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COMPARISON OF CHILI PRICE VOLATILITY IN CRUSHING PROVINCE OF INDONESIA

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ABSTRACT

The price of chili commodity can be used as the main indicator of inflation because it can respond quickly, especially to changes in demand and economic changes. Production fluctuations and consumption fluctuations have an impact on price fluctuations. Prediction of time series data using the ARIMA model approach has good performance for predicting chili prices in the future. Crucial province is the province that has big impact such as the province with the highest production, or the province with the highest consumption or the province with the gaps such as Jawa barat and Banten province. The purpose of this research is to create a time series model to predict chili prices in Jawa barat and Banten provinces and to measure and compare the level of volatility in chili prices in Jawa barat and Banten provinces. The best ARIMA model for chili price data in Jawa Barat and Banten Provinces is the ARIMA model (0,1,1). The results of chili forecast data in the provinces of Jawa Barat and Banten using the ARIMA model show relatively stable prices. The volatility of chili prices in Jawa Barat province is 19.68%. Chili price volatility in Banten province is 20.49%. This shows that the volatility level of chili prices in Jawa Barat province is relatively lower than in Banten province, although it is relatively the same and is still under control. This is confirmed by the result that the model has no ARCH effect.

INTRODUCTION

Chili commodity prices volatility has an impact on the prices of other food commodities, even though chili is not the only commodity that generates inflation. There are several other inflation-forming commodities whose prices are regulated by the government (Administered prices). The price of this food commodity can be used as the main indicator of inflation because it can respond quickly, especially to changes in demand and economic changes, especially the impact of disasters (Furlong & Ingenito, 1996). This agricultural commodity is also a commodity that is sensitive to changes and economic uncertainties (Joëts, Mignon, and Razafindrabe, 2017). The increase in the price of chili for a certain period of time is significant enough to affect the inflation rate (Pusdatin 2016). Chilies also often experience sharp price increases, thus contributing to high inflation(Sukiyono and Janah, 2019).

Chili is one of 11 food commodities that contribute significantly to the formation of inflation, especially volatile food inflation. The government can implement a price control policy, including: Optimizing the buffer function owned by government agencies such as Bulog through market operations, under certain conditions it is hoped that the government can start initiating a basic price policy and roof prices for farmers and consumers respectively, and improving the chili distribution system through the empowerment of producers and traders (Adhis & Jamil, 2021).

In fact, not all chili data contains volatility. The results of Nurjati (2018) for chili data in Central Java Province show that only prices at the consumer level contain volatile elements, while prices at the producer level do not have volatile elements. Price volatility at the consumer level in the future will be less, but it will last for a long time.

In microeconomic theory (Lipsey et al. 1995) production fluctuations and consumption fluctuations cause shifts in the supply and demand curves and have an impact on price fluctuations. On the other hand, income, changes in the prices of substitute commodities, and shifts in tastes lead to variations in consumption (Gilbert & Morgan, 2010). Changes in these factors can cause price volatility in the market. The market cannot automatically stabilize price changes that occur, therefore there is a need for government involvement to intervene in price changes (Huffaker et al., 2018).

Research by Irnawati and Trisusanto (2019) uses the ARIMA model to predict the possibility of red chili price fluctuations so that they can analyze and predict red chili prices for the following months. Based on the results of his research, the government can make efforts to anticipate price fluctuations and strive for a stable supply of red chilies throughout the year.

Prediction of chili price time series data using the ARIMA model approach has good performance for predicting chili prices in the future. This

prediction has good performance for data testing and training. This can be used as a basis for anticipating fluctuating market demand (Nur Hadiansyah, 2017).

ARCH GARCH method and the Single Moving Average carried out by Puspatika et al., (2018) in the city of Semarang. The results showed that the ARIMA ARCH GARCH method is more suitable for data that has high volatility, namely red bird's eye chili data and the Single Moving Average ARIMA method is more suitable for data that is not much different from the actual data, namely binocular, curly and green bird's eye chilies.

Crucial province is the province that has big impact such as the province with the highest production, consumption, the gaps between production and consumption. Based on BPS data for 2021, Jawa Barat is the province with the highest chili production and consumption and Banten is the province with the highest deficit. this can be seen in Table 1. chili price data in Jawa barat and Banten provinces can be used as a sample to see chili price volatility in Indonesia. There is no research that discusses the comparison of chili price volatility between provinces with high demand or supply.

Table 1. Data for 10 provinces with the highest consumption production and chili deficit in 2021

No	Province	Chili Production (Ton)	Chili Consumption (Ton)	Surplus / Deficit (%)
1	Jawa Barat	343,067.00	70,246.66	388.37
2	Sumatera Utara	210,220.00	60,939.48	244.97
3	Jawa Tengah	169,282.00	57,318.30	195.34
4	Jawa Timur	127,429.00	39,243.64	224.71
5	Sumatera Barat	115,766.00	39,508.04	193.02
6	Sumatera Selatan	23,556.00	24,626.45	- 4.35
7	Riau	14,097.00	28,831.60	- 51.11
8	Banten	6,406.00	27,500.16	- 76.71
9	Kepulauan Riau	2,967.00	6,354.72	- 53.31
10	Maluku	2,029.00	2,905.70	- 30.17
	Indonesia	**1,360,573.00**	**495,048.33**	**174.84**

Source: BPS 2021

The volatility analysis measures the standard deviation or variation in chili prices that fluctuate over a certain period of time. Because data is constantly moving and one of the goals of this study is to predict future volatility, a time series model is needed so that the calculation of price volatility can be used as a basis for choosing a policy strategy.

Based on the description above, the purpose of this research is to create a time series model to predict chili prices in Jawa barat and Banten provinces and

to measure and compare the level of volatility in chili prices in Jawa barat and Banten provinces. Demand and supply are the main factors in determining price. Therefore, the hypothesis is that the volatility for chili commodity prices in West Java and Banten provinces is relatively the same.

The benefits of the research results are as a reference for conducting further research and are useful as a source of consideration in formulating policy strategies and mitigating inflation based on chili price volatility.

RESEARCH METHODS

This type of research is quantitative and qualitative research. The quantitative research was carried out by establishing a time series model to predict future prices to be used as a basis for calculating volatility values and comparing chili price volatility values in Jawa barat and Banten Provinces as provinces with the highest production, consumption and deficits. This type of quantitative research is used to answer the formulation of problems 1 and 2. The qualitative research conducted is a literature study by providing several recommendations for policy strategies in addressing the level of volatility in the Provinces of Jawa barat and Banten.

Method of Collecting Data

In this study, the data used is monthly time series data in the form of chili prices in Jawa barat and Banten Provinces from July 2017 to February 2023. The data used is secondary data sourced from Bank Indonesia and the National Strategic Food Price Information Center. Chili price data in Jawa barat and Banten provinces can be used as a sample to see chili price volatility in Indonesia due to those province are crucial province that has big impact such as the province with the highest production, consumption, the gaps between production and consumption.

Data Analysis Method

Analysis of chili price volatility uses the ARIMA or ARCH-GARCH models if the data contains the ARCH effect with the help of R studio software. The use of this model is because the data used is time series data. The steps for volatility analysis can be seen in Figure 1.

The first stage carried out in this study was checking the stationarity of the time series data for curly chili prices in Jawa barat and Banten provinces. The stationarity test is one of the most basic and most important things to determine the behavior of time series data (Sugiarto et al., 2017). There are two behaviors of the time series data that are tested for stationarity, namely stationary on the mean and stationary on the diversity of the data. If the data is not stationary on the average, then a differencing process is needed on the data. If the data is not stationary on diversity, then transformation is needed on the

data (Pamungkas, 2019) stationarity test that is used both to determine the behavior of the average and the diversity is the Augmented Dickey Fuller test (Rabbani, 2021).

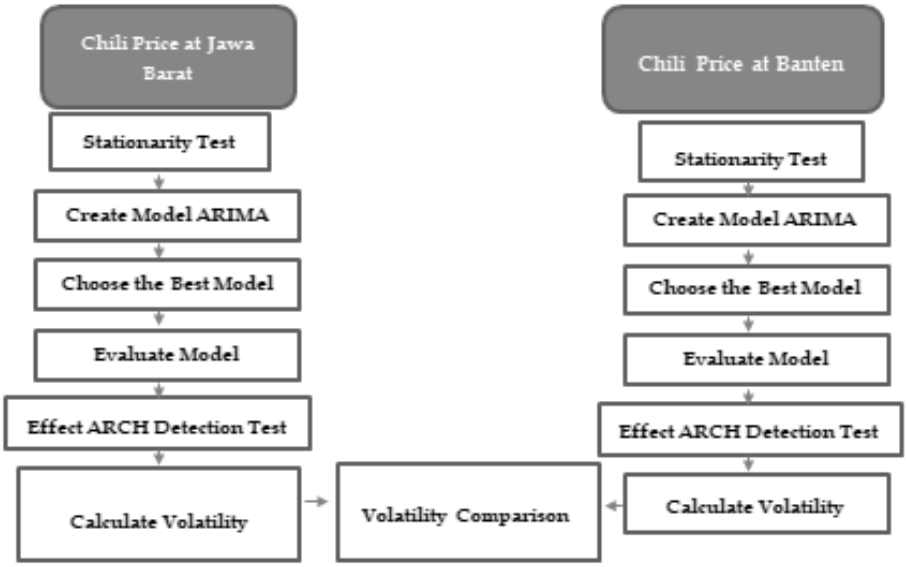

Figure 1
Analysis Method Flow

Stationary data can be used to create forecasting models. The method used is the ARIMA model. The stationary data determines the AR order (p) and MA order (q) of a tentative ARIMA (p.d.q) model. The order d is determined based on the stationarity of the data. The p, d, q orders were determined by observing the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) patterns (Makridakis et al., 1999).

General form of the model $ARIMA\ (p,\ d,\ q)\ \phi p\ (B)(1\ -\ B)\ dXt\ =\ \theta 0\ +\ \theta q\ (B)et$, $e\ t\sim N(0,\ \sigma\ 2)$,(3) where Xt is the time data variable t, ϕp are AR operators with $\phi p\ (B)\ =\ 1-\ \phi 1B\ -\ \cdots\ \phi pB\ p$, θq are MA operators with $\theta q\ =\ 1-\ \theta 1B\ -\ \cdots\ -\ \theta qB\ q$, $\theta 0\ =\ \mu(1-\ \phi p\ -\ \cdots\ -\ \phi p)$ and et is the residual value at the time t.

The best arima model is a model that meets the criteria of residual random forecasting, parsimonius, parameter estimates are significantly different from zero, conditions of invertibility and stationarity are met, iteration convergence process, and small MSE. At this stage, the best ARIMA model will be selected based on the smallest Akaike Information Criteria (AIC) and Schwatrz Criterion (SC) values.

Evaluation of the model is done by testing the assumptions. If the model does not meet the assumptions, then return to the modeling stage to get a better model. The steps taken are to analyze the residuals as follows.

a. Normality Test

The test used to measure whether the residuals are normally distributed is by plotting the residual data on the Q-Q plot. If the residuals form a straight line, it can be concluded that the model is normally distributed. The normality test can also use the Kolmogorov-Smirnov statistical test. The residuals are said to be normally distributed if the p-value is more than alpha (5%) (Pamungkas, 2019).

b. Residual Freedom

The test used to measure residual freedom is the L-Jung Box statistical test. This test examines the residual squared autocorrelation coefficients. The model has no residual freedom or is not feasible if the Q value is greater than the X2 value (α) with k-p-q degrees of freedom or if the p-value is less than the 5% significance level (Dahoklory et al., 2016).

Determination of the ARCH GARCH model can be done if the average model obtained contains the ARCH effect. The method for checking the Arch effect is to do the Lagrange Multiplier test (ARCH-LM test), in which the null hypothesis (H0) has no ARCH error. If the p-value > α, it can be concluded that there is no Arch effect. Data that does not contain ARCH errors does not need to be modeled using ARCH-GARCH (Nugrahapsari & Arsanti, 2018).

The steps for determining the model begin with simulating several models of variance using the best ARIMA model, estimating model parameters, and selecting the best ARCH-GARCH model from several alternative models based on the size of the goodness of the model and the real coefficients. The criteria used as a measure of the goodness of the model are AIC and SC. If the AIC and SC values are getting smaller, then the model is getting better. Other requirements in the ARCH GARCH model that must be met are significant coefficients, coefficient values not greater than one ($\delta + \alpha < 1$), and coefficients not negative ($k > 0$, $\delta > 0$, $\alpha > 0$).

In time series data, there are generally several data points that have different error variances than the others. This difference in error variance has an impact on the prediction level of the model. Heteroscedasticity test can be used to detect differences in error variances. Prediction of time series data using the ARIMA model approach has a drawback where the difference in error variance is not considered as a variant to be modeled. This causes unreadable information or data behavior in the ARIMA model so that the level of prediction accuracy of the model becomes smaller. The approach using the ARCH GARCH model views heteroscedasticity as a variant to be modeled. This approach not only corrects the shortcomings of the ARIMA approach, but also calculates the variance of each error (Engle, 2001).

The best model will be used to estimate the volatility of chili prices in Jawa barat and Banten Provinces. Volatility is measured using the standard

deviation value which is the square root of the estimated model variance. The greater the volatility value can be interpreted the more likely the price will rise and fall significantly.

RESULTS AND DISCUSSION

Sub 1 Stationarity Test

The first step in the research is to make sure the data is of the time series data type and then plot it to see the trend of the time series data. This can be seen in Figure 2 and 3. Chili prices during the period June 20017 to February 2023 in the provinces of Jawa barat and Banten experienced fluctuations. The highest chili price in Jawa barat province occurred in July 2022, which was IDR 94.450,00/Kg. This also happened to chili commodities in Banten province. The highest chili price in Banten province occurred in July 2022 reaching IDR 95.450,00/Kg. The price of this commodity increased due to reduced supply as a result of high rainfall, attacks by athracnose/patek pests. Other factors that caused prices to increase were the transfer of land use to other commodities, changes in cropping patterns/schedules, and increases in pesticide prices in several production centers.

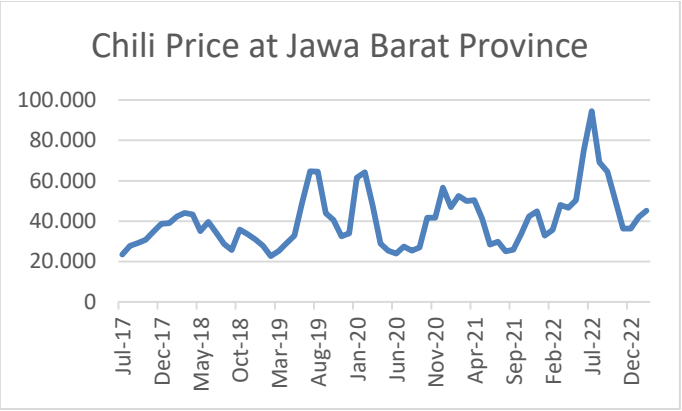

Figure 2
Chili Prices at Jawa barat Province (July 2017 - February 2023)

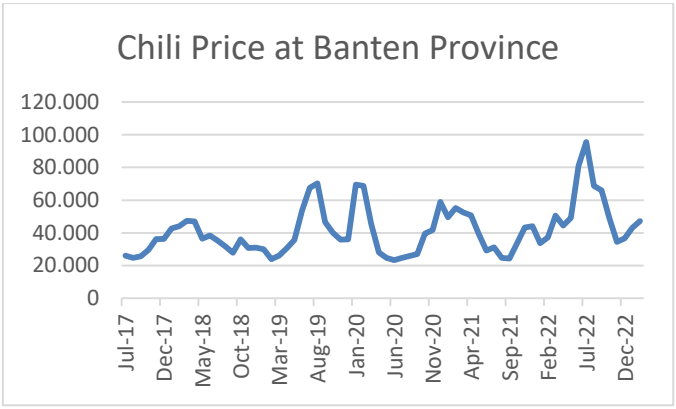

Figure 3
Chili Prices at Banten Province (July 2017 - February 2023)

Then a stationary test was carried out on the price data of chilies in Jawa barat and Banten Province. The stationary test uses the Augmented Dickey-Fuller Test and the data is said to be stationary if the p-value < α. Stationary test results using the Augmented Dickey-Fuller Test show that chili price data in the provinces of Jawa barat and Banten are stationary with p-value = 0,034 and p-value = 0,043 at α = 5%.

Sub 2 Create Model

In the Rstudio software there is a package that provides recommendations for the best model based on iteration of several scenarios. In this package, the Schwatrz Criterion (SC) value is represented by the Schwatrz Baynesian Criterion (BIC). Based on the iteration results, the best model recommendations for chili prices in Jawa barat and Banten provinces are ARIMA (0,1,0) and ARIMA (0,1,0) respectively with AIC and BIC criteria as in table 2.

Table 2. Chili Prices Recommendation Model by Iteration Result of Software.

Chili Prices in Province	Model	AIC	BIC
Jawa Barat	ARIMA (0,1,0)	1421,67	1423,87
Banten	ARIMA (0,1,0)	1433,86	1436,07

Source : Secondary Data

Sub 3 Choose the Best Model

Selection of the best model is done by making several ARIMA models. The smaller the AIC and BIC values, the better the prediction level of the ARIMA model. The ARIMA model that will be formed uses data on the prices of shallots, red chilies and cayenne pepper. The list of ARIMA models formed can be seen in Tables 3 and 4. The ARIMA model for chili prices that is recommended based on several scenarios is ARIMA (0,1,1) because the AIC

value is the smallest even though the BIC value is not the smallest. This shows the need for differencing on chili price data in both Jawa Barat and Banten provinces. Table 3 shows that the ARIMA model formed from chili price data in Jawa Barat province with the smallest AIC value is the ARIMA model (0,1,1) which is 1419.91 although the BIC value is not the smallest, namely 1324.32. Table 4 shows that the ARIMA model formed from chili price data in Banten province with the smallest AIC value is the ARIMA model (0,1,1) which is 1431.73 although the BIC value is not the smallest, namely 1436.14.

Another way to choose the best model is to approach the ACF and PACF graphs. Based on the ACF graph in Figure 4, the price of chili in Jawa Barat province shows that the lag that crosses the line occurs at lag 1. Based on the PACF graph, there is no lag that crosses the line. Based on the ACF graph in Figure 5, the price of chili in Banten province shows that the lag that crosses the boundary occurs at lag 1. Based on the PACF graph, there is no lag that crosses the boundary. Therefore the order at p is 1. The ACF and PACF graphical approaches are in line with the ARIMA models in tables 3 and 4 so that the best ARIMA model for chili price data in Jawa Barat and Banten Provinces is the ARIMA model (0,1,1).

Table 3. Skenario ARIMA Model of Chili Prices in Jawa Barat Province

Model	AIC	BIC
ARIMA (0,0,0)	1494,64	1499,08
ARIMA (0,1,0)	1421,67	1423,87
ARIMA (1,1,0)	1420,91	1425,32
ARIMA (0,1,1)	1419,91	1424,32
ARIMA (1,1,1)	1421,68	1428,30

Source : Secondary Data

Table 4. Skenario ARIMA Model of Chili Prices in Banten Province

Model	AIC	BIC
ARIMA (0,0,0)	1504,25	1508,69
ARIMA (0,1,0)	1433,86	1436,07
ARIMA (1,1,0)	1433,16	1437,57
ARIMA (0,1,1)	1431,73	1436,14
ARIMA (1,1,1)	1433,01	1439,62

Source : Secondary Data

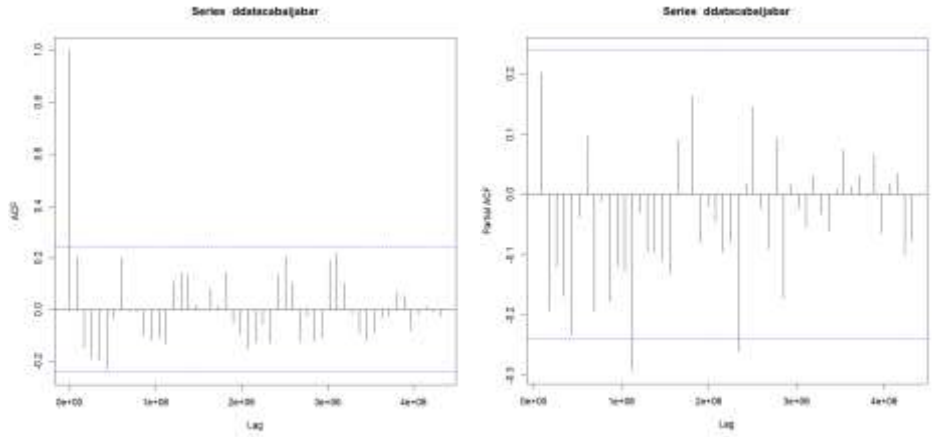

Figure 4
ACF and PACF graphs of chili prices in Jawa Barat province

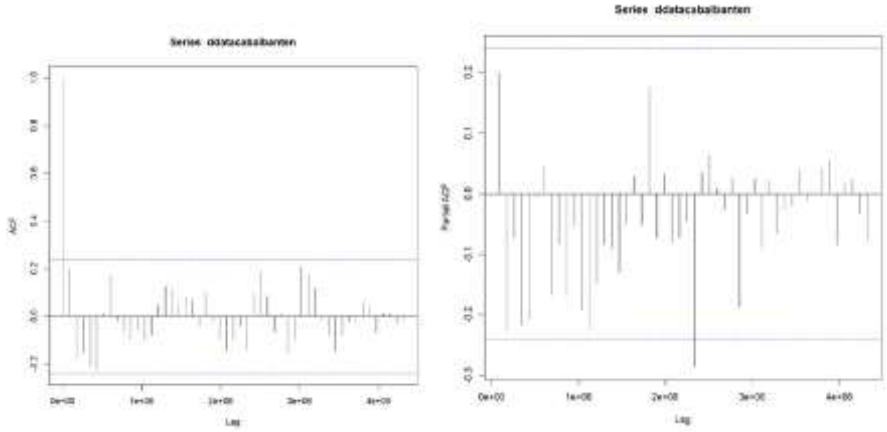

Figure 5
ACF and PACF graphs of chili prices in Banten province

Sub 4 Evaluate Model

The next step is model evaluation or model feasibility testing. The model feasibility test was carried out by carrying out a normality test using the qqnorm graph or Q-Q plot and testing the residual freedom or white noise using the Ljung-Box Test. In the Q-Q plot, it can be seen that the residuals of the ARIMA model for chili prices in the provinces of Jawa Barat and Banten form a relatively straight line and can be seen in Figures 6 and 7. This shows that the model residuals have normally distributed. The next step is to perform a residual freedom test using the Ljung-Box Test. The Ljung-Box Test on the residual ARIMA model of chili prices in the provinces of Jawa Barat and Banten yields a p-value = 0.88; 0.78. This shows that receiving H0 or residual

random and white noise assumptions are met in the ARIMA model of chili prices in Jawa Barat and Banten Provinces.

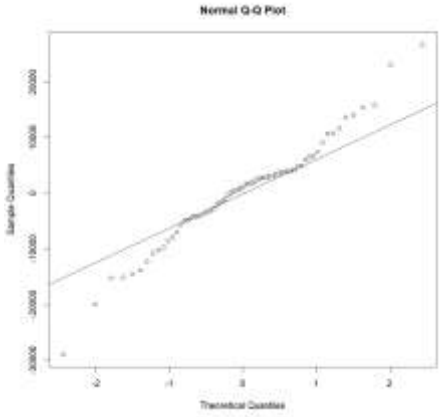

Figure 6
Residual normality test of ARIMA model for chili prices in Jawa Barat Province

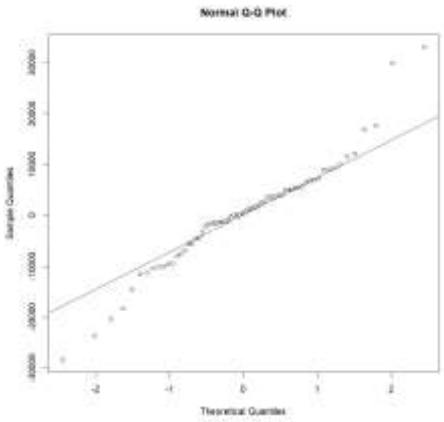

Figure 7
Residual normality test of ARIMA model for chili prices in Banten Province

Sub 5 Effect ARCH Detection Test

Before calculating volatility based on the ARIMA model, it is necessary to check the ARCH effect by conducting the Lagrange Multiplier test (ARCH-LM test). If there is an ARCH effect on the residual model, it is necessary to model using ARCH GARCH. If the p-value > α, it can be concluded that there is no ARCH effect. The test results on the chili ARIMA model in the provinces of Jawa Barat and Banten showed p-values of 0.367 and 0.236, respectively. This shows that the residuals in the ARIMA chili price model (0,1,1) in both Jawa Barat and Banten provinces do not have an ARCH effect so there is no need to form an ARCH GARCH model with the following equation:

Chili Price in Jawa Barat Province (ARIMA (0,1,1))
CHILIJBt = 0,25966 et-1 + et

Chili Price in Banten Province (ARIMA (0,1,1))
CHILIBt = 0,28957 et-1 + et

Sub 6 Volatility

The results of chili forecast data in the provinces of Jawa Barat and Banten using the ARIMA model show relatively stable prices. The volatility of chili prices in Jawa Barat province is 19.68%. Chili price volatility in Banten province is 20.49%. This shows that the volatility level of chili prices in Jawa Barat province is relatively lower than in Banten province, although it is relatively the same and is still under control. This is confirmed by the result that the model has no ARCH effect. The absence of the ARCH effect means that the data is still considered to have relatively the same diversity of variants and is in line with the level of volatility that is still under control despite a number of anomalies such as prices rising significantly in July 2022 due to decreased commodity supply due to reduced supply as a result of high rainfall, transfer of land use to other commodities, changes in cropping patterns/schedules, and increases in pesticide prices in several production centers. In line with Preciosa's research (2019) that Indonesian chili price data has relatively low volatility because it does not have an ARCH effect. This is also the impact of the post-pandemic. (Sadiyah et al., 2021) revealed that the impact of the Covid-19 pandemic was an increase in the price of agricultural commodities which could reach 50%. Irawan, (2007) explains that there are several factors that affect the volatility of chili prices, such as:

1. Vegetable production tends to be concentrated in certain areas.
2. The pattern of production is not synchronized between producing regions.
3. Demand for vegetable commodities is generally very sensitive to product freshness.
4. There are no supply storage facilities capable of efficiently maintaining product freshness.

Fluctuations in food prices have a lot of impact and harm long-term economic growth because they weaken the structure of the productive capital stock and restrict productivity gains that are often linked to the population's health and education. In fact, the development literature contains abundant substantial contemporary microeconomic evidence linking income volatility to lower investment in physical capital, human capital, and even research and development (Jacks et al., 2009).

Increased the volatility price is problematic for investment (Timmer, 2002). It is explains that investment decisions could be blurred by a wrong long term of estimation, estimations that are more complicated because of the

disorderly movements of prices. In such circumstances, it is not the quantity of investment that is at stake, but rather its quality.

Agricultural price and income instability were shown by Verma & Hertel (2009) to cause more erratic food intake. They also emphasized how vulnerable the poorest were to price hikes and changes due to the early malnutrition seen in this group. According to Myers (2006), the economic literature even went as far as to propose formulae connecting volatility with the survival likelihood of the poorest. In fact, it is not unreasonable to think that fluctuations in food prices can cause a decrease in nutritious rations, even below the level needed for subsistence, particularly in the most vulnerable households, and might as a result affect the survival rate.

Agricultural price shocks and volatility threaten the poorest people's access to food and economic welfare, but they also have greater negative consequences on their capabilities, according to Sen (1993). Jensen (2000) uses the phrase "investment in children," which refers to providing children with a healthy diet as well as ongoing education. According to him, "investment in children and the development of human capital are the cornerstones of boosting well-being and breaking the cycle of poverty. They are also important to national growth and economic development."

According to Meerman & Aphane (2012), the tight financial constraints cause both a drop in school attendance and a rise in child work. Health-related spending tends to decline when real household income is lower (drugs or visits to the doctor). Additionally, it is typically linked to a rise in the number of women working, which has a negative impact on the health of the household. After all, women traditionally serve as the primary caregivers, and wage work implies that they have less time to look after the kids, prepare their meals, or breastfeed them. Budget restrictions in some situations may even force the sale of productive assets, which will only serve to further the dynamics of poverty.

CONCLUSIONS AND POLICY IMPLICATIONS

Conclusions

The best ARIMA model for chili price data in Jawa Barat and Banten Provinces is the ARIMA model (0,1,1). The residuals in the ARIMA chili price model (0,1,1) in both Jawa Barat and Banten provinces do not have an ARCH effect so there is no need to form an ARCH GARCH model with the following equation:

Chili Price in Jawa Barat Province (ARIMA (0,1,1))
CHILIJBt = 0,25966 et-1 + et

Chili Price in Banten Province (ARIMA (0,1,1))
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The results of chili forecast data in the provinces of Jawa Barat and Banten using the ARIMA model show relatively stable prices. The volatility of chili prices in Jawa Barat province is 19.68%. Chili price volatility in Banten province is 20.49%. This shows that the volatility level of chili prices in Jawa Barat province is relatively lower than in Banten province, although it is relatively the same and is still under control. This is confirmed by the result that the model has no ARCH effect. The absence of the ARCH effect means that the data is still considered to have relatively the same diversity of variants and is in line with the level of volatility that is still under control despite a number of anomalies such as prices rising significantly in July 2022 due to decreased commodity supply due to reduced supply as a result of high rainfall, transfer of land use to other commodities, changes in cropping patterns/schedules, and increases in pesticide prices in several production centers. This is also the impact of the post-pandemic.

Fluctuations in food prices have a lot of impact and harm long-term economic growth because they weaken the structure of the productive capital stock and restrict productivity gains that are often linked to the population's health and education. Agricultural price shocks and volatility threaten the poorest people's access to food and economic welfare.

Suggestion

Based on the results of research that has been carried out with various limitations, the researchers suggest that the ARIMA model should be used for short-term forecasting because the prediction accuracy value is only for a few future periods. One other method that can be used for long-term forecasting is the Long Memory Model.

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