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ASSESSING THE IMPACT OF RUBBER DEVELOPMENT POLICIES ON THE NATIONAL ECONOMY, INTRA-SECTOR DYNAMICS, AND EMPLOYMENT: UTILIZING A COMPUTABLE GENERAL EQUILIBRIUM MODEL APPROACH

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ABSTRACT

Purpose – This research explores the effects of three rubber development policies on Thailand's economy and employment: increasing import taxes on rubber products, raising the rubber export tariff (CESS), and boosting domestic rubber consumption. The goal is to strengthen the rubber industry's foundation by promoting policies that enhance domestic rubber utilization, expand the rubber processing industry, and support farmer institutions.

Methodology – Using a Computable General Equilibrium (CGE) model, the study analyzes the impact of these policies. Expert brainstorming sessions and in-depth interviews provided additional insights, guiding recommendations for government strategies to streamline rubber supply management and support the entire rubber production chain.

Results – Key findings include: 1) Raising the rubber export tariff has minimal impact on the overall economy. 2) Mandating 30% domestic rubber utilization leads to modest economic growth and employment increases, despite Thailand's limited production structure. And 3) Increasing tariffs on imported rubber products has significant macroeconomic effects: a 10% tax increase results in 3.63% economic growth (612,707.70 million THB) and a 2.93% price rise. Employment increases by 6.69%, rubber product prices surge by 23.287% to 26.094%, and primary rubber prices rise by 41.091%.

Implications – Policy recommendations include: Streamlining national rubber supply management, supporting upstream rubber production and creating value-added products, aligning rubber research with synthetic rubber needs, - enhancing domestic rubber usage and procurement regulations, developing new strategies for rubber growth, promoting the rubber glove industry, and achieving a 40:60 ratio of natural to synthetic rubber within five years, Establishing rubber special economic zones and strengthening farmer institutions and the Rubber Authority of Thailand (RAOT), and addressing low productivity per acre, establishing a central market, and creating an online platform for future rubber trading to boost producers' earnings and global competitiveness.

Originality/Value – Implementing a 10% tariff increase on imported rubber products, comprehensive rubber system management, and maintaining a 30% domestic rubber usage rate are crucial. These measures are expected to invigorate the rubber market and enhance producers' earnings, securing a sustainable competitive advantage globally.

Keywords: Rubber development policies, Economic impact, Rubber industry, Computable general equilibrium

Paper Type: Research Article

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INTRODUCTION

Thailand, as the world's leading natural rubber producer, holds the top position with approximately 86% of its rubber production, as primary products, directed towards exports. The remaining 14% of rubber is domestically utilized for the production of various rubber products. Notably, the majority of Thailand's natural rubber is exported to international markets.

Based on Thailand's rubber statistics (Rubber Division Department of Agriculture, 2022), it is observed that over the past decade (2013-2022), the proportion of exported processed natural rubber products (such as smoked rubber sheets, rubber blocks, latex, etc.) to rubber products (rubber for vehicles, elastic rubber, rubber gloves, etc.) has increased. In 2013, the total value of exported processed natural rubber was 249.29 billion THB, from a volume of 3.66 million metric tons of natural rubber, compared to exported rubber products with a total value of 0.79 million metric tons, accounting for 4.61 times per unit. Moving forward to 2022, the total value of exported processed natural rubber is 178.06 billion THB, from a volume of 4.40 million metric tons of natural rubber. In contrast, the total value of exported rubber products is 373.80 billion THB, from a volume of 0.45 million metric tons of natural rubber, indicating that the volume of exported rubber products is higher than the exported processed natural rubber, at a ratio of 9.77 to 1.

The predominant focus on exporting processed natural rubber products has led to an imbalance between production and continuous consumption of natural rubber in Thailand over an extended period. Thailand, emphasizing the expansion of production for more processed natural rubber, faces low bargaining power, making it challenging to set appropriate selling prices. This is due to the market for processed rubber being dominated by powerful buyers who dictate prices, leaving sellers unable to negotiate effectively and susceptible to risks through forward contracts. Depending heavily on international markets and a lot of substitutes products, it has allowed the global market to exert pressure on the purchase prices of natural rubber domestically. This situation results in market fluctuations and consistent depression of rubber prices in the global market, beyond the country's control, directly impacting the livelihoods of local farmers. Therefore, the current production structure, emphasizing only the quantity of exported processed rubber, poses significant risks to the country. The higher the proportion, the greater the risk of increased dependence on international agricultural product markets.

In this scenario, the situation is not conducive to the long-term development of the Thai economy and industry. It is crucial to continuously develop the industrial structure to create added value for natural rubber. This involves transitioning from raw materials at the upstream level to an industry that produces innovative rubber products. There is a need to foster a sufficient number of rubber processing industries to create economic stability and self-reliance for the Thai rubber industry. This includes diversifying risks and promoting economic resilience. Therefore, it is necessary to establish a system that adds value to natural rubber within the country, transforming it into high-value rubber products. This transformation will contribute to building a robust industry with the potential to absorb a significant quantity of rubber production from the agricultural sector. This, in turn, will lead to a sustainable rubber system and related industries that can thrive both at the midstream and downstream levels. The goal is to create a sustainable and resilient rubber industry that can absorb a substantial portion of rubber production from the agricultural sector and develop into a high-value, diversified industry.

The industrial development experiences of countries in the past indicate that the development of the rubber industry leads to significant economic expansion, positively influencing continuous industrial development and domestic employment. This is particularly significant as natural rubber is a key economic crop closely tied to households across all regions in Thailand. It serves as a backbone industry, representing a crucial part of the value chain, including the automotive industry (with 58.6% reliance on natural rubber), rubber glove industry (10.2%), elastic and band industry (10.7%), and other industries (20.5%) (Sowcharoensuk, 2023).

However, the current government has a policy to promote the domestic use of natural rubber, aiming to achieve a domestic consumption target of 30% within five years. Despite these efforts, the measures have yet to yield clear results, evident in the reduction of domestic natural rubber consumption from 13.60% in 2019 to 12.73% in 2020. This is attributed to the short-term

nature of the policy and the lack of a comprehensive analysis of the entire natural rubber supply chain. Additionally, the measures to encourage and support investment in the rubber industry are not specifically tailored to promote the natural rubber sector.

This implies that the current policies and measures are not sufficiently effective in bringing about the necessary structural changes in the natural rubber industry. It is crucial to implement both short-term and long-term measures to develop a continuous natural rubber industry. These measures should be based on a comprehensive analysis and management of the entire natural rubber supply chain system. There is a need to analyze the problems and obstacles of the existing policies and measures, including policies promoting investment in the initial processing industry in all regions. Additionally, there should be encouragement for industries producing rubber-related products linked to community-level rubber industries. This would enhance the quality of production in alignment with the needs of farmers and address various regulations and challenges.

Supporting research and development, skills enhancement, and incentives for entrepreneurs to invest in establishing rubber processing industries in Thailand are also necessary. The policy and measures, both short-term and long-term, should be detailed and structured to enhance the value of rubber products, increase competitiveness in raw material procurement, and ensure a fair price transfer to farmers/agricultural institutions. These actions should be accompanied by analytical measures in the regional economy to assess the impact on economic expansion and employment. This evaluation is crucial to determine the effectiveness of policies and measures. Overall, it is essential for the government and related agencies to recognize the importance of developing industries that create value and coordinate efforts to promote sustainable industrial development (e.g., Ministry of Agriculture, Ministry of Industry, Ministry of Science, etc.).

LITERATURE REVIEW

Natural rubber is a crucial economic crop for Thailand, where the country has been a major producer and exporter on a global scale since the year 1991 and continues to hold a significant position in the market. The production of natural rubber has consistently increased over the years, underscoring its importance to the Thai economy. Recognizing the fluctuations and occasional downturns in natural rubber prices, the Thai government has deemed it essential to implement policies addressing the rubber sector. These policies take into account various factors, including anticipated yields, supply and demand dynamics, seasonal variations, market forecasts, and challenges posed by middlemen. This strategic approach is aimed at mitigating the challenges faced by rubber farmers and fostering a favorable social and economic environment within the rubber cultivation sector.

Analyzing the policy development information on rubber in the study by Pinitjitsamut et al. (2012), it was found that in the year 2001, there was a strategic response to the challenges faced by the Thai natural rubber industry. The primary issue was the high production costs compared to competitive countries like Indonesia and Vietnam, resulting in limited rubber exports and a narrow market. Additionally, the inability to set rubber prices in the global market posed a significant constraint. In light of these challenges, a comprehensive strategy was formulated, encompassing six key areas. First, there was a focus on increasing rubber production yields to meet the demands of processors while maintaining low production costs. Second, efforts were directed towards strengthening the agricultural institutions by developing the basic infrastructure for rubber farmers. Third, initiatives were undertaken to organize business ventures at the grassroots level. Furthermore, there was an emphasis on enhancing the quality and standards of raw rubber processing industries to align with consumer needs. This multi-faceted approach aimed to address the complex issues in the rubber industry and position Thailand as a competitive force in the global market.

This involves developing the rubber product industry to meet international standards and creating value added for natural rubber. In a study by Satsue and Phitthayaphinant (2016), it was suggested that the government should promote increasing the value of rubber products in both midstream and downstream industries. Supports should be provided to cultivate rubber varieties

that yield higher production than current ones. Another study by Pongchomphoo (2013) pointed out that Thailand's natural rubber production per hectare is relatively low, contributing to the instability of prices, especially those received by farmers. This aligns with statistical data indicating that farmers still face low production levels per hectare and higher costs compared to competing countries. The study also highlighted ongoing issues related to the inadequate management of price volatility, indicating that the implementation of the outlined plans has not yielded the expected success.

In recent times, most government measures have been short-term interventions to address the fluctuation of natural rubber prices, typically occurring during periods of low prices. These interventions aim to alleviate the financial strain on rubber plantation owners, allowing them to sell rubber at higher prices, making it more cost-effective in response to production costs. This approach servPes as a tool to address specific challenges during certain periods. For instance, in 2009, the government, under the leadership of the Prime Minister Abhisit Vejjajiva, implemented a policy supporting rubber processing institutions to increase the targeted stockpile value, tackling the issue of plummeting rubber prices. An investment of 8 billion THB was allocated for this purpose. Subsequently, the Yingluck Shinawatra's Government carried out initiatives to enhance the capabilities of agricultural institutions to stabilize rubber prices. These involved institutions purchasing rubber from members, using the rubber as collateral, and utilizing revolving funds for the processing and distribution of rubber products, all aimed at maintaining a reasonable purchase price of 120 THB per kilogram with a budget of 15 billion THB. Despite these efforts, rubber prices continued to decline consistently. This approach achieved only limited success and proved insufficient to establish price stability. Moreover, the project accounted for a mere 5.83% of the total rubber production, indicating a relatively small proportion that had minimal influence on rubber prices. Additionally, domestic rubber traders, having already entered forward contracts, found it challenging to elevate prices. As a result, the task of increasing rubber prices remains a formidable challenge.

Short-term measures were implemented as part of the comprehensive plan to address the issues within the natural rubber system, introduced as a policy in 2014. Under this policy, financial support was provided to farmers as a production factor, amounting to 2,520 THB per Rai. The aim was to potentially increase rubber prices for farmers by approximately 12 THB per kilogram from market prices. However, there was a restriction on the allocated area, limiting it to no more than 25 Rai per individual. It's worth noting that there was no simultaneous development of a network market to purchase the produce in remote areas, which could have reduced transportation costs. Consequently, these urgent measures did not have a long-term impact on the overall capacity development of the Thai natural rubber system.

A notable policy involved establishing a joint venture rubber company among Thailand, Malaysia, and Indonesia. This initiative included forming a joint management committee with representatives from all three countries. Additionally, an office was set up in Thailand to manage a jointly registered fund, based on each country's share of natural rubber production. This office was responsible for facilitating the buying and selling of rubber from all three countries. To achieve specific goals, such as reducing overall rubber production by 4%, a Supply Management Scheme (SMS) was introduced. Simultaneously, the Agreed Export Tonnage Scheme (AETS) aimed to decrease export quantities by 10%. Unfortunately, both measures ultimately failed.

The export restrictions contradicted the principles of promoting exports to bring foreign currency into the country. Consequently, this policy contradicted itself when the government-imposed export quotas, leaving approximately 85% of rubber unaccounted for, requiring business operators to continue operations under normal conditions.

Moreover, with a limited monthly budget of 5 billion THB, the government's intervention led to a potential drop in rubber prices, further exacerbated by the fact that there was insufficient funding to support the program. The most affected were rubber plantation farmers, losing access to international markets due to their inability to compete with the government-set prices.

The short-term measure of suspending the collection of rubber welfare for a period of four months aimed to uplift the rubber prices for farmers, anticipating an increase within the country or a delay in the downward adjustment. However, statistical data on domestic rubber prices

indicated that this measure had limited effectiveness. While there was a short-term adjustment in rubber prices after the initiation of the project, influenced by psychological factors, there was a consistent trend of subsequent downward adjustments. Upon evaluating the period from September to December 2013, it was evident that this measure did not justify the incurred loss of 2 billion THB.

Furthermore, the Rubber Industry Development Plan (2013-2016) outlined strategies to increase the domestic consumption of natural rubber, boost rubber product exports, and develop rubber research organizations. This plan comprised three key programs: improving the quality of raw rubber, researching and developing of rubber technology, and developing market system with a focus on reducing production costs. However, Phaoprasert (2016) found a decline in support for rubber research funding, both in terms of project numbers and budget allocation. While research on traditional and new products received the highest research funding, the implementation of these studies did not translate into serious practical applications.

Furthermore, it was observed that various measures took a relatively long time to implement, such as the tax structure overhaul. Upon reviewing the execution of these measures, it was found that the focus was on developing the rubber industry and rubber products, particularly in addressing the issue of reducing production costs (raw materials/labor), reducing import tariff on raw materials and machinery, and tackling technology and management deficiencies. Additionally, efforts were directed towards training and courses in the rubber industry, marketing, and promoting investments in industries using natural rubber. However, the study highlighted the limited use of natural rubber in rubber product industries, leading to increased investments and support for greater benefits. Unfortunately, after the development plan ended, it couldn't fully achieve its objectives due to a lack of evaluation and the absence of additional supporting development plans.

The Ministry of Agriculture and Cooperatives' Rubber Development Plan for 2002-2006 established production targets for natural rubber. The primary aim was to maintain stable prices and prevent any decline. It introduced the first-ever goal to reduce rubber production, aiming to decrease it from 2.52 to 2.40 million tons per year. The plan also specified adjustments to the production ratios of smoked rubber sheets, rubber sheets, latex, and other types from 50:28:18:4 to 35:40:20:5. This was intended to reduce smoked rubber sheet while increasing rubber sheet, latex and other types of rubber production. Additionally, the plan aimed to limit the export of raw rubber materials to not exceed 2 million THB per year and maintain rubber cultivation areas at the level of 12 million Rais.

Moreover, the focus in previous studies should emphasize the development of agricultural institutions. This involves enhancing the capabilities of agricultural cooperatives and utilizing business plans (Pisanwanich et al., 2012). The entrepreneurial approach involving cooperative members from universities, community enterprise universities (industrial sector), and government agencies was recommended (Wanichcharoenteeratham et al., 2014). Risk management through rubber price insurance and price risk insurance purchases was suggested as well (Thiraphat & Tanthanongsakkun 2017). Additionally, fostering collaboration with farmers and communication with agricultural communities, community leaders, and stakeholders was highlighted.

Subsequently, a comprehensive strategy for the development of the rubber industry was implemented during the Rubber Master Plan (2002-2006) focusing on five key areas: rubber production, rubber industry, para rubber wood industry, market, and rubber sector management. This initiative involved both short-term and long-term measures with main operational frameworks, such as adjusting and reducing customs duties on chemicals and other raw materials, supporting the use of rubber products domestically, enhancing the efficiency of processing, and developing technology in rubber product manufacturing. There was an emphasis on increasing the use of natural rubber, developing high-quality products, and aligning national rubber product standards with international ones. Collaboration with synthetic rubber due to mutual and interconnected impacts was also considered (Rungreunganan et al., 2012).

The Ministry of Agriculture and Cooperatives played a central role in coordinating and executing the plan. However, due to the absence of allocated funds, specifically for the plans and projects, operational activities did not achieve significant success. This situation mirrored the

Rubber Development Strategic Plan for the fiscal years 2009-2013, initiated by the Natural Rubber Policy Committee, Ministry of Agriculture and Cooperatives, as a framework for operations. Unfortunately, the lack of additional budgetary provisions for various plans and projects meant that the agencies had to operate within the normal budget. Consequently, the implementation of the plan did not meet with considerable success. This was similar to the situation with the Para Rubber Development Plan of the Ministry of Agriculture and Cooperatives for the years 2002-2006. The plan aimed to develop the entire rubber production cycle and comprised eight strategies: enhancing production efficiency and the quality of rubber as a raw material, developing the domestic and international rubber market system, improving the rubber processing and product industry, reforming the state management system, promoting international cooperation to support the ASEAN Economic Community (AEC), supporting research, boosting income, and raising the quality of life for rubber farmers, and developing human resources (Rungreunganan et al., 2012).

Nevertheless, this plan is still lacking in crucial aspects, such as establishing a balance in the para rubber supply chain and developing infrastructure, particularly transportation routes and ports (Satsu, & Phitthayaphinant, 2016). The development of market networks for para rubber to facilitate purchasing in remote areas also needs attention (Pongchompoo, 2012). Additionally, logistical and supply chain management, as well as processing facilities (Nimsai, 2014), risk management, and enhancing production efficiency for environmental friendliness, disaster preparedness, promoting proactive use of natural rubber within the country, strengthening the competitiveness of natural rubber, and elevating the competitiveness of para rubber at the regional and global levels should be included (Suksaroj et al., 2012).

Therefore, past studies have found that there has not been a truly successful strategic plan for the development of para rubber. Operations have fallen short of their objectives, and there needs to be an integrated plan within the supply chain and regulatory adjustments to strengthen the para rubber industry (Pisanwanich et al., 2012). The policies on para rubber in Thailand in the past have mainly been ad-hoc solutions and temporary measures to address urgent situations, such as low rubber prices. While a strategic plan for para rubber was formulated in 2006, the operational outcomes have not been evident. Furthermore, the predominantly reactive nature of the guidelines without proactive development policies and a clear industry leadership direction have resulted in minimal impact. The para rubber policy has been minimally implemented, and overall, policy responses lack a comprehensive and long-term approach. In summary, policy issues related to para rubber are both directional and practical, hindering successful implementation. There is a lack of appropriate reviews that persist to the present day. The Thai government continues to focus on short-term and populist policies instead of addressing long-term issues, aiming to improve the living standards of rubber farmers and the overall potential of the para rubber system.

METHODOLOGY

The research aims to explore viable policy models and strategies, assessing their applicability and direction—examining options like bolstering the supply chain (e.g., tax incentives, financial support) or stimulating demand (encouraging domestic rubber product purchases, public sector rubber use). This analysis covers short and long-term perspectives, with a focus on fostering growth in the rubber processing sector to add value along the natural rubber supply chain. It entails forging connections between agricultural entities and the rubber industry nationwide and setting up oversight mechanisms for policy adherence. Furthermore, the study seeks to evaluate the economic and employment impacts of policies supporting the expansion of rubber processing and product manufacturing, thoroughly assessing both cost-effectiveness and societal advantages. The research methodologies are as follows.

1) Document research: The research is conducted by reviewing the information related to the rubber industry including research reports and statistical data on natural rubber, such as cultivation areas, production quantities, policies promoting rubber processing, support for agricultural institutions, and analyses of suitable policies and practical measures for promoting the rubber processing industry. Additionally, it encompasses measures to promote rubber

processing at the agricultural institution level, data on the rubber supply chain in Thailand, and information on rubber policy/strategies. This also involves addressing issues and limitations in developing the rubber industry in various dimensions, including regulations and laws, agricultural institutions, and private sector entities such as the Department of Agriculture, the Rubber Authority of Thailand, National Natural Rubber Commission, and other relevant organizations.

2) Group Discussion: The goal of these meetings is to gather opinions and insights on the development of value-added and rubber processing industries, including tax incentives and other conditions. Participants in these discussions include experts, business professionals, farmers, and individuals involved in the rubber sector. The meetings will involve presenting questions to stimulate discussions and knowledge sharing, promoting the sustainable and efficient development of the rubber processing industry, including testing opinions on the three groups of natural rubber policies.

3) In-Depth Interviews: Conducting in-depth interviews with relevant stakeholders, including industry professionals, policy-level officials, practitioners, and experts, to gain a profound understanding of the development of measures promoting the rubber processing industry. The insights from these interviews contribute to a comprehensive understanding of the sustainable and effective development of the rubber processing industry.

4) Impact Analysis Using CGE Model: This involves analyzing the impact of policies promoting the development of the natural rubber and rubber product industries. The process includes developing an Input-Output Table, Social Accounting Matrix (SAM) and a set of CGE equations for the Thai economic system. Subsequently, the analysis is carried out using a CGE model. Detailed information on the economic impact of policies promoting the expansion of the rubber processing industry and rubber product manufacturing, affecting the country's economy and employment, is presented. This includes the analysis of social impacts, groupings in the SAM matrix, and trade data related to natural rubber between Thailand and other countries.

5) Research findings and Public Consultation: This phase includes presenting the study findings and gathering feedback from relevant organizations, academic experts, private sector professionals, and individuals associated with the rubber sector. It encompasses industrial agencies and other relevant organizations.

RESULTS

The study employs the Thailand Standard Industrial Classification (TSIC) structure for the year 2015, covering major categories from A to U, with a detailed analysis under category C (manufacturing). The focus is on the potential of the natural rubber industry to determine which rubber policies have the potential to generate positive economic impacts and drive economic growth. The analysis also investigates the impact on the development of related industries, both directly and indirectly, providing insights into suitable measures to promote production in the Thai natural rubber industry. The CGE model, known for its computable general equilibrium analysis, is utilized to demonstrate the multi-dimensional impacts of policy measures. This model excels in presenting simultaneous and detailed insights into the policy impacts that may occur in the future. The parameters of the CGE model are determined based on the data from the Social Accounting Matrix (SAM) and external sources, such as pre-existing research studies, time-series economic dimension estimates, and adjustments based on factor and production data from 2015, with assumption of economic structure remains consistent with the present structure in 2021.

1) Modifying the Up-to-date Input-Output Table and developing the SAM Matrix

To analyze the impact of promoting the natural rubber industry, especially the transformation into rubber products, the researchers have constructed the Input-Output Table for the year 2015 and 2021, by utilizing the primary data of Thailand's national income and categorizing into three main parts: 1) Production, 2) Expenditure, and 3) Income. Then, grouping activities in the Input-Output Table from the original 180 activities to 15 activities based on the national income data of Thailand. This adjustment covered aspects of production, expenditure, and income. The national income data related to production were compiled by the National Economic and Social Development Council (NESDC), encompassing production, expenditure, and

income aspects. Expenditure data were measured based on final expenditure on goods and services produced within the specified timeframe, including contributions from the private sector, government, and overall investments (capital accumulation and changes in inventories). Subsequently, adjusting the value-added figures with Thailand's national income data and separating activities related to the natural rubber industry, resulting in an Input-Output Table of 26 activities. Finally, adjusting the intermediate demand values using the production structure ratios and updating the current-year data.

A new Social Accounting Matrix (SAM) has been created by the researchers for studying and analyzing purposes. The matrix involves adjusting the data from the Input-Output Table, covering 180 activities. This dataset is the most recent publicly available information from the Office of the National Economic and Social Development Council (NESDC). The matrix is presented as the current-year Input-Output Table, and the economic and social data are adjusted for the ultimate goal, imports and exports, and trade margins and transportation to provide up-to-date data. Additionally, export data, import data, production and import tariff, and finally, balancing adjustments to the Social Accounting Matrix (SAM) were incorporated.

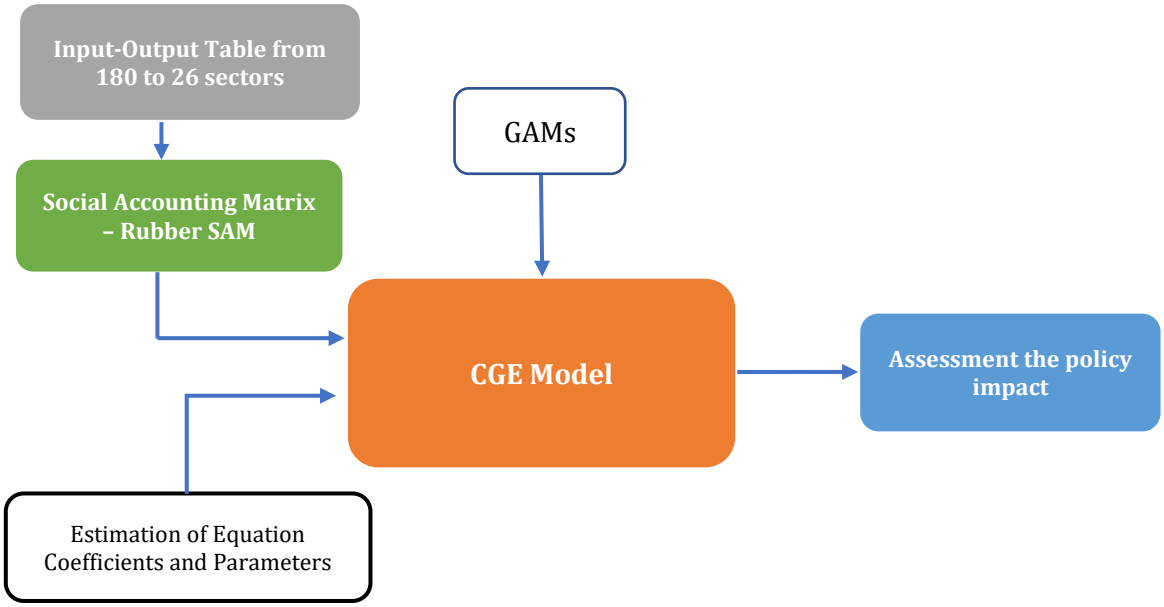

Figure 1. The Linkage of Social Accounting Matrix (SAM) and CGE Model

Table 1. Proportion of Intermediate and Final Value Added

No.	Code	Activities	Value at Intermediate	Final Value Added
1	1-29	Agriculture	0.37	0.63
2	30-41	Mining and Quarrying	0.37	0.63
3	042-123,125-126,128-134	Manufacturing	0.76	0.24
4	106	Secondary Steel Products	0.77	0.23
5	124	Railway Equipment	0.74	0.26
6	127	Repairing of Motor Vehicle	0.68	0.32
7	135-144	Public Utilities and Construction	0.65	0.35
8	145-146	Trade	0.79	0.21
9	147-148	Restaurants and Hotels	0.73	0.27
10	149	Railways	0.23	0.77
11	150,152-153,155,157-159	Transportation and Communication	0.16p	0.84

Table 1. (Cont.)

No.	Code	Activities	Value at Intermediate	Final Value Added
12	151	Road Freight Transport	0.67	0.33
13	154, 156	Ocean Transport	0.55	0.45
14	160-162	Bank and Insurance Services	0.53	0.47
15	163-178, 180	Other Services	0.74	0.26

Table 2: List of 26 Activities in the Social Accounting Matrix (SAM)

Code	Sector
016	Rubber (Agriculture sector)
001-015, 017-029	Other Agriculture Cereals
085	Synthetic Resins and Plastics
086	Fertilizer and Pesticides
087	Paints Varnishes and Lacquers
095	Rubber Sheets and Block Rubber
096	Tyres and Tubes
097	Other Rubber Products
098	Plastic Wares
125	Motor Vehicle
126	Motorcycle, Bicycle & Other Carriages
030-084,088-094,99-124, 127-137	Other Manufacturing
138-144	Construction
145	Wholesale Trade
146	Retail Trade
151	Road Freight Transport
152	Land Transport Supporting Services
153	Ocean Transport
147-150, 154-180	Other Service
190	**Total Intermediate Transaction**
201	Wages and Salaries
202	Operating Surplus
203	Depreciation
204	Indirect Taxes less Subsidies
209	**Total Value Added**
210	Control Total

2) Impact Analysis of Rubber Development Policies

The CGE Equations were developed as a diagram in Figure 2 and the number of equations shown in Table 3. The base simulations are conducted to ensure that the model system balance, and are used to predict the impact. The analysis of the policy impact on the overall economy and employment from the promotion of the rubber processing industry and rubber product manufacturing is categorized into three policy groups:

2.1) Policy to Increase Domestic Rubber Utilization: Simulating scenarios with a +10%, +20%, and +30% increase in domestic rubber utilization.

2.2) Policy to Increase Export Tariff on Natural Rubber: Simulating scenarios with a +5%, +10%, and +15% increase in export tariff to incentivize the export of rubber products and stimulate domestic processing, considering the exemption from export duties on rubber products.

2.3) Policy to Increase Import Tariff on Rubber Products: Simulating scenarios with a +5%, +10%, and +15% increase in import tariff on rubber products to protect the domestic market and encourage domestic processing.

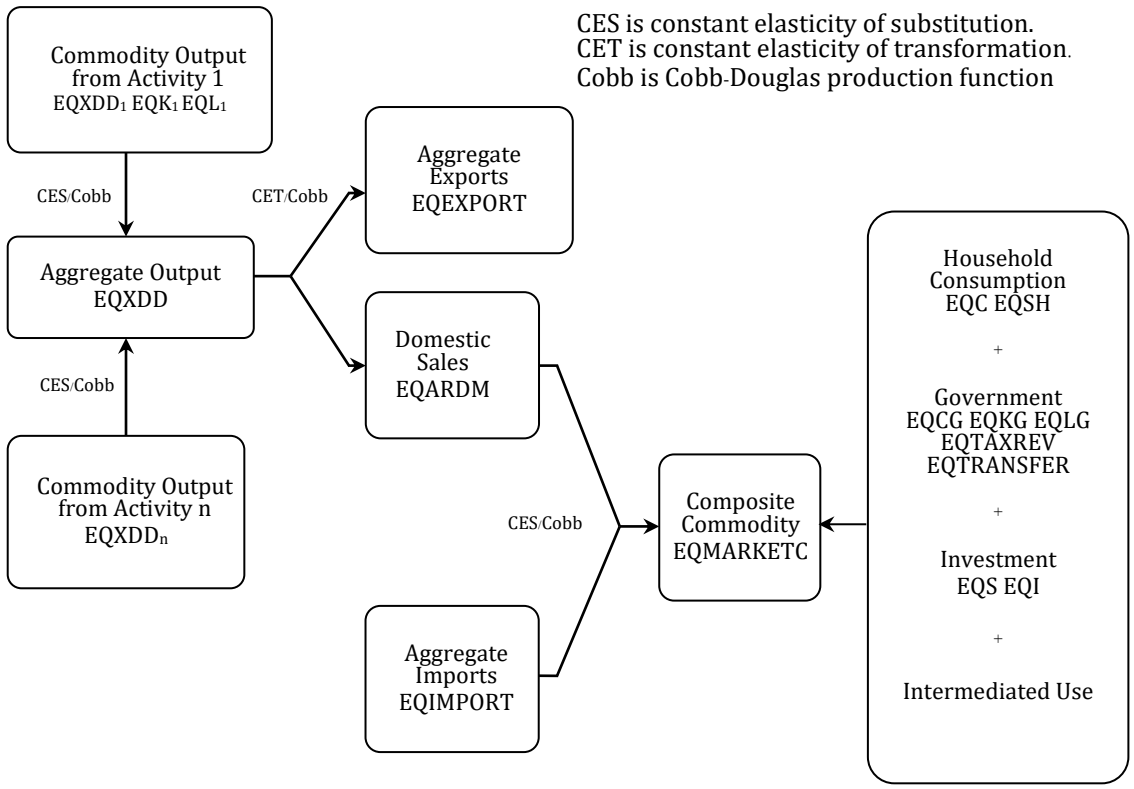

Figure 2. Structure of the General Equilibrium Model

Table 3. System of Equations for the Computable General Equilibrium Model (CGE equations)

Category	Equation	Description
* Households	EQC (sec)	consumer demand for commodity(sec)
	EQSH	household savings
* Firms	EQK (sec)	capital demand function firm(sec)
	EQL (sec)	labor demand function firm(sec)
	EQPROFIT (sec)	zero profit condition for the firms
* Investment	EQS	total savings
	EQI (sec)	the investment demand function for commodities
* Government	EQCG (sec)	government demand for commodities
	EQKG	government capital demand function
	EQLG	government labor demand function
	EQTAXREV	total tax revenues
	EQTRANSFER	total transfers
* Imports and exports	EQEXPORT (sec)	export supply
	EQXDD (sec)	domestic supply of domestic goods
	EQPROFITT (sec)	CET zero profit condition
	EQIMPORT (sec)	import demand
	EQARMD (sec)	demand for domestic goods
	EQPROFITA (sec)	armington's zero profit condition
* Market clearing	EQMARKETL	market-clearing for labor
	EQMARKETK	market-clearing for capital
	EQMARKETC (sec)	market-clearing for commodities
	EQTRADEBAL	balance of payments

Table 3. (Cont.)

Category	Equation	Description
* Definitions	EQEXPRICE (sec)	export price equation
	EQIMPRICE (sec)	import price equation
	EQPCINDEX	laspeyres consumer index
	EQINCOME	household income
	EQCBUD	household expenditure on commodities
	EQPHILLIPS	wage curve
* Objective function	OBJECTIVE	objective function

The analysis results from the model demonstrate the limitations of policies on the overall regional economy. Increasing export tariff on natural rubber producr does not significantly impact the overall economy. Conversely, the policy to increase domestic rubber utilization has the potential to generate modest economic growth. With a 30% increase in domestic rubber utilization, the overall economy could grow by 0.01%, equivalent to a value of 1,687.90 million THB. This policy also affects the domestic rubber price and the overall price level by 0.005%, leading to a 0.031% increase in employment.

However, the policy to increase domestic rubber utilization still has limited economic growth potential due to the constrained production structure of the continuous rubber industry within the country. With only a 14% share of domestic rubber utilization, the domestic rubber product manufacturing sector remains insufficiently linked to raw natural rubber. On the other hand, the policy to increase import tariff on rubber products significantly impacts the overall regional economy. A 10% increase in import tariff on three groups of rubber products generates substantial economic expansion—3.63%, equivalent to 612,707.70 million THB. This increase in import tariff leads to a 2.93% rise in the price of natural rubber and the overall price level within the country, contributing to a 6.69% increase in employment.

2.4) Policy to Increase Domestic Rubber Utilization by +10%, +20%, and +30%

The analysis of the simulated scenarios reveals that this policy yields short-term results and is unable to sustainably expand the volume of processed natural rubber. The production quantity responds minimally to the increased demand for rubber products within the country. Specifically, for three groups of rubber products: Rubber Sheet and Block Rubber Industry, (28), Vehicle Tire and Rubber Tube Industry (29), and Other Rubber Product Industry (30), these industries experience marginal growth (0.001%). Meanwhile, the prices of rubber products decrease by 0.011%-0.013%. Even with a +30% increase in domestic rubber utilization, the impact on employment so small as 0.014% in the Rubber Sheet and Rubber Block Industry, 0.019% in the Vehicle Tire and Rubber Tube Industry, and 0.003% in Other Rubber Product Industry. Overall, the employment impact remains modest.

This indicates that despite a 30% increase in domestic rubber utilization, the continuous impact on fostering the rubber product industry's growth is limited. The current structure of the rubber industry predominantly focuses on long-term raw material exports, and the continuous impact of increasing domestic rubber utilization on the rubber product manufacturing industry within the economy is restricted. An interesting consequence of the +10% domestic rubber utilization policy is the 27.98% increase in the export-adjusted price of natural rubber. This results from utilizing domestic rubber to produce additional rubber products.

Table 4. The Impact of Increase Domestic Rubber Utilization (27)

Sector	Increasing rate		
	10%	20%	30%
Rubber Sheets and Block Rubber (28)			
- Marginal growth (%)	0.001%	0.001%	0.001%
- Price (%)	-0.013%	-0.012%	-0.011%
- Employment (%)	n.a.	n.a.	0.014%

Table 4. (Cont.)

Sector	Increasing rate		
	10%	20%	30%
Tyres and Tubes (29)			
- Marginal growth (%)	0.001%	0.001%	0.001%
- Price (%)	-0.013%	-0.012%	-0.011%
- Employment (%)	n.a.	n.a.	0.019%
Other Rubber Products (30)			
- Marginal growth (%)	0.001%	0.001%	0.001%
- Price (%)	-0.013%	-0.012%	-0.011%
- Employment (%)	n.a.	n.a.	0.003%

2.5) Policy to Increase Export Tariff on Natural Rubber

This policy aligns with the idea of boosting incentives for higher rubber product exports, expecting to stimulate domestic processing due to the absence of tariff on domestically used rubber. Simulating scenarios with +5%, +10%, and +15% tariff increases, the study indicates a minimal expansion of the rubber product manufacturing industry, similar to the policy of increasing domestic rubber utilization. The impact is marginal (0.001%) across the three industries (28, 29, and 30), and there is no effect on rubber and rubber product prices.

Table 5. The Impact of Rubber Product Export Tariff to the Overall Rubber Production Quantity

Sector	Increasing rate		
	5%	10%	15%
Rubber Sheets and Block Rubber (28)	0.001%	0.001%	0.001%
Tyres and Tubes (29)	0.001%	0.001%	0.001%
Other Rubber Products (30)	0.001%	0.001%	0.001%

2.6) Policy to Increase Import Tariff on Rubber Products

The analysis of this policy shows a noteworthy economic expansion of the rubber industry. With import tariff increase of +5%, +10%, and +15% across the three industry groups, there is a significant rise in the price index of rubber products, particularly when import tariff on all three groups are increased by 10%. This results in a price increase of 23.287% to 26.094%. Simultaneously, the price of raw natural rubber adjusts upward by 41.091%, and the production quantity of the rubber product industries, including both manufacturing and agricultural rubber, also increases. The product group with the most substantial expansion is the Tyres and Tubes industry, experiencing a growth of 13.27%.

Table 6. The Impact of Rubber Product Import Tariff to the Rubber Price Index

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.004%	41.091%	0.013%
Rubber Sheets and Block Rubber (28)	0.086%	24.113%	0.235%
Tyres and Tubes (29)	0.087%	26.094%	0.237%
Other Rubber Products (30)	0.032%	23.287%	0.086%

Table 7. The Impact of Rubber Product Import Tariff to the Overall Rubber Production Quantity

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.012%	3.379%	0.033%
Rubber Sheets and Block Rubber (28)	0.021%	0.553%	0.060%
Tyres and Tubes (29)	0.030%	13.271%	0.082%
Other Rubber Products (30)	0.004%	3.043%	0.011%

Table 8. The Impact of Rubber Product Import Tariff to the Domestic Rubber Production Quantity

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.014%	4.925%	0.036%
Rubber Sheets and Block Rubber (28)	0.037%	3.640%	0.099%
Tyres and Tubes (29)	0.040%	22.357%	0.111%
Other Rubber Products (30)	0.006%	6.217%	0.015%

Table 9. The Impact of Rubber Product Import Tariff to the Rubber Import Quantity

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.002%	-1.586%	0.006%
Rubber Sheets and Block Rubber (28)	-0.089%	-0.872%	-0.232%
Tyres and Tubes (29)	-0.158%	-1.484%	-0.415%
Other Rubber Products (30)	-0.079%	-0.743%	-0.205%

Table 10. The Impact of Rubber Product Import Tariff to the Employment in Rubber Sectors

Sector	Increasing rate		
	5%	10%	15%
Rubber (Agriculture sector) (27)	0.003%	6.888%	0.009%
Rubber Sheets and Block Rubber (28)	0.005%	2.796%	0.014%
Tyres and Tubes (29)	0.007%	9.848%	0.019%
Other Rubber Products (30)	0.001%	3.682%	0.003%

The policy of increasing import tariff on rubber products can significantly stimulate the expansion of the domestic rubber product market, particularly in the Tyres and Tubes industry, with a tariff rate of 22.357%. The import quantities of rubber products in industrial groups 28, 29, and 30 have decreased when import tariff is increased. The impact of increased import Tariff has led to the reductions of 0.872%, 1.484%, and 0.743% in the import quantities respectively. This reduction is less than the increased tariff rates, reflecting the policy's effectiveness.

Furthermore, employment rates have increased, especially with a 10% increase in import tariff. The Tyres and Tubes sector experienced 9.848% increasing in employment, while there are contrasting trends in the Rubber Sheet and Block Rubber, and Other Rubber Product industries (Groups 28 and 30). This demonstrates a positive impact on job creation in the agricultural natural rubber sector as well. Therefore, an appropriate and beneficial level for expansion is achieved by implementing a 10% import tariff increase on rubber products.

2.7) Other Policies

Other policies and measures analyzed to study the expansion impact on the natural rubber and rubber product industries (Sections 27 to 30) include the analysis of the effects of changes in situations and policies. These factors include oil prices, labor shortages in rubber tapping, reduced yield per hectare, and reduced rubber planting areas. The analysis, based on the

comparison of the initial production output of the rubber sector (Section 27), indicates that a 10% and 15% increase in oil prices does not affect the rubber and rubber product production quantities. It also doesn't influence the stimulation of adjusting rubber prices in the global market. Additionally, an increase in oil prices has indirect effects on exchange rates, reducing them by 4.28%, with a consequential impact on the international rubber sales volume.

Concerning the factors of labor shortages in rubber tapping, reduced yield per hectare, and reduced rubber planting areas due to government policies, the analysis suggests that these factors could lead to a reduction in rubber production by 10% and 15%. This reduction would impact rubber prices in the domestic market, potentially allowing local farmers to sell their product at slightly higher prices. However, such policies or changes are deemed not cost-effective since they reduce the production potential by 10%, while the returns are minimal, with an increase in rubber prices by only 0.439%. Further detailed analysis is recommended.

3) Key Issues from Stakeholder Meetings on Thai Rubber Development

From the four stakeholder meetings, several key issues for the development of the natural rubber industry in Thailand have emerged:

3.1) Management of the Rubber Supply Chain by the Government

Effective management of the country's rubber system by the government should consider the entire system throughout the supply chain. The upstream, midstream, and downstream industries have different needs and knowledge levels. The upstream industry is concerned with pricing, while the midstream and downstream industries, being private sectors, require stability in prices for cost control in production. The government should support the rubber product industry (end of the chain) by setting conditions or quantities for using raw rubber in production and creating a linkage from upstream rubber tapping to downstream rubber product industries with value added.

3.2) Value Addition to Natural Rubber

The government should focus on adding value to the natural rubber industry throughout the upstream, midstream, and downstream levels through research and development. This can be achieved by improving the quality of products and creating high-value rubber products. Emphasis should be placed on producing rubber products with high value added, such as medical rubber products, engineering and safety rubber products (e.g., earthquake-resistant rubber sheets, shock-absorbing rubber, and road underlayment rubber sheets), and rubber products in rail transportation systems. This policy aims to replace the import of rubber products and promote the increased domestic production of high-value rubber products.

3.3) Promotion of Domestic Use of Natural Rubber

The government should take the lead in promoting the use of natural rubber domestically by increasing the usage in public sector organizations. This can be achieved by enhancing the use of rubber products in government agencies and creating sustainability by improving procurement regulations, tendering processes, and/or providing extra points for products produced domestically. As the budget allocated from the rubber fund is insufficient, a regular budget should be used to support the promotion of domestic rubber usage.

3.4) Rubber Strategy Direction

Given the changing economic landscape, evolving competition dynamics, and the impact of COVID-19, the government should clearly redefine its rubber strategy. Urgent measures are needed to advance the natural rubber glove industry. This can be accomplished by creating leading rubber products for the international market, with strong government support. The management of the natural rubber supply chain should be systematic, focusing on increasing the domestic use of natural rubber instead of addressing low rubber prices by reducing planting areas. This is crucial for Thailand to maintain its market share globally. Additionally, the establishment of Special Economic Zones (SEZ) or global rubber centers can better respond to the competitive rubber market than industrial estates, contributing to the country's economic development.

3.5) Strengthening Agricultural Institutions and Communities

Policies should be in place to promote the collaboration in the natural rubber sector between private sector, agricultural institutions, and educational institutions. This collaboration

should encourage joint research and development initiatives, linking with the creation of innovations or knowledge-based products and compounded formulations at the university level. Students should be engaged as research scholars, working on experiments in university's laboratories to disseminate knowledge or research findings. Farmers should be empowered to produce compounded rubber in households and communities, promoting the production of higher-quality natural rubber.

3.6) Role of the Rubber Authority of Thailand (RAOT)

RAOT should address the declining trend in rubber yield per hectare, a common issue among rubber farmers. This involves enhancing the quality of planting soils and water sources for rubber cultivation. Additionally, RAOT should improve the efficiency of the central market, controlling and certifying the quality of rubber that passes through the market. This should be done systematically and with standardized procedures. RAOT should establish rubber storage warehouses to negotiate and support credit sales of rubber to farmers. Furthermore, developing a forward contracts market linked to spot and future rubber markets can help stabilize the rubber market.

CONCLUSIONS

The aim of this research is to fostering a robust natural rubber industry and sustainably elevating the sector's competitiveness. This is achieved through policy mechanisms to increase the domestic consumption of natural rubber. The study explores suitable policy models and measures in both short and long terms to facilitate the expansion of the rubber processing industry. Additionally, it investigates strategies to link agricultural institutions with the overall rubber processing industry of the country. The study evaluates the impacts of policies that promote the expansion of the rubber processing industry and rubber product manufacturing on the country's economy and employment, along with the overall effectiveness of these policies.

The analysis indicates that the overall impact on the regional economy is not substantial. The policy of increasing export tariff rates on natural rubber does not generate significant overall economic impact. Simultaneously, the policy of increasing the domestic use of natural rubber by 30% has limited economic growth and employment generation due to the modest existing structure of the domestic natural rubber processing industry. The use of natural rubber within the country is only 14%, reflecting the need for stronger links between the domestic rubber product manufacturing industry and the raw material, natural rubber.

On the contrary, the policy of increasing import tariff on rubber products significantly impacts the regional economic system. A 10% increase in import tariff on three industrial categories; Rubber Sheet and Block Rubber industry (28). Tyres and Tubes industry (29), and Other Rubber Products industry (30) results in substantial overall economic growth of 3.63%, equivalent to a value of 612,707.70 million THB. This policy elevates the prices of natural rubber and overall rubber products by 2.93%, creating a 6.69% increase in employment.

For the specific impact on the rubber and rubber product manufacturing industry, the policy of increasing export tariff rates on natural rubber aligns with the objective of stimulating the export of rubber products and domestically processed natural rubber. The simulated scenarios of a 5%, 10%, and 15% increase in export tariff rates demonstrate a minor expansion of the domestic rubber product industry. Importantly, there is no significant effect on rubber prices or the prices of rubber products.

In contrast, the policy of increasing the domestic use of natural rubber by 10%, 20%, and 30% from the current level only provides short-term expansion, with negligible sustainable growth. This is evident from a minimal increase (0.001%) in the quantity of rubber produced. Additionally, the prices of rubber products decrease by 0.011%-0.013%, indicating a limited impact on the industry. The study highlights the necessity for continuous long-term policies focusing on linking the rubber product manufacturing industry with the increasing utilization of natural rubber.

Moreover, the policy of increasing import tariff on rubber products shows a substantial impact. A 10% increase in import tariff on three industrial groups results in a considerable increase in product prices, particularly for rubber tyres and tubes, which experience the highest expansion of 13.27%. This policy stimulates significant growth in the domestic rubber product market. Importantly, the policy demonstrates a balanced approach, with import quantities decreasing by 0.872%, 1.484%, and 0.743% for the three respective categories. This reflects the policy's effectiveness and its ability to increase employment, particularly with a 10% increase in import tariff, which leads to a 9.848% increase in employment in the motor vehicle tyres and tubes industry.

In conclusion, the research suggests that an appropriate and beneficial level for expanding the industry is to implement a 10% increase in import tariff on rubber products. This policy provides a well-balanced and effective approach that promotes economic growth, stable rubber prices, and substantial employment generation in the rubber and rubber product manufacturing sector.

POLICY IMPLICATIONS

In order for Thailand's natural rubber to compete sustainably in a changing market landscape, it is essential to design a new strategy for natural rubber and implement the following policies:

1) Increase Import Tariff on Rubber Products

The government should consider raising import tariff on rubber products by 10% to support the country's rubber industry. This policy is projected to have a positive impact on the overall economy, with a growth rate of 3.63%, equivalent to a value of 612,707.70 million THB. It would elevate the prices of natural rubber and overall rubber products by 2.93%, creating a 6.69% increase in employment. However, compliance with international trade agreements, such as those under the World Trade Organization (WTO), may limit the use of tariff mechanisms. In such cases, non-tariff barrier measures should be explored at an equivalent level of 10%. Moreover, leveraging the Regional Comprehensive Economic Partnership (RCEP) framework is advised to expand the scope of trade in rubber products.

2) Holistic Management of the Natural Rubber System

The government should implement comprehensive management of the entire natural rubber supply chain. The existing link between raw natural rubber and rubber product manufacturing is currently weak and insufficient. Supports from the rubber product manufacturing industry, particularly from downstream activities like natural rubber latex, should be reinforced. This can be achieved by establishing conditions for the use of natural rubber in product manufacturing, fostering connectivity, setting fair rubber purchase prices, and focusing on value addition in the natural rubber industry across upstream, midstream, and downstream levels. Research and development efforts should be intensified to ensure high-quality and diversified products.

3) Domestic Use of Natural Rubber

The government should adopt a policy to encourage the domestic use of natural rubber to reach a sustained level of 30%. This initiative aims to promote short-term economic growth and employment. The restructuring of the natural rubber production system should establish stronger links between rubber products and natural rubber in the agricultural sector. This includes promoting the processing of rubber products, improving procurement regulations, setting criteria for domestic product points, and addressing regulations that hinder the growth and development of the natural rubber supply chain.

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CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest found in this research.

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