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CAUSALITY ANALYSIS OF RICE PRICES WITH INFLATION RATE IN INDONESIA

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ABSTRACT

Indonesia is one of the countries with the largest rice consumption in the world. The strategic value of rice places it as a commodity contributing to inflation. This study aims to investigate the causal relationship between rice prices and the inflation rate in Indonesia and to analyze the role of rice prices in the inflation rate in Indonesia. The rice price and inflation rate data used are secondary data with monthly periods obtained from the Indonesian Central Bureau of Statistics, Bulog (The National Logistics Agency), Ministry of Agriculture, Ministry of Trade, FAO and United States Department of Agriculture, and the United States Census Bureau. The analysis was carried out using Granger Causality and Vector Error Correction Model (VECM) utilized by the E-Views application. The Granger Causality test results show a causality relationship between rice prices and the inflation rate in Indonesia with a bi-directional causality pattern. We also found a long-run relationship. Impulse Response Function shows that shock in the rice prices will affect inflation throughout the sixth month until it converges and is stable. In line with the results of the Impulse Response Function, analysis of Variance Decomposition shows that changes in rice prices play a role in explaining the difference in the inflation rate of 2,77%.

Keywords: *causality, inflation, rice price, VECM*

BACKGROUND

Rice is the main staple food supporting the consumption of the Indonesian people (Antriyandarti et al., 2021; Salam et al., 2019). Based on data from the United States Department of Agriculture in 2019, Indonesia is one of the countries with the largest rice consumption in the world. Rice has an important role considering that in the short term, rice consumption is difficult to substitute for other commodities (Sugiyanto, 2006), while on the other hand, Reza et al. (2014) states that the demand for rice continues to increase in line with the increase in population growth. FAO 2020 data shows domestic rice prices for the last five years have been higher than world rice prices. The high price of domestic rice can encourage inflation. Food inflation is very influential on poverty (Fujii, 2013), inflation causes an increase in the poverty rate (Antriyandarti, 2015; Saputra et al., 2014). High prices will reduce the purchasing power and consumption of the poor (Dawe, 2014; Dawe & Peter Timmer, 2012; Sasmal, 2015). Maintaining stable food prices is important to impact poverty and the process of structural change and macroeconomic effects (Grabowski & Self, 2016).

Indonesia is a developing country where the food commodity market is one of the goods markets that play a key role in determining the inflation rate, especially for main food commodities (Ministry of Trade, 2015). Increases in rice prices are often followed by increases in prices of other basic commodities (Ohyver & Pudjihastuti, 2018). The role of rice as a strategic commodity (BAPPENAS, 2015) can be seen from two sides; namely, as the main food, the rice must be available

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in sufficient quantities and as a source of income and employment for some Indonesian people, Siswanto et al. (2018) stated that this makes rice one of the cost pushes inflation factor. Furthermore, the high demand for food commodities that exceeds the rate of increase in production can cause prices to increase and affect inflation (Sasmal, 2015).

Rice indirectly correlates strongly to economic development and non-economic situations (Ekowati et al., 2020). Disruptions in the rice supply can lead to economic, social, and political instability (Suryani et al., 2022). Several studies on rice have been conducted to determine the relationship between rice prices and inflation; rice has a significant effect on food inflation (Widiarsih, 2012), and rice prices have a positive and significant relationship to inflation in Indonesia (Saputra et al., 2014), in the long run, rice prices have a significant effect on inflation in Banten Province (Setiawan & Hadianto, 2014), the increase in rice prices is the main determinant of inflation in Sri Lanka in the long term (Ratnasiri, 2011). However, previous studies did not pay attention to the effect of shocks on rice prices. This paper will address this gap by analyzing the causal relationship between rice prices and the inflation rate and knowing the length of the response from the shock of the rice price variable to the inflation rate in Indonesia.

RESEARCH METHODS

This study used basic descriptive and analytical methods (Singh, 2006). The research location was determined purposively, namely Indonesia, considering that Indonesia is ranked the second country with the largest per capita rice consumption in the world based on data from the United States Department of Agriculture 2021. The data used in this study is secondary data from 2008-2019. Data were obtained from the Central Bureau of Statistics of Indonesia, Bulog, the Ministry of Agriculture, the Ministry of Trade, and also Food and Agriculture Organization Statistics Division (FAOSTAT).

In this study, the Granger test (Granger, 1969) based on Vector Autoregressive (VAR) was applied to determine the causal relationship between rice prices and inflation rates in Indonesia and the speed of adjustment of each variable in the study. Before applying the VAR model, first, the stationarity test for each time series and cointegration between rice prices and the inflation rate is carried out. Stationary was tested using Augmented Dickey-Fuller (Dickey & Fuller, 1981). The possibility of a cointegrated relationship was checked through the Johansen Cointegration Test (Johansen, 1988). The trace statistic value is greater than the critical value, and a pair of time series is said to be cointegrated (Basuki & Prawoto, 2016; Escribano & Wang, 2021).

$$\Delta HB_t = a_1 + \sum_{i=1}^{r_1} \alpha_{1i} \Delta HB_{t-i} + \sum_{i=1}^{r_1} \beta_{1i} \Delta INF_{t-i} + \theta_{1i} ECT_{t-1} + \varepsilon_{1t}$$
$$\Delta INF_t = a_2 + \sum_{i=1}^{r_2} \alpha_{2i} \Delta HB_{t-i} + \sum_{i=1}^{r_2} \beta_{2i} \Delta INF_{t-i} + \theta_{2i} ECT_{t-1} + \varepsilon_{2t}$$

Information:

HB	: Rice prices (Rp/Kg)
INF	: Inflation (%)
ECTt-1	: Error correction term
ε	: Conventional residual term

The causality test of a pair of cointegrated time series data was carried out under the VECM framework (Escribano & Wang, 2021). The VECM causality test tested short-term causality and long-

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term causality. Short-term causality relationships were investigated with F-statistical significance values, and long-term relationships were investigated with appropriate error correction ect (-1) using t-test values (Enders, 2015). The empirical model used to estimate the causal relationship includes rice prices (Rp/Kg), Inflation (%), ECT_{t-1} represents the error correction term that contains information on the long-term equilibrium between the variables, is the difference operator, r denotes the lag length.

RESULT AND DISCUSSION

Development of Rice Price Variables

Rice plays a role as a commodity contributing to inflation. This is inseparable from the culture of the Indonesian people, who make rice the main staple food (Grabowski & Self, 2016). The consumption of rice aggregates is so large that Indonesia is the country with the second-largest rice consumption in the world (Table 1).

Table 1. Countries with the Largest Rice Consumption in the World 2019

Country	Total Consumption (ton)	Total Population (person)	Average Total Consumption (kg/person)
China	145,030,000	1,394,015,977	104.04
India	105,926,000	1,326,093,247	79.88
Bangladesh	35,500,000	162,650,853	218.26
Indonesia	35,500,000	267,026,366	132.95

Sources: United States Department of Agriculture and United States Census Bureau, 2019

Rice prices from 2008 to 2019 continued to increase. This upward trend in rice prices can affect the inflation rate. In its development, the increase in rice prices was motivated by several things: an increase in population (Kasryno et al., 2016).

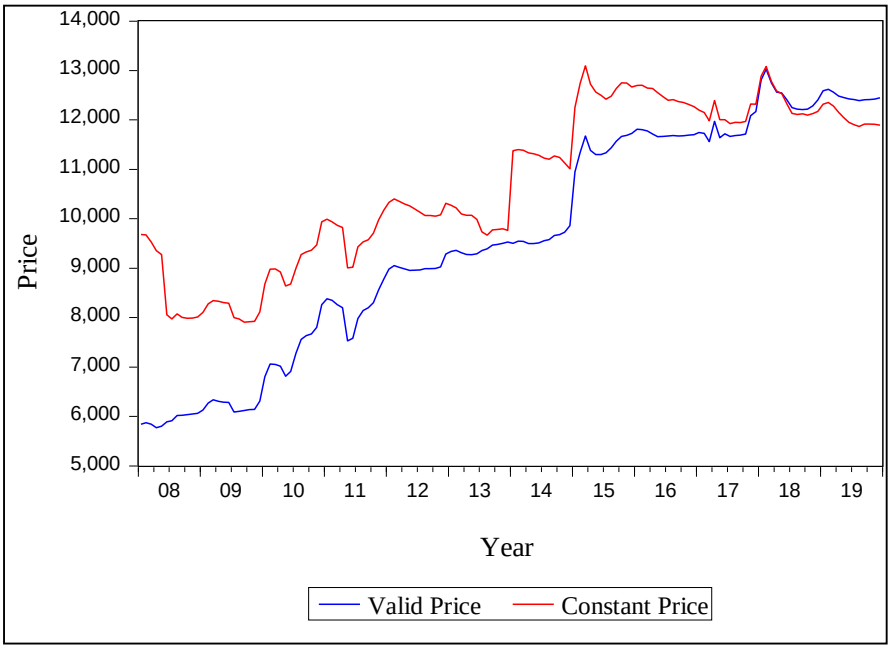

Figure 1. Retail Rice Price Development in Indonesia in 2008-2019
Source: BPS, 2020

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Development of Inflation Variables

Since the 1997 crisis, inflation in Indonesia has fluctuated from year to year. Inflation in developing countries tends to be more volatile compared to developed countries which are relatively more stable and controlled (Rahmadhani, 2016). Inflation in Indonesia from January 2008 to December 2019 reached its highest value in July 2013. Inflationary pressure was high in July due to the supply of food commodities being disrupted amid rising demand during Ramadan. An increase in food prices will lead to an increase in food inflation. Food inflation significantly contributes to aggregate inflation because food is one of the largest components in the CPI in developing countries (Zhang & Law, 2010).

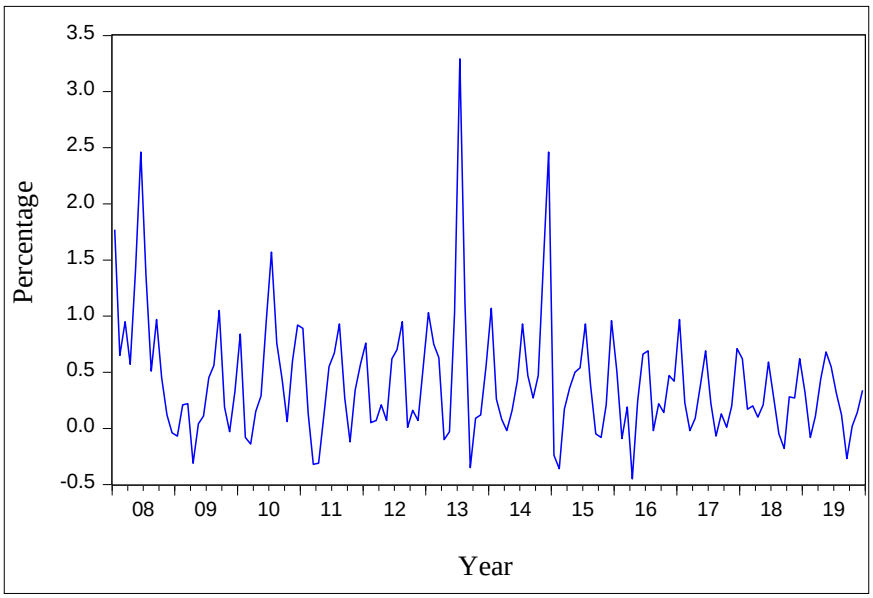

Figure 2. Indonesia's Inflation Development in 2008-2019
Source: BPS, 2020

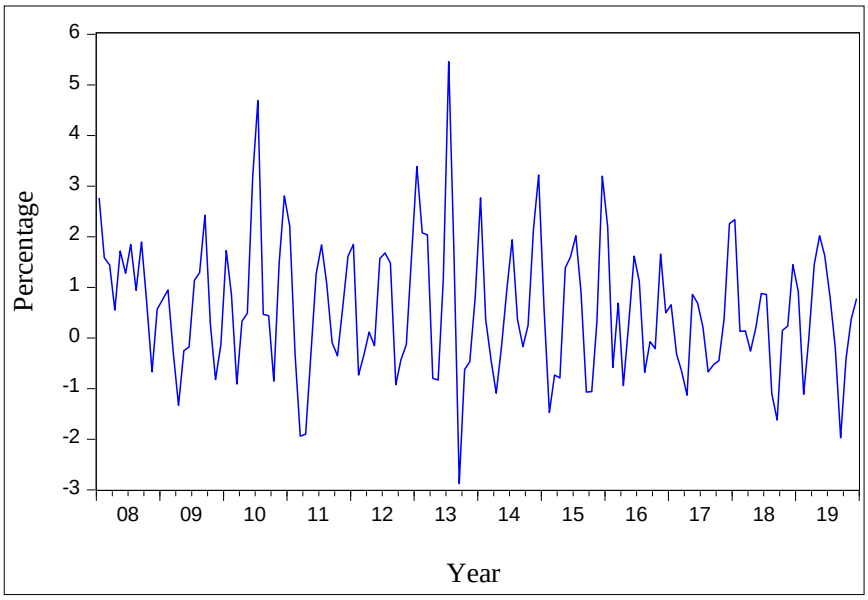

Figure 3. Indonesia's Food Inflation Development in 2008-2019
Source: BPS, 2020

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Food inflation in Indonesia is volatile and similar to aggregate inflation. From 2008 to 2019, the highest inflation peak was in July 2013. This is similar to the peak point of aggregate inflation. Food inflation contributes significantly to aggregate inflation (FAO Reginal Office for Asia and the Pacific, 2013). Based on the description above, it can be concluded that the high level of inflation is motivated by the increase in food commodity prices, one of which is rice. This can be proven in this study, where the results show a relationship between the price of rice and the inflation rate.

Results and Intrepretation

The stationarity test is an important initial stage in analyzing time series data to see whether there are unit roots in a variable so that the relationship between variables in an equation becomes valid. This study uses Augmented Dickey-Fuller (ADF) to test the unit root. The data can be stationary if the absolute value of t-statistics in the ADF is greater than the critical value of the ADF in the table (Gujarati, 2009).

Table 2. Unit Root Test Results at Level

Variable	ADF Statistic	McKinnon Critical Value			Explanation
		1%	5%	10%	
INF	-9.465876	-4.023975	-3.441777	-3.145474	Stationary
Log (HB)	-2.027771	-4.023975	-3.441777	-3.145474	Not Stationary

Table 3. Unit Root Test Results on First Difference

Variable	ADF Statistic	McKinnon Critical Value			Explanation
		1%	5%	10%	
INF	-10.74859	-4.025942	-3.442712	-3.146022	Stationary
Log (HB)	-8.556608	-4.023975	-3.441777	-3.145474	Not Stationary

Based on the test result (Table 2), it can be seen that the rice price variable has an absolute value of ADF smaller than McKinnon's critical value. This means that the tested variable contains the unit root at the level. A series that contains a unit root can be made stationary by differencing (Enders, 2015). Based on Table 3, it can be seen that all variables are stationary. The absolute value of the ADF statistic is greater than the McKinnon critical value. The test results show that all the variables estimated are stationary at the same degree, the degree of integration of one or the first difference.

Table 4. Optimum Lag Test Results

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-109.6796	NA	0.016902	1.595423	1.637446	1.612500
1	267.0894	737.3907	8.23e-05	-3.729848	-3.603778	-3.678617
2	284.3032	33.19814*	6.81-05*	-3.918618*	-3.708500*	-3.833232*
3	286.8882	4.911509	6.95e-05	-3.898403	-3.604239	-3.778864
4	289.1462	4.225687	7.13e-05	-3.873518	-3.495307	-3.719824

Following that, the determination of lag length is intended to avoid serial correlations between the error term and endogenous variables that potentially cause estimator inconsistency. Lags that are too short can cause specification errors in the model, while lags that are too long can reduce the degree of freedom (Hanifah et al., 2019). The optimum lag test results in Table 4 indicate that the optimal

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lag is based on LR criteria, FPE, AIC, SC, and HQ are lag length 2. The lag length selected is the lag with the smallest value and the most symbols (*).

Table 5. Granger Causality Test Results

Null Hypothesis	Obs	F-Statistic	Probability	Keterangan
LogHB does not Granger Cause INF	142	2.44723	0.0903	H_0 rejected
INF does not Granger Cause LogHB	142	4.71718	0.0104	H_0 rejected

After determining the lag length, the causality relationship is established by using the Granger causality test. The causality test results indicate a causal relationship between rice prices and inflation. The pattern of the causal relationship between the rice prices and the inflation rate is bidirectional, indicated by the statistical F value greater than the probability. This shows that changes in the price of rice in the past affect changes in the inflation rate in the present; on the contrary, changes in the inflation rate in the past affect changes in the price of rice in the present. This is in line with the study (Ratnasiri, 2011) that an increase in rice prices is an important determinant of inflation, but (Saputra et al., 2014) concluded that there is only a one-way causal relationship where inflation affects rice prices.

The data is stationary at the degree of integration of one, so a cointegration test was carried out with Johansen Cointegration. The test uses lag two based on the previous SC determination. The results of the Johansen cointegration test in Table 6 show that there is cointegration. The Johansen Cointegration Test shows that the value trace statistic is greater than the critical value, so it can be concluded that there is a long-term equilibrium relationship.

Table 6. Johansen Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None**	0.302789	53.44664	15.49471	0.0000
At most 1	0.018219	2.592521	3.841466	0.1074

Furthermore, the VECM estimation is carried out to find out more about the long-term and short-term effects between the inflation rate and the price of rice. The short-term to long-term adjustment mechanism is shown through the error correction parameter, which is negative. In the long run, rice prices significantly affect the inflation rate (Table 7). An increase in the price of rice by one percent will affect the inflation rate by 0.29 %. This is in line with the research results (Ratnasiri, 2011) that a one percent increase in rice prices will increase inflation by 0.33% in the long term. Meanwhile, in the short term, the inflation variable in the first lag has a statistically significant effect on the inflation rate in the current month. An increase of one percent will cause the inflation rate in the current month to increase by 0.36%, which follows that the inflation rate in the previous month determines optimism about the current month's inflation rate.

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Table 7. VECM test results

Variable	Coefficient	t-Statistic	Description
	Short-term		
D(INF(-1))	0.362448***	3.98192	Significant
D(INF(-2))	-0.014007	-0.16539	Not Significant
D(LOG(HB(-1))	1.291092	0.59861	Not Significant
D(LOG(HB(-2))	-3.727089*	-1.73098	Significant
C	0.009869		
CointEq1	-0.826336		
	Long-term		
INF(-1)	1.000000		
LOG(HB(-1))	0.288974*	1.65295	Significant
C	-3.049744		

Note: *** Significant at 1%, * Significant at 10%

The rice price variable in the short term has a statistically significant effect on the inflation rate in the second lag. An increase in the price of rice by one percent will decrease the inflation rate for the current month by 3.73%. This statement is reinforced by the findings of (Widiarsih, 2012) that in the short term, rice imports negatively affect inflation.

A non-linear relationship between the short and long term-is possible because the existing policies are still limited to short-term stabilization efforts (Khudori, 2016). Bulog through its buffer stock policy, has not been able to be implemented optimally, considering the high funds for procurement. According to Khudori (2016), the government only controls rice reserves of 350,000 tons, a relatively minimal amount compared to Thailand at 2 million tons and Vietnam at 1 million tons. This indirectly affects market operation policies, where research results Resnia and Wirastuti (2009) state that market operation policies have a significant psychological impact but are still not optimal considering that market operation rice's share of total rice supply in the market is relatively small. BULOG, the institution responsible for the stability of staple food prices needs to be strengthened to address the rice problem (Ellis, 1993; Ismet et al., 1998; Panuju et al., 2013).

Stock shortages cause prices to fluctuate and encourage imports (Reza et al., 2014). However, the stabilization policy through imports is also considered less effective for long-term stabilization. In the short term, rice imports affect rice price stability. However, based on the analysis of the Regulatory Impact Assessment, rice imports have not been able to effectively ensure long-term stability (Ministry of Trade, 2015). The government should also not rely too much on imports for price stabilization, as it makes them vulnerable to global crises that affect food prices (Svanidze et al., 2019). The rice prices and inflation phenomenon was distorted by the dynamics of stocks originating from domestic and imported products. In the short term, the stock can be met by imports, so it seems as if there are no shocks in the short term. Impulse Respond Function Analysis further identified the relationship between rice prices and the inflation rate. IRF is used to determine the effect of the shock of a variable on other variables.

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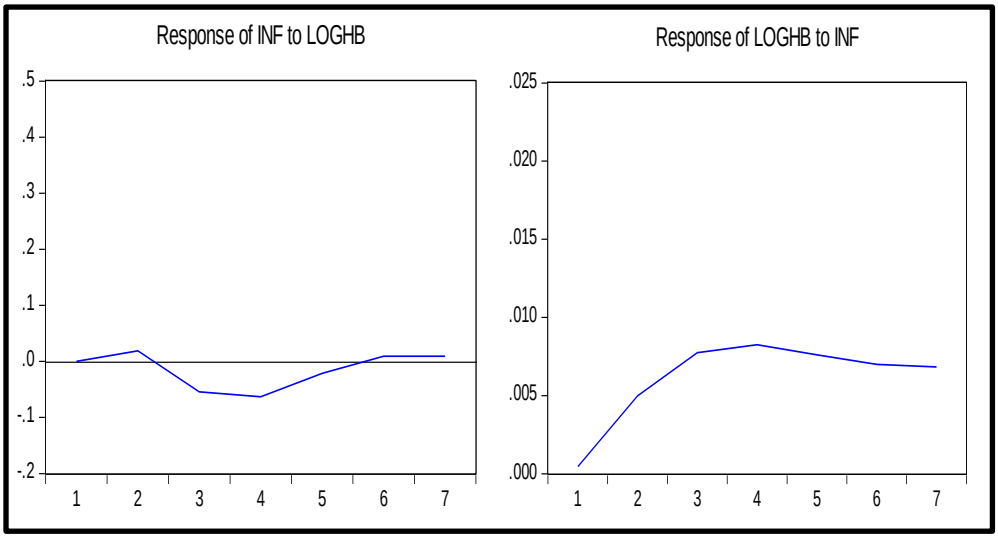

Figure 4. Impulse Respond Function

Impulse response in Figure 4 shows that shocks to rice prices will impact inflation and take six months to reach a convergence point and stabilize. This phenomenon can occur due to price stabilization efforts by the government. The rice price control instruments used by the government include market operations, rice import policies, and the determination of the highest retail price. The effectiveness of market operations can be seen within one month after its implementation (Ministry of Trade, 2015). Apart from market operations, the rice import policies also significantly affected the decline in rice prices (Widiarsih, 2012). The government through Bulog also sets the highest retail price (HET) to fulfill rice price stability (Agustono et al., 2020). According to Nugrahapsari and Hutagaol (2021), the government does not yet have adequate instruments to keep prices from exceeding the HET, the effectiveness of the HET policy in stabilizing rice prices depends on the accuracy of national rice stock data and the management and distribution of rice.

Table 8. Results of Variance Decomposition of INF

Month	INF	LOG(HB)
1	100.0000	0.000000
2	99.86444	0.135555
3	98.74145	1.258550
4	9740109	2.598909
5	97.27844	2.721562
6	97.25098	2.749019
7	97.22838	2.771622

The results of the variance decomposition test in Table 8 show that the contribution of the rice price variable to inflation always increases. The variable contribution of rice prices until the end of the month was 2.77%. This shows that the rice price variable plays a role in increasing inflation with a contribution that continues to increase until the end of the month of observation. Widiarsih, (2012) states that in developing countries, food expenditure is the largest proportion of income expenditure, so an increase in rice prices will encourage higher wage demand and be transmitted to rising inflation.

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This study's results align with the findings (Setiawan & Hadianto, 2014); the variance decomposition test found that rice prices contributed 2.68% to inflation in Banten Province.

CONCLUSION AND SUGGESTION

This study aimed to examine the existence and direction of a causal relationship between rice prices and the inflation rate. Furthermore, this study also analyzes the length of the response of the rice price shock to the inflation rate. This analysis is considered important in designing and implementing an effective rice policy. Using the Granger causality test and VECM, this study establishes a two-way causality between rice prices and the inflation rate in Indonesia. This shows that the price of rice and the inflation rate determine and influence each other. Rice is a commodity that is difficult to substitute in the short term, so an increase in rice prices will cause an increase in the inflation rate. On the other hand, inflation drives up the price of goods, including rice.

The findings show that the price of rice affects the inflation rate in the long run and has no effect in the short term. This noise from imports has not yet described the true causality and has only been described in the long run. The results of the Impulse Respond Function analysis show that rice price shocks will impact inflation for six months until it finally converges and stabilizes.

The above emphasizes the importance of controlling rice prices because an uncontrolled increase in rice prices will make it difficult for the poor and cause an increase in inflation. This study suggests that the government should solve rice problems in production, distribution, supply and reserves, infrastructure, and price control. The government needs to strengthen the role of BULOG in overcoming rice problems. The government must optimize existing policies and also formulate effective policies to maintain rice price stability and not only focus on stabilizing efforts in the short term.

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