Kasetsart University Journal of Economics 16 (1): 54-74

ISSN 0858-9291

Forecasting Model of RSS3 Price in Futures Market

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Abstract The agricultural futures market affects the rubber price in Thailand. Rubber processors use the agricultural futures market to avoid risks associated with fluctuations in rubber price. Investors make profits from the difference between the current price and the future price. This paper presents the forecasting models for futures price of the natural rubber ribbed smoked sheets no.3 (RSS3). The results from the most efficient model can inform the decision of investors on buying and selling at the proper time. The study employs the least mean squared error as a criterion for the selection of the best prediction model. It includes an analysis of factors affecting the RSS3 futures prices in Thailand's futures market. The results show that the previous monthly futures prices and oil prices significantly affected the futures prices in the same direction. The net import of natural rubber by Japan was the leading indicator for the trend in rubber futures prices in Thailand. The analytical model was shown to be applicable and would facilitate related studies in forecasting the futures prices of other commodities. Time-series data was found to be suitable for the forecasting model.
Keywords: futures price, forecasting, agricultural futures market

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วารสารเศรษฐศาสตร์ มหาวิทยาลัยเกษตรศาสตร์ 16 (1): 54-74

ISSN 0858-9291

ตัวแบบการพยากรณ์ราคายางแผ่นรมควันชั้น 3 ในตลาดล่วงหน้า

*ศุภนันทา ร่มประเสริฐ** ภาควิชาเศรษฐศาสตร์การบริหาร คณะบริหาร มหาวิทยาลัยอัสสัมชัญ

บทคัดย่อ การเปลี่ยนแปลงของราคายางในประเทศไทยได้รับอิทธิพลมาจากตลาดสินค้าเกษตรล่วงหน้า โดยผู้ผลิตและแปรรูปยางอาศัยกลไกของตลาดสินค้าเกษตรล่วงหน้าป้องกันความผันผวนของราคายางพารา ส่วนนักลงทุนใช้ตลาดสินค้าเกษตรล่วงหน้าหากำไรจากส่วนต่างระหว่างราคายางในปัจจุบันเปรียบกับราคายางในอนาคต บทความนี้นำเสนอรูปแบบและวิธีการพยากรณ์ราคายางพาราล่วงหน้า เพื่อช่วยให้นักลงทุนสามารถนำข้อมูลไปใช้ประกอบการตัดสินใจซื้อ-ขายในช่วงเวลาที่เหมาะสม การศึกษาใช้ค่าเฉลี่ยผลรวมกำลังสองของความคลาดเคลื่อนจากการพยากรณ์ที่มีค่าน้อยที่สุดเป็นเกณฑ์ การศึกษารวมถึงการวิเคราะห์ปัจจัยพื้นฐานที่มีผลกระทบต่อราคายางในตลาดล่วงหน้าประเทศไทย ผลการศึกษาพบว่าปัจจัยที่มีผลต่อราคายางแผ่นรมควันชั้น 3 ในตลาดล่วงหน้า ได้แก่ ราคายางย้อนหลังหนึ่งเดือน และราคาน้ำมัน โดยมีความสัมพันธ์ไปในทิศทางเดียวกัน ปริมาณการนำเข้าสุทธิของประเทศญี่ปุ่นสามารถชี้นำแนวโน้มราคายางล่วงหน้าของไทยได้ นอกจากนี้ยังพบว่ารูปแบบและวิธีการพยากรณ์ที่ใช้ในการศึกษามีความเหมาะสมเฉพาะกับการเปลี่ยนแปลงอันเนื่องมาจากอิทธิพลของแนวโน้ม การศึกษานี้เสนอว่าควรได้มีการศึกษาทำนองเดียวกันนี้ต่อไปกับสินค้าชนิดอื่นๆ ในตลาดสินค้าล่วงหน้าโดยพิจารณาจากลักษณะข้อมูลของอนุกรมเวลา
คำสำคัญ: ราคาสินค้าล่วงหน้า การพยากรณ์ ตลาดสินค้าเกษตรล่วงหน้า

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Introduction

The forecasting logic of rubber prices in the futures market is to a certain extent similar to the price movement in the stock market. Moreover, it can provide an estimate, taking into consideration the effects of external factors. This is because adjustment in the rubber price in the long term may be affected by the law of supply and demand. However, the purpose of futures market is to serve as an instrument for agricultural rubber groups, producers, agricultural suppliers, and investors to manage risks associated with fluctuations in commodity prices. This involves buffering of risk related to efficiency, transparency and fairness. Hence, the study will focus on the methods of forecasting by using two cases. The first case, using technical analysis, focuses only on the duration of rubber prices without considering exogenous variables. The second, which is a fundamental analysis, accounts for the effects of exogenous variables.

Each analysis has its strong and weak points. The paper integrates technical analysis and fundamental analysis as the approach for investigating the issue of probability of the results of the fundamental analysis, which shows to what extent the fundamental analysis can be trusted. This is to double check the results. The fundamental analysis in current year has many forecasting methods, but the most well-known and frequently used analytical methods include the naïve or random walk (RW), simple moving average (MA), simple exponential smoothing (SES), Holt's linear exponential smoothing, Brown's triple exponential smoothing, Holt-Winters smoothing, regression analysis, decomposition, and Box's Jenkins. In choosing the most suitable and the most reliable method, this paper takes into consideration various factors such as the period of forecasting, the amount of data, and the level of prediction validity. Additionally, this study highlights the proper method for investigating the movement of the rubber price data in the futures market and finds the proper period of time and appropriate number of data used in the forecasting. The paper uses the line graph in considering the trend of rubber price that occurs in the next period. Fundamental analysis is used to examine the factors that influence rubber prices and search the model of rubber price when the factors that influence rubber price are dynamic. However, only the market price mechanism is considered in this paper.

The study aims to discover the proper forecasting model, identify the suitable number of data used for forecasting, and identify the appropriate time period applicable in estimating rubber prices in both the short and long term. To achieve these objectives, the paper focuses on a number of key considerations, as follows. First, the futures market in Thailand market (AFET). Second, rubber prices refers to the natural rubber ribbed smoked sheets no. 3 (RSS3) because it makes up a major share of the exports, taking into account the observation of the level of exports FOB that is applied as the selling price in the futures market. Third, the forecasting model used in the study of the rubber price in the futures market are classified into two cases: a) short time prediction, targeted at finding a forecasting model that is most suitable period using daily rubber prices, and b) long time prediction by using monthly forecasting. Before making the final decision, the paper considers and examines external factors that may affect the rubber futures prices. To consider the period that rubber price tends to move up or down in the future, we build graph-leading indicators.

Fourth, the time period used in short time prediction are classified as follows a) using 100 days data starting from 17 August 2007 to 7 January 2008, divided into 5 varying periods of 15, 30, 50, 75 and 100 days, and b) finding the appropriate forecasting method for 5-, 10-, and 15-day periods as the benchmark period whose outcome is comparable to cash trading in the period during 8-28 January 2008. Fifth, the time period used in a monthly basis from July 1999 to December 2007 comprising 102 months is divided into two periods as follows: a) 90 months starting from July 1999 to December 2006 divided into four periods of 30, 50, 75 and 90 months, and b) finding the appropriate forecasting method using 3, 5, and 12 months as the benchmark period derived from a verifiable method, thereby coming up with results comparable to spot trading in the period January 2007 to December 2007.

Sixth, for long time prediction, the paper observes the variables that affect rubber price by using multiple regressions of data from Year 1999 through 2007. The variables comprise time, exchange rate, imports of natural rubber in China, imports of synthetic rubber in China, imports of natural rubber in Japan, imports of synthetic rubber in Japan, oil prices, stock of natural rubber in Japan, stock of synthetic rubber in Japan, world consumption of natural rubber, world consumption of synthetic rubber, world production of natural rubber, and world production of synthetic rubber. Lastly, periods when rubber prices expand or shrink via indicated factors are examined by graphical analysis between monthly rubber prices. Constructing the model of monthly rubber price derives from indicated variables with the monthly natural rubber ribbed smoked sheets no. 3 price as the reference line.

The paper is organized as follows. The concepts of futures market efficiency and forecasting method are described followed by the methods and data used in the study. The last two sections discuss the results of the analysis and the implications of the forecasting model.

Concept of Futures Market Efficiency

Given the importance of and interest in the pricing efficiency of futures markets as a topic of inquiry, numerous studies have examined the efficiency of agricultural futures markets. Nearly every agricultural futures contract listed by an exchange today has been examined in some context (Garcia, Hudson, and Waller, 1988). In examining the necessary conditions for futures market efficiency, three sets of forecasts are use in predicting the USDA's announced Class III price: futures forecasts, forecasts generated from simple time-series models, and expert opinion forecasts. These forecasts are first evaluated using the traditional forecast accuracy measure of root mean squared error. In addition to casual comparisons of mean squared error, the multiple data model (MDM) procedure tests for statistical differences in forecast accuracy (Harvey, Leybourne, and Newbold, 1997) are used. The more stringent test of pricing efficiency, which is forecast encompassing, is then tested in a multiple encompassing framework using the MS test statistic put forth by Harvey and Newbold (2000) which they suggest as a test statistic MS based on the generalized Hotelling's T^2-statistic. Intuitively, futures market efficiency should be intimately linked to the ability of that market to forecast. Nevertheless, Working (1958) was reluctant to call futures prices forecasts.

In addition, Tomek and Gray (1970) suggested that cash prices of non-storable commodities may be able to forecast deferred prices better than futures prices can. The futures market will not forecast if doing so elicits behavior that will prove the forecast wrong (Koontz, Hudson, and Hughes, 1992). Yet, poor forecasting does not necessarily make a market inefficient. The futures market may still be the best forecast available. Thus, the mere existence of poor forecasts is not sufficient to contradict efficiency. Fama (1970) suggested that a futures market is efficient if the prices contain all relevant information. He also described efficiency in terms of whether abnormal trading profits can be earned conditional upon three possible sets of information, namely, weak form, semi-strong form, and strong form.

Grossman and Stiglitz (1980) extended Fama's definition by noting that where information has a cost, informational efficient markets will be impossible. Essentially, their work adds that for perceived inefficiencies to be real inefficiencies, they must be large enough to merit the cost of trading them out. Fama (1970) acknowledged this as well. In addition, profit comparisons for efficiency testing should account for risk. Makridakis and Winkler (1983) studied the accuracy of combination method by emphasizing on method of averaging from 14 forecasting methods such as naïve, simple moving average, exponential, ratio, Brown, Holt's, regression, Holt's and Winter, Automatic AEP, Lewandowski's FORSYS, Parzen's ARIMA methodology, Bayesian forecasting, and BOX by MAPE. They found that the accuracy depends on the number of methods used; the prediction is stable if more than four methods are combined. In addition, Batchelor and Dua (1995) studied monthly period on four types: RGDP growth, inflation in the implicit GNP deflator, growth of cooperating profit and the unemployment rate of 22 predictors. They observed that in every data, the more we added, the greater is the accuracy on value or the less the deviation causing a decrease in mean squared error (MSE). Furthermore, Terry and Ted (1995) concluded that ordinary least squares regression can also be used for the forecast. They presented the models of 19- and 29-week forward futures price forecasts. Hypothetical futures funds, based on simulated trading of the forecasting systems, translate futures forecasting into an economic framework suitable for analyses of resultant trading profits.

To enhance the plausibility of dynamic forecast selection over such a long period, three simple forecast selecting/combining techniques are used in choosing a forecast to act upon at any given week. Wang and Ke (2005) studied the efficiency of the Chinese wheat and soybean futures markets and assessed the conditions in agricultural commodity futures and cash markets in China. Formal statistical tests were conducted through Johansen's co integration approach using three different cash prices along with different futures forecasting horizons ranging from one week to six months. Results suggest a long-term equilibrium relationship between the futures price and cash price for soybeans, and a weak short-term efficiency of the soybean futures market.

Forecasting Methods

A method is needed to assist futures traders and analysts in identifying whether a product's futures market price behavior is better explained by the existing theory. The method should also provide quantitative information to identify the appropriate theory for RSS3. The methods can be classified into quantitative forecasting and qualitative forecasting. The quantitative forecasting is divided into two main groups: *1) time-series model,* which views that the past behavior of an object that we want to predict should be enough to forecast behavior in the future, and includes the naïve method, moving average method, decomposition method, exponential method, and Box's Jenkins, and *2) casual mode,* which views that the behavior of an object can be predict from others that have suitable aspects to relate to each other, such as regression method and econometrics method. The forecasting methods have different characteristics, strong points and weak points. None can provide a perfect forecast, so that the most proper and reliable forecasting method should be selected. Selection criteria include the factors used in the method; for example, time period, data, number, validity, reliability and cost of applying the method (Makridakis, Wheelwright, and McGee, 1983).

There are 4 statistical methods used in this paper:

1) Regression analysis. This method is used to examine the relation of a dependent variable or response variable to be specified by independent variables or explanatory variables. It can be used as a descriptive method of data analysis, such as curve fitting, without relying on any assumptions about the underlying processes in generating the data (Richard, 2004).

2) Exponential smoothing method. In statistics, exponential smoothing refers to a particular type of moving average technique applied to time-series data, either to produce smoothed data for presentation or to make forecasts. The time-series data are a sequence of observations. The observed phenomenon may be an essentially random process, or an orderly, but noisy, process. Exponential smoothing is commonly applied to financial markets and economic data, but it can be used with any discrete set of repeated measurements. The raw data sequence is often represented by X_t, and the output of the exponential smoothing algorithm is commonly written as S_t which may be regarded as our best estimate of what the next value of X_t will be. When the sequence of observations begins at time $t = 0$, the simplest form of exponential smoothing is given by the formula where "α" is the smoothing factor, and $0 < \alpha < 1$. Intuitively, the simplest way to smooth a time series is to calculate a simple, or unweighted, moving average. The smoothed statistic S_t is then just the mean of the last k observations: where the choice of an integer k > 1 is arbitrary. A small value of k will have less of a smoothing effect and be more responsive to recent changes in the data, while a larger k will have a greater smoothing effect, and produce a more pronounced lag in the smoothed sequence. One disadvantage of this technique is that it cannot be used on the first k-1 term of the time series. A slightly more intricate method for smoothing a raw time series X_t is to calculate a weighted moving average by first choosing a set of weighting factors and then using these weights to calculate the smoothed statistics S_t.

In practice the weighting factors are often chosen to give more weight to the most recent terms in the time series and less weight to older data. This technique has the same disadvantage as the simple moving average technique; it entails a more complicated calculation at each step of the smoothing procedure. The simplest form of exponential smoothing is given by the formula where "α" is the smoothing factor, and $0 < \alpha < 1$. In other words, the smoothed statistic S_t is a simple weighted average of the latest observation X_t and the previous smoothed statistic S_{t-1}. Simple exponential smoothing is easily applied and it produces a smoothed statistic as soon as two observations are available. Values close to unity have less of a smoothing effect and give greater weight to recent changes in the data, while values closer to zero have a greater smoothing effect and are less responsive to recent changes. There is no formally correct procedure for choosing a. The statistician might use a judgment to choose an appropriate factor. Alternatively, a statistical technique may be used to optimize the value of a. For example, least squares might be used to determine the value of which the sum of the quantities $(S_{n-1} - X_n)^2$ is minimized. The simple form of exponential smoothing is also known as "Brown's exponential smoothing" and as an "exponentially weighted moving average". Technically it can also be classified as an ARIMA (0,1,1) model with no constant term. In other words, as time passes the smoothed statistic S_t becomes the weighted average of a greater number of past observations X_{t-n}, and the weights assigned to previous observations are in general proportional to the terms of the geometric progression {1, (1-α), (1-α)2, (1-α)3,…}. A geometric progression is the discrete version of an exponential function (this is where the name for this smoothing method originated from). The simplest form of exponential smoothing is as follows:

$S_0=X_0$, and

$S_t=\alpha X_t+(1-\alpha)S_{t-1}$

where α is the smoothing factor, and $0 < \alpha < 1$. To choose α by starting from 0.01 and continuing, each α calculates the value of S_{t+m} because $S_{t+m}=S_{t+0}+S_t$; also, finding MSE. After that comparing all MSE values and choose α value that gives the lowest MSE.

3) Holt's linear exponential method. Holt's linear exponential is suitable to the data that the trend of movement is linear form including up and down smoothly as follows:

$S_{t+m}=a_t+\gamma\beta_t$

where $a_t=\alpha X_t+(1-\alpha)S_{t-1}$

$\beta_t=\zeta(a_t+a_{t-1})+(1-\zeta)\beta_{t-1}$

X_t = observed value of X at time t

α = exponential that value is between 0 and 1

ζ = trend that value is between 0 and 1

m = forecasting time period

Holt's method uses two parameters in exponential that are α, $0 < \alpha < 1$ and ζ, $0 < \zeta < 1$ which predictors must define these values and define the starting point of a_t and β_t.

4) Box's Jenkins method. The Box-Jenkins approach was described in a highly influential book by statisticians George Box and Gwilym Jenkins in 1970. The method provides a convenient framework that allows an analyst to review the data and find an appropriate statistical model that can be used to help answer relevant questions about the data. It involves identifying an appropriate ARIMA process which is used for forecasting, fitting it to the data, and then using the fitted model for forecasting. One of the attractive features of the Box-Jenkins approach is that it is usually possible to find a process which provides an adequate description to the data. The original Box-Jenkins modeling procedure involves an iterative three-stage process of model selection, parameter estimation and model checking. This is a complicated method and needs specialized expertise in data analysis. However it gives a higher accuracy than others in short-term prediction (Newbold and Granger, 1974). Recent explanations of the process often add a preliminary stage of data preparation and a final stage of model application or forecasting (Makridakis, Wheelwright and Hyndman, 1998).

Data

Time-series data of RSS3 in the futures market of the daily and monthly data were collected. The rubber prices in time series were used for plotting graph checks for moving characteristics. The paper sets the period of time series in each type as 2 phases: 1) daily rubber price time series is divided into 5 sizes of 15, 30, 50, 75, and 100 days, and 2) monthly rubber prices are divided into 4 sizes as 30, 50, 75, and 90 months. The analysis of daily and monthly prices would provide an insight information to support buying and selling decisions in short and long periods.

The paper also seeks the appropriate forecasting methods for 5, 10, 15 day periods and 3, 5, 12 months. For daily rubber price data, the Exponential method, the Holt's method, and the Box's – Jenkins method are applied for the forecasting; and the decomposition method for monthly rubber price. Each value of prediction method is compared to the true value and calculates the mean squared error (1) or MSE_1[1] of each one along with the number of data as 15, 30, 50, 75, and 100 for daily price and 30, 50, 75, and 90 for monthly price. The forecasting is based on 15 values of the latest day period for daily and 12 values for monthly. Then the results are compared with the true value of the benchmark period. The MSE_2[2] are calculated for the periods of 5, 10, and 15 days including 3, 5, and 12 months. The model of rubber price for monthly time series is constructed by studying the variables that affect the rubber price via regression from the year 1998 through 2006. The key variables are time, historical monthly rubber prices, the world's total production of natural rubber, the quantity of natural rubber used in Japan, quantity of imports of natural rubber for Japan, quantity of synthetic rubber used in Japan, quantity of producing synthetic rubber in Japan, quantity of synthetic rubber in stock for Japan, and quantity of natural rubber in stock for Japan. The paper also constructs the model in order to examine the variables affecting rubber prices. It considers the period when the trend in rubber price is influenced by expansion or recession as well as business cycle index. This is done by graph analysis showing the relations between monthly rubber price and quantity of variables.

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[1] $MSE_1 = \frac{\sum_{t=1}^{n}\left(Y_t - \hat{Y}_t\right)^2}{n}$ where n is the number of time-series.

[2] $MSE_2 = \frac{\sum_{i=1}^{n}\left(Y_{t+i} - \hat{Y}_{t+i}\right)^2}{m}$ where m is the number of time-series.

Results and Discussion

The section presents the results on determining the most suitable forecasting model for the movement of rubber prices in the futures market and the proper number of data including the period of future forecast that gives the least mean squared error. The variables are examined with the view of determining the rubber futures price that can help guide, plan, and control rubber price thereby making it less volatile. The last part presents the trends of rubber prices using the relationship between rubber prices and the leading indicator variables.

Relationship between Data and Factors of Daily Time Series

Autocorrelation (ACF) and partial autocorrelation (PACF) analyses show that ACF went downward when k value increased. This suggests that the spot price depends on the futures price. The past information of daily rubber price can be used to predict the future rubber price. The test on trend and seasonal time series showed that the daily time-series data indicated upward or downward movement (i.e. price volatility is evident) while the seasonal data did not indicate any movement.

Table 1 shows that the model of exponential third pattern explained the time series of daily rubber price with the highest R-square value (86.3 percent). Using the same testing technique for monthly data the results reveal the same ramifications as that of daily data. This means that the past information of monthly rubber price can be used to predict the future rubber price.

Table 1 Testing the trend on daily rubber price

Trend	Equation	R-square
Linear	$Y = a_0 + a_1 t$	0.7845
Exponential 2nd	$Y = \beta_0 + \beta_1 t + \beta_2 t^2$	0.7854
Exponential 3rd	$Y = \beta_0 + \beta_1 t + \beta_2 t^2 + \beta_3 t^3$	0.8630

Suitable Size of the Models

The study also found that the daily time series did not have seasonal movement but had time trend. Thus the suitable forecasting model is SES, HOL, and AR or Box's Jenkins. The MSE_1 values for various sizes of time series and models were estimated and then compared (Table 2).

Table 2 MSE_1 values estimated by using different methods and different sizes (daily) of rubber prices

Forecasting method	Size of time series					MSE_1 in average
	15	30	50	75	100	
SES	0.167	0.206	1.203	6.028	6.290	2.779
HOL	0.167	1.156	1.285	6.029	6.290	2.985
BOX	0.146	0.206	1.203	6.028	6.290	2.775
MSE_1 in average	0.160	0.523	1.230	6.028	6.290	

Table 2 shows that the SES model gave the lowest MSE_1 value at time-series size of 15 days (0.167) and so do the HOL model. The highest was of 100 days (6.290). The average for MSE_1 was 2.779, but HOL average was 2.985. BOX also gave the lowest MSE_1 in the size 15 days, but the difference was only 0.146. The highest values had a similar result except that the average was 2.775. The average values of MSE_1 show that the lowest MSE_1 was for the case of 15 days (0.160). This suggests that daily rubber prices used for predicting should be collected within 15 days. The true values and predicting values of 15 days future forecast classified by methods are presented in Table 3.

Table 3 True price values and predicting price values of 15 days future forecast classified by methods

Date	True value	Predicting value		
		SES	HOL	BOX
08-01-08	80.43	82.93	81.44	72.77
09-01-08	80.50	81.90	82.20	72.77
10-01-08	80.64	81.00	82.97	72.51
11-01-08	80.43	80.12	83.74	72.20
15-01-08	81.93	76.15	86.80	71.89
16-01-08	81.64	75.19	87.57	71.75
17-01-08	80.93	74.34	88.34	71.40
18-01-08	80.64	73.25	89.11	71.49
21-01-08	81.07	69.79	91.41	72.24
22-01-08	80.29	68.72	92.17	72.33
23-01-08	80.86	67.45	92.94	72.82
24-01-08	80.07	66.29	93.71	73.08
25-01-08	80.93	65.12	94.47	73.93
28-01-08	81.21	61.83	96.78	73.79
29-01-08	81.64	60.80	97.54	73.79

In Table 4, MSE_2 shows that Box-Jenkins gave the lowest average value on MSE_2 which is 0.198, which suggests that this model should be used for daily forecasting and integrated with SES and HOL. Thus, it can be concluded that a short time-series period would give a more accurate forecasting than a long time-series period.

Table 4 MSE_2 values estimated by using different methods and different sizes (daily) of rubber prices

Forecasting method	Size of time series			MSE_2 in average
	5	10	15	
SES	0.161	0.268	0.269	0.232
HOL	0.159	0.268	0.269	0.232
BOX	0.080	0.265	0.270	0.198
MSE_2 in average	0.133	0.266	0.269	

For monthly time-series data, SES, HOL, ARIMA, and DEC were used. These models are suitable for long period forecast as recommended by Makridakis, Wheelwright, and McGee (1983). MSE_1 were then re-estimated based on these models as the results shown in Table 5.

Table 5 MSE_1 values estimated by using different methods and different sizes (monthly) of rubber price

Forecasting method	Size of time series				MSE_1 in average
	30	50	75	90	
SES	11.548	15.216	54.173	56.358	34.324
HOL	11.548	15.216	54.173	56.358	34.324
BOX	11.548	15.216	54.173	56.358	34.324
DEC	95.430	9.741	280.855	258.662	161.172
MSE_1 in average	32.52	13.85	221.687	106.934	

From Table 5, it can be noted that the lowest MSE_1 was the size of time series in 50 months with a value of 13.85. Therefore, the collection of data for monthly rubber price should be done within 50 months. The true values and predicting values of 12 months future forecast classified by methods are presented in Table 6. Choosing the least error on time series to forecast the result can be guided by the results shown in Table 6.

Table 6 True price values and predicting price values of 12 months future forecast classified by methods

Month/year	True value	Predicting value			
		SES	HOL	AR	DEC
01-07	67.16	18.412	53.482	53.650	80.850
02-07	75.42	18.412	28.432	61.300	22.818
03-07	71.89	18.412	50.142	59.720	71.573
04-07	76.23	18.412	43.462	61.950	53.640
05-07	77.73	18.412	35.112	66.980	36.90
06-07	77.66	18.412	55.152	71.846	84.898
07-07	64.22	18.412	50.142	61.887	74.138
08-07	66.76	18.412	46.802	67.046	67.422
09-07	64.04	18.412	46.802	68.339	69.071
10-07	72.15	18.412	45.132	73.789	61.424
11-07	78.51	18.412	45.132	78.832	193.792
12-07	76.72	18.412	43.462	77.712	54.300

The MSE_2 values in Table 7 shows that SES, HOL, and AR gave the lowest MSE_2 (13.330). This suggests that any of these methods could be used for monthly forecasting. It can also be concluded that a short time-series period would give a more accurate forecasting than a long time-series period.

Table 7 MSE_2 values estimated by using different methods and different sizes (monthly) of rubber price

Forecasting method	Size of time series			MSE_2 in average
	3 months	5 months	12 months	
SES	7.722	4.693	27.577	13.330
HOL	7.722	4.693	27.577	13.330
BOX	7.722	4.693	27.577	13.330
DEC	16,618.23	47,859.13	1,878,937.126	647,805.095
MSE_2 in average	8,312.976	23,931.911	939,482.351	

Factors Affecting the RSS3 Futures Price

To find the factors affecting the movement of monthly rubber futures price, multiple regressions was carried out on all data collected since January 1999 until December 2007. The dependent variable is RSS3 futures price AFET on monthly (PRICE). The independent variables are: time, RSS3 futures price AFET on monthly rubber price backward in one month (PRICE_1), exchange rate between Thailand and U.S., exchange rate between Japan and U.S., quantity of consuming natural rubber of the world, quantity of net imports natural rubber in China, quantity of net imports natural rubber in Japan, quantity of stock natural rubber in Japan, quantity of consuming syntactical rubber of the world, quantity of net imports syntactical rubber in China, quantity of net imports syntactical rubber in Japan, quantity of stock syntactical rubber in Japan, and oil price (OIL). The regression analysis show that only two variables affected monthly rubber futures prices as follows:

$$\text{PRICE} = -2.412 + 0.911(\text{PRICE\_1}) + 0.087(\text{OIL})$$

$$(-0.369) \quad (37.696)^{**} \quad (3.446)^{**}$$

R-square = 0.997 Adjusted R-square = 0.996

Durbin Watson = 0.902 F-statistic = 2119.164

Note: The numbers in blankets are t-statistic and ** is significant at 0.01.

The results from the multiple regression analysis were then used for the comparison of the true value with the predicted value as in Table 8.

Table 8 The true value and the predicted value from regression analysis

Month/year	True value	Predicted value
10-07	72.15	76.56
11-07	78.51	81.83
12-07	76.72	81.05

Price Movement and Estimation of the Proper Period

Choosing the variables that are expected to be used as the leading indicators for monthly rubber futures prices, a bar chart was used to compare the relationship with the movement of monthly rubber futures price 108 months starting from year 1999 through year 2007. The variables are: 1) quantity of imports of natural rubber in Japan, 2) quantity of imports of synthetic rubber in Japan, 3) quantity of imports of natural rubber in China, 4) quantity of imports of synthetic rubber in China, 5) quantity of consumption of natural rubber in the World, and 6) quantity of consumption of synthetic rubber in the World.

The reference variable is RSS3 futures price one month forward AFET (in Thai Baht) showing the relationship of the movement as follows. From Figure 1 to Figure 6, each pair of the relationships is visually compared between the reference quantity imported and the rubber futures price. The quantity is normalized into price as for the comparison. This visual examination is aimed to find the expected leading indicator. The results reveal that the most appropriate future-leading indicator is the quantity of net imports of natural rubber in Japan. After this exercise, the last 10-month period of this future-leading indicator, starting from March to December 2007, is selected to analyze the future trend. The results are presented in Figure 7.

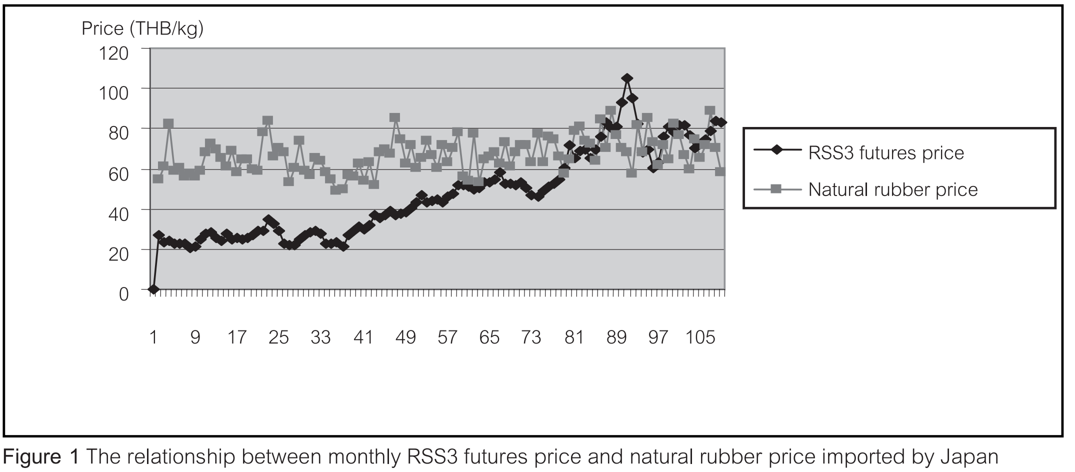

Figure 1 The relationship between monthly RSS3 futures price and natural rubber price imported by Japan

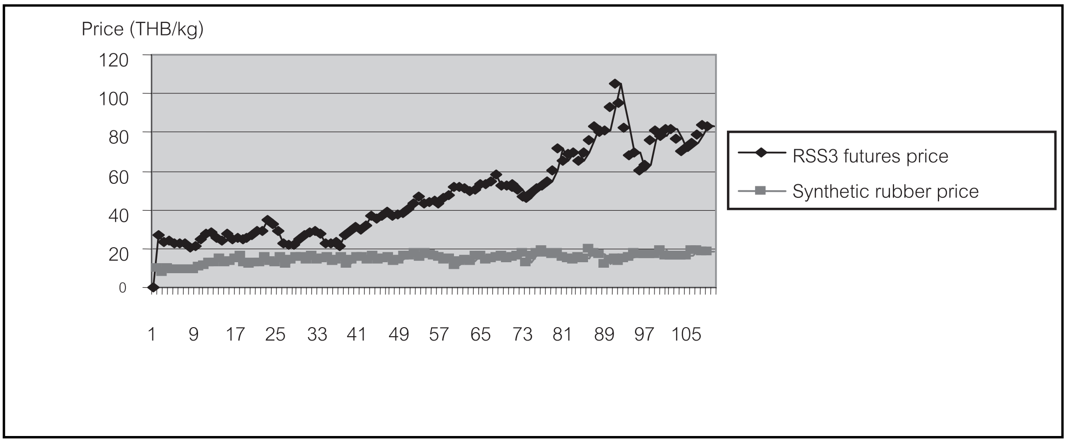

Figure 2 The relationship between monthly RSS3 futures price and synthetic rubber price imported by Japan

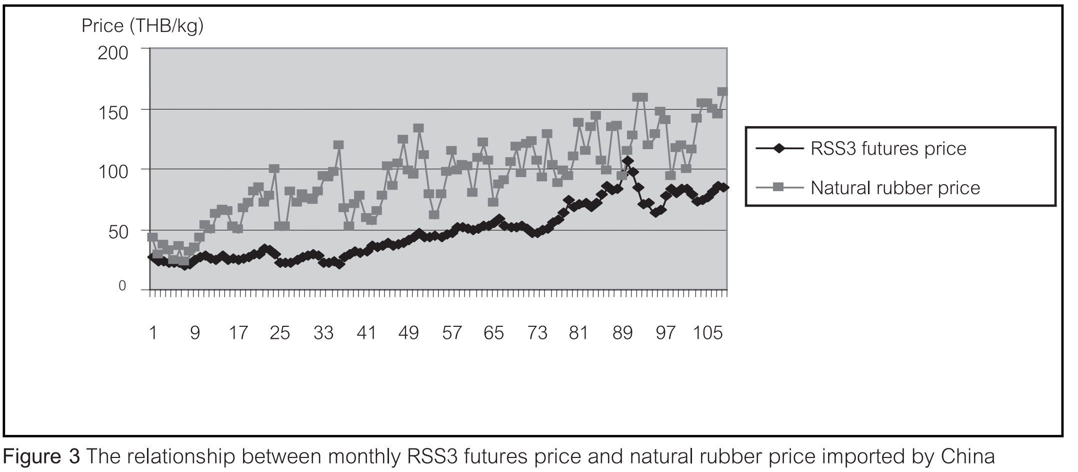

Figure 3 The relationship between monthly RSS3 futures price and natural rubber price imported by China

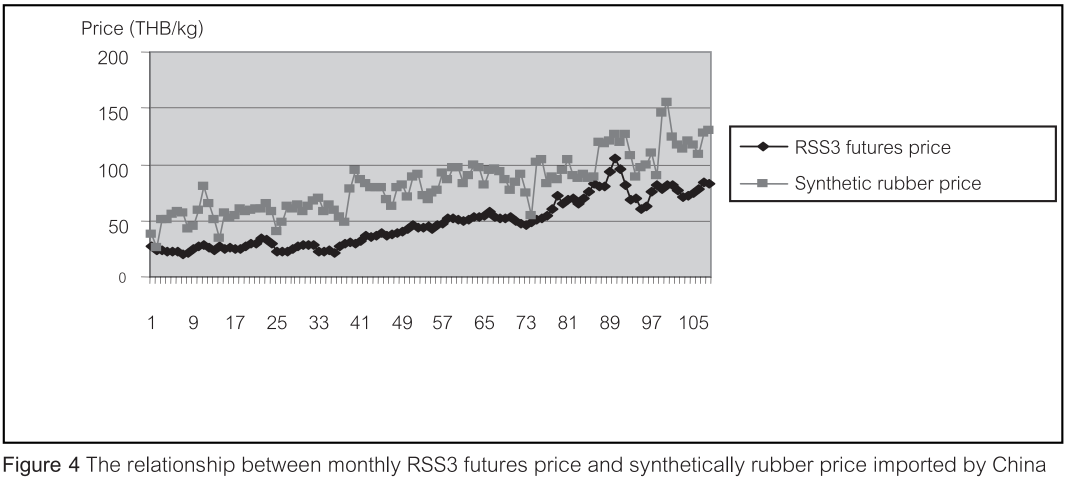

Figure 4 The relationship between monthly RSS3 futures price and synthetically rubber price imported by China

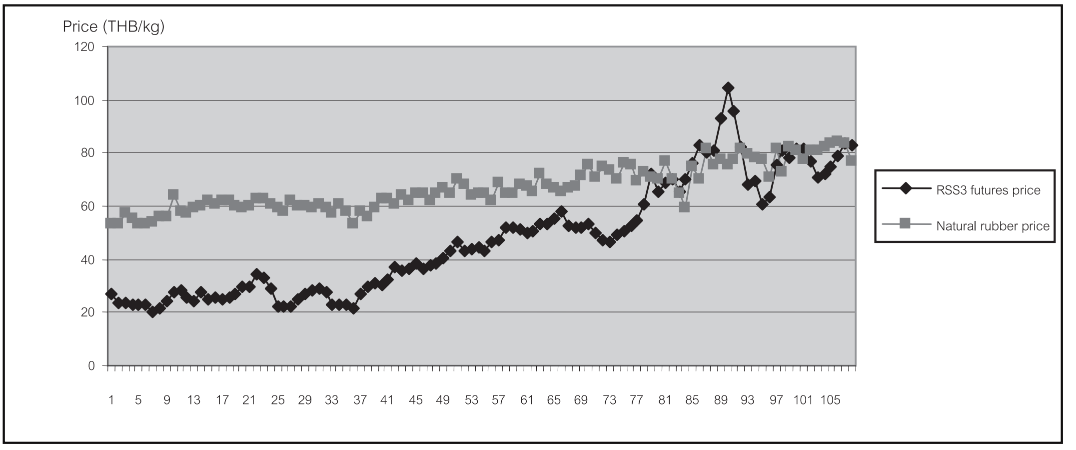

Figure 5 The relationship between monthly RSS3 futures price and natural rubber price in the world

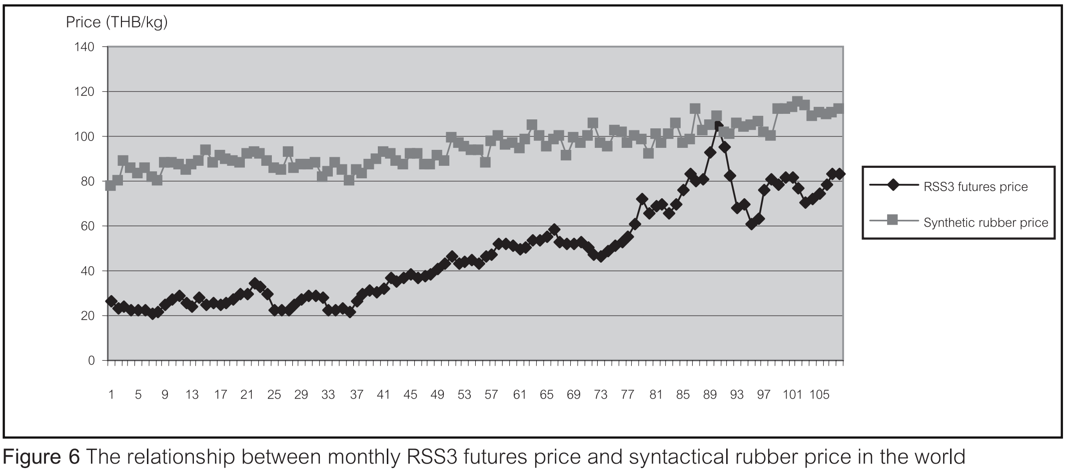

Figure 6 The relationship between monthly RSS3 futures price and syntactical rubber price in the world

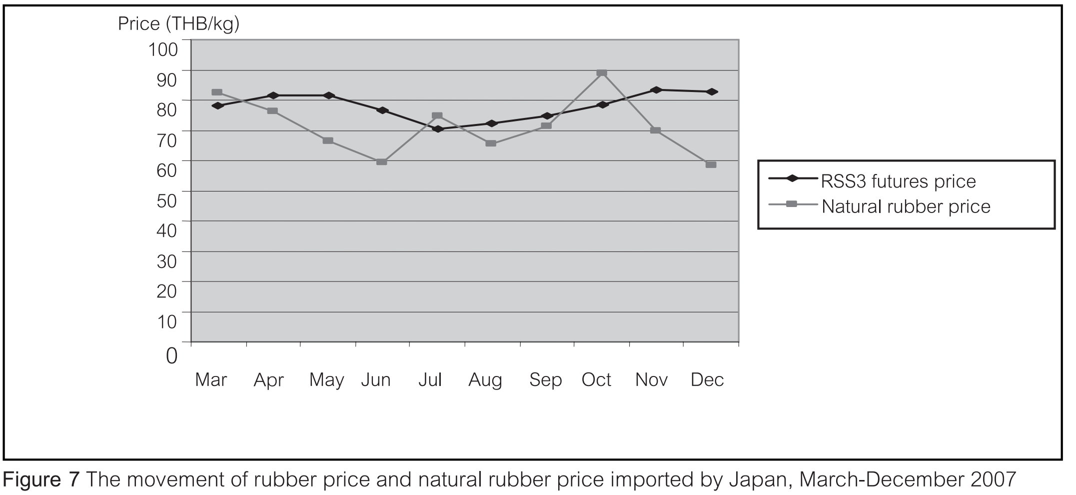

Figure 7 The movement of rubber price and natural rubber price imported by Japan, March-December 2007

Figure 7 shows that the trend slightly decreased from March 2007 and dropped to the lowest level in June 2007 for the net imports of natural rubber in Japan. This indicates that the smoothing drop of net imports in these four months pushed the rubber prices down during these months. However, the next period estimated the increase in prices, which indicated the recovering net imports of Japan from July to October 2007. This trend was in line with the true value, which increased from 64.22 in July to 72.50 THB/kg in October, except that in September (Table 9). The decrease in September may have been caused by the influence of JTEPA on the bilateral relationship between Japan and Thailand.

Table 9 The true value and the expected future trend on the forward period of natural rubber price

Month number	Month and year	True value
103	July 2007	64.22
104	August 2007	66.76
105	September 2007	64.04
106	October 2007	72.50

Conclusion

The analysis of the relationship of data for daily and monthly rubber futures prices from ACF and PACF shows that both daily and monthly rubber futures prices had relationships with past rubber futures prices. This implies that the period used for the study provides a trend that is useful for a technical analysis aimed at forecasting rubber prices. Studying the movement and the factors of time series also indicates that changes in daily period had an exponential 3rd time trend. A similar result is seen from changes in the monthly period. The forecasting analysis on time series also shows that the appropriate size for daily time-series would be 15 days and the suitable forecasting method would be the Box's Jenkins method. The accuracy of forecast decreased with a longer time-series period. This clearly shows that the accuracy of predicting would be supported by a short period forecast, especially a five-day forward.

For monthly time series, the proper range would be 30 months and the suitable forecasting methods would be the Simple Exponential Smoothing, Holt's Linear Exponential Smoothing, and Box's Jenkins. SES method would be most appropriate to apply when the data pattern is horizontal. This is because there is neither cyclic variation nor trend in the historical data. The HOL method is used when the data exhibits both trend and seasonality. The Box's Jenkins method changes with the movement of the time series, and a repeated investigation must be made each time the true data is created. According to the 30 months time series, the Box's Jenkins method provides the least mean squared error at ARIMA.

It should also be noted that the more the period is expanded the less accurate the forecasting becomes. The best fit would be the three-month forward prediction, since the results show the least MSE. In selecting the most appropriate model for period in time series the paper considers variables from MSE_1 and MSE_2 findings which show that the movements were not in the same direction. Therefore, the best forecasting was derived from MSE_2 that gave the least value. It also suggests that the monthly time series should not be used for forecasting by applying the decomposition method as the results show the highest MSE_1 and MSE_2.

A visual cross examination of the figures of important variables, comparing between the reference price and the futures price, reveals that the quantity of net import of natural rubber in Japan can be used as a future-leading indicator.

This paper, however, does not compare the accuracy of the forecast. Using regression analysis, one should realize that it needs to predict the trend of independent variables before substituting values in the forecasting model. In addition, the variables that affect market mechanism always have a strong relationship. This could be explored in future study.

The frame of the study involves rubber prices in AFET only. Thus the analysis on fundamental factors by regression is suitable for Thailand because the quantities of imports and consumption by Japan, China, and the other markets will absolutely affect the rubber prices in Thailand. The knowledge from this paper can be useful for making buying and selling plans that mitigate the risks from the volatility of rubber prices. The findings would inform measures to control and make the rubber prices in Thailand more stable.

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