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ORIGINAL ARTICLE

Analysis of Stock Market Reaction in Malaysia During Covid-19 Pandemic via ARIMA

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ABSTRACT – Investment has become a major money-making business in this world through investment in financial markets, stock markets, and forex. There is uncertainty about which stocks to buy during a pandemic like Covid-19. Poor investment choices will affect the profitability of the investors, shifting their risk appetite to be more defensive. Thus, this research is carried out to study the movement of stocks for the year 2020 in Malaysia based on the data obtained from Yahoo Finance. The objective is to provide investors with a guide to investing efficiently during a pandemic. This study investigates how Covid-19 impacts the rate of growth or reduction of stocks so that the performance of the stocks can be forecasted in the future. The moving average method is used to analyze the trend of the stock by comparing the top gainers against the top losers during the periods of pre Covid-19 and Covid-19. The Autoregressive Integrated Moving Average (ARIMA) model studies the autocorrelation function (ACF) graph of selected stocks to further understand the movement of the stocks and compare it to the closing prices of the selected stocks. Based on the findings, it was demonstrated that the quantitative method used could be used to study the effects of a pandemic, as well as the severity of the losses incurred, and profits earned by the industries. The industries that are essential to the country, like pharmaceuticals and rubber manufacturing, are able to maintain their businesses. Moreover, these sectors have profited from the pandemic. The tourism and aviation industries have been hit the hardest by the pandemic, as evidenced by falling stock prices. Thus, it would be wise for investors to invest in an essential sector company during the Covid-19 pandemic.

INTRODUCTION

In the history of civilization, humanity has been struck by major pandemics throughout its history. Human civilization will still be continuously hit by such uncalled-for events in the coming time if mankind ceases to exist, as it is part and parcel of human evolution. With the help of financial markets, the damages taken by the affected countries can be minimized as it gives an opportunity for investors to carry out investment activities to fund the industry, they think might seem fit [1]. Unfortunately, few investors appear to have profited from the Covid-19 pandemic because poor industry choices cost them money and pre-invested stocks that suffered large losses would have shifted their risk appetite to be more defensive [1]. Investment has become a major money-making business in this world through investment in financial markets, stock markets, and forex. The stock market's movements tend to be unpredictable. During a pandemic like Covid-19, there is uncertainty about which stocks to invest in, and poor industry choices during Covid-19 have impacted investor profitability, shifting their risk appetite to be more defensive. The art of investing is allocating money with the expectation of generating profit in the future. Stock market returns are uncertain. There are possibilities for generating huge profits or massive losses. It is wise to invest with proper knowledge of the market, as there are many determinants affecting the volatility of the stock market.

This research is carried out to study the movement of stocks for the year 2020 in Malaysia. Malaysia reported its first Covid-19 case in 2020, and it has continued to grow and impact the stocks since then. For example, "Top Glove" stocks have been soaring since the start of the pandemic, but at what rate has it kept on growing? That is the concern expressed in the research. One of the reasons conducting this study is to understand how Covid-19 impacts the rate of growth or reduction of stocks so that we can further forecast how the stocks will perform in the future.

Forecasting the stock market return is considered one of the most effective ways to evaluate a portfolio and to diversify the portfolio [2]. Prediction is very difficult, especially about the future [3]. Without a proper model to forecast the future price, this will be a hurdle, as it is not possible to quantify the risk involved in the stock price [4]. There are several ways to find out the profitability of certain publicly listed companies that could yield a high return during the pandemic, as not

all industries are seen to be making losses during this period, such as the companies involved in producing the essentials, pharmaceuticals, and rubber.

To reinstate the courage in the investors, an instrument is needed to quantify the risk, which is the volatility present in the market of the selected stock. To achieve this goal, this study applied the ARIMA model, which is simple to apply and understand. The ARIMA model needs only prior data to generalize the forecast [5]. The ARIMA model increases the prediction accuracy while keeping the number of parameters to a minimum. Salman and Kanigoro [6] proved that the ARIMA can outperform other complex models in weather forecasting. ARIMA had been used successfully in predicting death cases caused by the Covid-19 pandemic [7]. There are several research studies that have utilized ARIMA models. Salman and Kanigoro [6] observed the accuracy of the ARIMA model in forecasting the weather. Jansson [8] utilized ARIMA modeling in forecasting indices on the Stockholm Stock Exchange. This study used ARIMA in forecasting the stock price of the aviation and tourism industries. The standard assumption for time series analysis is that the data should be stationary. The final outcome of this research should help investors minimize their losses and increase their profit margin. The remainder of this paper is organized as follows: Section 2 explains the methodology used in this study. Section 3 discusses the experimental results. Section 4 concludes the paper.

METHODOLOGY

To study the impact of Covid-19 on the Malaysian stock market, the data of four stock companies from different sectors was extracted. The sectors focused on for the study are aviation, pharmaceutical, tourism, and the rubber industry. Air Asia Berhad, Pharmaniaga Berhad, Genting Berhad, and Top Glove Corporation Berhad are the stocks used in the study. This study uses daily data from January 25, 2020, the first Covid-19 case detected in Malaysia, to January 25, 2021. The data is collected from Yahoo Finance by following the prices stated in Bursa Malaysia. The analysis is then done by applying the closing prices of those stocks.

This study utilized the closing price of the stocks in the industry, which was obtained from Yahoo Finance. After being able to look at the trend of the industry, it will give an insight into the health of the organization and its reaction to the Covid-19 pandemic. Thus, with the information obtained from applying the model, it will help investors analyze and forecast the prospects of the organization, allowing the investors to decide whether investing in that company would be profitable or not.

Descriptive statistics

To analyze the stock performance, descriptive statistics are applied. Descriptive statistics are applied to the daily returns of each stock to understand the performance of a particular stock. The daily returns of each stock are calculated by applying the formula in equation (1) below.

$$Daily\ returns\ (x) = \frac{(Y_n Closing\ price - Y_{n-1} Closing\ price) \times 100\%}{Y_{n-1} Closing\ price} \tag{1}$$

where Y_n represent the current closing price and Y_{n-1} represents to the prior closing price.

By applying descriptive statistics to the daily returns, several statistics can be obtained to further understand the performance of a stock. The statistics that can be obtained are the average daily returns (mean), variance of daily returns, standard deviation of daily returns, median of the daily returns, minimum value of daily returns, maximum value of daily returns, range of daily returns, and the coefficient of variation (CoV). The average daily return of the stock (mean) is measured to understand the estimated daily return of a stock over a period of a year. This is able to gauge the performance of a company's stock returns over a period of a year. The variance indicator is used to measure the variability of the data from the mean. It is crucial to find variance to determine the standard deviation value, as the standard deviation is a measurement to understand the volatility of a stock. Once the variance of daily returns is computed, it is possible to obtain the value of the standard deviation of the daily returns. The standard deviation reflects the volatility of the stock, or in other words, the risk behind each stock. Moreover, it is crucial to understand the difference between the highest gain and the highest loss a stock has made during a year. It can provide an indication of the maximum range of stock return differences. The correlation of variation is measured as well to show the variability of a dataset in relation to its mean. This simply means that it is a measure to show the number of risks assumed in comparison to the returns from a stock.

Following the computation of all descriptive statistics, further research can be conducted to examine the relationship between the standard deviation of daily returns and the average daily return of the stocks. As standard deviation refers to the risk of a particular stock and average returns refer to the profit or loss stocks make over a year, a graph can be computed to look at the relationship between the risk and the return of a particular stock.

ARIMA Analysis

The ARIMA model uses time series to forecast future trends of data by giving us an understanding of past historical data. The general equation of an ARIMA model is shown in equation (2) below.

$$\hat{y}_t = c + \emptyset_1 y_{t-1} + \cdots + \emptyset_p y_{t-p} - \theta_1 e_{t-1} - \cdots - \theta_q e_{t-q} + e_t \tag{2}$$

ARIMA is applied based on both autoregressive and moving average components. ARIMA can be modelled in the form of (p, d, q) where "p" represents the Auto Regression (AR) component, which is the number of changes prior to the previous time. The term "d" represents the differencing done on the data to make it stationary, and "q" represents the smoothed trend of the data. ARIMA is applied to study the trends of stocks, which can be further used to visualize the movement of stocks in depth and analyze the performance of the stocks. Before coming up with the model, the autocorrelation function (ACF) and partial autocorrelation function (PACF) plots are determined to check if the data is stationary.

The two most important components to determine the model are the ACF and PACF plots. It is an extremely crucial element to forecasting using the ARIMA model. The ACF plot measures the average correlation between the points of data in a time series and the previous data points that are measured with different lags. The PACF plot is somewhat similar to the ACF plot, but the correlation is observed for a shorter length of lag. The data is not stationary, so the first differencing is applied to make the data stationary. Then, the ACF and PACF plots for the first differencing are plotted to check if the data is stationary. If the data is stationary, it is an indication to proceed with the ARIMA modeling.

Figure 1 shows the ACF and PACF plots for each stock's first differencing. Since the data is now stationary, the ARIMA model can be applied. For all the stocks, ARIMA (1,1,1) is applied in order to study the previous trend of the stocks and come up with a 5-day forecast of the closing stock prices with 95% confidence in the closing price range. To test the validity of the model, it is tested with the Ljung-Box test. The ARIMA model can be validated if the -value produced by the Ljung-Box is greater than 0.05. Furthermore, a comparison can be made between the value generated by the Ljung-Box test and the Q Chi square obtained from the model with 95% confidence to test the validity of the Ljung-Box test. If the Q Chi square value is greater than the Q^* value, the Ljung-Box is valid, and the model can be applied.

RESULTS

Closing price and daily returns of stocks

From Figure 2, the closing price of Air Asia, it can be noticed that the stock movement has been in a decreasing trend throughout the year 2020. Since the first Covid-19 case was announced in Malaysia on January 25, 2020, the pattern of stock movement has been declining, and it took a major hit on March 18, 2020, when the Malaysian government announced the Movement Control Order (MCO) as a preventive measure to curb the spread of the Covid-19 virus. There are many restrictions in place, and only the essential companies are allowed to run. Besides that, there are restrictions on interstate travel, and since the borders are closed, international travel is disallowed, so tourists and foreign visitors can't visit Malaysia. As Air Asia's main concern is the aviation industry, which focuses on both interstate and international travel, the implementation of MCO has severely affected their business and thus had a negative impact on their stock prices. According to [9], Air Asia might even have the potential to face bankruptcy in terms of its shares.

Figure 3 refers to the returns of the Air Asia stock throughout the year 2020. Despite being in a decreasing trend in the long run, there are some moments where the stock price rises. There is a surge in Air Asia stock returns on March 20, 2020, just 2 days after MCO is announced. Because the market is recovering from the announcement, more stocks are traded at a higher volume as traders are influenced to pursue gains in regional markets due to the confidence in global policymakers' efforts.

Figure 4 shows the closing price of Genting. The trend of Genting's stock closing price has been decreasing since the first Covid-19 cases were reported in Malaysia. The stock movement follows almost a similar pattern as the Air Asia stock. The stock suffered greatly when the MCO was implemented throughout Malaysia, resulting in an all-time low in 2020 and a closing price of RM 2.950364. Prices rose following the event, but they continue to fall in the long run. The downward trend is due to the lack of tourism activities in Genting, as Genting heavily relies on its tourism activities. Since the implementation of MCO, with restrictions on interstate travel and a temporary ban on international tourists visiting Malaysia, no tourism activities have been able to take place.

Figure 5 describes the returns of Genting stock throughout the year 2020. The returns on the stock have been close to consistent. On March 18, 2020, the stock returned to its all-time low. But then the stock seems to stabilize after the implementation of MCO, as on March 20th, the stock was able to rise over time and continue to stabilize, yet it still moves at a downward trend in the long run.

Figure 6 refers to the closing price of Pharmaniaga. Pharmaniaga is a Malaysian integrated pharmaceutical company. According to the stock movement trend, the stock price has soared over time. Despite the price dropping slightly on the day MCO was announced, the stock was able to recover, remain stable, and grow over time. The stock showed a huge growth on July 22, 2020, when it increased from RM 3.462966 to RM 4.501855. It was largely due to the government's announcement that vaccine processes would be handled by Pharmacia. Malaysia had an agreement with Sinovac to perform and finish the vaccine process in Malaysia with Pharmaniaga [4]. Thus, it gives confidence on investors to invest on pharmaceutical companies is their hope of curbing the pandemic by the Covid-19 vaccine. Ever since that giant leap in price, Pharmaniaga stock prices have continued to grow constantly over time.

Figure 7 represents the daily returns of the stock for Pharmaniaga. As can be seen, the stock took a significant hit when the MCO was first announced; it was their all-time low return for 2020; but it quickly recovered and began generating more positive returns. The stock prices have been growing consistently, and thus the returns have grown higher over time.

Figure 8 shows the daily closing price for Top Glove. Top Glove, a rubber glove company based in Malaysia, is well known in the world of stock markets. By looking at the closing price of the stock, throughout all the stocks discussed earlier, Top Glove is the only company that is least affected by the MCO. Top Glove share prices have been constant

throughout the early periods of MCO, and they soared due to local and international demand for personal protective equipment (PPE). Despite enjoying constant growth and high profit, in the fourth quarter of the year, Top Glove stock started dropping consistently due to the rollout of vaccines worldwide and the reduced demand for PPE required worldwide.

Figure 9 describes the returns of the Top Glove stock. Despite being on an increasing trend, there are several moments when the stock return drops. Despite this, the negative returns are not as significant because Top glove stocks recover quickly, gaining over 15% on three occasions and touching 20% on one. Meanwhile, daily losses have reached a maximum of 10%.
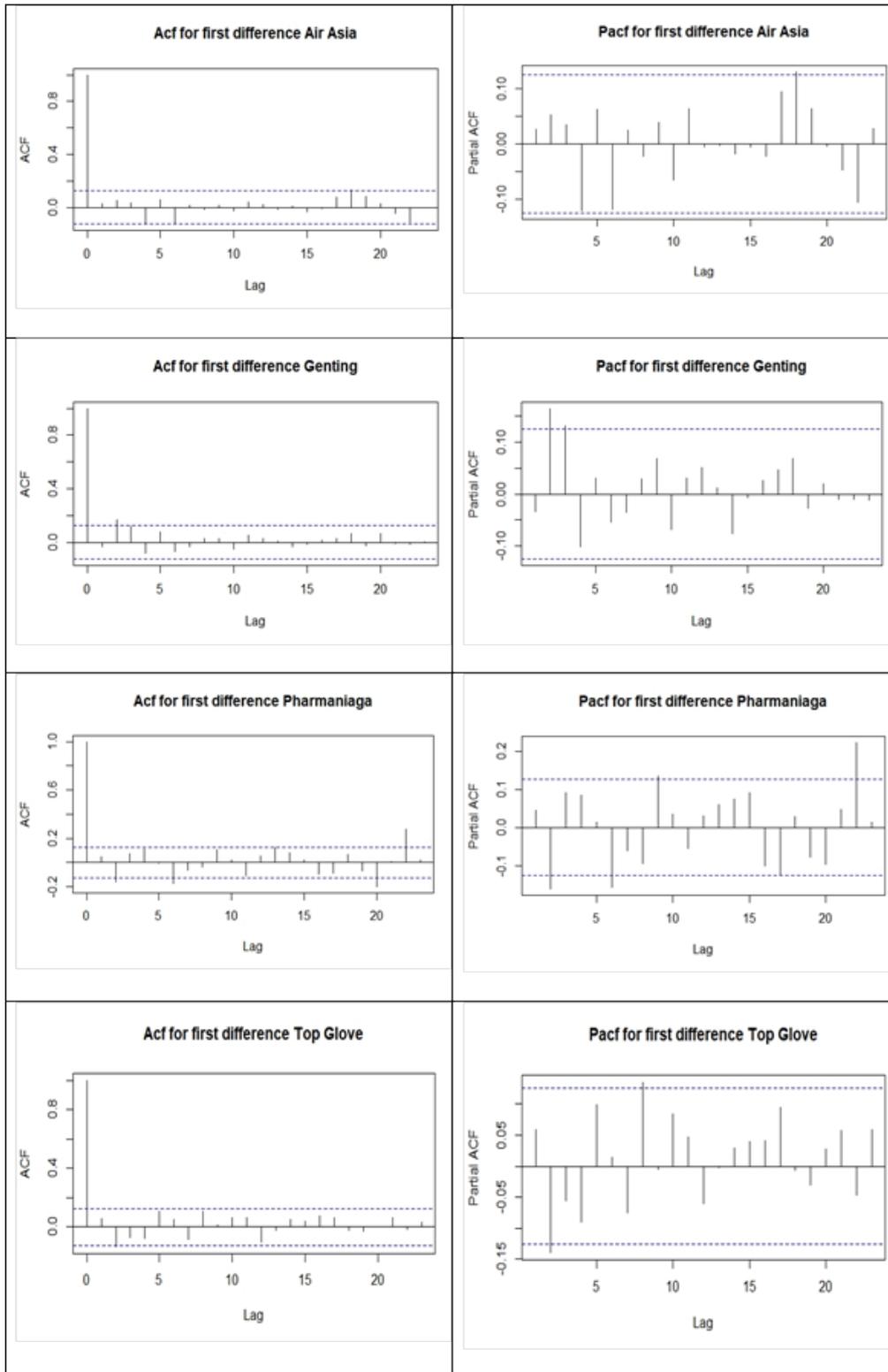

Figure 1. The ACF and PACF plots of stock closing prices.

Figure 2. Air Asia's closing price from January 25th, 2020 to January 25th, 2021 .
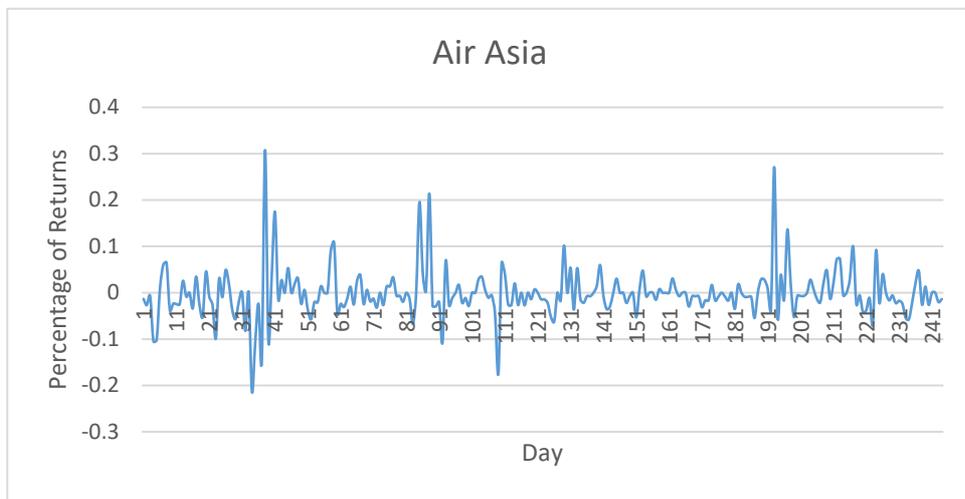

Figure 3. Air Asia's daily returns from January 25, 2020 to January 25, 2021

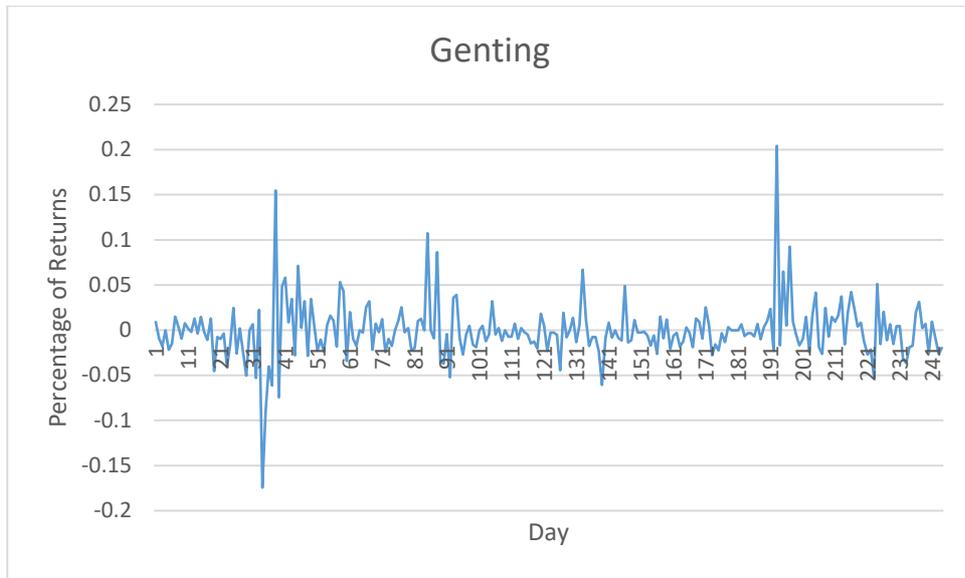**Figure 4.** Genting's closing price from January 25th, 2020 to January 25th, 2021 .

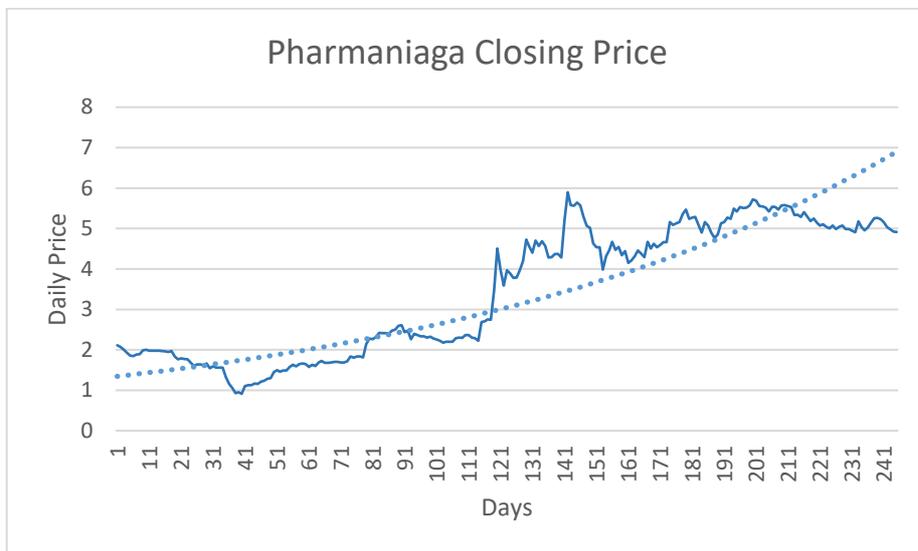**Figure 5.** Genting's daily returns from January 25, 2020 to January 25, 2021.

Figure 6. Pharmaniaga's closing price from January 25th, 2020 to January 25th, 2021.
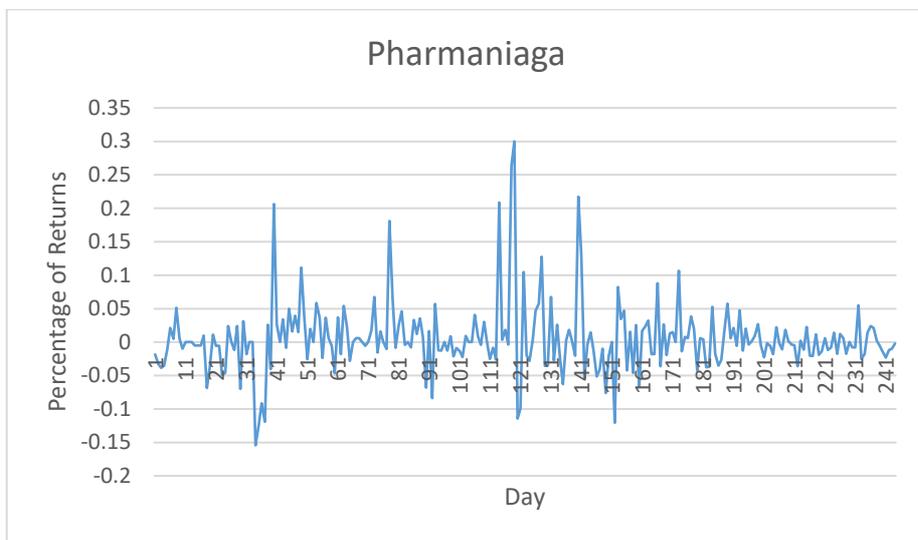

Figure 7. Pharmaniaga's daily returns from January 25, 2020 to January 25, 2021.

Figure 8. Top Glove's closing price from January 25th, 2020 to January 25th, 2021.
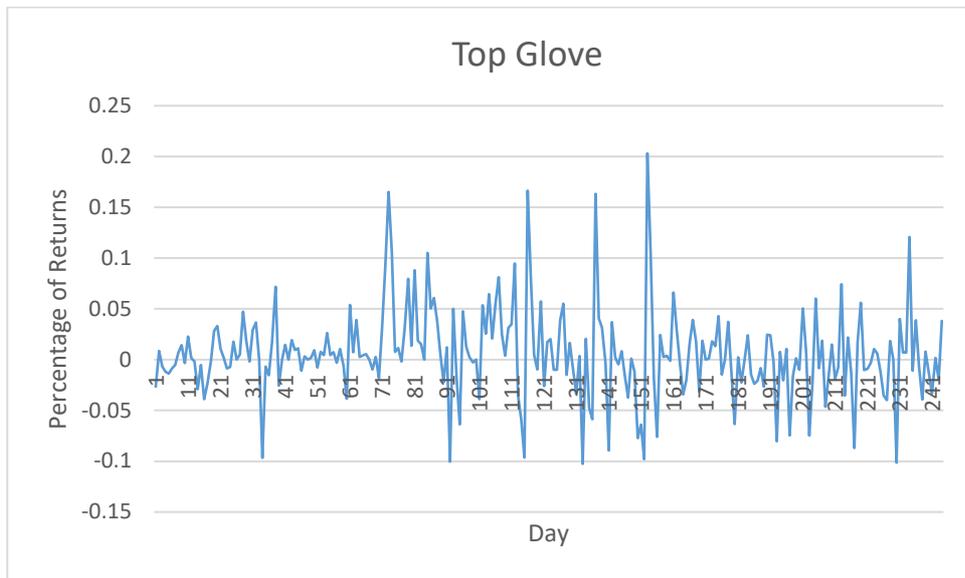

Figure 9. Top Glove's daily returns from January 25, 2020 to January 25, 2021.

Statistical performance of each stock

Some statistical analysis is done to study the performance of the stock. Some are looking into the relationship between the mean of the returns and the standard deviation of the returns, as well as the range and CoV of the stocks. Table 1 refers to the descriptive statistics for each stock. With an average daily return of RM 0.005825141, the top glove stock generated the highest average daily returns, while Air Asia generated the lowest average daily returns. Air Asia is expected to lose approximately RM -0.001639449. Among all those four stocks, Air Asia is the one with the highest daily loss among those four stocks, having lost RM -0.213483146 on the 18th of March, the day MCO was announced. Besides that, despite Air Asia not having a good performance throughout the year 2020, it is the only stock that generated the maximum gain per day among those four stocks by generating RM 0.30792308, which was on March 20th, just 2 days after MCO was implemented. It is solely due to the market adjusting itself to the implementation of MCO and also due to the large volume of stock being traded, which is the reason the prices of stock increased due to the supply and demand of the stocks.

Table 1. Descriptive Statistics for each stock.

Statistics	Air Asia (RM)	Genting (RM)	Pharmaniaga (RM)	Top Glove (RM)
Mean of daily returns	RM -0.001639449	RM -0.000647271	RM 0.004768063	RM 0.005825141
Variance of daily returns	0.002835828	0.001027667	0.002765199	0.001902165
Standard deviation of daily returns	0.053252492	0.032057249	0.052585156	0.043613821
Median	RM -0.006968726	RM -0.002921013	0	RM 0.002392099
Minimum daily returns	RM -0.213483146	RM -0.174418684	RM -0.15432139	RM -0.102564155
Maximum daily returns	RM 0.307692308	RM 0.204013188	RM 0.299999769	RM 0.203100951
Range of daily returns	RM 0.521175454	RM 0.378431872	RM 0.454321159	RM 0.305665106
Coefficient of Variation (CoV)	32.48194499	49.52678106	11.02862096	7.487170297

The CoV is used to measure the dispersion of data around the mean value, which comprises the ratio of standard deviation to mean. In the area of finance and investment, this can be used as an indicator to give investors an idea of the risk of an investment. The lower the CoV, the better the risk return. The CoV for Air Asia is 32.48194499, Genting is 49.52678106, Pharmaniaga is 11.02862096, and Top Glove is 7.487170297. This shows that the CoV for Genting is the highest, whereas the one for Top Glove is the lowest. This indicates that Top Glove has the best risk return among these four stocks, while Genting has the worst risk return.

Standard deviation vs daily returns of the stocks

Figure 10 refers to the comparison of the standard deviation against the average daily return of each stock. In finance, "returns" simply mean the amount of profit or loss a stock is making. The standard deviation measures the number of returns that differ from the mean. In other words, the standard deviation is applied to measure the volatility or risk of an investment. The higher the standard deviation, the higher the risk, and vice versa. In the investment world, it is said that the higher the risk, the greater the reward, and vice versa.

Based on the data analyzed, top glove was the best performing stock and the safest stock to invest in throughout the year 2020 due to its low standard deviation and higher returns, in other words, less risk and higher returns. Pharmaniaga, despite having high returns, also comes with high risk, but due to its high standard deviation, the stock is very volatile. The stock price may rise or drop easily. Genting stock can be the perfect example of a lower-risk, lower-return stock. Investors with a low appetite for risk would consider investing in it. Among those four stocks, we can conclude that Air Asia was the most severely impacted by Covid-19. It is extremely volatile due to a very high standard deviation and provided the lowest return among all the four stocks. As a conclusion, it wouldn't be wise to invest in Air Asia during the year 2020.
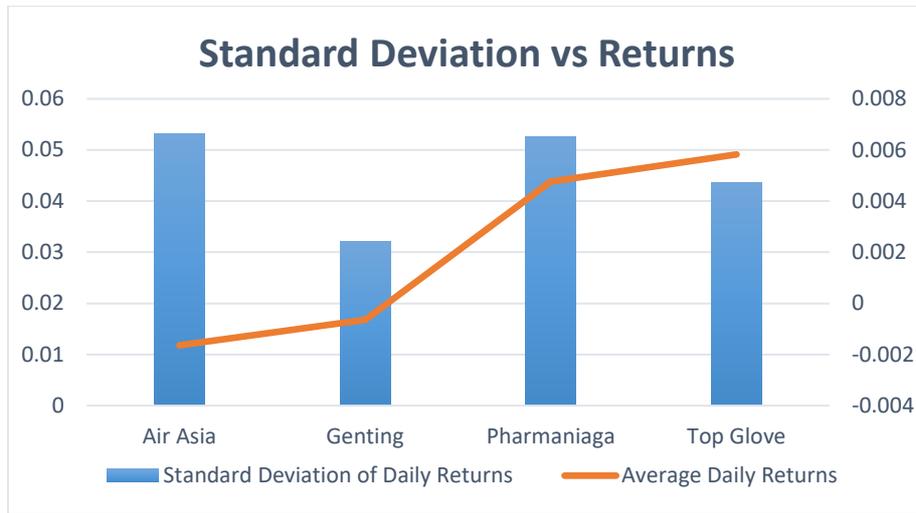
Figure 10. The comparison of standard deviation and average daily returns of each stocks.

ARIMA result analysis

In this study, ARIMA is applied to study the trends of stocks. For the respective stocks, ARIMA (1,1,1) is applied to all the stocks in order to study the previous trend of the stocks and come up with a 5-day forecast of the stock prices. To validate the model to apply, the ACF and PACF plots are determined. The data of company stocks is differentiated once because the first difference is enough to make the data stationary. Once the data is stationary, the ACF plot and PACF plot are computed again to understand the data in depth. Once the model is verified by the ACF and PACF plots, the ARIMA model is further tested by doing the Ljung-Box test to examine the validity of the model. Ljung-Box is a modified version of the Box-Pierce test. The following Table 2 refers to the Q^* value, the Q Chi square value and the p-value.

Table 2. Summary of Ljung box test and Q-Chi Square value

Air Asia	Pharmaniaga
Ljung-Box test	Ljung-Box test
data: Residuals from ARIMA(1,1,1)	data: Residuals from ARIMA(1,1,1)
$Q^* = 10.262, df = 10,$	$Q^* = 16.526, df = 10,$
$p - value = 0.2471$	$p - value = 0.06544$
Qchisq(0.95,10)	Qchisq(0.95,10)
18.30704	18.30704

Genting	Top Glove
Ljung-Box test	Ljung-Box test
data: Residuals from ARIMA(1,1,1)	data: Residuals from ARIMA(1,1,1)
$Q^* = 15.451, df = 10,$	$Q^* = 14.318, df = 10,$
$p - value = 0.05095$	$p - value = 0.07385$
Qchisq(0.95,10)	Qchisq(0.95,10)
18.30704	18.30704

With this information, we are able to forecast the stock prices of each company for the next 5 days with a 95% confidence level for each stock price. Tables 3, 4, 5, and 6 refer to the forecast values with 95% accuracy for each stock, and it is clear that, by ARIMA forecasting, the forecasted value follows the historic trend of stock prices. As can be seen from Table 4, the Air Asia forecasted values show a decreasing trend in the next 5 days. For Genting in Table 5, the forecasted prices show a rather constant price with very minimal difference among the forecasted prices. Based on Table 6, the forecasted closing price for Pharmaniaga shows a decreasing trend, but the price difference is not so significant. As shown in Table 7, the forecasted value of Top Glove shows a decreasing trend with a noticeable difference between the closing price differences. Since there is a 5-day forecast for each stock, it is important to consider the 95% interval of the stock prices. As forecast, the stock price may not be 100% accurate, but the stock will be in the range of the 95% confidence interval.

Table 3. Forecast values for Air Asia

Days	Forecast	Low 95	High 95
246	0.7196299	0.6386716	0.8005882
247	0.7192674	0.6043003	0.8342345
248	0.7189124	0.5775328	0.8602920
249	0.7185647	0.5546587	0.8824707
250	0.7182241	0.5342486	0.9021995

Table 4. Forecast values for Genting

Days	Forecast	Low 95	High 95
246	3.936750	3.708139	4.165361
247	3.935548	3.621677	4.249419
248	3.936047	3.552360	4.319733
249	3.935840	3.494374	4.377306
250	3.935926	3.442983	4.428868

Table 5. Forecast values for Pharmaniaga

Days	Forecast	Low 95	High 95
246	4.920903	4.583763	5.258044
247	4.916809	4.412658	5.420961
248	4.919746	4.307263	5.532228
249	4.917640	4.203520	5.631759
250	4.919150	4.122421	5.715879

Table 6. Forecast values for Pharmaniaga

Days	Forecast	Low 95	High 95
246	5.991511	5.486406	6.496615
247	5.974159	5.222544	6.725773
248	5.983234	5.063741	6.902727
249	5.978488	4.910252	7.046724
250	5.980970	4.785632	7.176308

CONCLUSION

To study and understand the performance of those respective stocks, descriptive statistics are applied to measure the performance of the stocks. The daily return of the stock is the primary concern. As throughout the year 2020, Top Glove Corporation Berhad was the best-performing stock, which delivers high average daily returns with a lower risk, and the worst-performing stock is Air Asia Berhad, due to its high standard deviation and the lowest average daily returns among all stocks, with negative average daily returns throughout the year 2020. In this study, ARIMA (1,1,1) is applied with 95% confidence to the forecasted values. In conclusion, the forecasted values from ARIMA prove to be consistent and precise as they have a close margin of difference compared to the actual values. Throughout the experience of handling the research, much new information unfolded that cannot be unlearned and was useful to moving forward in obtaining the complete output of the research. There are several limitations that could be observed in the models and in carrying out this research to study the stock market reactions to Covid-19. Since the Covid-19 pandemic has not ended, a complete analysis of the stock market's reaction to the pandemic is impossible, as the duration of the pandemic plays an important role in determining the stock market's reaction throughout the Covid-19 pandemic. Furthermore, because the time frame boundary of the Covid-19 is still expanding, it is impossible to conduct a comprehensive analysis of the stock market reaction. Therefore, a complete analysis can only be done when the pandemic ends. Inclusion of the overall data of the companies studied can be used to compute the forecast values of the companies throughout the pandemic period since the pandemic has ended. Furthermore, the non-linear properties that exist in the stock market make the ARIMA model a weak forecasting instrument. A study discusses how ARIMA has limitations in forecasting stock market reactions due to the complex relationship between various factors that cannot be fully explained by a single linear function. Once the pandemic ends, researchers can carry out stock market forecasting for future pandemics with complex forecasting tools such as ANN, Delphi, Holt-Winter, and the Judgmental Model and compare the outcomes of each model to find the best forecasting tool for each company, as no model is perfect. In comparing the outcomes of the models, researchers should focus more on the accuracy and consistency of the outcomes.

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