



Prediction Calculation of PT. Indofood Sukses Makmur Tbk. Stock using R Studio with Autoregressive Integrated Moving Average (ARIMA) Method

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ABSTRACT

PT. Indofood Sukses Makmur Tbk is one of the consumer stocks with a parent company, namely PT. Indofood Sukses Makmur Tbk (INDF) is also in the consumer sector. In 2020, the impact of the coronavirus pandemic will be felt by the public and the government, one of which also has a significant effect on the economic sector. Macro companies show stock prices dropping drastically in early 2020 due to the pandemic. And that's where investors are tempted to buy shares. However, until now, the price of macro companies' claims, including INDF's shares, still fluctuates. So it is difficult to determine the future stock price. Therefore, research is needed to predict INDF stock prices in the future. This study aims to provide information about INDF stock prices in the future based on prediction results which investors can then use to read INDF stock charts in the future so that they do not experience capital loss. This research uses R Studio with Autoregressive Integrated Moving Average (ARIMA) method. Based on the research method carried out in input and data processing, checking stationarity, model specifications, parameter estimation, residual analysis, and forecasting, the results obtained regarding the prediction of INDF stock prices show fairly accurate results. This can be seen from the results of stock price predictions in February – April 2021 with the actual data available. Figures from the

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actual data are still included in the upper and lower limits of the predicted results.

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1. INTRODUCTION

In Indonesia, one type of market is currently developing and has a significant impact on the global economy, namely, the capital market. The capital market or stock exchange is a form of private company activity in the form of investment. Investment is allocating assets or funds by a company or individual for a certain period to achieve greater returns in the future (Pardiansyah, 2017). There are several forms of investment, and one of them is stocks. Stocks are one of the public's most well-known and widely used forms of investment. The number of retail investors in the capital market has reached 4.16 million, with a ratio of about 2.2 percent.

Stocks that can be traded are listed on the Indonesia Stock Exchange, and their existence is monitored according to applicable regulations. The buying and selling of stocks cause stock prices to fluctuate by percent. Stocks do not move linearly; they often change and are not bound by a specific time, which results in various risks. The risks involved in stock investment can be minimized, and investors must know how to analyze and predict stock movements in the stock market. Due to the numerous factors that can influence stock prices, it is impossible to determine when stocks will rise or fall. At best, investors can only predict stock prices. These predictions are usually based on trends at that time and are not guaranteed to be accurate.

PT. Indofood CBP Sukses Makmur Tbk is one of the consumer goods (Budialim, 2013) stocks, with its parent company being PT. Indofood Sukses Makmur Tbk (INDF) operates in the same field. There is a desire by PT. Indofood Sukses Makmur Tbk to acquire all or a majority stake in Pinehill Company, which resulted in a decline in its stock price due to the funds used for the acquisition and the financing, which can also be referred to as debt. This caused the stock price to plummet to the lower auto reject (ARB) level. Currently, the world is facing the coronavirus outbreak, which has impacted many countries' economic and financial sectors. The stock performance of PT. Indofood Sukses Makmur Tbk still appeared positive in March 2020, as INDF stocks rebounded and strengthened by 18.32%, reaching Rp 5,975 per share on Thursday, March 26, 2020. At the beginning of April 2020, the stock of PT. Indofood Sukses Makmur Tbk can still be considered resilient or defensive, despite the surge of the coronavirus in April, affecting almost all countries, including Indonesia. However, in mid-April 2020, the stock price of PT. Indofood Sukses Makmur Tbk started to decline along with the decrease in the Composite Stock Price Index (Lumempow et al., 2021).

Given the uncertainty of the current situation, it is essential to conduct an analysis that can predict the stock movements of PT. Indofood Sukses Makmur Tbk. This analysis is based on the price movements of the stock, which exhibit specific patterns that can be used to predict future trends (Sukanto and Setiawan, 2018). This allows for the analysis of stock price movements. One approach that can be used is R Studio (Allaire, 2012) with the Autoregressive Integrated Moving Average (ARIMA) method. This research aims to predict future stock prices, making it easier for investors to make investment decisions in the capital market (Fadilah, et al., 2020).

2. METHOD

The writing of this scientific paper is also conducted through research to address the issues that will be discussed. The research includes analyzing future stock predictions using R Studio with the ARIMA technique. This research is applied research (Didiharyono et al., 2018) with the concept of Identify, Review, Clarify, Define Terms and Concepts, and Define the Populations. The reason for using this research concept is because it has advantages seen from its systematic working procedure, where each step to be taken refers to the previous step that has been improved, resulting in a more effective outcome. The following are the steps involved:

The research methodology contains a detailed explanation of how the research is conducted. Each paragraph can consist of several subparagraphs, indicated by the following sections.

1. Identify the Problem
 - During this pandemic, many people are flocking to investments.
 - Novice investors often struggle with predicting charts.
2. Review the Literature
 - A literature search was conducted to support the research being conducted. The literature search focused on finding relevant studies related to stocks and investments and data analysis techniques using R Studio.
3. Clarify the Problem
 - Statistical analysis of the collected stock price data was conducted.
4. Define Terms and Concepts
 - Stock is proof of ownership of a company's value.
 - The ARIMA model is a group of time series models that establish statistically significant relationships between the variables being forecasted and their historical values (Shumway and Stoffer, 2017; Nelson 1998).
5. Define the Population
 - The data collected consists of 61 stock price data points from April 2016 to April 2021.

2.1. Study Literature

A literature review was conducted to gather relevant research studies that support this scientific writing. The literature review utilized trusted sources. The main topics covered in the literature review include:

1. Stock prediction techniques
2. The application of digitization in mathematics and statistics.
3. Using the ARIMA method, R studio is an application for predicting future data.

2.2. Data gathering

The data for this research was collected from the website investing.com. The data collected consists of Indofood (INDF) stock price data from April 2016 to April 2021, spanning 5 years. The following is the Indofood stock price data (in Indonesian Rupiah) from April 2016 to April 2021, presented in Microsoft Excel format.

Bulan	Harga Saham	Bulan	Harga Saham
Apr-16	7125	Nov-18	6600
May-16	6925	Dec-18	7450
Jun-16	7250	Jan-19	7750
Jul-16	8325	Feb-19	7075
Aug-16	7925	Mar-19	6375
Sep-16	8700	Apr-19	6950
Oct-16	8500	May-19	6600
Nov-16	7575	Jun-19	7025
Dec-16	7925	Jul-19	7075
Jan-17	7925	Aug-19	7925
Feb-17	8125	Sep-19	7700
Mar-17	8000	Oct-19	7700
Apr-17	8375	Nov-19	7950
May-17	8750	Dec-19	7925
Jun-17	8600	Jan-20	7825
Jul-17	8375	Feb-20	6500
Aug-17	8375	Mar-20	6350
Sep-17	8425	Apr-20	6525
Oct-17	8200	May-20	5750
Nov-17	7325	Jun-20	6525
Dec-17	7625	Jul-20	6450
Jan-18	7750	Aug-20	7625
Feb-18	7575	Sep-20	7150
Mar-18	7200	Oct-20	7000
Apr-18	6975	Nov-20	7100
May-18	7075	Dec-20	6850
Jun-18	6650	Jan-21	6050
Jul-18	6350	Feb-21	6050
Aug-18	6375	Mar-21	6600
Sep-18	5900	Apr-21	6700
Oct-18	5975		

Figure 1. INDF stock data April 2016 – April 2021

2.3. Data processing

The data processing technique employed in this research utilized R Studio with the Autoregressive Integrated Moving Average (ARIMA) method. (Lilipaly, et al., 2014) The steps involved in this method are as follows:

1. Data input and processing;
2. Checking for stationarity;
3. Model specification;
4. Parameter estimation;
5. Residual Analysis;
6. Forecasting.

3. RESULTS AND DISCUSSION

3.1. Input and data processing

The data was imported into R Studio based on the collected Indofood stock price data.

```
# data plotting  
Harga_Saham=ts(Harga_Saham,frequency=12,start=c(2016))  
plot(Harga_Saham,xlab="Bulan",ylab="Harga Saham",main="Harga Saham Indofood",type = "l")
```

Figure 2. Data Plotting Algorithm in R Studio

Figure 3 shows a monthly stock price graph of INDF for the past 5 years. The chart can be seen in the following image (Hamonangan and Sulistyawati, 2012).

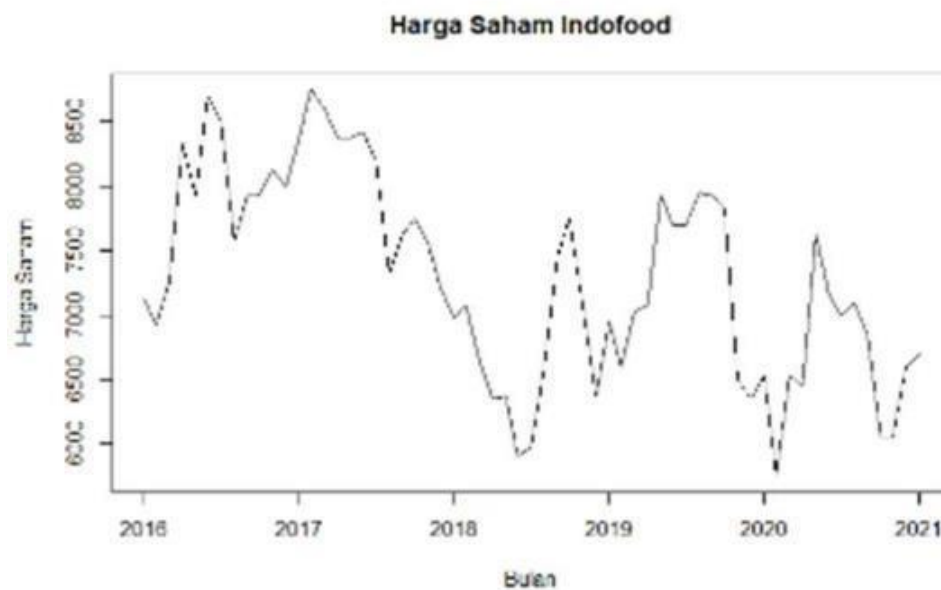


Figure 3. Indofood Stock Price Graphic

The stock price of Indofood over the past 5 years has shown relatively high volatility. This can be observed from the significant increases and decreases that occur monthly. The graph above shows a decrease in stock price from mid-2017 to mid-2018 and from late 2019 to early 2020. The stock price graph can be decomposed into four components: random, seasonal, trend, and observed (Nofsinger and Sias, 1999). The decomposition of the Indofood stock price graph can be seen in the image below.

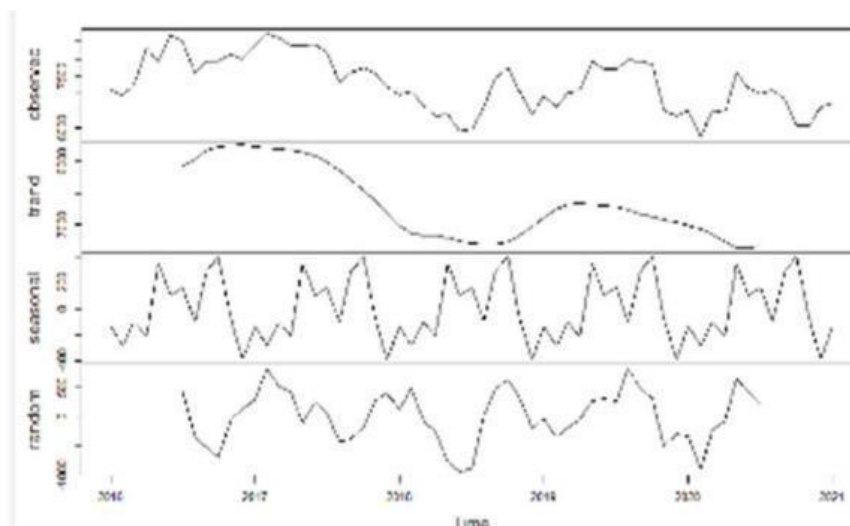


Figure 4. Indofood Stock Price Graphic Decomposition

3.2. Checking for stationarity

The next step is to check for stationarity in the Indofood stock price data (Sukamto and Setiawan, 2018). This is done to determine whether the time series data is stationary in terms of both mean and variance. A data series is considered stationary if the p-value of the data is less than 0.05. This can be achieved using the Augmented Dickey-Fuller Test (ADF Test).

```
Augmented Dickey-Fuller Test
data: Harga_Saham
Dickey-Fuller = -2.9896, Lag order = 3, p-value = 0.1746
alternative hypothesis: stationary
```

Figure 5. Before Differencing

In picture 5, the obtained p-value is larger than 0.05. Therefore, differencing is needed to reduce the p-value below 0.05.

```
Augmented Dickey-Fuller Test
data: diff_Harga_Saham
Dickey-Fuller = -4.3146, Lag order = 3, p-value = 0.01
alternative hypothesis: stationary
```

Figure 6. After Differencing

After one round of differencing, the p-value becomes smaller than 0.05. This indicates that the available data is now stationary. The number of differencing performed at this stage represents the value of d in the ARIMA(p,d,q) model.

3.3 Model specification

After differencing, the Indofood stock price graph also undergoes differentiation. The differentiated chart can be seen in the following picture.

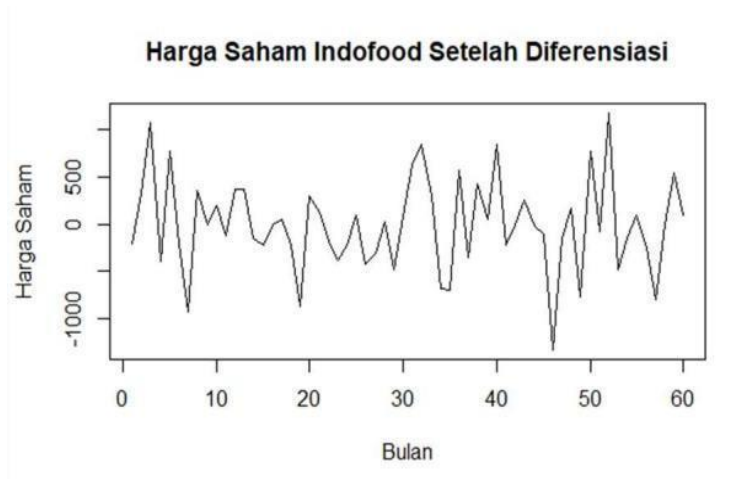


Figure 7. Indofood Stock Price Graphic After Differencing

To determine the values of p and q in the $ARIMA(p,d,q)$ model, we need to examine the values of the ACF and PACF. The ACF has cut-offs at lag 6 and 13, while the PACF has a cut-off only at lag 6. The values of ACF and PACF can be seen in the graph below.

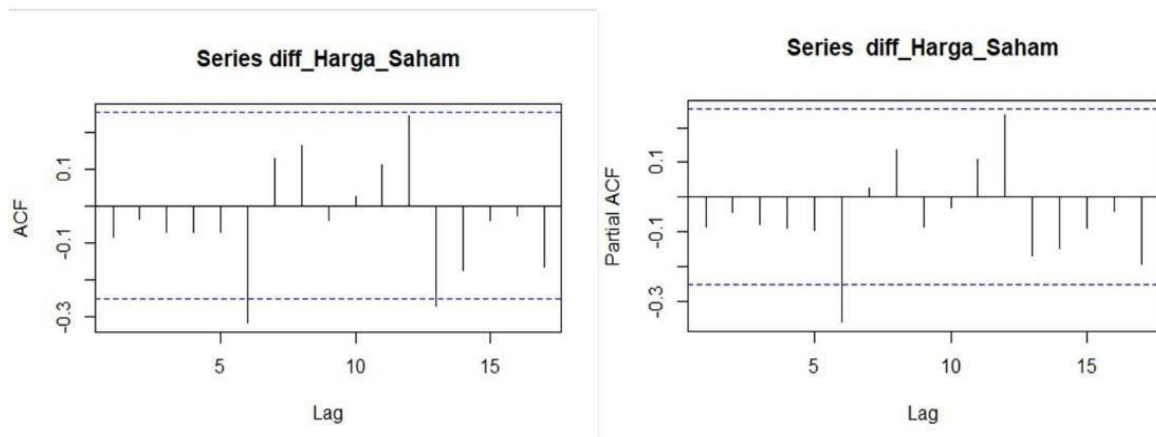


Figure 8. ACF and PACF Graphic

After obtaining the values of p, d, and q, we can generate several ARIMA Models.

ARIMA MODEL	p	d	q
ARIMA MODEL 1	0	1	0
ARIMA MODEL 2	1	1	0
ARIMA MODEL 3	2	1	0
ARIMA MODEL 4	3	1	0
ARIMA MODEL 5	4	1	0
ARIMA MODEL 6	5	1	0
ARIMA MODEL 7	6	1	0
ARIMA MODEL 8	0	1	1
ARIMA MODEL 9	1	1	1
ARIMA MODEL 10	2	1	1
ARIMA MODEL 11	3	1	1
ARIMA MODEL 12	4	1	1
ARIMA MODEL 13	5	1	1
ARIMA MODEL 14	6	1	1
ARIMA MODEL 15	0	1	2
ARIMA MODEL 16	1	1	2
ARIMA MODEL 17	2	1	2
ARIMA MODEL 18	3	1	2
ARIMA MODEL 19	4	1	2
ARIMA MODEL 20	5	1	2
ARIMA MODEL 21	6	1	2
ARIMA MODEL 22	0	1	3
ARIMA MODEL 23	1	1	3
ARIMA MODEL 24	2	1	3
ARIMA MODEL 25	3	1	3
ARIMA MODEL 26	4	1	3
ARIMA MODEL 27	5	1	3
ARIMA MODEL 28	6	1	3
ARIMA MODEL 29	0	1	4
ARIMA MODEL 30	1	1	4
ARIMA MODEL 31	2	1	4
ARIMA MODEL 32	3	1	4
ARIMA MODEL 33	4	1	4
ARIMA MODEL 34	5	1	4
ARIMA MODEL 35	6	1	4
ARIMA MODEL 36	0	1	5
ARIMA MODEL 37	1	1	5
ARIMA MODEL 38	2	1	5
ARIMA MODEL 39	3	1	5
ARIMA MODEL 40	4	1	5
ARIMA MODEL 41	5	1	5
ARIMA MODEL 42	6	1	5
ARIMA MODEL 43	0	1	6
ARIMA MODEL 44	1	1	6
ARIMA MODEL 45	2	1	6
ARIMA MODEL 46	3	1	6
ARIMA MODEL 47	4	1	6
ARIMA MODEL 48	5	1	6
ARIMA MODEL 49	6	1	6

Figure 9. ARIMA Model Combination

3.4. Parameter estimation

Estimating parameters is done to obtain the best ARIMA model (Deviana et al., 2021). There are 49 ARIMA models obtained from combinations of values for p, d, and q. Therefore, parameter estimation is performed using AIC (Akaike Information Criterion), Shapiro-Wilk test, and Box-Ljung test (Cavanaugh and Neath, 2019; González-Estrada and Cosmes, 2019).

ARIMA MODEL	p	d	q	AIC	SHAPIRO TEST			BOX TEST			AIC	SHAPIRO TEST	BOX TEST		
					12	24	36	12	24	36			12	24	36
ARIMA MODEL 1	0	1	0	945.19	0.7722	0.000254	0.00015	0.0495	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 2	1	1	0	328.37	0.4228	0.000327	0.008643	0.0009	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 3	2	1	0	323.67	0.6091	0.004554	0.000605	0.0196	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 4	3	1	0	322.54	0.3211	0.008596	0.002855	0.0003	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 5	4	1	0	322.25	0.7821	0.001314	0.000115	0.0069	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 6	5	1	0	324.09	0.8141	0.00099	0.000115	0.0081	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 7	6	1	0	317.58	0.405	0.003335	0.005716	0.0072	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 8	0	1	1	305.63	0.3163	0.05589	0.009887	0.0017	NO	YES	YES	NO	NO	NO	NO
ARIMA MODEL 9	1	1	1	307.34	0.6759	0.03304	0.004107	0.0005	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 10	2	1	1	309.3	0.8936	0.02173	0.003665	0.0005	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 11	3	1	1	311.05	0.8788	0.0452	0.002562	0.0005	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 12	4	1	1	312.7	0.8447	0.005361	0.000653	0.0001	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 13	5	1	1	316.25	0.3595	0.005096	0.00207	0.0003	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 14	6	1	1	307.17	0.4266	0.3911	0.2495	0.2397	NO	YES	YES	YES	YES	YES	YES
ARIMA MODEL 15	0	1	2	307.32	0.8781	3076	0.004201	0.0005	NO	YES	YES	NO	NO	NO	NO
ARIMA MODEL 16	1	1	2	306.55	0.3932	0.06475	0.01615	0.0035	NO	YES	YES	NO	NO	NO	NO
ARIMA MODEL 17	2	1	2	311.24	0.8832	0.01274	0.002214	0.0003	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 18	3	1	2	310.1	0.2929	0.02172	0.005396	0.0012	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 19	4	1	2	316.26	0.6666	0.002685	0.000338	0.0432	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 20	5	1	2	316.24	0.6707	0.004931	0.000228	0.0327	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 21	6	1	2	303.11	0.4083	0.2397	0.1859	0.2384	NO	YES	YES	YES	YES	YES	YES
ARIMA MODEL 22	0	1	3	309.25	0.8903	0.02371	0.00425	0.0007	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 23	1	1	3	311.23	0.8973	0.0125	0.002393	0.0003	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 24	2	1	3	310.52	0.3939	0.02783	0.009446	0.0004	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 25	3	1	3	312.47	0.3975	0.00552	0.007441	0.0022	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 26	4	1	3	313.78	0.3681	0.005047	0.004485	0.0003	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 27	5	1	3	308.91	0.8313	0.003758	0.005102	0.0039	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 28	6	1	3	895.96	0.7852	0.3188	0.4869	0.6264	YES	YES	YES	YES	YES	YES	YES
ARIMA MODEL 29	0	1	4	910	0.4316	0.05461	0.009083	0.0037	NO	YES	YES	NO	NO	NO	NO
ARIMA MODEL 30	1	1	4	910.18	0.3931	0.02181	0.005539	0.0012	NO	YES	NO	YES	NO	YES	NO
ARIMA MODEL 31	2	1	4	907.28	0.7254	0.0362	0.03821	0.0346	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 32	3	1	4	911.35	0.5075	0.01659	0.008404	0.0031	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 33	4	1	4	910.77	0.3606	0.002582	0.000953	0.0004	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 34	5	1	4	312.5	0.3889	0.002392	0.001862	0.0012	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 35	6	1	4	897.91	0.7583	0.1868	0.4319	0.5923	YES	YES	YES	YES	YES	YES	YES
ARIMA MODEL 36	0	1	5	911.85	0.784	0.02943	0.005044	0.002	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 37	1	1	5	313.2	0.5493	0.02396	0.005134	0.0029	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 38	2	1	5	913.31	0.273	0.03606	0.01669	0.01	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 39	3	1	5	912.92	0.5407	0.008937	0.008368	0.0029	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 40	4	1	5	914.52	0.5016	0.006003	0.008331	0.0048	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 41	5	1	5	898.66	0.7951	0.004919	0.04691	0.0893	YES	YES	NO	NO	NO	YES	YES
ARIMA MODEL 42	6	1	5	894.9	0.7479	0.007705	0.173	0.3252	YES	YES	NO	YES	YES	YES	YES
ARIMA MODEL 43	0	1	6	912.71	0.378	0.02736	0.01307	0.0023	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 44	1	1	6	914.71	0.2594	0.03204	0.008988	0.0072	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 45	2	1	6	913.26	0.3336	0.01568	0.004852	0.0008	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 46	3	1	6	902.6	0.1685	0.05055	0.408	0.461	NO	YES	YES	YES	YES	YES	YES
ARIMA MODEL 47	4	1	6	914.58	0.5494	0.007996	0.008687	0.0021	NO	YES	NO	NO	NO	NO	NO
ARIMA MODEL 48	5	1	6	899.27	0.5056	0.001964	0.04883	0.1094	YES	YES	NO	NO	NO	YES	YES
ARIMA MODEL 49	6	1	6	896.25	0.1795	2.48E-07	0.4059	0.6808	YES	YES	NO	YES	YES	YES	YES

Figure 10. ARIMA Parameter Model Estimation

From picture 13, the best ARIMA model is ARIMA (6,1,3) with an AIC of 895.96, Shapiro-Wilk test value of 0.7852, and Box-Ljung test values that are all greater than 0.05.

3.5 Residual analysis

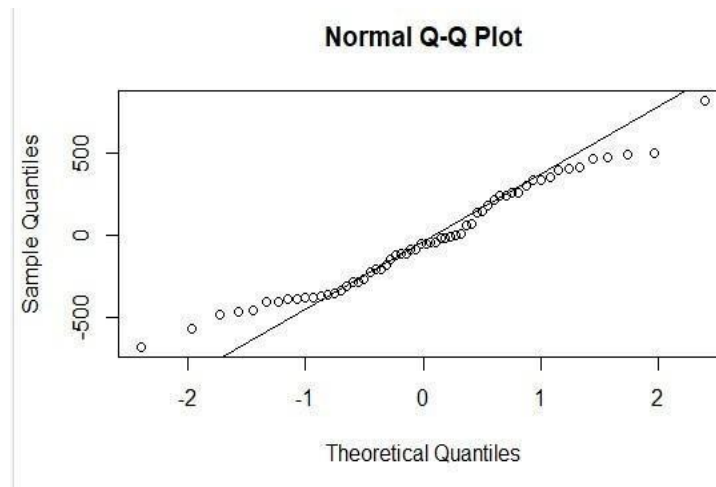


Figure 11. QQ Plot ARIMA (6,1,3)

In the QQ plot, the ARIMA (6,1,3) model has relatively small residuals, indicating a small error. Besides ARIMA (6,1,3), R Studio provides the auto.arima function helps determine the suitable model for future predictions (Khanif and Ahmad, 2016). Using auto.arima, the ARIMA (0,0,0) model is obtained with an AIC value of 915.78. Compared to ARIMA's AIC (6,1,3), the AIC of ARIMA (0,0,0) is higher. Therefore, the chosen model is ARIMA (6,1,3).

Figure 12. AIC ARIMA (0,0,0)

```
sigma^2 estimated as 240823: log likelihood=-456.89
AIC=915.78 AICC=915.85 BIC=917.88
> |
```

3.6 Forecasting

The predicted values for Indofood's stock price using the ARIMA(6,1,3) model can be seen in the following table (Harell and Frak, 2015; Taylor and Letham, 2018).

Table 1. Indofood Stock Price Forecast Result

Month	Forecast	Bottom Limit	Upper Limit	Actual Data
Feb 21	6657,842	5621,898	7693,785	6050
Mar 21	6463,092	5061,329	7864,854	6600
Apr 21	6862,049	4979,949	8744,148	6700
Mei 21	6793,059	4675,236	8910,881	-
Jun 21	6275,161	4065,318	8485,004	-
Jul 21	6367,716	4051,488	8683,944	-
Agu 21	6673,132	4330,961	9015,302	-
Sep 21	6681,882	4286,374	9077,391	-

Okt 21	6366,572	3888,155	8844,989	-
Nov 21	6485,728	3894,149	9077,308	-
Des 21	6864,395	4134,454	9594.337	-
Jan 22	6648,682	3824,794	9472,570	-

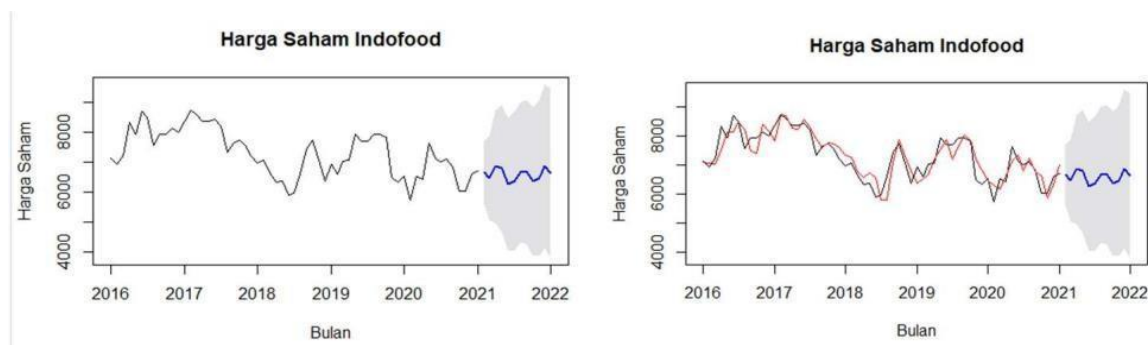


Figure 13. Indofood Stock Price Forecast Result Graphic (Pankratz, 2012; Wan and Alan, 2017)

- _____ Actual Data
- _____ ARIMA (6,1,3)
- _____ Forecast Results for the Next 12 Months

Predicting Indofood's stock price for the next 12 months using ARIMA (6,1,3) show fairly accurate results (Hartati, 2017). The actual stock price data for February, March, and April 2021 are still within the lower and upper bounds of the prediction. This indicates a high likelihood that the actual stock prices from May 2021 to January 2022 will not exceed the upper and lower bounds of the prediction.

4. CONCLUSION

The prediction of PT. Indofood Sukses Makmur, Tbk's stock using R Studio with the Autoregressive Integrated Moving Average method shows relatively accurate results. This can be seen from the predicted stock prices for February to April 2021 compared to the actual data. The actual data values are still within the upper and lower bounds of the prediction. With stock price predictions, investors can make informed decisions. If the stock price decreases, investors can buy stocks from companies with good prospects. Conversely, investors can sell stocks to companies with good prospects to gain capital gains if the stock price increases.

5. AUTHOR'S NOTE

The authors declare that there are no conflicts of interest associated with the publication of this article. The authors also ensure that this paper is free from plagiarism.

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