Forecasting Monthly Prices of Selected Fish Commodities in National Capital Region in The Philippines Through ARIMA Modeling

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Abstract*— The researchers aim to analyze the behavior of the prices of selected fish commodities in National Capital Region like bangus (milkfish), tilapia (cichlid fish), galunggong (blue mackerel scad), alumahan (long-jawed mackerel), tambakol (yellowfin tuna), dalagangbukid (mountain maiden), alimasag (crab), pusit (squid), hipon (shrimp) and lato (sea grapes) from data gathered for the years 2016-2022. A total of 84 observations and 10 variables are used in this research. The data were gathered from the Bureau of Fisheries and Aquatic Resources. This study used an application of EVIEWS to forecast prices of these selected fish commodities from 2023-2027 using the ARIMA model (Autoregressive Integrated Moving Average). The researchers followed a research paradigm to be applied to the data to come up with the expected output. The study showed the best ARIMA models for bangus ARIMA (1,1,1), tilapia ARIMA (1,1,1) galunggong ARIMA (1,1,1), alumahan ARIMA (1,1,1), tambakol ARIMA(1,2,1), dalagangbukid ARIMA (8,1,8), alimasag ARIMA (6,1,6), pusit ARIMA (12,1,12), hipon ARIMA (1,1,1), and lato ARIMA (3,1,3). This study will be of importance in assessing future prices that affect the economy.

***Indexed Terms*— ARIMA, EViews, Fishery, Forecasting, Prices**

I. INTRODUCTION

The Philippines is located within the coral triangle, which dubbed the archipelagic country as the center of the center of marine biodiversity (Carpenter and Springer, 2005). One of the major sources of livelihood in the country is fishing and most of the fishers are involved in capture fishing while others are involved in aquaculture, vending, gleaning, and processing. In 2018, the contribution of the fisheries sector to the gross domestic product of the country was 1.2 % and 1.3 % at current and constant prices, respectively. Out of the estimated population of 105 million people, about 82 million are fish eaters and each one consumes about 38.2 kg of fish per year (BFAR, 2018).

In 2018, tuna products (fresh, chilled, frozen, smoked, dried, or canned) were the top exported commodities with a volume of about 171,452 t valued at more than US$ 492 million. Other major fish and fishery products include seaweed, crab, shrimp/prawn, octopus, grouper, squid, sea cucumber, ornamental fish, and roundscad. (BFAR, 2018).

As the whole world are slowly recovering from the pandemic happened in 2019 including the Philippines, more production from different industries are evident including Fisheries. The Department of Agriculture (DA) assures consumers that fish supply and prices have stabilized, particularly in the National Capital Region (NCR) and adjoining provinces of Bulacan, Rizal, Cavite, and Laguna, collectively known as NCR plus. (DA Communications Group, 2021)

A. Objective of the Study

This research aims to study the behavior of the prices for years 2016-2022 of the following fresh fish commodities:

- Bangus
- Tilapia
- Galunggong
- Alumahan
- Tambakol

- Dalagang bukid
- Alimasag
- Pusit
- Hipon
- Lato

Figure 1. Conceptual Framework

And to forecast its prices for the next five years (2023-2027) using Autoregressive Integrated Moving Average (ARIMA) modeling.

B. Conceptual Framework

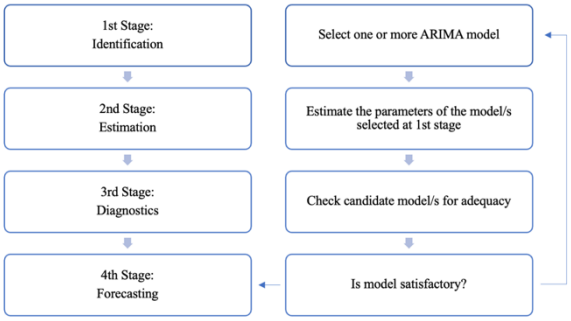

Figure 1. Conceptual Framework

In this study, gathered data of monthly prices of selected fish commodities from 2016 to 2022 were used to forecast the prices of the selected fish commodities for the next five years, 2023 to 2027 using ARIMA Model in application of EVIEWS (Econometric Views).

C. Statement of the Problem

This study is conducted to forecast prices of Fish Commodities in the National Capital Region using the ARIMA model with the application of EViews. Specifically, the point of this study is to answer the following questions:

1.What is the behavior of prices of the selected fish commodities between 2016-2022?

2.What are the forecasted prices of selected fish commodities for the year 2023-2027?

2.1 Bangus
2.2. Tilapia
2.3 Galunggong
2.4 Alumahan
2.5 Tambakol
2.6 Dalagang Bukid
2.7 Alimasag
2.8 Pusit
2.9 Hipon
2.10 Lato

D. Scope and Limitations

The data were gathered from the Bureau of Fisheries and Aquatic Resources with a total of 84 observations and 10 variables were used in this research between 2016 to 2022. The study will forecast the monthly price for the next five years (2023-2027) of the fishery commodities in National Capital Region in the Philippines such as bangus, tilapia, galunggong, alumahan, tambakol, dalagang bukid, alimasag, pusit, hipon and lato using Autoregressive Integrated Moving Average (ARIMA) through Box-Jenkins Approach.

II. REVIEW OF RELATED LITERATURE

The Coral Triangle is a marine area located in the western Pacific Ocean. It includes the tropical waters of Philippines, Indonesia, Malaysia, Papua New Guinea, Timor Leste and Solomon Islands. Located at the apex of the coral triangle is the Philippine Archipelago, dubbed as the center of the center of marine biodiversity. The Philippines is composed of 7,641 islands with a total land area of 301,000 sq km, territorial waters of 2,200,000 sq km and the coastline of 36,289 km (Carpenter and Springer, 2005).

Philippine Fisheries is known as one of the major fish producing countries. The Philippine fisheries sector is categorized into commercial fisheries, municipal fisheries and aquaculture. Commercial fisheries refer to capture fishing operations using fishery vessels of over 3 gross tons outside the municipal waters whereas Municipal fisheries refer to capture fishing operations using fishery vessels of 3 gross tons or less including other sources of forms of fishing not involving the use of watercraft. Aquaculture, on the other hand, involves fish culture activities in inland and marine waters (SEAFDEC, 2022)

According to Namisi (2005), few of the major factors identified to influence the price demand of fish in the market include environmental change, quality of fish, water pollution, location and the price demand of key informants. Knowing the factors that affect the market value of fish can help the producer and consumers create and establish the buying and selling strategies.

In the study of Savin, et.al, (2010), fish prices may vary considerably by different factors; however, the more educated producers and consumers are about the process, the better their chances to address the problems of both the fisherman and consumers and make a good profit

In the study by Alapan (2019), the market price differential is dependent on the varying factors, which include the quality of fish, fishing location, weather condition, water pollution, and price demand. These factors give a significant influence on formulating the market price of fish when there is a high purchasing power of consumers, abundant fish population, inaccessible fishing areas, weather conditions, and water pollution.

Fisheries are a strategically important factor because it has a positive nutritional effect as a source of necessary protein and essential nutrients (Prein and Ahmed, 2000; Irz et al., 2007)1. Total fish consumption has been rising steadily with increases in production (Cuvin-Aralar et al., 2016).

In the study of Suh and Pomeroy (2022), climate change will affect the fisheries over a long period of time. Accordingly, it means that the Philippines must prepare itself to get ready for the impact and endeavor to mitigate climate change. The climate change impacts on marine capture fisheries in the Philippines is projected to cause a decrease by about 9% of fisheries GDP with the mitigation scenario and about 18% of GDP with the extreme scenario up to 2060, compared to the baseline scenario. This impact results in income reduction by as much as 0.36% for urban households and 0.38% for rural households in the Philippine economy. In addition, urban-rural income disparity increases because loss for rural households is slightly higher than that of urban households.

In the study of Ferrer et al., (2021), The impacts of COVID-19 are both direct and indirect, the fishers were affected directly due to lack of financiers and middlemen to transport their products.

In the paper of Tahiluddin, A. B. & Terzi, E. (2021) entitled An Overview of Fisheries and Aquaculture in the Philippines, the Philippines is one of the significant contributors to world fisheries. In 2018, the total production from the three fishery sectors was approximately 4.36 million MT. With this, the Philippines ranked 13th as the top fish-producing country and placed 4th as the major seaweed producer worldwide. The authors emphasized that the Philippine fisheries sector is an essential contributor to the national economy.

In the study of Urrutia, J. et al. (2015). “Modeling and forecasting the exchange rate of the Philippines: A time series Analysis. The study used the ARIMA model to forecast the Exchange Rate of the Philippines. The researchers were able to formulate an ARIMA model for the 6-year forecast of Exchange rate in the Philippines after considering all the assumptions in ARIMA modeling.

Another study of Urrutia, J. et al. (2015) Forecasting Income Tax Revenue of the Philippines using Autoregressive Integrated Moving Average (ARIMA) modeling: A Time Series Analysis emphasized the usage of ARIMA to create a model wherein the predicted values obtained from the model with 99% coefficient of determination reveals that there is no significant difference between the actual values of Income Tax Revenue examined through Paired T-Test.

In the study of Urrutia, J. et al. (2018), where it used ARIMA modeling to develop a best model that will forecast the electricity rate distribution utilities per region in Luzon. The study revealed that there were no significant differences between the actual and forecasted values.

Forecasting Philippines Imports and Exports Using Bayesian Artificial Neural Network and Autoregressive Integrated Moving Average was conducted by Urrutia, J. et al (2017), showed two models in forecasting the imports and exports of the

Philippines. It was determined the best fit among the models in forecasting the imports and exports of the Philippines. The study could help the economy of the Philippines by considering the forecasted Imports and Exports which can be used in analyzing the economy's trade deficit.

III. METHODOLOGY

In this research, Econometrics View or EViews are the statistical tools used by the researchers to observe the behavior of prices of selected fresh commodities from data gathered for the years 2016 to 2022 then to forecast prices from 2023 to 2027

The relevant data needed for the study is monthly data of prices of chosen fishery commodities from 2016 to 2022. These data were obtained from the Bureau of Fisheries and Aquatic Resources and Philippine Statistics Authority.

A. Box-Jenkins Methodology

The Box-Jenkins Model forecasts data using three principles: autoregression, differencing, and moving average, An ARIMA model is labeled as an ARIMA model (p, d, q), wherein: p is the number of autoregressive terms; d is the number of differences; and q is the number of moving averages. This methodology is predicated on the assumption that past occurrences influence future ones. The three stages are: Identification, Estimation, Diagnostic and Forecasting.

In checking stationarity of variables this study uses Graph, Correlogram and Formal tests (ADF, PP, KPSS). First step is Identification, Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) suggest possible models to estimate all possible candidate models. Possible candidates must be stationary and parsimonious model that fits the data well. Lastly, residuals of the models are White Noise (Ljung-Box Q Statistic) and AR and MA roots are stationary and lie within the circle.

A nonseasonal ARIMA model is classified as an "ARIMA(p,d,q)" model, where:

- p is the number of autoregressive terms,
- d is the number of nonseasonal differences needed for stationarity, and
- q is the number of lagged forecast errors in the prediction equation.

The forecasting equation is constructed as follows. First, let y denote the d^{th} difference of Y, which means:

If d=0: $yt = Yt$

If d=1: $yt = Yt - Yt\text{-}1$

In terms of y, the general forecasting equation is:

$$\hat{y}t = \mu + \phi 1\, yt\text{-}1 + \ldots + \phi p\, yt\text{-}p - \theta 1 et\text{-}1 - \ldots - \theta q et\text{-}q$$

Here the moving average parameters (θ's) are defined so that their signs are negative in the equation, following the convention introduced by Box and Jenkins.

To identify the appropriate ARIMA model for Y, you begin by determining the order of differencing (d) needing to stationarize the series and remove the gross features of seasonality, perhaps in conjunction with a variance-stabilizing transformation such as logging or deflating. If you stop at this point and predict that the differenced series is constant, you have merely fitted a random walk or random trend model. However, the stationarized series may still have autocorrelated errors, suggesting that some number of AR terms ($p \geq 1$) and/or some number MA terms ($q \geq 1$) are also needed in the forecasting equation.

1. Identification

a. Augmented Dickey Fuller Test

An Augmented Dickey Fuller Test (ADF) is a test for a unit root in a time series sample. It is an augmented version of the Dickey-Fuller Test for a larger and more complicated set of time series models. The Augmented-Dickey Fuller (ADF) statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence.

Null Hypothesis: D(BANGUS) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-13.28872	0.0000
Test critical values:	1% level	-2.593468	
	5% level	-1.944811	
	10% level	-1.614175	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(BANGUS,2)
Method: Least Squares
Date: 02/13/23 Time: 17:18
Sample (adjusted): 2016M03 2022M12
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(BANGUS(-1))	-1.371094	0.103177	-13.28872	0.0000

R-squared	0.685547	Mean dependent var	0.000000
Adjusted R-squared	0.685547	S.D. dependent var	14.71960
S.E. of regression	8.254181	Akaike info criterion	7.071437
Sum squared resid	5518.652	Schwarz criterion	7.100787
Log likelihood	-288.9289	Hannan-Quinn criter.	7.083221
Durbin-Watson stat	2.108443		

Figure 2. Augmented Dickey Fuller Test

b. Correlogram

Also known as Auto Correlation Function (ACF) plot, is a graphic way to demonstrate serial correlation in data that doesn't remain constant with time. A correlogram gives a fair idea of autocorrelation between data pairs at different time periods. It's used as a tool to check randomness in a data set which is done by computing autocorrelations for data values at different time lags.

Date: 02/13/23 Time: 17:19
Sample (adjusted): 2016M02 2022M12
Included observations: 83 after adjustments

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.381	-0.381	12.458	0.000
		2	0.005	-0.164	12.460	0.002
		3	-0.025	-0.102	12.516	0.006
		4	0.047	-0.003	12.711	0.013
		5	-0.118	-0.125	13.981	0.016
		6	0.047	-0.059	14.180	0.028
		7	0.047	0.030	14.381	0.045
		8	-0.018	0.011	14.412	0.072
		9	-0.036	-0.033	14.537	0.104
		10	-0.084	-0.151	15.211	0.125
		11	0.058	-0.057	15.541	0.159
		12	0.023	0.019	15.591	0.211
		13	-0.000	0.016	15.591	0.272
		14	0.032	0.041	15.699	0.332
		15	-0.100	-0.113	16.740	0.335
		16	0.118	0.061	18.199	0.312
		17	-0.069	0.013	18.706	0.346
		18	0.062	0.054	19.130	0.384
		19	-0.071	-0.047	19.691	0.413
		20	0.110	0.046	21.034	0.395
		21	0.069	0.211	21.575	0.424
		22	-0.120	0.024	23.238	0.388
		23	-0.080	-0.135	23.981	0.405
		24	0.155	0.059	26.863	0.311
		25	-0.196	-0.153	31.534	0.172
		26	0.111	0.059	33.051	0.161
		27	-0.007	-0.000	33.057	0.195
		28	0.088	0.076	34.040	0.200
		29	-0.180	-0.097	38.272	0.116
		30	0.009	-0.132	38.282	0.143
		31	0.111	0.129	39.950	0.130
		32	-0.094	-0.105	41.165	0.129
		33	0.135	0.114	43.754	0.100
		34	-0.022	0.042	43.823	0.121
		35	-0.023	-0.027	43.898	0.144
		36	-0.149	-0.120	47.235	0.100

Figure 3. Correlogram

2. Estimation

Equation Estimation

Specification Options

Equation specification

Dependent variable followed by list of regressors including ARMA and PDL terms, OR an explicit equation like Y=c(1)+c(2)*X.

d(bangus,1) c ar(1) ma(1)

Dependent Variable: D(BANGUS,1)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/23 Time: 17:21
Sample: 2016M02 2022M12
Included observations: 83
Convergence achieved after 44 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.776982	0.423651	1.834012	0.0704
AR(1)	0.123712	0.151757	0.815201	0.4174
MA(1)	-0.589251	0.137447	-4.287107	0.0001
SIGMASQ	62.60239	6.445447	9.712653	0.0000

R-squared	0.182586	Mean dependent var	0.722892
Adjusted R-squared	0.151544	S.D. dependent var	8.804535
S.E. of regression	8.110002	Akaike info criterion	7.074567
Sum squared resid	5195.998	Schwarz criterion	7.191137
Log likelihood	-289.5945	Hannan-Quinn criter.	7.121398
F-statistic	5.882066	Durbin-Watson stat	2.014656
Prob(F-statistic)	0.001120		

Inverted AR Roots	.12
Inverted MA Roots	.59

ARIMA 1,1,1

Equation Estimation

Specification Options

Equation specification

Dependent variable followed by list of regressors including ARMA and PDL terms, OR an explicit equation like Y=c(1)+c(2)*X.

d(bangus,1) c ar(21) ma(1)

Dependent Variable: D(BANGUS,1)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/23 Time: 17:26
Sample: 2016M02 2022M12
Included observations: 83
Convergence achieved after 34 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.719608	0.512584	1.403884	0.1643
AR(21)	0.081721	0.174440	0.468477	0.6407
MA(1)	-0.476980	0.088348	-5.398863	0.0000
SIGMASQ	62.34379	6.286881	9.916490	0.0000

R-squared	0.185962	Mean dependent var	0.722892
Adjusted R-squared	0.155049	S.D. dependent var	8.804535
S.E. of regression	8.093234	Akaike info criterion	7.071732
Sum squared resid	5174.535	Schwarz criterion	7.188303
Log likelihood	-289.4769	Hannan-Quinn criter.	7.118564
F-statistic	6.015695	Durbin-Watson stat	1.981048
Prob(F-statistic)	0.000959		

Inverted AR Roots	.89	.85-.26i	.85+.26i	.73-.50i
	.73+.50i	.55+.69i	.55-.69i	.32+.83i
	.32-.83i	.07+.89i	.07-.89i	-.20+.87i
	-.20-.87i	-.44+.77i	-.44-.77i	-.65+.60i
	-.65-.60i	-.80+.39i	-.80-.39i	-.88+.13i
	-.88-.13i			
Inverted MA Roots	.48			

ARIMA 21,1,1

Figure 4. Estimation

3. *Diagnostic*

Dependent Variable: D(BANGUS,1)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 02/13/23 Time: 17:21
Sample: 2016M02 2022M12
Included observations: 83
Convergence achieved after 44 iterations
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.776982	0.423651	1.834012	0.0704
AR(1)	0.123712	0.151757	0.815201	0.4174
MA(1)	-0.589251	0.137447	-4.287107	0.0001
SIGMASQ	62.60239	6.445447	9.712653	0.0000

R-squared	0.182586	Mean dependent var	0.722892
Adjusted R-squared	0.151544	S.D. dependent var	8.804535
S.E. of regression	8.110002	Akaike info criterion	7.074567
Sum squared resid	5195.998	Schwarz criterion	7.191137
Log likelihood	-289.5945	Hannan-Quinn criter.	7.121398
F-statistic	5.882066	Durbin-Watson stat	2.014656
Prob(F-statistic)	0.001120		

Inverted AR Roots	.12
Inverted MA Roots	.59

ARIMA 1,1,1

Figure 5. Diagnostic

4. *Forecasting*

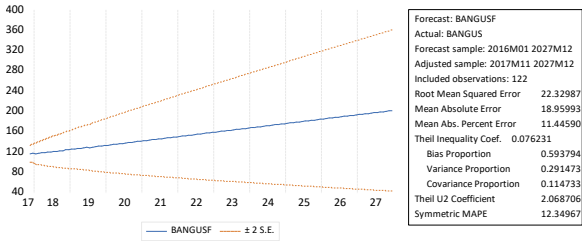

Figure 6. Forecasting

IV. RESULTS AND DISCUSSION

In this study, the price forecasting of the fish commodities in the National Capital Region is based on real data from the Bureau of Fisheries and Aquatic Resources.

The graph shown below are the monthly prices of fish commodities in the National Capital Region. The significant increase of prices is observed in the graph from 2016-2022 specifically in bangus, tilapia, galunggong, alumahan, tambakol, dalagang bukid, alimasag, pusit and hipon. While lato is significantly constant in price starting 2019-2022.

The ARIMA Model and Box Jenkins Methodology are used to forecast the prices of each fish commodity for the year 2023-2027.

Using the model of each selected fish commodity in Eviews, the graphs below show the movement of prices from the gathered data of years 2016 to 2022 up to the forecasted years of 2023 to 2027. The graphs below show continuous increase in prices of the fish commodities and minimal movement of upward and downward spikes.

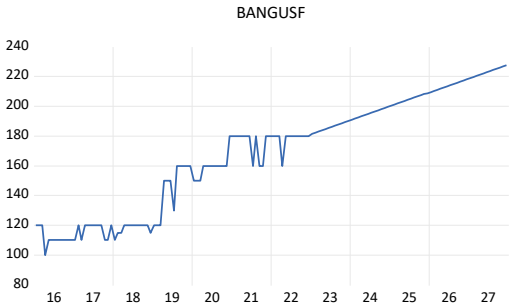

Figure 7. Bangus

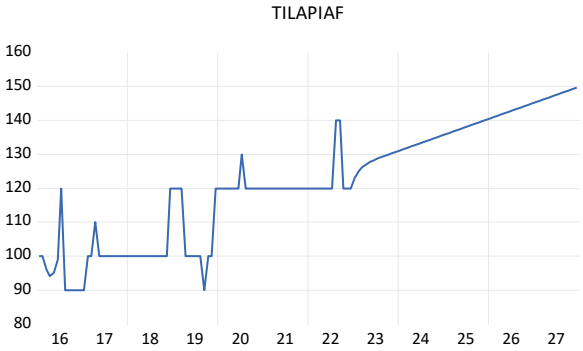

Figure 8. Tilapia

As observed on the above graphs, both Bangus and Tilapia has a significant down movement for the year 2019 indicating a lower price. The reason is that it was the year when Covid-19 happened. Series of lockdown was imposed to heighten the health security. Moreover, both graphs showed a significant upward movement at year 2022 indicating a higher price when the world is slowly recovering from the pandemic. Per graph of figure 7 & 8, forecasted values for years 2023 – 2027 is upward indicating a higher prices for these fish commodities.

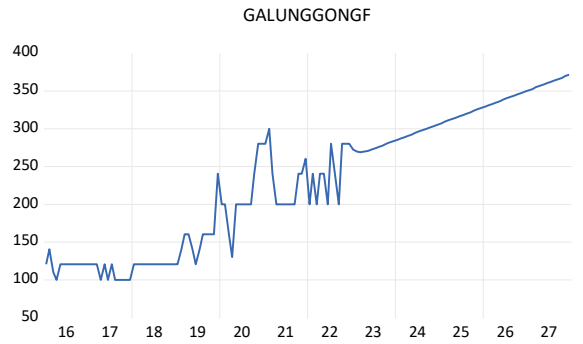

Figure 9. Galunggong

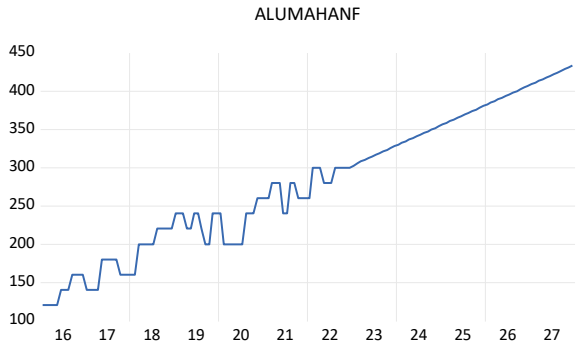

Figure 10. Alumahan

As observed on the above graphs, both Galunggong and Alumahan has a significant down movement for the year 2020 indicating a lower price. The reason is that series of lockdown was imposed to heightened the health security. Moreover, both graphs showed a significant upward movement at year 2022 indicating a higher price when the world is slowly recovering from the pandemic. Per graph of figure 9 & 10, forecasted values for years 2023 – 2027 is upward indicating a higher price for these fish commodities.

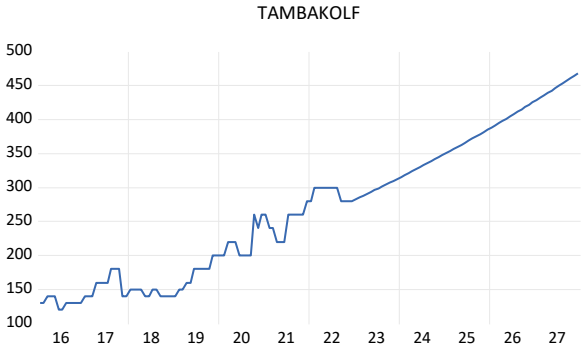

Figure 11. Tambakol

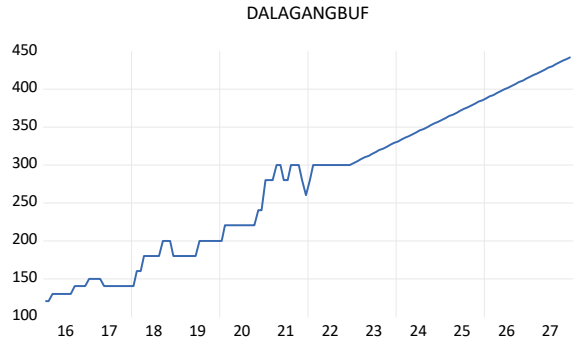

Figure 12. Dalagang Bukid

As observed on the above graphs, both Tambakol and Dalagangbukid has an up and down of prices from the gathered data for years 2016 to 2022. Then there was a significant down for both fish commodities for the year 2021 afterwards at mid-2022 , price starts to go upward. . Per graph of figure 10 & 11, forecasted values for years 2023 – 2027 is upward indicating a higher price for these fish commodities.

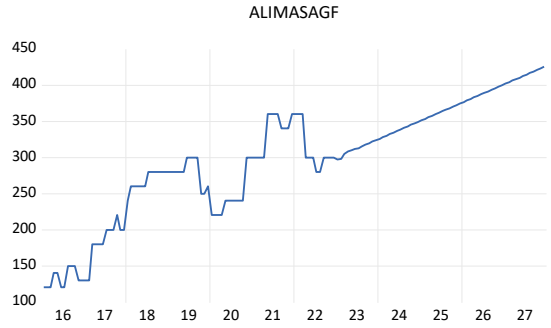

Figure 12. Alimasag

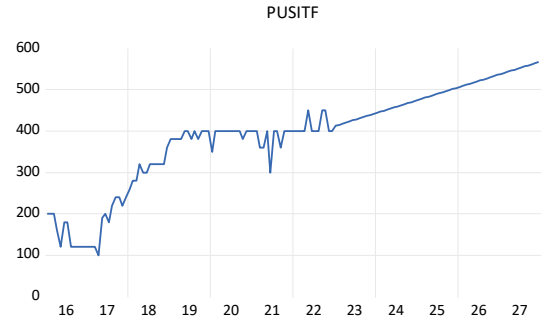

Figure 13. Pusit

As observed on the above graphs, both Alimasag and Pusit has a significant down movement at the mid-2019 indicating a lower price. Moreover, both graphs showed a significant upward movement at year mid-2022 indicating a higher price when the world is slowly recovering from the pandemic. Per graph of figure 12 &13, forecasted values for years 2023 – 2027 is upward indicating a higher price for these fish commodities.

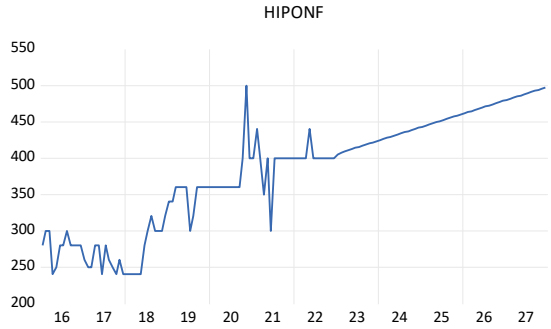

Figure 14. Hipon

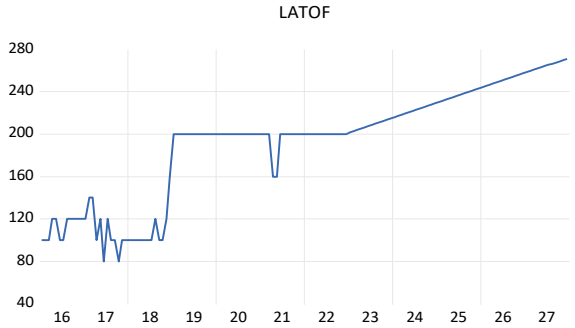

Figure 15. Lato

As observed in above graphs, for the figure 14 & 15, there was a significant down movement on 2021, following a upward trend in 2022. Both commodities, showed increase in prices in forecasted years of 2023 to 2027.

V. CONCLUSION AND RECOMMENDATION

The study showed the best ARIMA models for bangus ARIMA (1,1,1), tilapia ARIMA (1,1,1) galunggong ARIMA(1,1,1), alumahan ARIMA (1,1,1), tambakol ARIMA(1,2,1), dalagangbukid ARIMA (8,1,8), alimasag ARIMA (6,1,6), pusit ARIMA (12,1,12), hipon ARIMA (1,1,1), and lato ARIMA (3,1,3). Based on the forecasted values using Eviews, prices of selected fish commodities are continually increasing for the years of 2023-2027. This study will be of importance in assessing future prices that affect the economy.

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