

Abstract

This research focused on the factors affecting Thailand rubber export to the United States, the results are from the ordinary least square (OLS) regression of the Gravity Model which used as the based model and extended the model with potential determinants. The data used time series secondary data that was collected from 1996 to 2014. The additional variables, including US Fuel oil price, Thailand exchange rate per US Dollar, GDP value-added of rubber import of US, and Thailand rubber quantity export to US are statistically significant with positive effect on Thailand rubber export volume. The factors that are expected to affect the Thailand rubber trade volume came from the others studies that have similar topics and similar methodology, which this paper tries to adapt through the case of Thailand.

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i) Introduction

Thailand is an agricultural country that has prosperous natural resources and is also the breadbasket of Asia. Thailand also has comparative advantage in Agricultural sector and Agricultural products, which play an important role in Thailand economic growth for a long time. Natural Rubber is Thailand's primary commodity. It is the basic agricultural raw material of industrial production. Most of rubber exporters mostly are developing countries such as Thailand, Indonesia, and Malaysia. These main rubber export countries will export rubber to industrial developed countries in order to transform natural rubber into manufacturing products, which they have technology and proficiency. According to the high cost of importing and complexity of technology, Thailand will not be able to produce finished goods at lower cost compare to those developed countries.

Natural rubber is one of the most significant economic crops and potential products mostly from Southern part of Thailand, especially for the exporting product to foreign countries. The trend of natural rubber export (by types) from 1999 to 2014 is increasing through time (Rubber Research Institute Department of Agriculture, 2014) which means that the rubber export sector is still Thailand's crucial export product and worth to concentrate on. (Products exported by Thailand, 2014) Thailand has large export RCA on Rubber at 26.8 and also hold 2.7 percent of Thailand total export, showed in Figure 1; Appendix 1. This shows that Thailand has high competitiveness on rubber.

On the latest update, Thailand's export presents 7.4% of world export for rubber and its world ranking export is 4 (List of supplying markets for the product imported by United States of America, 2015), which can refer to the good performance of Thai rubber export market. Top 3 importing rubber market from Thailand are China, the United States, and Malaysia, respectively.

From Trademap Graph (Prospects for market diversification for a product exported by Thailand, 2015), it showed top 10 countries, which are Thailand's main trade partners of rubber sector in 2015. The United States had the highest share in the world imports of Thailand for rubber product although Thailand exports growth to the Unites States is less than the United States import growth from the world as showed in Figure 2; Appendix 1.

In the past, Thailand major trade partner of rubber is Japan (Export destinations of Rubber from Thailand (1996), 2016) at 28 percent of Thailand rubber export, followed by China, which held 19 percent of Thailand rubber export showed in Figure 3; Appendix 1. Nevertheless, the current top importer is China that has 44 percent shares in the World market

(OEC - Rubber (HS92: 4001) Product Trade, Exporters and Importers, 2016) showed in Figure 4; Appendix 1.

This paper will not concern about Thailand rubber export to Japan since, on the present day, Japan is no longer the main importer of Thailand's rubber. For the reason that Japan had moved their production based around the world according to the globalization, they are able to produce at the lower cost compare to the production by themselves. Therefore, Japan does not need to import natural rubber from Thailand.

Likewise, this paper will not consider about China's market even though China is one of the prime importer of Thailand's rubber. China is one of the world's largest importers of Polybutadiene rubber (PBR). The global trend of the supply of natural rubber is increasing, the Association of Natural Rubber Producing Countries (ANRPC) expected that in 2014, global supply of natural rubber growth will reach 5.8% and the oversupply of capacity will rise to 36.6 million tons. In the recent times markets still have oversupply in PBR and Styrene Butadiene (SBR) (China Rubber market Review and outlook", 2015) So, government of China try to scale down domestic rubber supply and further reduces the size of the domestic natural rubber stocks, which results in rapid fall of natural rubber's price. The sharp decreases in crude oil price dampened overall petrochemical industry. Decreasing in the amount of the new resources caused by the main areas of the domestic natural rubber in China stopped cutting period, but the main production areas in foreign countries continued to increase, which helped maintaining the stability of the foreign import growth. (Campoy, R. China natural rubber market analysis: January 2014) China's economy slowed down and the natural rubber price kept falling. These factors affect downward pressure on the domestic rubber market. With this trend of China oversupply of rubber, the future trend may not be in a good situation. As this paper will focus on bilateral trade with the United States, we will have more opportunities to study further and be able to support Thailand rubber sector even more.

Though the trend in the past, the United States is one of the main importer of Thai export rubber and, from Trademap (Prospects for market diversification for a product exported by Thailand in 2015, 2016), it indicated that, in 2015, the United States had the highest share in the world imports of Thailand's rubber product even though Thailand exports growth to the United States is less than the United States import growth from the rest of the world.

Hence, the objective of this paper is to find the factor that will affect Thailand rubber export to the United States and to suggest the policy recommendations to support Thailand's export rubber.

ii) Literature Reviews

This research focuses on the trend of rubber export to the United States, which is one of the major importers. There are many related researches to Thailand rubber's industry, which can be separated into main 3 categories;

1. Literature related to factors that affect Thai rubber export

- ❖ Chaiyanatekraisin (2008) indicated the factors affecting rubber export to Japan and forecasted of export volume through OLS focusing on only one import country. The result is that the exchange rate of THB/ JPY and the price of Ribbed Smoked Sheet have positive effect to the quantity of rubber export.
- ❖ Padoongsereewit (2010) considered the factors that affect the quantity of Thailand's rubber export through OLS estimation and used similar determinant. Factor that affects rubber export quantity is the Agricultural Production Index (API).
- ❖ Weerathamrongsak and Wongsurawat (2013) showed the overview of development from 2005 to 2011. The major factors that determine sustainability of Thailand's competitive advantage in rubber industry are factors of production, demand conditions, related and supporting industries, and firm strategy, structure, and rivalry. The opportunity for Thai rubber industry is increasing in rubber demand.
- ❖ Obispo (2014) focused on the factors affecting Thai natural rubber market equilibrium with demand and supply response analysis using two-stage Least Squares Approach (2sls). The rubber farmers in Thailand respond to economic incentives and environmental factors in the production and government must encourage farmers to plant high modern yielding varieties to reduce production costs.
- ❖ Utramat (2015) did the research through the case study about the main effect of the balance in natural rubber by using simultaneous equations model with the demand, supply model, and rubber price equilibrium equation through 2sls method from 1970 to 2013. The fluctuation of the cost and export quantity of rubber were affected by external factors.

2. Literature related to the growth and impact of Thai rubber industry

- ❖ Stifel (1937) studied about the growth of the rubber economy of Southern Thailand, which uses OLS regression between two periods; prewar and postwar. The model showed that the smallholders varied intensity of their tapping and smallholder rubber cultivation had provided a highly satisfactory way of life that the economics returns were high and the social structure of the village was preserved.
- ❖ Woodcock (1983) considered the impact of competition among exporters on Thai wholesales rubber market prices using hypothesis testing. This study sets hypothesis that competition among exporters for supply of RSS3 (Rib smoked sheet type 3) acts upon Hatyai wholesale market prices can center around the distinction between perfect competition and monopsony and it is possible that access to low cost capital by large exporters in Thailand is not a barrier to entry.
- ❖ Dawling (2001) studied of the supply response of rubber in Thailand, which used supply response model with the estimation of OLS regression. The result found that Thailand has short price horizons. Usage of the relative price of rubber to rice resulted in more satisfactory statistical results than rubber price alone.
- ❖ Doner and Abonyi (2013) indicated about upgrading Thailand's rubber industry compared with Malaysia, one of the biggest rubber export country. Thailand's rubber value chain is unevenly developed, which is quite successful and robust upstream but weaker. Nonetheless, the technology from foreign investors has been limited. Insufficient laboratories cannot support further development of R&D. Challenge is to create globally competitive downstream rubber-based Thailand manufacturing cluster.
- ❖ Dawson and Soontaranurak (2015) did the study of rubber acreage supply response in Thailand from 1962 to 2009, providing strong evidence that Thai rubber farmers respond rationally to economic incentive and the estimated elasticity of rubber acreage with respect to own price is significant and positive. However, in the short-run, rubber farmer's response to the price change only in the small amount.

3. Other Literature related methodology

- ❖ Sakarindr (1979) focused on an econometric study of Thai rubber industry and the world rubber market using demand and supply theory from Thai rubber industry model to produce structure and system to determine the value of variables that contribute to the understanding of the domestic rubber market.
- ❖ Sang-Ngam (1995) studied about the demand for natural rubber in the United States, Japan, and China: Thai natural rubber through OLS estimation. The natural rubber demand model of these countries can be used to forecast and to explain the study about Thai natural rubber situation and how Thailand should increase the quantity and promote more production.
- ❖ Stifel (2001) concerned about the imperfect competition in a Vertical Market Network: Case of Rubber in Thailand using the OLS method. The results showed that the competition is imperfect, but work in the sense of no administratively feasible alternatives appears capability to transfer the final price down to the producer level. Government can provide more competition to ensure the standardization of product quality, improve efficiency of the capital market and, increase the size of effective markets.
- ❖ Rahman (2003) did study about a panel data Analysis of Bangladesh's Trade with its major trading partners using the Gravity Model Approach and also has established that the application of the Gravity Model in applied research of bilateral trade is justified. The major determinants of exports are the exchange rate, partner countries' total import demand, and openness of Bangladesh's economy that is positively related.
- ❖ Tho (2013) studied about the determinants of Vietnam's export for its forty major exporting markets from 1995 to 2011 with the Gravity Model Approach. The results showed that Vietnam's exports pattern followed the basic of the Gravity Model or it can be said that Vietnam's export increased as its GDP and importing countries' GDP increased.

Research Gap

This research tries to look through time series data in the past and tries to find the factors affecting Thailand rubber export to the United States. The concern is to comprehend about expected determinants and linkages between these two countries. The sets of the data usage are from 1996-2015, quarterly, which is the latest updated data. The range of this study is confined because of the limitation of data availability for some sectors and some variables that may related to the rubber export as the data cannot be collected. So that, the indicators that predicted to affect the market may not be concerned in all aspects.

iii) Data & Methodology

3.1) Data

This study is cross-sectional analysis based on time series from secondary data, quarterly, between 1996 and 2014 of bilateral trade flows between Thailand and the United States. This paper tries to confine the dependent variables that will affect the trade volume between these two countries. Noted that the fuel oil price has been use to be a representative of crude oil price to analyze the effect of the oil price through the rubber trade volume.

Table 1: Source of Data

Data	Source of Data	Unit
Trade volume of rubber export to US	Ministry of Commerce	USD Million
Thailand GDP	CEIC Generate	USD Million
US GDP	FRED	USD Million
Distance	Distance Calculate	Kilometer
Thailand Real Exchange rate	CEIC Generate	THB per USD
Thailand Consumer Price Index	IMF	USD
Thailand fuel oil Price	BOT	USD per unit
US fuel oil price	EIA	USD per Barrel
GDP value added of rubber import of US	IMF	USD Million
Thailand Rubber quantity export to US	BOT	Metric Ton

3.2) Methodology

To accomplish the objective of this study, the methodology will be divided into 2 main parts which are Related Theoretical Model, or the based model, and the Specification Model, which is the extension of the variables that skeptical to be the determinants of the Thailand rubber export to the United States.

i) Related Theoretical Model

- Gravity Model of Trade

This model was first applied to the international trade field by Tinbergen (1962), an econometric method of estimating trade flows, comparing the size of bilateral trade, and the flows between any two countries to the gravitational force in physics between two objects. It normally used in order to assess the world global trade trends and estimate the trade pattern. It was originally founded on Newton's physical theory, Law of Universal Gravitation. This model has also been used to analyze the effectiveness of the trade agreements and organizations.

With the increasing in the importance of geographical factor in the international trade theory and success from the empirical point of view, the Gravity Model becomes more popular and the theoretical foundations has been developed through time, which allows Gravity equation to extend with additional variables as the topic concern.

The basic gravity model of trade is

$$M_{ij} = G (Y_i Y_j / D_{ij})$$

The expression in logarithm form and attaching a random error, U_{ij} , the basic Gravity equation is as follows:

$$\ln M_{ij} = G + \beta_1 \ln Y_i + \beta_2 \ln Y_j + \beta_3 \ln D_{ij} + U_{ij}$$

Denoted that M_{ij} = Imports of country i from country j.

G = Constant

Y_i = Gross Domestic Product of importing country

Y_j = Gross Domestic Product of exporting country

D_{ij} = Distance between importing and exporting country

U_{ij} = Error term

Where β 's = Coefficients

The Gravity Model hypothesized relationship of the coefficients that β_1 and β_2 are expected to be positively related with the import of country i from country j, while β_3 is expected to be negatively related. In this model, the distance between importing and exporting country is actually a proxy for the trade costs, which blocks bilateral trade.

Other variables that capture trade costs can be added to this basic equation along with other explanatory variables.

- Ordinary Least Square Regression (OLS)

The method of estimation, commonly named linear regression, is a method for estimating unknown parameters and coefficient of the relationships expressing in the model. This method corresponds to minimize the sum of square differences between the observed and predicted values. The technique may be applied to single or multiple explanations of variables and also categorical explanation of variables. OLS is used in the fields as economics (econometrics), political science, psychology, and electrical engineering.

$$\text{OLS regression function: } Y_i = \alpha + \beta * X_i + U_i$$

Where Y_i = Dependent variable

α = Intercept of the model

β = Coefficient

X_i = Corresponds to i explanatory variable of the model

U_i = the random error with the expectation 0 and variance σ^2

With more explanatory variables of the model, the OLS regression function will be:

$$Y_i = \alpha + \beta_1 * X_1 + \beta_2 * X_2 + \dots + \beta_n * X_n + U_i$$

Note that: n is the independent variables and slope for each.

ii) Specification Model

This paper studies about Thailand rubber export to the United States and the base model is the Gravity Model. To make sure that the extension of the additional variables expected to be the determinants of the effect to Thai rubber export will be done in the theoretical base properly, this research needed to begin with checking the model that adjusted to the concern of the study.

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + U_{ij} \quad (1)$$

Where R_{ij} = Trade volume of Thailand rubber export to US (USD Million)

Y_{TH} = Gross Domestic Product of Thailand (USD Million)

Y_{US} = Gross Domestic Product of US (USD Million)

D = Distance between the capital city of Thailand and US,
Bangkok to Washington D.C. (km.)

Extension of the Model¹:

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{exrate} + U_{ij} \quad (2)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{USpfuel} + U_{ij} \quad (3)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{THpfuel} + \beta_5 \ln \text{THcpi} + U_{ij} \quad (4)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{USpfuel} + \beta_5 \ln \text{GDPvaRubMus} + U_{ij} \quad (5)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{THpfuel} + \beta_5 \ln \text{GDPvaRubMus} + U_{ij} \quad (6)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{USpfuel} + \beta_5 \ln \text{QrubXus} + U_{ij} \quad (7)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{THpfuel} + \beta_5 \ln \text{QrubXus} + U_{ij} \quad (8)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{GDPvaRubMus} + \beta_5 \ln \text{QrubXus} + U_{ij} \quad (9)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \text{GDPvaRubMus} + \beta_5 \ln \text{QrubXus} + \beta_6 \ln \text{exrate} + U_{ij} \quad (10)$$

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln D + \beta_3 \ln \text{GDPvaRubMus} + \beta_4 \ln \text{QrubXus} + \beta_5 \ln \text{exrate} + U_{ij} \quad (11)$$

(For Expected sign of additional variable in Table 2; Appendix 2)

¹ The potential variables that expected to have the effect on the rubber trade volume of Thailand export to US came from Chaiyanatekraisin (2008), Sang-Ngam (1995) and, Doner and Abonyi (2013).

iv) Result Analysis

(Summary of the OLS regression, Table 5; Appendix 2)

The regression results from the data from 1996 to 2015, which are presented in the Table 1. This paper has the sample size of 80, quarterly data with the bilateral trade test between Thailand and the United States. The exogenous variables chosen in this experiment are Thailand GDP, US GDP, distance between capital city of Thailand and the United States (Bangkok to Washington DC), Thailand exchange rate per US Dollar, Thailand Consumer Price Index, price of fuel oil in Thailand, price of fuel oil in US, GDP value added of rubber export to US, and quantity of rubber export to the US. In the models, independent variables will significant in different aspects. From the models in Methodology part, there are 3 models that have significant independent variables, including based model, which can explain the effect of Thailand rubber export trade volume.

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + U_{ij} \quad (1)$$

As the based Gravity Model, the dependent variable, which is Thailand rubber export to the US (USD Million), and the independent variables; Thailand GDP, US GDP and the distance, are significant with R-squared at 91.14 per cent. The coefficient of Thailand GDP equals to 0.74, the coefficient of US GDP equals to 2.23, and the coefficient of the distance is omitted. Thus, these two variables are statistically significant with positive coefficient. The result showed in Table 6; Appendix 2.

By adding other variables extended from the based Gravity Model that expected to be the determinants of the rubber bilateral trade between Thailand and the US, there are 2 equations whose addition variables are significant.

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln Y_{US} + \beta_3 \ln D + \beta_4 \ln \underline{USpfuel} + U_{ij} \quad (3)$$

From the based Gravity Model, this regression added one variable, which is the fuel oil price from the US that statistically significant to explain the effect to the trade between Thailand rubber exports to the US. The implication is that 1 per cent change in the US fuel oil price will increase the trade volume of the rubber exports to US by 0.26 per cent. The increase in the US fuel oil price, which is raw material for rubber, raises the cost of production for the US. Therefore, the US would choose to import from Thailand causing amount of import to be higher. This equation can better explain Thailand rubber export volume than the based model with R-Squared equals to 92.50 per cent, which the result showed in Table 7; Appendix 2.

The relationship between rubber and crude oil has strong effect on each other since crude oil is one of the major raw materials for synthetic rubber production. (The impact of the changes of the World crude oil prices on the natural rubber industry in Malaysia, 2013).

The price of the rubber in global market is closely connected with crude oil prices because the synthetic rubber, which consumed more than natural rubber in global market, is produced from crude oil as a substitution for natural rubber. If the crude oil price improves, the price of synthetic rubber will boost up and consumers might not use the synthetic rubber, which will shift consumers to employ natural rubber instead. The plunge of the crude oil prices in the global market will push down the prices of natural rubber and make the natural rubber production sector in Thailand even worse, vice versa. (Fall in crude oil prices likely to deepen natural rubber crisis in India, n.d.), (Sadali, n.d.). It can be concluded that the performance of the natural rubber export also depends on the movements in oil prices.

$$\ln R_{ij} = \beta_0 + \beta_1 \ln Y_{TH} + \beta_2 \ln D + \beta_3 \ln \underline{GDPvaRubMus} + \beta_4 \ln \underline{QrubXus} + \beta_5 \ln \underline{exrate} + U_{ij} \quad (11)$$

In this model, three variables are added and the result is that these variables have significant level of 0.05, which better explain the effect of Thailand rubber trade volume of export than the based model showed by higher R-Squared of 94.62 per cent. The first exogenous variable added is the GDP value-added of rubber import of US with the co-efficient of 0.168. The implication is that 1 per cent change in the GDP value-added of the rubber import of the US will increase the trade volume of the rubber exports to the US by 0.168 per cent. Higher GDP value-added induces more incentives to Thai firms to export more to the US, or increases demand for high value-added rubbers from Thailand by the US. The second exogenous variable that has been added is Thailand rubber quantity export in the US with the coefficient of 0.21. The interpretation is that 1 per cent change in the quantity of Thai rubber export to the US will increase the trade volume of the rubber export to the US by 0.21 per cent. In other words, higher trade volume of the rubber leads to higher trade value. The last variable that added into this model is Thailand exchange rate per US Dollars with the coefficient of 1.31. It denotes that 1 per cent of change in Thailand exchange rate per USD will increased the trade volume of Thailand rubber export to the US by 1.31 per cent. The depreciation of Thai Baht causes Thai rubber relatively cheaper, so the trade value between Thailand and the US will be higher. (The regression result showed in Table 9; Appendix 2.)

In addition, after three variables are added, the US GDP is not statistically significant at 5% confident level and is considered as redundant in the new model. Hence, we dropped the variable for the model's parsimony. These three exogenous variables are statistically significant with the positive coefficient and can explain the effect of the trade volume of Thailand rubber export to the United States.

V) Policy Recommendations

Nowadays, the rubber production in Thailand might not grow as quickly as in the past due to the falling of rubber price. The government should impose more policies to support this sector because Thailand has competitive advantage in producing natural rubber. Government should support in:

Research and Development(R&D) in rubber cultivation and harvesting and introduce knowledge to farmers in order to improve output efficiency and quality of rubber products by encouraging farmers to plant modern high yield varieties to reduce production cost. It will increase their ability to compete with the other major rubber producing countries.

Government should also assist more in downstream productions to increase the demand in domestic rubber consumption by *promoting an investment on rubber products factories*. It will help preventing the oversupply of the rubber products and add value to natural rubber products.

As the rubber price in 2016 is expected to track global slowing economy. Nevertheless, this crisis can turn to be an opportunity to make profit. Consequently, government should try to attract FDI to Thailand tire industry that will raise usage of rubber in huge quantities, reduce dependence of external market and increase bargaining power of the price of the rubber.

Provide more of the *commodity exchange* for rubber market to reduce instability of the price of rubber in the future because most of the rubber farmers sell rubber through middlemen, which offer lower price than the other markets.

Thailand is one of the leaders in exporting natural rubber of the world and has high potential in competition. Hence, Thailand needs to adjust the structure of the rubber production to suit with the world's rubber situation. Government can promote rubber industry through business matching activities, which will boost rubber industry and build strong relationship with foreign potential trade partners. Supporting technological research that produce the highest quality of rubber to meet the market demand and establishing the center of production will help Thai rubber industry expand around the world.

vi) Conclusion

From the OLS regression, the factors that affect Thailand's trade volume of export to the United States are the US fuel oil price, Thailand exchange rate per US Dollar, GDP value-added of rubber import of the US, and the quantity of Thailand rubber export to the US. All exogenous variables are 5% level of significant with positive coefficient. So, these variables showed significant and positive relationship with the rubber trade volume. The results also imply that the movement of the US fuel oil price effecting trade volume of rubber export dramatically as the synthetic rubber is produced from crude oil as a substitution for natural rubber. When taking the production of the rubber into account, the issue of the crude oil needs to be considered as well and the price effect of these two issues will go along together in the same direction.

On the other hand, there are some additional variables that cannot be explained of do not have the effect on the Thailand trade volume of rubber export to the United States; Thailand consumer price index (TH CPI), and Thailand fuel oil price. They will not be analyzed in these implications. Government should launch the policies to boost and develop Thailand's rubber industry to compete with other rubber producing countries since Thailand still has competitive advantage to be the world's rubber exporter. Preparing to adjust Thailand's rubber production in accordance with the current or future situation of the rubber market will benefit Thai economy as a whole.

vii) Suggestions for further research

1. This research does not include other factors such as political situation, weather, financial crisis, etc. in consideration, especially the issue of Thailand rubber price. These factors may affect the change of the trade volume of Thailand export rubber to the US. If this study concludes those factors mentioned above for further research, it will be more thoroughly and more factors that would affect the rubber trade volume of Thailand export will be found.
2. From the methodology that used Ordinary Least Square regression to find the factors that affect Thailand rubber export to the US that did not test for the robustness check so, for further study, should do the robustness check to help diagnose misspecification of the data and due with non-normality and heterogeneity. Finding that the coefficients don't change much is taken to be evidence that these coefficients are "robust."
3. There is no trade agreement for rubber issue between Thailand and the US specifically. Thus, in the future, government should promote this industry by raising the issue with trading partners to see whether this issue can form trade agreement or not since Thailand rubber market is one of the leading export that should be encourage.
4. Due to the limitation of time and data, we could develop the model from the current available data. If further studies have more approachable information, this model should be tested repeatedly or use different methodology to compare the results. While collecting the data, researchers should avoid the data errors and find more accurate one with reliable sources to estimate for the systematic results.
5. This study does not concern about demand and supply for rubber in both export and import countries. To make the model be more specified, researchers should include the demand and supply response for rubber.

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Appendix 1: Figures

Figure 1: Thailand total export in 2014 from OEC

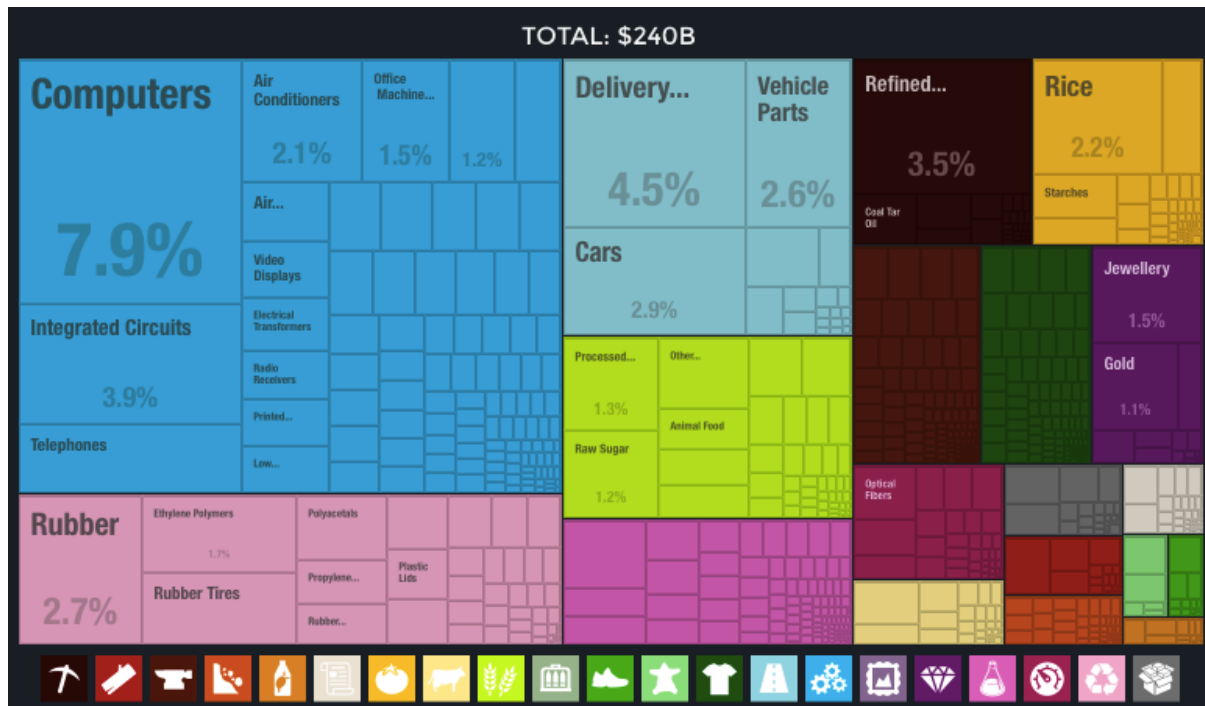


Figure 2: Top ten countries that Thailand exported rubber and articles thereof in 2015 from Trademap

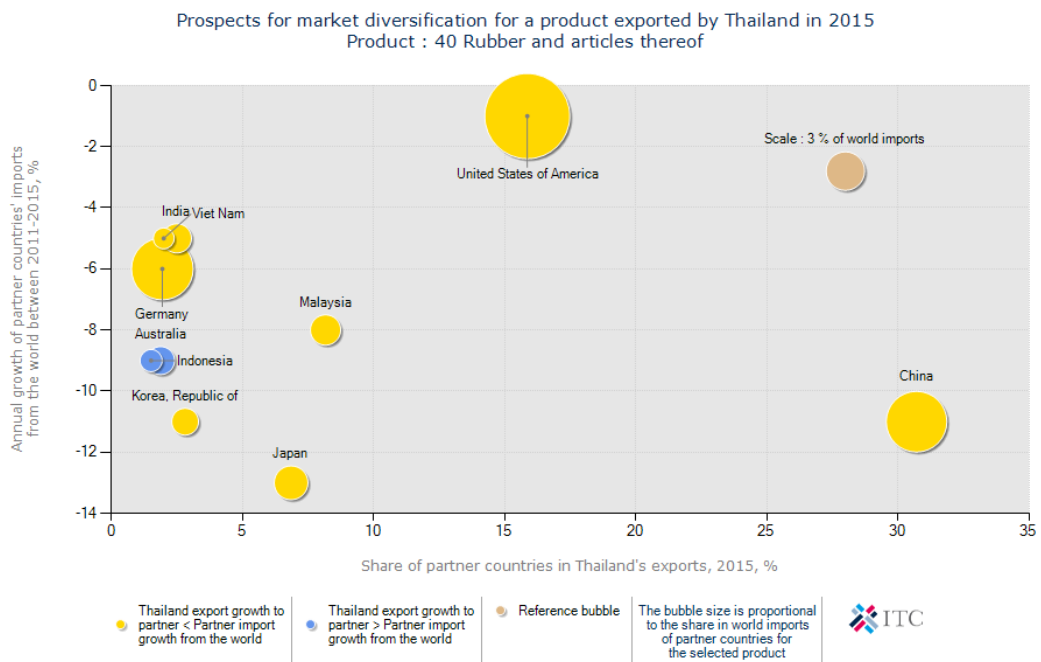


Figure3: Thailand rubber importer in 1996 from OEC

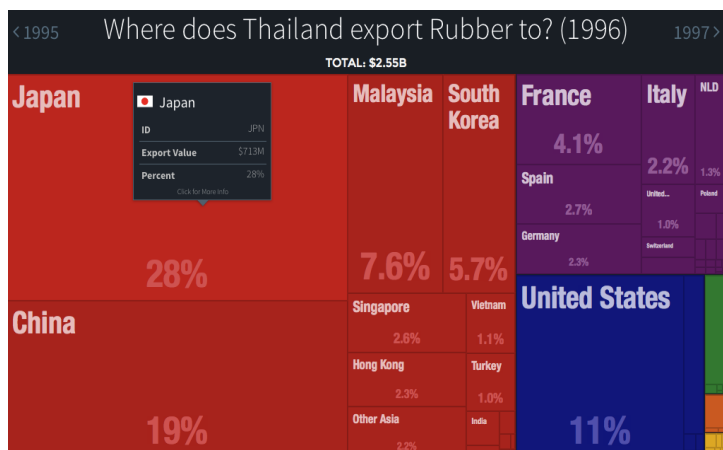
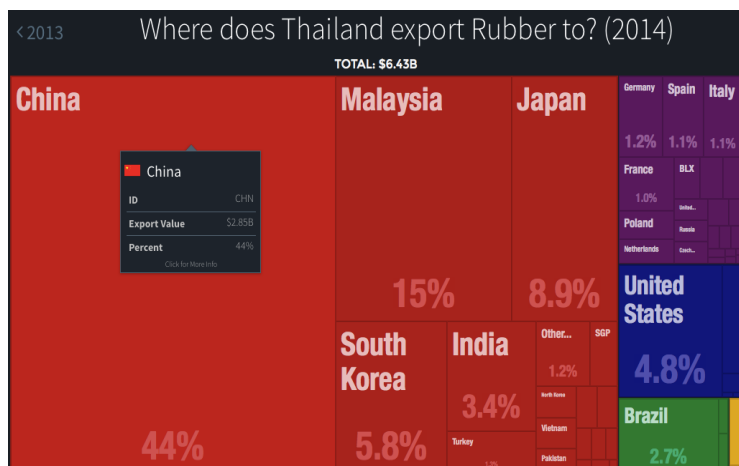


Figure4: Thailand rubber importer in 2014 from OEC



Appendix 2: Tables

Table 2: Description of variables using in the model and the predicted sign

Variables	Description	Predicted sign
R _{ij}	Trade volume of rubber export to US	+
Y _{TH}	Thailand GDP	+
Y _{US}	US GDP	+
D	Distance between Bangkok and Washington D.C.	0
Exrate	Thailand exchange rate	-
THcpi	Thailand Consumer Price Index (Inflation)	+/-
THpfuel	Thailand fuel oil price	-
USpfuel	US fuel oil price	+
GDPvaRubMus	GDP value added of rubber import of US	+/-
QrubXus	Thailand Rubber quantity export to US	+/-

Table 3: Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
LnR	80	4.435595	0.6194609	3.407729	5.532584
lnYth	80	10.91487	0.4643565	10.1922	11.61773
lnYus	80	16.43464	0.1236763	16.15237	16.61831
lnD	80	9.557823	0	9.557823	9.557823
lnexrate	80	3.563599	0.1559628	3.200072	3.812497
lnTHcpi	80	0.9205469	0.2476607	0.4968061	1.303411
lnTHpFuel	80	-0.9549292	0.6504289	-1.916963	-0.004688
lnUSpFuel	80	3.794607	0.6885276	2.342767	4.879159
lnGDPvaRubMus	80	4.831821	0.586571	3.552773	6.097769
lnQrubXus	80	6.804445	0.7305984	5.4349	8.18564

Table 4 : Cross-Correlation

	lnR	lnYth	lnYus	lnD	lnexrate	lnTHcpi	lnUSpFuel	lnTHpFuel	lnGDPvaRub	lnQrubXus
lnR	1									
lnYth	0.9199	1								
lnYus	0.8997	0.8186	1							
lnD						
lnexrate	-0.3885	-0.6369	-0.1074	.	1					
lnTHcpi	0.8344	0.9679	0.6728	.	-0.7918	1				
lnUSpFuel	0.9182	0.8722	0.8674	.	-0.387	0.7953	1			
lnTHpFuel	0.9572	0.9461	0.9061	.	-0.4362	0.8753	0.9584	1		
lnGDPvaRub	0.8062	0.7881	0.592	.	-0.5781	0.7772	0.776	0.7876	1	
lnQrubXus	0.9283	0.9119	0.7883	.	-0.5256	0.8516	0.9129	0.9265	0.9065	1

Table 5: The factors affecting Thailand rubber export to US

	(1)	(2)	(3)	(4)	(5)	(6)
	LnR	LnR	LnR	LnR	LnR	LnR
lnYth	0.742***	1.141***	0.556***	0.875*	0.362***	0.240*
	-9.42	-4.02	-6.27	-2.32	-4.14	-2.03
lnYus	2.226***	1.095	1.564***	0.372	2.151***	1.918***
	-7.52	-1.32	-4.78	-0.62	-6.9	-5.11
lnD	0	0	0	0	0	0
lnexrate		0.714				
		-1.46				
lnUSpFuel			0.256***		0.106	
			-3.71		-1.55	
lnTHpFuel				0.564***		0.239
				-4.3		-1.87
lnTHcpi				-0.923		
				(-1.64)		
lnGDPvaRub~s					0.261***	0.254***
					-4.85	-4.75
_cons	-40.24***	-28.56**	-28.30***	-9.837	-36.53***	30.70***
	(-9.61)	(-3.17)	(-5.61)	(-1.20)	(-7.71)	(-4.53)
r2	0.91142	0.91384	0.92498	0.92929	0.9429	0.94369

	(7)	(8)	(9)	(10)	(11)
	LnR	LnR	LnR	LnR	LnR
lnYth	0.274**	0.169	0.283**	0.714**	1.042***
	-2.79	-1.4	-2.95	-2.99	-9.74
lnYus	1.858***	1.580***	2.180***	1.001	
	-6.3	-4.51	-8.22	-1.53	
lnD	0	0	0	0	0
lnexrate				0.764	1.309***
				-1.97	-8.39
lnUSpFuel	0.0424				
	-0.56				
lnTHpFuel		0.194			
		-1.47			
lnQrubXus	0.344***	0.318***	0.219*	0.199*	0.208*
	-4.76	-4.77	-2.36	-2.16	-2.25
lnGDPvaRub~s			0.155*	0.174*	0.168*
			-2.02	-2.29	-2.19
_cons	-31.59***	-25.35***	-36.72***	-24.73**	-13.83***
	(-7.02)	(-3.98)	(-9.31)	(-3.42)	(-11.00)
r2	0.94239	0.94377	0.94514	0.94787	0.94621

legend: * p<.1; ** p<.05; *** p<.01

Table 6: Regression output of the based Model

Source	SS	df	MS	Number of obs	=	80
				F(2, 77)	=	396.13
Model	27.6295201	2	13.8147601	Prob > F	=	0
Residual	2.68529387	77	0.034873946	R-squared	=	0.9114
				Adj R-squared	=	0.9091
Total	30.314814	79	0.383731823	Root MSE	=	0.18675
LnR	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
lnYth	0.741992	0.0787807	9.42	0	0.5851195	0.8988645
lnYus	2.22552	0.2957912	7.52	0	1.636524	2.814515
lnD	0	(omitted)				
_cons	-40.23877	4.186589	-9.61	0	-48.57534	-31.90221

Table 7: Regression output for the equation 3 in model expansion

Source	SS	df	MS	Number of obs	=	80
				F(3, 76)	=	312.36
Model	28.0406509	3	9.34688362	Prob > F	=	0
Residual	2.27416313	76	0.029923199	R-squared	=	0.925
				Adj R-squared	=	0.922
Total	30.314814	79	0.383731823	Root MSE	=	0.17298
LnR	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
lnYth	0.5556989	0.0886074	6.27	0	0.379222	0.7321758
lnYus	1.563787	0.327021	4.78	0	0.9124679	2.215105
lnD	0	(omitted)				
lnUSpFuel	0.2556207	0.068962	3.71	0	0.1182709	0.3929706
_cons	-28.30004	5.041156	-5.61	0	-38.34038	-18.25971

Table 8: Regression output for the equation 10 in model expansion

Source	SS	df	MS	Number of obs	=	80
				F(5, 74)	=	269.11
Model	28.7345321	5	5.74690641	Prob > F	=	0
Residual	1.58028192	74	0.021355161	R-squared	=	0.9479
				Adj R-squared	=	0.9443
Total	30.314814	79	0.383731823	Root MSE	=	0.14613
LnR	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
lnYth	0.7139118	0.2386954	2.99	0.004	0.2383008	1.189523
lnYus	1.001364	0.6537173	1.53	0.13	-0.301196	2.303924
lnD	0	(omitted)				
lnQrubXus	0.1986552	0.0918461	2.16	0.034	0.0156479	0.3816626
lnGDPvaRubMus	0.1740709	0.0760091	2.29	0.025	0.0226195	0.3255223
lnexrate	0.7636349	0.3884236	1.97	0.053	-0.010316	1.537586
_cons	-24.72783	7.225164	-3.42	0.001	-39.12428	-10.33138

Table 9: Regression output for the equation 11 in model expansion

Source	SS	df	MS	Number of obs	=	80
				F(4, 75)	=	329.88
Model	28.6844241	4	7.17110602	Prob > F	=	0
Residual	1.63038991	75	0.021738532	R-squared	=	0.9462
				Adj R-squared	=	0.9433
Total	30.314814	79	0.383731823	Root MSE	=	0.14744
LnR	Coef.	Std. Err.	t	P>t	[95% Conf.	Interval]
lnYth	1.041511	0.1069516	9.74	0	0.8284529	1.25457
lnD	0	(omitted)				
lnGDPvaRubMus	0.1676825	0.0765728	2.19	0.032	0.0151417	0.3202233
lnQrubXus	0.20829	0.0924493	2.25	0.027	0.0241215	0.3924585
lnexrate	1.309388	0.1560944	8.39	0	0.9984323	1.620344
_cons	-13.82601	1.256655	-11	0	-16.3294	-11.32263