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Does Rice Price Integration Between Traditional Markets In East Java And East Nusa Tenggara Reflect Efficient Market Relationships?

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ABSTRACT
East Java plays a crucial role as one of Indonesia's leading rice-producing provinces, contributing significantly to the nation's rice supply. In contrast, East Nusa Tenggara (NTT) is a rice-deficit region that relies heavily on imports from East Java to meet its consumption needs. This study aims to examine the long-term and short-term relationships between rice prices in East Java and NTT, as well as analyzing their price fluctuation patterns. Using monthly rice price data from January 2018 to December 2023, the Vector Error Correction Model (VECM) was applied to assess cointegration and causality, while the coefficient of variation (CV) was used to measure price volatility. The Augmented Dickey-Fuller (ADF) stationarity test showed that the data were stationary at the first difference level, with ADF statistics of -11.01718 (East Java) and -10.81884 (NTT), both significant at the 1% level ($p < 0.0001$). Johansen cointegration tests confirmed a long-term equilibrium, with trace statistics of 18.83 and maximum eigenvalue statistics of 16.61 exceeding the critical values at the 5% level. VECM analysis highlighted faster short-term adjustments for NTT, as indicated by an error correction term (ECT) coefficient of 0.4436 (t-statistic = 4.10). The Granger causality test showed a unidirectional influence, with rice price changes in East Java significantly affecting those in NTT (F-statistic = 8.27, $p < 0.0006$). Price fluctuation analysis revealed higher volatility in East Java (CV = 7.7%) compared to NTT (CV = 6.61%). These findings demonstrate East Java's dominant role in price formation and emphasize the need for policy interventions to stabilize interregional rice markets and improve supply chain resilience.
Keywords: Rice prices, market integration, price volatility, East Java, NTT, VECM, cointegration.

INTRODUCTION

In Indonesia, most people consume rice as their staple food. Rice is the main food consumed by more than 95% of the Indonesian population, so rice is the main priority in Indonesian food policy (Amang and Sawit, 1999). Rice is considered a staple food with a strategic position because it is involved in the rice industry and plays an important role in the consumer price index.

Over the past seven years, Indonesia's rice production has tended to decline. Climate change has caused a decline in rice production in Indonesia. Climate change has occurred in several regions in Indonesia and poses significant dangers to agricultural systems, especially rice and secondary crops (Ruminta and Handoko, 2012).Some provinces in Indonesia produce large amounts of rice, while some other provinces produce small amounts of rice. Among the many provinces, East Java is one of the national rice barns because it is the province that is the center of rice production in Indonesia, with its rice production ranking first in Indonesia. East Java Province is the province with the largest national rice production with production of 5.53 million tons of rice throughout 2023. The volume of rice production in East Java is estimated to increase slightly by 0.68% from the previous year. Thus, East Java becomes a rice supplier market that contributes 81% of rice nationally. It even becomes a rice supplier for 16 provinces in Indonesia, one of which is NTT (BPS-East Java Province, 2022).

East Nusa Tenggara Province is one of the provinces where the majority of its population prefers to consume rice. The amount of rice consumption has increased significantly as a result of the shift in lifestyle from the habit of eating local food to rice as a staple food. This increase in rice consumption is in line with the increase in rice production which is intended to meet the needs of the community.

Fluctuations in rice prices at the consumer level are determined by national rice production. The pattern of rice production from year to year tends to be the same, namely a deficit at the end of the year to the beginning of the year which causes prices to soar. Then production increases during the main harvest starting in February and continues until the second harvest in August-September which causes prices to decline. The movement of rice prices tends to be different in the NTT and East Java regions, so it is necessary to conduct a Market Integration analysis. Market Integration is an important indicator related to the efficiency of the existing market. Carolina, et al., (2016) stated that when the price of a marketing company can be transferred to other marketing companies in a marketing chain, the market can be considered well integrated. Market structure, behavior, and performance are often associated with vertical price linkages.

Market integration or integration is one indicator of marketing efficiency, especially price efficiency. According to Asmarataka (2009), market integration is a measure that shows the level of price changes in the reference market (eg retail market), which then has an impact on changes in the following market (eg farmer's market). A market is considered integrated if price changes simultaneously or gradually spread to other markets. This occurs in a perfectly competitive market, where other markets have enough market information to interact quickly. Market integration is the level of price movement in different regions, where the same product will have the same price, even though it is sold in different places and price signals and market information are transmitted evenly (Gosh, 2000). According to Hutabarat (2006), market integration in different places means that prices move simultaneously or have a long-term relationship with each other. This is defined as the smooth transmission of prices and market information through different markets.

Based on the description above, this study aims to determine the integration of the rice market between traditional markets in NTT Province and East Java Province and to describe the pattern of rice price movements in NTT Province and East Java Province.

RESEARCH METHODS

Location and Time of Research: This research was conducted in two provinces, namely East Java Province and NTT Province by considering the location of the research, it was carried out intentionally (Purposive Method). Data collection began in January to March.

Data Types and Sources: This study uses time series data from January 2018 - December 2023 which is monthly rice price data in NTT Province and East Java Province. This time series data is secondary data obtained from BPS and PIHPSN Bank Indonesia.

Data collection technique: This study applies the observation technique and recording of time series data found on BPS and the official website of Bank Indonesia https://www.bi.go.id which is price data owned and presented in real time (daily, weekly, and monthly price data).

Data Analysis Methods

1. Unit Root Test

The stationary test in this study uses the Augmented Dickey Fuller (ADF) unit root test. The ADF unit root test formulation is as follows:

$$\Delta Pt = \alpha 0 + \gamma Pt\text{-}1 + \beta i + \varepsilon t \sum_{j=1}^{m} \Delta P_{t-1}$$

Where:
Pt: rice price variable at each market level in period t (Rp/Kg)
Pt-1: rice price variable at each market level in the previous period (Rp/Kg)
ΔPt : Pt – Pt-1
ΔPt-1 : Pt-1 – P(t-1)-1
m : number of lags
α0 : intercept
α1, β, γ : parameter coefficient
εt : error term

By Hypothesis:
H0: Y = 0 indicates that the data is not stationary.
H1: Y< 0 indicates that the data is stationary.

Testing Rules:
a. If ADFstatistic > ADFcritical, then rejecting H0 means the data is stationary.
b. If ADFstatistic ≤ ADFcritical, then accept H0, namely the data is not stationary.

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2. Optimum Lag Test

Determining the optimal lag length using the Akaike Information Criteria (AIC) and Schwarz Criteria. To determine the optimal lag length, you can use the following equation:

In(aic) = $+\frac{\sum a_i^2}{n}\frac{2k}{n}$

In SIC = In + In (n)$(\frac{\sum a_i^2}{n})\frac{k}{n}$

Information:

$u'_i{}^2$= sum of squared residuals

k= number of independent variables

n = number of observations

3. Cointegration Test

Cointegration test is the second stage in integration testing which in this study aims to determine the existence of long-term correlation between markets. When the data is stationary at the level, cointegration test can be performed. Statistical tests (trace test or maximum eigenvalue test) can be used to test the hypothesis (Rosadi, 2012). The temporary assumption is rejected if the condition of the trace test value and the maximum test value exceeds the t-statistic value. The following is the equation of the trace test and maximum eigenvalue:

λtrace = -T ∑ 1n (1- i)$\hat{\gamma}$

λmax (r, r+1) = - T ∑ 1n (1- i+1)$\hat{\gamma}$

Where:

$\hat{\gamma}_i$= estimated values of characteristic roots (eigenvalues) obtained from the estimation of matrix II.

R = power indicating the number of cointegration vectors

T = number of observations

4. Impulse Response Function

To find out how much influence a variable shock has on other variables in the system, the Impulse Response Function (IRF) is used. IRF (Impulse Response Function) also shows how the estimated time of a variable shock to other variables and which variables will give the greatest response or influence to the shock received. In the graph, the standard deviation will show the shock caused by a variable to other variables.

IRF(h) = rh

Information:

IRH: Impulse Response Function

h: Forecast Period

r: Parameter Matrix of the VAR model

5. VECM Test: To overcome the non-stationary data, the VECM model is used, where this model corrects the imbalance gradually through short-term partial adjustments (Enders, 1995 and Gujarati, 2004). In addition, this method leads to long-term equilibrium, also known as the Error Correction Model (ECM). This method uses regression, which relates the first difference in the dependent variable and other independent variables.

The results of statistical tests on the R2 coefficient or residual from the first regression, called the Error Correction Term, can be used to determine the model specifications with ECM using a valid model. The test results indicate that the observed model specifications are valid. If the relationship between variables is cointegrated, the equilibrium condition will be achieved in the long run.

The VECM model used in this study is as follows:

ΔPK = + ΔPK + ΔPK + ΔPJ+$a_t\alpha_0\sum_{l=1}^{P}\quad \alpha_i\, a_{t-1}\sum_{l=1}^{P}\quad \beta_i\, 0_{t-1}\sum_{l=1}^{P}\quad y_i\, k_{t-1}\varepsilon_{it}$

ΔPK = + ΔPK + ΔPK + ΔPJ+$0_t\delta_0\sum_{l=1}^{P}\quad \delta_i\, a_{t-1}\sum_{l=1}^{P}\quad \sigma_i\, 0_{t-1}\sum_{l=1}^{P}\quad \Phi_i\, k_{t-1}\varepsilon_{it}$

Information:

ΔPK = Commodity price in the reference market in period t (Rp/Kg)a_t

ΔPK= Commodity price in the reference market in the previous period t (Rp/kg)a_{t-1}

ΔPK0_t = Commodity price in the follower market in period t (Rp/Kg)

ΔPK= Commodity price in the follower market in period t (Rp/Kg)a_{t-1}

A,δ,θ,β,ϒ,σ,ϕ,ω,φ = regression coefficients

ε_{it} =*error term*i-th, time t

With the observational study as follows:

1. If the T statistic value | Tstatistic| < | Tcritical|, then it does not have a significant effect.
2. If the T statistic value |Tstatistic| > |Tcritical|, then it has a significant effect.

6. Granger Causality Test: The Granger Causality Test is used to determine whether two variables have a reciprocal relationship or not. In other words, is there a causal relationship between one variable and another, because each variable in the study has the possibility of being an endogenous or exogenous variable. The probability value can be compared with the level of confidence, in this study the critical value used is 5%. If the probability value is greater than 5%, the null hypothesis is rejected, which means there is a causal relationship between the variables being tested.

7. Coefficient of Variation

The coefficient of variation (CV) is a measure of relative risk calculated by dividing the standard deviation by the expected value (Pappas and Hirschey, 1995).

SD=$\sqrt{\frac{\sum(Xi-\bar{X})^2}{N}}$

CV = x100%$\frac{\text{standar devisiasi harga}}{\text{rata}-\text{rata harga}}$

If the CV value in the market ranges between 5-9%, then the fluctuation is considered unstable or there is a price fluctuation. Conversely, if the CV value is less than 5%, the price is considered stable (Ministry of Trade of the Republic of Indonesia, 2010).

Data Management

In this study, data management was carried out using Software: Eviews9 and Microsoft Excel, which aims to test stationarity, produce cointegration analysis, and fluctuations to describe price movement patterns.

RESULTS AND DISCUSSION

Stationarity Test

The results of the stationary test on rice prices in the markets in East Java Province and NTT Province can be seen in the table below:

Table 1 Stationary Test Results of Time Series Data on Rice Prices in East Java Province 2018-2023

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistics			-11.01718	0.0001
Test critical values:	1% level		-3.527045	
	5% level		-2.903566	
	10% level		-2.589227	

*MacKinnon (1996) one-sided p-values.

Source: Secondary data processed, 2024

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Based on the results of the stationarity test using the ADF test, it is known that at the level*First Difference*stationary data, which is marked by the ADF test statistic value of 10.81884 which is greater than the ADF test critical value at a confidence level of 1%, namely 3.527045 and the probability value is less than 0.05, namely 0.0001. So it can be concluded that the time series data of rice prices in NTT Province has been stationary at the first difference level or in other words has accepted H1.

Table 2 Stationary Test Results of Time Series Data on Rice Prices in East Java Province 2018-2023

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistics			-11.01718	0.0001
Test critical values:	1% level		-3.527045	
	5% level		-2.903566	
	10% level		-2.589227	

*MacKinnon (1996) one-sided p-values.

*Source: Secondary data processed, 2024*Based on the results of the ADF test, it is known that the data is stationary at the First Difference level, which is indicated by the ADF test statistic value of 11.01718 which is greater than the ADF test critical value at a confidence level of 1%, namely 3.527045 and the probability value is smaller than 0.05, namely 0.0001. So it can be concluded that the time series data of rice prices in East Java Province is stationary.at the first difference level or other meaning has accepted H1.

Optimum Lag Testing: Before proceeding to the next stage, determining the lag length is crucial. This is because the optimal lag length will ensure that the model sensitivity can explain thoroughly without being too short or too long, which can result in inefficient estimation due to the reduction of degrees of freedom, especially in models with small samples. The results of the optimal lag test can also be used to understand the causality value or reciprocal relationship between the two rice variables at a certain lag.So to find out the amount of lag in these two data, you can see the table below:

Table 3 Results of Optimum Lag Testing of Time Series Data on Rice Prices in NTT and East Java Provinces

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-56.04012	NA	0.021640	1.842543	1.910579*	1.869302
1	-50.17292	11.17561*	0.020398*	1.783267*	1.987375	1.863544*
2	-49.25286	1.694083	0.022504	1.881043	2.221223	2.014838
3	-48.15969	1.943417	0.024709	1.973323	2.449575	2.160636
4	-46.12496	3.488096	0.026355	2.035713	2.648037	2.276543
5	-44.57408	2.560194	0.028580	2.113463	2.861859	2.407811
6	-41.65963	4.626098	0.029724	2.147925	3.032393	2.495791
7	-39.29129	3.608907	0.031512	2.199723	3.220264	2.601107
8	-38.03891	1.828875	0.034687	2.286949	3.443562	2.741851
* indicates lag order selected by the criterion						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

Source: Secondary Data processed, 2024

Based on the table above, it can be seen that the one with the most asterisks is Lag 1, where there are 4 criteria, namely based on the lowest value of LR, FPE, AIC, and HQ, which indicates that the first lag (1) is the optimal lag length in this VAR-VECM test.

Cointegration Test:

The next step in this study is the cointegration test, which is a technique used to understand the long-term equilibrium relationship between rice price variables in East Java and NTT. The method used in the cointegration test is the Johansen test. The Johansen test is useful for identifying data, making data stationary, testing the level of integration, and testing cointegration. This method uses a critical value of 0.05 and relies on two test statistics, namely trace statistics and maximum eigenvalue. To determine the cointegration value, a comparison is made between the test statistic value and its critical value. If the trace statistic and maximum eigenvalue values exceed the critical value, it indicates cointegration or a long-term equilibrium relationship between the variables.The results of the cointegration test can be shown in the table below.

Table 4 Results of Cointegration Test of NTT and East Java Provinces

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistics	0.05 Critical Value	Prob.**
None *	0.213895	18.83018	15.49471	0.0151
At most 1	0.031723	2.224342	3.841466	0.1358
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistics	0.05 Critical Value	Prob.**
None *	0.213895	16.60584	14.26460	0.0209
At most 1	0.031723	2.224342	3.841466	0.1358
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				

**MacKinnon-Haug-Michelis (1999) p-values

Source: Secondary Data processed, 2024

Based on the results of the VAR analysis using the Johannsen test, it can be seen that the trace statistic value (18.83018) > critical value (15.49471) at none*, is the same as the maximum eigenvalue value (16.60584) > critical Value (14.26460) with a probability value of less than 5%. Thus, it can be stated that rice prices in NTT Province and East Java have a long-term equilibrium relationship or there is cointegration. This is in accordance with research conducted by Wati Sukma (2021), which shows that there is a long-term equilibrium between prices in traditional markets in NTB (Mataram and Bima) and Kupang City, marked by price changes that occur in the central market always followed by the following markets.

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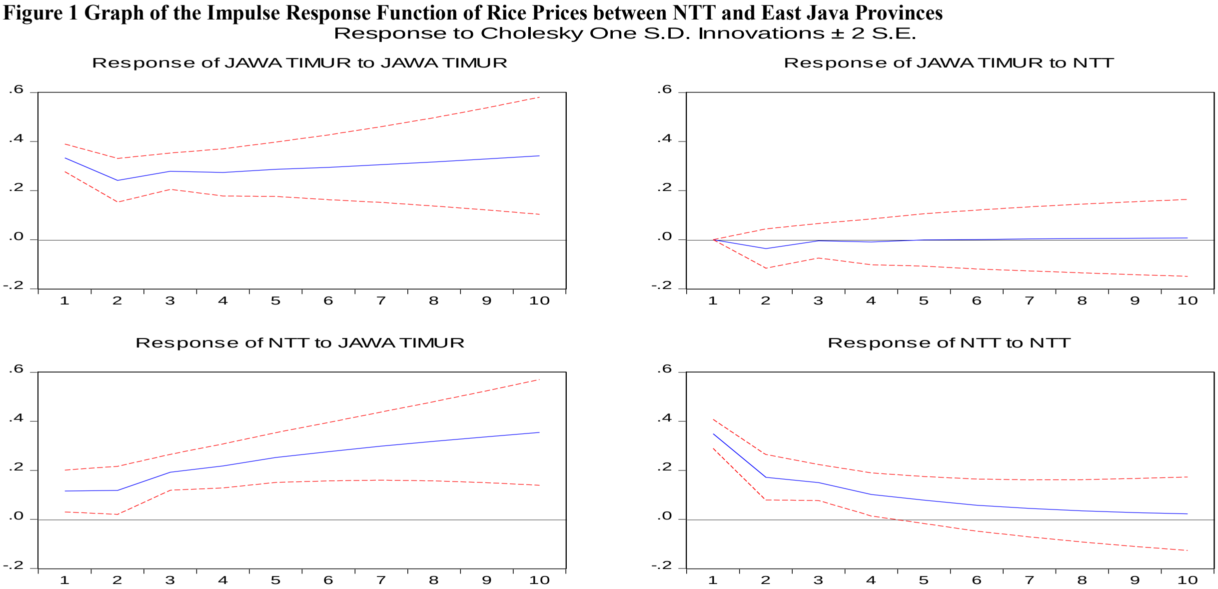
Impulse Response Function (Impulse Response Function)

Impulse response testing is very useful in estimating current and future responses in a VAR (Vector Autoregression) system by considering the impact of shocks generated by disturbance variables on the affected variables (Widarjono, 2010). This step is intended to complete the incomplete VAR stages and without using the Johannsen test because the VAR approach does not show its impact. This step also helps in analyzing when is the right time to achieve long-term and short-term equilibrium. The impulse response function is useful for illustrating economic dynamics, which in this study is the balance between the two markets in NTT and East Java Provinces. This picture will show how fast the impact of a variable is on other variables, so that it can be known how long the effect is and when the effect will disappear.This visualization can be seen in the impulse response graph below:

Figure 1 Graph of the Impulse Response Function of Rice Prices between NTT and East Java Provinces



The four line graphs above provide information about the impact of the independent variables that affect the dependent variable. The two orange lines illustrate the projection of the impact experienced by the blue line. Based on the image above, the following can be concluded:

1. The response graph of East Java Province to East Java shows an increasing graph, which means that if there is a price shock in East Java Province now, it will have an impact on the future. The shock in East Java (blue line) started in the first period and continued to increase until the 10th period with prices increasing and getting further from the equilibrium point. This shows that the current shock is directly proportional to the shock in the future.
2. The response graph of East Java Province to NTT Province shows that if there is a rice price shock in East Java Province, it will affect NTT. The impact of the shock in East Java Province began in the middle of the first period and continued to move away from the equilibrium point until the 10th period. However, the price changes that occurred were not as large as the price changes experienced by East Java Province to East Java itself.
3. The graph of NTT Province's response to East Java shows a change in balance in NTT when East Java experienced a shock. This change can be seen from the increase in the first period which continued until the 10th period. The shock projection experienced by East Java had a positive impact on NTT.
4. Response graph of NTT Province to NTT Province. This shows that if there is a shock in NTT Province at this time, it will affect price fluctuations in the future. Similar to the first graph, each variable forms a similar pattern to itself. This graph shows that NTT Province is no longer at the equilibrium point since the first period, and the increase continues until the 10th period.

Based on the explanation, each variable interacts with and influences other variables, including themselves, within a certain period of time. However, these variables do not return to the equilibrium point in the 10th period and beyond. The impulse response graph shows a sudden change (shock) in a variable that can affect other variables, but this graph does not measure the equilibrium value and its relationship. Therefore, VECM testing is needed to analyze the relationship.

Vector Error Correction Model (VECM)

The next step in this study is to use the VECM (Vector Error Correction Model) model, which is a method for measuring the relationship between the long and short term when two variables have been cointegrated. Short-term estimation involves transforming the equation to the short term by changing the dependent and independent variables into first difference form. To determine the relationship between the long and short term, attention is paid to the significance value. If the T-statistic value exceeds the T-table value, it can be concluded that the two variables have a good relationship in the long and short term.The results of the VECM stage testing can be seen in the table below:

Table 5 Results of VECM Test of Rice Price Data for NTT and East Java Provinces

Cointegrating Eq:	CointEq1	
EAST JAVA (-1)	1,000,000	
NTT (-1)	-0.803712	
	(0.13701)	
	[-5.86590]	
C	-0.818853	
Error Correction:	D(EAST JAVA)	D(NTT)
CointEq1	0.069851	0.443625
	(0.09888)	(0.10830)
	[0.70641]	[4.09616]
D (EAST JAVA (-1))	-0.323216	-0.287013
	(0.15562)	(0.17044)
	[-2.07699]	[-1.68392]
D (EAST JAVA (-2))	-0.047621	-0.176784
	(0.14252)	(0.15609)
	[-0.33415]	[-1.13255]
D (NTT (-1))	-0.097767	-0.170019
	(0.10969)	(0.12014)
	[-0.89132]	[-1.41520]
D (NTT (-2))	-0.091974	0.052646
	(0.10760)	(0.11785)
	[-0.85476]	[0.44671]

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C	0.046145	0.051660
	(0.04119)	(0.04511)
	[1.12033]	[1.14513]
R-squared	0.111954	0.273371
Adj. R-squared	0.041474	0.215702
Sum sq. resids	7.150539	8.577932
SE equation	0.336899	0.368995
F-statistic	1.588459	4.740351
Log likelihood	-19.69806	-25.97724
Akaike AIC	0.744871	0.926876
Black SC	0.939141	1.121147
Mean dependent	0.029710	0.035507
SD dependent	0.344110	0.416659
Determinant residual covariance (dof adj.)		0.013947
Determinant residual covariance		0.011627
Log likelihood		-42.13563
Akaike information criterion		1.627120
Black criterion		2.080417
Number of coefficients		10

Source: Secondary Data processed, 2024

Table of Vector Error Correction Model (VECM) test results that measure the short-term and long-term relationship between rice prices in NTT Province and East Java Province. The following are the results of the VECM test in the table above, namely:

1. Cointegrating Equation (CointEq1):
- For EAST JAVA (-1), the coefficient is set to 1 as the basis for comparison.
- For NTT (-1), the coefficient is -0.803712 which shows that in the long-term relationship, changes in rice prices in NTT are negatively related to rice prices in East Java. The value in brackets is the standard error, and the number in square brackets is the t-statistic value indicating statistical significance. With a t-statistic value of -5.86590, this relationship is very statistically significant.
- "C" is a constant (intercept) of the cointegration equation with a value of 0.818853.

2. Error Correction Term (ECT or CointEq1):
In column D (EAST JAVA), the ECT coefficient is 0.069851, while in column D (NTT) the ECT coefficient is 0.443625. This shows how quickly the variable returns to long-run equilibrium after the shock. The significant value in column D (NTT) t-statistic 4.09616 indicates that rice prices in NTT adjust quite quickly back to long-run equilibrium after the deviation.

3. Columns D(EAST JAVA) and D(NTT):
Columns D (EAST JAVA) and D (NTT) show the short-run relationship. The lag coefficients of both time series (rice prices in East Java and NTT from previous time, i.e. -1 and -2) show how rice prices in the current period are affected by prices in the previous period. Most of these coefficients are insignificant (referring to relatively low t-statistics).

4. R-squared and Adjusted R-squared:
R-squared and Adjusted R-squared show how well the model explains the variability in the data. These values are relatively low, indicating that the model does not explain most of the variability in the rice price data.

5. Other statistics such as AIC, SC, and Log likelihood:
Other statistics such as AIC, SC, and Log likelihood are used to evaluate the overall fit of the model. Lower AIC and SC indicate a better model. Higher Log Likelihood indicates a better fit.Based on the description above, it can be concluded that there is a cointegration relationship between rice prices in East Java and NTT Provinces, which indicates a long-term relationship between the two time series. In the short term, rice prices in NTT adjust back to long-term equilibrium faster than East Java after experiencing a shock. The overall model does not explain most of the variation in rice price data, which is caused by many other factors that are not included in the model. The results of this VECM modeling test are in line with research conducted by Wati Sukma (2021) which states that the existence of a short-term relationship between the two regions marked by price changes that occur in NTB has a positive effect, namely that every increase in the price of shallots in NTB (Mataram and Bima) will be followed by Kupang City.

Granger Causality Test

The analysis of the causal relationship of each rice price variable in East Java and NTT can be observed through the Granger causality test. In this study, the causality test was carried out using the Granger Causality Test with H0 that there is no causal relationship, and H1 that there is a causal relationship. Rejection of H0 is carried out based on a probability value that is smaller than the predetermined critical value.

Table 6 Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
NTT does not Granger Cause EAST JAVA	70	0.59324	0.5555
EAST JAVA does not Granger Cause NTT		8.27521	0.0006

*Source: Secondary Data processed, 2024*Based on the test results above, there is a one-way relationship between East Java Province and NTT as evidenced by the probability value of East Java against NTT, which is 0.0006, which is smaller than the specified probability value of 0.05 or 5%. This is in accordance with research by Kapioru, et al., (2020) which states that the results of the Granger Causality test only occur in one direction, namely between collectors and traditional markets, where price changes at collectors or distributors have an impact on prices in traditional markets, but vice versa does not occur.

Rice Price Movement Patterns in NTT Province and East Java Province

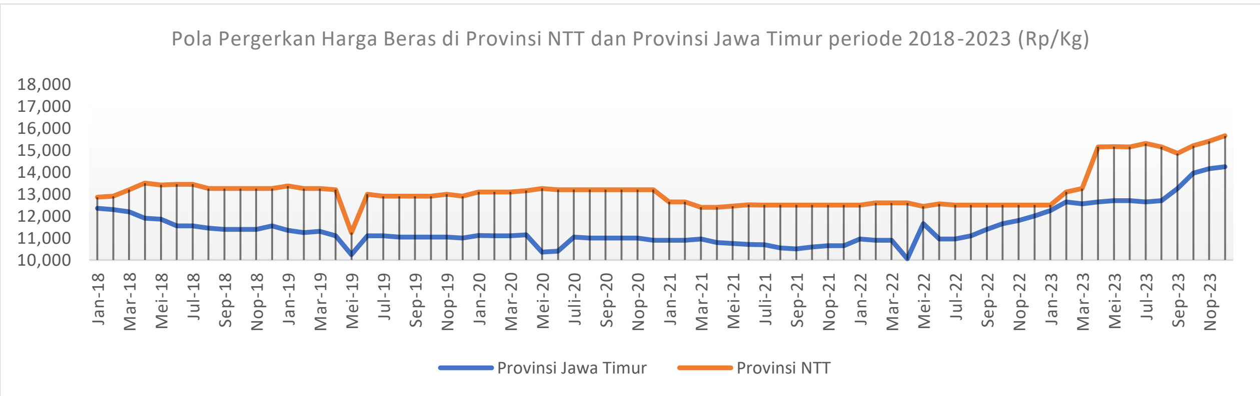

Figure 2 Trend of Rice Price Movement in NTT Province and East Java Province for the period 2018-2023

Picture2 shows the trend of rice price data from these 2 regions, it can be seen from each region having fluctuating prices. In April 2022, the price of rice in East Java Province was the lowest price, which was IDR 10,050 (the Blue Line represents the fluctuation of rice prices in East Java Province) and in December 2023, the price of rice in East Java Province reached the highest price, which was IDR 14,250. This was due to factors that influenced rice production in the area. Then the movement of rice prices that occurred in NTT Province experienced the lowest price in May 2019, which was IDR 11,250, but the price of rice rose again in June 2019, which was IDR 13,000 (shown by the orange line). While the highest rice price that occurred in NTT Province was in December 2023, which was IDR 15,650.

Based on Figure 4.6, it can also be seen that these two regions have price fluctuations that can be displayed in the graph above, and show that the trend in NTT Province experienced greater fluctuations than East Java Province. To prove this statement, it can be seen in the calculation of the Variation Coefficient below.

Coefficient of Variation

The coefficient of variation (CV) is a metric that measures relative risk, obtained by dividing the standard deviation by the expected value (Pappas and Hirschey, 1995).

If the coefficient of variation (CV) value is in the range of 5%-9%, it can be concluded that the fluctuations in the data tend to be unstable. Conversely, if the CV value is less than 5%, then the data is considered stable or has very low fluctuations (Ministry of Trade of the Republic of Indonesia, 2010). To assess data stability, calculations were carried out in two regions using time series data on rice prices from January 2018-December 2023, as described below:

a. Coefficient of Variation of East Java Province

$CV = \frac{882{,}0697}{11.447} x100\%$

CV = 7.7%

The coefficient of variation in East Java Province is 7.7% which is greater than 5% so it can be stated that the price of rice in this area fluctuates and the price is unstable.

b. Coefficient of Variation of NTT Province

$CV = \frac{871{,}0763}{13.169} x100\%$

CV = 6.61%

The coefficient of variation in NTT Province is 6.61% when compared to alpha 5%, so the CV value of NTT Province is very large so it can be stated that the price of rice in this area is unstable.

Based on the two calculations above, it can be concluded that East Java Province and NTT Province, when viewed through price movement trends, have almost the same trend and the comparison of the highest and lowest prices in the two regions is not too far apart, especially in NTT Province, but based on calculations using the coefficient of variation, the largest fluctuations occurred in East Java Province which has a CV value of 7.7% greater than the alpha value and the CV value in NTT Province with a CV value of 6.61%. Although it is a reference market and a rice producing center, East Java Province has fluctuating and unstable rice prices, followed by NTT Province which also has fluctuating and unstable rice prices. This study is in line with Eylanor, MI (2022) whose CV calculation results in East Lombok were 45% and CV in Kupang City was 39%, which means high and very unstable chili price fluctuations.

Discussion

The rice market dynamics between East Java and East Nusa Tenggara (NTT) represents a critical case study in regional economic interdependence within Indonesia. East Java, as one of the largest rice-producing provinces, functions as a price-setter and distribution hub, while NTT, a rice-deficit region, depends heavily on imports to meet its domestic consumption needs. This relationship underscores the significance of understanding the underlying mechanisms, including stationarity, cointegration, and market adjustments, to address regional disparities and enhance market stability.

The stationarity test using the Augmented Dickey-Fuller (ADF) method confirmed that rice prices in both East Java and NTT were stationary at the first difference level. Stationarity is a prerequisite for reliable time-series analysis, ensuring that the statistical properties of the data remain constant over time. Previous studies, such as those by Sembiring and Sibuea (2018), have highlighted the importance of stationarity in modeling rice price behaviors in Indonesia, validating the approach used in this study (Sembiring & Sibuea, 2018).

The cointegration analysis further revealed a long-term equilibrium relationship between the two regions' rice markets, indicating that prices in NTT are significantly influenced by those in East Java over time. This finding aligns with previous research by Kusumaningsih et al. (2017), who demonstrated similar long-term relationships in Indonesia's rice markets. The existence of cointegration suggests that while short-term price deviations occur due to local shocks or supply chain disruptions, the markets tend to return to equilibrium in the long run (Kusumaningsih et al., 2017).

A key component of the analysis involved determining the optimal lag length using criteria such as the Akaike Information Criterion (AIC) and Final Prediction Error (FPE). The results identified Lag 1 as optimal, ensuring a balance between capturing immediate market responses and avoiding overfitting. This methodological rigor is consistent with findings from Primageza et al. (2021), who emphasized the importance of precise lag selection in forecasting rice prices in Indonesia (Primageza et al., 2021).

The Impulse Response Function (IRF) analysis provided insights into the dynamic interactions between these markets. Price shocks in East Java have a significant and sustained impact on NTT, lasting up to 10 periods. Conversely, the influence of shocks in NTT on East Java is minimal, reflecting the unidirectional dependency of NTT on East Java for its rice supply. This asymmetric relationship aligns with findings by Arida et al. (2023), who observed similar dynamics in other Indonesian rice markets, where dominant regions disproportionately influence dependent markets (Arida et al., 2023).

The Vector Error Correction Model (VECM) results highlight the mechanisms through which the markets adjust to equilibrium. The error correction term (ECT) for NTT was significant, indicating that deviations from long-term equilibrium were corrected more rapidly in NTT than in East Java. This dynamic reflects the structural dependency of NTT on East Java, where price stabilization in the latter has direct implications for the former. Nasir et al. (2021) similarly noted the role of dominant markets in ensuring equilibrium in dependent regions during periods of disruption (Nasir et al., 2021).

The Granger causality test confirmed the unidirectional influence of East Java on NTT. Changes in rice prices in East Java were found to significantly influence prices in NTT, while the reverse was not observed. This finding is consistent with the hierarchical structure of Indonesia's rice markets, where central markets often dictate pricing trends in peripheral regions. Research by Kustiari and Suhaeti (2016) has similarly highlighted the centrality of dominant markets in regional price dynamics settings (2016).

The coefficient of variation (CV) analysis revealed higher price volatility in East Java compared to NTT, with CVs of 7.7% and 6.61%, respectively. This volatility reflects the inherent instability of Indonesia's rice markets, where production risks, policy inefficiencies, and supply chain disruptions exacerbate price fluctuations. Suryadi et al. (2014) similarly observed that such volatility poses challenges for both producers and consumers, highlighting the need for effective policy interventions (Suryadi et al., 2014).

Policy implications from this study are multifaceted. Strengthening the distribution network between East Java and NTT is paramount for ensuring stable rice prices and food security in the latter. Efficient logistics and targeted interventions in East Java can mitigate the transmission of price shocks to NTT, as supported by Rifin's (2022) findings on the critical role of marketed surplus in stabilizing dependent markets (Rifin, 2022).

Additionally, incorporating exogenous factors such as climate variability, trade policies, and production risks into future models could provide a more comprehensive understanding of rice market dynamics. Anggraeni et al. (2019) illustrates the importance of including such variables in forecasting models to enhance predictive accuracy and policy relevance (Anggraeni et al., 2019).

This comprehensive analysis highlights the pivotal role of East Java as a stabilizing force in Indonesia's rice market. By addressing vulnerabilities in the interdependent system between East Java and NTT, policymakers can enhance market resilience, reduce volatility, and ensure equitable access to food. The findings provide a robust foundation for further research and targeted interventions, ensuring that Indonesia's rice market remains both stable and sustainable.

Conclusion

This study reveals the presence of cointegration, indicating a long-term relationship between East Nusa Tenggara (NTT) and East Java provinces. The relationship is unidirectional, where price changes in East Java influence rice prices in NTT, but the reverse does not hold true. Additionally, the price movement patterns in both provinces are similar—fluctuating and relatively unstable. This is proven by the Coefficient of Variation (CV), with East Java showing a higher CV of 7.7% compared to NTT's 6.61%.

Recommendations

The findings suggest that policymakers can use this study as a foundation for developing strategies to mitigate unstable price fluctuations and leverage price movement patterns to anticipate price increases during specific periods. Future research could explore the efficiency of rice distribution networks between NTT and East Java, which could play a critical role in improving price stability and supply consistency.

Future Research and Limitations

This research is limited by the absence of detailed data on other potential factors affecting rice prices, such as distribution dynamics, government interventions, and climatic conditions. Future studies should incorporate these variables to provide a more comprehensive analysis. Additionally, investigating the logistics and infrastructure supporting rice distribution between NTT and East Java could offer deeper insights and inform more effective policy recommendations.

REFERENCES

Amang dan Sawit H, 1999. Kebijakan Beras dan Pangan Nasional, ed kedua, Penerbit IPB Press, Bogor.

Asmarantaka, R.W. 2009. Pemasaran Produk-produk Pertanian. Bunga Rampai Agribisnis: Seri Pemasaran. Bogor: IPB Press.

BPS 2022. Provinsi Jawa Timur dalam Angka 2022. Badan Pusat Statistik Jawa Timur.

Carolina, R.A., Mulatsih, S., dan Anggraeni L. 2016. Analisis Volatilitas Harga Dan Integrasi Pasar Kedelai Indonesia Dengan Pasar Kedelai Dunia. Jurnal Agro Ekonomi. http://dx.doi.org/10.21082/jae.v34n1.2016.

Enders, Walter. 2004. Applied Econometric Time Series 4th Edition. Ed. John New York. https://new.mmf.lnu.edu.ua/wpcontent/uploads/2018/03/enders_applied_econometric_time_series.pdf. Diakses pada 14 Februari 2022.

Eylanor, M.I. 2022. Analisis Integrasi Pasar Spasial Cabai Merah antara Pasar Tradisional di Provinsi NTB dan NTT (Studi Kasus: Kota Lombok Timur dan Kota Kupang). 2022. Kupang

Ghosh, M. 2000. *Cointegration Test andSpatial Integration of Rice Market inIndia.Indian Journal of AgricultureEconomics. Vol 55. No 4, October–December*, pp 616-625.

Hutabarat, B. 2006. Analisis Saling Pengaruh Harga Kopi Indonesia dan Dunia. Jurnal agro Ekonomi vol. 24 (no.1). hal 21 – 40.

Kapioru Charles, Nendissa Roy, Bano Maria. 2020. Market Cointegration And Red Chili Price Behavior Between Wholesalers And Traditional Markets. 2020. Kupang

Pappas, J.M dan M. Hirschey. 1995. Ekonomi Managerial. Edisi Keenam Jilid II. Binarupa Aksara. Bandung.

Rosadi, Dedi. 2012. Ekonometrika dan Analisis Runtun Waktu Terapan dengan Eviews. Yogyakarta: Penerbit Andi Yogyakarta.

Ruminta & Handoko. 2012. Climate Risk and Adaptation Assessment of Agriculture Sector in the Great Malang East JavaSynthesis Report. Jakarta: Ministry of Environment.

Wati Sukma. 2021. Kointegrasi Pasar Bawang Merah Antar Provinsi Nusa Tenggara Barat dan Nusa Tenggara Timur. 2021. Kupang.

Sembiring, S. A., & Sibuea, P. (2018). The long-run equilibrium between retail price and market operations: Based on the Presidential Instruction for Rice Policy. *IOP Conference Series: Earth and Environmental Science*, 205. DOI: 10.1088/1755-1315/205/1/012006

Kusumaningsih, A., Jamhari, J., & Darwanto, D. (2017). Analysis of Rice Price Trend and Vertical Integration of Rice Market in Indonesia. *Ilmu Pertanian (Agricultural Science)*, 1(1), 74-79. DOI: 10.22146/IPAS.10783

Primageza, H., Vinarti, R., Tyasnurita, R., Riksakomara, E., & Muklason, A. (2021). Comparison of NNs-ARIMAX and NNs-GSTARIMAX on Rice Price Forecasting in Indonesia. *2021 International Conference on Advanced Computer Science and Information Systems (ICACSIS)*. DOI: 10.1109/ICACSIS53237.2021.9631332

Arida, A., Masbar, R., Majid, M., & Indra, I. (2023). Does vertical asymmetric price transmission exist in the rice markets? *Agricultural and Resource Economics: International Scientific E-Journal*. DOI: 10.51599/are.2023.09.01.04

Nasir, M., Jamhari, J., & Mulyo, J. (2021). The implications of the COVID-19 pandemic on rice market performance in Java, Indonesia. *IOP Conference Series: Earth and Environmental Science*, 637. DOI: 10.1088/1755-1315/637/1/012049

Kustiari, R., & Suhaeti, R. (2016). Rice Market Integration in Indonesia: A Cointegration Analysis. *Journal of Agribusiness Economics*, 17(1), 1-12. DOI: 10.21082/jae.v17n1.1998.1-12

Suryadi, R., Anindita, R., Setiawan, B., & Syafrial, S. (2014). Impact of The Rising Rice Prices on Indonesian Economy. *Journal of Economics and Sustainable Development*, 5(24), 71-79. DOI: N/A. Access here

Rifin, A. (2022). Marketed surplus of Indonesian rice production. *Cogent Economics & Finance*, 10. DOI: 10.1080/23322039.2022.2119694

Anggraeni, W., Mahananto, F., Sari, A. Q., Zaini, Z., & Andri, K. B. (2019). Forecasting the Price of Indonesia's Rice Using Hybrid Artificial Neural Network and Autoregressive Integrated Moving Average (Hybrid NNs-ARIMAX) with Exogenous Variables. *Procedia Computer Science*. DOI: 10.1016/j.procs.2019.11.171

Respatiadi, H., & Nabila, H. (2017). Rice Policy Reform: Removing Restrictions on Rice Trade in Indonesia. DOI: 10.35497/271865