \mu \sum_{i=1}^{\infty} \Phi i\ \varepsilon_{r-1}$$

Description:
X_t, Y_t : vector of variables to be measured (DIND, DMAL, DPHIL, DTHAI, DVIET)
Φ : impulse response function
X_r : $\frac{Xt}{Yt}$
μ : $\frac{x}{y}$

RESULTS AND DISCUSSION

Trend Analysis of Imports and Exports

The trend pattern of Indonesia's rice imports tends to decrease, while the import trend in Malaysia and the Philippines increases with the largest average growth rate in Malaysia. Meanwhile, the export trend patterns of Thailand and Vietnam are also increasing every year.

Rice Market Integration Analysis

The first test of stationarity at the level level shows the result that some variables are not stationary at the level. Therefore, the data is then transformed to level one or first difference data so that the form of data analyzed can be stationary in VECM estimation. Variables that have the same degree will most likely have a cointegration relationship (Abdullah, 2009).

Table 1. Stationarity Test Results with ADF 1st Difference

Variables	Coefficient					
	Test Without Constants and Trends	Test with Constant without Trend		Test with Constant and Trend		
		Coefficient γ	C	Coefficient γ	C	Trend
IND	-1.0265***	-1.0340***	-0.0024ns	-1.0379***	0.0005***	-0.0001***
MAL	-1.9343***	-1.9344***	-0.0121ns	-1.9361***	0.0263***	-0.0012ns
PHIL	-2.7763***	-2.7774***	0.0012***	-2.7795***	0.0046***	-0.0001ns
THAI	-0.9374***	-0.9378***	0.0005***	-0.9565***	0.0065***	-0.0001ns
VIET	-0.5023***	-0.5070**	0.0005***	-0.7166***	0.0029***	-0.0000ns

Data source: Secondary Data Analysis, 2023
Description:
***: significant at the 1% level
**: significant at the 5% level
*: significant at 10% level
ns: insignificant

The results of the stationarity test on the 1st Difference show that the data on all variables are stationary. It can be seen from the stationary test results above that the t-statistic value is smaller than the Mac Kinnon critical value with a probability of zero percent, which means H_0 is rejected. When H_0 is rejected, it means that there is no unit root in the data of all variables.

The next stage in the formation of the VECM model is to test the optimum lag or the best lag in the model. Determining the optimal lag is very important because the independent variable used is none other than the lag of the dependent variable (Akbar et al., 2016).

Table 2. Optimal Lag Test Results

Lag Length	LogL	LR	FPE	AIC	SC	HQ
0	383.6693	NA	5.58e-13	-14.02479	-13.84062*	-13.95376
1	432.8773	87.48092	2.29e-13	-14.92138	-13.81639	-14.49523*
2	465.5343	52.00940*	1.76e-13*	-15.20498*	-13.17916	-14.42370
3	488.4079	32.19239	2.03e-13	-15.12622	-12.17957	-13.98981
4	496.6146	10.03040	4.29e-13	-14.50424	-10.63677	-13.01271

Data source: Secondary Data Analysis, 2023
Description:
*: best value

The most optimal lag results are indicated by the criteria at the second lag, so the next model estimation is carried out at the second lag length. This means that the variables in the VAR model affect each other not only in the current period, but also the previous two periods.

Before going further into the VECM model, first test the model whether the data used is stable or not. This stability test affects the impulse response and variance decomposition results to be more valid.

Table 3. VAR Stability Test Results

Roots	Modulus
0.156297 - 0.683253i	0.700901
0.156297 + 0.683253i	0.700901
-0.403273 - 0.512024i	0.651765
-0.403273 + 0.512024i	0.651765
-0.455433 - 0.416363i	0.617072
-0.455433 + 0.416363i	0.617072
0.430737 - 0.412288i	0.596251
0.430737 + 0.412288i	0.596251
-0.031433 - 0.562844i	0.563721
-0.031433 + 0.562844i	0.563721

Data source: Secondary Data Analysis, 2023

A VAR system is said to be stable if all of its roots have a modulus smaller than one (Basuki & Prawoto, 2016). Table 3. is the result of the lag structure test which shows the modulus of the roots of each variable. The results of this stage of analysis show the magnitude of the modulus which is less than one in all roots. Therefore, the data can be said to be stable to be tested in the model.

There are two types of VAR model estimates that can be used, namely differential-level VAR if there is no cointegration and Vector Error Correction Model or VECM if there is cointegration (Widarjono, 2013). This cointegration test is carried out with the aim of knowing which model to use next, whether it is a differential-level VAR or VECM.

Table 4. Cointegration Test Results with Trace Statistic

Null Hypothesis	Alternative Hypothesis	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability
r = 0**	r ≥ 1	0.530603	97.83581	69.81889	0.0001
r ≤ 1*	r ≥ 2	0.332691	53.97001	47.85613	0.0120
r ≤ 2*	r ≥ 3	0.189492	30.50893	29.79707	0.0413
r ≤ 3*	r ≥ 4	0.169411	18.32347	15.49471	0.0182
r ≤ 4**	r = 5	0.122170	7.557503	3.841466	0.0060
r = 0**	r ≥ 1	0.530603	97.83581	69.81889	0.0001

Data source: Secondary Data Analysis, 2023
Description:
**: significant at the 1% level
*: significant at the 5% level

If the trace statistic value is greater than the critical value, then H_0 is rejected. This means that there is cointegration among the variables in the model. Table 4 shows that at 1% and/or 5% significance level, there is cointegration among the variables in the model. The values of r ≥ 1, r ≥ 2, r ≥ 3, r ≥ 4 and r = 5 also indicate that at least more than or equal to one, two, three, four and/or as many as five cointegrating equations among the variables at 5% significance level can be constructed.

The VECM model is used in the non-structured VAR method when the time series data is not stationary in level, but stationary in delta differential and cointegrated, thus indicating a theoretical relationship between variables. The existence of cointegration causes the VECM model, which is a non-structured VAR model, to be called a restricted VAR model (Rosadi, 2011). The result of cointegration in the previous test using the Johansen method led this study to use the VECM regression model.

Table 5. Results of Cointegration Equation in VECM Model

Variables	Cointegration Coefficient
IND(-1)	1.000000
MAL(-1)	-0.890106***
PHIL(-1)	-15.81221***
THAI(-1)	-0.654422
VIET(-1)	-7.643164**

Data source: Secondary Data Analysis, 2023
Description:
***: significant at the 1% level
**: significant at the 5% level

*: significant at 10% level

N t-table values: t(α=1%) = 2.668216, t(α=5%) = 2.004045, t(α=10%) = 1.673034

Based on Table 5, it can be seen that in the long run, the rice price variables of the three countries significantly affect the price of rice in Indonesia at the one percent real level. The cointegration equation that emerges places Indonesia as the dependent variable whose long-term equilibrium price formation is influenced by the other three countries. The effect of changes in Malaysia negatively affects the price of rice in Indonesia. If the price of rice in Malaysia increases by one percent, the price of rice in Indonesia will decrease by 0.89% from the previous price. In the long run, if the price in the Philippines increases by one percent, the equilibrium price in the Indonesian market will decrease by 15.8%.

The price of Vietnamese rice also affects the price of rice in Indonesia with a similar pattern, responding negatively where if there is a one percent increase in the price in Vietnam, the price of rice in Indonesia will decrease by 7.64%. This result is likely to occur because even if the price of Vietnamese rice rises, Indonesia will still import rice from Vietnam considering that over the last five years based on rice price data, Vietnamese rice prices are the lowest compared to rice prices in other ASEAN countries.

The cointegration equation that appears theoretically in the data is used to determine the short-run relationship in the VECM that constrains the short-run relationship towards its long-run equilibrium. If there is no cointegration, then the model used is an ordinary VAR model. In the VECM model, there is a short-term relationship. In this case, the speed of the short-term relationship adjusts to the long-term relationship previously discussed. In this VECM model, one long-term equation is used with Indonesia as the dependent variable.

Table 6. Results of Short-Term Relationship Coefficient in VECM

Variables	Dependent Variable Coefficient				
	D(IND)	D(MAL)	D(PHIL)	D(THAI)	D(VIET)
CointEq1	0.007458	0.586670***	0.045375***	0.015003***	0.002229
D(IND)$^{t-1}$	0.019131	-15.59799***	0.020276	-0.274546***	-0.026230
D(IND)$^{t-2}$	-0.305903	-4.301289	0.039133	0.167559	-0.013457
D(MAL)$^{t-1}$	0.001621	-0.350973**	0.034487**	0.007233	-0.001358
D(MAL)$^{t-2}$	0.004653	-0.101481	0.018381*	0.013442***	0.000752
D(PHIL)$^{t-1}$	0.026588	7.366930***	-0.339219*	0.171385**	0.033197
D(PHIL)$^{t-2}$	0.076512	2.676973*	-0.194070	0.042005	0.005807
D(THAI)$^{t-1}$	-0.244629	4.651971	-0.166086	0.221767*	0.293509***
D(THAI)$^{t-2}$	-0.128450	-4.158602	-0.418819	-0.308106**	0.096250
D(VIET)$^{t-1}$	0.337710	-1.542768	0.036102	-0.053562	0.506823***
D(VIET)$^{t-2}$	-0.298068	-0.433240	2.059728***	0.298262	-0.322724**
R-squared	0.152744	0.693628	0.615090	0.462915	0.544436
Adj. R-Squared	-0.054363	0.618737	0.521000	0.331627	0.433076

Data source: Secondary Data Analysis, 2023

Notes:
***: significant at 1% level
**: significant at 5% level
*: significant at 10% level
T-table values: t(α=1%) = 2.668216, t(α=5%) = 2.004045, t(α=10%) = 1.673034

The significance of the model and equation is determined by comparing the t-table and t-count values for each variable. Significant coefficients are those that meet the probability criteria for comparing t-tables and t-counts. If the t-count is greater than the t-table, then H_0 is rejected. The VECM model results in table 6 show the short-term relationship between variables that appear in the VECM analysis results using Eviews software.

The VECM model provides a cointegration coefficient that is included in the Error Correction Term (ECT) in the model equation. In the long run, the ECT is equal to zero. If the cointegration coefficient deviates from the long-term equilibrium of the previous period, then the ECT is not equal to zero and each variable will adjust back to its long-term equilibrium with the speed of adjustment indicated by the cointegration coefficient.

In the short term, the Indonesian market and ASEAN markets illustrate that no ASEAN rice prices affect the Indonesian market. The Malaysian rice market is negatively affected by the Indonesian rice market in the previous month, while the Philippines positively affects the Malaysian rice market. The Philippines rice market is positively influenced by Malaysia and Vietnam. The Thai rice market is negatively influenced by Indonesia in the first month, while Malaysia and the Philippines positively influence the Thai rice market. Meanwhile, Vietnam's rice market is positively affected by Thailand's rice market.

Causality is a reciprocal relationship or a relationship of mutual influence. The purpose of the Granger causality test is to determine whether the markets in ASEAN countries influence each other. The decision taken in this test is to find out whether one country affects other countries, or is influenced by other countries. The Granger causality test in this study uses a real level of five percent. The test results of this test are listed in table 3 below.

Table 7. Pairwise Granger Cause Test Results

Null Hypothesis (H_0)	Obs.	F-hit	Probability
MAL *does not Granger Cause* IND	58	1.22672	0.3014
IND *does not Granger Cause* MAL	58	10.4579***	0.0001
PHIL *does not Granger Cause* IND	58	1.38666	0.2588
IND *does not Granger Cause* PHIL	58	0.00224	0.9978
THAI *does not Granger Cause* IND	58	1.30675	0.2793
IND *does not Granger Cause* THAI	58	6.88668***	0.0022
VIET *does not Granger Cause* IND	58	3.27102**	0.0458
IND *does not Granger Cause* VIET	58	0.51959	0.5978
PHIL *does not Granger Cause* MAL	58	0.58412	0.5611
MAL *does not Granger Cause* PHIL	58	0.36286	0.6974
THAI *does not Granger Cause* MAL	58	3.65791**	0.0325
MAL *does not Granger Cause* THAI	58	3.85678**	0.0273
VIET *does not Granger Cause* MAL	58	4.46941**	0.0161
MAL *does not Granger Cause* VIET	58	0.18223	0.8339

Null Hypothesis (H_0)	Obs.	F-hit	Probability
THAI *does not Granger Cause* PHIL	58	0.28619	0.7523
PHIL *does not Granger Cause* THAI	58	0.61967	0.5420
VIET *does not Granger Cause* PHIL	58	0.53264	0.5902
PHIL *does not Granger Cause* VIET	58	0.77106	0.4676
VIET *does not Granger Cause* THAI	58	0.49980	0.6095
THAI *does not Granger Cause* VIET	58	9.13581***	0.0004

Data source: Secondary Data Analysis, 2023
Description:
***: significant at 1% level
**: significant at 5% level
*: significant at 10% level

The market influence 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. It is possible that there is no market between two countries that influence each other, but can influence or be influenced by the other country. The null hypothesis indicates that the independent variable cannot affect the dependent variable, if the probability level is less than 1%, 5% and 10% then H_0 will be rejected, thus giving the conclusion that the independent variable significantly affects the dependent variable. If the probability $\alpha > 0.05$, then that market (independent variable) does not significantly affect the other market (dependent variable). The causality test establishes the pattern of rice market influence as unidirectional causality (Indonesia affects Malaysia, Indonesia affects Thailand, Vietnam affects Indonesia, Vietnam affects Malaysia, and Thailand affects Vietnam) and bidirectional or reciprocal causality (Thailand and Malaysia).

Impulse response function (IRF) can provide an overview of the response of a variable in the future to a disturbance or shock. Thus, the duration of the effect of a variable shock on other variables until the effect disappears or returns to the equilibrium point can be seen and known (Basuki & Prawoto, 2016). This study will describe the relationship between each country's rice price and other countries' shocks. This study will show how rice prices in a specific country are affected by a shock from four other countries.

The impulse response of Indonesia when there is a price shock in the Philippines is positive, while when there is a price shock in Malaysia, Thailand, and Vietnam it is negative. The impulse response of Malaysian rice prices when there is a rice price shock in ASEAN countries has a negative effect, where the change is below the equilibrium line. The impulse formed from the shock response in the Philippines tends to be stable, except in Malaysia and Thailand, so that if there is a price shock in various ASEAN countries, the Philippines is not so affected. The price shock that occurs in Thailand towards Indonesia is positive, where price changes will be above the equilibrium point, while changes in Malaysia, the Philippines, and Vietnam will cause changes below the equilibrium or negative. In contrast to Vietnam, in the event of a Thai rice price shock, Vietnamese rice prices tend to respond positively, thus influencing each other.

CONCLUSION

Based on the results of the study, the conclusion is that the trend pattern of Indonesia's rice imports tends to decrease, the import trend in Malaysia and the Philippines increases with the largest average growth rate in Malaysia. Meanwhile, the export trend pattern of Thailand and Vietnam also increases every year. There is a long-term cointegration or relationship between rice markets in ASEAN. In the long run, the markets of Malaysia, the Philippines, and Vietnam negatively affect the rice market in Indonesia. In the short run, the Indonesian market with ASEAN markets illustrates that no rice prices in ASEAN affect the Indonesian market. The Malaysian rice market is negatively affected by the Indonesian rice market in the previous month, while the Philippines positively affects the Malaysian rice market. The Philippines rice market is positively affected by Malaysia and Vietnam. Thailand's rice market is negatively affected by Indonesia in the first month, while Malaysia and the Philippines positively affect Thailand's rice market. Meanwhile, Vietnam's rice market is positively influenced by Thailand's rice market. Based on the causality test, the pattern of influence of the rice market is formed as unidirectional causality (Indonesia affects Malaysia, Indonesia affects Thailand, Vietnam affects Indonesia, Vietnam affects Malaysia, and Thailand affects Vietnam) and bidirectional or reciprocal causality (Thailand and Malaysia). The impulse response of Indonesia when there is a price shock in the Philippines is positive, while when there is a price shock in Malaysia, Thailand and Vietnam it is negative. The impulse response of Malaysian rice prices when there is a rice price shock in ASEAN countries has a negative effect where the change is below the equilibrium line. The impulse formed from the shock response in the Philippines tends to be stable except in Malaysia and Thailand, so that if there is a price shock in various ASEAN countries, the Philippines is not so affected. Price shocks that occur in Thailand to Indonesia are positive, where price changes will be above the equilibrium point, while changes in Malaysia, the Philippines, and Vietnam will cause changes below equilibrium or negative. In contrast to Vietnam, in the event of a Thai rice price shock, Vietnamese rice prices tend to respond positively, thus influencing each other.

Based on information about rice price policies in various countries, the government plays an important role in controlling domestic prices. For this reason, government planning and regulations are needed in each country to maintain the stability of rice prices since rice is a staple food in ASEAN. The international rice market is a thin market, with only five percent of the world's total rice production in the market. Therefore, countries that are still heavily dependent on rice imports should continue to improve their food sovereignty efforts, especially rice commodities. The policy of price control through imports is very risky and can only solve the problem in the short term, especially with price fluctuations and the right of each exporting country to stop exports in the event of a disaster or shock. The government should begin to seriously maintain price stability by controlling domestic stocks by maximizing state-owned enterprises engaged in the rice sector. Future research should discuss a comparative study of rice policies between countries in ASEAN, because integration in such a thin market is very easy to change due to market mechanisms and domestic shocks that cannot be predicted.

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