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Forecasting of Health Sector stock prices during Covid-19 pandemic using Arima and Winter Methods

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Abstract: This study aims to compare the accuracy of the ARIMA and WINTER methods in forecasting or predicting the daily stock price of the health sector. The data used in this study is secondary data in the form of historical data on the daily stock price of PT. Darya Varia Laboratori, PT. Indofara Persero, PT. Kimia Farma, PT. Kalbe Farma, and PT. Merck Indonesia from March 14, 2020 to April 14, 2021. The five issuers were selected because they are members of the Indonesian Sharia Stock Index (ISSI). Researchers used the ARIMA and WINTER forecasting methods with the help of SPSS version 25 software. Starting from checking stationarity to choosing the best model to be used as a forecasting model. The results of the study stated that PT. Kimia Farma is suitable to use the ARIMA (1, 0, 1) model, while others use the WINTER Additive and Multiplicative methods. Then the selected model is used to predict the daily stock prices of five issuers from April 14, 2021 to July 15, 2021 and the results tend to increase. This is presumably because investors tend to increase capital due to the effects of increasingly stringent health protocols in the second wave and the assumption that when the rate of virus spread has begun to decline but health sector shares continue to rise, although not significantly.
Keywords: Forecasting; Health sector; Stock prices; ARIMA; WINTER; Covid-19

INTRODUCTION

The Covid-19 pandemic began in Wuhan in early December 2019, Hubei, China. Now it has spread to all parts of the world including Indonesia. This of course has an impact on public health and also weakens the corporate sector. Many industries have suffered losses due to this pandemic. However, there are some sectors that are experiencing gains, such as the health sector. The health sector, which includes the pharmaceutical, chemical and medical equipment sectors, is believed to be able to meet basic needs to combat the COVID-19 pandemic. (Widiyani, 2018)

The development of stock prices has always been an interesting topic of prediction and analysis. What capital market players (especially capital market investors) need are methods and accuracy to predict stock price movements properly. According to Zacharias, J. A. (2020), the stock price is the value that happens on the stock trade which is vital for the organization. The stock price decides the worth of the organization and can demonstrate the progress of the organization's administration. Financial backers have a popularity for the portions of an organization.

The ARIMA model is actually a combination of the AR (autoregressive) model and the MA (moving average) model. The AR model is used to explain the movement of variables through the variables themselves in the previous period, while the MA model is used to see the variables through the residuals in the previous period. Compared to several forecast methods with different characteristics, such as GARCH, VAR, and CAPM, the ARIMA method is the most suitable method for the characteristics of time series data. According to research (Rusyida & Pratama, 2020) the ARIMA method is able to predict the stock price of PT. Garuda Indonesia for the period 20 April 2019 to 20 April 2020 with the smallest RMSE value of 38.03. (Pratama & Rusyida, 2020) also use the ARIMA method in predicting the daily share price of the Sinar Mas Group on inheritance rights events. In this study, also produced the best ARIMA model with the smallest RMSE of 4,680 for the company PT. Bank China Construction Bank Indonesia, Tbk.

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The Holt-Winters exponential smoothing method is used to generate forecasts for seasonal data. The Holt-Winters method is a triple exponential smoothing technique where the smoothing is done three times and then forecasting is done. The Holt-Winters method is an extension of the two-parameter Holt method. The Holt-Winters method is a prediction method for time series data derived from seasonal data and can be processed based on previous data. (Sulandari dkk, 2020) used the Holt-Winters method to compare the Holt-Winters method and the Box-Jenkins method to predict OLR Water Anomalies in western Indonesia. The advantages of the Hot-Winters method are that it can predict data patterns with seasonal trends well, has trend elements, is simple, and easy to implement, and can compete with other more complex forecasting models. (Darsyah, 2015) comparing the ARIMA and WINTER methods in bank stock forecasting, the results show that of the 3 bank companies, Bank BRI fits other ARIMA models such as Bank Mandiri and Bank BCA more in line with the WINTER model. In this study, it is said that the stock data of Bank Mandiri and Bank BCA contain seasonal trend patterns so that they are more in line with the WINTER model. Meanwhile, the ARIMA model requires data stationarity.

To determine the accuracy of the prediction results, the authors tried to use the Holt-Winters exponential smoothing method and ARIMA to analyze the comparison of prediction results and calculate prediction errors including Mean Square Error (MSE) and Mean Absolute Percentage Error (MAPE) so as to get the minimum error value.

The purpose of this study is to prove the accuracy of the ARIMA and WINTER methods in predicting stock prices in the health sector from March 14, 2020 to April 14, 2021 and also to compare the ARIMA and WINTER methods in predicting stock prices in the health sector for the period 15 April 2020 to 15 July 2021 as well as an overview of the prediction results of the five companies.

LITERATURE REVIEW

Signalling Theory

Signal theory is an action taken by the company's management as a reference for investors about the management's perspective on the company in the future. This signal contains information about the things that have been done by management in realizing the wishes of the investor. (Beaver, 1968) defines information as an expected change in the outcome of an event. Information issued by the company will affect investment decisions from parties outside the company, because the information will provide a view for the survival of a company from the past, present, and future periods and how the effect of that information will be (Brigham & Houston, 2001).

Technical Analysis

Dow (Charles H. Dow) began technical analysis in 1884, when Dow calculated its inventory based on time series data. Some people believe that the Dow Theory aims to determine long-term market prices based on historical data about past market prices Zacharias, J. A. (2020). According to (Rode dkk., 2015), the main theory of technical analysis is a trading method that uses certain data from time to time to make the right investment decisions. Therefore, the purpose of technical analysis is to use accurate forecasting and calculation methods to make forecasts based on time series data.

The advantage of this kind of technical analysis is that it can provide information more quickly, so with intelligence and intuition the analysts can immediately convert it into buying and selling shares to get significant profits from these shares. (Soliha, 2014)

ARIMA (Autoregressive Integrated Moving Average)

ARIMA is a technique that produces predictions based on the synthesis of historical data patterns (Arsyad, 2001). ARIMA does not include independent variables because this model uses the present value and the past value of the dependent variable to produce accurate short-term predictions. ARIMA is widely used in the fields of economic forecasting, budget analysis, quality control and process management, as well as census analysis.

According to (Mulyono, 2017) using the Box-Jenkins method to predict stock prices shows that this method is suitable for predicting many variables quickly, easily and economically, because only predictor variable data is needed. This is a short term (5 days) forecasting method. Changes in the JCI on the JSX, including daily data and an estimated period of 3 months.

According to (Arsyad, 2001) the Box-Jenkins method for stationary time series data is ARIMA. ARIMA is a special linearity test that completely ignores independent variables when making predictions, as it uses the current and past values of the dependent variable to make accurate short-term predictions. The Box-Jenkins method can only be applied, interpreted, or expressed as a stationary series, or remains unchanged during the

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differentiation process. Since the stationary series does not have a trend element, this method aims to explain the remaining elements, namely errors.

ARIMA's Model (Autoregressive Integrated Moving Average)

The ARIMA model is a time series model that is used based on the assumption that the time series data is stationary, meaning the average and variance (σ^2) of a constant time series data (Rosadi, 2011).

$$\phi_p(B)\nabla^d Z_t = \mu + \varepsilon_t - \theta_q(B)\varepsilon_t \text{ ..... } (1)$$

with:

Z_t : Observation value at t time
ϕ_p : Autoregressive Parameter
θ_q : Moving average Parameter
d : Differencing Parameter
μ : Constant Parameter
B : Back slide operator
p : Autoregresive degree (AR)
q : Moving average degree (MA)
ε_t : Residual value (error)

Winter's Model

Winter's model is one of the forecasting methods used to solve problems in previous forecasting, which is specifically to overcome seasonal trends (Walters & Cai, 2015). There are two Winter's models, namely multiplicative and additive (Abepro et al., 2017).

a. Multiplicative's model

$$L_t = a\left(\frac{Y_t}{s_{t-p}}\right) + (1-a)[L_{t-1} + T_{t-1}]$$
$$T_t = g[L_t - L_{t-1}] + (1-g)T_{t-1}$$
$$S_t = d\left(\frac{Y_t}{L_t}\right) + (1-d)s_{t-p}$$
$$\hat{Y}_{t+h}(t) = (L_t + T_t h)s_{t+h-p} \ (2)$$

where:

L_t : Level at t time, a is the value for level
T_t : Trend at t time, g is the value for trend
S_t : The seasonal component at t-th time, d is the value for the seasonal component
p : Seasonal (seasonal period)
Y_t : Data values at the t-th time
h : The amount of forecast
$\hat{Y}$: Fit value at the t-th time

b. Additive's model

$$L_t = a\left(\frac{Y_t}{s_{t-p}}\right) + (1-a)[L_{t-1} + T_{t-1}]$$
$$T_t = g[L_t - L_{t-1}] + (1-g)T_{t-1}$$
$$S_t = d\left(\frac{Y_t}{L_t}\right) + (1-d)s_{t-p}$$
$$\hat{Y}_{t+h}(t) = L_t + T_t h + s_{t+h-p} \ (3)$$

where:

L_t : Level at t time, a is the value for level
T_t : Trend at t time, g is the value for trend
S_t : The seasonal component at t-th time, d is the value for the seasonal component

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p : Seasonal (seasonal period)
Y_t : Data values at the t-th time
h : The amount of forecast
$\hat{Y}$: Fit value at the t-th time

METHOD

The type of data used in this study is secondary data in the form of daily stock prices of the health sector from March 14, 2020 to April 14, 2021. The source of data in this study comes from historical search of daily stock prices of several issuers in the health sector included in the Sharia Stock Index in Indonesia (ISSI), among others: PT. Darya Varia Laboratori Tbk (DVLA), PT. Indofarma Persero (INAF), PT. Kimia Farma (KAEF), PT. Kalbe Farma (KLBF), and PT. Merck Indonesia (MERK).

The process of data analysis using ARIMA and WINTER methods by using SPSS 26 software. The steps to implement the model are as follows.

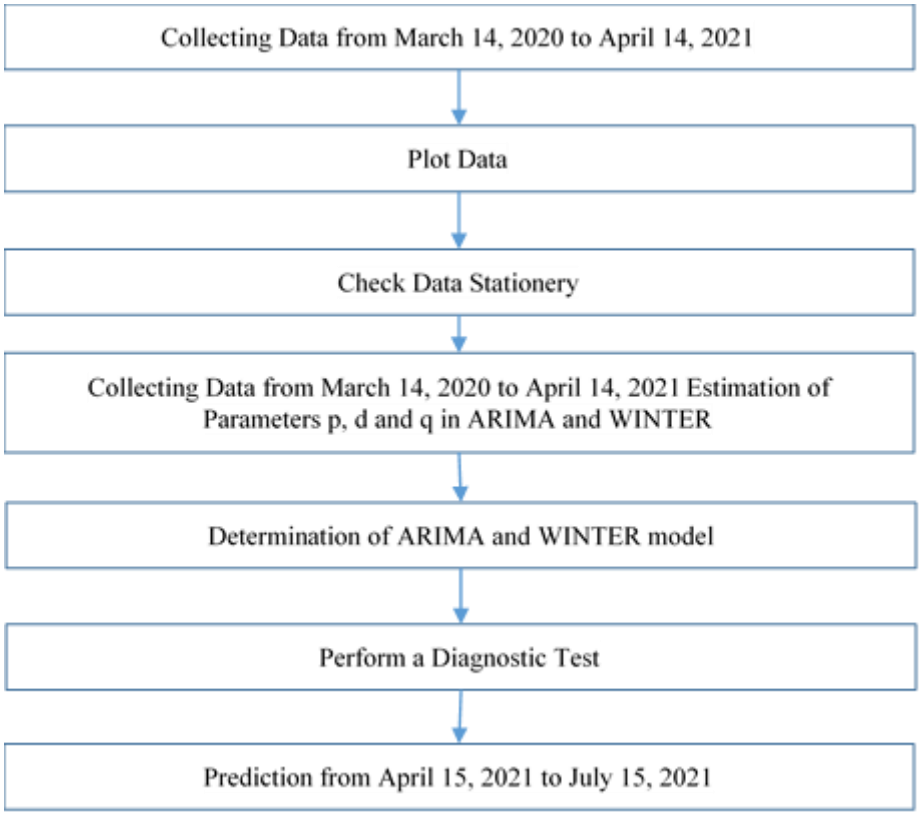

Figure 1. Flowchart of the research

The population in this study is a health company that is included in the Islamic Stock Index in Indonesia (ISSI). Of the several merged companies, there are 5 companies that still exist in sharia shares. The sample selection method in this study is probability sampling. The sampling technique in this study is disproportionate stratified random sampling. The sample of this study is listed in table 1 below.

Table 1. List of Company Names

Name of Company	Abbreviation
PT. Darya Varia Laboratori Tbk (DVLA)	DVLA
PT. Indofara Persero (INAF)	INAF
PT. Kimia Farma (KAEF)	KAEF
PT. Kalbe Farma (KLBF)	KLBF
PT. Merck Indonesia (MERK)	MERK

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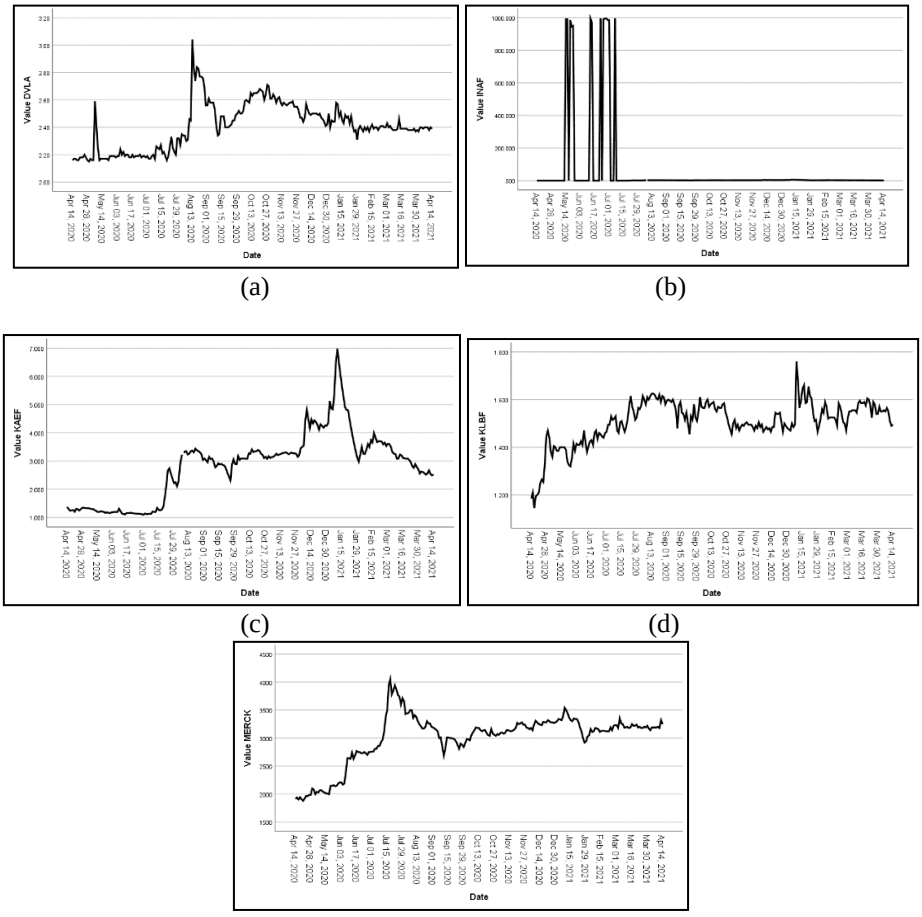
Data collection techniques in this study use secondary data. Data is taken from historical data on the website https://www.investing.com/ for each company in the health sector shares PT. Darya Varia Laboratori Tbk (DVLA), PT. Indofarma Persero (INAF), PT. Kimia Farma (KAEF), PT. Kalbe Farma (KLBF), and PT. Merck Indonesia (MERK).

RESULT

Plot Data

company's sixth daily share price data is time series data taken from March 14, 2020 to April 14, 2021 (61 days).



(a) (b) (c) (d) (e)

Figure 2. Daily Share Price Plot for The Five Companies: (a) DVLA (b) INAF (c) KAEF (d) KLBF (e) MERCK

In Figure 1 it is seen that the daily stock price data plot of PT. Darya Varia Laboratori Tbk (DVLA), PT. Indofarma Persero (INAF), PT. Kimia Farma (KAEF), PT. Kalbe Farma (KLBF), and PT. Merck Indonesia (MERK) shows a graph that contains fluctuating trends. The next step required is a data stationary check.

Data states' is needed to minimize model confusion. From Figure 1 it can be seen that the daily stock price data plots of the five firms tend to be fluctuating (not stationary). Therefore, it is necessary to do a differentiation process (differencing) in order to become stationary data. In the five plots, the daily stock price data shows a recurring pattern in a fixed time interval (seasonal).

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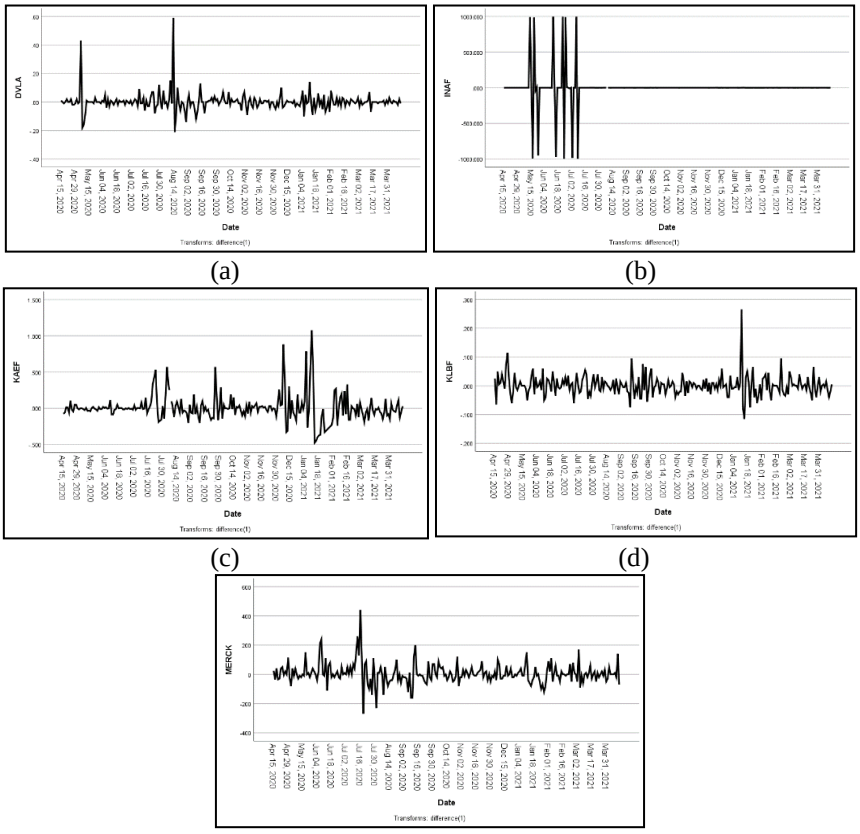
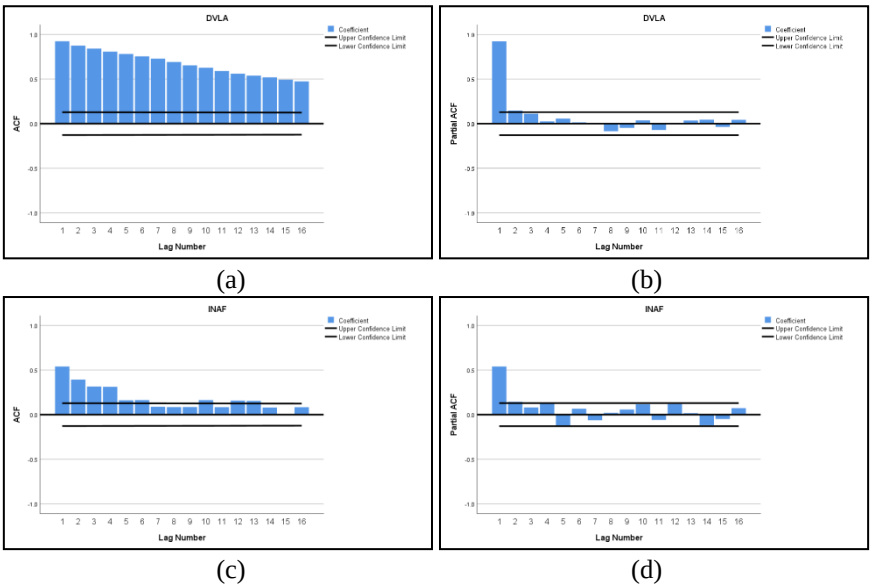
Check Data Stationery



(a) (b) (c) (d) (e)

Figure 3. The Process of Differencing: (a) DVLA (b) INAF (c) KAEF (d) KLBF (e) MERCK

In Figure 2 it can be seen that after the differentiation process with level 1, the daily stock data of the fifth company moves around the average. From the data it can be observed that the data is stationary. The differentiation process (differencing) that has been done identifies that the value of d that can be used is d = 1.



(a) (b) (c) (d)

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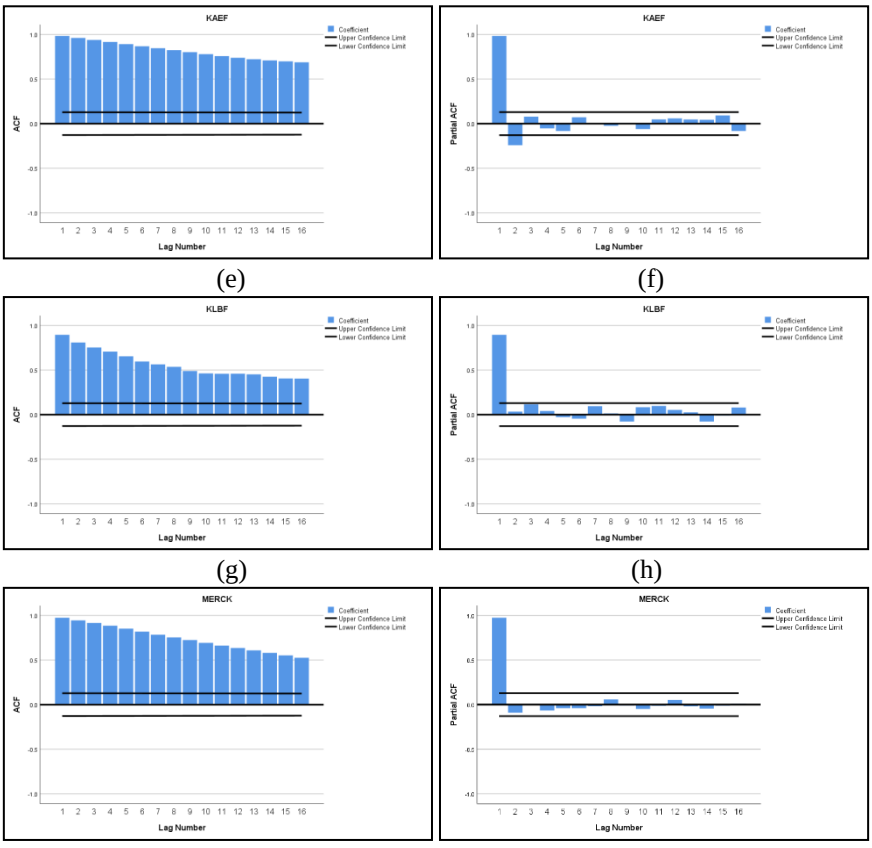

Figure 4. Plot of ACF and PACF for The Five Companies: (a) ACF DVLA (b) PACF DVLA (c) ACF INAF (d) PACF INAF (e) ACF KAEF (f) PACF KAEF (g) ACF KLBF (h) PACF KLBF (i) ACF MERCK (j) PACF MERCK

Based on the ACF and PACF plots, it is seen that in the INAF model, both the ACF and PACF plots show a drastic decrease pattern (cut off), meaning that the INAF model uses a combined model of AR and MA. Meanwhile, in the DVLA, KAEF, KLBF, and MERCK models, it has been seen that the ACF plot shows a slow decreasing pattern close to zero (dying down) and the PACF plot shows a drastic decreasing pattern (cut off), meaning that the four models had to use the exponential smoothing model.

Estimation Parameter p, d, and q for ARIMA and WINTER

Next, the appropriate ARIMA model parameters/order will be selected by using RMSE (Root Mean Squared Error) values with the following formula:

$$RMSE = \sqrt{\frac{\sum (y_i - \hat{y}_i)}{n}} \quad (4)$$

Based on theory, the smaller the RMSE value produced by a model, the better the model (Dewi and Muslikh, 2013). So that the model with the smallest RMSE is obtained for each company.

Table 2. RMSE value of ARIMA

Orde	RMSE (d=1)				
	DVLA	INAF	KAEF	KLBF	MERK
(1,0,0)(0,1,0)	0.083	281.102	0.262	0.045	96.663
(0,0,1)(0,1,0)	0.090	286.198	0.336	0.047	124.529
(1,0,1)(0,1,0)	0.083	280.441	0.244	0.045	94.433
(1,0,0)(1,1,0)	0.073	226.899	0.228	0.042	86.719
(0,0,1)(1,1,0)	0.085	235.929	0.333	0.045	124.263
(1,0,1)(1,1,0)	0.074	226.821	0.211	0.041	85.253
(1,0,0)(0,1,1)	0.066	207.243	0.189	0.037	74.411
(0,0,1)(0,1,1)	0.084	216.264	0.332	0.044	124.215

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(1,0,1)(0,1,1)	0.065	205.538	0.177	0.037	73.426
(1,0,0)(1,1,1)	0.066	207.113	0.189	0.037	74.554
(0,0,1)(1,1,1)	0.083	216.742	0.326	0.044	123.271
(1,0,1)(1,1,1)	0.065	205.192	0.176	0.037	73.673

Table 3. RMSE value of Exponential Smoothing Holt Winter

Emiten	Holt Winter	
	Additive	Multiplicative
DVLA	0.062	0.062
INAF	198.816	187.052
KAEF	0.185	0.190
KLBF	0.035	0.036
MERK	71.488	72.576

Furthermore, it will be used to predict the daily stock data of PT. Darya Varia Laboratori Tbk (DVLA), PT. Indofarma Persero (INAF), PT. Kimia Farma (KAEF), PT. Kalbe Farma (KLBF), and PT. Merck Indonesia (MERK) from April 14, 2021 to July 15, 2021.

DISCUSSIONS

ARIMA and Holt Winter models are used to predict the daily share price of PT. Darya Varia Laboratori Tbk (DVLA), PT. Indofarma Persero (INAF), PT. Kimia Farma (KAEF), PT. Kalbe Farma (KLBF), and PT. Merck Indonesia (MERK) from April 14, 2021 to July 15, 2021. The stock price forecasting graph is as shown in Figure below.

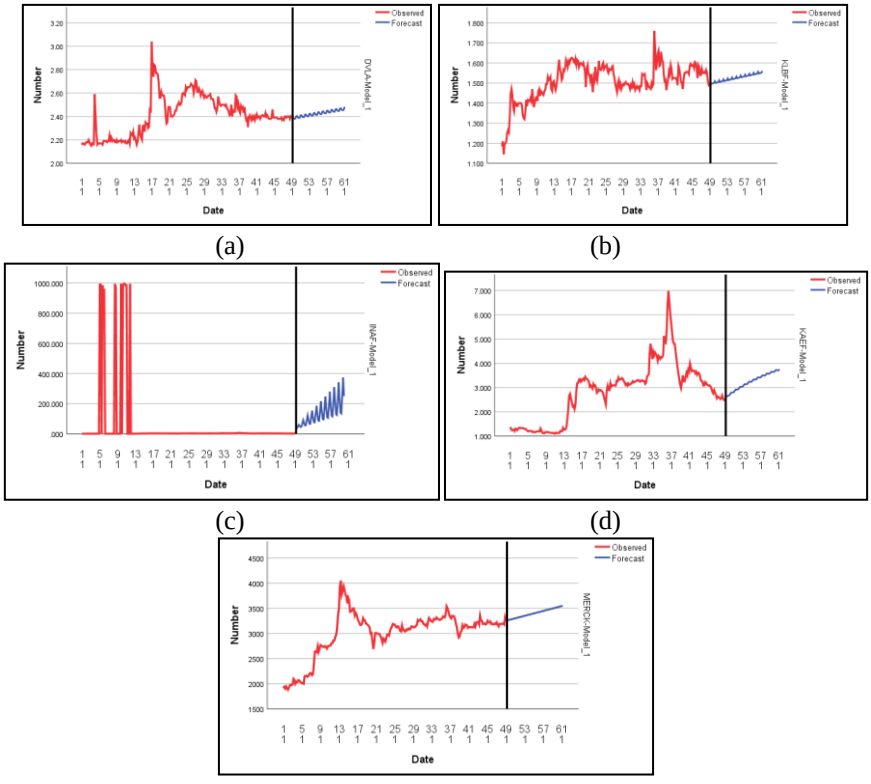

Figure 5. Forecasting: (a) DVLA (b) KLBF (c) INAF (d) KAEF (e) MERCK

The red curve indicates an observation. While the prediction (forecast) is visible in the image with a blue curve. The red line shows the daily stock price data plot of the five companies from March 14, 2020 to April 14, 2021. While the blue line is the prediction (forecast) of the sixth company stock price on April 15, 2021 to July 15, 2021.
The nominal daily stock price is as follows.

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Table 5. Company's Fifth Share Price Forecast for April 15, 2021 to July 15, 2021

Date	DVLA	INAF	KAEF	KLBF	MERCK
15-Apr-21	2.4	34.997	2.552	1.505	3262
16-Apr-21	2.38	37.675	2.585	1.496	3259
19-Apr-21	2.38	48.317	2.608	1.498	3268
20-Apr-21	2.38	60.61	2.608	1.498	3272
21-Apr-21	2.4	52.598	2.601	1.5	3270
22-Apr-21	2.4	45.462	2.627	1.509	3282
23-Apr-21	2.39	47.286	2.67	1.5	3278
26-Apr-21	2.39	68.551	2.672	1.502	3287
27-Apr-21	2.39	91.619	2.664	1.503	3292
28-Apr-21	2.41	72.191	2.661	1.505	3289
29-Apr-21	2.41	55.949	2.689	1.514	3301
30-Apr-21	2.4	56.916	2.731	1.505	3298
3-May-21	2.39	88.825	2.736	1.507	3307
4-May-20	2.39	122.689	2.729	1.508	3311
5-May-20	2.42	91.823	2.725	1.509	3309
6-May-20	2.42	66.456	2.753	1.519	3321
7-May-20	2.4	66.565	2.797	1.509	3317
10-May-20	2.4	109.139	2.802	1.512	3326
11-May-20	2.4	153.822	2.794	1.512	3331
17-May-20	2.42	111.494	2.79	1.514	3328
18-May-20	2.42	76.984	2.819	1.523	3340
19-May-20	2.41	76.234	2.863	1.514	3337
20-May-20	2.41	129.493	2.868	1.516	3346
21-May-20	2.41	185.016	2.861	1.517	3350
24-May-20	2.43	131.205	2.856	1.519	3348
25-May-20	2.43	87.533	2.885	1.528	3360
27-May-21	2.42	85.921	2.931	1.519	3356
28-May-21	2.41	149.888	2.936	1.521	3365
31-May-21	2.41	216.273	2.928	1.522	3370
2-Jun-21	2.44	150.954	2.924	1.523	3367
3-Jun-21	2.44	98.103	2.953	1.533	3379
4-Jun-21	2.42	95.628	3	1.523	3376
7-Jun-21	2.42	170.324	3.005	1.526	3385
8-Jun-21	2.42	247.591	2.997	1.526	3389
9-Jun-21	2.44	170.743	2.992	1.528	3387
10-Jun-21	2.44	108.694	3.022	1.537	3399
11-Jun-21	2.43	105.354	3.07	1.528	3395
14-Jun-21	2.43	190.799	3.075	1.53	3404
15-Jun-21	2.43	278.971	3.066	1.531	3409
16-Jun-21	2.45	190.57	3.062	1.533	3406
17-Jun-21	2.45	119.306	3.093	1.542	3418
18-Jun-21	2.44	115.099	3.141	1.533	3415
21-Jun-21	2.43	211.316	3.146	1.535	3424
22-Jun-21	2.43	310.413	3.138	1.536	3428
23-Jun-21	2.46	210.437	3.133	1.537	3426
24-Jun-21	2.46	129.939	3.164	1.547	3438
25-Jun-21	2.44	124.864	3.214	1.538	3435
28-Jun-21	2.44	231.872	3.219	1.54	3443
29-Jun-21	2.44	341.916	3.21	1.54	3448
30-Jun-21	2.46	230.342	3.205	1.542	3445
1-Jul-21	2.46	140.592	3.237	1.552	3457
2-Jul-21	2.45	134.647	3.288	1.542	3454
5-Jul-21	2.45	252.469	3.293	1.544	3463

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6-Jul-21	2.45	373.482	3.284	1.545	3467
7-Jul-21	2.47	250.287	3.278	1.547	3465
8-Jul-21	2.47		3.311	1.556	3477
9-Jul-21	2.46		3.363	1.547	3474
12-Jul-21	2.45		3.368	1.549	3482
13-Jul-21	2.45		3.359	1.55	3487
14-Jul-21	2.48		3.354	1.551	3484
15-Jul-21	2.48		3.387	1.561	3496

There are several factors that can influence forecasting activities, including:

1. The nature of the product, namely the period of time the product will be produced. Long or short term production.
2. Distribution method, namely market reach between companies and consumers. The company's ability to reach consumers in the market.
3. The company's position in the market. Enter the market leader category, new challenger or just join in enlivening the market.
4. level of competition. How is the company's position with its competitors. What are the strengths, weaknesses, opportunities and challenges that will be faced between the company and competitors.
5. Historical data. All event data related to the company in the past. Usually the data taken is at least development data from five years ago.

Although Forecasting or Forecasting is needed on stock price movements, Forecasting also has drawbacks. The following are the advantages and disadvantages of Forecasting or Forecasting according to researchers (Tealab, 2018).

a) Advantages of Forecasting (Advantages of Forecasting)
An organization uses various forecasting methods or techniques to assess the results that are "possible" to be obtained by the organization or its company. The method used depends on the available data and the type of industry the company operates in. The main advantage of forecasting or forecasting is that it provides valuable information that can be used by companies to make decisions about the future of the company concerned.

b) Disadvantages of Forecasting
It can be said that it is almost impossible to predict the future with 100% accuracy, this is due to the nature of forecasting itself. Scenarios or business conditions may change and differ depending on the interpretation of the data obtained as well as changes and other unforeseen factors in the business environment. Therefore, an organization or company cannot be 100% dependent on certain forecasting methods. But organizations can effectively use forecasting with the help of other analytical tools to get the best information that "probably" will happen in the future. Making decisions based on forecasting results with a low level of accuracy will result in the destruction of the company's finances. In other words, companies are encouraged to integrate forecasting with other business analysis tools.

CONCLUSION

Based on the results of the study it can be concluded that PT. Darya Varia Laboratori Tbk (DVLA) and PT. Kalbe Farma (KLBF) is suitable for prediction using the winter additive model with RMSE 0.062 and 0.035. While PT. Kimia Farma (KAEF) is suitable for prediction using the ARIMA Seasonal model (1,0,1)(1,1,1) with RMSE 0.176. However, for PT. Indofara Persero (INAF) and PT. Merck Indonesia (MERK) is not suitable for prediction using ARIMA or WINTER because the RMSE is still relatively large, they are 187,052 and 71,488. This can be used as material for further researchers in order to predict the company with other models

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