Research on World Agricultural Economy
https://journals.nasspublishing.com/index.php/rwae

ARTICLE

Economic Factors Influencing the Price of Rubber for Forecasting Rubber Prices Using the Box-Jenkins Technique

Suphattana Tachochalalai [1] **, *Somkid Yakean*** [2*] **, *Suriya Suwannatippayachot*** [2] **, *Piyaphong Supanyo*** [2] **, *Chanchai Pommi*** [2] **, *Konnut Pugatekaew*** [2]

[1] *Faculty of Business Administration, Rajamangala University of Technology Krungthep, Bangkok 10120, Thailand*
[2] *School of Business and Communication Arts, University of Phayao, Phayao 56000, Thailan*

ABSTRACT

Rubber is one of the most economically significant agricultural products in Thailand. It creates jobs in rural communities, thereby alleviating the problem of labor migration from rural to urban areas, helping to maintain family unity and strengthen communities. The objective of this study is to examine the macroeconomic factors affecting rubber concentrated latex prices during the period from January 2011 to December 2024 and to apply the Box-Jenkins technique for forecasting daily rubber concentrated latex prices in Thailand from January 4, 2017, to March 31, 2025. The data were collected from several secondary sources, including the Rubber Authority of Thailand, Investing.com, and the Rubber Intelligence Unit. Pearson's correlation and multiple regression were applied for data analysis, while the Box-Jenkins technique was used for forecasting. The results indicated that crude oil prices, exchange rates, imports of rubber products, and exports of rubber products significantly predict rubber concentrated latex prices in Thailand. The Box-Jenkins technique (1,1,0) model was chosen, as it satisfies the goodness-of-fit criteria. The developed forecasting model enables rubber market participants to mitigate price volatility and optimize their strategic decisions. Given the interconnected nature of commodity markets, factors

*CORRESPONDING AUTHOR:
Somkid Yakean, School of Business and Communication Arts, University of Phayao, Phayao 56000, Thailand; E-mail: somkid.ya@up.ac.th

ARTICLE INFO
Received: 14 July 2025 | Revised: 17 August 2025 | Accepted: 2 September 2025 | Published Online: 19 January 2026
DOI: https://doi.org/10.36956/rwae.v7i1.2464

CITATION
Tachochalalai, S., Yakean, S., Suwannatippayachot, S., et al., 2026. Economic Factors Influencing the Price of Rubber for Forecasting Rubber Prices Using the Box-Jenkins Technique. Research on World Agricultural Economy. 7(1): 400–413.
DOI: https://doi.org/10.36956/rwae.v7i1.2464

influencing rubber prices often exhibit similar effects across related agricultural commodities, making this model valuable for broader commodity market investment decisions.
Keywords: Box-Jenkins Technique; Macroeconomics; Price Risk; Rubber Price

1. Introduction

1.1. Introduction

Rubber is one of the most economically significant agricultural products in Thailand. One million farming families are involved in rubber production. Since 1991, Thailand has been the world's leading exporter of rubber and rubber concentrated latex, producing approximately 37% of the global total of rubber concentrated latex [1]. However, 87% of these exports consist mainly of intermediate processed rubber products, such as block rubber, smoked sheet rubber, and concentrated latex, which have low added value. This represents only 13% of the value that could be generated by developing rubber into downstream products such as tires and rubber gloves, resulting in reduced income generation for the country and lower income levels for farmers. Regarding exports, rubber prices have experienced high volatility and instability, as the price of rubber concentrated latex fluctuates according to demand and supply dynamics and macroeconomic factors. Additionally, based on study results, Khin et al. concluded that natural rubber production, total natural rubber consumption, crude oil prices, and Shanghai natural rubber prices have a significant relationship with Malaysian natural rubber prices [2]. Srisuksai concluded that past rubber prices affect future rubber prices [3]. Sungkaew indicated that the volume of rubber stocks in Thailand and foreign countries has the greatest effect on Thailand's natural rubber prices [4]. Therefore, understanding the macroeconomic factors affecting rubber prices and forecasting rubber concentrated latex prices is essential so that the results will assist participants in rubber markets in reducing price risk.

Rubber is an economically important product that helps one million farming families earn stable incomes and creates jobs in rural areas, helping to reduce the problem of labor migration from rural to urban areas. As a result, it allows families to prosper and strengthens local communities. However, rubber prices in Thailand are related to the demand and supply in the global market. Moreover, rubber is mostly traded in U.S. dollars. Although Thailand is the world's largest rubber producer, hundreds of Thai manufacturers in Thailand compete to export, and most rubber buyers are large companies. As a result, producers do not have the power to negotiate prices. In addition, farmers and those who participate in the rubber market cannot know prices in advance for trading. Therefore, a study on forecasting rubber concentrated latex prices using the Box-Jenkins technique will assist those involved in the appropriate management of price risk.

There are various methods that can be used for forecasting rubber prices. The Box-Jenkins technique is an approach that is suitable for forecasting time-series data. Thus, the researchers studied previous research on agricultural commodity price forecasting in order to identify a forecasting technique that is suitable for forecasting rubber concentrated latex prices. Based on the results of a study by Keerativiboo, it was found that the Box-Jenkins technique was the most accurate method to predict rubber prices [5]. Thanapala et al. predicted the price of pineapples sent to the factory by using the Box-Jenkins technique. Their findings revealed that the most accurate forecasting model is SARIMA $(0,1,1)(0,1,1)$ [6]. Riansut and Nisan also concluded that the Box-Jenkins technique is the most accurate forecasting method [7]. Thus, the researchers chose to apply the Box-Jenkins technique to predict rubber concentrated latex prices. In addition, based on previous research by Keerativibool and Jittavech, who suggested that those who study the volatility of rubber prices should investigate the macroeconomic factors affecting the price of rubber concentrated latex [8], this study also intends to examine the variables that affect the rubber concentrated latex price. The results of this research will help those associated with the rubber industry to manage price risk and achieve their goals.

1.2. Objectives

The aim of this study is to examine the macroeconomics affecting the rubber concentrated latex prices and to apply the Box-Jenkins technique for forecasting rubber concentrated latex prices in Thailand.

2. Literature Review

2.1. Factors Influencing Rubber Prices

Rubber concentrated latex prices have recently experienced high volatility. Therefore, this study investigates the variables that affect rubber concentrated latex prices, detailed as below.

2.1.1. Export and Import Rubber Products

As the dominant global producer and supplier of rubber and rubber concentrated latex, Thailand significantly influences international market conditions. Consequently, worldwide market forces of supply and demand represent the key determinants of rubber concentrated latex pricing. The highest levels of global latex consumption occur in major markets, including the United States, China, Western Europe, and Japan. This study applies the export of rubber products in Thailand as a proxy variable. Moreover, Thailand also imports rubber from neighboring countries like Laos and Cambodia to support neighboring agricultural farmers and help them earn income. Thus, imports of rubber products are also applied as a proxy variable in this study.

2.1.2. Consumer Confidence Index

The Consumer Confidence Index (CCI) gauges how optimistic consumers feel about economic conditions. As a forward-looking metric, it serves as a predictor of household expenditure patterns, which significantly influence broader economic performance. Rubber is one component that is related to consumer consumption in products like tires, gloves, and other items. Thus, this study uses the Consumer Confidence Index as a proxy variable.

2.1.3. Crude Oil Prices

Fluctuations in crude oil costs directly and indirectly impact various sectors to different extents, including automotive, chemical, paint, rubber productions, and petroleum industries that rely on crude oil as either a main or supplementary input material. Such crude oil price changes substantially affect natural rubber pricing. Thus, in this study, the crude oil prices are also applied as a proxy variable.

2.1.4. Exchange Rate

In recent years, global economic volatility and fluctuating currency values have inevitably affected rubber concentrated latex prices, particularly for international trade operations. Consequently, the global rubber concentrated latex market must closely monitor currency movements across all nations, with special attention to exchange rates in the three primary producing countries and the yen-to-dollar relationship. Variations in the yen-dollar exchange rate create corresponding effects on rubber concentrated latex import costs, which subsequently influence domestic rubber pricing. Therefore, in this study, the exchange rate is applied as a proxy variable.

2.2. Study of the Factors Affecting Rubber Prices

Based on previous studies of the factors affecting rubber prices, the findings are as follows:

Khin et al. concluded that the natural rubber production, total natural rubber consumption, crude oil prices, and the Shanghai natural rubber price have a significant relationship with Malaysian natural rubber prices; however, in contrast, the exchange rate was not significant [2].

Mathew concluded that the dumping of natural rubber imports in the domestic market affected Indian natural rubber prices [9].

Srisuksai concluded that historical global rubber prices influenced short-term price expectations for rubber, thereby affecting anticipated income in the rubber sector. Previous free-on-board (FOB) pricing had distinct impacts on projected farm-level rubber prices when exchange rate factors were considered. Furthermore, the rubber pricing framework revealed that Thai rubber plantation farmers' income relies exclusively on international rubber prices in the short term. Changes in Ribbed Smoke Sheet 3 (RSS3) prices on the Singapore

Commodity Exchange were positively correlated with farm-gate rubber price fluctuations in Thailand, aligning with typical Thai farmer market behavior [3].

Su et al. revealed that natural rubber pricing is influenced by supply-demand disparities, market inefficiencies among smallholder producers, petroleum price fluctuations, currency exchange variations, and weather pattern changes [10].

Raju determined that natural rubber pricing has exhibited significant fluctuations over the past two decades. Falling petroleum costs and the corresponding reductions in synthetic rubber prices are among the contributing factors to this price volatility and market instability in natural rubber [11].

Sungkaew found that rubber inventory levels both domestically and internationally exert the most significant impact on Thailand's natural rubber pricing. Thailand's domestic natural rubber prices are affected by purchasing markets from both local and foreign buyers [4].

Kumkongkaew et al. concluded that competitor rubber prices have the strongest influence on Thai field latex prices. Global rubber prices and domestic synthetic rubber prices have a positive influence on Thai field latex prices, while natural rubber production volume has an inverse [12].

Tengsuwan et al. showed that trading facilitation, purchasing processes (including dealings, transactions, quality control, and transportation costs), price/product variety, and process pricing affect purchasing decisions in the provincial central rubber market operated by the Rubber Authority of Thailand [13].

Monjagapate showed that crude oil prices, crude palm oil prices, and Thai rubber supply quantities significantly impact rubber sheet prices. Crude oil prices and Thai rubber supply demonstrate positive relationships with prices, while Thai GDP shows a negative effect [14].

Bashier et al. concluded that natural rubber prices, exchange rates, and total planted area negatively impacted production in the long run, while crude oil prices had a positive effect. For consumption, natural rubber prices and global stock levels positively influenced demand, while RSS1 prices had negative effects [15].

Hammond et al. demonstrated that farm structural characteristics could not reliably predict farmer motivations - all motivational types appeared across all farm types. Only about one-third of farmers showed willingness to try new interventions, with most citing conceptual rather than material barriers to change [16].

Fong et al. found that rubber production, crude oil prices, Shanghai rubber prices, and synthetic rubber prices positively affect natural rubber prices, while consumption negatively impacts prices [17].

As mentioned above, natural rubber prices involves complex interactions between multiple factors with varying geographic significance. Key determinants include production levels, consumption patterns, and crude oil prices, which strongly correlate with international exchange prices (Shanghai, Singapore). Exchange rates show mixed effects across studies. Supply-demand imbalances, smallholder market inefficiencies, and inventory levels significantly impact pricing. Trade dynamics, including import dumping, affect local markets. Oil prices influence rubber costs both directly and indirectly through synthetic rubber competition. Weather patterns add to market volatility. These interconnected variables create the complex pricing structure observed in global rubber markets.

2.3. Research on Forecasting Techniques

Many previous studies on the forecasting techniques for agricultural commodity prices have been conducted. For example, Anupen et al. concluded that the simple seasonal exponential smoothing method is the most suitable for forecasting Thailand's latex prices, since the MAPE is a lower value than the Box-Jenkins technique [18]. Riansut forecasted coconut prices using the Box-Jenkins technique and concluded that the most accurate model was AR(2) I(2) MA(2,13,15) with no constant [19]. Riansut and Nisan found that the Box-Jenkins technique was the most accurate method for forecasting the export volume of processed chicken [7]. In addition, Intarasat and Bootwisas concluded that the Box-Jenkins technique in the form of ARIMA (1,1,2) had the highest forecasting accuracy, with a mean absolute error (MAE) of 8,668 and a mean absolute percentage error (MAPE) of 9.73% for the validation dataset, both within

the acceptable criteria of the Rubber Authority of Thailand [20]. Khin et al. showed that RSS4 prices have a unidirectional Granger-causality relationship with both SMR20 prices and exchange rates. All variables are cointegrated, indicating long-run equilibrium relationships. Short-term forecasts predicted slightly increasing trends for both rubber prices and exchange rates from January to June 2016, attributed to government and trader behavior changes aimed at stabilizing the supply-demand balance through increased domestic consumption [21].

3. Research Methodology

This study intends to examine the macroeconomic factors affecting rubber concentrated latex prices during the period from January 2011 to December 2024 and to apply the Box-Jenkins technique to forecast daily rubber concentrated latex prices in Thailand from January 4, 2017, to March 31, 2025.

3.1. Data and Sources of Data

This study uses two datasets: monthly data on macroeconomic variables and rubber concentrated latex prices from January 2011 to December 2024 to examine how macroeconomic variables affect rubber prices, and daily data of rubber concentrated latex prices in Thailand from January 4, 2017, to March 31, 2025, to apply the Box-Jenkins technique for daily price prediction.

The datasets for this study was obtained from several secondary sources. Rubber concentrated latex price data were collected from the Rubber Authority of Thailand [22], and the export and import data of rubber products were gathered from the Rubber Intelligence Unit [23]. Crude oil prices, Consumer Confidence Index (CCI), and the exchange rate (USD/THB) were obtained from Investing.com [24].

3.2. Statistics

The first objective of this study is to examine the macroeconomic variables that affect the rubber concentrated latex prices. As required to successfully achieve the first objective of this study, Pearson's correlation and multiple regression were applied for testing. The multiple regression formula is expressed as Equation (1):

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + e_t \quad (1)$$

Where Y represents the rubber concentrated latex prices, x_1 represents the crude oil prices, x_2 is a proxy for the exchange rate (USD/THB), x_3 denotes the export of rubber products, x_4 represents the import of rubber products, x_5 is a proxy for the Consumer Confidence Index, a is the constant term, b_1, b_2, b_3, b_4, and b_5 are the regression coefficients, and e_t is the stochastic error term.

To achieve the second objective, the Box-Jenkins technique was applied to forecast the daily rubber concentrated latex prices in Thailand.

The definition of Box-Jenkins Technique is as follows:

According to Gujarati and Porter, the Box-Jenkins technique represents a predictive approach that begins by examining the stationarity of time series data through self-correlation measures, including the autocorrelation function (ACF) and partial autocorrelation function (PACF). This tool provides highly precise time series analysis because it examines temporal correlations within the data and subsequently develops an appropriate predictive model that accounts for seasonal fluctuations, which constitutes a crucial element of this approach [25]. The procedure for developing forecasts using the Box-Jenkins technique involves the following steps:

1. Determine whether the time series is stationary or not. This is determined by the time series versus time (Y_t, t) graphs and the ACF and PACF curves. To be stationary, it is essential that the time series must be stable before taking any further steps, such as data transformation by finding differences or seasonal differences, transforming data using a common logarithms or natural logarithms, transforming the data with exponents such as the power of 0.5 to the power of two, etc.
2. Determine the possible predictive models from the ACF and PACF graphs of the fixed time series. This determines the values of p, q, P, and Q and estimates the parameters of the forecasted model using the maximum likelihood method.

3. Eliminate insignificant parameters from the forecast model, one at a time, then define the model forecasts and re-estimate the parameters until a predictive model containing all significant parameters is obtained.
4. Select the forecasting model with the lowest Bayesian information criterion (BIC) value, the Ljung-Box Q statistic that is not significant, and forecast errors that a normal distribution, as verified by the ACF and PACF curves, with the mean error is zero.

4. Results

The objectives of this study are to examine the macroeconomic factors affecting the rubber concentrated latex prices and to apply the Box-Jenkins technique to forecast daily rubber concentrated latex prices in Thailand.

4.1. Descriptive Statistics

Table 1 depicts the results of this study.

Table 1. Descriptive Statistics of the Macroeconomic Variables and Rubber Concentrated Latex Prices in Thailand.

	Obv.	Minimum	Maximum	Mean	SD.	Skewness	Kurtosis
Rubber latex price (THB)	170	34.42	152.26	60.84	23.26	1.78	3.34
Crude oil price (USD)	170	26.35	125.89	78.09	24.52	0.09	−1.09
Exchange rate (USD/THB)	170	29.26	38.05	32.87	2.014	0.36	−0.77
Imports of rubber (kg.)	170	0.00	108,199,446.00	12,507,306.05	12,805,808.62	4.45	26.60
Exports of rubber (kg.)	170	0.00	8,074,342,905.00	3,815,426,152.91	1,237,554,260.93	0.51	1.40
Consumer Confidence Index (points)	170	39.60	84.10	67.15	12.96	−0.69	−0.87

Source: Data Analysis.

Table 1 presents the minimum, maximum, mean, and standard deviation of the rubber concentrated latex prices in Thailand, which are 34.42, 152.26, 60.84, and 23.26 Thai baht, respectively. The skewness value is positive at 1.78, while the kurtosis value is 3.34.

Regarding the second variable, the crude oil prices (USD) in relationship with the rubber concentrated latex price in Thailand, the minimum, maximum, mean, and standard deviation values of 26.35, 125.89, 78.09, and 24.52, respectively, were obtained. The skewness value is positive at 0.09, while the kurtosis value is −1.09.

For the exchange rate (USD/THB) in relationship with the rubber concentrated latex price in Thailand, the maximum, maximum, mean, and standard deviation values of 29.26, 38.05, 32.87, and 2.014, respectively, were indicated. The value of the skewness is 0.36, and −0.77 is the kurtosis value.

The minimum, maximum, mean, and standard deviation of the imports of rubber products are (kilograms) 0.00, 108,199,446.00, 12,507,306.05, and 12,805,808.62, respectively. The value of the skewness was indicated as 4.45, and 26.60 is the kurtosis value. (The minimum value of imports of rubber products is shown as 0.00, since one month of data was not available.)

For the fourth variable, rubber products imports (kilograms) with the rubber concentrated latex prices in Thailand, indicated that the minimum, maximum, mean, and standard deviation values are 0.00, 8,074,342,905.00, 3,815,426,152.91, and 1,237,554,260.93, respectively. The skewness value is positive at 0.51, while the kurtosis value is 1.40. (The minimum value of imports of rubber products is shown as 0.00, since one month of data was not available.)

For the Consumer Confidence Index (points) in relationship with the rubber concentrated latex prices in Thailand, the minimum, maximum, mean, and standard deviation are of 39.60, 84.10, 67.15, and 12.96, respectively. The value of the skewness was indicated as −0.69, and −0.87 is the kurtosis value.

4.2. Correlation Matrix

Table 2 presents the correlation matrix and the coefficients of correlation that are lower than 1, which means there is no multicollinearity problem or no perfect linear relationship between the independent and dependent variables. Therefore, all the variables could be employed for regression analysis.

The Pearson correlation between the crude oil prices and rubber concentrated latex prices is 0.67, which indicates that there is a moderate positive relationship between them. The 2-tailed significance is 0.00,

which indicates that there is a relationship between the crude oil price and rubber concentrated latex prices in Thailand.

The Pearson correlation for the exchange rate (USD/THB) and rubber concentrated latex price is −0.35, which indicates that there is a moderate negative relationship between them. The significance (2-tailed) is 0.00, which indicates that there is a relationship between the exchange rate (USD/THB) and the rubber concentrated latex prices in Thailand.

Table 2. Correlation Matrix.

		Rubber Concentrated Latex Price	Crude Oil Price	Exchange Rate	Imports of Rubber Products	Export of Rubber Products	Consumer Confidence Index
Rubber concentrated latex price	Pearson correlation Sig. (2-tailed)	1					
Crude oil price	Pearson correlation Sig. (2-tailed)	0.67** 0.00	1				
Exchange rate	Pearson correlation Sig. (2-tailed)	−0.35** 0.00	−0.29** 0.00	1			
Imports of rubber products	Pearson correlation Sig. (2-tailed)	0.39** 0.00	0.21** 0.01	−0.06 0.41	1		
Exports of rubber products	Pearson correlation Sig. (2-tailed)	0.67** 0.00	0.46** 0.00	−0.42** 0.00	0.17* 0.03	1	
Consumer Confidence Index	Pearson correlation Sig. (2-tailed)	0.20** 0.01	0.02 0.77	−0.28** 0.00	0.10 0.20	0.29** 0.00	1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Source: Data Analysis.

The Pearson correlation between the imports of rubber products and rubber concentrated latex prices is 0.39, which indicates that there is a moderate positive relationship between them. The significance (2-tailed) is 0.00, which indicates that there is a relationship between the imports of rubber products and the rubber concentrated latex prices in Thailand.

The Pearson correlation between the export of rubber products and the rubber concentrated latex prices is 0.67, which indicates that there is a moderate positive relationship between them. The 2-tailed significance is 0.00, which indicates that there is a relationship between the exports of rubber products and the rubber concentrated latex prices in Thailand.

The Pearson correlation between the Consumer Confidence Index and the rubber concentrated latex prices is 0.20, which indicates that there is a weak positive relationship between them. The 2-tailed significance is 0.01, which indicates that there is a relationship between the Consumer Confidence Index and the rubber concentrated latex prices in Thailand.

Therefore, this study concludes that macroeconomic factors, namely the crude oil prices, exchange rate (USD/THB), imports and exports of rubber products, and the Consumer Confidence Index, are related to the rubber concentrated latex prices in Thailand. The findings of this study are consistent with the research conducted by Khin et al., Srisuksai, Sungkaew, Mathew, Su et al., and Raju, who concluded that the crude oil prices and Shanghai natural rubber prices indicate a significant relationship with the Malaysian natural rubber prices. Changes in the global prices of rubber in the past period led to changes in the expected price of rubber in the short run, which influenced the expected rubber profit. In addition, the imbalance between supply and demand, inefficiencies of small-holders markets, the oil prices, exchange rates, and climatic changes are related to natural rubber prices, and a decline in oil prices and the subsequent decline in the prices of synthetic rubber are among the factors that have contributed to the volatility and instability of natural rubber prices [2–4, 9–11].

4.3. Multiple Regression Analysis

The multiple regression results are presented in **Table 3**.

Table 3. Results of Multiple Regression Analysis.

Variables	B	Std. Error	Beta	t	Sig.	Collinearity Statistics	
						Tolerance	VIF
Constant	1.3893	23.3161		0.0596	0.9525		
Crude oil price	0.3937	0.0501	0.4152	7.8483	0.0000	0.7342	1.3621
Exchange rate	(0.3494)	0.5945	(0.0302)	(0.5879)	0.5574	0.7755	1.2895
Imports of rubber products	0.0000	0.0000	0.2237	4.7837	0.0000	0.9397	1.0642
Exports of rubber products	0.0000	0.0000	0.4157	7.4030	0.0000	0.6516	1.5346
Consumer Confidence Index	0.0789	0.0878	0.0440	0.8993	0.3698	0.8588	1.1644

$R = 0.814$; R-Squared $= 0.663$; Adjusted R-Square $= 0.653$; $SE_{est} = \pm 13.705$; Sig. $= 0.000$;
$F = 64.526$; Durbin-Watson $= 0.627$

Source: Data Analysis.

Table 3 shows that the R-squared is 0.663, which means that 66.30% of the total variance in the rubber concentrated latex prices in Thailand is significantly explained by the crude oil price, exchange rate (USD/THB), imports of rubber products, exports of rubber products, and the Consumer Confidence Index. The crude oil prices and Consumer Confidence Index have a positive significant effect on the rubber concentrated latex prices, while the exchange rate (USD/THB) has a negative significant effect on the rubber concentrated latex prices. Imports of rubber products and exports of rubber products do not have a significant effect on the rubber concentrated latex prices. Based on these results, it is also shown that there are strong correlations between the variables since R is above 0.8140, the F-statistic value is 64.526, and the significance value is 0.000. These results indicate that the crude oil price, exchange rate (USD/THB), imports of rubber products, exports of rubber products, and the Consumer Confidence Index have a significant effect on the rubber concentrated latex prices at a 5% significance level. These result indicates that changes in these significant factors can reflect the changes in the rubber concentrated latex prices in Thailand. The Durbin-Watson value of 0.627 indicates positive autocorrelation in the model residuals. The regression equation is presented in Equation (2):

$$\begin{aligned} \text{Y (rubber prices)} = 1.3893 + 0.3937\ \text{(crude oil)} \\ -0.3494\ \text{(exchange)} + 0\ \text{(import)} + 0\ \text{(export)} \\ +0.0789\ \text{(CCI)} \end{aligned} \quad (2)$$

Based on the estimation of the model coefficients above, the significant predictors (sig. < 0.05) are detailed as follows:

Crude oil prices ($\beta = 0.2237$, sig. $= 0.0000$): This indicates a moderate positive relationship. For every unit increase in crude oil price, rubber concentrated latex price increases by 0.2237 units. This demonstrates that crude oil price is a strong predictor of rubber concentrated latex prices.

Imports of rubber products ($\beta = 0.2237$, sig. $= 0.0000$): This indicates that the beta coefficient of 0.2237 represents the moderate positive relationship among all variables. For every unit increase in import of rubber products, rubber concentrated latex prices increases by 0.2237 units. This demonstrates that imports of rubber products have the most substantial impact on pricing.

Exports of rubber products ($\beta = 0.4157$, sig. $= 0.0000$): This indicates that the beta coefficient of 0.4157 represents the strongest positive relationship among all variables. For every unit increase in exports of rubber products, rubber concentrated latex prices increases by 0.4157 units. This demonstrates that rubber exports have the most substantial impact on pricing.

Exchange rate ($\beta =$ -0.0302, sig. $= 0.5574$): This indicates a weak negative relationship. Exchange rate changes have minimal impact on rubber concentrated latex prices, and the exchange rate does not significantly predict rubber concentrated latex prices.

Consumer Confidence Index ($\beta = 0.0440$, sig. $= 0.3698$): This shows a very weak positive relationship, indicating that Consumer Confidence Index has minimal influence on rubber concentrated latex pricces. Consumer Confidence Index is not a reliable predictor of rubber concentrated latex price.

The moderate VIF values of crude oil, exchange rate

(THB/USD), import of rubber products, export of rubber products, and Consumer Confidence Index indicate no multicollinearity. The tolerance indicates no multicollinearity.

4.4. Box-Jenkins Technique Results

The results for predicting of daily rubber concentrated latex prices in Thailand using the Box-Jenkins technique are explained below.

The first step of this study begins with checking the movement of the time series data.

Figure 1, depicting the daily rubber concentrated latex prices in Thailand from January 2017 to December 2024, shows that the movement of daily rubber concentrated latex price in Thailand is seasonal. Currently, the movement of daily rubber concentrated latex prices in Thailand is horizontal.

In the second step, the stationarity of the Box-Jenkins technique was checked.

Figure 2 shows the residual ACF of the Thai daily rubber concentrated latex prices in which the mean of the residuals is close to zero, and there is no significant correlation in the residual series. The variation of the residuals stays much the same across the historical data, except for a single outlier. Therefore, this data are stationary and fitted for the Box-Jenkins technique.

The data stationarity are defined as the mean, variance, and autocorrelation structure that does not change over time. As shown in **Figure 3**, the analysis results show a flat-looking series without a trend, constant variance over time, a constant autocorrelation structure over time, and no periodic fluctuations. Thus, the residual autocorrelation function (ACF) and residual partial autocorrelation function (PACF) indicate that the data are stationary. The model selected is the Box-Jenkins technique (1,1,0).

In the third step, this study estimates the Box-Jenkins technique.

Table 4 shows the estimation of the Box-Jenkins technique mode (1,1,0), in which the MA coefficient is 0.467, stationary R-squared is 0.218 at the 0.05 significance level, R-squared is 0.995, MAPE is 0.870, RMSE is 0.833, and the normalized BIC is -0.361.

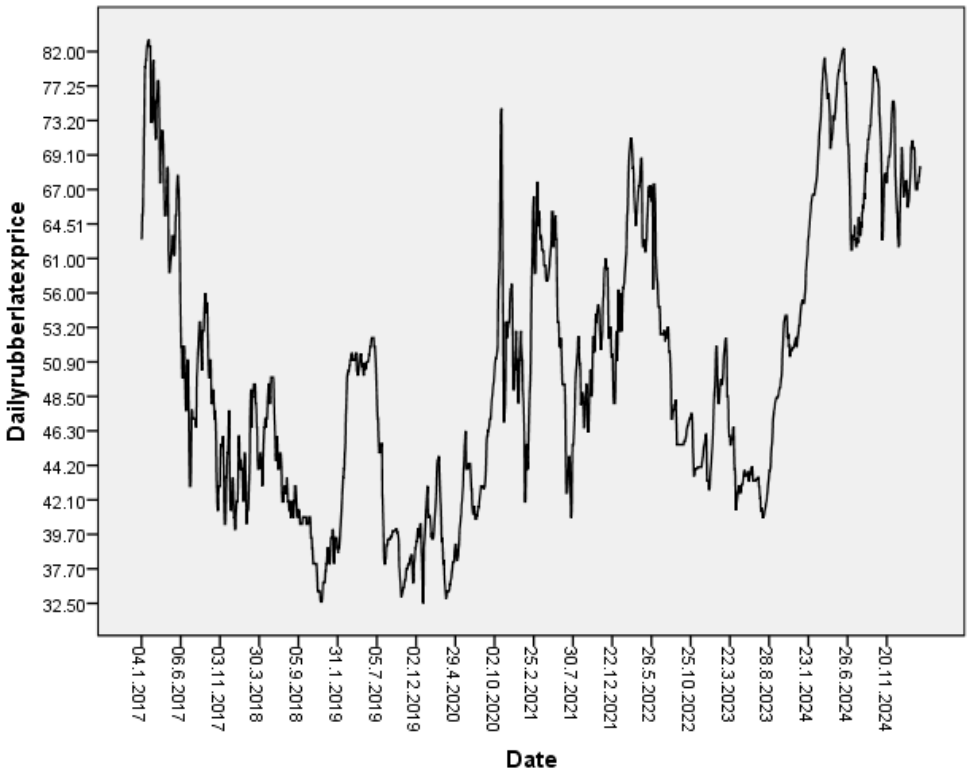

Figure 1. Movement of the Daily Rubber Concentrated Latex Prices in Thailand.

Source: Data Analysis.

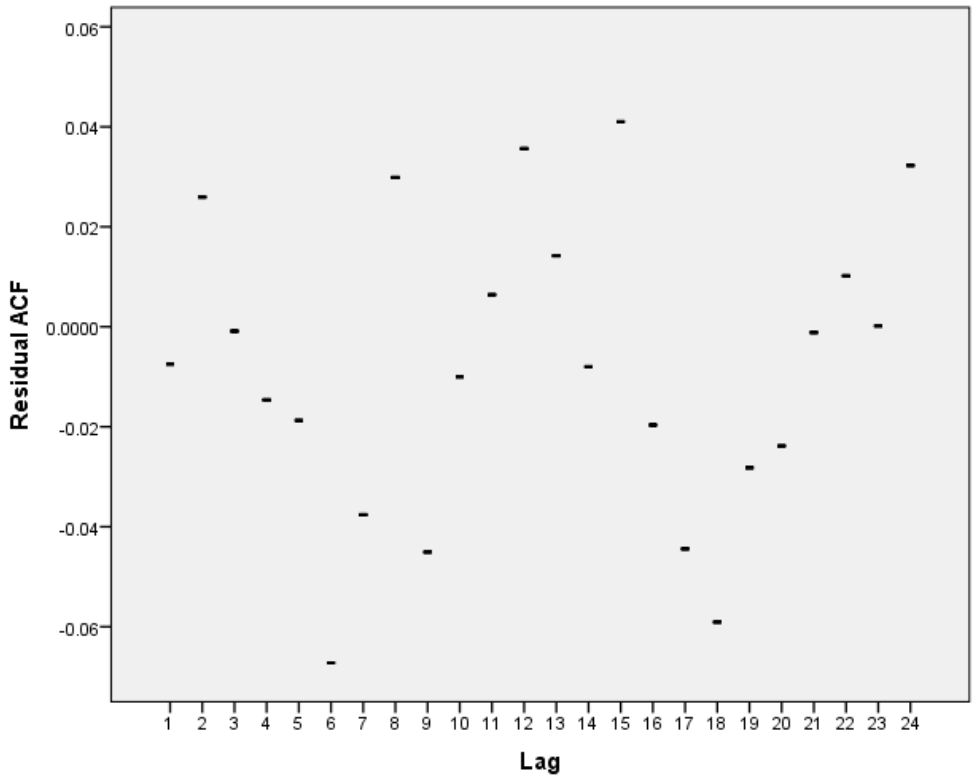

Figure 2. Residual ACF of the Raw Data.

Source: Data Analysis.

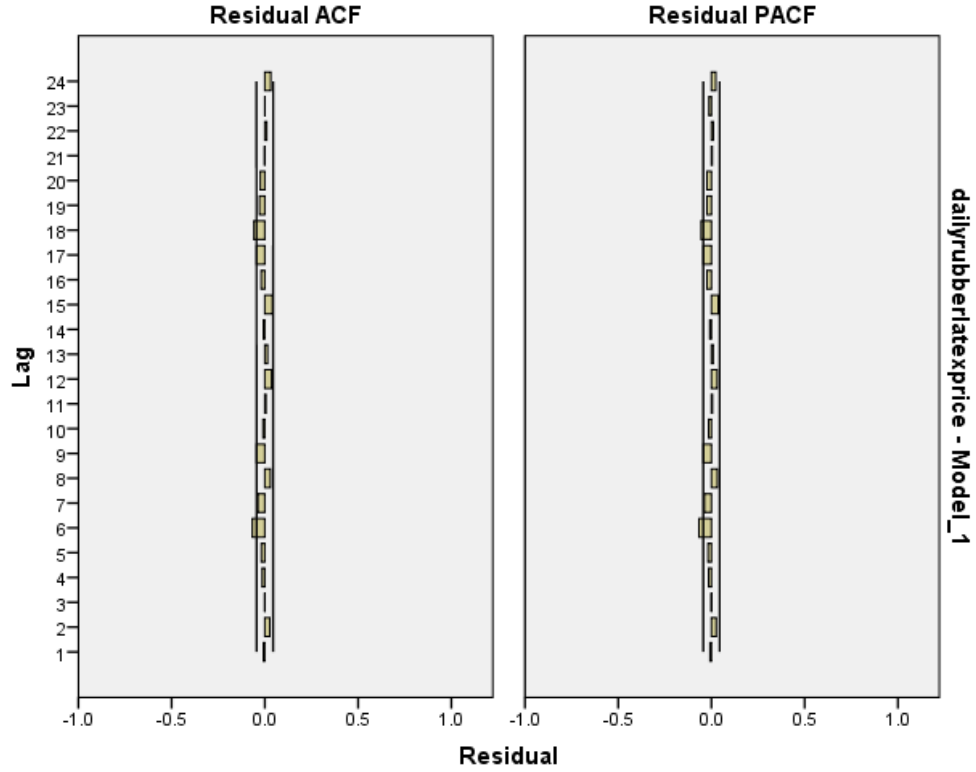

Figure 3. Residual Autocorrelation Function (ACF) and Residual Partial Autocorrection Function (PACF).

Source: Data Analysis.

Table 4. Estimation of the Box-Jenkins technique (1,1,0).

Variables	Coefficient	Std. Error	t	Sig.
Constant				
MA	0.467	0.020	23.533	0.000*
Stationary R-squared	0.218			
R-squared	0.995			
MAPE	0.870			
RMSE	0.833			
Normalized BIC	−0.361			

* Correlation is significant at the 0.05 level (2-tailed).
Source: Data Analysis.

The second objective of this study is to predict the daily rubber concentrated latex prices in Thailand using the Box-Jenkins technique. The results in **Table 5** and **Figure 4** show that the average daily forecasted price of rubber concentrated latex covering the period from January 4, 2017, to March 31, 2025, is 52.20 Thai baht.

Table 5. Forecasting the Daily Rubber Concentrated Latex Price in Thailand.

Descrip./Day	April 2025											
	1	2	3	4	7	8	9	10	11	14	15	16
Forecast	68.51	68.52	68.55	68.57	68.59	68.62	68.65	68.67	68.70	68.73	68.75	68.78
UCL	70.53	72.14	73.56	74.82	75.95	76.97	77.90	78.77	79.58	80.35	81.09	81.79
LCL	66.53	65.05	63.78	62.71	61.78	60.97	60.23	59.57	58.96	58.39	57.87	57.37

Source: Data Analysis.

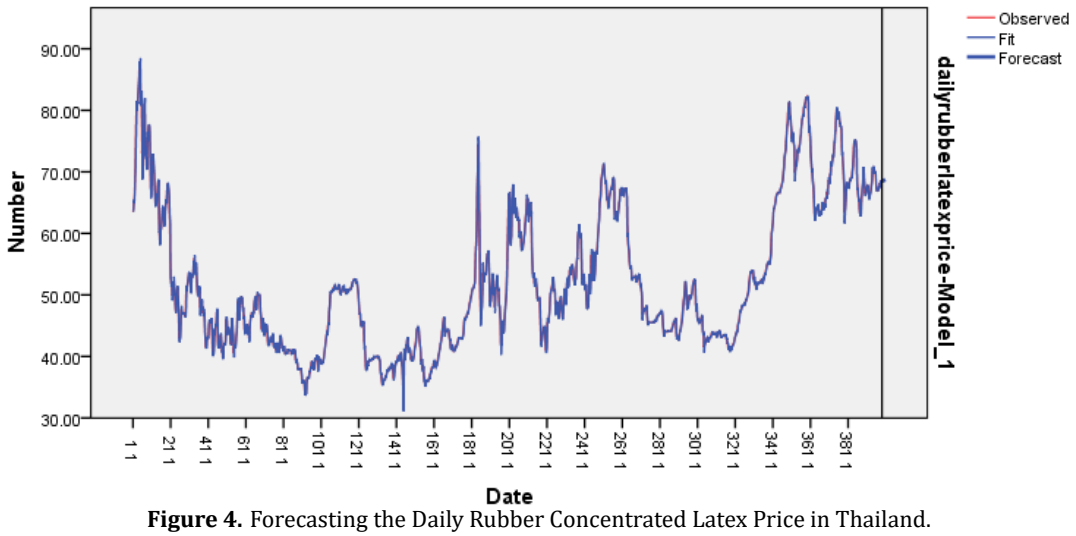

Figure 4. Forecasting the Daily Rubber Concentrated Latex Price in Thailand.

Source: Data Analysis.

The Box-Jenkins technique (1,1,0) is described as follows (Equations (3) and (4)):

$$\hat{y}_t = \mu + x_{t-1} + \varphi(x_{t-1} + x_{t-2}) + \Phi e_{t-1} \quad (3)$$

$$\hat{y}_t = 52.20 + (1 + 0) + 0.467_{t-1} \quad (4)$$

Where $\hat{y}_t$ represents the forecasting daily rubber concentrated latex prices in Thailand, φ is the AR Coefficient at time t, Φ is the MA coefficient at tine t, and t represents the time index of daily data.

5. Discussion

This study investigates the macroeconomic factors affecting monthly rubber concentrated latex prices from January 2011 to December 2024 and applies the Box-Jenkins technique for forecasting daily rubber concentrated latex prices in Thailand from January 4, 2017, to March 31, 2025. Based on the regression analysis results, this study revealed that 66.30% of the price vari-

ance is explained by the selected variables, with crude oil prices and export of rubber products emerging as significant predictors, consistent with previous research by Khin et al., Mathew, Su et al., Sungkaew, Kumkongkaew et al., Tengsuwan et al., Bashier et al., Hammond and Fong et al.[2, 9, 10, 12–17]. The strong positive correlation between crude oil and rubber concentrated latex prices reflects both direct input costs and indirect competition from synthetic alternatives, supporting Raju's findings on petroleum price impacts[11]. Thailand's position as a dominant global supplier is evident through the significant influence of export volumes on pricing dynamics, corroborating Srisuksai's conclusions about international market dependencies[3]. In contrast, the insignificant effects of exchange rates and consumer confidence index contradict some earlier studies by Khin et al., suggesting market-specific variations in price sensitivity. This divergence may reflect Thailand's unique market structure and trade relationships compared to other producing regions like Malaysia or India[2]. The interconnected nature of global commodity markets is clearly demonstrated through synthetic rubber competition and supply-demand imbalances. The results of this study provide valuable insights for policymakers and traders in understanding rubber market volatility and developing appropriate risk management strategies in an increasingly complex global trading environment.

Box-Jenkins (1,1,0) model demonstrated exceptional forecasting performance with an R-squared of 0.995 and MAPE of 0.870%, indicating strong predictive capability for Thailand's daily rubber concentrated latex prices from January 2017 to March 2025. The forecasted daily rubber concentrated latex prices averaging around 68 THB for April 2025 indicates market equilibrium, though narrow confidence intervals may underestimate actual volatility. These findings align with previous studies demonstrating Box-Jenkins effectiveness for agricultural commodities. Intarasat and Bootwisas achieved similar success with ARIMA (1,1,2) for rubber forecasting, while Riansut successfully applied Box-Jenkins for coconut prices and chicken export volumes[19, 20]. However, the present study differs from Anupen et al., who favored seasonal exponential smoothing over Box-Jenkins for latex prices[18]. This discrepancy highlights the importance of dataset-specific model selection and validation periods. The model's high accuracy supports strategic decision-making for Thailand's rubber industry stakeholders. Khin et al.'s findings on RSS4-SMR20 price relationships and cointegration patterns reinforce the complex market dynamics affecting rubber pricing[21]. The result of this study insights enable better risk management and investment planning for market participants, particularly given the government's efforts to stabilize supply-demand balance through increased domestic consumption. Finally, this study provides a forecasting model for participants in the rubber latex market to reduce price risk and achieve their investment goals.

6. Conclusions

This study aims to examine the macroeconomic factors affecting rubber concentrated latex prices and to apply the Box-Jenkins technique for forecasting rubber concentrated latex prices in Thailand. Based on regression analysis, this study identified crude oil prices, exchange rate (USD/THB), imports of rubber products, exports of rubber products, and Consumer Confidence Index as significant predictors, explaining 66.30% of the variance in rubber concentrated latex prices in Thailand. Crude oil prices and exports of rubber products showed the strongest predictive power. The Box-Jenkins (1,1,0) model demonstrated high accuracy (R-squared $= 0.995$, MAPE $= 0.870\%$), forecasting stable prices around 68 THB in April 2025.

The findings provide practical implications for industry stakeholders. Policymakers can develop targeted price stabilization strategies using these macroeconomic indicators. Market participants can optimize entry/exit timing to reduce price risk through the forecasting model. Finally, this study suggests that rubber market participants should consider crude oil prices, as the strong crude oil-rubber price relationship enables petroleum market monitoring to serve as an early warning system for proactive risk management.

Suggestions for Future Studies

There is scope for further research in which the model can be applied using other factors that affect rub-

ber prices, such as rubber futures prices, rubber price volatility, and the cost of rubber production. Moreover, new research should apply LSTM and XGBoost models for forecasting.

Limitation of this Study

This study is limited by the Durbin-Watson value of 0.627, indicating positive autocorrelation in the residuals, which may affect the model's reliability. The analysis focuses solely on Thailand's market, which limits generalizability to other rubber-producing countries. Additionally, external factors like weather patterns and geopolitical events were not included in the model. Data for one month were not available.

Author Contributions

Conceptualization, S.T., S.Y., S.S., S.P., C.P., and K.P.; methodology, S.T., S.Y., S.S., S.P., C.P., and K.P.; validation, S.T., and S.Y.; formal analysis, S.T., and S.Y.; writing— original draft preparation, S.Y.; writing— review and editing, S.T., S.Y., S.S., S.P., C.P., and K.P.; All authors have read and agreed to the published version of the manuscript.

Funding

This research was supported by the University of Phayao and the Thailand Science Research and Innovation Fund (Fundamental Fund 2025, Grant No. 5048/2567).

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

The data used in this study are available from the corresponding author upon reasonable request.

Conflict of Interest

The authors declare that there is no conflict of interest.

References

[1] Boonthong, T., Klinsukhon, C., Poonsin, P., 2019. Shedding light on the economic status of rubber farmers on a challenging path: perspectives on the next step of the policy. Bank of Thailand Education Paper. pp. 1–28. Available from: https://www.bot.or.th/Thai/MonetaryPolicy/RegionalEconomy/EducationPaper/Natural_Rubber_Policy.pdf (cited 25 April 2025)

[2] Khin, A.A., Leh Bin, R.L., Keong, O.C., 2019. Critical factors of the natural rubber price instability in the world market. Humanities & Social Sciences Reviews. 7(1), 199–208. DOI: https://doi.org/10.18510/hssr.2019.7124

[3] Srisuksai, P., 2020. The rubber pricing model: theory and evidence. Journal of Asian Finance, Economics and Business. 7(11), 13–22. DOI: https://doi.org/10.13106/jafeb.2020.vol7.no11.013

[4] Sungkaew, P., 2024. Factors affecting natural rubber prices in Thailand. International Journal of Economics and Business Research. 27(3), 489–510. DOI: https://doi.org/10.1504/IJEBR.2024.138077

[5] Keerativibool, W., 2016. Model selection criterion to overcome the weak signal-to-noise ratio and to reduce the probability of over/underfitting. Thailand Science Research and Innovation. Available from: https://dric.nrct.go.th/index.php?/Search/SearchDetail/300027 (cited 25 April 2025)

[6] Thanapala, D., Charoensiri, C., Sophonphimol, C., 2016. Forecasting of factory pineapple prices with Box-Jenkins method. Burapha Science Journal. 21(1), 110–118.

[7] Riansut, W., Nisan, N., 2017. Forecasting the export volume of processed chicken. Naresuan University Journal: Science and Technology. 25(2), 140–152.

[8] Keerativibool, W., Jitthavech, J., 2015. Model selection criterion based on Kullback-Leibler's symmetric divergence for simultaneous equations model. Chiang Mai Journal of Science. 42, 761–773.

[9] Mathew, S., 2021. To explore the factors that influence the price of Indian natural rubber and to determine the demand of natural rubber in different periods by employing seasonality index of price and production. International Journal of Mechanical Engineering. 6(Special Issue, Nov.–Dec. 2021), 23–31.

[10] Su, C., Liu, L., Tao, R., et al., 2019. Do natural rub-

ber price bubbles occur? Agricultural Economics Czech. 65(2), 67–73. DOI: https://doi.org/10.17221/151/2018-AGRICECON

[11] Raju, K.V., 2016. Instability in natural rubber prices in India: an empirical analysis. IOSR Journal of Economics and Finance (IOSR-JEF). 7(3), 24–28. Available from: www.iosrjournals.org (cited 25 May 2025)

[12] Kumkongkaew, N., Khunsaratham, T., Arnghin, C., et al., 2024. Factors influencing the price of field latex in Thailand. Journal of KMITL Business School. 14(2), 172–184.

[13] Tengsuwan, T., Wongsaen, C., Chansri, N., 2023. Factors affecting the decision to make a buying-selling transaction in the central rubber market of the rubber authority of Thailand. Journal of Economics and Management Strategy. 10(1), 203–221.

[14] Monjagapate, J., 2024. The determinants of the unsmoked rubber sheet price in Thailand. Journal of Innovative Management and Business Administration (JIMBA). 1(2), 5–23.

[15] Bashier, Y.M., Ahmed, E.M., Elfaki, K.E., et al., 2022. Factors affecting the Malaysian natural rubber production and consumption. Academy of Strategic Management Journal. 21(S2), 1–12.

[16] Hammond J., Wijk, T.V., Smajgl, A., et al., 2017. Farm types and farmer motivations to adapt: Implications for design of sustainable agricultural interventions in the rubber plantations of South West China. Agricultural Systems. 154(2017), 1–12. DOI: http://dx.doi.org/10.1016/j.agsy.2017.02.009

[17] Fong, C.Y., Khin, A.A., Chee Seong Lim, S.C., 2020. Determinants of natural rubber price instability for four major producing countries. Pertanika Journal of Social Science and Humanities. 28(2), 1179–1197. Available from: https://www.semanticscholar.org/paper/Determinants-of-Natural-Rubber-Price-Instability-Fong-Khin/08622f23ccb35daead0683d5731713f94a1be17c (cited 25 May 2025)

[18] Anupen, S., Phoolkasem, K., Ruesuk, T., 2020. Forecasting the export value of concentrated latex by comparing the simple seasonal exponential smoothing method and the Box-Jenkins method. In Proceedings of The 9th National Academic Conference of Muban Chombueng Rajabhat University Research, Ratchaburi, Thailand, 1 March 2021; pp.1211–1226. (in Thai)

[19] Riansut, W., 2019. Forecasting of coconut prices using the Box-Jenkins method. RMUTSB Academic Journal. 7(1), 87–100. (in Thai)

[20] Intarasat, U., Bootwisas, N., 2022. Time series forecasting models for predicting export volumes of Thailand's ribbed smoked sheets. Journal of Science and Technology, Ubon Ratchathani University. 24(1), 76–86. (in Thai)

[21] Khin, A., Chau, W., Yean, U., et al., 2017. Examining between exchange rate volatility and natural rubber prices: Engle-granger causality test. International Journal of Economics and Financial Issues. 7(6), 33–40.

[22] Rubber Authority of Thailand, 2025. Average rubber prices. Available from: https://www.raot.co.th/main.php?filename=index (cited 25 May 2025)

[23] Rubber Intelligence Unit, 2025. Rubber export and import data. Available from: https://rubber.oie.go.th/ImExThaiByProduct.aspx?pt=im&hgid=1 (cited 25 May 2025)

[24] Investing.com, 2021. Thailand consumer confidence. Available from: https://www.investing.com/economic-calendar/thai-consumer-confidence-803 (cited 25 May 2025)

[25] Gujarati, D.N., Porter, D.C., 2009. Basic Econometrics, 5th ed. McGraw Hill, Inc.: New York, NY, USA.