Forecasting Natural Rubber Price In Malaysia Using Arima

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Abstract. This paper contains introduction, materials and methods, results and discussions, conclusions and references. Based on the title mentioned, high volatility of the price of natural rubber nowadays will give the significant risk to the producers, traders, consumers, and others parties involved in the production of natural rubber. To help them in making decisions, forecasting is needed to predict the price of natural rubber. The main objective of the research is to forecast the upcoming price of natural rubber by using the reliable statistical method. The data are gathered from Malaysia Rubber Board which the data are from January 2000 until December 2015. In this research, average monthly price of Standard Malaysia Rubber 20 (SMR20) will be forecast by using Box-Jenkins approach. Time series plot is used to determine the pattern of the data. The data have trend pattern which indicates the data is non-stationary data and the data need to be transformed. By using the Box-Jenkins method, the best fit model for the time series data is ARIMA (1, 1, 0) which this model satisfy all the criteria needed. Hence, ARIMA (1, 1, 0) is the best fitted model and the model will be used to forecast the average monthly price of Standard Malaysia Rubber 20 (SMR20) for twelve months ahead.

1. Introduction

According to United Nations Conference on Trade and Development (UNCTAD), natural rubber (NR) comes from latex yielding plants called Havea Brasillensis. Natural rubber is commercially an important component in manufacturing a variety of products in the transportation, industrial, consumer and medical sector due to its elasticity, toughness and resilience [1].

Due to the large volatility in price of the natural rubber, it is compulsory to forecast the upcoming price of natural rubber by using the reliable statistical method. The decisions of the current production are strongly depending on the prevailing future prices [2].

Malaysia is one of main natural rubber production and consumer which is in the third-ranked position among the countries consists in ANRPC with 857.000 MT in 2009 and 970,000 MT in 2010. Thus, there are about 10 percent from the global output of natural rubber in 2010 [3]. Malaysia had estimated that five percent from the total natural rubber supply was consumed by Malaysia in 2010.

Essentially, the Malaysian market is considered one of main commercial hubs for the natural rubber industry [4].

In year 2008 and 2009, there are extremely low prices for all commodities due to outbreak of the global recession. This phenomenon contributed to price volatility and instability in many countries, especially rubber smallholders in South East Asia. Noticeably, the prices dropped again in year 2009 following the declination in international natural rubber prices were caused by the lower crude oil prices [5, 10].

The price of Standard Malaysia Rubber 20 (SMR20) always varies from time to time. Thus, agricultural commodities futures trading ware introduced. This trading was introduced to provide an efficient price discovery mechanism and to provide a hedging mechanism against the risk of price instability. Natural rubber was subjected to significant price fluctuations same as any agricultural commodities [6].

Therefore, the importance in accurate of forecasting model on price of natural rubber become more critical, especially for producers, traders and consumers who are involved in natural rubber industry. The high accuracy in price forecasts were particularly important to facilitate the decision-makers to make efficient decision making as there was considerable time-lag between making output decisions and the actual output of the commodity in the market [7, 11, 12]. There are other quite considerable studies were carried out to merge statistical techniques in Malaysia and other countries [16, 17, 18].

2. Materials and Method

In this research, the materials will be used is the past data of average monthly price of Standard Malaysia Rubber 20. The data is taken from Malaysia Rubber Board website which is from January 2000 until December 2016. The data from January 2016 to August 2016 will be used as validation where it will be compare with the forecast data.

The past data will be used to forecast the data for twelve months which from January 2016 until December 2016. The methods will be used for this research is Box-Jenkins method. Box - Jenkins analysis is the process of identifying, fitting, checking, and using integrated autoregressive, moving average (ARIMA) time series models. The method is appropriate for time series data which have at least 50 observations [8, 13, 14, 15].

As in [8], Box Jenkins Methodology consists of three basic steps which are identification, estimating and testing, and application visualized in Figure 1. For the first step is model identification. The time series data is plotted to see the pattern. The variance of the data is check by Box-Cox plotted. If the variance is not stable, the data is transform using appropriate formula. Then, autocorrelation function (ACF) and partial autocorrelation function (PACF) is plotted to check the stationarity of the mean. If the mean is not stationary, the differencing is taken. In order to produce stationary time series, data need to apply regular and seasonal differencing transformation [9, 14, 15].

After that, the parameter coefficient will be checked whether it satisfy the rules or not. The parameter value will be estimated by using p-value as reference. The p-value of estimate parameter must less than 0.05 and the p-value of modified Box-Pierce (Ljung-Box) Chi-Square statistic must greater 0.05.

The Box-Ljung test was a diagnostic tool used to test the lack of fit of a time series model. The test was applied to the residuals of a fitted model. If the autocorrelations are very small, conclude that the model does not exhibit significant lack of fit. If the p-value associated with the Q statistic is small (p-value < 0.05), the model considered inadequate [8]. If the model is inadequate, the model has been modified and the analysis continued until the level of satisfactory for model achieved. Once an adequate model has been selected, it was used to forecast for one period or several periods into the future.

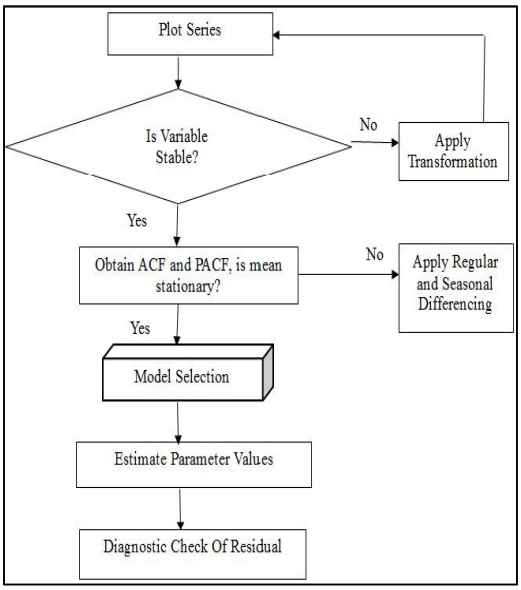

Figure 1. General process for forecasting by using an ARIMA model
(Source: http://www.otexts.org).

3. Result & Discussion

The data of average monthly price of Standard Malaysia Rubber 20 (SMR20) is being analyzed by using Minitab Software. The steps and procedures to carry out the Box-Jenkins method are applied to the data series to fulfill the objective of the research.

The first step in Box-Jenkins methodology is model identification. In model identification, the data is plotted by using time series plot to see the pattern of the data. The data needs to be transform by Box-Cox transformation to stabilize the variance since the variance is not stable. After the data has been transform, the mean of the data will be check by using Autocorrelation Function (ACF) plot and Partial Autocorrelation (PACF) plot.

From the Autocorrelation Function (ACF) plot, the decays extremely slowly in linear fashion and there are large autocorrelations persist even after several lags. On the other hand, PACF shows a large spike at lag 1 and the value is close to 1. Thus, these indicate the time series is non-stationary. Thus, the trend should be removed or the series should be difference. For this research, the researcher will difference the series that has been transformed to obtain stationary series.

After differencing, the time series plot has been plotted again by using transformed data that has been differencing denoted as dTPRICE. Since the plot fluctuate above and below horizontal line which equal to zero after the differencing. The situation indicates the series are stationary in mean. Thus, the data can be used to construct fit model.

To find the fit model, the Autocorrelation Function (ACF) and Partial Autocorrelation (PACF) have been plotted. ACF shows there are cuts off behavior at lag 2 which will present the order of Moving Average (MA) while PACF shows cut off at lag 1 which indicates the order of Autoregressive (AR). Thus, the suggested tentative model chosen by the researcher are ARIMA (1, 1, 2) or ARIMA (1, 1, 1).

To find the best fitted model for this time series we need to do trial and error. Trial and error is used to identify the order of autoregressive term (p) and moving average term (q) and to estimate the best model for the series. All the possible fitted model have to be checked whether the model satisfied the criteria or not. The p-value must be less than α=0.05 and t-statistic must greater than 2.0. Ljung-Box Test is commonly used to check the residuals from a time series model which resemble white

noise. The p-value for this test must be greater than α=0.05 so the model selected is fulfil the white noise properties. Then, the model with smallest mean square error (MSE) is the best model. The best fitted model for this time series which satisfy all the criteria is ARIMA (1, 1, 0) or ARI (1).

After the model has been chosen, the parameter of the model has to be estimated. From the Minitab, the parameter of the model is shown in Table 1.

Table 1. Estimated coefficient of ARIMA (1, 1, 0).

VARIABLE	COEFFICIENT	SE COEFFICIENT
AR (1)	0.1974	0.0713
Constant	-. 6.82 E□ 챌	1.12 E□ 챌

The equation of ARIMA (1, 1, 0) or ARI (1) is written as follows:

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The third step in Box□ Jenkins methodology is model validation which diagnostic checking is takes place. Diagnostic checking for ARIMA (1, 1, 0) or ARI (1) is checked for the model adequacy. The variance is checked whether it is constant or not by using residual plot. Figure 2 shows the residual plot of average monthly price of Standard Malaysia Rubber 20 (SMR20).

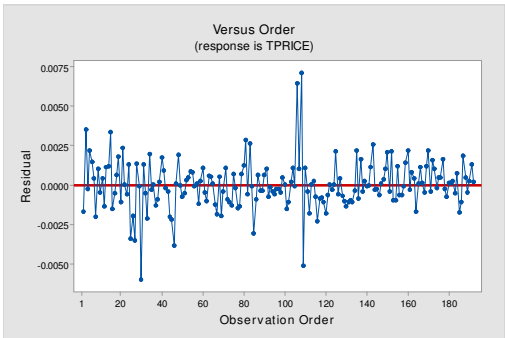

Figure 2. Residual plot of average monthly price of Standard Malaysia Rubber 20 (SMR20).

Since the residual plot shows the series has no trend, the variance of residual is constant. ACF and PACF of residual are plotted to check the independency of the residuals. Both plot are shown in Figure 3 and Figure 4 respectively.

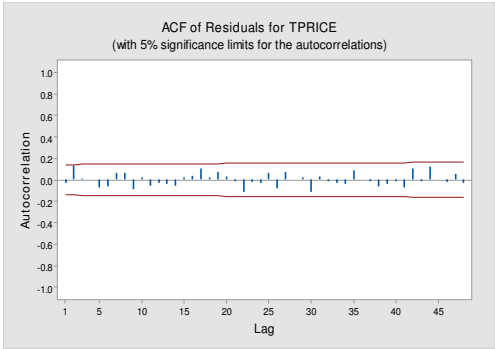

Figure 3. ACF of residuals.

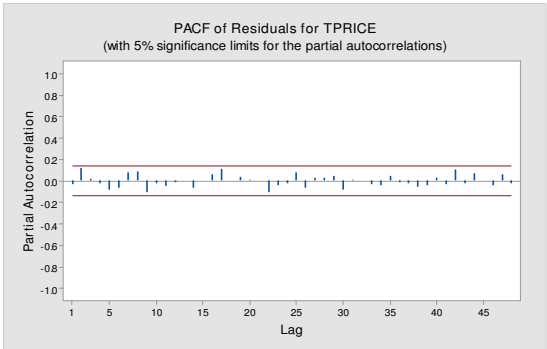

Figure 4. ACF of residuals.

Based on Figure 3 and Figure 4, both ACF and PACF of residuals show the points are mostly fall inside the 5% significance limits. This situation means that the fitted model is independent and valid to be used to forecast the data.

Then, the average monthly price of Standard Malaysia Rubber 20 (SMR20) is forecast for twelve months by using the best fitted model which is ARIMA (1, 1, 0) or ARI (1). The forecast value needs to transform back to original scale. Then, the forecast price value is compared with the actual price from January 2016 until August 2016. Table 2 shows the forecast price of SMR20.

Table 2. Average monthly price of natural rubber forecast result.

MONTH/YEAR	ACTUAL DATA (RM)	BOX-JENKINS OUTPUT	FORECAST VALUE IN ORIGINAL SCALE (RM)
Jan-16	488.89	0.0450947	491.755
Feb-16	454.03	0.0450277	493.220
Mar-16	516.98	0.0449463	495.008
Apr-16	572.43	0.0448621	496.868
May-16	542.98	0.0447773	498.752
Jun-16	510.62	0.0446924	500.648
Jul-16	507.78	0.0446075	502.556
Aug-16	515	0.0445225	504.476
Sep-16		0.0444376	506.406
Oct-16		0.0443527	508.347
Nov-16		0.0442678	510.299
Dec-16		0.0441828	512.263

Based on Figure 5, the actual average of natural rubber seems have fluctuations. There are slightly decreases pattern from January 2016 to February 2016 and the trend seems increasing from February 2016 to April 2016. The forecast value seems slightly increasing pattern from the beginning of 2016 to end of year.

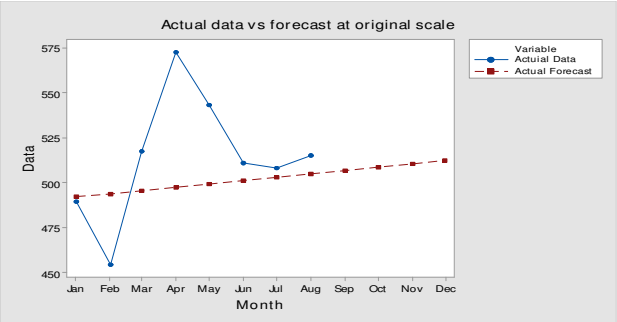

Figure 5. Comparison between actual data versus forecast value at original scale of average monthly price of natural rubber for 2016.

4. Conclusion

The research conducted is fulfilled the objectives of the research. The first objective is to identify the pattern or trend of the data by using time series model. The objective is achieved in which the pattern of the data has been identified by using time series plot. From the plot, the data series shows there are trend pattern. Thus, the mean and variance of the data are not stable. The data need to be transformed and will be differencing at lag 1. The second objective of the research is to find the best fitted model by using Box Jenkins Method. Box-Jenkins approach contained three iterative steps which are model identification, model estimation and diagnostic checking. In model identification, the model is chosen based on ACF and PACF plot. Then, we need to do try and error to find the best fitted model for this time series. The best model is ARIMA (1, 1, 0) or ARI (1).then the parameter of the model is being estimated by using Minitab software. Then, the model need to be diagnosed. ACF and PACF residual plot is plotted to check whether the residual is independent or not. Since, all the points of the residual plot of the data series is within 5% confidence significant, the model is said to be significant and the model can be used to forecast the data series. The last objective is to forecast the future price of Standard Malaysia Rubber 20 (SMR20) in 2016. Since the best fitted model has been identified, the data series can be forecast. For this research, the data need to be forecast are 12 months. The data series that has been forecast by using ARIMA (1, 1, 0) or ARI(1) model need to be transformed to the original data scale. Thus, the data can be compared with the actual average monthly price of natural rubber data which is from January 2016 until August 2016.

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