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Market integration analysis of Cayenne Pepper (*Capsicum frutescens* L.) in South Kalimantan

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Abstract

One of the horticultural products in great demand by the public is cayenne pepper. The need for cayenne pepper often increases dramatically. Conditions like this occur during religious holidays, so the impact is a sharp price increase which results in price instability. This research aims to analyze price variations and market integration for cayenne pepper between markets in South Kalimantan. The price variation analysis method uses the coefficient of variation, and market integration analysis uses the VAR *(Vector Autoregression)*/VECM (*Vector Error Correction Model*). The results showed that the price variation of cayenne pepper at the consumer level was high and unstable. The high coefficient of variation occurred in 2018 and 2021. Market integration in Banjarmasin City, Tabalong Regency and Kotabaru Regency is only integrated in one direction. Short-term and long-term VECM tests show that several variable indices have a relationship. Banjarmasin City and Kotabaru Regency, in the commodity of cayenne pepper show a long-term relationship with Tabalong Regency. The Impulse Response Function (IRF) shows that the cayenne pepper commodity has a positive and negative response. Forecast Error Variance Decomposition (FEVD) shows that prices in Banjarmasin City contribute to the markets of Kotabaru Regency and Tabalong Regency to varying degrees. Bajarmasin City Market contributed the most to itself by 79.91% in the commodity of cayenne pepper.

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Introduction

Stabilization is an action to maintain a price of goods or services at a certain level carried out by the government when the inflation rate is high to balance the prices of goods or services within a certain period. Changes in commodity prices and inflation are closely related, and commodity prices can be used as a leading indicator of inflation. The reason is that food prices can be responded to quickly if a general shock occurs in the economy, such as aggregate demand (aggregate demand shock). It can also respond in the event of non-economic shocks, such as natural disasters that hamper the distribution channels of these commodities.

Food plays an important role in the life of a nation. The availability of food that is different from its needs can create economic instability. Various social and political upheavals can also occur if food security is disrupted. This critical food condition can even endanger economic stability and national stability.

The government continues to make efforts to carry out price rehabilitation so that price increases do not increase too much, one of which is through the Staple Needs Market Monitoring System (*SP2KP* in Indonesian). Indications that could impact people's purchasing value, the government will respond quickly to overcome all problems.

Over the past five years, food prices in Indonesia have varied and fluctuated, especially beef, chilli and shallots. Price fluctuations that occur can encourage high inflation, especially in the volatile food.

One of the horticultural products in great demand by the public is cayenne peppe. This condition is caused by chilli being a daily necessity in household consumption. The need for cayenne pepper and large red chillies often increases drastically. Conditions like this occur during religious holidays, so the impact is quite sharp price increases. Although in terms of quantity, household consumers do not consume cayenne pepper quantities; people still need cayenne pepper. The stable price of cayenne pepper is the hope for the community. Cayenne pepper and large red chilli are food ingredients whose prices fluctuate considerably. If the price of bird's eye chillies and large red chillies soars, it will impact people's purchasing power and cause anxiety.

Integration between markets can impact price fluctuations that occur in the market. Price information differs among traders in these markets, causing price information that reaches consumers to vary. In an efficient market structure, even the slightest price change in one market will spread to the next in a marketing system (Lilimantik, 2020 : 3).

The causes of non-integrated markets include information factors determining the place of sellers and buyers in price formation, institutions involving the role of government in facilitating the process of commodity exchange between regions, information asymmetry, also known as information failure, which occurs when one party in an economic transaction has material knowledge that bigger than the other side.

This research aims to analyze price variations and market integration for cayenne pepper between markets in South Kalimantan. The benefits obtained in this study are an overview of price variations and market integration for cayenne pepper in South Kalimantan, contributions to the government in formulating policies on food prices, food for thought for actors in production activities related to information on prevailing prices.

Material and methods

The research implementation took place from November 2022, from preparation and data collection to the thesis preparation stage until March 2023. This research was carried out in South Kalimantan, which included the City of Banjarmasin, Tabalong Regency and Kotabaru Regency. The data used in this study is secondary data (time series) on monthly commodity prices for cayenne pepper at the consumer level for five years: 2018-2022.

This secondary data was obtained from the South Kalimantan Central Statistics Agency and the South Kalimantan Food Crops and Horticulture Service. Variations in commodity prices for cayenne pepper were analyzed using the coefficient of variation (CV) with the formula (Wirawan, 2016: 152):

$CV_{it} = \frac{\sigma_{it}}{\bar{x}_{it}}$ x 100%.....(1)

with:

CV_{it} : the coefficient of variation of commodity cayenne pepper

σ_{it} : standar deviation

$\bar{x}_{it}$: the average commodity price of cayenne pepper

The coefficient value of the price variation for cayenne pepper is based on Monitoring Performance Achievements Based on the 2019 Food Security Agency Performance Determination in Activity Performance Indicators with a maximum value of 30%. The smaller the value of the coefficient of variation can be interpreted that the price is relatively stable or has low fluctuations. Market integration is analyzed using VAR (*Vector Autoregression*)/VECM (*Vector Error Correction Model*).

Stationarity Test

The stationarity test can be carried out using the Augmented Dickey-Fuller (ADF) unit root test (Nur'Aini, 2018: 13-16):

$H_o : \delta : 0$

$H_1 : \delta \neq 0$

$ADF/|\tau| = \left|\frac{\hat{\delta}}{Se\,(\hat{\delta})}\right|$.....(2)

with:

$\hat{\delta}$: least squares estimator of $\delta\hat{}$

$S(\hat{\delta})$: standard error $\delta\hat{}$

t_{table} : $Ø_\infty + Ø_1T^{-1} + Ø_2T^{-2}$ (table MacKinnon)

H_o is rejected if the statistic value |ADF| < critical value at α, or p-value < α and t-statistic > test critical value

Optimal Lag Length Test

The optimum lag is based on the minimum AIC (*Akaike Information Criterion*) value. Here is the AIC equation (Fitrianti, 2009: 59) :

$AIC = -2\ell/T + 2k/T$.....(3)

with:

ℓ : log *likelihood*

T : observation size

K : the number of operating variables in the equation

VAR Stability Test

A VAR system is said to be stable (stationary, both in mean and variance) if seen from the root's characteristic of the polynomial. It has a modulus smaller than one, and all of them are located within the unit circle.

Cointegration Test

Testing the variable price of cayenne pepper and red chili, which is not stationary at the level to analyze long-term relationships (Aryani, 2009: 63):

Ho : no cointegration

H_1 : cointegration

Trace test statistics*:*

λ_{trace} (r) : $-T\sum_{i=r=1}^{p} \log(1-\lambda i)$.....(4)

Maximum eigenvalue test statistic*:*

$\lambda_{;max}$ (r) : $-T \log (1-\lambda_{i+1})$.....(5)

with:

T : the amount of observation time

λ : eigenvalue estimation (root of alleged features) resulting from matrix estimation a

H_o is rejected if the calculated value of λ_{trace} and λ_{max} is greater than the critical value or the p-value is less than α = 5%.

VAR/VECM estimation

The VAR model for commodity market integration for cayenne pepper is as follows:

$PBJM_t = c_1 + \alpha_1 PBJM_{t-1} + \alpha_2 PKTB_{t-1} + \alpha_3 PTBL_{t-1} + \beta_1 PBJM_{t-2} + \beta_2 KTB_{t-2} + \beta_3 PTBL_{t-2} + u_{t1}$...(6)

$PTBL_t = c_2 + \alpha_1 PBJM_{t-1} + \alpha_2 PKTB_{t-1} + \alpha_3 PTBL_{t-1} + \beta_1 PBJM_{t-2} + \beta_2 PKTB_{t-2} + \beta_3 PTBL_{t-2} + u_{2t}$.(7)

$PKTB_t = c_3 + \alpha_1 PBJM_{t-1} + \alpha_2 PKTB_{t-1} + \alpha_3 PTBL_{t-1} + \beta_1 PBJM_{t-2} + \beta_2 PKTB_{t-2} + \beta_3 PTBL_{t-2} + u_{3t}$.(8)

The VECM model for commodity market integration for cayenne pepper and red chili is as follows:

$\Delta PBJM = \theta_1 + \alpha PBJM\omega_{t-1} + \sum_{i=1}^{n} \delta_{11} \Delta PBJM + \sum_{i=1}^{n} \delta_{21}\Delta PTBL_{t-1} + \sum_{i=1}^{n} \delta_{31}\Delta PKTB + u_t$..(9)

$\Delta PTBL = \theta_2 + \alpha PTBL\omega_{t-1} + \sum_{i=1}^{n} \delta_{12} \Delta PBJM + \sum_{i=1}^{n} \delta_{22}\Delta PTBL_{t-1} + \sum_{i=1}^{n} \delta_{32}\Delta PKTB + u_t$.(10)

$\Delta PKTB = \theta_3 + \alpha PKTB\omega_{t-1} + \sum_{i=1}^{n} \delta_{13} \Delta PBJM + \sum_{i=1}^{n} \delta_{23}\Delta PTBL_{t-1} + \sum_{i=1}^{n} \delta_{33}\Delta PKTB + u_t$.(11)

with:

c_1, c_2, c_3 : constant

α,β : parameters to be estimated

$PBJM_t$: the price of cayenne pepper in Banjarmasin City in the t-periode (Rp/kg)

$PTBL_t$: the price of cayenne pepper in Tabalong Regency in the t-period (Rp/kg)

$PKTB_t$: the price of cayenne pepper in Kotabaru Regency in the t-period (Rp/kg)

$\theta_1, \theta_2, \theta_3$: *intercept*

δ : short term dynamic parameters

α : long-term adjustment parameters

$\omega_{t-1}(\beta)$: long-run equilibrium relationship between markets (error correction model)

u_t : residual

Grager Causality

This test is used to see the causality or reciprocal relationship between the two research variables to see whether the two variables statistically influence each other (two-way or reciprocal relationship, have a unidirectional relationship or no relationship).

H_o : there is no causality/reciprocal relationship between the commodity price variables for cayenne pepper

H_o : there is a causality/reciprocal relationship between the commodity price variables for cayenne pepper

$$F = (n\text{-}k) \frac{RSS_R - RSS_{UR}}{m(RSS)_{UR}} \quad \text{.....(12)}$$

with:

RSS_R : *residual sum of square equation restricted*

RSS_{UR} : *residual sum of square unrestricted equation*

n : a number of observations

m : number of lags

k : the number of estimated parameters in the unrestricted equation

If F count > F table (α) and p-value < α, then reject H_o means there is a causality/reciprocal relationship between the commodity price variables for cayenne pepper/red chili.

Impulse Response Function (IRF)

It is used to see the response of a commodity price variable from a district to shocks from commodity price variables in other districts. This analysis is not only in the short term but can be analyzed for some time as long-term information. Impulse response function analysis also serves to see how long this effect occurs.

Forecast Error Variance Decomposition (FEVD)

Estimating how much a variable contributes to changes in commodity price variables in one district itself and the commodity price variable of cayenne pepper/big red chili in other districts in the next several periods, where the value is measured in percentage.

Results and discussion

Coefficient of Variation

The price variation analysis conducted on the average monthly price of cayenne pepper and big red chilies at the consumer level during 2018-2022 shows a fluctuating movement pattern.

Table 1. The coefficient of variation of cayenne pepper commodities for 2018-2022.

Market	Year	CV (%)
		Cayenne Pepper
Banjarmasin City	2018	32.88
	2019	21.09
	2020	16.89
	2021	29.45
	2022	12.40
Tabalong Regency	2018	30.96
	2019	19.45
	2020	20.15
	2021	31.66
	2022	15.68
Kotabaru Regency	2018	27.93
	2019	25.66
	2020	28.25
	2021	31.90
	2022	25.35

Source: South Kalimantan Central of Statistics and South Kalimantan Horticultural Food Crops Service, 2023 (data processed)

Based on Table 1, the coefficient of price variation is more than 30% for both cayenne pepper. This condition indicates that the price variation coefficient is relatively large or the price fluctuation is high (unstable). In 2018, the causes of fluctuations were due to the availability of cayenne pepper on the market and high rainfall in the cayenne pepper supply areas, so many chilies experienced crop failure.

In 2021, the cause of fluctuations was due to the impact of the Covid-19 pandemic. Trade activities were hampered due to an increase in demand by the public for horticultural commodities such as fruit and vegetables, but people's mobility was limited so that product distribution also experienced obstacles. In addition, there were external factors which were quite

difficult to control, such as climate, causing horticultural commodities, especially chilies, to experience crop failure.

Market Integration of Cayenne Pepper

A market is said to be integrated if price changes in other markets respond to the price changes in one market. The market integration analysis includes several steps, starting from the stationarity of the data to the magnitude of the shock from one district and other districts.

Stationarity Test.

The initial test is carried out at the level. If the data is not stationary at the level, it is continued with the first difference by difference to get stationarity data. Testing the stationarity of the price data for cayenne pepper and red chili is presented in Table 2.

Table 2. Test the stationarity of cayenne pepper at the level and first difference

Variable	Level		First Difference	
	t-statistic	probability	t-statistic	probability
PBJM	-2.730770	0.0749	-6.699786	0.0000
PKTB	-2.782687	0.0669	-6.705300	0.0000
PTBL	-3.201665	0.0248	-7.235361	0.0000

Description: test critical value (level -2.911730, first difference -2.912631), α = 5%

Based on Table 2, the commodities of cayenne pepper at the PBJM and PKTB variable levels have a t-statistic value smaller than the critical value test and a probability greater than α=5%. If accept Ho, which means it is not stationary at the level. Thus, in this case, it is necessary to continue the stationarity test on the first difference to obtain stationary data by making a difference. After differentiating all variables in the commodity of cayenne pepper, the t-statistic value is greater than the critical value test, and the probability is smaller than α = 5%. Therefore, it can be concluded that the stationarity test rejects H_0, which means stationary at the first difference.

Optimal Lag Length Test

The optimal lag selection in this study uses the *Akaike Information Criterion* (AIC). The results of the lag test are presented in Table 3.

Table 3. Test the optimal lag length of cayenne pepper

Lag	AIC Criteria
	Cayenne Pepper
0	-1.412526
1	-1.637689
2	-1.498995
3	-1.664947*
4	-1.475429
5	-1.353008

Description: * optimal lag indication

Based on Table 3, the AIC information criteria for the cayenne pepper commodity show that lag 3 is optimal. All variables in the model (PBJM, PTBL, PKTB) for the commodity of cayenne pepper influence each other in the current and the previous periods.

VAR Stability Test

The VAR model is stable if the modulus value is < 1 or all the roots are in the unit circle. Based on the results of the VAR stability test, it is known that the modulus value for cayenne pepper ranges from 0.050310 to 0.813525. The modulus value in this test is < 1, so it is concluded that the large red chili commodity VAR model formed is stable at its optimal lag and the data used in the VAR estimation model is said to be good. Meanwhile, VAR stability estimates can be used for IRF and FEVD analysis.

Cointegration Test

The stationary data at the first difference is tested by cointegration to see if a picture of short-term dynamics is consistent with its long-term relationship. The cointegration test in this study uses the Johansen approach by comparing the trace statistics with the critical value and the maximum eigenvalue with the critical value at the 5% significance level.

Table 4. Cayenne pepper cointegration test

Hypothesis		Trace Statistic	Critical Value	Probability
Ho	H1			
r=0	r=1	78.15506	24.27596	0.0000
r=1	r=2	43.82221	12.32090	0.0000
r=2	r=3	19.98707	4.129906	0.0000
Hypothesis		Max-Eigen Value	Critical Value	Probability
Ho	H1			
r=0	r=1	34.33285	17.79730	0.0001
r=1	r=2	23.83515	11.22480	0.0002
r=2	r=3	19.98707	4.129906	0.0000

Based on Table 4, there are three cointegrated equations, i.e., at r=2; this can be seen in the value of the trace statistic and max-eigen value greater than the critical value. In addition, the cointegration results also show all probability values from the trace statistics and max-eigen values that are smaller than 0.05, which means that there is a long-term integration relationship. Therefore, it is concluded that the trace statistic and max-eigenvalue value reject Ho to a significance level of 5%, which means that there are three cointegration equations and cointegration rank r=2, which will explain the existence of a long-term relationship to the variables in the system of equations.

VECM Estimation

VECM is a restricted model because of the cointegration, which shows a long-term relationship between variables in the VAR system. The cointegration test that was carried out earlier stated that there were three cointegration equations in the long-term relationship and indicated the effect of the error term on the VAR model. The VECM model of integrated cayenne pepper commodity market is as follows:

$$\Delta PBJM_t = 0.001054 - 0.322189\ \xi_{1t} + 0.925459\ \xi_{2t} - 0.484267\ \Delta PBJM_{t-1} - 0.609338\ \Delta PKTB_{t-1} + 0.975038\ \Delta PTBL_{t-1} - 0.245746\ \Delta PBJM_{t-2} - 0.166166\ \Delta PKTB_{t-2} + 0.362440\ \Delta PTBL_{t-2} - 0.019175\ \Delta PBJM_{t-3} - 0.014060\ \Delta PKTB_{t-3} + 0.043635\ \Delta PTBL_{t-3} + u_t \quad (13)$$

$$\Delta PKTB_t = -0.003573 + 1.931397\ \xi_{1t} - 1.089426\ \xi_{2t} - 1.660940\ \Delta PBJM_{t-1} + 0.080284\ \Delta PKTB_{t-1} - 1.157345\ \Delta PTBL_{t-1} - 1.097542\ \Delta PBJM_{t-2} + 0.234940\ \Delta PKTB_{t-2} + 0.656213\ \Delta PTBL_{t-2} - 0.262879\ \Delta PBJM_{t-3} + 0.135971\ \Delta PKTB_{t-3} + 0.046376\ \Delta PTBL_{t-3} + u_t \quad (14)$$

$$\Delta PTBL_t = 0.003826 + 1.485668\ \xi_{1t} + 0.256449\ \xi_{2t} - 0.897545\ \Delta PBJM_{t-1} - 0.157390\ \Delta PKTB_{t-1} + 1.175158\ \Delta PTBL_{t-1} - 0.725785\ \Delta PBJM_{t-2} + 0.180317\ \Delta PKTB_{t-2} + 0.605064\ \Delta PTBL_{t-2} + 0.016954\ \Delta PBJM_{t-3} + 0.068169\ \Delta PKTB_{t-3} + 0.068736\ \Delta PTBL_{t-3} + u_t \quad (15)$$

Causality Test

The results of the causality test show that the commodity markets for cayenne pepper in South Kalimantan in the markets for Banjarmasin City, Kotabaru Regency and Tabalong Regency have yet to be fully integrated. The causality test results can be seen in Table 5.

Table 5. Cayenne pepper commodity causality test

Ho	F-count	F-table	Probability
PKTB does not Granger Cause PBJM	0.93851	2.76	0.4291
PBJM does not Granger Cause PKTB	1.90773	2.76	0.1403
PTBL does not Granger Cause PBJM	0.24491	2.76	0.8646
PBJM does not Granger Cause PTBL	3.59955	2.76	0.0197*
PTBL does not Granger Cause PKTB	4.30992	2.76	0.0088*
PKTB does not Granger Cause PTBL	1.26270	2.76	0.2973

Description: significant at the significance level of 5%

Based on table 5, the variables with a reciprocal relationship only occur in one direction. The variables that have a reciprocal relationship to the cayenne pepper commodity are prices in the Banjarmasin City market (PBJM) with prices in Tabalong Regency (PTBL) and prices in Tabalong Regency (PTBL) with prices in Kotabaru Regency (PKTB).

The price of cayenne pepper in Banjarmasin City (PBJM) statistically significantly influences the price of cayenne pepper in Tabalong Regency (PTBL) because the probability value of 0.0197 is less than 0.05 and the calculated F value is 3.59955 greater than the F table value of 2.76. The price of cayenne pepper in Tabalong Regency (PTBL) statistically significantly affects the price of cayenne pepper in Kotabaru Regency (PKTB) because the probability value of 0.0088 is less than 0.05 and the calculated F value is 4.30992, which is greater than the F table value of 2.76. Therefore, H_0 is rejected that there is a causal/reciprocal relationship between the commodity prices of cayenne pepper.

Impulse Response Function

The period used in this analysis is 24 periods. It means that the response of a variable will be valid for the next 24 periods (2 years). The following is an IRF graph of each commodity price variable for cayenne pepper and red chili.

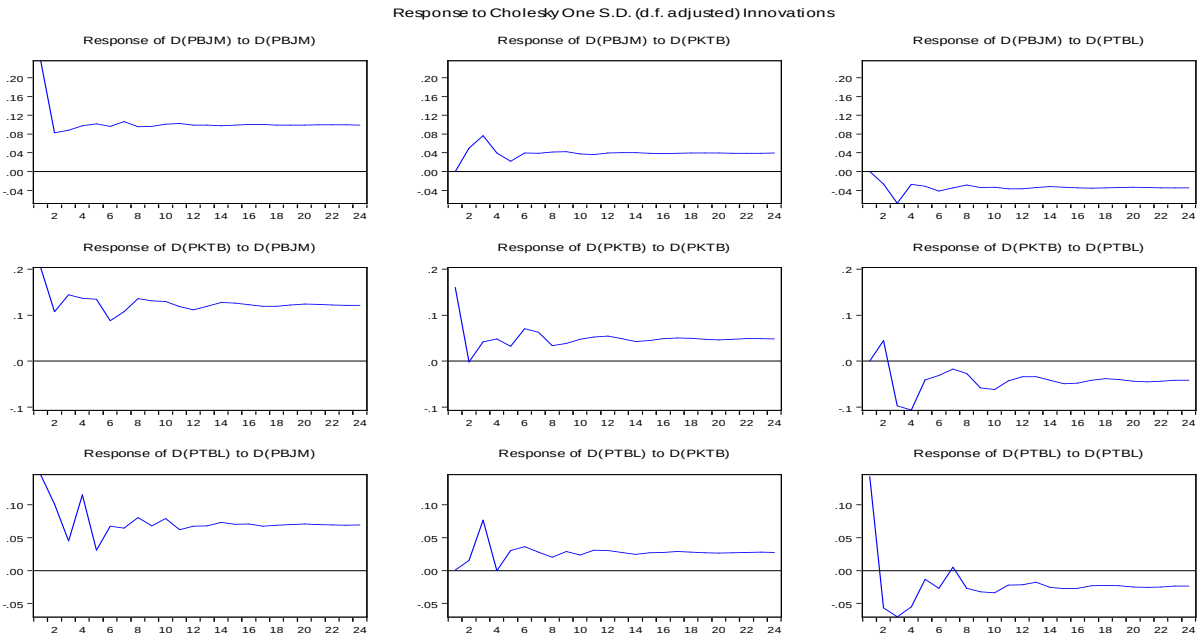

Fig. 1. The response of cayenne pepper prices in Banjarmasin City, Kotabaru Regency and Tabalong Regency to cayenne pepper price shocks.

The city of Banjarmasin's positive and negative response tends to reach a stable response faster; the average starts to stabilize in period 6.

Forecast Error Variance Decomposition

An important source of price variation in Banjarmasin City is the shock from Banjarmasin City itself from the first to the last period. In contrast, the shock from Tabalong Regency is relatively small. In the first period, the variability of the price of cayenne pepper was explained by the shock itself of 100% and no contribution from other districts. However, in the long term, the contribution of price shocks from Kotabaru and Tabalong Regency increases in explaining the variability of cayenne pepper prices in Banjarmasin City. Entering the final period, the role of price shocks in Banjarmasin City decreased by 79.90%, and the rest was explained by prices in Kotabaru and Tabalong Regencies of 11.46% and 8.63%.

The sources of price variation in Kotabaru Regency are shocks from Banjarmasin City and Kotabaru Regency itself, while shocks from Tabalong Regency are relatively small. In the first period, the variability of cayenne pepper prices was explained by shocks from Banjarmasin City of 61.52% and contributions from the district of 38.47%. However, in the long run, price shocks from Kotabaru Regency continue to decline, and contributions from the Banjarmasin City and Tabalong Regency continue to increase by 74.11% and 11.04%.

The price contribution from Banjarmasin City still dominates the source of price variation in Tabalong Regency. In the first period, the variability of cayenne pepper prices was explained by shocks from Banjarmasin City at 50.91%, Kotabaru Regency at 0.0002% and Tabalong Regency itself at 49.08%. However, in the long term, the contribution of price shocks from Tabalong Regency continues to decrease, while contributions from Banjarmasin City and Tabalong Regency continue to increase by 68.35% and 11.57%.

Conclusion

1. The price variation of cayenne pepper and red chili at the consumer level is high and unstable. For cayenne pepper, the coefficient of variation occurs in 2018 and 2021.
2. Market integration in Banjarmasin City, Tabalong Regency and Kotabaru Regency is only integrated in one direction. On the cayenne pepper commodity, it shows that the market in Banjarmasin City influences Tabalong Regency and Tabalong Regency influences Kotabaru Regency.

3. The commodity prices of cayenne pepper in South Kalimantan have a short-term and long-term relationship.
4. When shocks occur, the response shows positive and negative responses and prices in Banjarmasin City make a large contribution to the markets in Kotabaru Regency and Tabalong Regency.

Suggestion

1. The government is generally expected to monitor price developments for food ingredients or food commodities as a whole, so that the Regional Inflation Control Team and Bulog can arrange appropriate arrangements that adapt to conditions, for example famine, religious holidays for prices in order to minimize large fluctuations and high prices cause inflation.
2. Counseling to producers regarding the preparation of planting schedules so as to avoid the risk of crop failure due to high rainfall. The government and agricultural agencies provide guidance and facilities for young farmers or millennial farmers to continue to develop agriculture, especially horticultural products.
3. Further research is needed on the factors influencing price fluctuations and the reasons for the non-integration of markets in South Kalimantan as well as vertical integration of producer to wholesale business actors.

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