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Forecasting the Price of Field Latex in the Area of Southeast Coast of Thailand Using the ARIMA Model

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Abstract

The purposes of this study were to select an independent variable with an influence to the prices of field latex and construct a forecasting model suitable for the time series of field latex prices in the area of southeast coast of Thailand. Box–Jenkins forecasting method was employed in this study where 180 values of the first month data series from January 2002 to December 2016 were used to construct the forecasting model and the 12 values of the second month data series from January to October 2017 were used to verify the accuracy of the constructed forecast. The findings revealed that PriceRSS3, the independent variable, affected the prices of field latex and in terms of model fit, SARIMA (0,1,0)(1,0,1) forecasting model was able to describe the variation of latex prices at 98.70% efficiency rating with MAPE at 3.637. When comparing with the actual prices of field latex in the second data series, it was found that the MAPE value was 24.60 and RMSE was 14.90.

Keywords: Box-Jenkins model, Forecasting, Field latex prices

INTRODUCTION

Rubber is considered to be one of the key economic crops of Thailand as each year, it generates 12-figure revenue in baht to the nation. In 2014, Thailand generated a revenue from the total rubber export value of 193,749.21 million baht, while in 2015, the value was 170,376.87 million baht. Thailand ranked the world's second after Indonesia as nation with largest area of rubber plantation. In terms of domestic rubber consumption, in 2015, Thailand consumed approximately 600,491 tons of rubber, constituting 13% of the national production. Key industries that consumed most rubber were tire, rubber gloves, and etc. Looking at the past, it was found that in 2011, rubber farmers were able to sell their ribbed smoked sheets No.3 (RSS3) at an average price of as high as 150 baht per kilogram while field latex was sold at an average price of 140 baht per kilogram. Later on however, prices of both products consistently declined until now. It was clear especially during the past three years that rubber prices of both products were nowhere exceeding average prices of 70 baht per kilogram [1] as exhibited in Figure 1.

One of the problems that caused the current declination of rubber price was that, according to Table 1, since 2012, Thailand has continued to increase plantation area for rubber which when compare the production volume, export volume, and domestic consumption, it was clear that the remaining

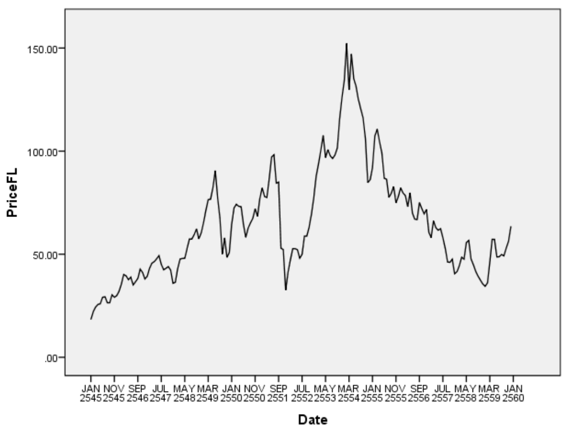


Figure 1: Field Latex Prices (PriceFL)

Table 1: Rubber data of Thailand from 2012 to 2015

Year	Area of Planation (Rai)	Production Volume (Ton)	Export Volume (Ton)	Domestic Consumption (Ton)	Stock (Ton)
2012	21,958,349	3,778,010	3,121,332	505,052	516,675
2013	22,176,714	4,170,428	3,664,941	520,628	502,855
2014	23,583,208	4,323,975	3,770,649	541,003	516,756
2015	23,561,155	4,473,370	3,749,456	600,491	642,895

Stock was proportionally high. It was, therefore, a cause of rubber overproduction which resulted in price fluctuation towards a declining trend in various types of rubber. The situation impacted the income of rubber farmers which eventually led to the life misery that many of them were forced to encounter.

For this reason, the researcher took a particular interest and examined the influencing factors that affect the field latex prices as acquiring such intelligence would be useful for price forecasting. The price forecast can further be used as a reference price for rubber farmers as a prediction of the future price of their field latex. Moreover, it would also help farmers prepare to for changes in field latex prices where they could cultivate alternative crops or produce handicrafts instead during periods when field latex prices go low. In the field of price forecast of field latex, W. Riansut [2] had already conducted a study on this by creating a forecasting model that conforms with time series. Her study, however, did not incorporate independent variables into the predictive algorithm. This was different from this study, as it incorporated independent variables affecting field latex prices into its predictive algorithm.

METHODOLOGY

This study constructed a forecasting model using SPSS, using time series of Field Latex Prices (PriceFL) derived from the Central Rubber Market, Hat Yai, Songkhla, Thailand from January 2002 to December 2016 which totally comprised 180 values. This study divided the data into two parts: Part 1 analyzed 180-month sample data from in January 2002 to December 2016 to find an appropriate model for forecasting. Part 2 used the 10-month sample data from January to October 2017 to compare with the forecasted values derived from the constructed forecasting model.

The following chart exhibits the process flow.

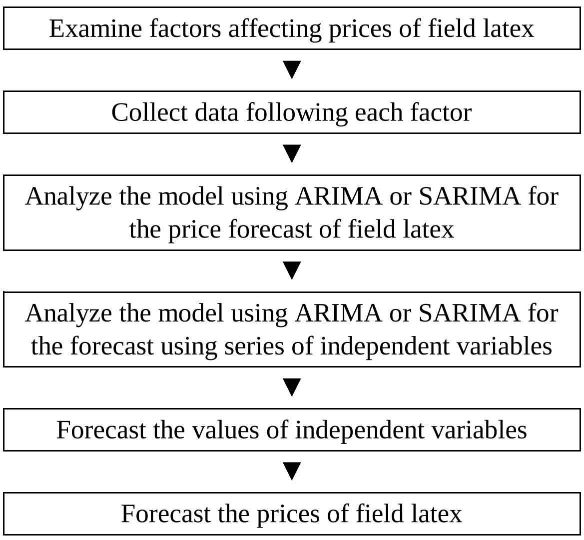


Figure 2: The methodological steps

A. Examining influencing factors of field latex prices and data collection

In this section, the researcher will discuss the origination of each factor in the independent variables which caused the declination of field latex prices. The researcher [3] carried out a performance assessment of rubber plantation aid fund cooperatives in the east coast of southern Thailand using an in-depth survey on the respondents who were the local experts in rubber and its price. The findings indicated that the fluctuation of field latex prices depended on numerous factors including politics and economy. More importantly, the prices primarily depended on the prices of unsmoked sheet rubber and ribbed smoked sheets No.3. S. Sdoodee and S. Rongsawat [4] conducted an impact study of global warming on rubber production in Songkhla and discovered that the increased amount of rainfall and the number of rainy days decreased the number of days of rubber tapping. As a result, rubber yield decreased and that drastically impacted the price of field latex. From that influencing factor of price of field latex, this study incorporated factors of Unsmoked Sheet Rubber Prices (PriceUSB), Ribbed Smoked Sheets No.3 Prices (PriceRSS3), Rainfall (RF), and Rainy Days (RD) into the independent variables to analyze and see which factors affected the field latex prices. Data on Unsmoked Sheet Rubber Prices and Ribbed Smoked Sheets No.3 Prices were collected from the Central Rubber Market, Hat Yai, Songkhla, Thailand whereas the data on Rainfall and Rainy Days were collected from the Meteorological Department of Thailand in the area of southeast coast especially from Hat Yai, Songkhla.

This study opted to employ a statistical method, Box–Jenkins [5] [6] to construct the forecasting model since the previous time-series analysis was excessively complex when it involves trend and seasonal variation. In contrast, the time series analysis of Box–Jenkins can simplify such difficulty which allows the forecast that involves time series becomes highly accurate and makes it possible to further be used to accurately predict the future in a very more realistic fashion. Numerous researchers employed the time series analysis of Box–Jenkins in their forecasts: M. Napi Bin Daud [7] employed Box-Jenkins method to forecast the rubber price, Aye Aye Khin and S. Thambiah [8] analyzed rubber behavior and forecast its price, a case of central market in Malaysia, P. Arumugam and V. Anithakumari [9] constructed an ARIMA forecast data transfer model by specifying pattern and estimating import parameters for rubber production forecast in Indonesia, and W. Keerativibool [10] discovered that the most suitable forecast model for export value of jasmine rice is the forecast method of Box-Jenkins with lowest.S. Cherdchoongam and V. Rungreunganun [11] employed Box-Jenkins method to forecasting the price of natural rubber in Thailand.

B. Time series analysis for field latex price forecast

When determining the fluctuation of field latex prices according to time series from January 2002 to December 2016, as shown in Figure 1, it can be seen that this set of time series contains unstable trend and seasonal variation. In the other words, this time series of field latex prices has unstable average and variation. Therefore, the researcher converted the data through finding the difference ($d = 1$) and the natural logarithm (ln). The ACF and PACF graphs of the converted data of time series can be seen in Figure 3 and 4. According to the results, it was found that the time series was constant so the possible forecasting model was constructed with estimated parameters as shown in Table 2.

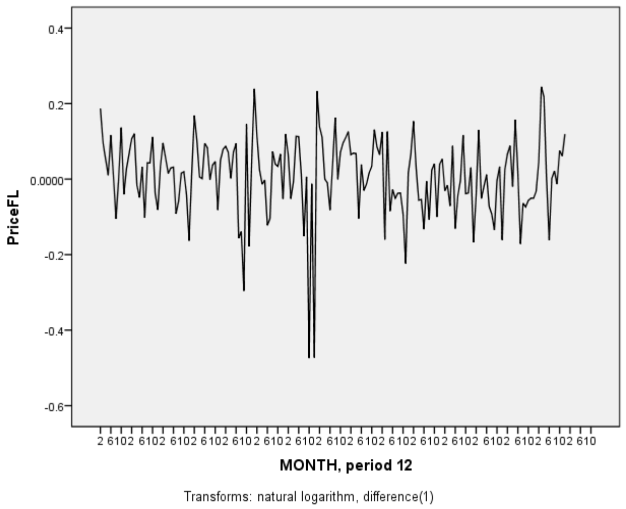


Figure 3: Time series plot when converted the data using the difference seasonal difference 1 and natural logarithm

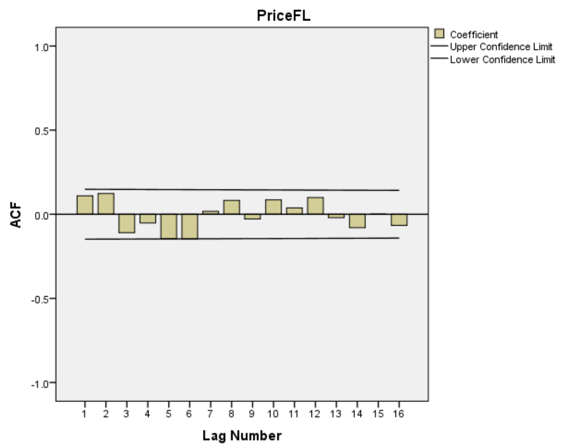


Figure 4: ACF and PACF when converted the data using the difference seasonal difference 1 and natural logarithm

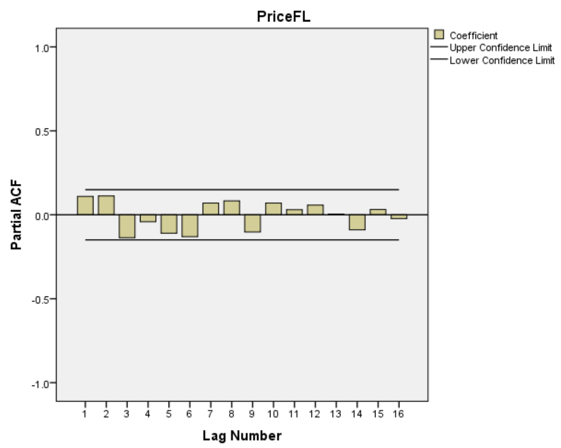


Figure 4: ACF and PACF when converted the data using the difference seasonal difference 1 and natural logarithm (Cont.)

Table 2: Model fit statistics of ARIMA and SARIMA

Model	Model Fit Statistics		Ljung-Box Q (18)		
	R-Squared	MAPE	Statistics	DF	Sig.
ARIMA (0,1,0)	0.930	7.862	23.214	18	0.183
ARIMA (1,1,0)	0.931	7.804	20.395	17	0.255
SARIMA (0,1,0)(1,0,0)	0.930	7.819	21.208	17	0.217
SARIMA (0,1,0)(1,0,1)	0.931	7.520	19.979	16	0.221
SARIMA (1,1,0)(1,0,1)	0.931	7.759	18.084	16	0.319
SARIMA (1,1,0)(1,0,1)	0.932	7.795	26.775	15	0.030

From Table 2, when looking at the values of MAPE, it can be seen that SARIMA (0,1,0)(1,0,1) has the smallest value which is ideal as a forecasting model. When determining the Ljung-Box Q (Sig. = 0.221), with no statistical significance at the significant level of 0.05, it can be concluded that the random error of SARIMA (0,1,0)(1,0,1) contains no self-correlation which follows the basic agreement of the model. In conclusion, SARIMA (0,1,0)(1,0,1) is suitable to be used to forecast the field latex prices. Parameter estimates are shown in Table 3 which can be written as Box-Jenkins's ARIMA Model equation as described in Equation 2.1.

Table 3: Parameter estimates of SARIMA (0,1,0)(1,0,1)

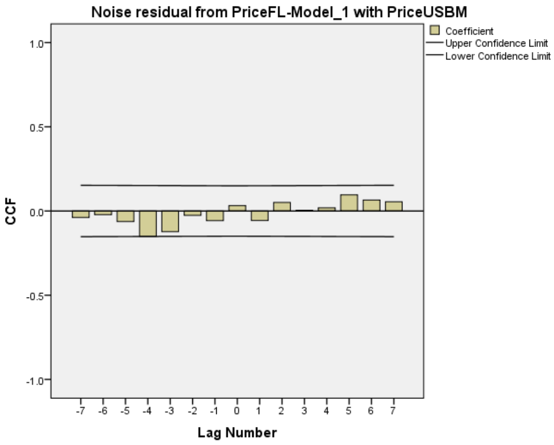
		Estimate	SE	t	Sig.
PriceFL Natural Logarithm	Difference	1			
	AR, Seasonal Lag 1	.993	.077	12.885	.000
	MA, Seasonal Lag 1	.959	.231	4.152	.000

$$\ln(y_t) = \ln(y_{t-1}) + 0.993\ln(y_{t-12}) - 0.993\ln(y_{t-13}) + a_t - 0.959a_{t-12} \quad (2.1)$$

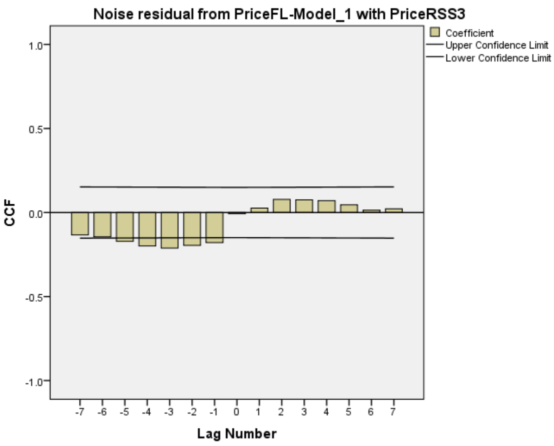
Forecasting Equation 2.1 can explain the variability of the price data of field latex at 93.10% efficiency as the R-squared value was 0.931 and the absolute error value was at 7.520% from Table 2. The independent variables expected to affect the prices of field latex were then taken into consideration to construct the forecasting model as shown in Step C.

C. ARIMA or SARIMA model analysis for forecasting with series of independent variables

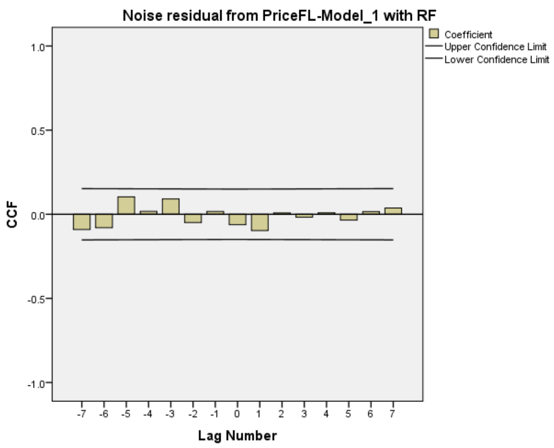
At this stage, some independent variables were determined to be added to the forecasting model for field latex prices. The process began with determining the Cross Correlation Function (CCF) obtained from SARIMA (0,1,0)(1,0,1) of PriceFL in Step B with time series of four independent variables: PriceUSB, PriceRSS3, RF and RD.



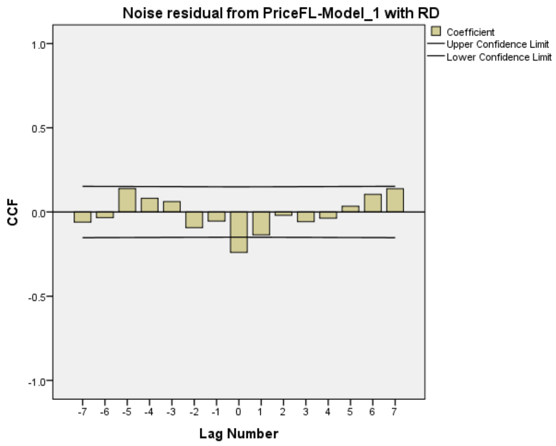
(a)



(b)



(c)



(d)

Figure 5: CCF graph of the remaining noise residual obtained from the model SARIMA (0,1,0)(1,0,1) of PriceFL with (a) PriceUSB, (b) PriceRSS3, (c) RF and (d) RD

According to Figure 5 showing CCF graph of the remaining noise residual obtained from the model, only the data derived from SARIMA (0,1,0)(1,0,1) of PriceFL with PriceRSS3 and RD indicated exceeding CCF values or in the other words, the CCF values were different from zero. Therefore, in order to forecast the field latex prices using the forecasting Equation 2.1 based on the data derived from independent variables, the variables that affected the forecasting results were Ribbed Smoked Sheets No.3 Prices (PriceRSS3) and Rainy Days (RD). The results are shown in Table 4 and 5

Table 4: Model statistics of PriceFL with independent variables

Model	Number of Predictors	Model Fit Statistics		Ljung-Box Q (18)		
		R-Squared	MAPE	Statistics	DF	Sig.
PriceFL - PriceRSS3	1	.987	3.637	22.767	16	.120
PriceFL - RD	1	.940	7.390	19.699	16	.234

From Table 4, PriceFL parameter estimates with independent variables, the independent variable, PriceRSS3 had Sig. = .000. This implies that this independent variable was statistically significant at 0.05 level with PriceFL whereas RD found to be Sig. = .000 which was statistically significant.

Table 5: PriceFL parameter estimates with independent variables

PriceFL- PriceRSS3		Estimate	SE	t	Sig.
PriceFL Natural Logarithm	Difference	1			
	AR, Seasonal Lag 1	.952	.077	12.359	.000
	MA, Seasonal Lag 1	.849	.140	6.075	.000
PriceRSS3 Natural Logarithm	Numerator Lag 0	.996	.043	23.141	.000
	Difference	1			
PriceFL- RD		**Estimate**	**SE**	**t**	**Sig.**
PriceFL Natural Logarithm	Constant	.084	.018	4.662	.000
	Difference	1			
	AR, Seasonal Lag 1	.055	2.935	.019	.985
	MA, Seasonal Lag 1	.028	2.940	.010	.992
RD No Transformation	Numerator Lag 0	-.005	.001	-4.714	.000

On the other hand, when determining PriceFL with AR, Seasonal Lag 1 and MA, Seasonal Lag 1 were Sig. = .985 and Sig. = .992, respectively with no statistical significance at 0.05. These posed a high risk of error when used to forecast the field latex prices in conjunction with the RD. Therefore, it is necessary to remove RD, the independent variable out of the forecasting in this section.

Therefore, to analyze SARIMA model in forecasting the field latex prices using a series of independent variables, only PriceRSS3 will affect PriceFL, which can be formulated in equation following Box-Jenkins theory of ARIMA Model as follows:

$$\ln(y_t) = \ln(y_{t-1}) + 0.952\ln(y_{t-12}) - 0.952\ln(y_{t-13}) + a_t - 0.849\,a_{t-12} + 0.996\ln(y_{t-12}) \quad (2.2)$$

For Equation (2.2), the PriceFL forecasting equation for the independent variable, PriceRSS3, has an R-squared value of 0.987. This equation was able to describe the variation in field latex prices at 98.70% efficiency and it has the absolute error percentage of MAPE at 3.637 described from Table 4.

D. Analysis of Model for Forecasting Independent Variables

To obtain the accurate data in forecasting the field latex prices using Equation 2.2, it is necessary to forecast the PriceRSS3 variable first. In this case, 10 advanced time periods were forecasted from January to October 2017. The finding indicated that the best model fit to forecast PriceRSS3 was SARIMA (1,1,0)(1,0,1) as shown in Table 6 and parameter estimates in Table 7.

Table 6: Model fit statistics of SARIMA (1,1,0)(1,0,1)

Model	Model Fit Statistics		Ljung-Box Q (18)		
	R-Squared	MAPE	Statistics	DF	Sig.
PriceRSS3	.945	6.371	18.238	15	.250

Table 7: Parameter estimates of the independent variables, PriceRSS3

PriceRSS3		Estimate	SE	t	Sig.
PriceRSS3 Natural Logarithm	AR, Lag 1	.230	.073	3.128	.002
	Difference	1			
	AR, Seasonal Lag 1	.904	.171	5.273	.000
	MA, Seasonal Lag 1	.837	.218	3.840	.000

Once the forecasting equation model of PriceRSS3 has been formulated, the 10 advanced time periods were forecasted from January to October 2017 and the results are shown in Table 8.

Table 8: 10 advanced forecasts of future period of the independent variables, PriceRSS3

Forecast	PriceRSS3	LCL	UCL
Jan-60	79.29	66.77	93.49
Feb-60	78.24	65.88	92.25
Mar-60	80.93	68.15	95.42
Apr-60	80.09	67.44	94.43
May-60	83.28	70.12	98.18
Jun-60	82.54	69.50	97.31
Jul-60	81.44	68.58	96.02
Aug-60	77.37	65.15	91.22
Sep-60	76.01	64.00	89.61
Oct-60	76.12	64.10	89.74

RESULTS AND DISCUSSION

The forecasting results of field latex prices (PriceFL) covering 10 advanced time periods from January to October 2017 using Equation 2.2 are as follows:

Table 9: Actual and forecasted PriceFL

		SARIMA (0,1,0)(1,0,1) model		
	Actual	Forecast	LCL	UCL
Jan-60	75.92	65.70	52.09	79.32
Feb-60	75.09	68.58	49.33	87.83
Mar-60	71.07	69.86	46.29	93.43
Apr-60	63.53	70.78	43.56	98.00
May-60	64.95	71.06	40.63	101.49
Jun-60	52.02	70.93	37.59	104.26
Jul-60	46.31	69.72	33.72	105.73
Aug-60	51.16	68.78	30.29	107.27
Sep-60	52.65	68.60	27.77	109.42
Oct-60	45.76	68.49	25.46	111.53
MAPE		24.60		
RMSE		14.90		

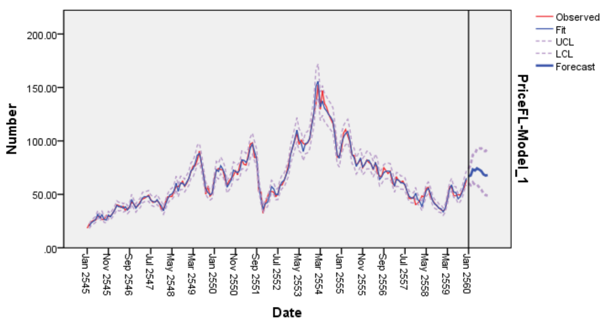


Figure 6: Graph showing forecast values of PriceFL with ARIMA (0,1,0)(1,0,1) model

Table 9 exhibits the comparison of actual and forecasted prices of field latex with the values obtained from SARIMA (0,1,0)(1,0,1) model. MAPE was at 24.60 and RMSE was at 14.90. The graph of the forecast is as shown in Figure 6.

CONCLUSIONS

This study presents a method to select independent variables and a way to construct a fit forecast model for the time series of field latex prices. The first month data series was from January 2002 to December 2016, which contained 180 values used to construct the forecast model and the second month data series from January to October 2017, which contained 12 values used to verify the accuracy of the constructed forecast. The findings indicated that the independent variable, PriceRSS3 affected the prices of field latex and in terms of forecast model fit, SARIMA (0,1,0)(1,0,1) was able to describe the variation of latex prices at 98.70% efficiency rating with MAPE at 3.637. When comparing with the actual prices of field latex in the second data series, it was found that the MAPE value was 24.60 and RMSE was 14.90.

It was obvious, from the result, that MAPE and RMSE values of the test were still relatively high. One notion that caused high MAPE and RMSE values were the fact that, according to Table 9 at the actual values, since June 2017, the prices of field latex fell drastically when compared to prices during January and May 2017. From this problem, future study could possibly tackle additional independent variables such as purchase and sales prices of ribbed smoked sheets No.3 in futures market of Tokyo and Singapore. The factors presented in this study were based on the opinion of the researcher. There could possibly be other factors with better fit than the ones presented.

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