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Vertical Market Integration Analysis of Rice in Indonesia

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A B S T R A C T

Rice is a staple food in Indonesia, but challenges in the country's rice markets and marketing systems persist, leading to significant losses for both producers and consumers due to volatile price fluctuations. The prices of various food products are rising sharply due to growing demand driven by population growth, which is not adequately supported by supply. This study aims to examine the vertical market integration of rice in Indonesia using the Vector Error Correction Model (VECM) as the analytical method. The findings reveal that the markets for harvested dry grain at the producer level and rice at the consumer level are integrated in the long term, indicating that changes in producer-level harvested dry grain prices are influenced by consumer-level rice prices. However, this integration is not observed in the short term.

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INTRODUCTION

Rice is a staple food consumed by the Indonesian people, rice is widely produced domestically and imported, with the development of the population increasing every year, resulting in rice consumption will increase, but Indonesia has an import dependence that will cause low food security, because domestic production cannot meet rice consumption in Indonesia (Hermawan, 2016). In addition, many farmers and stakeholders in Indonesia are engaged in the rice business in Indonesia which has provided large income and employment opportunities, rice plays a vital role as a strategic commodity in supporting the national economy and ensuring food security (Suriaatmaja, 2015).

The prices of various food products are rising sharply due to growing demand driven by population growth, which is not adequately supported by supply. Global price increases are primarily caused by efforts to address shortages through imports, while domestic price hikes are influenced by global price trends. This situation is closely related to the fluctuating rice prices in Indonesia (Sugiyanto & Hadiwigeno, 2018). Changes in domestic supply and demand for rice can cause rice prices to change, which impacts rice prices at the consumer level (Yulnita & Yeniwati, 2019). However, it remains to be explored whether these price changes are transmitted to rice producers. Price transmission is essential to realize more efficient rice market integration (Musarofah et al., 2022).

Price transmission should take place both at the producer or farmer level and, conversely, at the consumer level for rice (Proborini et al., 2018). Vertical integration takes place when the price of rice fluctuates at the wholesale level before rising at the community or consumer level. The current Indonesian rice market must also be well integrated in order to guarantee that rice prices remain steady and do not fluctuate significantly (Hermawan & Budiyanti, 2020). To achieve sustainable food security in Indonesia, it is crucial to carry out research on the study of vertical market integration of rice since market instability and greater price swings might hurt farmers and merchants.

LITERATURE REVIEW

In the study “Vertical Market Integration Analysis of Rice in Indonesia”, several theories are used to analyze vertical market integration. One of the main theories is the Market Integration Theory, which explores how prices at different levels of the supply chain (producers, wholesalers, and retailers) are interconnected. Market integration occurs when price changes in one market (e.g., producer market) rapidly affect other markets (e.g., wholesale and retail markets). In the context of the rice market in Indonesia, this theory is used to examine the rate and magnitude to which producer-level price changes impact consumer-level prices.

Furthermore, the Price Transmission Theory is employed to comprehend the transmission of price changes from one level of the supply chain to other levels. This theory is important in assessing the effectiveness of price policies, government interventions, as well as the impact of distribution costs and other barriers that affect price movements between farmers, traders, and consumers. Asymmetric price transmission theory can also be part of this analysis, where price transmission may not always be symmetric. For example, a price increase at the producer level may be transmitted to the consumer level faster than a price decrease, creating a market imbalance.

Econometric approaches are also applied in this study, to assess the presence of long-term correlations between prices at various market levels, such as cointegration models. Despite the possibility of short-term price instabilities, this model is used to determine if Indonesia's rice markets are integrated over the long term. The short- and long-term dynamics of price linkages between markets are frequently investigated using the Vector Error Correction Model, or VECM. These theories together help in analyzing the extent to which the rice market in Indonesia is vertically integrated and how price policies and government intervention can affect the structure of the country's rice market.

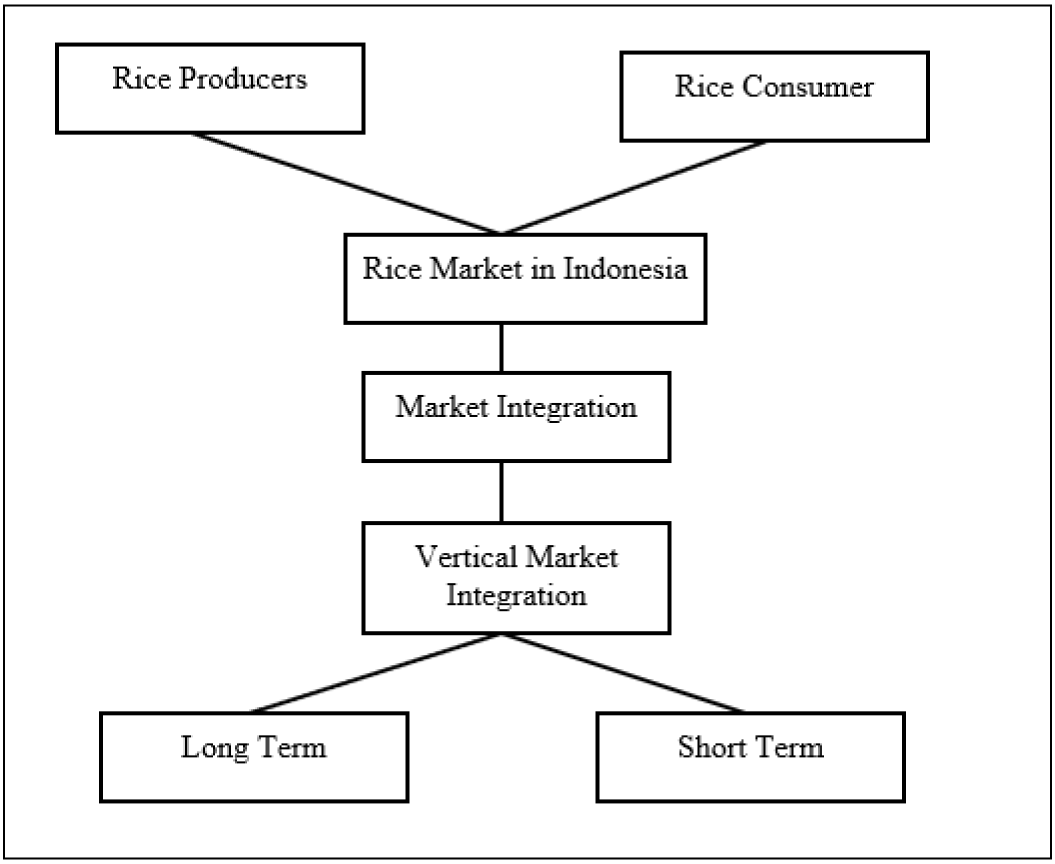

Figure 1. Conceptual Framework

METHODOLOGY

The vertical market integration of rice in Indonesia is being analyzed using the Vector Error Correction Model (VECM) research approach. Monthly time series data on Indonesian rice prices at the producer and consumer levels from 2014 to 2023 are used in this study. The following are the phases of the research process that employ the Vector Error Correction Model (VECM) method:

a. Stationarity Test

The Augmented Dickey-Fuller (ADF) unit root test was employed in this study's stationarity test. In rice research, the ADF test formulation is as follows: (Widarjono, 2013) :

$$\Delta PProd_t = \alpha 0 PProd_t + \alpha 1 T + \beta 1 \sum^{m} \Delta PProd_{t-1} + \gamma 1 PProd_{t-1} + \varepsilon_t \ldots (1)$$

Description:

$PProd_t$	= The variable representing the HDG (Harvested Dry Grain) price in Indonesia for the current phase (t) (Rp per kg).
$PProd_{t-1}$	= Indonesia's HDG price variable during the prior time frame (t-1) (Rp per kg)
$\Delta PProd_t$	= the variable representing the difference between the HDG price in Indonesia during the current prior time (t) and the HDG price during the preceding period (t-1) (Rp per Kg)
m	= Total Lag
$\alpha 0$	= Intercept
$\alpha 1, \beta 1, \gamma 1$	= Parameter Coefficient
ε_t	= Error Term

$$\Delta PKons_t = \alpha 0 PKons_t + \alpha 1 T + \beta 1 \sum^{m} \Delta PKons_{t-1} + \gamma 1 Pkons_{t-1} + \varepsilon_t \ldots (2)$$

Dimana :

$Pkons_t$ current	= Price of rice at the consumer level in Indonesia for the time phase (t) (Rp per kg)
$PKons_{t-1}$	= Variables affecting rice prices at the consumer level in Indonesia during the previous (t-1) (Rp per kg)
$\Delta Kons_t$ current the (Rp/kg).	= The variable representing the difference between the period (t) consumer-level rice price in Indonesia and consumer-level rice price in the previous period (t-1)
m	= Lag Count
$\alpha 0$	= Intercept
$\alpha 2, \beta 2, \gamma 2$	= Parameter Coefficient
ε_t	= Error Term

1) If the ADF statistic is greater than the ADF critical value, reject the null hypothesis (H0), indicating that the time series data does not have unit roots, and thus the data is stationary.
2) If the ADF statistic is less than or equal to the ADF critical value, fail to reject the null hypothesis (H0), suggesting that the time series data contains unit roots, meaning the data is not stationary.

b. Ideal Lag Calculation

To observe how each variable affects other variables in the VAR model, the ideal lag time must be chosen. The Akaike Information factors (AIC), Schwartz Information Criteria (SIC), Hannan-Quinn Criteria (HQ), Likelihood Ratio (LR), and Final Prediction Error (FPE) are some of the factors that can be used to determine the ideal lag time. The Akaike Information Criteria (AIC) are used in this study to determine the ideal lag length.

c. Cointegration Analysis

This study's cointegration test is the Johansen cointegration test, which may be used to determine how many variables are cointegrated (rank cointegrated) (Sugiyono, 2016). We accept the cointegration of several variables if the estimated value of LR is higher than the critical value, and vice versa if the calculated value of LR is lower than the critical value.

d. Granger Causality Analysis

The Granger causality test is used to ascertain whether two variables have a reciprocal or causal link since each variable in the study has the potential to be either an endogenous or an exogenous variable.

e. **Vector Error Correction Model Analysis (VECM)**

The link between short-term and long-term dynamic equilibrium in a system of equations is demonstrated by VECM analysis. There are long-term equilibria in markets, but they are not the same as short-term ones. Since the short-term relationship may differ significantly, the cointegrating equation displays the long-term equilibrium relationship. Consequently, the short- and long-term correlations of several market price factors are combined in VECM (Fazaria et al., 2016)

f. Impulse Response Function Analysis

Due to the difficulty in interpreting the individual coefficients in the VAR/VECM model, impulse response analysis is required in VAR/VECM estimation. Impulse response is used to monitor how the endogenous variables in the VAR/VECM system react to perturbations or modifications to the disturbance variables. Researchers can monitor shocks for a number of future periods by using impulse response (Widarjono, 2013).

g. Variance Decompositions Analysis

In estimate, dynamic VAR systems are described using variance decomposition. The relative significance of each variable in the VAR system as a result of shocks is described by variance decomposition. The proportion contribution to each variable's variance caused by changes in specific variables in the VAR system is predicted using variance decomposition (Nugrahapsari & Arsanti, 2018).

RESEARCH RESULT

Stationarity Test

The results of the DF and ADF tests indicate that, at the second level of differentiation (II(2)), where the critical value is greater than the ADF statistical value and the probability value is less than 0.05, both HDG (Harvested Dry Grain) price data at the producer level and rice prices at the consumer level are stationary. Table 1 displays the results of the ADF test. Findings of the ADF Test for Data Stationarity on Producer-Level HDG Price Data and Consumer-Level Rice Prices from 2014 to 2023

Table 1. Shows the Findings of the ADF Test for Data Stationarity using Producer-Level HDG Price Data (Dry Grain Harvest) and Consumer-Level Rice Prices from 2014 to 2023

Level	Equation Test (Tren Dan Intersep)	*Critical Value*		Prob.
Producer (Harvested Dry Grain Price)	Level	1 %	-4.046072	0.7244
		5 %	-3.452358	
		10 %	-3.151673	
	First Differentiation	1 %	-4.046072	0.1416
		5 %	-3.452358	
		10%	-3.151673	
	Second Differentiation	1 %	-4.046072	0.0000
		5 %	-3.452358	
		10%	-3.151673	
Consumer (Rice Price)	Level	1 %	-4.037668	0.2021
		5 %	-3.448348	
		10 %	-3.149326	
	First Differentiation	1 %	-4.037668	0.0000
		5 %	-3.448348	
		10%	-3.149326	
	Second Differentiation	1 %	-4.046072	0.0000
		5 %	-3.452358	
		10%	-3.151673	

Source: Secondary data (processed)

Lag Length Test

The Akaike Information Criteria (AIC) method for calculating lag length Additionally, the optimal lag test is performed to determine the optimal lag duration for analyzing the long-term association between the variables under investigation. Table 2 displays the results of the optimal lag test.

Table 2. Results of the Optimal Lag Test for the Producer-Level Price of Harvested Dry Grain (HDG) and the Consumer-Level Price of Rice Rice Prices at the Producer And Consumer Levels

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1483.897	NA	1.45e+09	26.77292	26.82174	26.79272
1	-1474.868	17.56971	1.33e+09	26.68231	26.82877	26.74172
2	-1462.718	23.20546*	1.15e+09*	26.53546*	26.77956*	26.63448*
3	-1458.933	7.092135	1.15e+09	26.53934	26.88108	26.67797
4	-1455.799	5.760032	1.17e+09	26.55494	26.99432	26.73318
5	-1455.605	0.348983	1.25e+09	26.62352	27.16054	26.84137
6	-1452.784	4.981703	1.28e+09	26.64476	27.27942	26.90222
7	-1450.237	4.404983	1.32e+09	26.67094	27.40325	26.96802
8	-1447.813	4.106582	1.36e +09	26.69933	27.52928	27.03601

Source: Secondary data (processed)

Latency 2 is the ideal latency, according to the findings of the optimal lag test using the AIC criterion. Since lag 2 is chosen as the model's ideal lag, it follows that all of the variables have an impact on one another not just in the present but also in the past, as seen by the price variables' interdependence.

VAR Stability Testing

Before proceeding to the next stages of analysis, the estimation results of the VAR system of equations must be tested for stability through a VAR stability check, which involves examining the roots of the characteristic polynomial for all variables used, multiplied by the number of lags in each VAR. Testing VAR stability is essential because if the estimation results are unstable, the IRF and FEVD analysis will be invalid. According to the test results, a VAR system is considered stable if all of its roots have a modulus smaller than one. In this study, the VAR stability test results, as shown in Table 3, indicate that the estimated VAR system is stable for use in IRF and FEVD analysis, as the modulus values are all less than one.

Table 3. VAR Stability Testing of Producer-Level HDG (Harvested Dry Grain) and Consumer-Level Rice Prices

ROOT	MODULUS
-0.010858 – 0.696787 i	0.696872
-0.010858 + 0.696787 i	0.696872
0.387631 - 0.400112 i	0.557088
0.387631 + 0.400112 i	0.557088
-0.301963	0.301963
-0.016775	0.016775

Source: Secondary Data (processed)

Cointegration Analysis

To ascertain the long-term relationship that takes place at the marketing level, the Johansen cointegration test was used. Table 4 displays the findings of the Johansen cointegration test.

Table 4. Results of the Johansen Cointegration Test Producer-Level Prices for Harvested Dry Grain (HDG) and Consumer-Level Prices For Rice

Cointegration Total	Trace Stat	0,05 Critical Value	Prob	Max-Eigen Stat	0,05 Critical Value	Prob
Relationship between Producers and Consumers						
None	82.02003	15.49471	0.0000	43.46457	14.26460	0.0000
At most 1	38.55546	3.841466	0.0000	38.5546	3.841466	0.0000

Source: Secondary data (processed)

There is cointegration, according to the findings of the Johansen cointegration test, which is based on the trace statistic as well as the maxe-igenvalue of producer and consumer prices. According to the trace statistic, there is only one cointegration at rank = 0 (none) and at most 1 between the rice consumer and the dry grain harvest (HDG) producer. This is demonstrated by the probability value being less than 5% and the trace statistic value being higher than the crucial value of 5%. These findings suggest that these markets have a long-term relationship or equilibrium, although there might be an imbalance in the near term.

Kausalitas Granger Test

Each variable's impact on the others is examined one at a time using the Granger Causality test. Table 5 displays the results of Granger Causality.

Table 5. Consumer Level Granger Causation Findings of the Producer-Level HDG (Harvested Dry Grain) Price and the Consumer-Level Rice Pricing

Null Hypothesis	Obs	F-Stat	Prob
Consumer Price of Rice does not granger cause Producer Price of Dry Harvested Grain (HDG)	118	8.02633	0.0006
Grain Price does not granger cause Rice Consumer Price	118	6.47213	0.0022

Source: Secondary Data (Processed)

The Granger Causality test results indicate that there is one-way causality, meaning that the price at the level of producers of harvested dry grain (HDG) is influenced by the price at the level of rice consumers ($\alpha < 0.05$), as indicated by the F statistic and the probability at the level of producers and consumers of rice. According to the Granger Causality test results, there is one-way causality, meaning that the price of rice consumers is influenced by the price at the level of harvested dry grain producers (HDG) ($\alpha < 0.05$), as indicated by the F statistical value and probability at the level of HDG.

Vector Error Correction Model Test (VECM)

When the time series data is stationary in the difference data and cointegrated to demonstrate the theoretical relationship between variables, but not stationary at the level, VECM is employed in the model. When a persistent shock occurs, this model can be used to compare a variable's short-term behavior to its long-term behavior (Kostov and Lingard, 2000 in Ajija et al, 2011). If the retraction results are over detected using LR test criteria and the p-value is greater than 5%, the VECM equation is deemed legitimate. Table 6 displays the results of the VECM model estimation.

Table 6. Results of the VECM Model's Estimation of Rice Prices at the Consumer Level and HDG (Harvested Dry Grain) at the Producer Level

Error Correction	D(Producer)		D(Consumer)	
	Coefficient	T-Statistik	Coefficient	T-Statistic
ECT1	0.016983	[0.18282]	0.764125	[6.98444]
D(Producer(-1),2	-0.147846	[-1.43121]	-0.297210	[-2.44299]
D(Producer(-2),2	-0.545284	[-5.79594]	-0.277149	[-2.50137]
D(Consumer(-1),2	-0.051724	[-0.50045]	0.062336	[0.51212]
D(Consumer(-2),2	0.099014	[-1.31919]	0.032058	[0.36267]
C	3.057786	[0.18727]	2.415854	[0.12563]
R-Squared	0.351687		0.507228	

(Source: Secondary Data Processed)

According to Table 6's VECM results, the error correction term has a positive impact of 0.016983 and 0.764125 on rice prices at the producer and consumer levels, respectively, and is significant at the 5% real level. This demonstrates how crucial a long-term cointegration relationship is to each market's price development process. Because the ECT value at the consumer level is higher than the ECT value at the producer level, the ECT coefficient value shows that price adjustment occurs more quickly at the consumer level than at the producer level.

Analysis of Impulse Response Function

IRF analysis will describe how a shock to one variable affects another variable; this analysis is not limited to the short term; it can also examine data for multiple future horizons as long-term information. If there is a specific shock of one standard error in each equation, this analysis can show the long-term dynamic response of each variable. Analysis of the impulse response function is also used to determine the duration of the effect. The standard deviation value, which indicates the amount of response a variable will provide in the event that other variables are shocked, is displayed on the vertical axis. In the meantime, the horizontal axis displays the duration of the response to the shock in years. The reaction above the horizontal axis suggests that the shock will be beneficial. On the other hand, a response that falls below the horizontal axis suggests that the shock will have a detrimental impact.

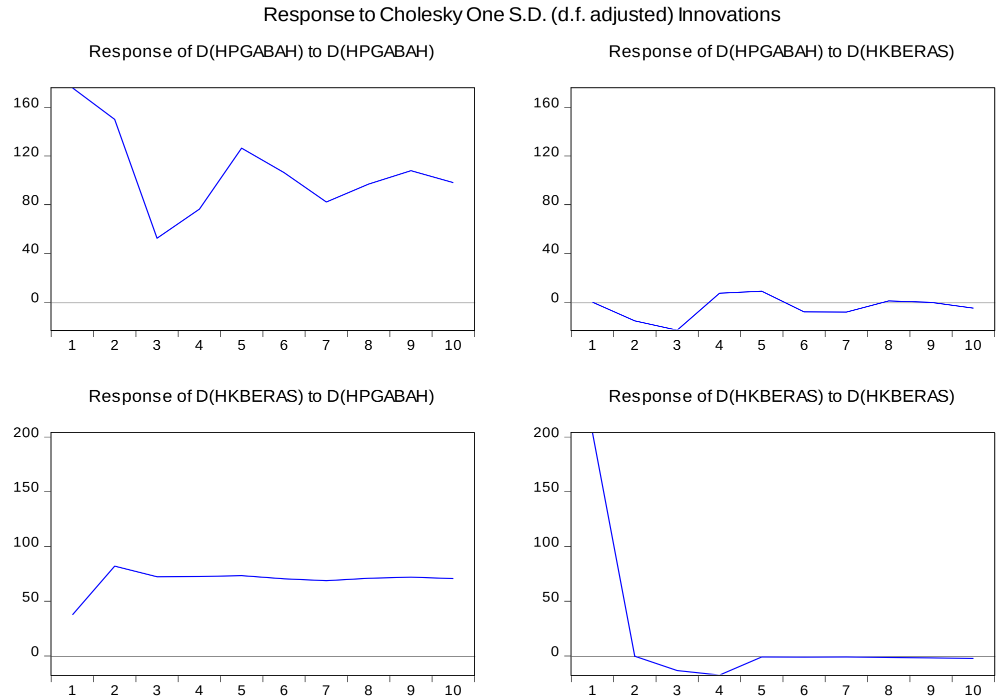

Figure.1 IRF Analysis Results Graph (First Row of Column One), the Variable Producer Price of Dry Harvested Grain (HDG)

According to the IRF analysis results in the figure above the first graph (first row of column one), the variable producer price of dry harvested grain (HDG) responded favorably to a shock to the variable producer price of HDG from the first to the tenth period. The IRF line, which stays above the horizontal line until the eleventh period, illustrates this. A high response rate of 175.78% was recorded during the first session. The response rate for the third session was a dismal 53.50%. The variable price of harvested dry grain producers (HDG) responded positively to a shock to the variable consumer price of rice in the first period, negatively in the second and third periods, and positively in the fourth to fifth periods, according to the second graph (first row of column two). Additionally, there was a downward tendency in the sixth, seventh, ninth, and tenth quarters.

The IRF line, which has a tendency to vary and is occasionally just above and occasionally just below the horizontal line, serves as an indicator of this. From the first period to the tenth period, as indicated by the IRF line above the horizontal line, the variable consumer price of rice response to a shock to the variable producer price of harvested dry grain (HDG) is showing a positive trend. In the second period, there is a high response of 82.02%, as shown in the third graph (second row of the first column). After that, it tends to drop to 70.66% from the third level to the tenth. The fourth graph (second row of the second column) illustrates how the rice consumer price variable responded to a shock by showing a positive trend in the first period, as indicated by the IRF line above the horizontal line, and a negative trend from the second period to the tenth period, as indicated by the IRF line below the horizontal line.

Variance Decomposition

Tabel.7 Variance Decomposition

Variance Decomposition of D(HPGABAH):			
Period	S.E.	D(HPGABAH)	D(HKBERAS)
1	175.7875	100.0000	0.000000
2	231.5641	99.56095	0.439049
3	238.5474	98.66142	1.338584
4	250.5557	98.70094	1.299063
5	280.7992	98.86187	1.138127
6	300.3930	98.93479	1.065210
7	311.5501	98.94119	1.058812
8	326.2628	99.03348	0.966516
9	343.6472	99.12878	0.871220
10	357.4248	99.17597	0.824029
Variance Decomposition of D(HKBERAS):			
Period	S.E.	D(HPGABAH)	D(HKBERAS)
1	207.0256	3.295797	96.70420
2	222.6826	16.41625	83.58375
3	234.4998	24.30512	75.69488
4	246.0609	30.74417	69.25583
5	256.7504	36.38978	63.61022
6	266.2566	40.84938	59.15062
7	274.9837	44.54319	55.45681
8	284.0020	48.00680	51.99320
9	292.9741	51.13868	48.86132
10	301.3837	53.82192	46.17808
Cholesky Ordering: D(HPGABAH) D(HKBERAS)			

Decomposition of output variance for the producer price of harvested dry grain (HDG). While the price shock at the consumer level of rice still has no effect during the first period, the producer price of harvested dry grain (HDG) is heavily impacted by the shock to the producer price of HDG (100%) during that time. Furthermore, with a contribution of 99.17%, the shock of the producer price of harvested dry grain (HDG) to the producer price of HDG itself remains a significant factor from the second period to the tenth period. However, the impact of the shock to the producer price of harvested dry grain (HDG) on the producer price of HDG itself gradually diminishes. Additionally, the impact of the rice consumer price shock increases until the seventh period, after which it declines from the eighth to the tenth.

Decomposition of Rice Consumer Price Output Variance. In the first period, the producer price of harvested dry grain (HDG) had a less significant impact on the shock to the consumer price of rice (3.29%), but the consumer price of rice was influenced by the shock to the consumer price of rice (96.70%). Additionally, the percentage of the rice consumer price shock to the rice consumer price itself tends to decline by 46.17% between the second and tenth periods. Additionally, over time, the producer price shock of harvested dry grain (HDG) has contributed more and more. The producer price shock of harvested dry grain (HDG) has even added 53.82% to the consumer price of rice from the tenth period. It turns out that the consumer price of rice is more affected by the size of the shock to the producer price of harvested dry grain (HDG) than by the size of the shock to the consumer price of rice.

DISCUSSION

The long-term relationship between producers and consumers affects variations in producer prices. Short-term producer price changes are not impacted by changes in consumer pricing; instead, they are only impacted by the producer's own price changes that occurred one or two months prior. The long-term interaction between producers and consumers affects changes in consumer prices. (Muhlis & Nababan, 2021). Short-term changes in consumer prices are not impacted by changes in producer prices; rather, they are only impacted by changes in consumer prices during the preceding two months. This suggests that the production and consumer markets are not connected in the near term. (Firdaussy, 2013)

Based on the findings of the VAR and VECM analyses of the Indonesian rice market, it can be concluded that there is long-term integration between the producer and consumer markets. There is no short-term integration between the two markets since short-term changes in producer and consumer pricing have no effect on one another. (Lubis et al., 2023). Long-term lack of market integration between the producer and consumer markets suggests that the producer level market creates an imperfectly competitive market. According to Sexton, Kling, and Carman (1991), the agricultural commodities market structure is typically oligopsony, meaning that farmers will receive lower prices as a result of incomplete market knowledge. Because only traders have the power to determine prices, this market structure is detrimental to producers. Due to the actions of traders who aim to maximize their profits and the imperfect nature of market information, particularly pricing information gathered by market participants, producers typically receive low prices in these market settings.

Farmers may find it difficult to control their offerings in order to secure better prices as a result of this incomplete market knowledge (Irawan, 2017). Pricing at the producer level are not affected by changes in consumer pricing. This is because the rice marketing process involves numerous marketing organizations, all of which will generate a profit or margin. Because of this, consumer prices will keep rising, though they aren't always transferred to producers (Haryani, 2013). Furthermore, the inability of the consumer market to function as a reference market for the producer market may be due to successful price-stabilizing government interventions, such as the government purchase price policy at the producer level and the highest retail price of rice policy at the consumer level (Hermawan, 2016).

CONCLUSIONS AND RECOMMENDATIONS

Long-term integration between Indonesia's producer-level harvested dry grain and consumer-level rice markets means that shifts in producer-level harvested dry grain prices are influenced by shifts in Indonesian consumer-level rice prices, rather than being integrated in the short term.

ADVANCED RESEARCH

This study's shortcoming is that it solely looks at market integration; it is advised to look at rice price transmission and volatility.

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