ANALYSIS OF INDONESIAN NATURAL RUBBER EXPORT USING ROBUST S-ESTIMATOR FOR FIXED EFFECTS PANEL DATA MODEL

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Abstract

Indonesia is the second largest producer and exporter of natural rubber in the world after Thailand. In recent years, world's demand for natural rubber has been increasing because the automotive industry in the world has increased so that natural rubber exports in Indonesia also increased. This study aims to determine the development of Indonesian exports natural rubber to five largest importer countries, which are the United States, Japan, China, South Korea, and India. The method used in this research is robust S-estimator regression. Based on the fixed effect model using robust S-Estimator regression, real GDP is significantly positive effect while the economic distance is significantly negative effect to export volume of Indonesian natural rubber. The recommendations for the government are making an improvement for producing TSNR SIR natural rubber and changing the export of primary forms into semi-finished or finished natural rubber products, so more value added will be gained. The e-commerce application system should be developed for natural rubber farmers in upstream and downstream industries. This application should provide facilities to distribute natural rubber products without intermediaries from the seller to the buyer, so it will cut the long chain of sales.

Keywords: International Trade, Natural Rubber, Robust Regression, S-Estimator

JEL Classification: C230, F1, Q17

INTRODUCTION

Indonesia is one of agricultural country in the world and most of Indonesian citizens work in agricultural sector. Data from Badan Pusat Statistik (BPS) (2016) shows that 32.99 million ha of agricultural land in Indonesia were ready to plant. BPS (2017) also shows that 35.9 million or about 29.68 percent 15 years above of Indonesian citizens worked in the agricultural, plantation, forestry, and fishery sector.

Agricultural, plantation, forestry, and fishery are important sectors for economics activity in Indonesia. Those sectors are the third largest contributors of GDP after manufacturing industry sector and the wholesale and retail trade sector, exclude cars and motorbikes. Data from BPS (2012) shows that agricultural, forestry, hunting, and fishery contribute to GDP by 12.68 percent.

Agricultural, farming, hunting, and agricultural services subsectors are important subsectors in agricultural, forestry, and fishery sectors. In agricultural, forestry, and fishery

sectors, the largest share is contributed by agricultural, farming, hunting, and agricultural services subsectors. Data from BPS (2017) shows that 77,4 percent total GDP from agricultural, forestry, and fishery sectors are contributed by agricultural, farming, hunting, and agricultural services subsectors.

Plantation crops sub-sub sectors is one of important sectors from agricultural, farming, hunting, and agricultural services subsector. On agricultural, farming, hunting, and agricultural services subsectors, the largest contributor is plantation crops. And 38,06 percent from total GDP of agricultural, farming, hunting, and agricultural services subsector is contributed by plantation crops.

The largest plantation crops production in Indonesia are palm oil, sugar cane, coconut, and rubber. Meanwhile, rubber production in Indonesia is the fourth largest from the other crops, but the rubber export is the second largest. Thus, the rubber export in one of the largest contributor on Indonesian economies.

The world demand of rubber is getting improve because the growth of automotive industry is more increasing, especially in the largest automotive country, such as United States, Japan, China, South Korea, and India. Rubber is raw materials for producing tire in automotive industry. Budiman (2004) suggested that world demand of natural rubber and synthetic rubber will continue to increase due to the development of the automotive and tire industries.

Export priority in Indonesia has been started since 1983 (Basri, 2002). According to Dumairy (1996), since 1998, main source of foreign exchange earnings rests on non-oil and gas export revenues. To fulfill the world demand, Indonesia has been exporting rubber to automotive industry countries, such as United States, Japan, China, South Korea and India. Data from BPS (2017), around 83.42 percent of the total Indonesian rubber production is exported abroad, the rest is used to fulfill domestic needs.

World rubber production is divided into two types, natural rubber and synthetic rubber. World synthetic rubber production is more than natural rubber. Even that, the utility of natural rubber cannot be replaced with synthetic rubber because natural rubber is needed as a raw material for tire manufacturing in the automotive industry. Currently around

70 percent of the world's natural rubber production is used to make tires while the rest is used as raw material in other products.

The five largest natural rubber producing and exporting countries in the world are the regions that have a tropical climate. Based on data from the BPS (2017), the five largest natural rubber producing countries in the world are Thailand, Indonesia, Vietnam, India and Malaysia. The world's largest rubber producing countries are also the world's largest natural rubber exporters.

BPS (2016) states that Indonesian natural rubber export volume since 2013 has continued to decline even though in every year, natural rubber production in Indonesia has increased. Data from the trade map in 2016 states that the increase of Indonesian natural rubber export volume to Japan, China, South Korea and India in 2016 each was 6.2 million tons, 13.43 million tons, 6.45 million tons, and 26.35 million tons. Thus the demand of Japan, China, South Korea and India to Indonesian natural rubber remained high, although Indonesian natural rubber total export volume continued to decline in 2013.

Indonesian export is affected by the real income of the importing country and the real Indonesian currency exchange rate against the importing country. According to Batiz Fransisco and Luis A. Reivera Batiz (1994), the higher real income of the importing country, the higher demand for Indonesian exports. However, the increase of real rupiah exchange rate against the importing country will decrease Indonesian export. This is because the increase of rupiah exchange rate causes foreign currencies to be cheaper so that they tend to import rather than export.

Robust regression S-Estimator is an analysis method used when there are outliers in a continuous data and has a high breakdown point up to 50 percent. The existence of outliers cannot be immediately removed from observation. Draper and Smith (1992) state that outliers can provide unusual information by other data points. This is because outliers arise from a combination of unusual circumstances which may be very important for further investigation.

LITERATURE REVIEW

According to Zhang, et al. (2017), factors influencing China's iron exports to destination countries are GDP, resources, trade openness, port

development levels, polical risk, exchange rates, electricity consumption, and transportation systems. Research conducted by Zhang, et al. (2017) states that using the gravity model method shows that the factors influencing China's LNG exports are importer's GDP, importer's natural gas production, importer's gas pipeline volume, natural gas import prices, the proportion of the main consumption of gas in the importing country, distance, language and political risk. Mirawati, et al. (2016) in his research on natural rubber exports stated that the factors that affect Indonesian natural rubber exports include population and exchange rates. Bramati & Croux (2002) in their research using the robust fixed effects panel data method by comparing WGM-Estimator and WMS-Estimator. Based on the description above, the research aims to study the development of Indonesian natural rubber exports and the determinant of Indonesian natural rubber exports to the five largest importers of Indonesian natural rubber.

METHODS

This research using panel data analysis with 5 cross-sectional units (United States, Japan, China, South Korea and India) and 17 of time series units. Data used in this research are:

1. Real Gross Domestic Product (GDP) of importer countries from The World Bank
2. Economic distance, the formula is $ED_{ijt} = \frac{Distance_{ij} \, x \, GDP_{it}}{GDP_{jt}}$, where i refers to importer countries, and j refers to exporter county (Indonesia). Distance data is generated from http://distancefromto.net/.
3. Real Effective Exchange Rate (REER), the formula is $REER_t = \prod[\frac{(CUR_{it}/CUR_{jt})}{(CUR_{i0}/CUR_{j0})}]^{w_t} \times [\frac{(P_j/P_i)_t}{(P_j/P_i)_0}]^{w_i}$ where CUR is currency, P is consumers price index, and w is weight. Weight (w) that used to calculate REER is based on the proportion of the value of exports and imports from the importer country to the exporting country. Currency is from the International Monetary Fund (IMF), and consumers price index is from The World Bank.
4. Population of importing countries from The World Bank.
5. Indonesian natural rubber export volume with HS codes 4001 from The World Bank.

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ROBUST S-ESTIMATOR

Robust regression can be used if there are outliers in the data. Outliers make OLS estimation producing bias conclusions. Therefore, we can use robust regression as the alternative method.

According to Chen (2002), there are five parameter estimation procedures in robust regression, one of which is S-Estimator. S-Estimator can be used to analyze the presence of bad observation in the data so the method can be used to distinguish the existence of bad leverage points and good leverage points. S-Estimator is an estimator that has a high breakdown point, which can be used to estimate the standard deviation of residual (s) (Chen, 2002). High breakdown point is a general measure of proportion of an outlier data that can be handled before the observation affects the prediction model. The form of S-Estimator is:

$$\hat{\beta}_S = min_\beta s(r_1, r_2, \dots, r_n)$$

According to Salibian & Yohai (2006), the minimum robust (s) scale estimator value, following this equation:

$$\hat{\beta}_S = \min \sum_{i=1}^{n} \rho \left(\frac{y_i - \sum_{j=0}^{k} x_{ij}\beta}{s}\right) \quad (1)$$

In the equation, the solution can be found by finding the derivative of β so that the following results can be obtained:

$$\hat{\beta}_S = \sum_{i=1}^{n} \rho'\left(\frac{y_i - \sum_{j=0}^{k} x_{ij}\beta}{s}\right) = 0 \text{ , } j = 0, \dots k$$

$$\frac{\partial \hat{\beta}_S}{\partial \beta} = \sum_{i=1}^{n} x_{ij}\, \psi\left(\frac{y_i - \sum_{j=0}^{k} x_{ij}\beta}{s}\right) = 0, \; j = 0, \dots k \quad (2)$$

Tukey (1977) states that ψ is called the function of influence which is a derivative of ρ (ρ '= ψ), so that the derivative of the function ρ is:

$$\rho'(u_i) = \begin{cases} u_i \left(1 - \left(\frac{u_i}{c}\right)^2\right)^2 & , |u_i| \le c \\ 0 & , |u_i| > c \end{cases}$$

In Eq. (2) it can be solved through the Weighted Ordinary Least Square method (Weighted OLS) which is done iteratively so that it is called the Iterative Reweighted Least Square (IRLS). The initial portion used by the S-Estimator is the rest obtained from M-Estimator.

Furthermore, it is said that IRLS is an estimation process that is used through weighted OLS methods and then carried out by calculating the new residual and weighting w(ui) and carried out repeatedly until it reaches convergent conditions. Convergence is achieved if the absolute number of changes is made $\sum_{i=1}^{n} |\varepsilon_{i:m}|$, from the last iteration to the next iteration is less than 0.01 (Salibian & Yohai, 2006).

So that the formula w_i which is weighting of IRLS function is:

$$w_i(u_i) = \frac{\psi(u_i)}{u_i} =$$

$$\begin{cases} \frac{u_i(1-(\frac{u_i}{c})^2)^2}{u_i} & ,|u_i| \le c \\ 0 & ,|u_i| > c \end{cases}$$

$$w_i(u_i) = \begin{cases} [1-(\frac{u_i}{c})^2]^2 & ,|u_i| \le c \\ 0 & ,|u_i| > c \end{cases}$$

with $u_i = \frac{r_i}{s}$ and c = 1,547. The c value is suggested at 1.547 in order to get a breakdown point of 50% (Rousseeuw & Leory, 1987).

According Salibian and Yohai (2006), the steps in determining the robust S-Estimator regression are as follows:

a. Calculates the β parameter using the OLS method
b. Calculate the residual value of $r_i = y_i - \hat{y}_i$
c. Calculate the value of s

$$s = \begin{cases} \frac{median|e_i - median(e_i)|}{0{,}6745}, iterasi = 1 \\ \sqrt{\frac{1}{nK}\sum_{i=1}^{n} w_i e_i^2} \quad , iterasi > 1 \end{cases}$$

with K= 0,199

d. Calculate the value of $u_i = \frac{r_i}{s}$
e. Calculate weighting

$$w_i = \begin{cases} [1-(\frac{u_i}{1{,}547})^2]^2 & ,|u_i| \le 1{,}547 \\ 0 & ,|u_i| > 1{,}547 \end{cases}$$

f. Calculate the parameter $\hat{\beta}_S$ by the WLS method with the weight w_i
g. Repeat the steps from b to g to gain converging $\hat{\beta}_S$ values.
h. Test the hypothesis to find out whether the independent variable has a significant influence on the dependent variable.

The robust S-Estimator fixed effects model for panel data is:

$$EXP_{it} = \alpha_i + \beta_1 GDP_{it} + \beta_2 ED_{it} + \beta_3 REER_{it} + \beta_4 POP_{it} + \varepsilon_{it}$$

where EXP_{it} is Indonesian natural rubber export volume, PDB_{it} is real GDP of import countries, ED_{it} is economic distance, $REER_{it}$ is real effective exchange rate, POP_{it} is population of import countries, α_i is constant, β is slope, and ε_{it} is error terms.

RESULTS AND DISCUSSION

Indonesian Natural Rubber Production

From 2000 to 2016, Indonesia is the second largest natural rubber producer after Thailand. Natural rubber productions in Thailand, Indonesia and India tend to increase year by year. Whereas in Malaysia the productions tend to decrease.

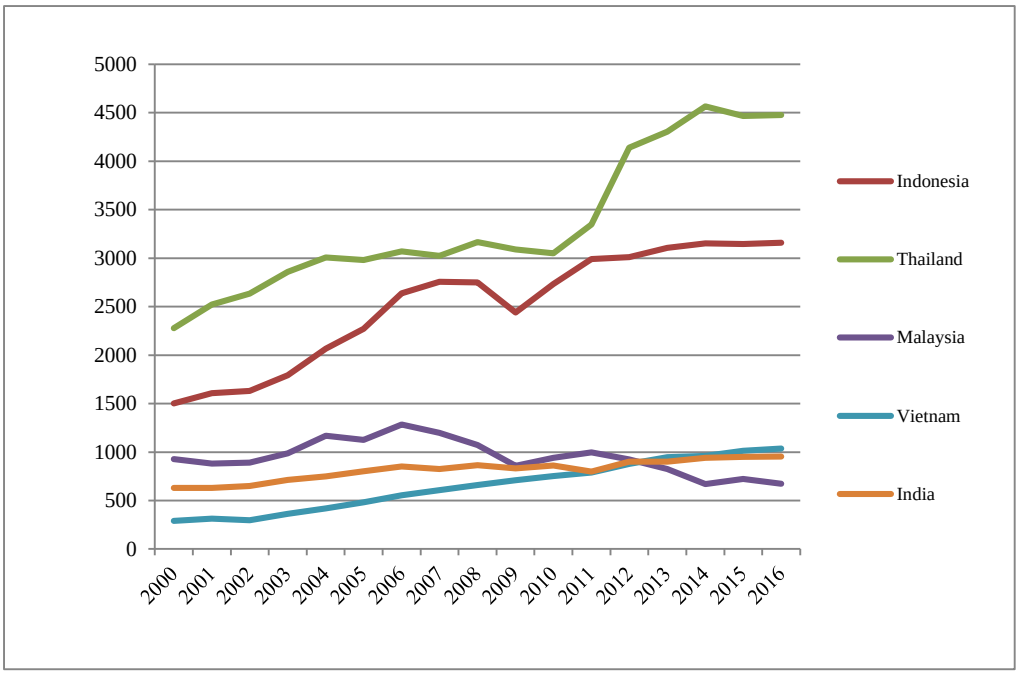

Figure 1. Natural Rubber Production in Five Largest Exporter Countries (000 tons)

Source: Food and Agricultural Organization (2018)

In 2009, there was a decline in natural rubber production because of the global crisis. The decline happened in Thailand, Indonesia and Malaysia. The global crisis caused the costs of natural rubber production became more expensive, it had an impact of decreasing of total production.

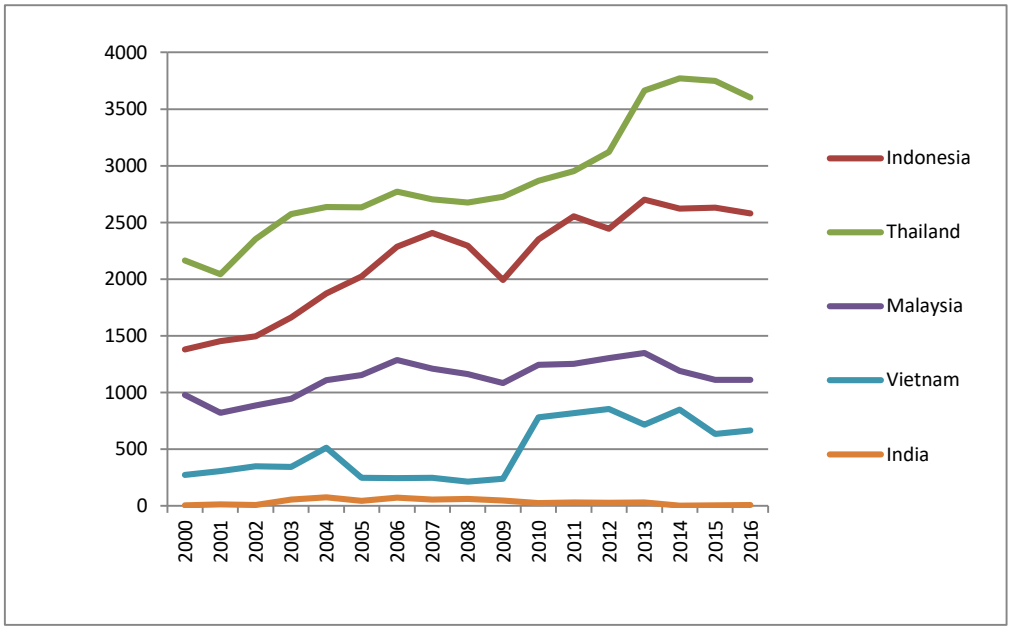

Figure 2. Natural Rubber Export Volume in 5 Largest Exporter Countries (000 tons)

Source: Trade Map (2018)

Indonesian Natural Rubber Export

Based on Figure 2, Indonesia is the second largest natural rubber exporter in the world. Indonesian natural rubber export volume from 2000 to 2016 generally tends to increase. In 2007 was the starting point for the decline of the natural rubber exports volume and 2009 is the peak of the decline that caused by the global crisis at 2008, where the total export volume was 1.9 million tons.

Then in 2012 there was also a decline of Indonesian natural rubber export volume. It was because Thailand, Indonesia, and Malaysia as members of The International Tripartite Rubber Council (ITRC), did export restrictions in 2012 to 2016 to protect the natural rubber price which continued to decline. With this policy, it caused a decrease not only for Indonesian natural rubber exports volume but also Thailand and Malaysia. The highest natural rubber export in Indonesia occurred in 2013, where total exports reached 3.7 million tons.

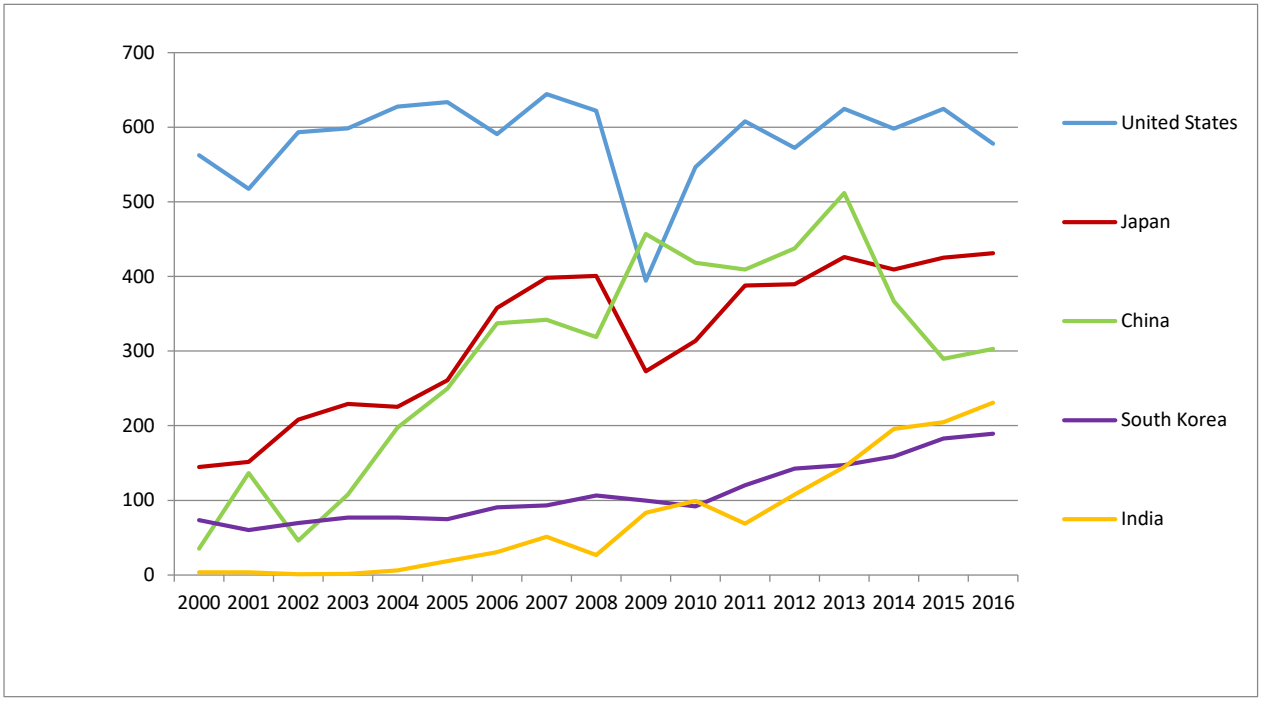

Figure 3. Natural Rubber Export Volume to 5 Largest Importer Countries (000 tons)

Source: Trade Map (2018)

Based on Figure 3, Indonesia exported natural rubber to five main destination countries, United States, China, Japan, India and South Korea. In Japan and China, there were position changes in the period 2000-2009 and

2009-2015. In 2000-2009, Japan became Indonesian second largest natural rubber importer after the United States and China in the third position. The global crisis that occurred throughout the world caused a decline in Indonesian export volume to the United States, Japan and South Korea.

However, after 2009, the United States, Japan and South Korea managed to rise from the effects caused by the global crisis in 2008 so the volume of Indonesian natural rubber exports to these countries rose further.

The global crisis that occurred throughout the world did not cause a decrease in the volume of Indonesian natural rubber exports to China and India. But after the global crisis in 2009, Indonesian natural rubber export volume to China tended to decline. The decline in the volume of natural rubber exports to China did not change China's position as the second largest of Indonesian natural rubber importer until 2013.

Based on the figure in Appendix 1, it can be concluded that Indonesia is the largest exporter of TSNR SIR-type natural rubber, while for RSS and latex are dominated by Thailand. All of natural rubber exported by Indonesia, 85 percent is natural rubber type SIR, the rest is another type of natural rubber. The existence of a deep gap in the export of natural rubber of SIR type between Indonesia and Thailand makes Indonesia as the largest exporter country for natural rubber of SIR type in the world.

Panel Unit Root Test

Based on Table 1. by using LLC test, we can conclude that all of variables are not stationary in their level. But all of variables are stationary after we do the transformation into first difference form.

Table 1. Unit Root Test (LLC Test)

Variable	Stationary Level			
	Level		*First Difference*	
	Prob.	Note	Prob.	Note
Ln Export	0,184	Not stationary	0,000	Stationary
Ln Real GDP	0,977	Not stationary	0,003	Stationary
Ln *Economic Distance*	0,098	Not stationary	0,005	Stationary
Ln *REER*	0,103	Not stationary	0,000	Stationary
Ln Population	0,960	Not stationary	0,007	Stationary

Panel Data Regression Model Estimation

Chow test

The Chow test hypothesis is :

$H_0 : \alpha_1 = \alpha_2 = \ldots = \alpha_i$ (*Common Effect Model*)

H_1 : at least 1 $\alpha_i \neq \alpha_j$ for $i \neq j$ *(Fixed Effect Model)*

The result of the Chow test show that the p-value (0.000) is less then alpha (0.005), then we can conclude Fixed Effect Model is better than the Common Effect Model.

Hausman test

The Hausman test hypothesis is:

$H_0 : E(w_{it} \mid X_{it}) = 0$ (*Random Effect Model)*

$H_1 : E(w_{it} \mid X_{it}) \neq 0$ (*Fixed Effect Model)*

The results of the Hausman test show that the p-value (0.00) is less than alpha (0.05) so we can conclude that the Fixed Effect Model is better than the Random Effect Model.

Fixed Effect Model

The estimation result of Fixed Effect Model is:

$$\Delta\widehat{lnEXP}_{it} = -0{,}446 + 4{,}543\ \Delta lnGDP^{*}_{it} - 0{,}740\ \Delta lnED^{*}_{it} - 0{,}045\ \Delta lnREER_{it} - 41{,}20\ \Delta lnPOP_{it} \quad (3)$$

*significant at α = 5%

Outlier

Based on the figure in Appendix 2 and Table 2, it can be concluded that there is a leverage point on observations 35, 37, 82, 83, 84, and 85. The observations are located on the horizontal axis (x-axis) and far from the regression line.

Table 2. Outlier

Observation	*E*	*Cook's SD*
35	-1,341	0,142
37	-1,516	0,151
82	-1,517	0,142
83	-1,760	0,217
84	-1,149	0,101
85	-1,197	0,152

Based on these characteristics, it can be concluded that there is a bad leverage point on the data used.

This condition makes the data cannot be estimated using the OLS method. If the data is still estimated using the OLS method, it will affect the bias estimation of OLS both the intercept and the slopes. Therefore, the estimation method used is S-Estimation.

Robust S-Estimator Fixed Effects Model Panel Data

Based on the normality test on appendix 3, the results obtained the abnormal distribution of errors. It is because of the presence of outliers. After detecting the outliers, it turns out that in the data used there is a bad

leverage point. Maronna & Yohai (2000) explained that M-Estimator is used for categorical variables while S-Estimator is used for continuous variables.

$$\Delta\widehat{lnEXP}_{it} = -0{,}337 + 4{,}028\Delta lnPDB^{*}_{it} - 0{,}433\Delta lnED^{**}_{it} - 0{,}022\ \Delta lnREER_{it} + 29{,}092\ \Delta lnPOP_{it} + 29{,}092\ \Delta lnPOP_{it} \quad (4)$$

*significant on α = 5%
**significant on α = 10%

Real GDP of Indonesian natural rubber importing countries is significant and has a positive correlation to Indonesian natural rubber exports. This is suitable with the theory by Mankiw (2006) which explained that when the GDP of a country increased, the purchasing power of a country would increase so that at the same time the country's demand for an imported commodity increased. It caused the export volume of Indonesian natural rubber increases.

In the estimation of the S-Estimator fixed effect robust regression model (Eq.(4)) , it can be concluded that if the growth of real GDP increases 1%, Indonesian natural rubber export volume will increase 4.028 percent.

Economic distance from Indonesia to natural rubber importing countries is significant with negative sign, so that Indonesia will export more natural rubber to countries that have closer distance to Indonesia.

REER has no significant effect and negative sign to Indonesian natural rubber exports. This is in line with the research of Hastuti & Meri (2011), Claudia (2016), and Zhang (2017) which estimated that REER had no significant effect on Indonesian natural rubber export volume. Although there was a change in the rupiah exchange rate against the currency of the importing country, the volume of Indonesian rubber exports did not significantly change. It is because the high needs of natural rubber for each importer as the automotive industry countries These five importing countries need a lot of natural rubber with TSNR SIR specifications that are produced in Indonesia.

Based on Eq. (4), the population of Indonesian natural rubber importing countries is not significant but has a positive sign to Indonesian natural rubber exports. The demand of Indonesian natural rubber exports by importing countries is not affected by their large number of population. The needs of Indonesian natural rubber by importing countries, especially the

TSNR SIR is caused of the largest automotive producing in those countries.

CONCLUSION AND POLICY RECOMMENDATION

The development of Indonesian natural rubber export to the five largest importing countries in general tends to increase. In 2009, Indonesian natural rubber exports to the United States, Japan and China are decline. This is caused by the effects of the global crisis that occurred throughout the world. The decline in 2012 is caused by the export restriction policy that was implemented by the state which was incorporated in The International Tripartite Rubber Council (ITRC).

Real GDP has a significant effect and positive sign to Indonesian natural rubber export volume. While economic distance has a significant effect and negative sign. REER variable and population have no significant effect on Indonesian natural rubber export volume.

Based on the conclusions of the study results, the authors propose the following suggestions such as because of Indonesian natural rubber exports are dominated by the type of TSNR (Technically Specified Rubber), almost 85 percent of them are natural rubber TSNR type SIR, it is necessary to increase the production of SIR natural rubber. World demands for natural rubber types of SIR are very high. This condition makes Indonesia has a good opportunity because Indonesia is the largest exporter of SIR rubber.

Indonesia should develop the process of raw natural rubber products into semi-finished or finished goods for exports, so it can give the value added for Indonesia.

The government should develop an e-commerce application system for natural rubber farmers in upstream and downstream industries. This application should provide facilities to distribute natural rubber products without intermediaries from the seller to the buyer, so it will cut the long chain of sales.

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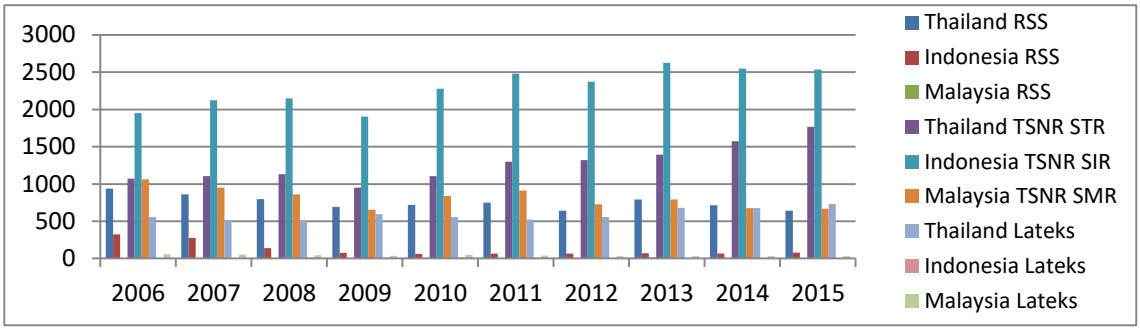
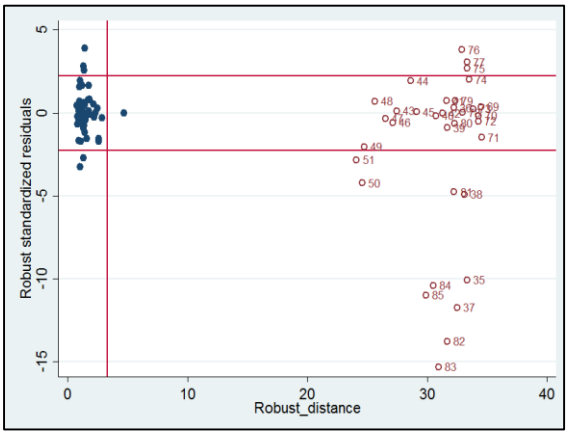
APPENDIX

Appendix 1. Export of RIS, TSNR and Latex Natural Rubber for Thailand, Indonesia and Malaysia in 2006-2015 (Million Tons)



Source: Trade Map (Processed)

Appendix 2. Outlier



Appendix 3. Normality Test

```
. predict res, e
(5 missing values generated)

. sktest res

                    Skewness/Kurtosis tests for Normality
                                                       ------- joint ------
> --
    Variable |   Obs   Pr(Skewness)   Pr(Kurtosis)  adj chi2(2)    Prob>ch
> i2
-------------+---------------------------------------------------------------
> --
         res |    80       0.0022         0.0000        25.73         0.000
> 0
```