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ANALYSIS OF TUNA PRICE VOLATILITY IN PRODUCTION CENTERS IN INDONESIA APPLICATION MODEL ARIMA (AUTOREGRESSIVE INTEGRATED MOVING AVERAGE)

Analisis Volatilitas Harga Ikan Tuna Di Sentra-Sentra Produksi di Indonesia Aplikasi Model Arima (Autoregressive Integrated Moving Average)

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ABSTRACT

One of the marine biological resources in Indonesia is tuna which has a high enough economic value so that tuna can be used as one of the mainstays of non-oil and gas exports from the fisheries sector. The purpose of the study included: analyzing the form of the ARIMA model that most appropriately measures the price volatility of tuna fish in production centers in Indonesia and analyzes the price volatility of tuna fish in production centers in Indonesia. The study used 108 months of time series data from January 2012 to December 2020. In this study, the data analysis method used was ARIMA. The results showed that 1) the best models to measure tuna price volatility are National ARIMA model (3,1,2), Aceh model ARIMA (2,1,2), Bali model ARIMA (1,1,12), North Sulawesi model ARIMA (29,1,29), North Maluku model MA (0,1,2) and West Papua model ARIMA (2,1,1), 2) On the data on tuna prices at the producer level that has been analyzed with the best ARIMA model that the volatility of national tuna prices, Aceh, Bali, North Sulawesi, North Maluku and West Papua are high. The price of tuna in North Maluku cannot be analyzed due to the (0,1,2) moving average model.

Keywords: volatility, tuna, model ARIMA

ABSTRAK

Salah satu sumber hayati laut di Indonesia adalah ikan tuna yang memiliki nilai ekonomis cukup tinggi sehingga ikan tuna dapat dijadikan salah satu andalan ekspor non migas dari sektor perikanan. Tujuan penelitian antara lain: menganalisis bentuk model ARIMA yang paling sesuai mengukur volatilitas harga ikan tuna di sentra-sentra produksi di Indonesia dan menganalisis volatilitas harga ikan tuna di sentra-sentra produksi di Indonesia. Penelitian ini menggunakan data time series selama 108 bulan dari bulan Januari tahun 2012 hingga bulan Desember tahun 2020. Dalam penelitian ini, metode analisis data yang digunakan adalah ARIMA. Hasil penelitian menunjukkan bahwa 1) model terbaik untuk mengukur volatilitas harga ikan tuna yaitu Nasional model ARIMA (3,1,2), Aceh model ARIMA (2,1,2), Bali model ARIMA (1,1,12), Sulawesi Utara model ARIMA (29,1,29), Maluku Utara model MA (0,1,2) dan Papua Barat model ARIMA (2,1,1), 2) Pada data harga ikan tuna di tingkat produsen yang telah dianalisis dengan model ARIMA yang terbaik bahwa volatilitas harga ikan tuna Nasional, Aceh, Bali, Sulawesi Utara dan Papua Barat tinggi. Harga ikan tuna di Maluku Utara tidak dapat dianalisi dikarenakan model (0,1,2) model moving average.

Kata kunci: volatilitas, ikan tuna, model ARIMA

INTRODUCTION

Tuna is one of the leading fisheries commodities after shrimp. In 2015, tuna production decreased by 20.2% from 2014 production of 313,873 tons. However, in 2018, tuna production reached 409,024.18 tons, where production increased by 28.31% from 2017 production. A somewhat different phenomenon occurred in shrimp, where in 2017 there was a significant increase of 36.87% from the previous year. In the following year, shrimp production experienced a significant decrease of 42.11%. Similar to tuna and shrimp, squid also experienced an increase in production with an average of 14.06% from 2010 to 2018, where production in 2010 was 94,167 tons and in 2018 was 216,977 tons (Ministry of Marine Affairs and Fisheries, 2020).

In ensuring stable and productive economic growth, it is necessary to encourage price stability and industrialization to maintain social, political, and security stability. Usually, people also want to get stable prices, because large price fluctuations will have a negative impact on the risks and uncertainties that must be considered during the process of getting a decision. Demand and supply have an impact on price fluctuations; To find out the price fluctuations, it can be seen from the volatility (Sumaryanto, 2009).

Volatility is a measure that indicates the fluctuation or magnitude of price fluctuations over a period of time. According to Rosadi, (2011) volatility can be interpreted as a conditional variance of data relative to time. Volatility can be expressed by standard deviation and is commonly called risk. The higher the level of volatility, the higher the level of uncertainty in the return obtained. High volatility means that the price is rising quickly, but it can also fall quickly, while low volatility indicates low prices.

There are many models that previous research has used to measure price volatility, namely ARIMA, ARCH/GARCH and Coefficient of Variation (CV). In this study, the model used is the Autoregressive integrated moving average (ARIMA). ARIMA is one of the time series analysis techniques that is widely used for forecasting future data. In the case of estimating forecasting models, for example, ARIMA is the best model among the alternative models used, such as in the research conducted by Sukiyono et al., (2018) on cocoa commodities, Novanda et al., (2018) on coffee commodities, and Putri & Wiwik, (2018) on chili prices. Further, ARIMA uses the past and present values of the dependent variables to generate accurate short-term forecasts. The ARIMA method can also be used to measure volatility. The best ARIMA model obtained will be used to measure price volatility. This can be seen in the research of Sumaryanto, (2009) which examined the price volatility of several food commodities in Indonesia. From the study, it was concluded that cooking oil and egg commodities are more suitable using the ARIMA model. This is because no ARCH was found in cooking oil and egg commodities. In addition to agricultural commodities that were previously researched, the ARIMA model can also be used to estimate forecasting models on fishery commodities. In previous studies, no one has used the ARIMA model in measuring the volatility of fishery commodity prices. Therefore, the purpose of this study is to estimate and analyze the volatility of Tuna Prices in Production Centers in Indonesia.

METHODS

The data used is secondary data in the form of time series data from 2012:1-2020:12 with a monthly period. The secondary data used is the price of national tuna producers, namely Aceh, Bali, North Maluku, North Sulawesi and West Papua for the period 2012:1–2020:12 obtained from the Central Statistics Agency. This study uses descriptive and quantitative analysis methods. The descriptive analysis method is used to explain and describe tuna price data nationally. Quantitative analysis is used to forecast the price model of tuna producers. Quantitative analysis using the ARIMA Box Jenkins model is as follows:

Stationary Test

Stationary testing is done through root unit testing. In this test, ADF (Augmented Dickey-Fuller) is used with the following equation:

$$\Delta Y_t = \alpha_0 + \gamma Y_{t-1} + \sum_{i=2}^{n} \beta_i \Delta Y_{t-1} + e_t$$

Information:
Y_t= Price data for period t
β_i= i-th autoregresive parameters,
e_t= Error value at t

Model Autoregressive Integrated Moving Average (ARIMA)

The general model of the ARMA process is a mixture of pure p-order (AR) and q-order (MA), which is formulated by the following mathematical equation (Firdaus, 2020).

$$Z_t = \delta + \Phi_1 Z_{t-1} + \Phi_1 Z_{t-1} + \cdots + \varepsilon_t - \Theta_1 \varepsilon_{t-1} - \Theta_2 \varepsilon_{t-2} - \cdots - \Theta_q \varepsilon_{t-q}$$

Z_t = Price data for period t
Z_{t-1}, Z_{t-2},..., ε_{t-1},ε_{t-2},... = Value of previous period price data
ε_t = Error value at t
δ, Φ_1, Φ_2, ..., Θ_1, Θ_2, ... = Parameters (constants and coefficients) of regression analysis;

Determining the Value of Volatility

The measurement of volatility is indicated by the standard deviation value which is the root mean square percentage error of the estimated ARIMA models. RMSPE is a measure of volatility that focuses on the uncertainty aspect of volatility. RMSPE can be represented as follows: (Daly, 2011)

$$RMSPE = 100\sqrt{\frac{1}{T}\sum_{t=1}^{T}\left(\frac{E_t - E_{t-1}}{E}\right)^2}$$

E_t = Actual price data
E_{t-1} = Forecast data
E = Mean

RESULT

Uji Stationary Test

The results of the ADF test of stationary data are seen as the probability value, where the probability value is less than the critical value. Critical values are used at a level of accuracy of 5% or 0.05. The following is a tuna ADF test table.

Table 1. ADF Results

Variabel	ADF			
	Level	Conclusion	*First Difference I(1)*	Conclusion
Nasional	0,7905	Not Stationer	0,0000	Stasioner
Aceh	0,5609	Not Stationer	0,0000	Stasioner
Bali	0,7258	Not Stationer	0,0000	Stasioner
Sulawesi Utara	0,7311	Not Stationer	0,0000	Stasioner
Maluku Utara	0,1130	Not Stationer	0,0000	Stasioner
Papua Barat	0,5094	Not Stationer	0,0000	Stasioner

Source: Secondary Data, 2022 (processed)

The results of the ADF (Augmented Dickey Fuller Test) test in the table above with a real level of 5% which produces a probability value of > 0.05 so that the tuna price data can be concluded stationary at the level of first difference. For example, the probability value in the Aceh Market variable is 0.0000 where the value is less than the critical value. This also happens with all five other market variables. The values obtained show that the probability values of the six variables at the stationary level of first difference are smaller than the critical value, which is 5 percent or equal to 0.05.

National ARIMA Model

After detecting the data station problem, the next step is to identify the right ARIMA model by looking at the ACF and PACF correlograms. In accordance with the general form of ARIMA (p,d,q), several ARIMA models have been tested to find the best model. In selecting the best ARIMA models, the six models that were tested were estimated with Eviews software so that they produced output. In this study, the best model selection is to look at the smallest Akaike Information Criterion (AIC) and Schwarz's Information Criterion (SIC) values. The following is a recapitulation of the 6 ARIMA models by looking at the AIC and SIC models respectively:

Table 2. National ARIMA Model

Model	AIC	SIC	Conclusion
2,1,3	14.37387	14.54873	
2,1,4	14.48418	14.68402	
2,1,5	14.49283	14.71765	
2,1,6	14.50515	14.75494	
3,1,1	14.64432	14.55521	
3,1,2	14.37363	14.54849	Best Models
3,1,3	14.41801	14.61785	
3,1,4	14.40712	14.63194	
3,1,5	14.40785	14.65764	
3,1,6	14.42470	14.69948	
4,1,1	14.49971	14.67457	

Source: Eviews Output Results (Processed)

Table 3.2, the national best model is ARIMA (3,1,2) with an AIC value of 14.37363 and a SIC value of 14.54849 which is the smallest value. Thus, the ARIMA model (3,1,2) can be selected as the best model to be used in estimating the level of volatility in the price data of tuna at the national producer level. The equation of the ARIMA model (3,1,2) is as at:

$$Z_t = \delta + \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + \cdots + \varepsilon_t - \Theta_1 \varepsilon_{t-1} - \Theta_2 \varepsilon_{t-2} - \cdots - \Theta_q \varepsilon_{t-q}$$

$$Z_t = 119.5385 + 0.821467Z_{t-1} - 0.823193Z_{t-2} - 0.174059Z_{t-3} + 1.029826\varepsilon_{t-1} - 0.999999\varepsilon_{t-2}$$

ARIMA Aceh Model

Tuna price data in the Aceh market that has been tested stationary, the next stage is to identify the right ARIMA model by looking at the ACF and PACF correlograms. In accordance with the general form of ARIMA (p,d,q), where the p value is the autoregressive determination model, the q value is the determining moving average model. The general form of the ARIMA model (p,d,q) there are 14 models that are tested by the best ARIMA which are estimated as follows:

Table 3. Arima Aceh Model

Model	AIC	SIC	Conclusion
1,1,1	17.51317	17.61309	
1,1,2	17.53126	17.65616	
1,1,3	17.50444	17.65431	
1,1,4	17.45873	17.63359	
2,1,1	17.53170	17.65659	
2,1,2	17.41250	17.56238	Best Models
2,1,3	17.42603	17.60088	
2,1,4	17.47448	17.67431	
3,1,1	17.47429	17.62417	
3,1,2	17.49221	17.66706	
3,1,3	17.42290	17.62273	

Source: Eviews Output Results (Processed)

In the selection of the best ARIMA models, the 11 models above are estimated with Eviews software so as to produce output. The best model is said to have the smallest AIC and SIC values. The results of the recapitulation show that the smallest AIC and SIC values are the ARIMA model (2,1,2) where the AIC and SIC values are 17.41250 and 17.56238, respectively. The equation of the ARIMA model (2,1,2) is as follows:

$$Z_t = \delta + \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + \cdots + \varepsilon_t - \Theta_1 \varepsilon_{t-1} - \Theta_2 \varepsilon_{t-2} - \cdots - \Theta_q \varepsilon_{t-q}$$

$$Z_t = 159.3758 - 1.683982Z_{t-1} - 0.886084Z_{t-2} - 1.641748\varepsilon_{t-1} - 0.768233\varepsilon_{t-2}$$

ARIMA Bali Model

The determination of the ARIMA general model (p,d,q) for tuna price data in the Bali market was carried out by stationary data test. Tuna price data in the Bali market no longer contains seasonal elements (has been stationary) at the first differencing level with a d-order value of 1, the next stage is to determine the best ARIMA model by looking at the smallest Akaike Information Criterion (AIC) and Schwarz's Information Criterion (SIC) values.

Table 4. Recapitulation of the ARIMA Bali Model

Model	AIC	SIC	Conclusion
12,1,1	17.48410	17.85880	
12,1,2	17.48447	17.88415	
12,1,3	17.49880	17.92346	
12,1,4	17.50589	17.95553	
12,1,5	17.51054	17.98515	
1,1,12	17.48096	17.85566	Best Models

2,1,12	17.49937	17.89904	
3,1,12	17.50467	17.92933	
4,1,12	17.50905	17.95869	
5,1,12	17.49288	17.96749	
6,1,12	17.52460	18.02419	

Source: Eviews Output Results (Processed).

Based on table 4, the recapitulation results show that ARIMA (1,1,12) is the best model, with the smallest AIC and SIC values of 17.48096 and 17.85566, respectively. Models (1,1,12) can be used to estimate volatility values. The equation of the ARIMA model (1,1,12) is:

$$Z_t = \delta + \Phi_1 Z_{t-1} + \Phi_1 Z_{t-1} + \cdots + \varepsilon_t - \Theta_1 \varepsilon_{t-1} - \Theta_2 \varepsilon_{t-2} - \cdots - \Theta_q \varepsilon_{t-q}$$

$$Z_t = 174.8667 + 0.364971 Z_{t-1} + 0.440979 \varepsilon_{t-1} + 0.162448 \varepsilon_{t-2} - 0.051069 \varepsilon_{t-3} + 0.022237 \varepsilon_{t-4} + 0.034684 \varepsilon_{t-5} - 0.086711 \varepsilon_{t-6} + 0.090401 \varepsilon_{t-7} + 0.007874 \varepsilon_{t-8} - 0.037293 \varepsilon_{t-9} + 0.198438 \varepsilon_{t-10} - 0.078770 \varepsilon_{t-11} + 0.292521 \varepsilon_{t-12}$$

ARIMA North Sulawesi Model

The price data in the North Sulawesi market is already stationary, so the next step is to identify the right ARIMA model by looking at the ACF and PACF correlograms. In accordance with the general form of ARIMA (p,d,q), there are 11 models that will be tested in the best ARIMA that are estimated, namely:

Table 5. ARIMA North Sulawesi Model

Model	AIC	SIC	Conclusion
27,1,26	16.27794	16.37785	
27,1,27	16.28447	16.38439	
28,1,26	16.28248	16.38240	
28,1,27	16.26326	16.36318	
28,1,28	16.27657	16.37649	
29,1,26	16.25339	16.35331	
29,1,27	16.23633	16.33625	
29,1,28	16.23714	16.33706	
29,1,29	16.23594	16.33586	Best Models
29,1,30	16.24937	16.34929	
29,1,31	16.25108	16.35100	

Source: Eviews Output Results (Processed)

In the selection of the best ARIMA models, the 11 models above are estimated so that they produce output. The ARIMA model (29,1,29) is the best model. This is because it has the smallest AIC and SIC values, which are 16.23594 and 16.3358, respectively. The equation of the ARIMA(29,1,29) model is as follows:

$$Z_t = \delta + \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + \cdots + \varepsilon_t - \Theta_1 \varepsilon_{t-1} - \Theta_2 \varepsilon_{t-2} - \cdots - \Theta_q \varepsilon_{t-q}$$

$$Z_t = 54.07352 - 0.749285 Z_{t-29} + 0.518984 \varepsilon_{t-2}$$

ARIMA North Maluku Model

After the price data in the North Maluku market is tested for stationarity and the data has been stationary, the best ARIMA model is determined by looking at the smallest Akaike Information Criterion (AIC) and Schwarz's Information Criterion (SIC) values. The following is a table of ARIMA models that are being tested:

Table 6. ARIMA North Maluku Model

Model	AIC	SIC	Conclusion
0,1,1	16.52565	16.60059	
0,1,2	16.52480	16.60063	Best Models
0,1,3	16.55707	16.68197	
0,1,4	16.56672	16.71660	
0,1,5	16.57928	16.75414	
0,1,6	16.59782	16.79766	
0,1,7	16.61479	16.83960	

Source: Eviews Output Results (Processed)

Of the 7 models that have been tested, the smallest AIC and SIC values are the ARIMA model (0,1,2). Where the AIC and SIC values are 16.52480 and 16.60063, respectively. This model cannot be used to estimate the volatility of tuna prices in North Maluku, this is seen as the general form of the MA model is (q) while the (0,1,2) model has a value of the order p (0) and q (2) so that the model is an MA model. The equation of the MA model (2) can be seen:

$$Z_t = \delta + \varepsilon_t - \Theta_1\varepsilon_{t-1} - \Theta_2\varepsilon_{t-2} - \cdots - \Theta_q\varepsilon_{t-q}$$

$$Z_t = -1987.703 + 0.025767\varepsilon_{t-1} - 0.105600\varepsilon_{t-2}$$

West Papua ARIMA Model

Price data in the West Papua market that has been stationary is the next step to determine the best ARIMA model. The determination of the ARIMA model was carried out by testing several models, from these models to see the best ARIMA model seen from the smallest AIC and SIC values. Here are the ARIMA models that are being tested:

Table 7. West Papua ARIMA Model

Model	AIC	SIC	Conclusion
1,1,1	18.86189	18.96369	
2,1,1	18.83879	18.96181	Best Models
3,1,1	18.85742	19.00730	
1,1,2	18.84346	18.96836	
2,1,2	18.85739	19.00727	
3,1,2	18.87448	19.04934	
1,1,3	18.86020	19.01008	
2,1,3	18.87555	19.05041	
3,1,3	18.89225	19.09209	

Source: Eviews Output Results (Processed)

Table 5.15 presents that seven models were tested to determine the best model. The model (2,1,1) is the best model that has the smallest AIC and SIC values of 18.83879 and 18.96181. The ARIMA model (2,1,1) will be used to estimate the value of tuna price volatility in West Papua. The equation of the model (2,1,1) ish:

$$Z_t = \delta + \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + \cdots + \varepsilon_t - \Theta_1\varepsilon_{t-1} - \cdots - \Theta_q\varepsilon_{t-q}$$

$$Z_t = 50.06879 - 0.770068Z_{t-1} - 0.311463Z_{t-2} - 0.582067\varepsilon_{t-1}$$

Tuna Price Volatility

The price of tuna nationally and in the five provinces in Indonesia has a high volatility value. The following are the results of tuna price volatility:

Table 8. Tuna Price Volatility

Market	Model	AIC	SIC	RMSE	Volatility (%)	Conclusion
Nasional	3,1,2	14.37363	14.54849	1.371,383	137.138,30	High
Aceh	2,1,2	17.41250	17.56238	4.162,336	416.233,60	High
Bali	1,1,12	17.48096	17.85566	2.959,871	295.987,10	High
North Sulawesi	29,1,29	16.27574	16.42562	1.744.702	174.470,2	High
North Maluku	0,1,2	16.52480	16.60063	1.960,597	-	-
West Papua	2,1,1	18.83879	18.96369	12.407,98	1.240.798	High

Source: Eviews Output Results

DISCUSSION

The national ARIMA model of Aceh, Bali, North Sulawesi and West Papua from the above tuna prices produced a high volatility value, while the price data of North Maluku produced an MA model (0,1,2) so that the volatility results could not be identified. The RMSE produced by the MA model is to measure the accuracy of data. The volatility value of national tuna prices is very high, this is due to the amount of production. The amount of tuna production is influenced by tuna fishing gear. Tuna fishing in Indonesia is still dominated by small-scale fishermen with simple fishing gear (API) such as fishing rods (handlines). In addition, the fleet of large tuna fishing vessels in Indonesia is still very small so that tuna production is still unstable which makes the decrease in tuna supply cause unfulfilled consumer demand that is erratic and even increases every day (KKP, 2019).

Furthermore, the high volatility of tuna prices in Aceh is due to the lack of tuna supply due to bad weather such as strong winds and high waves. The low catch makes some fishermen not go to sea because if they sail, they will incur quite high costs that can harm fishermen because they are not in accordance with the income received. (Amiruddin, 2021). In addition, tuna in Aceh is experiencing a famine season, where many fish groups are not at the surface of the middle of the sea, so that fishermen who have spread fishing nets get little tuna / the catch has declined. This phenomenon is called the fish famine season. This season occurs every year from December to February (Rahman & Razi, 2021).

The high price volatility in Bali is influenced by several factors, one of which is the number of fish availability that cannot meet consumer demand. In 2020, the value of tuna production in Bali Province is the largest in Indonesia, which is 281,429 tons (Central Statistics Agency, 2019). In 2020, tuna is the only export commodity that has developed positively compared to other marine commodities. The Balinese market tuna is exported to several countries, namely the United States, Japan, New Zealand, Australia, and Saudi Arabia (Satrya, 2021). The high export of tuna in Bali is due to the price of tuna in the International Market is more expensive than in the local market. The large number of tuna exported to destination countries makes the supply of tuna fish in the local/domestic market. The lack of tuna production in the local market makes the unmet demand of consumers who are not constant every day and even increase due to the increase in population.

The high volatility of tuna prices in North Sulawesi is due to the reduced amount of tuna production offered to the local market. Tuna is a fishery commodity with high economic value and has a wide market share abroad. BPS data in 2018, the export quantity of tuna, cob and skipjack commodities from North Sulawesi obtained 21.5 million Kg, with revenues of around USD,129 million. The high export of tuna to export destination countries has made the availability of tuna in the local market decrease. This makes consumer demand unfulfilled due to the scarcity of tuna. In addition, the decline in tuna production in North Sulawesi is also caused by extreme negligence. The decline in fish production in the local market has caused a surge in fish prices. This causes price movements that make price uncertainty, commonly called tuna price volatility in North Sulawesi, high.

The high price volatility in West Papua is influenced by the lack of tuna production in the local market due to the impact of bad weather conditions such as strong winds and high waves. This makes fishermen's catches decrease so that consumer demand is not met, while consumer demand for tuna fish is constant every day and even increases (Heatubun, 2019). In addition, West Papuan tuna production is also exported to several destination countries, namely the European Union and Japan (Pasific pos, 2019).

In addition, West Papuan tuna production is also exported to several destination countries, namely the European Union and Japan (Pacific post, 2019). If the price of tuna is more expensive in the export market than in the local market, then producers prefer to sell their products to the export market. Producers will also respond to the amount of tuna production sold to the export market. Price increases will be responded to by producers to increase production (Hidayati, et al., 2017). This event has reduced the amount of tuna production in the local market which cannot meet consumer demand. This makes the price of tuna in the local market increase. Therefore, the volatility of tuna prices is influenced by demand and supply which results in price fluctuations. On the demand side, if the price of tuna decreases, the demand for fish will increase and if the price of tuna rises, the demand for tuna decreases. This causes price changes that cause price uncertainty. This price uncertainty is a problem of volatility, high volatility causes the price of tuna to rise and fall drastically so that it experiences a large difference at a certain time.

High volatility in tuna prices is that the increase in tuna prices is quite high (soaring) and also occurs in a short period of time. In economic theory, the concept of volatility is related to the movement or surge in tuna prices, price movements that are difficult to predict are due to several external factors that are difficult to control (Nurmapika et al., 2018). The role of price is also very important in economic analysis, especially in production and consumption. The price increase will be responded by producers to increase production (Hidayati et al., 2017).

CONCLUSION

The results of the study of the development of tuna prices in production centers in Indonesia during the 2012-2020 period generally show high fluctuations and it is projected that the price of tuna will continue to fluctuate in the future. Fluctuations in tuna prices are caused by several things such as weather factors, demand, supply, and lack of supply of tuna in the local market so that consumer demand is not met, where consumer demand for tuna is constant every day, even increasing due to the increase in population. This can result in price changes that are difficult to predict so that price uncertainty arises, commonly called price volatility. Therefore, to prevent high price volatility, producers need to carry out price stability policies in the local market. One of the policies that can be done to stabilize tuna prices is to increase the amount of production by increasing the number of ship fleets and the number of tuna fishing vessels to increase tuna production, so that tuna production can respond more quickly to price changes that occur. In addition, further research is needed by educational institutions and institutions as well as research on factors affecting tuna prices in Indonesia to further deepen the analysis of the causes of price volatility.

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REFERENCES

Amiruddin. (2021). Suplai Berkurang Harga Ikan Laut di Aceh Tinggi.

Badan Pusat Statistik. (2019). *Nilai Produksi Ikan Tuna Provinsi Bali Terbesar di Indonesia*.

Badan Pusat Statistik. (2020). *Statistik Harga Produsen Pertanian Subsektor Peternakan dan Perikanan 2012-2019*. Jakarta: Badan Pusat Statistik.

Daly, K. (2011). An Overview of the Determinants of Financial Volatility: An Explanation of Measuring Techniques. *Modern Applied Science, 5*(5), 46. DOI:10.5539/mas.v5n5p46

Firdaus, M. (2020). *Aplikasi Ekonometrika dengan E-views, Stata dan R*. PT Penerbit IPB Press.

Hidayati, S., Darawanto, D. H.& Mashyuri. (2017). *Kinerja Ekspor Ikan Tuna Indonesia*. Yogyakarta: Penerbit ANDI.

Heatubun, D. (2019). Kenaikan Harga Ikan Segar Penyebab Inflasi di Papua Barat.

Kementerian Kelautan dan Perikanan, (2019). *Mengapa Penangkapan Tuna Masih Didominasi Nelayan Skala Kecil*.

Kementerian Kelautan dan Perikanan. (2020). *Produksi Perikanan.*

Novanda, R. R., Sumartono, E., Asriani, P. S., Yuliarti, E., Sukiyono, K., Priyono, B. S., Irnad, Reswita, Suryanty, M., & Octalia, V. (2018). A Comparison of Various Forecasting Techniques for Coffee Prices. *In Journal of Physics: Conference Series*, 1114(1), 12119.

Nurmapika, R., & Nurliza, I. (2018). Analisis Volatilitas Harga Komoditas Pangan Strategis di Provinsi Kalimantan Barat (Studi Kasus Pasar Flamboyan Pontianak). *Jurnal Social Economic of Agriculture*, *7*(1). 10.26418/j.sea.v7i1.30751

Pos, Pasific. (2019). Jenis Ikan ini Diekspor Ke Jepang, Cina, dan Eropa.

Putri, M. C. K., & Anggraeni, W. (2018). Penerapan Metode Campuran Autoregressive Integrated Moving Average dan Quantile Regression (ARIMA-QR) untuk Peramalan Harga Cabai sebagai Komoditas Strategis Pertanian Indonesia. *Jurnal Teknik ITS, 7*(1), 132-137.

Rahman, M., & Razi. (2021). Diakse dari Mengantisipasi Dampak Musim Paceklik Ikan pada Masa Pandemi.

Rosadi, D. (2011). *Analisis Ekonometrika dan Runtun Waktu Terapan dengan R.* Yogyakarta: Andi Offset.

Satrya, I, G, N. (2021). Digemari Konsumen Luar Negeri, Ekspor Ikan Tuna dari Bali Masih Tumbuh Positif Meski Ada Pandemi.

Sukiyono, K., & Rosdiana, R. (2018). Pendugaan Model Peramalan Harga Beras pada Tingkat Grosir. *Jurnal AGRISEP: Kajian Masalah Sosial Ekonomi Pertanian dan Agribisnis, 17*(1): 23-30.

Sumaryanto, N. (2009). Analisis Volatilitas Harga Eceran Beberapa Komoditas Pangan Utama dengan Model ARCH/GARCH. *Jurnal Agro Ekonomi*, *27*(2), 135.