

Optimizing the role of rice central market in Java, Indonesia: the effect of toll roads construction to the rice market integration

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Abstract. Rice is considered as the primary staple food that Indonesian people mostly consume on daily basis. The need of rice in Indonesia is always increasing. However, the production of rice in Indonesia has not meet its demand. One of the factors resulting the number of paddy field decreasing is the construction of toll roads. The government of Indonesia has invested intensely in the development of a toll road network. The length of toll road operation has increased from around 750 km in 2014 to over 2,500 km in 2022. The construction encroaching paddy fields and resulting the production of rice decreasing every year. The paper objective is to investigate the implications of toll road investment to the rice market integration by focusing on Java as the central rice-producing region in Indonesia. We used the Vector Error Correction Model (VECM) approach to analyze the long-ranging daily rice price data series. The result of the study found that Cipinang Central Market in Jakarta has not the significant spatial market integration with rice markets in Java. Despite the fact that West Java, East Java, and Central Java with Cipinang Central Market have a major business tie, prices are not increasing. This shows a severe lack of market integration. The phrase "optimal market integration" refers to a more efficient market, especially when it comes to establishing rice market prices.

Keywords: toll road, rice market integration, Cipinang Central Market, rice markets in Java

1. Introduction

Market performance has a significant impact on the stability of food supply, distribution, and pricing [1]. Markets that are well-functioning and efficient play a crucial part in guaranteeing a country's food security. Market performance in many emerging nations, on the other hand, is less efficient. Long distances between producer and consumer locations, as well as a lack of distribution infrastructure, are often factors that cause markets to work poorly [2]. The functioning of developing-country food markets must be evaluated since these markets are very prone to disruption [3].

Rice is the staple food of the Indonesian people. Rice demand continues to rise in parallel with population growth. Indonesia now ranks fourth in the world in terms of rice consumption, with 29.13 million tons consumed in 2017. The rice consumption is expected to rise to 31.7 million tons by 2045. As a result, it has been the government's responsibility to ensure the supply of food for its citizens. On the supply side, according to USDA statistics, Indonesia produced 34.9 million tons of rice in 2021 [4]. Aside from that, being part of Asia, Indonesia contributes 90% of total world rice production.

Several studies have found elements that have a substantial impact on the population's ability to meet their rice demands. The supply chain is one of the most important factors in ensuring rice accessibility, which involves how rice from one location is transmitted to dealers in other regions before reaching consumers. This is owing to variances in rice production across areas, which necessitates the use of logistics to ensure rice supply in each region. Rice-producing hubs in Indonesia, such as East Java, West Java, and Central Java, must be transferred to other parts of the country. In general, rice from production center locations is gathered first at the major market before being dispersed to other places



both on and off the island of Java. Rice prices in each area can be regulated when rice distribution is effective, thus the government must interfere to manage the rice market in Indonesia.

Indonesia is currently experiencing the event of rising rice prices in 2023. Given the significance of rice as a basic food supply that cannot yet be substituted by other commodities, this has a substantial influence on government policy on the provision of food for the community. In preparation for the present high rice price, the Maluku administration even implemented a policy of not eating rice one day every week. The protracted dry season, which impacts rice supply, is one of the causes behind the rise in rice prices. If the price of rice rises until it surpasses the price of imported rice without intervention from the government, an increasing amount of imported rice will enter the domestic market. As a result, the government imposes import tariffs as a trade barrier.

The author connects this issue with the toll road infrastructure development agenda, which has been one of the central government's strategic policies for numerous years. Since 2014, toll road development has steadily increased up to 2022, from 750 km to 2500 km. Quite an amount of agricultural land was lost during its development since it was transformed into toll roads. This will have a direct influence on rice output in regions that have been transformed into toll highways. [5].

According to [5], the influence of toll roads may be noticed on the development of commerce, accessibility, and investment in a certain area. This dual effect requires additional investigation, and research on the effects of toll road building on the agriculture sector are relatively sparse. As a result, the purpose of this research is to investigate the implications of toll road investment to the rice market integration by focusing on Java as the central rice-producing region in Indonesia.

2. Materials and Methods

2.1. Data and data sources

In this study, secondary data (time series data on average daily prices of medium-grade rice) is employed. The data reviewed spans the months of December 2019 to July 2023. The month of December 2019 marked the end of operation for all Trans Java toll road portions. Rice prices refer to wholesale market pricing in one IDR/kg. This information is utilized to perform research on market integration and rice market price transmission. Data is obtained from connected organizations such as the Central Statistics Agency and the Bank of Indonesia.



Fig 1. Map of toll roads' construction in Java Island

2.2. Data analysis method

The multivariate vector error correction model (VECM) was used to examine the data. VECM defines price changes over time as a function of lagged departures from long-run equilibria and price changes over time [3].

$$\Delta P_t = \mu + \pi P_{t-1} + \sum_{i=1}^{k-1} \theta \Delta P_{t-i} + \delta t + \epsilon_t \quad (1)$$

$$\Delta P_t = \mu + \alpha \beta' P_{t-1} + \sum_{i=1}^{k-1} \theta \Delta P_{t-i} + \delta t + \epsilon_t \quad (2)$$

where ΔP_t illustrates price differences from day $t-1$ to day t , and μ denotes a vector of constant terms. The β parameters capture the extent of co-integration and long-run relationship between prices across different markets. The α parameters capture the speed of adjustment to equilibrium prices. The ϵ_t is a vector of stochastic error terms. The δ captures the trading pattern. θ captures additional responses to changes in lagged prices.

3. Results and discussion

3.1. Summary statistics

The research data consisted of average daily data for medium rice at the wholesale level. The integration pattern may be found in certain places. Rice market integration may offer a snapshot of the price differentials between surplus and deficit locations. The western section of Java Island is the area having a rice production disadvantage. Meanwhile, the eastern portion of Java Island has a rice output excess. As a result, Table 1 shows that the primary markets for rice in succession are Cipinang, West Java, Central Java, and East Java. The Cipinang main market has the highest medium rice prices since the major market is in the DKI Jakarta Province, which is a consumption hub [6]. The difference in average prices formed in the four marketplaces is not significant.

Table 1. Summary statistics of the medium rice price

Markets	Mean	Max	Min	Std. dev.
Cipinang Central market	10.731	13.175	9.850	708
West Java	10.262	11.650	9.900	394
Central Java	9.839	12.200	8.900	620
East Java	10.166	12.450	9.500	676

The decline in production then triggers an increase in prices for both producers and consumers. This is in line with the results of research from [7] which states that there is a positive effect from the emergence of El Nino with an increase in rice prices. The decrease in output leads to a rise in pricing for both producers and consumers. This is consistent with the findings of [7], which found that the arrival of El Nino had a beneficial influence on rice prices.

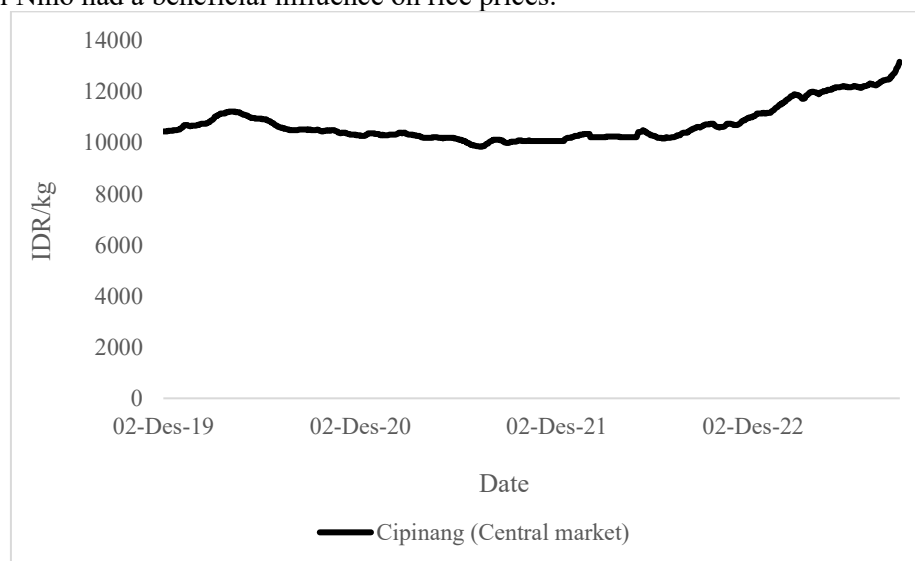


Fig. 2. Estimated Average Price of Medium Rice in Central Market

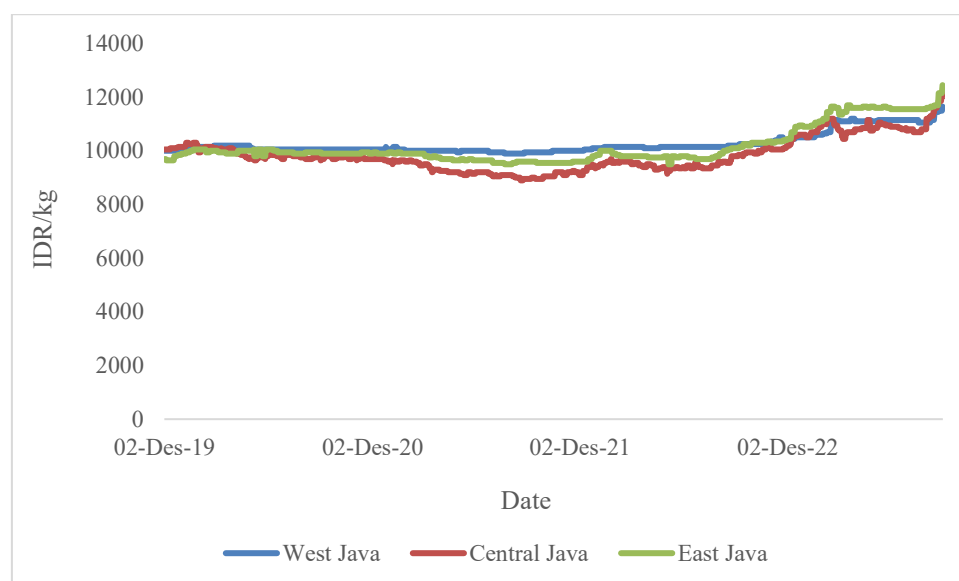


Fig. 3. Estimated Average Price of Medium Rice in West Java, Central Java, and East Java

3.2. Econometric estimation: Vector Error Correction Model

Prior to cointegration analysis, the order of integration is tested. The Augmented Dickey-Fuller (ADF) test is used to determine if variables follow a unit-root process. According to the ADF findings, medium rice prices in all marketplaces include a unit-root process. After initial differencing, prices become stationary, implying spatial market analysis using a multivariate technique. This demonstrates that the null hypothesis is rejected at the 1% significance level in the first derivative. In other words, all medium rice prices are integrated at the same derivative level, order 1(1). As a result, testing may be continued to analyze the medium rice price series on the island of Java.

Table 2. The Result of ADF Test

Markets	Price in levels		Price in differences	
	Intercept	Trend + Intercept	Intercept	
Cipinang Central market	2,78	1,50	-8,29***	
West Java	2,55	0,74	-31,28***	
Central Java	2,04	0,68	-31,08***	
East Java	2,10	0,63	-11,97***	

Notes: H_0 : series has a unit root; H_1 : series does not have a unit root; *** $p < 0,01$.

In Table 3, we provide the cointegration test across rice markets in Java. Johansen maximum likelihood multivariate cointegration model which is used to see cointegration in the price series. We found four cointegrating relationships among the markets. The trace statistics and critical values show that Cipinang Central market is the center of trade flows from several rice surplus areas in Java. Based on the study conducted by [8], this can be interpreted as meaning that there are reasons behind the long-run equilibrium relationship between all of the market pairings. [9] stated in their research results that cointegration in the rice market implies that government policy intervention can be realized to stabilize market prices in the entire market system. In this case, the availability of Trans Java toll road infrastructure can increase market interaction and trade between markets throughout Java. These results is in line with research results from [10] as he stated that toll road development programs tend to open up access to the growth of the trade.

Table 3 shows the cointegration test for rice markets in Java. The Johansen maximum likelihood multivariate cointegration model is used to examine price series cointegration. We discovered four market cointegration linkages. According to the trace data and crucial values, the Cipinang Central market is the hub of trade flows from rice surplus locations in Java. According to [8], this might be read as implying that there are reasons underlying the long-run equilibrium connection between all market pairs. [9] claimed in their study findings that cointegration in the rice market means that government policy action to stabilize market prices in the overall market system is possible. In this example, the existence of Trans Java toll road infrastructure helps boost market engagement and commerce throughout Java. These findings are consistent with the findings of [10], who said that toll road building initiatives tend to increase access to trade growth.

Table 3. Johansen Test

Markets	Rank Test (Trace)	Trace Statistic	0.05 Critical Value
Cipinang Central market + West Java + Central Java + East Java	4	7,94	3,84

Long-run coefficients may also be used to determine long-run elasticity. Table 4 shows the long-run price elasticities related with Java's rice markets. As predicted, all price elasticities are negative, suggesting substitution linkages among rice products. Long-run pricing elasticities show that price changes in West Java, East Java, and Central Java have no influence on price changes at the Cipinang Central Market in the long run. This may be attributed to Cipinang's strong position as a primary market with a huge supply of items, such that whenever a price shift happens, the price is maintained by the availability of stock. In terms of government interference in price creation, this may be linked to the 2017 decision of the highest retail price or Highest Retail Price (HET). The Ministry of Trade issued Decree 57/M-DAG/PER/8/2017, which established this policy. According to [11], this strategy has the potential to impact price formation in the rice market, particularly in the Cipinang primary market. Price variations in the market may be minimized due to the presence of the HET regulation, ensuring that the price of rice in the market stays steady. Aside from that, import policies may help to calm rice price shocks.

Regardless of the outcome, there remains a relative lack of spatial integration in rice markets. Prices are not rising despite the significant commercial relationship between West Java, East Java, and Central Java with Cipinang Central Market. This demonstrates a significant lack of market integration. As a result, this is an essential remark for the government to consider when developing policies to improve rice market integration on the island of Java. Optimal market integration denotes a more efficient market, particularly in terms of determining rice market prices [12].

Table 4. Long run price elasticities

Markets	West Java	Central Java	East Java
Cipinang central market	-3,75 ^{ns} (0,77)	-2,48 ^{ns} (0,30)	2,72 ^{ns} (0,57)

Notes: ns: not significant

4. Conclusion

This article uses long-term daily rice price data to examine spatial rice market integration in Java. We use the multivariate vector of error-correction cointegration models (VECM) to describe market integration. According to the findings of the research, Cipinang Central Market in Jakarta does not have considerable spatial market integration with rice markets in Java. Despite the fact that West Java, East Java, and Central Java are all linked by the Cipinang Central Market, prices are not rising. This demonstrates an extensive lack of market integration. As a consequence, the government of Indonesia

should keep this in mind when designing measures to increase rice market integration on the island of Java. The term "optimal market integration" refers to a more efficient market, particularly in terms of determining rice market prices. These results have significant policy implications for increasing the efficiency and functioning of Java's rice markets. The government of Indonesia should maintain the integration of rice producer in Java with Cipinang Central Market to stabilize the price of rice in Java and Indonesian.

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