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Analysis of the Potential and Volatility of Big Chili and Cayenne Chili After Covid-19 In Yogyakarta City

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ABSTRACT

Chili is a category of 10 agricultural commodities and a staple in Indonesia. Price movements that go up and down or fluctuate are certainly a problem in themselves, where chili as a strategic commodity is one of the main determinants of the dynamics of national inflation. Regarding the policy of protecting farmers with restrictions on chili imports, chili stocks become more stable in the country so that local prices can compete with imported products. This observe uses secondary information obtained from the Bank Indonesia website to determine volatility and potential. The cause of this observe is related to the importance of volatility in big chili and cayenne pepper as well as the potential considering that they are the main commodities in agriculture and price projections in October 2023. This study uses quantitative descriptive analytical tools using ARIMA and GARCH time series models to predict time patterns and calculate potential with Location Quotient (LQ) analysis. This research shows volatility in Big Red Chili and Red Cayenne Chili and shows price forecasting that is experiencing a downward trend.

Keywords: Volatilitas, Cabai, ARIMA, Forecasting

INTRODUCTION

Food is a basic need at every level of society that must be fulfilled because it is related to human rights (Imelda & Nurmapika, 2019). As a primary need, food must be provided in an adequate, safe, nutritious, and top-notch.. Food accessibility and affordability are strategically important for national resilience, economic stability, and community well-being. Therefore, the government sets food security as a priority in national development (Joëts et al., 2017).

However, the biggest challenge that must be faced is fluctuations in food prices, which often occur due to the imbalance between supply and demand. Food demand has grown in tandem with population growth (Y Jasmin & Wibowo, 2020), living standards, and community welfare. Meanwhile, food production and distribution are highly vulnerable to climatic and natural conditions (Gu et al., 2022), the narrowing of agricultural land functions, and international geopolitical conditions. The fluctuation in food prices causes food price volatility, which then affects the gross domestic product (GDP) and inflation. As Furlong said in Lapinskaite & Miecinskiene (2019) that non-oil and gas commodity prices can be a leading indicator of inflation because they can respond quickly, especially to increased demand and economic changes due to disasters.

As one of the agricultural commodities, chili has common characteristics such as being perishable, voluminous, and only produced seasonally (Anisa et al., 2021). The amount of Indonesia's big chili consumption that reaches 636.56 thousand tons in 2022. Meanwhile, cayenne pepper consumption in 2022 was 569.65 thousand tons. (Ministry of Agriculture, 2022). In Yogyakarta City, which is known by its mild streak, the average weekly intake of big chili peppers was 0.028kg in 2022. While the average weekly consumption of cayenne pepper is 0.025kg in 2022.

Chili is recognized as a strategic food commodity because of its enormous consumption and significant influence on the inflation rate. The fluctuation in chili prices is caused by changes in the quantity of chili production. When the supply increases, the price decreases (Brækkan, 2014). The fewer offers, the higher the price. The frequent shifts in chili prices demonstrate volatility, despite the fact that not all chili is volatile (Wibowo, et al., 2023). Volatility is such a measure of statistical changes in the price of a security in a given period that volatility literally means volatility, a condition in which data moves up and down, sometimes even in extreme ways. An analysis of volatility describes the standard deviation or diversity of chili prices that fluctuate over a certain period (Wibowo, et al., 2023). Chili has higher price volatility compared to other agricultural commodities such as tomato and shallot (Brahmana et al., 2022). This is because chili fluctuations are also influenced by import policies. High levels of volatility increase the risk of losses for chili farmers (Kusnaman et al., 2023).

As thus, this study was carried out to forecast chili prices as well as examine the elements which affect chili prices. ARIMA time series data are used for forecasting (Bhinadi, 2019). This method was chosen because it is suitable for

data that has high volatility. Results of this study can be use to predict chili price changes and serve as a basis for the government to decide a suitable strategy to preserve chili price stability.

MATERIALS AND METHODS

A. Data

This study examines the prices of wholesalers of curly red chili, big red chili, green cayenne pepper, and red cayenne pepper commodities in Yogyakarta City. The records used is secondary information received from the country wide strategic meals rate statistics middle (PIHPS), then processed on a weekly time series basis from October 3, 2022, to September 25, 2023. As well as chili production of 14 sub-districts in Yogyakarta City obtained at Statistics of Yogyakarta Municipality.

B. Model Development

The ARIMA (Autoregressive Incorporated shifting average) technique is a technique used for quick time forecasting. The usage of the ARIMA method in brief-time period forecasting is very suitable due to the fact the ARIMA approach has very correct accuarcy. The stage in this study is the stationary unit root test, determining both the ACF and PACF correlograms. Then an ARCH check is performed; if the consequences display a p-value of <5%, afterwards the data contains an ARCH effect, but if the p-value is >5%, then the statistic makes use of ARIMA. After figuring out the appropriate version, forecasting is carried out the use of stage facts.

C. Method

This study used Gretl to conduct night training using the ARCH, GARCH, and ARIMA models. The ARCH and GARCH fashions can be utilized in instances of excessive and occasional information volatility. This situation shows heteroskedasticity because of massive mistakes relying on mistakes within the beyond or editions which have modified.

1. Stationary Test

The ADF (Augmented Dickey-Fuller) Test was used for testing. Assuming the test results identify a p-value < 5%, implying that the data was stationary compared to the mean and variance. Conversely, if the p-value is >5%, it means that the data is not stationary against the mean and variance, so a different process is needed.

2. ARIMA Model Estimation

The ARIMA model is determined by making a correlogram of stationary data and then identifying ACF and PACF patterns to determine the order of ARD (p) and MA (q) of a tentative ARIMA model with patterns (p, d, q). The ARIMA model consists of three models, as follows: First, the autoregressive version (AR) with the overall shape p (AR(p)) or ARIMA (p, 0, 0) is expressed as follows:

$$2+\ldots.+\phi 1X_{t-p}+\ \varepsilon_t$$

Information:

Xt = Data in the t-th period
Fp = Parameter autoregressive pth
Et = Value of error at time t
The Moving Average (MA) Model has a general form of order q (MA(q)) or the ARIMA model (q, 0, 0) which is mathematically expressed as follows:

$$X_t = \phi 1X_{t-1} + \phi 2X_{t-2}+\ldots.+\phi pX_{t-p} + \varepsilon t - 1\varepsilon(t-1) - \Theta 2\varepsilon\ (t-2)-\ldots.-\Theta q\varepsilon(t-q)$$

Information:

Xt = Data on t PeriodFp = P Parameter autoregressive
Θq = Parameter moving average
Et = Value Error at time t

3. Heterokedasticity Test

The heteroscedasticity take a look at is used to test whether the version used carries heteroscedasticity or homoscedasticity. The model contains a heteroscedasticity apablia p-value<5% so that it can be continued with the ARCH/GARCH test.

4. ARCH/GARCH Test

The ARCH-GARCH version is created if the imply version received carries an ARCH impact. The ARCH take a look at is carried out the usage of the Lagrange multiplier check (ARCH-LM) with H0; there is no ARCH error, which is mathematically expressed as follows:

$$\sigma_t{}^2 = y^0 + y_1e^2t_{-1} + \ y_2e^2t_{-2}+\ldots.+y_pe^2t_{-p}$$

The GARCH model is an ARCH model that undergoes variance modification as expressed in the following equation:

$$\sigma_t{}^2 = y^0 + y^{1u^2} t_{-p} + y^2 \sigma^2 t_{-q}$$

5. Forecasting

Forecasting is an activity carried out to forecast future events using historical data projected in the form of mathematical models. Chili price forecasting is useful for anticipating future chili prices and decreasing price uncertainty.

6. Location Quotient (LQ)

To determine the base and non-base sectors in the economy in Yogyakarta City (Manaraja, et al., 2023).

$$LQ = \frac{Si/Ni}{S/N}$$

LQ = Nilai Location Quotient (LQ)
Yes = Production Sector i in Sub-District
S = Total Production in Sub-District
Ni = Production Sector i in Yogyakarta City
N = Total Production in Yogyakarta City

If LQ >1, it can be interpreted that sector i in Yogyakarta City is a superior sector that is able to export to other regions and vice versa.

RESULTS AND DISCUSSION

A. Big Red Chili

The price of red chili has decreased significantly. This is due to the recovery of the supply chain and distribution chain of big red chili. However, the decline is not constant. Figure 1 shows fluctuating price movements, so it can be concluded that the price of big red chilies in Yogyakarta City has volatility. The highest jump occurred in the second quarter, influenced by an increase in demand for big red chilies ahead of Eid al-Fitr.

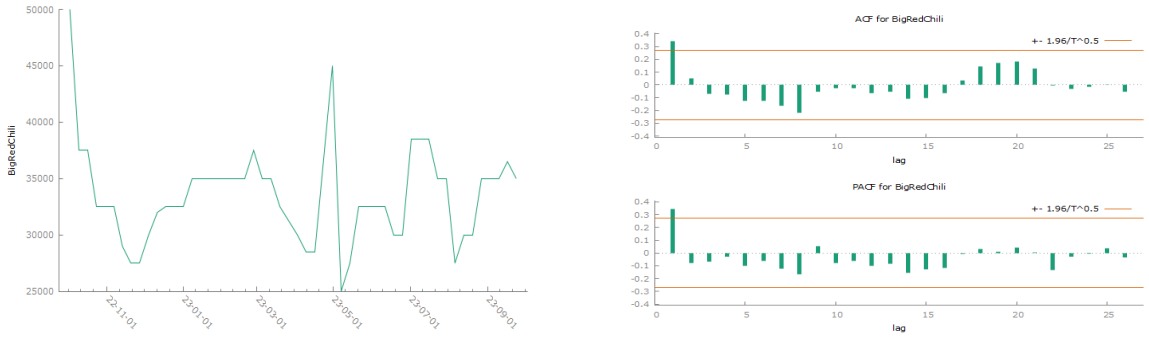


Figure 1. Big Red Chili Price Movement

The unit root test using Augmented Dickey-Fuller at the level data yields a probability of 0.000005458, which is higher that 5%. It can be concluded that the stationer results against the mean and variance at the level level. Identification was also accomplished by plotting both the ACF and PACF. The figure above shows that ACF and PACF intersect in Lag 1.

Table 1. ARIMA Big Red Chili

MODEL ARIMA	AIC
(1,0,1)	1015.813
(0,0,1)	1014.616
(1,0,0)	-
(0,0,0)	1021.544

The table above shows the estimation results of the ARIMA model. The ARIMA model (0, 0, 1) is the most ideal model because it has the lowest Akaike Criterion (AIC) value, which is 1014.616. Then test the LM to identify the effect of ARCH on the model. There is no ARCH error considering hypothesis (H0). If the p-value is greater than 5%, it can be

stated that the model has no ARCH effect. The heterokedasticity test findings confirm that the p-value is more than 5%, illustrating that the ARIMA model (0, 0, 1) does not have an ARCH effect, so that the ARCH-GARCH model.

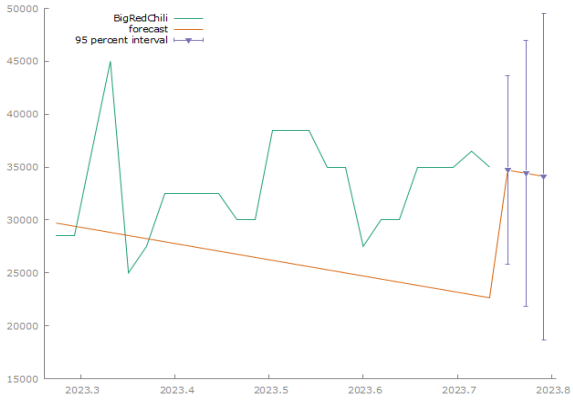


Figure 2. Price Forecasting of Big Red Chili

The forecasting results show that the price has a downtrend and will decline until the first three weeks of October 2023.

Curly red chili

At the beginning of the curve, the curly red chili price is rising significantly. But then the price movement of curly red chili in Yogyakarta City experienced ups and downs.

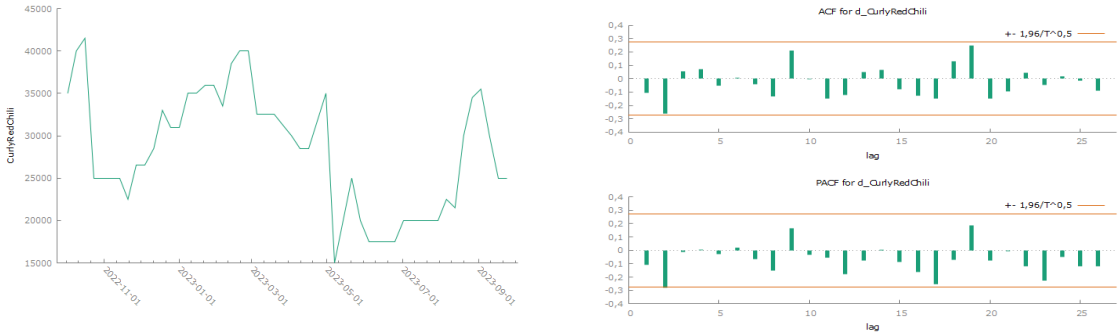


Figure 3. Curly Red Chili Price Movement

A p-value of 0.1069 > 5% was shown from the root test using Augmented Dickey-Fuller on the level data. This indicates that the results are not stationary at level, requiring a differencing method. After the first differencing process, it was found that the p-value of curly chili in Yogyakarta City is 0.00000001707 < 5%.

It can be concluded that the stationary results are both mean and variance at the level of first difference. Furthermore, identification was carried out by plotting ACF and PACF. Based on the plotting results, there was no intersection between ACF and lag, while the intersection between PACF and lag occurred in lag 2.

Therefore, it can be concluded that the intersection of lag occurs infinitely (μ). This indicates a lack of significance among the variables. In the analysis, the infinity value does not need to be considered because it does not provide useful information in determining the right time series model.

Red Cayenne Chili

The price of red cayenne pepper dropped in the first quarter following the Covid-19 outbreak. The highest price surge occurred in the second quarter of 2023. This happened due to increasing consumer demand ahead of Eid al-Fitr.

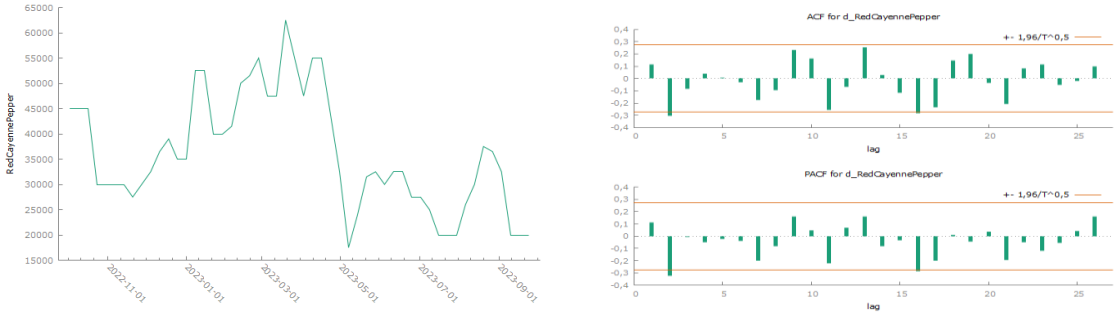


Figure 4. Red Cayenne Chili Price Movement

The Augmented Dickey-Fuller test found a p-value of 0.3118 > 5% for the root test at the level data. It can be concluded that the results are not stationary at the level level so it is necessary to carry out a differencing. After the first differencing process, it was found that p-value is 0.00000272 < 5% so that the stationary results on means and variance at the first difference level can be concluded. ACF and PACF plotting was then carried out to identify lags. The plotting results showed that the intersection between ACF and PACF to lag occurred in lag 2. Furthermore, the ARIMA test is performed to determine the best model for forecasting; the table test below illustrates outcomes of the ARIMA model estimation. The ARIMA model (0, 1, 1) is the most ideal model because it has the lowest AIC value, which is 1031,714.

Table 2. ARIMA Red Cayenne Chili

MODEL ARIMA	AIC
(0,1,0)	1054,532
(1,1,0)	1052,997
(2,1,0)	1042,217
(0,1,1)	1031,714
(1,1,1)	1032,853
(2,1,1)	1032,853
(0,1,2)	1031,768

Next, a LM test is performed to identify the effect of ARCH on the model. Following to the heterokedasticity test outcomes, the p-value is 0.416195 > 5%, which implies that the model of ARIMA (0, 0, 1) contains no ARCH effect along with the ARCH-GARCH method.

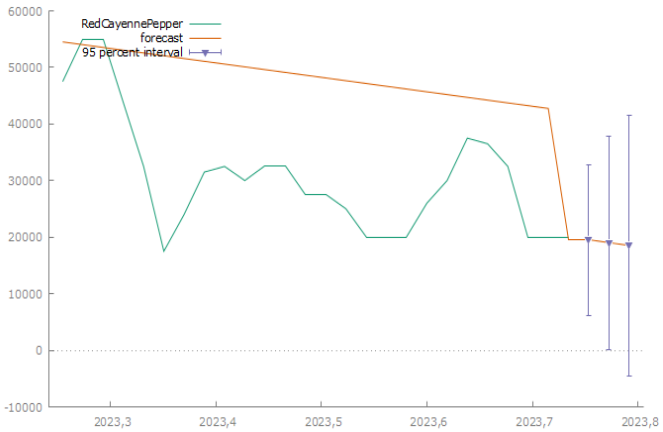
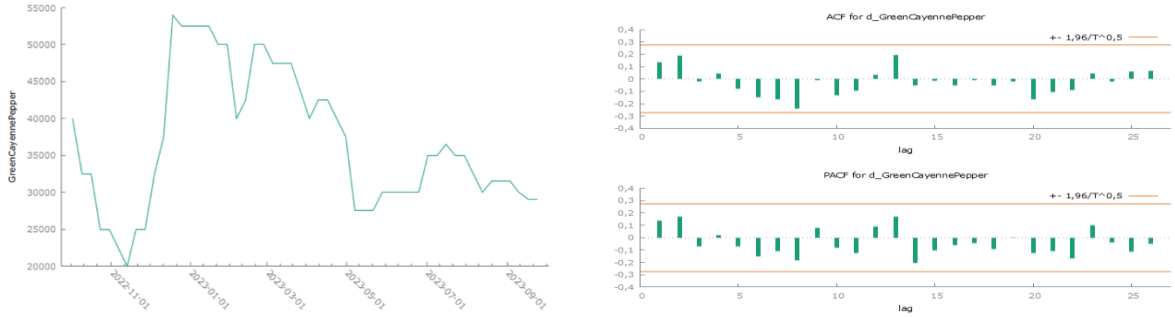


Figure 5. Red Cayenne Chili Price Forecasting

The findings of the red cayenne pepper price forecast indicate that the price of red cayenne pepper is experiencing a downturn in trend. The price of red cayenne pepper is expected to fall in the following three weeks.

B. Green Cayenne Chili

The price of green cayenne pepper after the Covid-19 pandemic experienced a downturn trend. A high spike had occurred at the end of 2022, but subsequently the price of green cayenne pepper fell.



On the level data, the root test through Augmented Dickey-Fuller identified a p-value of 0.1069 > 5%. This indicates the findings are not stationary at the level, thus a differentiating process is needed. Following the first differencing phase, the p-value of curly chili in Yogyakarta City was determined to be 0.00000001707 < 5%. The result is stationary. Moreover, identification was accomplished by plotting the ACF and PACF. Based on the plotting results, there was no intersection between ACF and lag, while the intersection between PACF and lag occurred in lag 2. Therefore, it can be concluded that the intersection of lag occurs infinitely (ì). This proves there is a lack of connection among variables, and the lag is quite long. The infinite result cannot be considered in the analysis of ACF and PACF because it offers no useful information in establishing the ideal time series model.

The Potential of Big Chili and Cayenne in Yogyakarta City Based on District

According to the LQ table 3, there are only two sub-districts which have bases, namely Mergangsan and Gondomanan, while the remaining sub-districts having non-base sectors.

Table 3. LQ of cayenne pepper per sub-district in Yogyakarta City

Subdistrict	2018	2019	2020	2021	2022	LQ Average	Category
Mantrieron	-	-	-	-	1.50	0.30	Non base
Kraton	-	-	-	-	-	-	
Mergangsan	-	-	-	-	5.61	1.12	Base
Umbulharjo	-	-	-	3.12	0.14	0.65	Non base
Cowed	-	-	-	-	1.79	0.36	
Gondongkusuman	-	-	1.64	0.29	0.24	0.44	
Danurejan	-	-	-	-	0.43	0.09	
Pakualaman	-	-	-	-	2.69	0.54	
Gondomanan	-	-	-	-	10.69	2.14	Base
Ngampilan	-	-	-	-	-	-	Non base
Wirobrajan	-	-	3.22	1.09	-	0.86	
Gedongtengen	-	-	-	-	1.31	0.26	
Jetis	-	-	-	-	0.18	0.04	
Tegalrejo	-	-	-	0.98	1.86	0.57	

In table 4, only four of the sub-districts remained bases, including Mantrijeron, Gondomanan, Gedongtengen, and Jetis, while the remaining sub-districts were non-base sectors.

Table 4. LQ Big Chili per District in Yogyakarta City

Subdistrict	2018	2019	2020	2021	2022	LQ Average	Category
Mantrieron	-	-	-	-	7.51	1.50	Base
Kraton	-	-	-	-	-	-	Non Base
Mergangsan	-	-	-	-	-	-	
Umbulharjo	-	-	-	-	-	-	
Cowed	-	-	-	-	1.09	0.22	
Gondongkusuman	-	-	-	-	-	-	
Danurejan	-	-	-	-	-	-	
Pakualaman	-	-	-	-	-	-	
Gondomanan	-	-	-	-	21.55	4.31	Base
Ngampilan	-	-	-	-	-	-	Non Base
Wirobrajan	-	-	-	-	-	-	
Gedongtengen	-	-	-	-	7.54	1.51	Base
Jetis	-	-	-	-	22.93	4.59	
Tegalrejo	-	-	-	-	-	-	Non Base

CONCLUSION

In this study related to big chilies and cayenne peppers in Yogyakarta City, the following conclusions can be drawn:

1. Volatility in Big Red Chili, Curly Red Chili, Red Cayenne Pepper and Green Cayenne Pepper.
   a. Price volatility on Big Red Chili after the Covid-19 pandemic: the best model chosen is ARIMA.
   b. Price volatility on Curly Red Chili after the Covid-19 pandemic, the best model selected is infinity. This can be considered as the Curly Red Chili price not providing meaningful information for selecting a suitable time series model.
   c. Price volatility in Red Cayenne Pepper after the Covid-19 pandemic, the best model selected is ARIMA.
   d. Price volatility in Green Cayenne Pepper after the Covid-19 pandemic: the best model chosen is infinity. This can be interpreted as the price of Green Cayenne Pepper does not provide useful information in determining the proper model time series.
2. The price of Big Red Chili and Red Cayenne Chili tends to undergo a downturn in predicting results, with prices decreasing from the previous quarter.
3. The prospect of Big Chili and Cayenne Pepper within Yogyakarta City is above average, while almost all of sub-districts are still designated as non-base, which means that chili production is still imported from different regions.

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