INSOLOGI: Jurnal Sains dan Teknologi
https://journal.literasisains.id/index.php/INSOLOGI
ISSN 2828-4984 (Media Online) | ISSN 2828-4992 (Media Cetak)
Vol. 2 No. 2 (April 2023) 385-391
DOI: 10.55123/insologi.v2i2.1871
Submitted: 05-04-2023 | Accepted: 10-04-2023 | Published: 29-04-2023

Application of ARIMA to Curly Red Chili Prices in Bengkulu City

Melda Juliza[1], Puce Angreni[2]
[1,2]Departement of Statistics, Institut Sains dan Teknologi Nahdlatul Ulama Bali, Denpasar, Indonesia
Email: [1]melda@istnuba.ac.id, [2]puceangreni@istnuba.ac.id

Abstract

Curly red chili in Bengkulu City often experiences price fluctuations from time to time. These price fluctuations are sometimes very extreme, causing public unrest both for food processing industry entrepreneurs and for daily household needs. Therefore, this study uses time series techniques to predict the price of curly red chili in Bengkulu City. This study discusses chili price forecasting using the Box-Jenkins ARIMA model based on curly red chili price data in Bengkulu City from 03 October 2022 to 28 February 2023. This research aims to look at the accuracy of the best model for curly red chili prices in Bengkulu city for the ARIMA model based on ACF & PACF criteria with autocorrelation coefficient values, and the smallest AIC criteria with the auto.arima function in R software. Next, forecast the price of curly red chili in Bengkulu City for the next period with the ARIMA model based on the best criteria obtained. Based on the ADF test, it can be seen that the data is not stationary so the data differencing process is carried out. The analysis results show that the best ARIMA model for curly red chili price data in Bengkulu City is the automatic ARIMA model with the smallest AIC criteria using the auto.arima function with the value of RMSE is 4197.7. The ARIMA model that is formed is the ARIMA (1,1,1) model. Next, the results of forecasting the price of curly red chili for Bengkulu City obtained based on the ARIMA (1,1,1) on 01 March 2023 is Rp 41,700.

Keywords: *Curly Chili, Chili Price, Autocorrelation, AIC, Auto.Arima.*

1. INTRODUCTION

Chili is a potential commodity to develop in Bengkulu Province. The types of chili cultivated by the community include curly red chili. Curly red chili is important in people is daily life, namely as a food flavoring or cooking seasoning in the household and as an additional processed ingredient in the food industry.

Bengkulu City is an area that is not a center for curly red chili production. Thus, to fulfill the demand for curly red chili in Bengkulu City, it is necessary to monitor reasonable market prices so that consumers do not complain about unstable prices. Curly red chili every day in Bengkulu City often experiences price fluctuations. Sometimes it soars up, and sometimes it drops drastically.

The curly red chili marketing system in Bengkulu City can run efficiently if adequate market information is received. So price changes can be immediately known by consumers, and the consequence will minimize public complaints or unrest about the erratic price of curly red chili can lead to extreme price increases.

The need for curly red chili often increases dramatically. This condition is common on religious holidays. So it will have an impact on price increases that are quite sharp. In

addition, the increases in chili prices were influenced by uncertain climatic conditions which would have a consequence in reducing the supply of chili commodities to the market due to decreased chili production. Based on the quantity, the need for curly red chili in household consumers is not the consumer in large quantity, but in the aggregate, curly red chili is quite large for people's daily lives. So, when the curly red chili commodity is not available, or there is a lack of supply in the market, as well extreme price fluctuation cause unrest in the people of Bengkulu City. This matter is similar to research by Puspatika & Kusumawati (2018), which states that the volatility of red chili prices can cause public complaints. Fluctuations in chili prices will also affect the effectiveness of the price stabilization policy for agricultural commodities as one of the basic needs (Nugrahapsari & Arsanti, 2019). Based on Presidential Regulation (Perpres) Number 71 of 2015 concerning stipulation and storage of prices of basic needs and imported goods, the government was obliged to make every effort to ensure the availability and stability of chili prices at all times. Therefore, complete information was needed regarding chili prices to support the success of the price stabilization policy for agricultural commodities in Indonesia.

Several studies have been conducted on chili price analysis that is Hadiansyah (2017) states that chili price prediction using the ARIMA time series model has good performance for predicting chili prices in the future measure to anticipate fluctuating market demand. Puspatika & Kusumawati (2018) forecast chili prices in Semarang City using the ARIMA ARCH GARCH and Single Moving Average of results show that the use of the ARIMA ARCH GARCH method is suitable for red chili data because the data has high volatility and the Single Moving Average ARIMA is more accordance for curly and green cayenne chili because the data is not much different from the actual data. This chili price forecasting can help stakeholders reduce the adverse effects of chili price fluctuations. Furthermore, Irnawati & Trisusanto (2019) analyzed chili prices using the ARIMA model focused on 10th cities, namely Bandar Lampung, Bandung, Denpasar, Jakarta, Makassar, Medan, Samarinda, Semarang, Surabaya, and Pontianak. The results of the analysis show that the ARIMA model can be used to predict red chili prices for the next four months.

The problem of fluctuating chili prices which tend to go up to extremes can result in complaints and losses for the community. A solution used to overcome this problem is to forecast the price of chili. The problem of fluctuating chili prices which tend to go up to extremes can result in complaints and losses for the community. A solution used to overcome this problem is to forecast the price of chili. Based on this, this study aims to look at the accuracy of the best model for curly red chili prices in Bengkulu City for the ARIMA model based on ACF & PACF criteria with autocorrelation coefficient values, and the smallest AIC criterion with the auto.arima function in R software. Next, forecast the price of curly red chili in Bengkulu City for the next period using the ARIMA model based on the best criteria obtained. Curly red chili in Bengkulu city is a time series data that is observed daily. Time series is a series of observations of a variable taken from time and recorded sequentially according to the time sequence of events with a fixed time scale (Wei, 2006). In the time series method, several things need to be considered, namely the stationarity of the data, the autocorrelation function (ACF), and the partial autocorrelation function (PACF).

The Autoregressive Integrated Moving Average (ARIMA) model is used for time series data analysis and forecasting (Hanke & Wichern, 2009). The ARIMA model can be used for forecast if the model obtained is adequate. The ARIMA model consists of

three main steps, the identification stage, the assessment and testing stage, and implementation stage (Makridakis, Wheelwright, & McGee, 1999). Parameter estimation is perform to determine the appropriate parameters for the ARIMA model. In practice finding parameter estimates takes a long time and is very complicated. More practical in determining values that are close to the optimal value, it is necessary to use optimization methods. One of the methods used to solve this problem is to use smallest AIC criterion with the help of R software using the auto.arima function (Hyndman & Khandakar, 2008). The complete ARIMA model in R applications can look in Cryer & Chan (2008).

The ARIMA model is also known as the Box-Jenkins model (Box, Jenkins, & Reinsel, 1994), which produces forecast values based on historical data patterns. The ARIMA model is a technique for finding the most suitable pattern based on a group of data, which make fulled use past and present data to perform accurate short-term forecasting (Brockwell & Davis, 1996). The ARIMA model is a model that completely ignores independent variables in forecast. So this model is a simple model. The ARIMA model is good to use if the observations from the time series are statistically related to one another (dependent).

2. METHODOLOGY

2.1 The ARIMA Model

The non-stationary time series model is called the Autoregressive Integrated Moving Average order (p, d, q) or abbreviated as ARIMA, where p is the order of the autoregressive parameters, d is the quantity that states how many times differencing is done to reach stationary, and q is the order of the moving parameters. average (Box, Jenkins, & Reinsel, 1994). The general formula of the ARIMA model is as follows:

$$W_t = \emptyset_1 W_{t-1} + \cdots + \emptyset_p W_{t-p} + a_t - \theta_1 a_{t-1} - \cdots - \theta_q a_{t-q} \quad (1)$$

with $W_t = X_t - X_{t-1}$

Where:

W_t : observation of d differencing in time (t)
X_t : observation of in time (t)
$\emptyset_p$: parameter *autoregressive*, $(p = 1, 2, \dots, n)$
θ_q : parameter *moving average*, $(q = 1, 2, \dots, n)$
d : degree of differencing
a_t : white noise in time (t)

2.2 Research Stages

The data analysis technique in this study used the help of software R. The data used in this study were the curly red chili prices in Bengkulu City, the next referred to as chili price data. The period data starts is 03 October 2022 to 28 February 2023, namely 107 data sourced from the website of the Ministry of Trade with the address https://sp2kp.kemendag.go.id/komoditas. Chili price data is daily data that is analyzed using the ARIMA model. This data is because the ARIMA model is accurate for producing short-term forecasts for time series data using past and present values of the dependent variables that are interrelated. The stages in processing research data using the ARIMA model are as follows:

1) Identify data by creating a time series graph on the actual data to see visually whether the data is stationary or not.

2) Perform a data stationarity test using the Augmented Dickey-Fuller test (ADF test). If stationarity not met, then the differencing stage is carried out.

3) Determine the ARIMA(p,d,q) tentative model on data that is stationary based on ACF & PACF criteria with autocorrelation coefficient values through ACF & PACF plots. Based on the ACF plot to determine the MA(q) order, and the PACF plot to decide the AR(p) order.

4) Determine the automatic ARIMA model based on the smallest AIC criteria with the auto.arima function in R software.

5) Comparing the best AIC and RMSE results from the ARIMA model based on steps (3) and (4).

6) Choose the best ARIMA model based on step (5).

7) Forecasting chili prices using the best ARIMA model obtained based on step (6).

3. RESULT AND DISCUSSION

Red chili is an important commodity for the Indonesian economy that often experiences sharp price increases. As a commodity, fluctuations in the price of red chili can affect people's behavior in both the food processing industry and daily household needs as well as affect the policy of price stability for agricultural commodities. Describe the behavior of the daily chili price in Bengkulu City a descriptive statistical analysis was carried out, which was displayed through graphs and tables. Based on analysis results with help of R software, it graphically can be seen in Figure 1 belows:

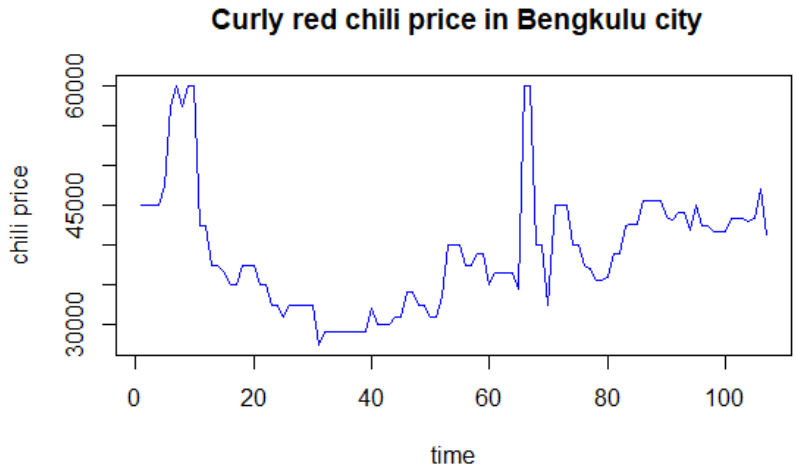

Fig 1. Graph of chili price in Bengkulu City

Based on an analysis of chili price behavior through the daily chart of curly red chili in Bengkulu City, it can be seen that chili prices for the period 03 October 2022 to 28 February 2023 relatively fluctuated. The highest chili price which were Rp 60,000 occurred on October 11, 13, 14, 2022, and January 2, 03, 2023. The lowest chili price, which was Rp 27,500 occurred on 14 November 2022. Meanwhile, the average chili price is around Rp 39,100 which is presented in full in Table 1 below:

Table 1. Descriptive statistics of chili price in Bengkulu City

Value	Chili Price
Maximum	Rp 60,000
Minimum	Rp 27,500
Mean	Rp 39,100

Furthermore, a stationarity check is carried out on the chili price data. The stationarity test used is the Augmented Dickey-Fuller (ADF) test with a significance of 5%. The test criterion is that if the p-value is less than 5%, then reject H0, meaning that the data series is stationary. Based on the results of the ADF test, the p-value of 0.4519 was obtained. That means that the p-value is greater than the 5% significance. That shows that the chili price data does not meet stationarity at the data level. Thus, it is necessary to do differencing of chili price data until stationarity met. The following is a graph of chili prices after differencing 1:

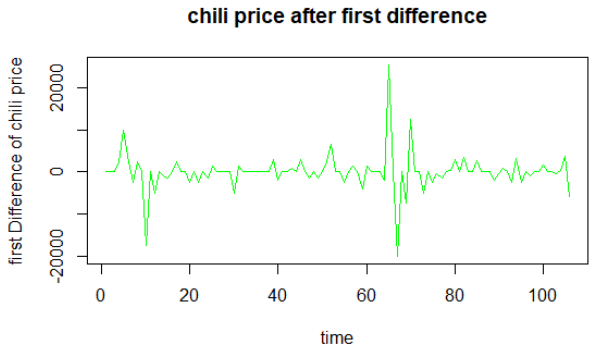

Fig 2. Chili price after first differencing

Based on Figure 2, its can be seen that the data fluctuates around the average. That shows that after differencing 1, the chili price data has reached stationarity. More accurate, the ADF test was carried out on the results of differencing 1. Based on the results of the ADF test on the data resulting from differencing 1, a p-value of 0.01 was obtained. That shows that the p-value is less than 5% significance. That means that the chili price data reaches stationarity at the time of the first differencing. Next, we will identify the tentative ARIMA model by looking at the ACF and PACF patterns resulting from differencing 1. The following figure shows the ACF and PACF plots after differencing 1.

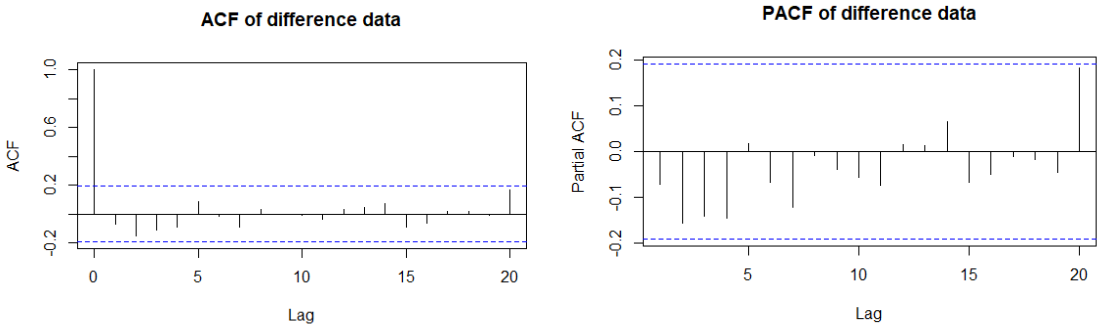

Fig 3. ACF and PACF plot of difference data

Based on Figure 3, the ACF pattern is cut off after the first lag, meaning that the MA order is 1. Meanwhile, the PACF pattern is dying down, meaning the AR order is 0. So the tentative model formed is the ARIMA (0,1,1) model. As a derivative, we also examine the ARIMA (0,1,2) model. So that the tentative ARIMA model with ACF and PACF pattern criteria obtained 2 models to be analyzed. The next step is to form the ARIMA model using the smallest AIC criteria with the help of R software through the *auto.arima* function, the package used is "*tseries"*. The *auto.arima* model obtained is ARIMA (1,1,1). In detail, the estimation of the ARIMA model and the results of the analysis of the three models formed are presented in Table 2 below:

Table 2. Recapitulation of the results of the ARIMA model analysis

Criteria of model	The ARIMA model	Parameter	Estimator	AIC	RMSE
The tentative ARIMA model	ARIMA (0,1,1)	MA 1	-0.1107	2081	4330.6
	ARIMA (0,1,2)	MA 1 MA 2	-0.1586 -0.2436	2078.31	4232.7
The automatic ARIMA model	ARIMA (1,1,1)	AR1 AR 2	0.6687 -0.8664	**2076.63**	**4197.7**

Based on Table 2. Choose the best ARIMA model by paying attention to the smallest AIC and RMSE values. The ARIMA model smallest AIC and RMSE values is the automatic ARIMA model criteria, namely ARIMA (1,1,1), with AIC and RMSE values of 2076.63 and 4197.7 respectively. So its can be said that the best model obtained is the ARIMA (1,1,1) model.

Then examine the residual ACF from the best ARIMA model, namely the ARIMA model (1,1,1). The following is an ACF plot of the residual ARIMA model (1,1,1):

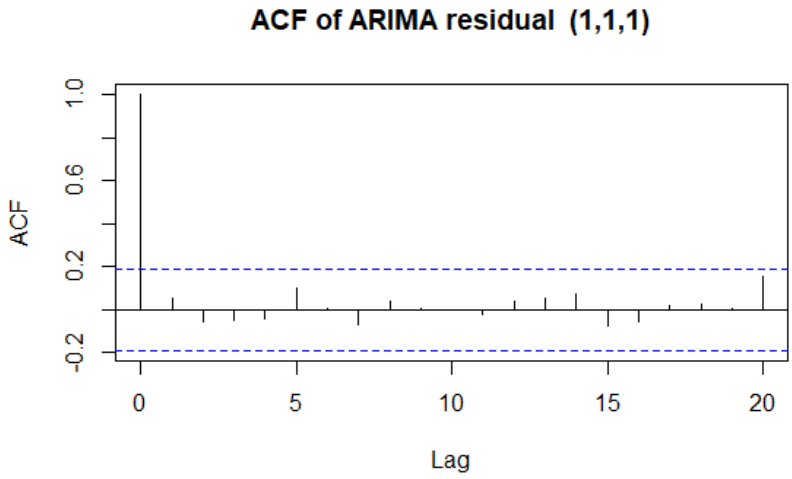

Fig 4. ACF plot of the residuals of the ARIMA (1,1,1)

Based on the ACF plot of the residual ARIMA model, it can say that all lags are within the dotted blue line area. It can say that the ARIMA (1,1,1) model can be used for forecasting. This model is used to determine the price of curly red chili in Bengkulu City for the next period. Forecasting results obtained based on the ARIMA (1,1,1) model, the price of curly red chili in Bengkulu City on 01 March 2023 is Rp 41,700.

4. CONCLUSIONS

Based on the result of the analysis and discussion, it was found that the best model for curly red chili price data in Bengkulu City is the automatic ARIMA model with the smallest AIC criteria, namely ARIMA (1,1,1), with an RMSE of 4197.7. The chili price forecasting results based on the ARIMA (1,1,1) model for the next period are Rp 41,700. So that in this case, determining the automatic ARIMA model is better than determining the tentative ARIMA model.

5. REFERENCES

Box GEP, Jenkins GM and Reinsel GC. 1994. Time series analysis forcasting and control. 3rd ed. Prentice Hall, New Jersey.

Brockwell PJ and Davis RA. 1996. Introduction to time series and forecasting. Springer, New York.

Cryer JD and Chan KS. 2008. Time series analysis with application in R. 2nd ed. Spinger Science and Business Media, USA.

Hadiansyah FN. 2017. Prediksi Harga Cabai dengan Menggunakan pemodelan Time Series ARIMA. *Indonesian Journal on Computing (Indo-JC*. 2 (1).

Hanke JE and Wichern DW. 2009. Business forecasting. 9th ed. Pearson Prentice-Hall, New Jersey.

Hyndman RJ and Khandakar Y. 2008. Automatic time series forecasting: The forecast package for R. *Journal of Statistical Software*, 26 (3).

Irnawati and Trisusanto T. 2019. Peramalan harga eceran cabai merah dengan permodelan time series ARIMA. *Jurnal Pilar Ketahanan Pangan*. 1: 39–48.

Makridakis S, Wheelwright SC and McGee VE. 1999. Metode dan aplikasi peramalan. Edisi revisi, Terjemahan Ir. Hari Suminto. Bina Rupa Aksara, Jakarta.

Nugrahapsari RA and Arsanti IW. 2019. Analisis volatilitas harga cabai keriting di indonesia dengan pendekatan arch garch. *Jurnal Agro Ekonomi*. 36 (1): 25–37.

Puspatika K and Kusumawati Y. 2018. Peramalan harga cabai dengan metode arima arch garch dan single moving average di kota semarang. *Journal of Information System*. 3 (1): 192–201.

Wei WWS. 2006. Time series analysis: univariate and multivariate methods. 2nd ed. Addison-Wesley Publishing Company, New York.