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PRICE VOLATILITY OF RED CHILI PEPPERS IN CENTRAL JAVA

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ABSTRAK

Cabai merah besar merupakan komoditas strategis nasional karena berpengaruh besar terhadap inflasi. Jawa Tengah merupakan salah satu sentra produsen cabai merah besar di Indonesia, namun produksi dan luas panennya cenderung mengalami penurunan pada Tahun 2017-2019. Oleh karena itu, volatilitas harga red chili peppers di tingkat produsen dan konsumen perlu dianalisis. Berdasarkan hasil tersebut kemudian dapat dirumuskan strategi stabilisasi harga cabai merah besar di Jawa Tengah. Penelitian ini menggunakan data sekunder berupa data deret waktu (*time series*) yaitu harga bulanan konsumen dan harga produsen cabai merah (Rp/kg) di Jawa Tengah pada Tahun 2006-2018. Hasil penelitian ini menunjukkan bahwa hanya harga di tingkat konsumen yang mengandung unsur volatil, sedangkan harga di tingkat produsen tidak memiliki unsur volatil. Volatilitas harga di tingkat konsumen di masa depan akan semakin kecil, namun akan berlangsung dalam waktu yang lama. Berdasarkan hasil penelitian tersebut, maka perumusan strategi stabilisasi harga cabai merah besar di Jawa Tengah, yaitu diseminasi teknologi inovatif untuk mengurangi gagal panen saat *off season,* pengaturan pola tanam, penguatan sistem kelembagaan kemitraan yang saling menguntungkan, perbaikan sistem logistik, perbaikan manajemen distribusi, pengembangan fasilitas gudang pendingin *(cold storage)* dan diseminasi teknologi pascapanen untuk cabai kering, dan pembatasan impor cabai.

Kata Kunci: *fluktuasi, harga produsen, harga konsumen, strategi*

ABSTRACT

Red chili peppers are an essential commodity because it affects inflation. Central Java is a province of one of the main producers of red chili peppers in Indonesia. Yet, the production and land area are decreasing in the period 2017-2019. The research was carried out to analyze the volatility of producer prices and consumer prices of red chili peppers. Based on the research results, it could be formulated the strategy to stabilize the price of red chili peppers in Central Java. This research used secondary data which was time-series data of monthly consumer price and producer price of red chili from 2006 to 2018. The result showed that only consumer price experienced the volatile, while the producer price had no volatility. The volatility of red chili peppers in the future would be lower, but the shock on the variant of price would occur for a long time. By following the research results, the strategy to stabilize the price of red chili peppers, i.e. dissemination of innovative technology to reduce the crop failure at the off-season, management of crop pattern, development the win-win solution of partnership and stakeholder system, development of logistic management, development of distribution systems, development the cold storage, dissemination of post-harvest technology for dry chili, and restriction of chili import.

Keywords: *fluctuation, producer price, consumer price, strategy*

INTRODUCTION

Red chili peppers cultivated in Central Java support domestic demands by 14.24%, making this commodity have a strategic role in regional economic development (BPS, 2019). However, the red chili harvested area in Central Java has a tendency to reduce in 2017-2019. This condition was also followed by a decline in the production of red chili peppers because of weather and climate factors, leading to a decline in productivity (Figure 1).

Hamilton et al. (2020) and Bene (2020) emphasized that shocks in the supply chain as a result of natural factors can make price spikes and food supply changes. Besides, the length of the supply chain of red chilies can lead to a high level of damage to the commodity. Therefore, this results in high sorting costs and affects high selling prices at the final consumer level. Aimin (2010) explained that farming is encountered with a high risk of uncertainty emerging from uncontrollable factors, including weather and climate.

The harvested area of red chili peppers has a tendency to reduce year by year because of the decreased interest of farmers in cultivating red chili peppers as the price tends to be unstable and even leads to economic losses. The imbalance of production and consumption of red chili peppers is the cause of fluctuations in the price of red chili peppers. Lepetit (2011); Timmer (2011); and Tadasse et al. (2016) confirmed that red chili peppers are one of the elements forming inflation caused by high price fluctuations in particular seasons.

Price volatility in red chili peppers happens every year and is also experienced by other regions in Indonesia. However, there has been no concrete solution offered by the government to overcome this issue (Anwarudin et al. 2015). Laila et al (2017) measured the price volatility of red chili in East Java which was motivated by high price fluctuations, resulting in high farming risk. The same issue also happens in West Kalimantan. Food price volatility affects farmers' income as red chili peppers producers (Nurmapika et al. 2018). Fluctuations in the price of red chili peppers are not only an issue at the micro-level but also an issue on a national level. Sumantri et al. (2017) investigate the price volatility of red chili peppers on the national scale as it is one of the strategic commodities in Indonesia.

Conversely, price instability not only threatens national food security but also can cause social unrest, political turmoil, and the sustainability of the national economy (Kalkuhl et al., 2016; Bellemare, 2014; Rotz and Fazer, 2015; d'Errico et al., 2018; Richardson et al., 2018; Arndt et al., 2016). Therefore, a real solution is required to formulate a price stabilization strategy for red chili peppers in Central Java.

Generally, this study aims to formulate a strategy to improve the competitiveness of red chili peppers in Central Java through a volatility analysis approach.

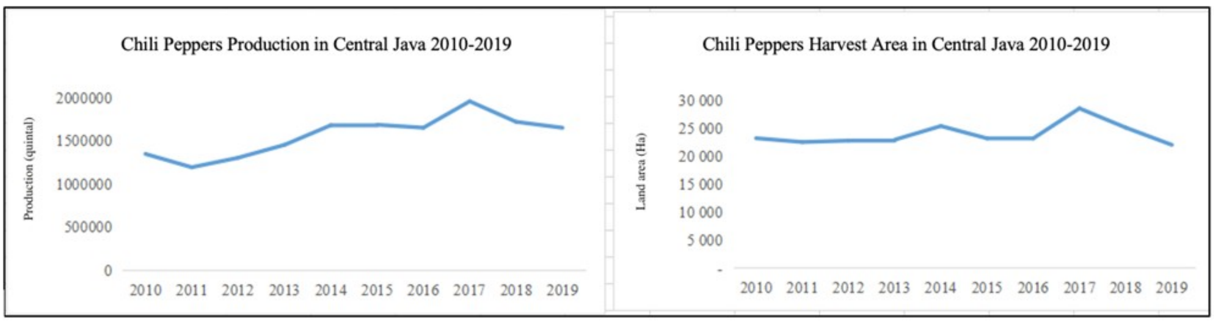


Figure 1. Dynamics of chili peppers production and harvested area in Central Java 2010-2019

The use of this approach was motivated by the issues of red chili peppers agribusiness in Central Java, one of which was caused by high price fluctuations. Based on this description, the formulation of the research problems to be answered in this study include (1) analyzing the volatility of producer price and consumer price of red chili peppers in Central Java, and (2) formulating a price stabilization strategy for red chili peppers in Central Java.

RESEARCH METHOD

Research Framework

The price of red chili peppers in Central Java fluctuated in 2010-2018, which leads to uncertainty for farmers in receiving income. Therefore, research is necessary to analyze the price volatility of red chili peppers both at the consumer and producer levels to obtain a complete overview of the price fluctuations of red chili peppers in Central Java. Based on the findings of the analysis and the literature study, a price stabilization strategy for red chili peppers in Central Java can be formulated. Overall, the research framework of this study is described in Figure 2.

Research Site and Time

This study focused on Central Java Province as one of the red chili peppers-producing locations in Indonesia. However, production and the harvested area had a tendency to decrease in 2017-2019. One of the contributing factors was the decreased interest of farmers in cultivating red chili peppers because of the unstable price, which often results in economic losses. This study was conducted in July 2020.

Methods of Data Collection

The data utilized in this study was secondary data sourced from the Statistics Indonesia (BPS). This study utilized time-series data on monthly consumer prices and producer prices of red chili peppers (IDR/kg) in Central Java Province for thirteen years from January 2006 to December 2018 consisting of 156 observations for each price level.

Producer prices obtained from rural producer prices formed based on transactions between farmers (producers) and buyers (collectors/middlemen) which were obtained covering all provinces in Indonesia except DKI Jakarta (32 provinces). Consumer prices are prices obtained from rural consumers in all 32 provinces in Indonesia, except DKI Jakarta. The areas were covered 32 provinces, including: Nanggroe Aceh Darussalam, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, Bangka Belitung, Riau Islands, West Java, Central Java, DI Yogyakarta, East Java, Banten, Bali, West Nusa Tenggara, East Nusa Tenggara, West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan, North Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi, Gorontalo, West Sulawesi, Maluku, North Maluku, West Papua and Papua.

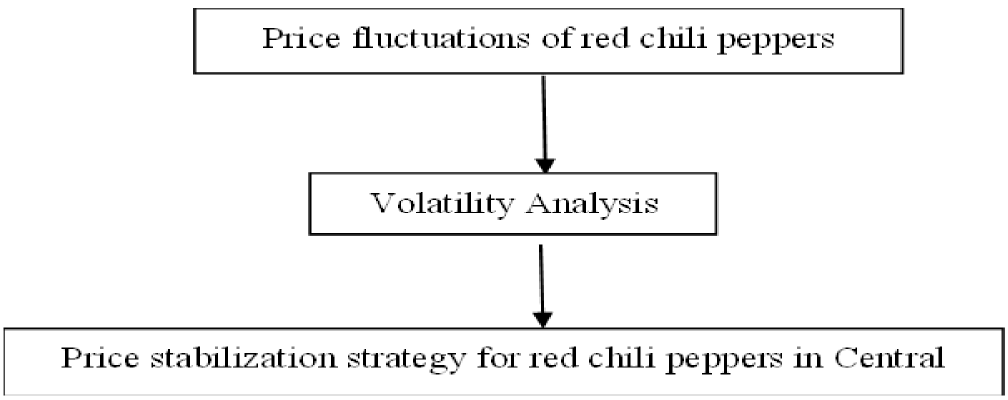


Figure 2. Research Framework

Methods of Data Analysis

Analysis of monthly volatility at the consumer price and producer price levels of red chili peppers in this study employed the ARCH/GARCH model approach and was processed using Eviews 9 software. The formulation of the red chili peppers stabilization strategy was achieved through descriptive analysis according to the results of the analysis and literature study. The stages of volatility analysis employing the ARCH-GARCH model include (Zhang and Choudhry 2013):

1 Stationary Test *(Unit Root Test)*

Stationary data testing was performed to examine the consistency of the movement of time series data and to avoid spurious regression. A stationary test was performed using Augmented Dicky Fuller Test (ADF). If the *t*-statistic value in the ADF test is less than the critical point value, the data is not stationary and required to be differentiated.

2 ARIMA Estimation

Estimation of the autoregressive integrated moving average (ARIMA) model was performed based on the correlogram, which was the autocorrelation function (ACF) and partial autocorrelation function (PACF) patterns from stationary data to determine AR order (p) and MA order (q) from an ARIMA model (p, d, q). Order d was data that has been set according to the stationarity of the data. The criteria for selecting the best ARIMA model were according to the smallest Akaide Information Criteria (AIC) and Schwatrz Criterion (SC). A heteroscedasticity test was employed to find out whether there is a heteroscedasticity issue, indicating based on the Obs*R-Squared value for the producer prices and consumer prices of red chili peppers which is greater than the F-statistic value of the ARCH test. If the probability value is less than the test level, then H0 is rejected and H1 is accepted. it means that there is a heteroscedasticity issue at the level of confidence according to the test level.

3 ARCH Effect Test

The ARCH effect test employed using the Lagrange Multiplier test (ARCH-LM test) to make sure that the GARCH model no longer contains heteroscedasticity elements. The ARCH effect test was examined from the F-statistical probability value. When prob. F-statistic > 0.05, then the model is free from the effect of ARCH, making it no longer needs to be modeled with ARCH/GARCH. If there is an ARCH effect, then the simulation of a number of variance models utilizing the best ARIMA model needs to be carried out. It was then proceeded by estimating the model parameters to determine the model coefficients that best fit the data.

4 Volatility Analysis

The calculation of the volatility was indicated by the standard deviation value of the square root of the estimated variance of the ARCH/GARCH model. The ARCH model contained two variance components that relied on the volatility of the previous period. If the volatility in the previous period was high, then the variance at this time will also be high. The higher the value of volatility, the more likely the price will increase or decrease drastically and vice versa. The general formulation of the ARCH(m) model is as follows:

$$ht = \xi+\alpha_0\varepsilon^2_t+\alpha_1\varepsilon^2_{t-1}+\alpha^2\varepsilon_{t-2}+\ldots..+\alpha_m\,\varepsilon^2_{t-m}$$

Notes:

ht = variance at time of t

ξ = constant variable

ε^2_{t-m} = volatility in the previous period (ARCH rate)

$\alpha_0, \alpha_1, \ldots, \alpha_m$ = estimated coefficient of order m

The GARCH model was developed by integrating autoregression obtained from the second lag residual square into the variance form in the first lag. This model was developed as a generalization of the volatility model. Volatility according to the GARCH (r,m) model expects that the variance of the fluctuation data is affected by several m previous fluctuation data and several r previous volatility data (Eliyawati et al. 2014). The general form of the GARCH model (r, m) include:

$ht = k+\delta_1 h_{t-1}+\delta_2 h_{t-2}+\ldots\ldots+\delta_r h_{t-r}+\alpha_1\varepsilon^2_{t-1}+\alpha_2\varepsilon^2_{t-2}+\ldots\ldots+\alpha_m\varepsilon^2_{t-m}$

Notes:

ht = variance at time of t

k = constant variance

ε^2_{t-m} = volatility in the previous period (ARCH rate)

h_{t-r} = variance in the previous period (GARCH term)

$\alpha_1, \alpha_2, \ldots, \alpha_m$ = estimated coefficient of order m

$\delta_1, \delta_2, \ldots, \delta_r$ = estimated coefficient of order r

RESULT AND DISCUSSION

Volatility Analysis of producer and consumer prices in Central Java in 2006-2018

Figure 3 shows the trend of monthly red chili peppers movements for consumers and producer prices in Central Java in 2006-2018. Consumer prices tended to be stable from 2006 to 2016. High price fluctuations happened at the level of producer prices. A high disparity between consumer prices and producer prices also occurred from 2009 to 2016. This condition indicates that high producer prices tend not to be favored by farmers as the primary actor providing red chili peppers.

Miftahuljanah et al. (2020) explained that price fluctuations occurred at the consumer level. However, at the producer level, prices tended to be stable, showing that farmers as red chili peppers producers were price takers or a party that could not control whether the prices increase or decrease. Fluctuations in chili peppers prices are definitely more detrimental to farmers than traders as farmers cannot control the time of sale to obtain a more profitable selling price.

Even though traders have provided value-added activities to products, including transportation costs, packaging, and other costs, farmers remain to have a weaker bargaining position than other actors in the agribusiness chain of chili peppers in determining the selling price of their crops. It is because of the lack of information on selling prices transmitted to farmers. The price information is one of the critical issues in the value chain.

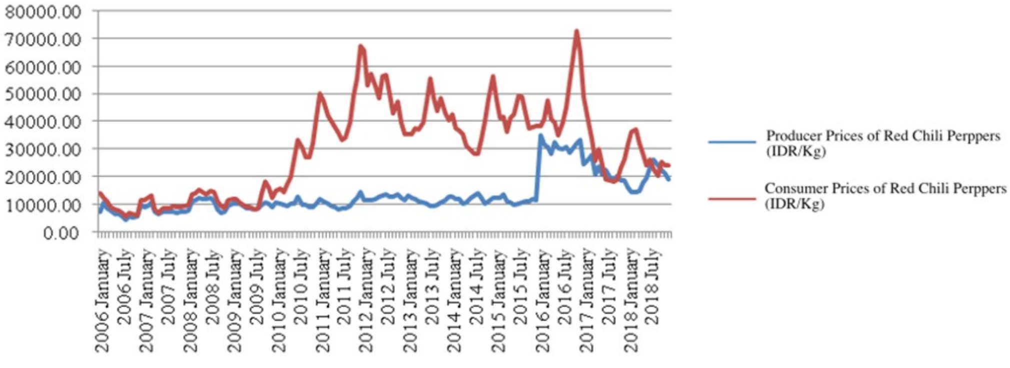


Figure 3. The dynamics of producer and consumer prices of red chili peppers in Central Java in 2006-2018

Table 1. Stationary data test results with the ADF method

Variables	Unit Root Test	ADF Value	*critical MacKinnon* (5% test level)	Prob.*
Red chili peppers producer prices	Second difference	-13.02642	-2.880591	$3.45.10^{-20}$
Red chili peppers consumer prices	First difference	-7.904091	-2.880591	$5.78.10^{-11}$

Source: Secondary data (processed using Eviews 9.0)

The Indonesian Logistics Association (2009) emphasized that the imbalance in information control between agricultural business actors happens starting from production activities to final marketing actors. In many instances, price information at the consumer level is not transmitted as fast as possible to all business actors. Therefore, there is always a disadvantaged party. Farmers as producers are actors with the biggest losses in this case.

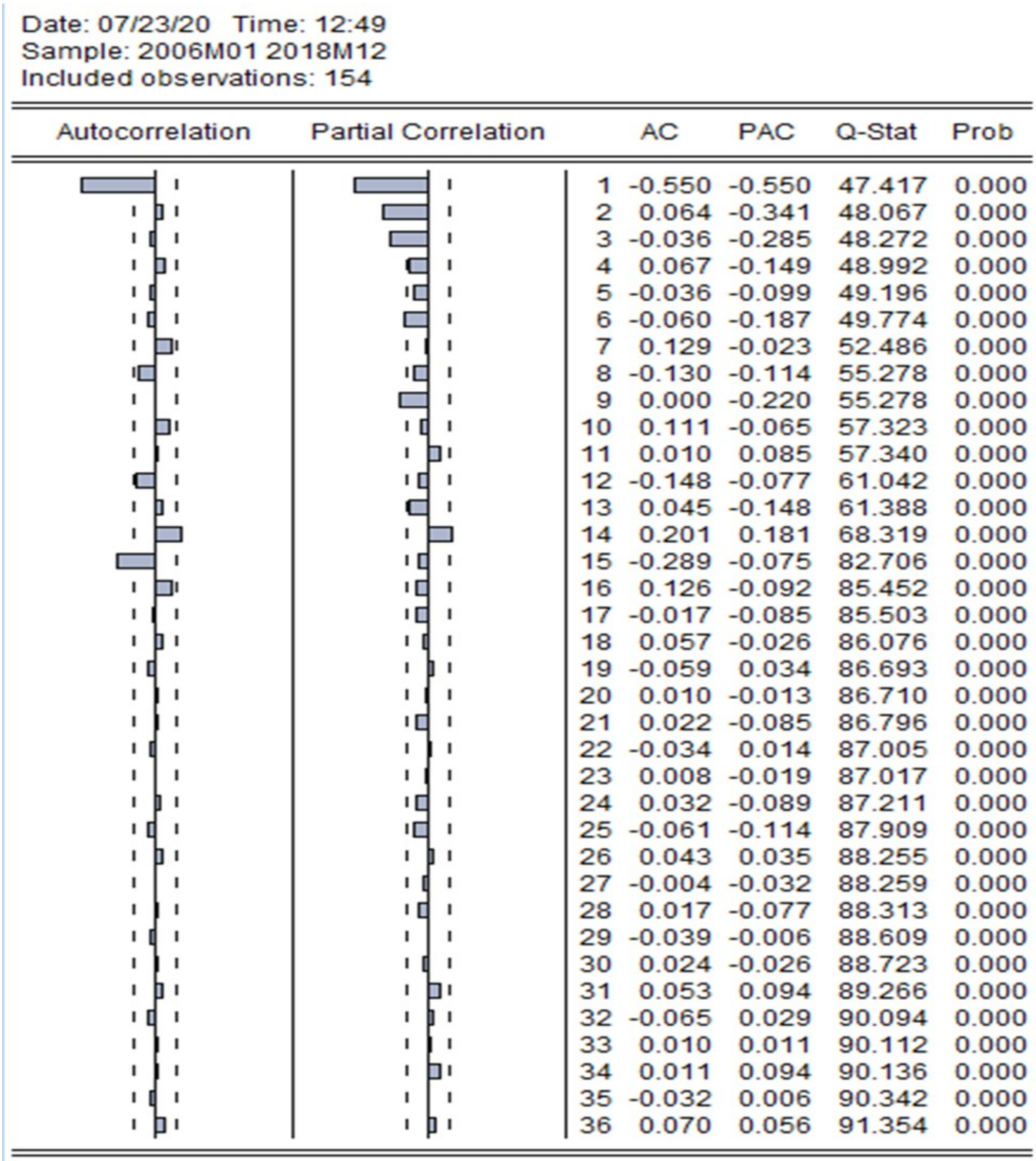
Stationary Test (Unit Root Test)

In the stage of analysis of the price volatility of red chili peppers, the findings of the stationary test of data of red chili peppers prices at the producer and consumer level were analyzed employing the Augmented Dickey-Fuller (ADF) test. The price of red chili peppers at the consumer level was performed in the form of a first difference while that at the producer level was performed in the second difference. Although the ADF *t*-statistic at the level of producer prices was higher than the critical MacKinnon value, the results of the correlogram at the first difference reveal that there is no ARIMA model as the correlogram image in lag 1 has shown a cut-off. It indicates that there was no ARIMA model in lag 1. Therefore, a second difference was utilized to obtain a better model.

Table 1 presents the results of a stationary test at the level of producer and consumer prices of red chili peppers utilizing the ADF method, which was stationary with the indicated value of Prob.* less than 5% and the ADF value less than the critical MacKinnon (5% test level). According to the results of the stationary test, order d was obtained, including 2 at the producer price of red chili peppers and 1 at the consumer price of red chili peppers. The stationarity of the data might determine the degree of integration in forming the next ARIMA model.

Estimation of ARIMA

Once the stationary data utilized the ADF test, the ARIMA model could be determined. Determination of the tentative ARIMA model was performed according to the ACF and PACF patterns on the correlogram to determine the AR order (p) and MA order (q). Figure 4 presents the behavior of ACF and PACF on producer prices of red chili peppers in Central Java in 2006-2018 utilizing the second difference unit root test. Based on the results of the correlogram on the second difference in the producer price of red chili peppers, it indicates that the ACF had cut off at the 2nd lag, which means that the MA (1) model would be tested. PACF had also shown a cut-off in the 4th lag, which means AR (1) – AR (4) models would be tested. Based on the results of the correlogram, the ARIMA that would be tested included ARIMA (1,2,0), ARIMA (2,2,0), ARIMA (3,2,0), ARIMA (4,2,0), ARIMA (0,2,1), ARIMA (1,2,1), ARIMA (2,2,1), ARIMA (3,2,1), and ARIMA (4,2,1).



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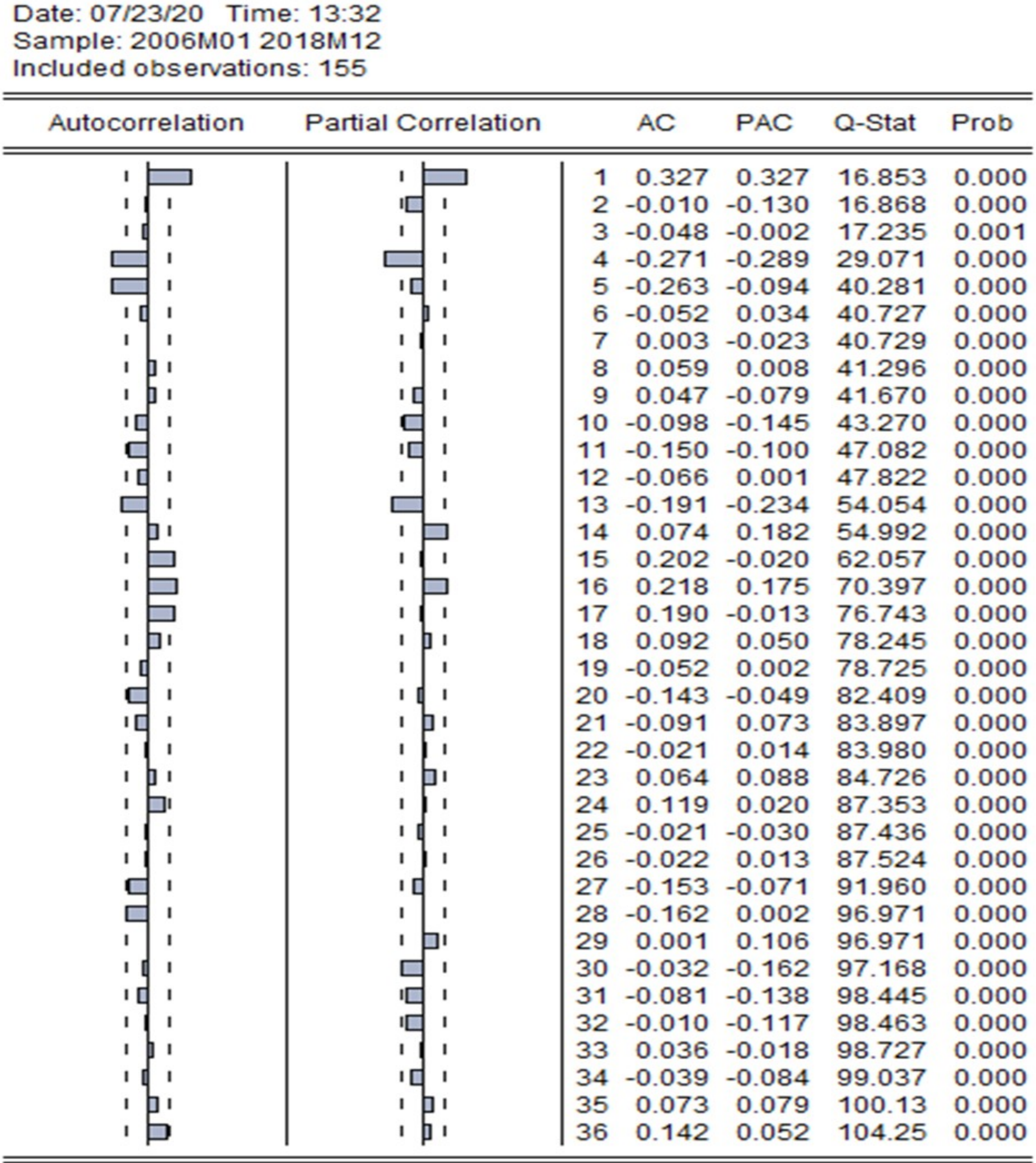
Sample: 2006M01 2018M12
Included observations: 154

	AC	PAC	Q-Stat	Prob
1	-0.550	-0.550	47.417	0.000
2	0.064	-0.341	48.067	0.000
3	-0.036	-0.285	48.272	0.000
4	0.067	-0.149	48.992	0.000
5	-0.036	-0.099	49.196	0.000
6	-0.060	-0.187	49.774	0.000
7	0.129	-0.023	52.486	0.000
8	-0.130	-0.114	55.278	0.000
9	0.000	-0.220	55.278	0.000
10	0.111	-0.065	57.323	0.000
11	0.010	0.085	57.340	0.000
12	-0.148	-0.077	61.042	0.000
13	0.045	-0.148	61.388	0.000
14	0.201	0.181	68.319	0.000
15	-0.289	-0.075	82.706	0.000
16	0.126	-0.092	85.452	0.000
17	-0.017	-0.085	85.503	0.000
18	0.057	-0.026	86.076	0.000
19	-0.059	0.034	86.693	0.000
20	0.010	-0.013	86.710	0.000
21	0.022	-0.085	86.796	0.000
22	-0.034	0.014	87.005	0.000
23	0.008	-0.019	87.017	0.000
24	0.032	-0.089	87.211	0.000
25	-0.061	-0.114	87.909	0.000
26	0.043	0.035	88.255	0.000
27	-0.004	-0.032	88.259	0.000
28	0.017	-0.077	88.313	0.000
29	-0.039	-0.006	88.609	0.000
30	0.024	-0.026	88.723	0.000
31	0.053	0.094	89.266	0.000
32	-0.065	0.029	90.094	0.000
33	0.010	0.011	90.112	0.000
34	0.011	0.094	90.136	0.000
35	-0.032	0.006	90.342	0.000
36	0.070	0.056	91.354	0.000

Figure 4. ACF and PACF behavior of producer price data of red chili peppers in Central Java in 2006-2018

Figure 5 reveals the behavior of PACF and ACF on consumer prices of red chili peppers in Central Java in 2006-2018. The results of the correlogram indicate that in the first difference ACF had shown a cut-off in the 2nd lag, which means that the MA model (1) would be tested. PACF had also shown a cut-off in the 2nd lag which means that the AR (1) model would be tested. The ARIMA model that would be tested on the variable of consumer prices of red chili peppers in Central Java included ARIMA (1,1,0), ARIMA (0,1,1), and ARIMA (1,1,1).

According to the tentative ARIMA model established, the best ARIMA model was selected based on the Akaike Information Criteria (AIC) and Schwatrz Criterion (SC) values.


Date: 07/23/20 Time: 13:32
Sample: 2006M01 2018M12
Included observations: 155

	AC	PAC	Q-Stat	Prob
1	0.327	0.327	16.853	0.000
2	-0.010	-0.130	16.868	0.000
3	-0.048	-0.002	17.235	0.001
4	-0.271	-0.289	29.071	0.000
5	-0.263	-0.094	40.281	0.000
6	-0.052	0.034	40.727	0.000
7	0.003	-0.023	40.729	0.000
8	0.059	0.008	41.296	0.000
9	0.047	-0.079	41.670	0.000
10	-0.098	-0.145	43.270	0.000
11	-0.150	-0.100	47.082	0.000
12	-0.066	0.001	47.822	0.000
13	-0.191	-0.234	54.054	0.000
14	0.074	0.182	54.992	0.000
15	0.202	-0.020	62.057	0.000
16	0.218	0.175	70.397	0.000
17	0.190	-0.013	76.743	0.000
18	0.092	0.050	78.245	0.000
19	-0.052	0.002	78.725	0.000
20	-0.143	-0.049	82.409	0.000
21	-0.091	0.073	83.897	0.000
22	-0.021	0.014	83.980	0.000
23	0.064	0.088	84.726	0.000
24	0.119	0.020	87.353	0.000
25	-0.021	-0.030	87.436	0.000
26	-0.022	0.013	87.524	0.000
27	-0.153	-0.071	91.960	0.000
28	-0.162	0.002	96.971	0.000
29	0.001	0.106	96.971	0.000
30	-0.032	-0.162	97.168	0.000
31	-0.081	-0.138	98.445	0.000
32	-0.010	-0.117	98.463	0.000
33	0.036	-0.018	98.727	0.000
34	-0.039	-0.084	99.037	0.000
35	0.073	0.079	100.13	0.000
36	0.142	0.052	104.25	0.000

Figure 5. ACF and PACF behavior of consumer price data of red chili peppers in Central Java in 2006-2018

Table 2 reveals the ARIMA model selected for the variable of producer price of red chili peppers was ARIMA (4,2,0) and that for the variable of consumer prices of red chili peppers was ARIMA (0,1,1). The selected ARIMA model had fulfilled the required criteria, including having the smallest AIC and AC values. According to the heteroscedasticity test, the variable of producer prices of red chili peppers price did not have an ARCH effect or the ARIMA model was sufficient without adding ARCH to the model. It indicates that there was no volatile element in producer prices of red chili peppers in ARIMA (4,2,0).

These results are in line with the study conducted by Erviana et al. (2020) which shows that producer prices of red chili peppers did not follow the price movements occurring at the wholesale and consumer levels.

Table 2. The model of average producer prices and consumer prices of red chili peppers in the best ARIMA model

Parameter	Variables	
	Red chili peppers producer prices (ARIMA (4,2,0))	Red chili peppers consumer prices (ARIMA (0,1,1))
Sig	√	√
AIC	18.78642	19.62029
SC	18.90474	19.67919
Autocorrelation	-	-
Heteroscedasticity (ARCH)	-	√
AR (4)	-0.164998	-
MA (1)	-	0.399284

Source: Secondary data (processed using Eviews 9.0)

It indicates that producer prices tend to be more stable than consumer prices. Regarding consumer prices of red chili peppers, there was an error in the ARCH model or the data was inhomogeneous. Therefore, for the variable of consumer prices of the red chili peppers in the ARIMA model (0,1,1), an ARCH/GARCH model was required to handle this condition.

ARCH Effect Testing

The results of the heteroscedasticity test show that the Prob value (F-statistics) on the variable of producer prices of red chili peppers was 0.848794 or greater than the test level of 0.05, indicating that there was no ARCH effect on the model. Therefore, there was no need to continue the ARCH effect testing. It means that the producer prices of red chili peppers did not contain volatile elements. The variable of consumer prices reveals that the Prob value (F-statistic) was 0.0000 or less than the test level of 0.05, indicating that the ARCH effect testing was required because it contained volatile elements. Under different conditions, the variable of consumer prices of the red chili peppers could proceed to the ARCH effect testing stage.

The findings of this study are in line with studies conducted by Pradana (2019) and Nurmapika et al. (2018) showing that there was a volatile element in the retail prices of red chili peppers in Banda Aceh and Pontianak Cities, but it did not occur for the producer prices.

The next stage was determining the proper ARCH/GARCH model by simulating a number of variance models utilizing the best ARIMA model that had been achieved. The criteria for the best ARCH GARCH model include having the smallest SC and AIC values, having a significant coefficient, and the coefficient of variance and residuals are not more than one and not negative. The model being tested was ARIMA – ARCH GARCH (0,1,1) (1,0), ARIMA – ARCH GARCH (0,1,1) (2,0), ARIMA – ARCH GARCH (0,1,1) (0,1), ARIMA – ARCH GARCH (0,1,1) (1,1), and ARIMA – ARCH GARCH (0,1,1) (1,2).

Table 3. ARIMA – ARCH GARCH Model Test

Parameter	ARIMA ARCH-GARCH Models				
	(0,1,1) (1,0)	(0,1,1) (2,0)	(0,1,1) (0,1)	(0,1,1) (1,1)	(0,1,1) (1,2)
Sig	√	-	√	√	-
AIC	19.45585	19.39368	19.41605	19.37483	19.38653
SC	19.53439	19.49185	19.49459	19.47301	19.50434
Residual	√	√	-	√	√

Table 3 reveals the parameters of the five ARIMA-ARCH GARCH models that were tested. According to the findings of ARCH effect testing, ARIMA-ARCH/GARCH (0,1,1) (1,1) was the best model as it had the best ARCH GARCH model parameter values, which had the smallest AIC and SC values, had significant coefficients, and coefficient of variance and residual were not negative and not more than one.

Volatility Analysis

According to the results of the analysis, the best model utilized in forecasting the volatility of consumer prices for red chili peppers in Central Java was the ARIMA ARCH-GARCH (0,1,1) (1,1) model. Based on data processing, the equation of the model was obtained as follows:

$$ht = 642055.4 + 0.789018\ h_{t-1} + 0.184850\ \varepsilon^2_{t-1}$$
$$0.0940 \quad 0.0000 \quad 0.0406 \ldots\ldots\ldots\ldots(3)$$

This model reveals that the movement of consumer prices of red chili peppers in Central Java was affected by the magnitude of the volatility of the previous period and the price variance of the previous period. This model can be interpreted that when the price of red chili peppers today has a residual price (ε2t) and a relatively large price variance (ht-1), then the price level of red chili peppers tomorrow has a tendency to be high. These findings are significant at 99%. The number of parameters of the ARCH and GARCH rates in this model had a value of not more than 1 and was not negative, indicating that the requirements of the ARCH-GARCH model were fulfilled.

The variety model of red chili peppers had the ARCH and GARCH terms. The ARCH coefficient value in the model was 0.184850. This value was relatively small (not close to 1), indicating that the volatility was low. The low volatility value also happened in the analysis of price volatility of curly red chili peppers conducted by Nugrahapsari and Arsanti (2019). Low volatility means that the characteristics of red chili pepper demand and supply are predictable. Changes in price are gradual and predictable. This finding might also imply that changes in the strategic environment beyond 2018 will not result in major price volatility adjustments. This is due to the fact that agricultural goods are seasonal commodities, with output declining during the rainy season (off season) and increasing during the dry season (on season).

The GARCH coefficient value in the model was 0.789018 which was relatively high (close to number 1). It means that shocks in the price variant will occur for a long time (persistence). According to the ARCH-GARCH coefficient value, the volatility of red chili prices in the future can be estimated, which will be smaller and last for a long time. These results are in line with the study carried out by Yahya (2018), explaining that the volatility of red chili peppers prices in the Gowa Regency would last a long time, leading to the difficulty for farmers to predict prices.

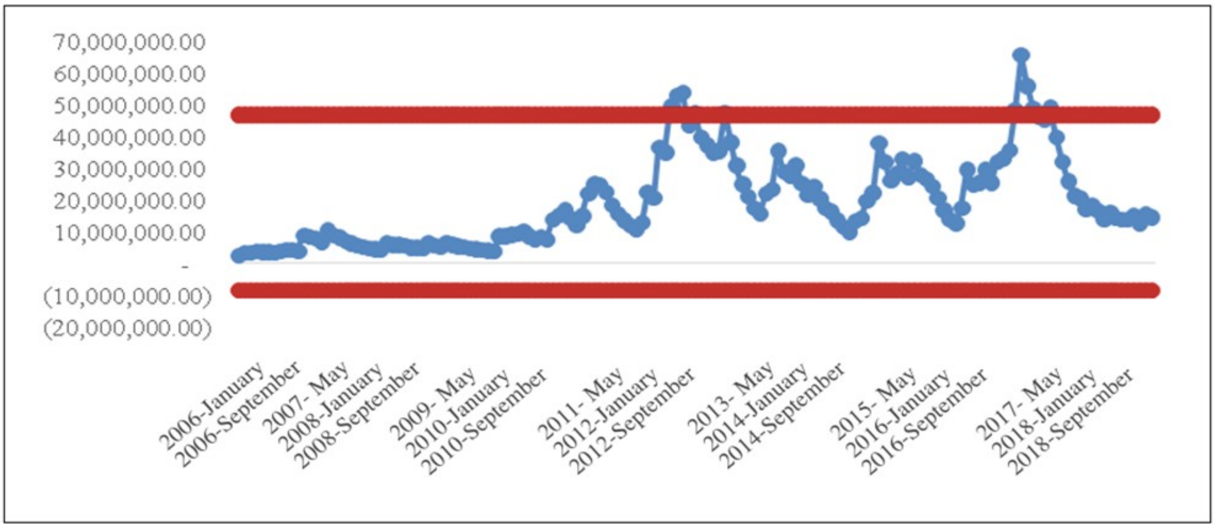


Figure 6. Consumer price volatility of red chili peppers in Central Java in 2006-2018

The volatility of red chili peppers prices did not only occur in rural areas. The results of a study conducted by Sumantri et al. (2017) also revealed that the consumer prices of red chili peppers had a volatile element at the national level. This phenomenon implies that the price fluctuation of red chili peppers needs to be a national priority. Therefore, it can be a solution both on a micro-level, which is agribusiness, and macro level, which is reducing inflation.

Figure 6 presents the results of the estimated volatility of consumer prices of red chili peppers in Central Java in 2006-2018, indicating variations over time. The volatility of consumer prices of red chili peppers occurred in 2012 and 2017. In 2012, there was volatility in March, April, May, and July, while in 2017 there was volatility in January, February, March, April, and July.

The high price during this period was expected to be associated with the month of Ramadan and the beginning of the rainy season which led to reduced supply and demand tended to increase, making producer prices also increase. Nugrahapsari and Arsanti (2019) described that in the month of Ramadan, there was a shift in people's tastes by having a tendency to cook more spicy food. Therefore, this tendency caused an increase in demand for red chili peppers. This statement was confirmed by Gilbert and Morgan (2010); Minot (2012); Junaedi (2013); Pertiwi et al. (2013) that price variations can be due to consumption shocks, such as a shift in consumer tastes. Simultaneously, high rainfall in the rainy season can also be a factor of crop failure because of the massive attack of plant-disturbing organisms. Islam and Al Mamun (2020); Hudha et al. (2020) stated that natural disasters like droughts, floods, and landslides might limit the affordability of food that can trigger an increase in food prices, a decrease in food product quality, to the detriment of farmers.

Formulation of Red Chili Peppers Price Stabilization Strategy in Central Java

Red chili peppers are one of the commodities with high economic value, making them be widely cultivated. Saptana et al. (2010) explained that the establishment of red chili peppers farming is considered significant due to the following factors, including (1) classified as a high economic value commodity, (2) becoming a national superior horticultural commodity, (3) dominating the list of spices in the cuisine menu in Indonesia, (4) has labor-intensive characteristics, and (5) has good export prospects.

Even though red chili peppers have high economic value, it also has a high risk of crop failure because of decreased productivity and perishable characteristics in post-harvest handling and distribution, and marketing. As a result, the development of competitiveness of red chili peppers also needs to be through appropriate supply chain handling. Gramberger et al. (2015) and Behzadi et al. (2018) asserted that supply chain inclusiveness becomes part of a national food security strategy whose primary development situates in the collaboration of stakeholders such as government, industry, and academia. Meuwissen et al. (2019) and Kangogo et al. (2020) described that supply chain efficiency needs to be accomplished by making farmers as food producers closer to the market. It implies that innovation and technology are required to bring the economic distance between farmers and consumers to be closer.

The institutional partnership becomes one of the significant factors to support the success of the agricultural supply chain. This system has also been implemented in various countries, including sub-Saharan Africa and Ethiopia to enhance agricultural competitiveness via strengthening agribusiness value chains (Morea and Bazarini 2018; Abate et al. 2011). Hermans et al. (2019) succeeded in mapping the advantages of inclusive agricultural development via partnerships with a variety of stakeholders. It has a goal to create sustainable farming in terms of the economic, environmental, and social dimensions.

Saptana (2011) has mapped three institutional patterns of farming partnerships of red chili peppers in Central Java, including (a) General trading patterns with diverse variations (including market institutions via commodity wholesale markets); (b) Core-plasma business partnership; and (c) Institutional contract farming business partnerships with diverse variations, including those developed by PT. Henz ABC as a partner company.

Based on the results of this analysis, strategies to improve the competitiveness of red chili peppers in Central Java can be formulated starting from anticipating high price fluctuations. Because of the volatility of red chili peppers prices, problems at the upstream and downstream levels of agriculture occur. Therefore, it is important to formulate a comprehensive strategy for price stabilization of red chili peppers which results in increased competitiveness via supply chain optimization (Ajmal and Kristianto 2010). Somashekhar et al. (2014) described the significance of supply chains in agricultural management as most of the economic losses that emerge are caused by improper post-harvest handling.

The alternative strategy focuses on maximizing the supply of red chili peppers based on the season (off season and on season). At the upstream level, it is important to disseminate innovative technologies to minimize crop failure during the off season, regulate cropping patterns, and strengthen the institutional system of mutually beneficial partnerships. At the downstream level, it is important to support the supply chain system by enhancing the logistics system, post-harvest, and distribution management to minimize the probability of yield loss. The development of cold storage facilities and dissemination of postharvest technology for dried chili can be an innovative attempt to minimize supply reserves during on season or harvest season. Furthermore, to agricultural infrastructure facilities, another policy alternative is the restriction of chili imports.

CONCLUSION AND SUGGESTION

Conclusion

The results of the volatility analysis reveal that only consumer prices of red chili peppers have volatile elements, while the producer prices of red chili peppers are not volatile. The test results illustrate that consumer prices of red chili peppers in Central Java have low volatility, but shocks in price variants will last for a long time.

Based on the results of the analysis, a stabilization strategy for red chili peppers in Central Java can be formulated, including (1) dissemination of innovative technology to minimize crop failure during off season, (2) determining cropping patterns, (3) strengthening the institutional system of mutually beneficial partnerships, (4) enhancement of logistics, postharvest and distribution management systems to minimize yield loss, (5) development of cold storage facilities and dissemination of postharvest technology for dried chili, and (6) restrictions on red chili peppers imports.

Suggestions

This study's strategy formulation is only a descriptive analysis based on research and literature results. As a result, there is still a need for greater research into the strategy for developing red chili pepper farming in Central Java using a more extensive analytical technique in the future. This further study is utilized to provide a synergistic policy formulation for the red chili pepper agribusiness from the upstream to downstream levels. Furthermore, further research is expected to include primary data gathered from farmers, distributors, wholesalers, and retail merchants. This is to address the issues that each red chili pepper agribusiness actor faces.

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