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Abstract: This study examines the role of factors affecting natural rubber prices in Thailand. The statistical results confirm that the rubber price is influenced by both domestic and external factors. The results indicate that the volume of rubber stock both inside and outside the country has the greatest effect on domestic natural rubber prices. Moreover, the domestic natural rubber price is also influenced by the market of buyers both inside and outside the country. Finally, according to the empirical analysis, it can be summarised that the rubber market in Thailand is a buyer's market (Monopsony). Although Thailand is the world's biggest producer of rubber, it still relies mainly on foreign sectors.

Keywords: natural rubber; rubber price; rubber market; Monopsony; Thailand.

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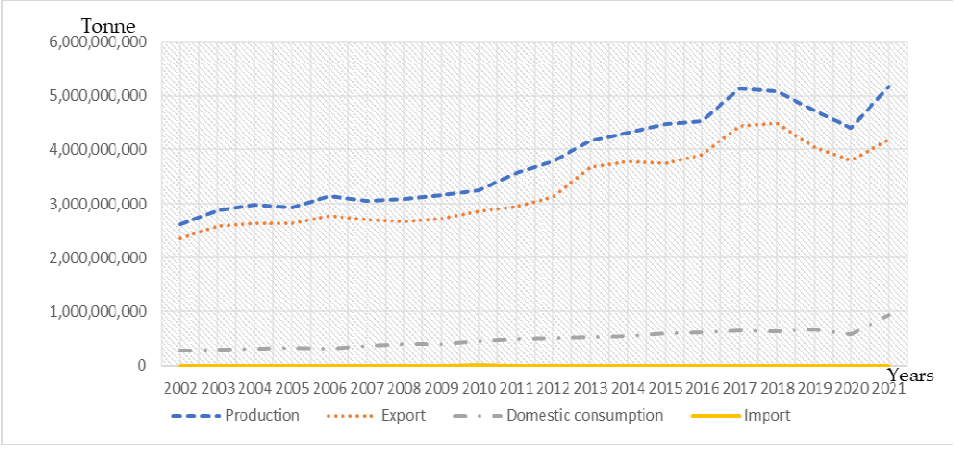
1 Introduction

Natural rubber (NR) is considered an important economic crop of Thailand. Thailand is the largest producer of national rubber in the world, accounting for 37.5% of the world's production in 2021. Moreover, Thailand is also the world's biggest exporter of ribbed smoked rubber sheets (RSS) and concentrated latex in proportions of 29% and 71%, respectively, while the export volume of technically specified rubber (TSR) represents 25% of the world's export volume. On the other hand, domestic consumption of NR still only accounts for a small proportion, representing 18.1% of total NR products. In addition, Thailand's rubber consumption is still only 4.2% of the world, while China consumes the most NR at 42.9% of the global volume (Sowcharoensuk, 2022). From the basic data, it can be observed that the NR situation in Thailand is still highly dependent on foreign trade as shown in Figure 1. For domestic consumption, rubber is used to

produce downstream products such as tires and elastic, representing 60.9% and 16.2% of the total products, respectively although most of them are the result of foreign direct investment. Therefore, the factors affecting the price of rubber are external rather than from NR production such as the exchange rate, export volume, oil price, and rubber price in the futures markets (Anukul et al., 2022; Dulparee and Kittichotipanit, 2015), while the government's price intervention policy does not affect the dynamics of the rubber market (Sertkaew and Socatiyanurak, 2017). Moreover, rubber consumption and the price of NR is a two-way relationship, similar to that between car sales and rubber prices since automobile production uses NR as a component for tires, etc. (Khwanruean and Kanjanasamranwong, 2018).

Figure 1 The NR market situation in Thailand (see online version for colours)



Source: Rubber Research Institute

On the other hand, in other countries such as Indonesia and Malaysia, the exchange rate affects the NR market (Burger et al., 2002). Furthermore, the world rubber market is dominated by the three biggest producers (Malaysia, Indonesia, and Thailand) who have collectively introduced price control policies for over a decade (Kopp et al., 2019). Price changes in a particular country affect the rubber market in the countries of the other countries (Ramli et al., 2019). Moreover, higher prices have resulted in an increase in the production of NR and a decrease in consumption, although the proportion of synthetic rubber (SR) consumption has increased. Exchange rate changes also affect the price of rubber. For example, currency depreciation in major NR importing countries (such as the USA and China) increases the cost of rubber imports from producing countries. As a result, NR producers must try to reduce their prices to continue exporting a high proportion of rubber to those countries. The price of crude oil also affects the NR and SR situation with a rise in the crude oil price resulting in more countries using NR in place of SR since crude oil is the raw material used in SR and has the same result in the rubber futures market (Fong et al., 2018). However, countries with low production capacity for rubber such as Nigeria depend mainly on the foreign sector (Mesike et al., 2008). In addition, changes in NR prices and increased consumption in the world market have also resulted in increased rubber plantations in Laos (Junquera et al., 2020). Moreover, NR production and its price dynamics in India are more influenced by foreign sectors than

domestic ones (Kannan, 2013). Countries with low production capacity are influenced by their position in the global rubber market, while at the same time; they have no influence on it, while large rubber-producing countries still have some influence.

Considering the demand side of the world rubber market, a relationship exists between the price of NR in the world market and the consumption the rubber in major countries (China, India, the USA, and Japan (63.3% of world consumption)). There is also a relationship between the world's NR stock and consumption in those countries. Whereas the world NR price has opposite effect on NR consumption in countries and NR consumption also opposite effect on world NR stock. In other words, consumption increases when world rubber prices fall, while rising NR consumption has the opposite effect on global NR stocks (Khin et al., 2021). Moreover, China, the world's largest consumer of rubber (42.9% of world consumption), has become an important player in the global rubber market and is instrumental in stabilising or destabilising the global NR price (Wong, 1975). The above information indicates that the rubber market is a dominant buyer's market. Meanwhile, major producing countries still maintain some control over the market. However, the increasing demand for rubber has caused many countries to grow more rubber such as Nigeria and Laos. Formerly major producing countries are losing their power to control the rubber situation in the world market. In addition, major rubber consuming countries will play an important role in changing the price and stock of rubber in the world market.

As for the situation of rubber in Thailand, there are many studies indicating that the problem of rubber prices in the country comes from demand problems from large buyers. (Middleman) mainly. While the results of using government policies to solve the problem of rubber prices in the country have needed to be more effective, the government should focus on policies that better support rubber products (Chantarakul and Chantanee, 2020; Somboonsuke and Kongmanee, 2018). However, even a group of sellers (rubber farmers) have come together in the form of a cooperative to solve the problem of falling rubber prices. But it is a cost solution rather than a price negotiation (Suphajaroenkool et al., 2019; Preuksa et al., 2018). Buying and selling on the spot is the best strategy for the cooperative because stocking rubber for too long may cause the quality of rubber to deteriorate and stocking rubber also causes cooperatives to incur additional costs. And rubber farmers have almost no power in determining the price of the products they sell (Janchum et al., 2022).

From the above information, this study has two objectives:

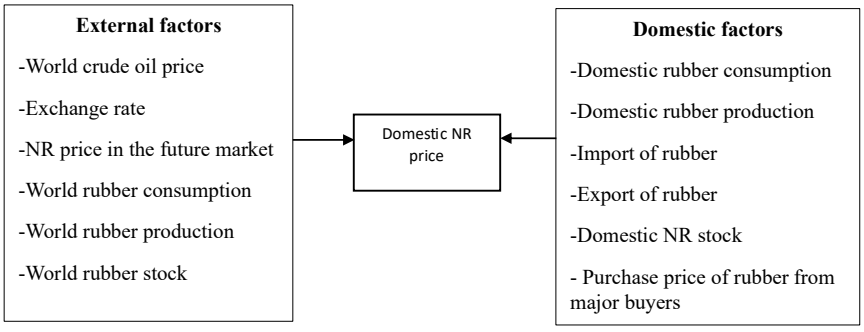
1 To study whether the price of rubber in Thailand is more dominated by the foreign or domestic sector.

2 To study how much the price of rubber in Thailand is influenced by buyers (Monopsony).

2 Methodology

From the literature review mentioned in the introduction and analysis of the supply chain from the structure of the rubber market by Sowcharoensuk (2022) and Darmawan et al. (2014). It can determine the price of NR as a dependent variable and external and domestic factors as independent variables, the factors affecting the price of rubber can be divided into external and internal, as shown in Figure 2.

Figure 2 Classification of the factors affecting the domestic NR price



Source: Author's analysis

From Figure 2, the following equations can be used to analyse the factors that affect long-term and short-term rubber prices for analyse the empirical impact that affects domestic rubber prices and prove whether the Thai rubber market is Monopsony or not.

Long-term factor analysis concerns factors such as domestic consumption, domestic production, domestic stock, imports, and exports as shown in equation (1).

$$P_i = C_0 + \beta_0 Q_{dom} + \beta_1 Q_{ex} + \beta_2 Q_{stock} + \beta_3 Q_{pro} + \varepsilon \tag{1}$$

In addition, many studies report that rubber stocks have a significant effect on changes in rubber levels. Therefore, identifying the factors affecting changes in rubber stocks makes it possible to analyse the situation of the domestic rubber market in more detail, as shown in equation (2).

$$Q_{stock} = C_1 + \gamma_0 Q_{pro} + \gamma_1 Q_{ex} + \gamma_2 Q_{dom} + \gamma_3 P_i + \varepsilon \tag{2}$$

Moreover, the analysis of factors affecting the price of rubber can also be broken down into the type of rubber used to produce each type of product to identify those with the main influence on the price of rubber in the country as depicted in equation (3).

$$\begin{aligned} P_i = {} & C_2 + \delta_0 Q_{Cacp} + \delta_1 Q_{Cbe} + \delta_2 Q_{Cel} + \delta_3 Q_{Cfo} + \delta_4 Q_{Cgl} + \delta_5 Q_{Cgu} + \delta_6 Q_{Cho} \\ & + \delta_7 Q_{Ctyr} + \delta_8 Q_{Cot} + \delta_9 Q_{Cret} + \delta_{10} Q_{Crb} + \delta_{11} Q_{Csci} + \delta_{12} Q_{Cshl} + \delta_{13} Q_{Csho} \\ & + \delta_{14} Q_{Ctym} + \delta_{15} Q_{pro} + \delta_{17} Q_{Stock} + \varepsilon \end{aligned} \tag{3}$$

On the other hand, external factors that affect the price of rubber, in the long run, consist of world consumption, world production, and world stock as depicted in equation (4).

$$P_i = C_3 + \omega_0 Q_{Wcon} + \omega_1 Q_{Wpro} + \omega_2 Q_{Wstock} + \varepsilon \tag{4}$$

While the factors identified as affecting the world's stock of rubber are depicted in equation (5).

$$Q_{Wstock} = C_4 + \tau_0 Q_{Wcon} + \tau_1 Q_{Wpro} + \varepsilon \tag{5}$$

Short-term factor analysis is used in this study to consider both external and domestic factors, including the foreign exchange rate of currencies against the Thai Baht for the world's major producers and consumers of rubber, rubber prices in futures markets such

as the TOCOM and SICOM, and the purchase price of rubber in front of the factory as depicted in equation (6).

$$PL_i = C_5 + \theta_0 BR + \theta_1 WTI + \theta_2 JPY + \theta_3 SGD + \theta_4 USD + \theta_5 EU + \theta_6 CY + \theta_7 RM + \theta_8 TOC + \theta_9 Tsr20SG + \theta_{10} Rss3SG + \theta_{11} Rss3Firm + \theta_{12} LatexFirm + \varepsilon \quad (6)$$

Finally, the impact of free-on-board (FOB) rubber prices on the local prices of each type of rubber is analysed as depicted in equation (7).

$$PL_i = C_6 + \rho_0 FOB_{STR20BK} + \rho_1 FOB_{STR20SP} + \rho_2 FOB_{STR5LBK} + \rho_3 FOB_{STR5LSP} + \rho_4 FOB_{LATEXBK} + \rho_5 FOB_{LATEXSP} + \rho_6 FOB_{RSS3BK} + \rho_7 FOB_{RSS3SP} + \varepsilon \quad (7)$$

where P_i are the FOB latex price, FOB rss3 price, FOB str20 price, FOB str5l price, local latex price, and local raw rubber sheet price.

- PL_i is the local price of raw rubber sheets, local price of RSS3, local price of cup lump, and local price of latex.
- $C_0 - C_6$ are the constant variables
- Q_{dom} is the quantity of domestic rubber consumed
- Q_{ex} is the quantity of exported rubber
- Q_{stock} is the quantity of stock
- Q_{pro} is the quantity of rubber produced
- Q_{Cacp} is the quantity of domestic rubber consumed for motor vehicle accessories
- Q_{Cbe} is the quantity of domestic rubber consumed for belts
- Q_{Cel} is the quantity of domestic rubber consumed for elastic
- Q_{Cfo} is the quantity of domestic rubber consumed for foam products
- Q_{Cgl} is the quantity of domestic rubber consumed for gloves
- Q_{Cgu} is the quantity of domestic rubber consumed for glue
- Q_{Cho} is the quantity of domestic rubber consumed for hoses
- Q_{Ctyr} is the quantity of domestic rubber consumed for tires
- Q_{Cot} is the quantity of domestic rubber consumed for other products
- Q_{Cret} is the quantity of domestic rubber consumed for retreading
- Q_{Crb} is the quantity of domestic rubber consumed for rubber bands
- Q_{Csci} is the quantity of domestic rubber consumed for scientific instruments
- Q_{Cshl} is the quantity of domestic rubber consumed for shoe layers
- Q_{Csho} is the quantity of domestic rubber consumed for canvas shoes and foam sandals

- Q_{Ctym} is the quantity of domestic rubber consumed for tires and tubes for motorcycles
- Q_{Wcon} is the quantity of world rubber consumed
- Q_{Wpro} is the quantity of world rubber produced
- Q_{Wstock} is the quantity of world rubber stock
- PL_i are the local price of cup rump, Rss3, raw rubber sheets, and latex
- BR is the Brent Crude oil price
- *WTI* is the West Texas Crude oil price
- *JPY* is the Japanese Yen to Thai Baht exchange rate
- *SGD* is the Singapore dollar to Thai Baht exchange rate
- *USD* is the US dollar to Thai Baht exchange rate
- *EU* is the Euro to Thai Baht exchange rate
- *CY* is the Chinese Yuan to Thai Baht exchange rate
- *R*M is the Malaysian Ringgit to Thai Baht exchange rate
- *TOC* is the Rubber Futures price in TOCOM
- *Tsr20SG* is the TSR20 Futures price in SICOM
- *Rss3SG* is the RSS3 Futures price in SICOM
- *Rss3Firm* is the purchase price of RSS3 in front of the factory
- *LatexFirm* is the purchase price of latex in front of the factory
- $FOB_{STR20BK}$ is the STR20 FOB price in Bangkok
- $FOB_{STR20SP}$ is the STR20 FOB price in Songkhla and Phuket
- $FOB_{STR5LBK}$ is the STR5L FOB price in Bangkok
- $FOB_{STR5LSP}$ is the STR5L FOB price in Songkhla and Phuket
- $FOB_{LATEXBK}$ is Latex FOB price in Bangkok
- $FOB_{LATEXSP}$ is the Latex FOB price in Songkhla and Phuket
- FOB_{RSS3BK} is the Rss3 FOB price in Bangkok
- FOB_{RSS3SP} is the Rss3 FOB price in Songkhla and Phuket.

This study uses annual time series secondary data from the Rubber Research Institute, Department of Agriculture, from 1997–2021 for analysis in equations (1) and (2). Equation (3) uses annual data from 2004–2021 for long-term factor analysis. Daily data from the Thai Rubber Association in 2021 is used for short-term factor analysis, as depicted in equations (4) and (5).

3 Results

The results of time series analysis by the multiple linear regression (MLR) method through troubleshooting Heteroskedasticity by Huber-White-Hinkley (HC1) heteroskedasticity consistent standard errors and covariance and autocorrelation problems by heteroskedasticity and autocorrelation consistent (HAC) to be the best linear unbiased estimator (BLUE) in Equation 1 shows that the factors affecting the price of each type of rubber are the quantity of rubber consumed, the export volume of rubber, the quantity of rubber stock, and the volume of rubber produced. While the proportion of rubber imports is comparatively small or it is 2,045 times less than exports, 1,988 times less than production, 453 times less than domestic consumption, and 622 times less than stocks according to 2021 as shown in Figure 1. The import is mainly latex from Malaysia for industrial use because the domestic rubber production is insufficient to meet the demand in some periods (Rubber Industry Department, 2021). And the quantity is too small, so it is not necessary to consider the quantity of rubber imported into the model. The statistical results confirm that the factor affecting rubber prices the most is the quantity of rubber stock. Whereas consumption and exports are less significant, with production having the least effect. The factors positively influencing rubber prices are rubber consumption and production, while export volume and stock volume have a negative effect, as shown in Table 1. Domestic rubber stocks have a strong and negative effect on domestic rubber prices, while rubber exports volume also has a negative effect. It can be observed that rubber stocks have a greater influence on rubber prices than exports, while the domestic consumption of rubber and production volume has a positive effect.

The results from equation (2) represent the repercussions that affect the quantity of rubber stocks in the country. The volume of exports, consumption, production, and price level of each type of rubber affects the quantity of rubber stock in the country. The factors of production volume and domestic consumption have positive effects on the quantity of stock while the volume of exports and price level of each type of rubber have the opposite effect, as shown in Table 2. The positive impact on the quantity of rubber stock was caused by production and domestic consumption and making a contract to buy and sell rubber, resulting in having to stock rubber for delivery. On the other hand, the negative impact on the quantity of rubber stock by export volume and price level of each type of rubber indicates that price increases and more exports cause the release of rubber stock in the country.

The results from equation (3) show the effect on rubber prices from the consumption of rubber for use in the production of each type of product. The consumption of rubber for use in the production of motor vehicle accessories, retreading, canvas shoes and foam sandals has a negative effect on rubber prices. On the other hand, the production of tires has a positive effect, as shown in Appendix. This demonstrates the importance of rubber to the Thai manufacturing sector, with tire production identified as the most important sector in manufacturing, while other products are less significant.

The results from equation (4) reveal the external factors affecting domestic NR prices. The quantity of world rubber production has a positive effect on the price of each type of rubber in Thailand while the quantity of world rubber stock has a negative effect as shown in Table 3. Furthermore, the statistical results confirm that the world's rubber stocks have a greater effect on NR prices than the production volume. Moreover, the quantity of rubber consumed and produced does not affect the world's rubber stocks [equation (5)].

Table 1 Estimated results from equation (1) (annual 1997–2021)

	Dependent variables (THB)					
Independent variables (kilogram)	P_i *(FOB Latex)*	P_i *(FOB rss3)*	P_i *(FOB str20)*	P_i *(FOB str5l)*	P_i *(Local latex)*	P_i *(Local raw rubber sheet)*
Q_{dom}	0.000151**	0.000255**	0.000248**	0.000248**	0.000242**	0.000251**
	(2.45321)	(2.462887)	(2.599578)	(2.474694)	(2.581368)	(2.721233)
Q_{ex}	–0.000124**	–0.000213**	–0.00021**	–0.000204**	–0.000167**	–0.000181**
	(–2.297997)	(–2.434555)	(–2.479696)	(–2.372228)	(–2.221257)	(–2.379577)
Q_{stock}	–0.000147***	–0.000243***	–0.000244***	–0.000234***	–0.000213***	–0.000226***
	(–5.24227)	(–5.148457)	(–5.591891)	(–5.164023)	(–5.346955)	(–5.461667)
Q_{pro}	0.000116*	0.000199**	0.000195**	0.000189**	0.000154*	0.000167*
	(2.077744)	(2.217261)	(2.237763)	(2.141208)	(1.987807)	(2.143174)
R-Square	0.718543	0.741480	0.747333	0.740401	0.735964	0.750995
Sig.	0.000	0.000	0.000	0.000	0.000	0.000

Notes: *indicates a 10% significance level. **indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author’s estimate

Table 2 The estimation results from equation (2) (annual 1997–2021)

	Dependent variables (kilogram)					
Independent variables (kilogram, THB)	Q_{stock}					
Q_{pro}	0.654973**	0.678467**	0.677393**	0.674012**	0.615678**	0.633702**
	(2.424057)	(2.596960)	(2.629089)	(2.534476)	(2.423142)	(2.566133)
Q_{ex}	–0.705839**	–0.730045***	–0.733132***	–0.729281***	–0.667844**	–0.686867***
	(–2.810998)	(–2.992148)	(–3.051230)	(–2.948054)	(–2.821349)	(–2.980368)
Q_{dom}	1.070833***	1.086990***	1.062553***	1.094066***	1.147499***	1.131053***
	(3.018609)	(3.297822)	(3.24336)	(3.240043)	(3.546131)	(3.612326)
P_i (FOB Latex)	–4,602.451***					
	(–6.297178)					
P_i (FOB rss3)		–2,817.018***				
		(–6.686888)				
P_i (FOB str20)			–2,916.703***			
			(–6.764419)			
P_i (FOB str5l)				–2,951.524***		
				(–6.771166)		
P_i (Local latex)					–3,233.771***	
					(–6.760731)	
P_i (Local raw rubber sheet)						–3,129.749***
						(–7.110494)
R-Square	0.964117	0.965289	0.968106	0.965802	0.965591	0.967572
Sig.	0.000	0.000	0.000	0.000	0.000	0.000

Notes: **indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate

Table 3 The estimation results from equation (4) and equation (5) (annual 1997–2021)

	Dependent variables						
Independent variables	P_i *(FOB Latex)*	P_i *(FOB rss3)*	P_i *(FOB str20)*	P_i *(FOB str5l)*	P_i *(Local latex)*	P_i *(Local raw rubber sheet)*	W_{stock}
W_{con}	–0.005148	–0.008698	–0.010401	–0.008297	–0.007529	–0.007792	0.009238
	(–1.111433)	(–1.112154)	(–1.449958)	(–1.181896)	(–1.130557)	(–1.153992)	(0.05273)
W_{pro}	0.013019**	0.022282**	0.022868**	0.021139**	0.019290**	0.020013**	0.178645
	(2.411775)	(2.426170)	(2.700154)	(2.545360)	(2.509231)	(2.536439)	(1.044827)
W_{stock}	–0.025929***	–0.041667***	–0.042406***	–0.040873***	–0.036843***	–0.038649***	
	(–4.730914)	(–4.337087)	(4.694653)	(–4.541497)	(–4.738783)	(–4.637799)	
R-Square	0.751900	0.747803	0.757830	0.759946	0.767378	0.761256	0.493451
Sig.	0.000	0.000	0.000	0.000	0.000	0.000	0.001

Notes: **indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate

Table 4 The estimation results from equation (6) (daily, 356 observations)

	Dependent variables			
Independent variables	*PL_i (raw rubber sheet)*	*PL_i (RSS3)*	*PL_i (Cup lump)*	*PL_i (LATEX)*
BR	–0.023203	–0.027914	–0.062222	0.062265
	(–0.749838)	(–0.834107)	(–0.935963)	(1.338395)
WTI	–0.037153	–0.041967	0.134009**	–0.044215
	(–1.220690)	(–1.349369)	(2.223232)	(–1.038003)
JPY	–142.7126***	–147.4910***	100.0578**	34.36843
	(–4.799782)	(–4.634539)	(2.059776)	(0.745819)
SGD	–0.872157	–0.780302	3.360332***	–1.221728
	(–1.200343)	(–1.022535)	(3.125586)	(–1.375302)
USD	–0.380829	–0.938976*	–0.139947	1.237102**
	(–0.918354)	(–1.898821)	(–0.203063)	(2.342241)
EU	1.097672***	1.214665***	–0.096616	–0.153465
	(4.318608)	(4.662648)	(–0.238579)	(–0.489582)
CY	5.244093**	7.995472**	–3.074609	–6.800392***
	(2.326286)	(3.049318)	(–0.953097)	(–2.607444)
RM	0.158581	0.043046	–6.865769**	5.185530***
	(0.097900)	(0.024545)	(–2.563344)	(2.640729)
TOC	0.015814***	0.016004***	0.022507**	0.005627
	(2.963477)	(3.206789)	(2.172830)	(0.941804)
Tsr20SG	–0.005445	–0.002389	0.186244***	–0.001122
	(–0.241088)	(–0.106730)	(3.739777)	(–0.085898)
Rss3SG	–0.004420	–0.010110	–0.072456**	–0.013648
	(–0.274372)	(–0.661268)	(–2.351537)	(–0.589329)
Rss3Firm	0.774212***	0.776490***	0.148423*	0.247571***
	(13.82623)	(12.68612)	(1.771470)	(3.076065)
LatexFirm	0.064090***	0.070281***	0.122804***	0.895290***
	(2.763992)	(3.061815)	(2.991720)	(25.36937)
R-Square	0.983239	0.977554	0.861263	0.978901
Sig.	0.000	0.000	0.000	0.000

Notes: *indicates a 10% significance level.
**indicates a 5% significance level.
***indicates a 1% significance level.

Source: Author's estimate

From an analysis of the short-term factors affecting rubber prices according to equation (6), the world crude oil price, foreign exchange rate against the baht, price of rubber in the futures market, and the price of buying rubber at the factory affect the price of each type of rubber in the country. The world crude oil price has a positive effect on the price of cup lump rubber, while the exchange rate has both a positive and negative effect on the price of each type of rubber. This is because it depends on the type of rubber

exported to the country of destination (negative effect) or used as an intermediate product for foreign companies investing in the country (positive effect) when the baht depreciates. The price of rubber in the futures market mostly has a positive effect on the price of rubber in the country. The purchase price of rubber in front of the factory also has a positive effect as shown in Table 4.

Table 5 shows the correlation between the local market and the FOB prices. The price of rubber in the local market is influenced by the FOB price of related rubber types in the key rubber market area by area.

Table 5 The estimation results from equation (7) (daily, 356 observations)

	Dependent variables			
Independent variables	PL_i *(raw rubber sheet)*	PL_i *(RSS3)*	PL_i *(Cup lump)*	PL_i *(LATEX)*
$FOB_{STR20BK}$	–0.121356	–0.149896	0.475706	–0.615718
	(–0.133374)	(–0.161090)	(0.829268)	(–0.570189)
$FOB_{STR20SP}$	0.071125	0.112843	0.201006	0.971245
	(0.077063)	(0.119606)	(0.351056)	(0.882465)
$FOB_{STR5LBK}$	0.751026	0.627822	–1.904862***	1.132734
	(0.942908)	(0.783708)	(–3.479972)	(1.168988)
$FOB_{STR5LSP}$	–0.706617	–0.593071	1.676043***	–1.150980
	(–0.982578)	(–0.821152)	(3.410422)	(–1.322602)
$FOB_{LATEXBK}$	0.074901	0.093668	–0.093793	1.359438***
	(0.932427)	(1.144751)	(–1.515922)	(13.53517)
$FOB_{LATEXSP}$	0.163634**	0.132009*	0.291191***	0.069989
	(2.254304)	(1.743143)	(6.069060)	(0.717704)
FOB_{RSS3BK}	0.879877**	0.884881**	0.023285	1.149639***
	(2.236799)	(2.280354)	(0.122370)	(4.420981)
FOB_{RSS3SP}	–0.164656	–0.146436	0.096558	–0.985412***
	(–0.449829)	(–0.411205)	(0.600067)	(–5.880142)
R-Square	0.926754	0.920710	0.802419	0.918607
Sig.	0.000	0.000	0.000	0.000

Notes: *indicates a 10% significance level.
** indicates a 5% significance level.
***indicates a 1% significance level.

Source: Author's estimate

4 Discussion

According to the results of the study, factors affecting the price of rubber can be analysed as follows. Domestic factors such as volume of production and consumption positively affect rubber prices, while the volume of exports and stocks both have a negative effect.

The positive impact of production volume is in line with previous studies (Fong et al., 2018) suggesting that the volume of production correlates with rising price levels, i.e.,

high rubber prices will attract farmers to produce more rubber. While the positive impact of the volume consumed is counterproductive to the work previously studied because Thailand's consumption of rubber accounts for only 18% of its total domestic rubber products. Therefore, it does not significantly affect the price of rubber. From the analysis of the rubber used for downstream production, the automobile tire industry was found to be the most important to the domestic rubber market. It uses the most rubber or 60.9% of the total rubber in the country.

The negative effect of exports on the price of rubber is also consistent with the findings revealed in the foregoing research. This is due to the willingness of exporters to lower the price of rubber to reduce import costs for major rubber buyers to increase exports. While the negative effect of rubber stocks on prices implies that increasing rubber stocks will put pressure on the supply side, according to Khin et al. (2008), this cause a decrease in domestic rubber prices. In addition, the statistical results show that stock volume is the main domestic factor affecting changes in the rubber price. Changes in the quantity of rubber stock are influenced by the price level, volume of production, exports, and consumption of rubber in the country.

External factors with a positive effect on the price of rubber include the volume of world production, oil price, rubber price in the futures market, and price of buying in front of the factory, while the volume of world stock is negative. Moreover, exchange rates have both a negative and positive effect.

The positive impact of world production is consistent with the results of previous studies (Kopp et al., 2019; Ramli et al., 2019), indicating that Thailand is one of the top three rubber producers in the world (Malaysia, Indonesia, and Thailand) and has long implemented a policy to control rubber prices in the global market, thereby affecting the global rubber output. In other words, if the price of rubber in the market increases, it will result in increased production of rubber in the country and ultimately the world market. At the same time, if the rubber price in the market decreases, it will have the opposite effect.

The positive impact of world crude oil prices indicates a relationship between the degree of substitution between NR and SR. The production of SR requires crude oil as the main ingredient and if the price of crude oil in the world market increases the SR will rise and affect the demand for consumption of NR. This causes the NR price in the market to rise, as indicated in previous studies.

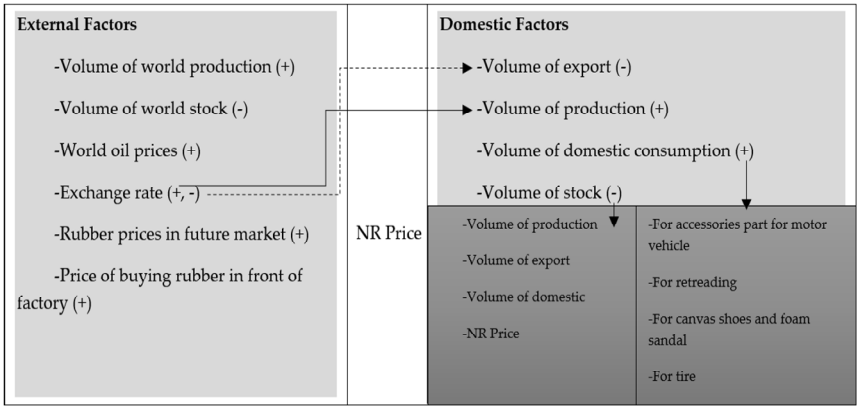
The positive impact of rubber prices in the futures market and the price of buying NR rubber in front of the factory are consistent with the results of the previous studies (Anukul et al., 2022; Stifel, 1975). This indicates that domestic rubber prices are influenced by prices in the futures markets such as those in Tokyo and Singapore. Moreover, the purchase price of rubber in front of the factory affects domestic rubber prices, demonstrating that the rubber market in Thailand is a buyer's market rather than a seller's market.

Exchange rates have both negative and positive effects on rubber. On the one hand, the appreciation of the baht will have a positive effect by decreasing the price of rubber in the country, with the willingness of exporters to reduce the price of rubber to help large rubber importers to still be able to export rubber to sell in large quantities. On the other hand, the appreciation of the baht will have a negative effect by increasing the price of rubber in the country, resulting in more foreign direct investment and increased consumption of rubber, causing the price of rubber to rise (Fong et al., 2018).

Moreover, the price of buying in front of the factory is considered an external factor, indicating that domestic rubber prices are dominated by large buyers. In addition, the results from Table 5 indicate that the comparison price between the local rubber price and the FOB price is inconsistent according to the type of rubber, which reflects that the rubber price does not depend on the seller, causing the FOB price to depend on external factors aside from the price of rubber in the local market, which is the price that farmers receive.

An analysis of the domestic and external factors affecting the price of rubber in the country is summarised in Figure 3.

Figure 3 The factors affecting the NR price in Thailand



Source: Author's analysis

5 Conclusions

The analysis of factors affecting the domestic rubber price revealed that domestic rubber price fluctuations were due to domestic and external factors. The statistical results confirm that the domestic and world rubber stocks have the greatest impact on rubber prices, while the foreign sector still has a strong influence on the domestic rubber price because the domestic rubber market depends on exports. Basic data show that Thai rubber consumption accounts for 18.1% of the country's total rubber production, while the remainder is entirely for export. In addition, exports have a negative impact on prices, since exporters are willing to lower the price of rubber if the baht appreciates so that it can be exported in large quantities. At the same time, domestic rubber consumption also affects domestic rubber prices, especially in tire manufacturing, which accounts for 60.9% of rubber consumption. In addition, external factors such as world crude oil price, exchange rates, and volume of rubber production have almost no influence on the price of rubber in the country. On the other hand, the price of buying rubber in front of the factory has a highly significant effect on the price of rubber in the country.

Considering the previous literature along with the background information and statistical analysis results, it can be observed that the rubber market in Thailand is a buyer's market (Monopsony). Although Thailand is the world's largest producer of rubber, it still relies mainly on buyers and foreign sectors. The basic data show that

Thailand produces 81.9% of its total rubber for export. The remainder for domestic consumption is mainly used by foreign companies in the manufacturing sector, while Thai companies mainly produce rubber to support foreign companies. Consequently, Thailand is unable to control changes in the price of rubber in the market, although the government has developed intervention policies. Therefore, a policy that encourages the use of rubber to produce a high-value final product by Thai companies may provide a solution for the government if it wants to address the problem of falling rubber prices in the country.

Finally, this study uses secondary data for analysis, which has limitations in the number of data sets and the coverage that can be used to analyse the factors in detail. However, the researcher had previously visited the area to study the state of the rubber market in the northeastern and eastern regions of the country and found that the Thai rubber market is a buyer's market and rubber farmers play a very small role in the market. This is consistent with the findings of this study. Moreover, this study is considered as confirmation of the situation of rubber in the country. To provide a guideline for the government sector to use policies to intervene and solve the rubber price problem in the country appropriately, and serve as a guideline for the agricultural and industrial sectors to adapt more efficiently.

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Appendix

Table A1 The estimation results from equation (3) (annual 2004–2021) (see online version for colours)

Independent variables	Dependent variables [P_i (Local latex)]														
Q_{Cacp}	–1.09E-05**														
Q_{Cbe}		–3.41E-06*													
Q_{Cel}			–2.23E-07												
Q_{Cfo}				–8.93E-05											
Q_{Cgl}					6.65E-07										
Q_{Cgu}						4.34E-06									
Q_{Cho}							–1.22E-06**								
Q_{Ctym}								–1.16E-06							
Q_{Cot}									–6.60E-07**						
Q_{Cret}										–7.59E-06**					
Q_{Crb}											–1.20E-06				
Q_{Csci}												–1.71E-05			
Q_{Cshl}													–6.90E-06		
Q_{Csho}														–7.14E-06**	
Q_{Ctyr}															3.13E-07***
Q_{pro}	–1.32E-08*	–4.94E-09	–3.67E-09	–1.80E-08	2.65E-09	–9.01E-09	–4.32E-09	7.79E-09	–1.11E-08	–2.57E-08*	–6.08E-09	–1.18E-08	–8.93E-09	–1.83E-08**	–2.14E-08*
Q_{stock}	–1.82E-09	–2.11E-08	7.25E-10	6.35E-09	–6.33E-08	–7.03E-09	–1.82E-08	–4.79E-08	3.12E-08	–1.25E-08	–2.71E-08	–2.37E-08	–2.68E-08	–6.92E-09	–8.22E-08**
R-Square	0.500925	0.222158	0.177365	0.290474	0.220895	0.183722	0.204637	0.236853	0.274346	0.48501	0.308228	0.205499	0.241254	0.532887	0.585667
Sig.	0.066	0.110	0.244	0.193	0.368	0.126	0.132	0.370	0.068	0.022	0.226	0.381	0.215	0.058	0.005

Notes: *indicates a 10% significance level. ** indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate

Table A1 The estimation results from equation (3) (annual 2004–2021) (continued) (see online version for colours)

	Dependent variables [P_i (Local raw rubber sheet)]														
Independent variables															
Q_{Cacp}	–1.12E-05**														
Q_{Cbe}		–3.25E-06													
Q_{Cel}			–2.35E-07												
Q_{Cfo}				–9.15E-05											
Q_{Cgl}					7.67E-07										
Q_{Cgu}						4.96E-06									
Q_{Cho}							–1.13E-06*								
Q_{Ctym}								–1.18E-06							
Q_{Cot}									–7.06E-07**						
Q_{Cret}										–7.99E-06**					
Q_{Crb}											–1.19E-06				
Q_{Csci}												–1.81E-05			
Q_{Cshl}													–6.95E-06		
Q_{Csho}														–7.40E-06**	
Q_{Ctyr}															3.27E-07***
Q_{pro}	–1.35E-08	–5.10E-09	–3.64E-09	–1.84E-08	3.88E-09	–9.54E-09	–4.54E-09	7.89E-09	–1.15E-08	–2.68E-08*	–6.18E-09	–1.22E-08	–9.05E-09	–1.88E-08**	–2.22E-08*
Q_{stock}	–3.27E-09	–2.26E-08	–1.96E-10	5.08E-09	–7.25E-08	–7.61E-09	–1.98E-08	–5.02E-08	3.26E-08	–1.42E-08	–2.88E-08	–2.60E-08	–2.87E-08	–8.43E-09	–8.70E-08**
R-Square	0.484244	0.214435	0.179637	0.285345	0.233230	0.188678	0.198805	0.198805	0.279101	0.484771	0.293928	0.207801	0.236829	0.520382	0.577437
Sig.	0.077	0.146	0.233	0.194	0.356	0.119	0.180	0.369	0.050	0.022	0.238	0.388	0.219	0.061	0.005

Notes: *indicates a 10% significance level. ** indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate

Table A1 The estimation results from equation (3) (annual 2004–2021) (continued) (see online version for colours)

Independent variables	*Dependent variables [P_i (FOB Latex)]*														
Q_{Cacp}	–7.29E-06**														
Q_{Cbe}		–2.49E-06*													
Q_{Cel}			–1.36E-07												
Q_{Cfo}				–5.44E-05											
Q_{Cgl}					4.67E-07										
Q_{Cgu}						1.93E-06									
Q_{Cho}							–9.05E-07**								
Q_{Ctym}								–9.19E-07							
Q_{Cot}									–4.63E-07**						
Q_{Cret}										–5.03E-06**					
Q_{Crb}											–8.25E-07				
Q_{Csci}												–1.14E-05			
Q_{Cshl}													–4.20E-06		
Q_{Csho}														–4.69E-06**	
Q_{Ctyr}															2.07E-07**
Q_{pro}	–1.04E-08*	–4.82E-09	–4.18E-09	–1.29E-08	4.86E-10	–6.94E-09	–4.34E-09	5.32E-09	–9.14E-09*	–1.86E-08*	–5.64E-09	–9.47E-09	–7.38E-09	–1.36E-08**	–1.58E-08*
Q_{stock}	–8.57E-11	–1.33E-08	5.97E-10	4.05E-09	–4.28E-08	–5.50E-09	–1.13E-08	–3.48E-08	2.35E-08*	–7.27E-09	–1.72E-08	–1.47E-08	–1.62E-08	–3.62E-09	–5.35E-08*
R-Square	0.500178	0.258601	0.207812	0.291842	0.253107	0.207225	0.241398	0.287016	0.305517	0.479183	0.333428	0.234398	0.255385	0.515614	0.568206
Sig.	0.071	0.083	0.137	0.119	0.272	0.110	0.082	0.240	0.039	0.024	0.143	0.293	0.157	0.057	0.006

Notes: *indicates a 10% significance level. ** indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate

Table A1 The estimation results from equation (3) (annual 2004–2021) (continued) (see online version for colours)

	Dependent variables [P_i (FOB Rss3)]														
Independent variables															
Q_{Cacp}	–1.27E-05**														
Q_{Cbe}		–3.72E-06													
Q_{Cel}			–2.67E-07												
Q_{Cfo}				–0.000105											
Q_{Cgl}					8.57E-07										
Q_{Cgu}						5.17E-06									
Q_{Cho}							–1.27E-06*								
Q_{Ctym}								–1.37E-06							
Q_{Cot}									–7.92E-07*						
Q_{Cret}										–9.20E-06**					
Q_{Crb}											–1.37E-06				
Q_{Csci}												–2.09E-05			
Q_{Cshl}													–7.90E-06		
Q_{Csho}														–8.39E-06**	
Q_{Ctyr}															3.61E-07***
Q_{pro}	–1.50E-08	–5.45E-09	–3.80E-09	–2.07E-08	4.56E-09	–1.02E-08	–4.86E-09	9.65E-09	–1.27E-08	–3.05E-08*	–6.69E-09	–1.37E-08	–9.95E-09	–2.10E-08**	–2.43E-08*
Q_{stock}	3.71E-10	–2.17E-08	3.83E-09	1.00E-08	–7.73E-08	–5.49E-09	–1.84E-08	–5.38E-08	4.04E-08	–1.20E-08	–2.88E-08	–2.56E-08	–2.86E-08	–5.52E-09	–9.25E-08**
R-Square	0.468261	0.184124	0.146690	0.259653	0.201127	0.153239	0.165903	0.206799	0.248580	0.476776	0.270813	0.177526	0.206977	0.504634	0.541953
Sig.	0.088	0.190	0.348	0.262	0.449	0.186	0.216	0.449	0.085	0.024	0.298	0.462	0.286	0.076	0.010

Notes: *indicates a 10% significance level. ** indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate

Table A1 The estimation results from equation (3) (annual 2004–2021) (continued) (see online version for colours)

	Dependent variables [P_i (FOB Str20)]														
Independent variables															
Q_{Cacp}	–1.24E-05**														
Q_{Cbe}		–3.67E-06													
Q_{Cel}			–2.49E-07												
Q_{Cfo}				–9.74E-05											
Q_{Cgl}					7.68E-07										
Q_{Cgu}						5.03E-06									
Q_{Cho}							–1.22E-06*								
Q_{Ctym}								–1.24E-06							
Q_{Cot}									–7.89E-07**						
Q_{Cret}										–8.86E-06**					
Q_{Crb}											–1.33E-06				
Q_{Csci}												–2.09E-05			
Q_{Cshl}													–7.93E-06		
Q_{Csho}														–8.20E-06**	
Q_{Ctyr}															3.56E-07***
Q_{pro}	–1.61E-08*	–6.68E-09	–5.22E-09	2.09E-08	2.18E-09	–1.13E-08*	–6.14E-09	6.87E-09	–1.39E-08	–3.08E-08*	–7.90E-09	–1.49E-08	–1.12E-08	–2.19E-08**	–2.53E-08*
Q_{stock}	–5.06E-09	–2.67E-08	–2.61E-09	3.14E-09	–7.60E-08	–1.09E-08	–2.34E-08	–5.52E-08	3.51E-08	–1.72E-08	–3.36E-08	–3.07E-08	–3.37E-08	–1.08E-08	–9.65E-08**
R-Square	0.520358	0.253591	0.216973	0.312979	0.259169	0.223767	0.235043	0.264572	0.317380	0.517550	0.331994	0.248500	0.277846	0.553039	0.594155
Sig.	0.058	0.116	0.132	0.126	0.232	0.064	0.144	0.257	0.045	0.014	0.152	0.289	0.129	0.043	0.004

Notes: *indicates a 10% significance level. ** indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate

Table A1 The estimation results from equation (3) (annual 2004–2021) (continued) (see online version for colours)

	Dependent variables [P_i (FOB Str5l)]														
Independent variables															
Q_{Cacp}	–1.22E-05**														
Q_{Cbe}		–3.73E-06*													
Q_{Cel}			–1.88E-07												
Q_{Cfo}				–0.000102											
Q_{Cgl}					7.51E-07										
Q_{Cgu}						5.42E-06									
Q_{Cho}							–1.24E-06*								
Q_{Ctym}								–1.18E-06							
Q_{Cot}									–7.25E-07**						
Q_{Cret}										–8.81E-06**					
Q_{Crb}											–1.33E-06				
Q_{Csci}												–2.27E-05			
Q_{Cshl}													–7.80E-06		
Q_{Csho}														–8.01E-06**	
Q_{Ctyr}															3.42E-07***
Q_{pro}	–1.58E-08*	–6.54E-09	–5.75E-09	–2.14E-08	2.07E-09	–1.15E-08*	–6.00E-09	6.29E-09	–1.33E-08	–3.06E-08*	–7.79E-09	–1.54E-08	–1.10E-08	–2.15E-08**	–2.45E-08*
Q_{stock}	1.42E-09	–2.00E-08	–2.67E-10	1.10E-08	–6.79E-08	–3.29E-09	–1.67E-08	–4.68E-08	3.74E-08*	–1.04E-08	–2.67E-08	–2.47E-08	–2.67E-08	–4.27E-09	–8.69E-08*
R-Square	0.487327	0.210639	0.164991	0.284190	0.212685	0.178936	0.189527	0.215473	0.260490	0.494866	0.293917	0.211310	0.233154	0.520504	0.551921
Sig.	0.077	0.145	0.234	0.206	0.395	0.093	0.176	0.400	0.072	0.019	0.245	0.370	0.220	0.060	0.008

Notes: *indicates a 10% significance level. ** indicates a 5% significance level. ***indicates a 1% significance level.

Source: Author's estimate