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Forecasting the Malaysian Crude Palm Oil Price during COVID-19 Pandemic

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Abstract
Purpose: Commodities forecasting can lead to an important element in commodities industry to ensure that each investment by individuals, companies and government was worth it. This study applied exponential smoothing models for analysis and forecasting the crude palm oil (CPO) price in Malaysia during COVID-19 pandemic.
Design/methodology/approach: The data used in this study is daily data of CPO price from March 2020 until May 2021.
Findings: Results obtained by applying exponential smoothing models and numerical calculation shows that it is effective for forecasting the number of CPO price. The best models are single exponential smoothing model were chosen by selecting the lowest value of forecast errors using mean absolute percentage error (MAPE), mean absolute deviation (MAD) and mean square deviation (MSD) as forecast evaluation. As a conclusion, single exponential model gives significant result to be the best model to forecast compared to exponential smoothing models.
Research limitations/implications: The analysis on the comparison between others commodity could be an analysis for future study.
Practical implications: This study contribute to the literature on the impact of COVID-19 towards palm oil industries in Malaysia.
Originality/value: This study will provide an understanding on forecasting crude palm oil price in Malaysia and this study is among the pioneer study in Malaysia that focus on the impact of COVID-19 towards crude palm oil price.
Paper type: Research paper

Keywords: Forecasting, Crude palm oil (CPO) price, Pandemic

Introduction

The World Health Organisation (WHO) announced the coronavirus (COVID-19) pandemic as a global threat in early March 2020. Governments worldwide have imposed controls movement to slow down the spread of the virus, consequently forcing the closure of most contact activities. Movement constraints including partial or complete blockades, closing non-essential businesses, and many more. As of August 2021, more than 213 million cases have been reported worldwide with more than 4.4 million deaths. According to Ministry of Health Malaysia (MOH), as for Malaysia, COVID-19 cases have been 1.5 million confirmed cases with 14,168 deaths. Due to the impact of the COVID-19 pandemic, commodity markets in a lot of countries have shown a volatile trend and many researchers to learn its characteristics and nature associated with the disease. Sharif et al. (2020) suggested the unpredictable COVID-19 pandemic has led to a sharp drop in crude oil demand during global economic catastrophe. Further, the commodity market has witnessed some of its highest uncertainties partly due to the COVID-19 pandemic and partly due to political manoeuvres among producers during the period according to Salisu et al. (2021). While Syahri and Robiyanto (2020) had studied the correlation of gold, foreign exchange rate during the COVID-19 pandemic period. They found that the gold price movement has significantly affected the stock price volatility, during this pandemic era.

Malaysian Palm Oil Board (MPOB) stated the oil palm industry is a backbone of the Malaysian economy and plays a crucial role in feeding and fuelling a developing global population. This has been proven by the contributions of Malaysian palm oil industry where oil palm holds the largest share in agriculture sector with 37.7 share for 2019 according to national account gross domestic product report 2019 by Department Statistics Malaysia (DOSM). Khalid et al. (2018) suggested the fluctuations of crude oil price may lead policy makers to modify their budgetary plans for more sustainable monetary in the palm oil market. Mungmee et al. (2013) suggested the CPO price is influenced by various factors, such as supply and demand, other oil-crop prices, the CPO price, weather phenomena, the impact of natural disasters, and government policies. Thus, resulting CPO price varies over time.

This study attempts to address the problem of predicting CPO price in a period of extraordinary situation. There is a sharp change in the demand for palm oil due to the spread of COVID-19. This study is concerned with the forecasting of CPO price in Malaysia during pandemic, as to assist management in predicting for future. However, forecasting price commodity in Malaysia still underdeveloped as compared to other countries. The objectives of this study are to identify the characteristics data and to validate the best forecasting model to forecast the of CPO price in Malaysia during pandemic COVID-19. With this study, the government could identify the number of expected of CPO price in Malaysia during pandemic for future and predict pattern of CPO price in Malaysia consistently. In addition, this study will provide valuable information to the top management of the tourism companies to observe the performance of the market. So, they can improve their company strategy and increase profit for their company.

Literature Review

Exponential smoothing models was introduced in the late 1950 (Hyndman & Athanasopoulos, 2018). During last few decades, many researchers had studied forecasting using exponential smoothing models. Mah & Nanyan (2020) studied performances of selected models on four-time series methods of the crude palm oil industry in Peninsular Malaysia. The results showed that the bivariate models had better performance compared to the univariate models for production and export of crude palm oil based on the forecast accuracy criteria used. A study on forecasting annual international tourist arrivals in Zambia using Holt-Winters exponential was carried out by Jere et al. (2019), MAE, RMSE and MAPE used as error indicators to evaluate Holt-Winter's, analyses of total quarterly rainfall by Fouli et al. (2018). Khalid et al. (2018) used monthly time series data from 2008 to 2017 to forecast on CPO in Malaysia. The smallest values of RMSE, MAE, MAPE are the best forecasting method to forecast CPO. Furthermore, the results also show that the spot price of palm oil is highly influenced by stock of palm oil, crude petroleum oil price and soybean oil price. Suppalakpanya et al. (2019) forecasted oil palm and crude palm oil data in Thailand using several exponential time-series methods. The MAPE was chosen as the forecasting error. The MAPE was used because it provides an accurate assessment of forecasting methods. The result indicates that the Double Exponential methods give the smallest forecasting error in predicting oil palm prices and crude palm oil prices.

Meanwhile, Tratar et al. (2016) proposed demand forecasting with exponential smoothing techniques. They analysed 756 quarterly and 1,428 monthly series data. Results showed that the method works highly well for the time series. Macaira et al. (2015) examined the residential electricity consumption using exponential smoothing techniques in Brazil. The historical data from 1995 to 2013 annually was taken from Energy Research Company. The results indicated the forecast data to be well adjusted to the historical data. Nochai & Nochai (2006) investigated on ARIMA model for forecasting oil palm price. The study is a used data from farm price, wholesale price and pure oil price from 2000 until 2004. Model for forecasting in three types of oil palm price by considering the minimum of mean absolute percentage error (MAPE). Result showed none to be found the forecasting of CPO price during pandemic situation. Hence, this study attempts to forecast the CPO price in Malaysia during COVID-19 pandemic.

Methodology

The data used in this study were daily data of CPO price from March 2020 until May 2021 which were available on DOSM website. In time series forecasting, it is important to evaluate forecast error using genuine forecasts. Hamzah et al. (2018), Thushara et al. (2017), and Hassani et al. (2017) suggested that data is divided into in-sample and out-of-sample data. The purpose of this process is to provide reliable indication of how well the model fits to both types of data (Hyndman & Athanasopoulos, 2018). In-sample data is used to estimate model, whereas the out-of-sample data is used to validate model. The size of the in-sample data is around 80% while for out-of-sample is typically around 20% of the total data (Hyndman & Athanasopoulos, 2018). In this study, the CPO price are divided into two parts: in-sample data from 1st March 2020 to 15th February 2021 with 280 data and out-of-sample data from 16th February 2021 to 31st May with 73 data.

Data screening is the process of determining data for errors and correcting the data prior to doing data analysis. Box-Cox transformation was used in data screening. Box-Cox transformation is used to transform non-normal data into normal data. Data transformations are widely used tools that can improve the stationary requirement of time series data. The Box-Cox transformation represents a family of power transformation to find the optimal normalising transformation for data.

Hanke et al. (2009) claimed that exponential smoothing model is a practice for continually revising an estimation in the moderate of more recent experience. The exponential smoothing models used in this study are single exponential smoothing, double exponential smoothing and Holt Winter's model. Single exponential smoothing model is a forecasting method that weights recent past data more moderate than more distant data with no trend. Equation for single exponential smoothing model as in [1].

$$\hat{Y}_{t+1} = \alpha Y_t + (1-\alpha)\hat{Y}_t \quad [1]$$

The value of $\hat{Y}_t$ come from the old forecast value. The value of α estimated by minimising sum of squared forecast errors is computed. A small value of α is required from 0 to 1. This small value of α indicates that the average level of the time series is not changing much over time. Double exponential smoothing model is extended of a single exponential smoothing model with a trend. Equation for double exponential smoothing model as in [2].

$$\hat{Y}_{t+1} = a_0(T) + b_1(T)_t \quad [2]$$

$$a_o(T) = \alpha y_t + (1-\alpha)[a_o(T-1) + b_1(T-1)] \quad [3]$$

$$b_1(T)=\beta[a_o(T)-a_o(T-1)]+(1-\beta)b_1(T-1)$$ [4]

In this model, α and β are smoothing constant between 0 and 1, while $a_0(T-1)$is called permanent component. It is an evaluate of the intercept of the time series when the origin of time is time of $(T-1)$. Other than that, $b_1(T-1)$ is known as trend component. Holt-Winter's model is an exponential smoothing model to forecast seasonal data. This model is an intuitive modification of the forecasting interval formula for double exponential model. Equation for Holt-Winter's model as in [5].

$$\hat{y}_{t+1}(T)=[a_0(T)+b_1(T)\tau]sn_{T+1}(T+1-L)$$ [5]

This model is an intuitive modification of the forecasting interval formula for double exponential model. In this model, $\bar{y}_m$ is the average of the consideration in year *m*, while $\bar{y}_1$ evaluate the levelling of the time series in the middle of year 1. Then, *m* refers to the year *m* and *L* is number of seasons.

Forecast Evaluation

A measure of forecast accuracy is used to compare the accuracy of different techniques. Difference between forecasts and actual values are referred to as forecast error. This study used mean absolute percentage error (MAPE), mean absolute deviation (MAD) and mean square deviation (MSD) as forecast evaluation, as it is commonly used in forecasting and simplest-to-use measures of forecast error.

Results and Discussions

This section contains analysis of exponential smoothing models for CPO price forecasting in Malaysia. Tratar et al. (2016) stated exponential smoothing models are easy to use and provide better forecasts when applied to the demand time series data. The analysis and results for forecasting CPO price in Malaysia are deeply explained through this section and all calculations was done using Minitab software. The CPO price was shown in Figure 1.

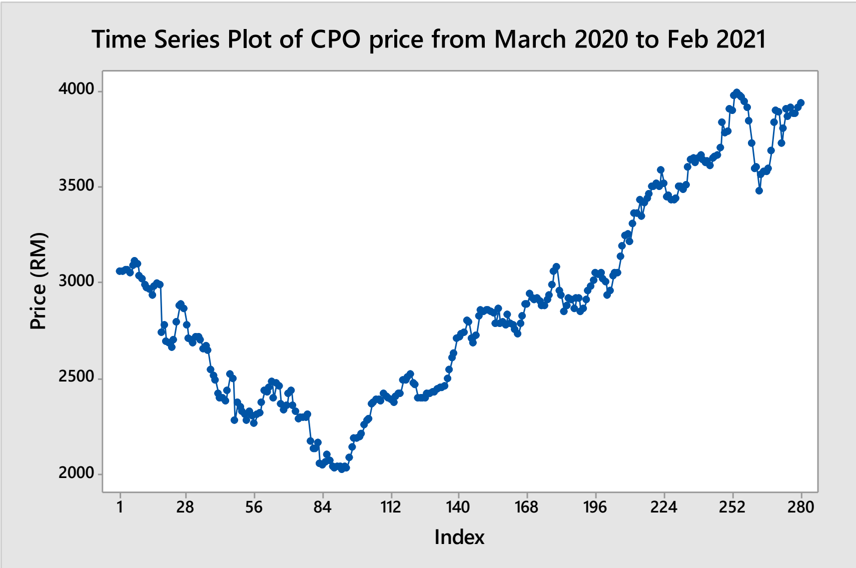

Figure 1: CPO Price from March 2020 to February 2021

Figure 1 shows the CPO price for in-sample data from March 2020 until February 2021 for training data. Based on the time series plot, the plot reveals that there is a steady decreasing in first 80th data and clear increasing trend increasing from 84th until 280th data. Thus, indicates that the data is not stationary. A stationary time series defined as its means and variance are constant over time. According to Olivier and Norberg (2010), Box-Cox transformation to make data set much reasonably normal. Therefore, Box-Cox transformation will be used to test the series follow the normal distribution and stationary in variance. Box-Cox transformation can be useful if the data show variation that increases and decreases with the significant value. Figure 2 show the Box-Cox transformation table for CPO price for training data.

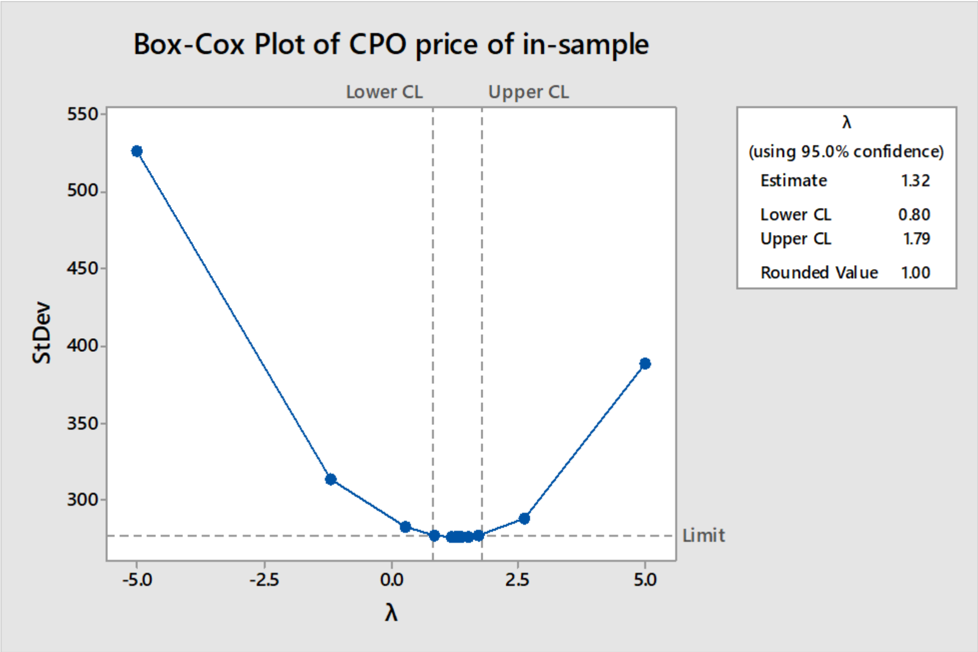

Figure 2: Box-Cox Transformation Table

The Box-Cox transformation table shown in Figure 2 contains an estimate of λ (1.32) and the rounded value (1), which is the value used in the transformation. Thus, implies that the data transformation used in this study is not necessary and proved that the data is stationary in variance. Figure 2 also includes the lower confidence limit (0.80) and upper confidence limit (1.79), which is marked on the graph by vertical lines. The 95% confidence limit includes all λ values which have a standard deviation less than or equal to the horizontal line.

Single Exponential Smoothing Model

Single exponential smoothing model is appropriate for a series that moves randomly above and below a constant mean with no trend. The forecast value is based on weighting the most recent observation with α and weighting the most recent forecast with $1-\alpha$. α is a weighting factor between 0 to 1 and for this study, α is generated by Minitab software. Figure 3 shows the time series plot for single exponential smoothing model for training data from March 2020 to February 2021.

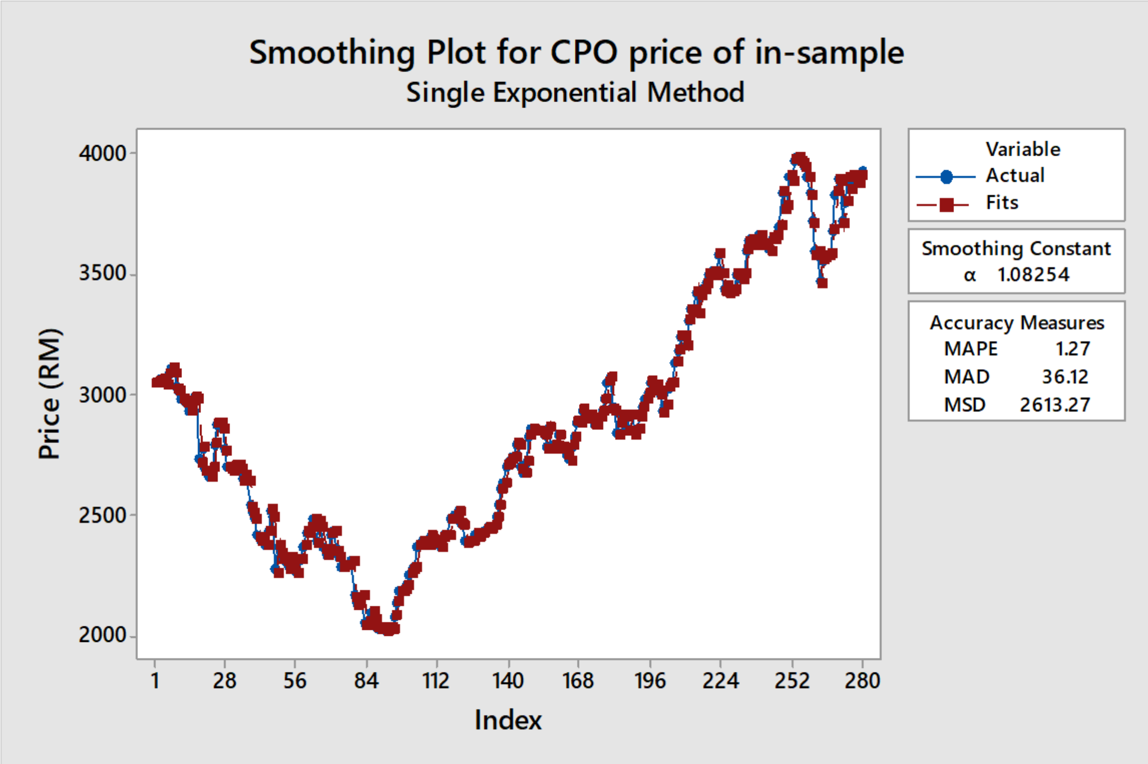

Figure 3: Single Exponential Smoothing Model for Training Data

From Figure 3 there is roughly similar pattern between actual and forecasted data. The smoothing constant from this equation is the initial estimate of the smoothing series. The smoothing constant serves as the balances the benefit of smoothing random variations with the benefits of real changes. The smoothing constant is generated by minimising sum square error given by $\alpha = 1.08$.

Table 1: Forecast Evaluation Values for Simple Exponential Smoothing Model

Forecast Evaluation	Value
MAPE (%)	1.27
MAD	36.12
MSD	2613.27

Table 1 tabulates the forecast evaluation for single exponential model for training data. MAPE shows 1.26% of forecast error while MAD 36.12 and MSD 2613.27 for single exponential model. Double exponential smoothing model is a model with two-parameter linear exponential smoothing. Double exponential smoothing employs a level component and a trend component at each period. Besides that, smoothing constant is not an arbitrary choice generally falls between 0 to 1. Smaller values of smoothing constant are used to stable the equation, while higher values are used when underlying average is susceptible to change. Minitab develops a regression equation using the variable of interest as Y and X time as. Figure 4 shows the in-sample data using double exponential smoothing model.

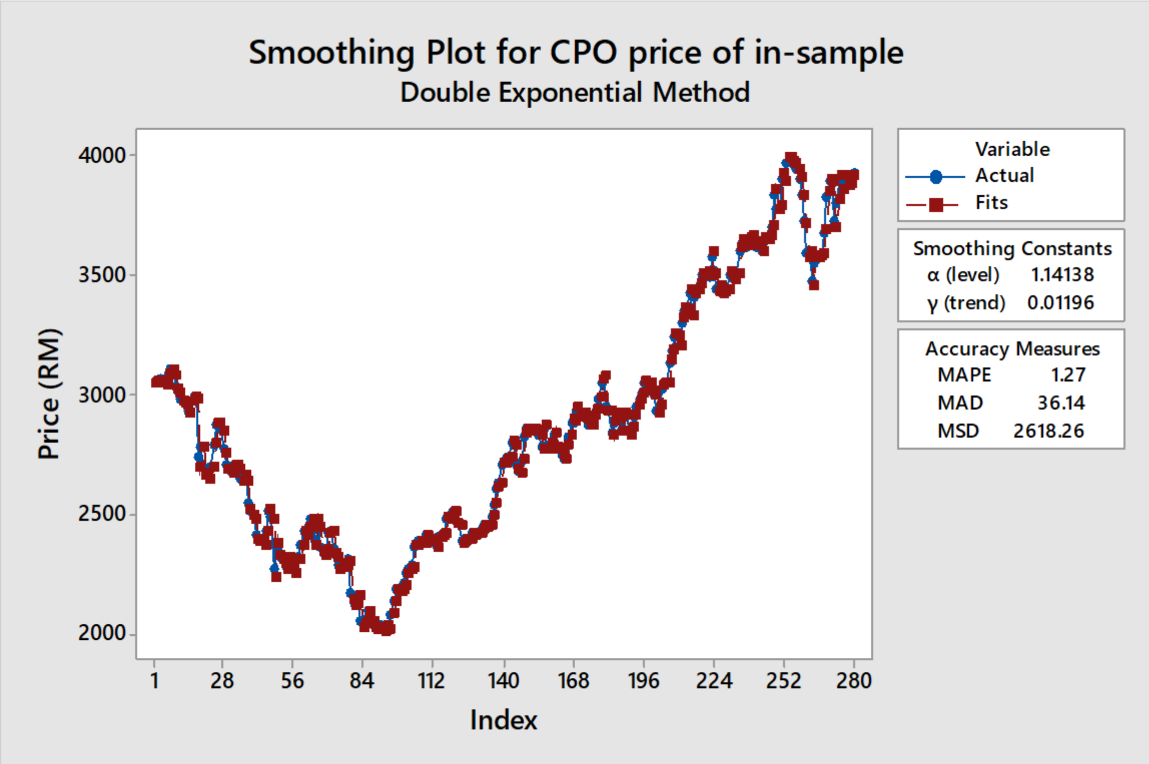

Figure 4: Double Exponential Smoothing Model for Actual and Forecasted Data

Figure 4 shows the data pattern for training data from March 2020 until February 2021. In this study, the smoothing parameters are estimated by minimising the sum square error. Smoothing constant of level equal to 1.141 and trend equal to 0.012 are used.

Table 2: Forecast Evaluation Values for Double Exponential Smoothing Model

Forecast Evaluation	Value
MAPE (%)	1.27
MAD	36.14
MSD	2618.26

As we can see, Table 2 shows forecast evaluation for double exponential model for in-sample data. MAPE shows 1.27% of forecast error while MAD 36.14 and MSD 2618.26 for simple exponential model. Holt's-Winter model is an extension of double exponential smoothing model with seasonality. There is one additional equation is used to estimate seasonality. The smoothing constant serves as the weighting factor. Holt's-Winter model estimates three components: level, trend, and seasonal. Figure 5 shows the in-sample data using Holt-Winter's model.

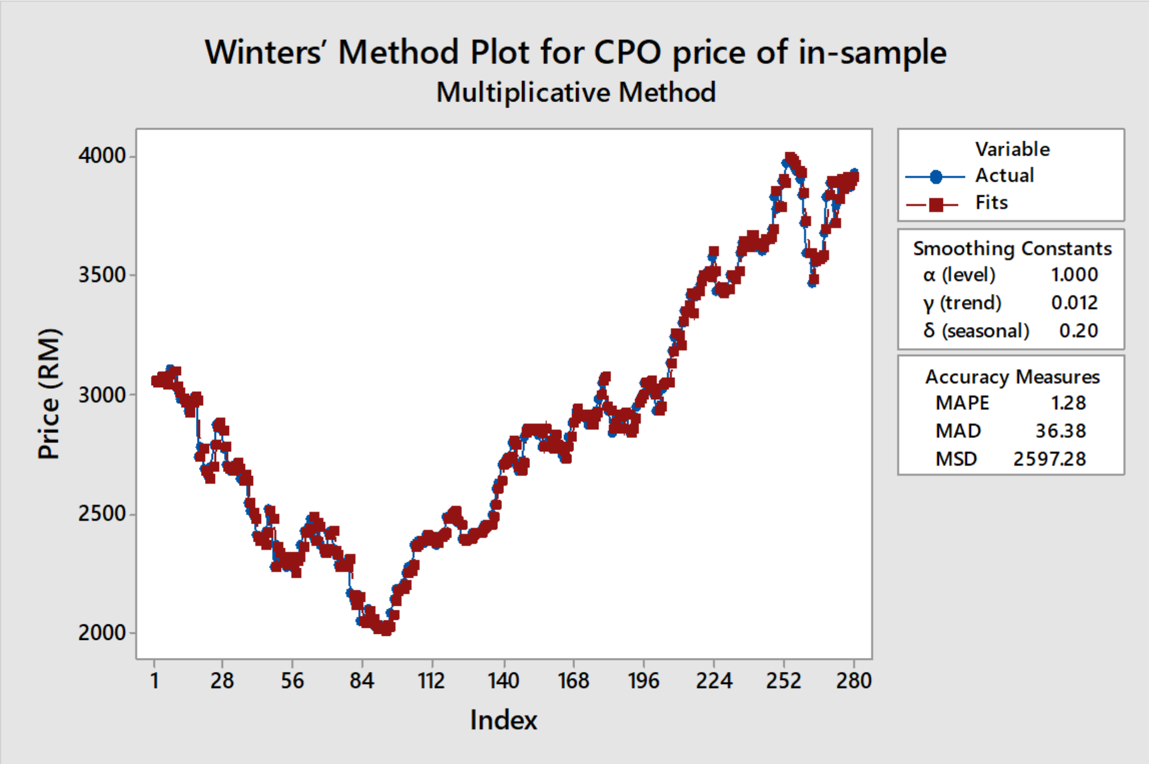

Figure 5: Holt-Winter's Model for Actual and Forecasted Data

From Figure 5, the order of the Holt-Winter's determines the smoothness of the trend-cycle estimate. In general, a larger order means a smoother curve. Figure 5 shows the effect of changing the order of the moving average for the CPO price of training data.

Table 3: Forecast Evaluation Values for Holt-Winter's Model

Forecast Evaluation	Value
MAPE (%)	1.28
MAD	36.38
MSD	2597.28

Table 3 presents forecast evaluation for Holt-Winter's model for in-sample data. The forecast evaluations result for moving average model MAPE is 1.84%, MAD 52.34 and MSD 4610.88.

Comparison of Time Series Models

MAPE is a measure of overall accuracy that gives an indication of the degree of spread. It is a generally technique for evaluating exponential smoothing models. Model with lowest MAPE value is selected as the best model for exponential smoothing models. Table 4 shows the comparison of MAPE values for exponential smoothing models.

Table 4: Forecast Evaluation Values for Time Series Models

Forecast Evaluation	Single	Double	Holt-Winter's
MAPE (%)	1.27	1.27	1.28
MAD	36.12	36.14	36.38
MSD	2613.27	2618.26	2597.28

As shown on Table 4, single exponential model is the best model since all forecast evaluation values are the lowest MAPE, MAD and MSD compared to double and Holt-Winter's exponential smoothing models. Based on the result of data analysis, single exponential smoothing with the smallest error value is the best model to predict CPO price in Malaysia. By using this model, the fitted forecast data are generated in validation of exponential smoothing as out-sample data. Then, values of actual and forecasted were compared to compute the evaluation of forecast. Time series plot for this dataset is shown in Figure 6.

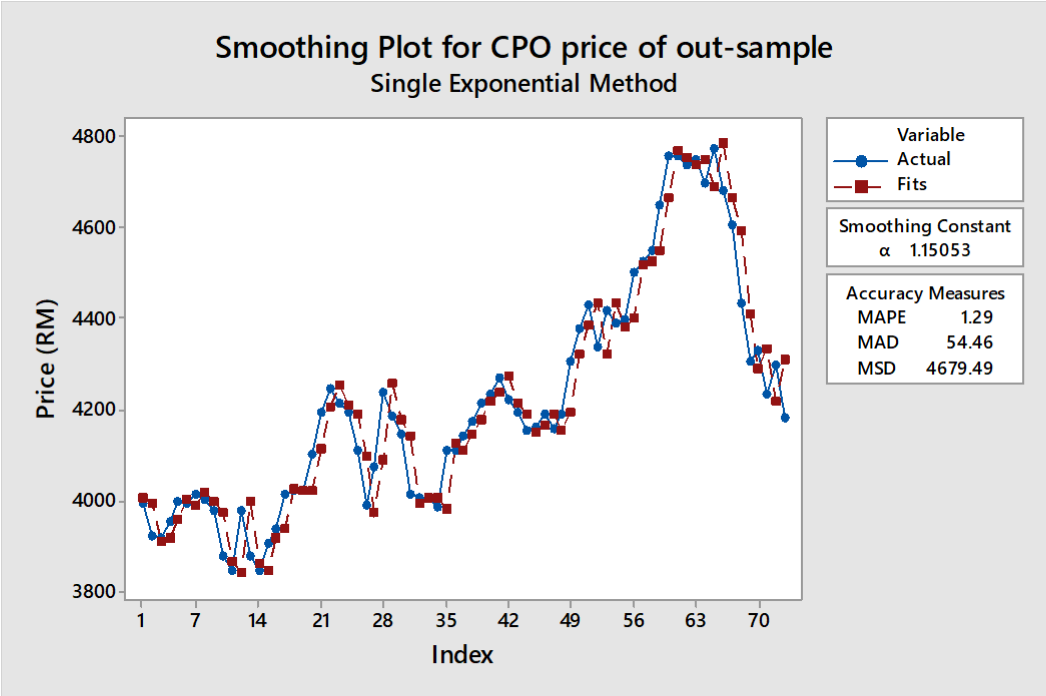

Figure 6: Single Exponential Smoothing Model for Out-sample Data

From Figure 6 there is roughly similar pattern between actual and forecasted data for out-sample data. The smoothing constant from this equation is the initial estimate of the smoothing series. The smoothing constant is generated by minimising sum square error given by $\alpha = 1.15$.

Table 5: Forecast Evaluation Values for Simple Exponential Smoothing Model Out-sample Data

Forecast Evaluation	Value
MAPE (%)	1.29
MAD	54.46
MSD	4679.49

Table 5 tabulates the forecast evaluation for single exponential model for out-sample data. MAPE shows 1.29% of forecast error while MAD 54.46 and MSD 4679.49 for single exponential model.

Conclusions

This paper was focusing on exponential smoothing approach to forecast CPO price in Malaysia during pandemic COVID-19. The first contribution of this study is to identify the characteristics data of CPO price in Malaysia. Based on the empirical results, it shows that the data are trend pattern. The paper followed steps in exponential smoothing models to investigate the forecasting model. In concluding upon the aims and objectives of this study it can be stated that single exponential is the best model for forecasting CPO price based on lowest values of forecast evaluations as compared to double exponential and Holt-Winter's. Based on the empirical results, single exponential smoothing model is the best model with the lowest value of forecast evaluation.

Theoretical Implications

There are many possible implications to enhance the performance of the proposed forecasting model. A literature review on the models can analyse and forecast data which reflects its pattern. Other than that, every model used in each step for every stage are thoroughly investigated and explained.

Practical and Social Implications

The implications of this study in practical and social can be summarised as follows.

1. The proposed models are applicable for any univariate time series data such as other commodity prices, stock price and many more.
2. This model suitable to use of at any frequencies of data such as weekly, monthly, and yearly.

Limitations and Suggestions for Future Research

For recommendation, since this study only focuses on exponential smoothing models, further research can be conducted using other forecasting models. Given the difficulty of finding a larger data, further research could focus on larger set of data which may help to identify the best models. The analysis on the comparison between others commodity could be an interesting research analysis. Besides that, comparison CPO price during pandemic COVID-19 and post pandemic should be consider as future research.

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