An Econometric Analysis of Natural Rubber Market In Malaysia

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Abstract— *The objective of this study is to identify the important factors that affecting natural rubber industry in Malaysia. Therefore, the Malaysian natural rubber market model where built. It consists of six behavioral equation and two closing identities. The six behavioral equations are production, import, domestic consumption, export, domestic price and world price equations and the closing identities are domestic and world stock. By using the annual data from year 1980 to 2012, the market model been examined using unit root test, cointegration test and simultaneous equation estimation. Method two stages least squares (2SLS) will be used in determining the factors that affecting natural rubber market. Results revealed that time trend, hectare natural rubber and production with lagged 1 year are important in production natural rubber equation. While,import depends on world price and exchange rate. Only synthetic rubber price isn't important in determining Malaysia's natural rubber consumption. All the factors in domestic price are significance except price with lagged 1 year while lastly crude oil price and lagged world price of rubber are the two variables that important in the world price equation compare to exchange rate and world price of synthetic rubber.*

Keywords— Econometric analysis, Malaysian natural rubber market, unit root test, cointegration test, two stages least squares (2SLS)

I. INTRODUCTION

Previously, agriculture is one of the main contributors in Malaysia. With contribution around 22.9 percent in year 1980, the sector is considered the one of the main contributors in Malaysia's Gross Domestic Product (GDP). These contributions also reflect the role of rubber in Malaysia's GDP. In year 1984, rubber contributed around 39.8 percent in agricultural sector. However, the changes to oil palm as the main commodity in Malaysia also had decreased the contribution and total number of estate rubber in Malaysia. Land development programme that been organized by Government had switch the role natural rubber as the main commodity to oil palm industry (Malaysian Rubber Research and Development Board, 1983). Early 1980s shows the amount of rubber estate decreased from 1,767 estates in year 1980 to 1,048 estate in year 1995.In year 2000 the total of rubber estate in Malaysia was only 229 before reduced to 172 estates in year 2012.

Parallel with the decreasing number of rubber estate, the total planted area also showed the decreasing trend. In year 1980, the total planted area for rubber was 1,998,200 hectares. In year 1995, the total area decreased from 1,688,800 hectares to 1,430,700 hectares in year 2000. In year 2010, the amount decreased again to 1,020,380 hectares before it increased around 41,000 tonnes to 1,041,540 hectares in year 2012 (DOSM, 2013).The decrease in natural rubber plantation also affect the smallholding sector, Malaysia's natural rubber consumption and trade. In year 2010, the percentage share natural rubber to GDP was 8.8 percent and it reduced to 8.2 percent in year 2012 (DOSM, 2013).

In year 2000, the trend for natural rubber consumption increased from 363,715 tonnes to 400,888 tonnes (year 2001) to 421,781 tonnes in year 2004. In year 2005 and 2006, the consumption was only around 300,000 tonnes. The highest consumption is in year 2008: 468,894 tonnes. In year 2013, the amount was only 434,192 tonnes (DOSM, 2013).

The natural rubber contribution in export also was quite low. In year 2000 and 2001, it's contribution was only around 0.69 percent and 0.56 percent each respectively. After year 2004, the contributions in export were around 1.11 to 1.40 percent. In year 2012, the contribution was only 1.12 percent.This contribution worsen because in year 2012, the import of natural rubber exceeds export. In year 2012, the total import of natural rubber in Malaysia was 871,535 tonnes compared to its export: 771,194 tonnes. In year 2013, the gap become bigger where Malaysia's natural rubber export was only 847,090

tonnes compared to import: 1,004,805 tonnes. The contribution to export also decreased to 0.98 percent. Therefore, it is important to determine the factors affecting Malaysian natural rubber industry especially in production, consumption, export and import of natural rubber in Malaysia.

The organization of the paper is as follows: Section 2 is the literature review. Section 3 is the methodology. Results of the study is in Section 4. Lastly, Section 5 the conclusion part.

II. LITERATURE REVIEW

In agricultural market research, majorities of the previous literature used market model as hasbeen introduced by Labys (1973). Labys (1973) model used four types of equations: supply, demand, price and stock as the closing identity. Mohamed and Mad Nasir (1993) used this model in these production, export, world price and stock equation while Amna*et al.* (2010) investigated in cocoa market and modified it into six behavioral equation called supply equation, import, consumption, export, domestic price and world price.

Besides, there are several authors that examined the factors affecting natural rubber industry such as Suwanakul (1987). He included the variable area in its production equation and had separated the area into tapped and untapped area. A year later, by using two stage least square (2SLS) estimation method, Mohammed (1988) examined the natural rubber market in Malaysia. The author used export and world price equation and added two more equations called acreage and yield equation.

Romprasert (2009) examined the factors for monthly RSS3 future prices by including crude oil prices as one of the variables. The obtained result showed that crude oil price is the significant variable in determining future price. An increasing of 1 percent petroleum prices will increase the RSS3 price to 0.0227 percent. Lately, Khin *et al.* (2012) also used the crude oil prices as the variable in natural rubber price. Besides, the author also used the substitute price, stock, production and consumption as the variables and all the variables are significant and played an important role in price equation.

In other commodity, Mad Nasir *et al.* (1992) studied the factors that affecting Malaysia's cocoa price. Lately, with the same equation, Amna *et al.* (2013) included the variables planted area in examining the importance of the variable in cocoa market. The positive relationship between planted area and production is the proved that area also played an important role in production.

In palm oil commodity, ShriDewi *et al.* (2009, 2011 and 2013) included new variable called biodiesel as the factors in the equation. In ShriDewi *et al.* (2009 and 2011) they included the variable in the export equation while in ShriDewi *et al.* (2013) the authors included the biodiesel variable as the factor in consumption equation.

From the literature review, there is less research that examined the Malaysia's natural rubber market. The previous research been conducted are in year 1988 by Mohammed study. From Labys (1973) equilibrium model, the author only used export and world price equation in its study. While, Mohamed and Mad Nasir (1993) also study on natural rubber market and the author using production, export, world price and stock equation in its model. Therefore, this study is attempted to fill the gap in the literature. It will extend the Labys (1973) market equilibrium by including more behavioral equation such as consumption and domestic price equation. It will clarify the factors for each new behavioral equation and examined it using the simultaneous equation. Although both author: Mohammed (1988) and Mohamed and Mad Nasir (1993) also used the simultaneous equation in their study but more recent data is needed in examine the factors in natural rubber industry.

Beside, new variable such as crude oil price will be inserting in world price equation which the variable hadn't been included in previous studies. Only Romprasert (2009) used this variable in forecasting future price. In Malaysia, Khin *et al.* (2012) used crude oil price as one of the factor and the result is significant. Therefore, crude oil price is important to be added in the world natural rubber price equation.

III. METHODOLOGY

3.1 Model Specification

The model in this study is followed Labys (1973) models. In Labys (1973) model, the factors of supply depends on price and supply with lagged, resource and government policy. Factors for demand are demand with lagged, own and substitute price, technology and income. Price equation is consists of price with lagged and changes in stock. Lastly, for stock equation, the formula is stock with lagged plus supply minus demand. With some modification based on Mohammed (1988); Mohamed and Mad Nasir (1993); Lubis (1994) and Amna *et al.* (2010), next is the natural rubber market model been developed. It consists of six behavioural equations and two identities. Next are the explanations for each of the equation:

3.1.1 Natural Rubber Production

The variables for production natural rubber are time trend, price palm oil, hectare natural rubber and government expenditure with lagged 5 years. Only a_2 is expected to have a negative sign with production while the other parameters expected to be positive (see equation 3.1). Any increasing in palm oil price will decrease the natural rubber production compare to natural rubber own price. Next, time trend and any increase in acreage natural rubber are expected to increase the production of natural rubber in Malaysia. Lastly, government expenditure is an incentive for producers to produce more natural rubber in the future. Therefore, it is also expected to have a positive sign. The equation can be written as follows:

$$PRODNR_t = a_0 + a_1T_t + a_2PRICEPO_t + a_3HECTARE_t + a_4GOV_{t-5} + \mu_{1t} \quad (3.1)$$

3.1.2 Natural Rubber Import Demand

In import demand equation (see equation 3.2), the variables are world price of natural rubber, world price of synthetic rubber and exchange rate. Only coefficient e_1 is expected to have a negative sign because country would reduce their import if the price is high in the market. It is different with world price of synthetic rubber which increasing in world price of synthetic rubber will increase the import. While, any appreciation value in exchange rate will reduce the cost which later will make the import of goods become lower and cheaper. Therefore, the import will increase.

$$IMNR_t = e_0 + e_1WNRP_t + e_2PSBR_t + e_3ER_t + \mu_{2t} \quad (3.2)$$

3.1.3 Natural Rubber Consumption

There are 3 variables been examined in consumption equation. The variables are Malaysia's GDP, Malaysia's population and price of synthetic rubber. GDP as the proxy for income, Malaysia's population and price of synthetic rubber are expected to have a positive relationship in consumption equation. The equation is in equation (3.3):

$$CNR_t = b_0 + b_1MGDP_t + b_2POPULATIONMSIA_t + b_3PSBR_t + \mu_{3t} \quad (3.3)$$

3.1.4 Natural Rubber Export Demand

The equation for export demand is as follows:

$$EXNR_t = c_0 + c_1IPIW_t + c_2WNRP_t + c_3T_t + \mu_{4t} \quad (3.4)$$

Modified from Mohammed (1988), Mad Nasir*et al*. (1992), Mohamed and Mad Nasir (1993), Alias *et al*. (1999), Amna*et al.* (2010), and Arifin and Akyuwen (2011), the export depends on world industrial production index, world price of natural rubber and time trend. Any increase in world industrial production index, world natural rubber price and time trend will increase the export of natural rubber in the market (Mohammed, 1988).

3.1.5 Natural Rubber Domestic Price

In natural rubber domestic price equation, 2 variables have been examined: domestic stock and world price. Less domestic stock means the domestic price will increase due to less stock in the market. While, increasing in world prices is parallel with increasing in domestic price of natural rubber. It can be written as in equation (3.5).

$$PRICENR_t = d_0 + d_1DSNR_t + d_2WNRP_t + \mu_{5t} \quad (3.5)$$

3.1.6 Natural Rubber World Price

Adapting world price equation from previous authors such as Mohammed (1988), Mohamed and Mad Nasir (1993), World Bank (2005), Khin*et al.* (2008), Amna*et al.* (2010), and ShriDewi*et al.* (2010), the world price is depends on price of synthetic rubber, exchange rate and crude oil price.

$$WPNR_t = f_0 + f_1PSBR_t + f_2ER_t + f_3OILP_t + \mu_{6t} \quad (3.6)$$

All the coefficients in equation (3.6) are expected to have a positive sign exceptfor f_2. Increasing in price of synthetic rubber and crude oil price will increase the world price of natural rubber. Whileappreciation in exchange rate also will decrease the world natural rubber price.

3.1.7 Natural Rubber Domestic Stock

The market model been closed by using domestic stock equation. The formula for domestic stock equation is domestic stock with lagged 1 year plus current import and production minus current consumption and export. It can be written as follows:

$$DSNR_t = DSNR_{t-1} + IMNR_t + PRODNR_t - CNR_t - EXNR_t \quad (3.7)$$

3.1.8 Natural Rubber World Stock Equation

The total of world stock is the sum of domestic stock and rest of world stock. The formula for world stock equation is as follows:

$$WSNR_t = DSNR_t + RESTWSNR_t \quad (3.8)$$

Overall, the summary of natural rubber market model with definition and classification of variables can be seen in Table 1 and Table 2:

TABLE 1
SUMMARY OF THE SYSTEM EQUATION FOR MALAYSIA NATURAL RUBBER MARKET

Natural Rubber Behavioural Equation:

$$PRODNR_t = a_0 + a_1T_t + a_2PRICEPO_t + a_3HECTARE_t + a_4GOV_{t-5} + \mu_{1t} \quad (3.1)$$

$$IMNR_t = e_0 + e_1WNRP_t + e_2PSBR_t + e_3ER_t + \mu_{2t} \quad (3.2)$$

$$CNR_t = b_0 + b_1MGDP_t + b_2POPULATIONMSIA_t + b_3PSBR_t + \mu_{3t} \quad (3.3)$$

$$EXNR_t = c_0 + c_1IPIW_t + c_2WNRP_t + c_3T_t + \mu_{4t} \quad (3.4)$$

$$PRICENR_t = d_0 + d_1DSNR_t + d_2WNRP_t + \mu_{5t} \quad (3.5)$$

$$WNRP_t = f_0 + f_1PSBR_t + f_2ER_t + f_3OILP_t + \mu_{6t} \quad (3.6)$$

Closing Identities:

$$DSNR_t = DSNR_{t-1} + IMNR_t + PRODNR_t - CNR_t - EXNR_t \quad (3.7)$$

$$WSNR_t = DSNR_t + RESTWSNR_t \quad (3.8)$$

TABLE 2
DEFINITION AND CLASSIFICATION OF VARIABLES

Classification		Definition
$PRODNR_t$	=	Production rubber at time t (tonnes)
$PRICENR_t$	=	Domestic price of natural rubber at time t (RM/tonne)
$PRICEPO_t$	=	Domestic price of palm oil at time t (RM/tonne)
T_t	=	Time trend at time t
$HECTARE_t$	=	Planted area rubber at time t (hectare)
μ_t	=	Error term
$MGDP_t$	=	Malaysia Gross Domestic Product at time t (RM million)
$POPULATIONMSIA_t$	=	Population in Malaysia at time t (million)
$IMNR_t$	=	Import natural rubber at time t (tonnes)
$RESTWSNR_t$	=	Rest of world stock natural rubber at time t (tonnes)
$WNRP_t$	=	World price of natural rubber at time t (USD/tonne)
$IPIW_t$	=	World industrial production index at time t (2005=100)
CNR_t	=	Consumption natural rubber at time t (tonnes)
$PSBR_t$	=	World price of synthetic rubber at time t (USD/tonne)
$EXNR_t$	=	Export natural rubber at time t (tonnes)
Classification		**Definition**
ER_t	=	Exchange rate at time t (RM/USD)
$DSNR_t$	=	Domestic stock natural rubber at time t (tonnes)
$WSNR_t$	=	World stock natural rubber at time t (tonnes)
$OILP_t$	=	Crude oil price at time t (USD/barrel)
$DSNR_{t-1}$	=	Domestic stock natural rubber with lagged 1 year (tonnes)

3.2 Estimation Procedure

In the methodology, the test begins with unit root and cointegration test. The unit root test is consists of Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shinn (KPSS) test while the cointegration test is followed Pesaran*et al.* (1999). After obtaining the long run cointegration, the model can proceed to simultaneous equation estimation. In simultaneous equation estimation, technique 2SLS will be conducted. Checking the order condition is necessary before proceed to 2SLS estimation (Gujarati, 2006).

3.3 Source of Data

The data is obtained from several sources such as Association of Natural Rubber Producing Countries (ANRPC), Department of Statistics, Malaysia (DOSM),International Financial Statistics (IFS), IRGS Rubber Statistical Bulletin, Malaysian Rubber Board (MRB) and World Bank. For this study, the data are from year 1980 until 2012.

IV. RESULTS

By using all the three test for unit root, the findings shows that only 1 variable (POPULATIONMSIA) is integrated at order I(0). While, other variables are integrated at order I(1). The finding can be seen in Table 3:

TABLE 3
UNIT ROOT TEST RESULTS

		ADF test				PP test				KPSS test			
Variable	**Level**		**1st difference**		**Level**		**1st difference**		**Level**		**1st difference**		**Decision**
	Intercept	**Trend and intercept**	**Intercept**	**Trend and Intercept**	**Intercept**	**Trend and intercept**	**Intercept**	**Trend and intercept**	**Intercept**	**Trend and intercept**	**Intercept**	**Trend and intercept**	
PRICEPO	-0.23626 [0.9237]	-2.3833 [0.3806]	-5.0518 [0.0003] ***	-5.0459 [0.0016] ***	-0.1736 [0.9321]	-2.4223 [0.3619]	-5.0044 [0.0003]***	-0.5060 [0.0015]***	0.6119***	0.1685***	0.2539*	0.1218**	**I(1)**
GOV_{t-3}	-1.1870 [0.6668]	-0.5427 [0.9754]	-7.8886 [0.0000] ***	-7.7106 [0.0000] ***	-5.6257 [0.0001]***	-5.5238 [0.0004]***	-9.8354 [0.0000]***	-9.5571 [0.0000]***	0.06751*	0.0690*	0.0192*	0.0192*	**I(1)**
IR	-2.3127 [0.1743]	-2.9660 [0.1583]	-5.5921 [0.0000] ***	-5.8235 [0.0002] ***	-2.1940 [0.2122]	-3.0000 [0.1478]	-11.8087 [0.0000]***	-12.0395 [0.0000]***	0.5181***	0.1019*	0.5000***	0.5000	**I(1)**
IPIW	-1.7019 [0.4208]	-0.3886 [-0.3886]	-5.1014 [0.0002] ***	-5.1681 [0.0011] ***	0.1074 [0.9614]	-2.4249 [0.3607]	-5.7323 [0.0000]***	-5.6433 [0.0003]***	0.6438***	0.1198**	0.1579*	0.1303**	**I(1)**
MGDP	-0.1510 [0.9350]	-2.2740 [0.4352]	-5.3082 [0.0001] ***	-5.2124 [0.0010] ***	-0.1242 [0.9383]	-2.2740 [0.4352]	-5.3126 [0.0000]***	-5.2044 [0.0010]***	0.6611***	0.0846*	0.0806*	0.0810*	**I(1)**
ER	-1.5740 [0.4839]	-1.2121 [0.8909]	-4.8138 [0.0005] ***	-4.8514 [0.0025] ***	-1.5740 [0.4839]	-1.2121 [0.8909]	-4.7800 [0.0005]***	-4.8182 [0.0027]***	0.5559***	0.1029*	0.1704*	0.0911*	**I(1)**
OILP	0.3807 [0.9789	-1.2032 [0.8929]	-6.5284 [0.0000] ***	-7.7250 [0.0000] ***	1.0909 [0.9966]	-1.2032 [0.8929]	-6.5363 [0.0000]***	-11.4168 [0.0000]***	0.4907***	0.1984***	0.6118***	0.0838*	**I(1)**
PRODNR	-1.4282 [0.5562]	-1.7314[0.7136]	-4.9837 [0.0003] ***	-4.9228 [0.0021] ***	-1.4954 [0.5230]	-1.8648 [0.6491]	-4.9516 [0.0004]***	-4.8829 [0.0023]***	0.5442***	0.1251**	0.0945*	0.0712*	**I(1)**
PRICENR	-1.4564 [0.5423]	-3.1934 [0.1037]	-5.4360 [0.0001] ***	-5.3858 [0.0007] ***	-1.2754 [0.6286]	-3.0104 [0.1451]	-7.5067 [0.0000]***	-9.5652 [0.0000]***	0.6385***	0.1408**	0.3027*	0.2389	**I(1)**
IMNR	-0.7969 [0.8065]	-2.6685 [0.2553]	-6.1358 [0.0000] ***	-6.0494 [0.0001] ***	-0.3348 [0.9087]	-2.7469 [0.2260]	-9.2334 [0.0000]***	-12.1631 [0.0000]***	0.6187***	0.1676***	0.5000***	0.5000	**I(1)**
WNRP	-1.7593 [0.3931]	-1.7462 [0.7067]	-4.8759 [0.0004] ***	-4.8059 [0.0028] ***	-1.8741 [0.3397]	-1.8600 [0.6515]	-4.8712 [0.0004]***	-4.7981 [0.0029]***	0.1166*	0.1111*	0.0891*	0.0800*	**I(1)**
CNR	-1.4433 [0.5483]	-0.8461 [0.9501]	-5.0506 [0.0003] ***	-5.1910 [0.0011] ***	-2.4502 [0.1368]	-0.9761 [0.9335]	-5.0415 [0.0003]***	-5.2005 [0.0011]***	0.5870*	0.1904***	0.5262***	0.0722*	**I(1)**
DSNR	-2.3441 [0.1651]	-3.0493 [0.1388]	-5.8554 [0.0000] ***	-5.7770 [0.0002] ***	-2.1481 [0.2283]	-2.9674 [0.1565]	-7.4749 [0.0000]***	-8.1849 [0.0000]***	0.6627***	0.1925***	0.2126*	0.1832***	**I(1)**
PSBR	-1.66821 [0.4372]	-1.55439 [0.7885]	-5.6894 [0.0000]***	-5.6707 [0.0003]***	-1.7912 [0.3779]	-5.6887 [0.0000]***	-1.6660 [0.7429]	-5.6722 [0.0003]***	0.14824*	0.1253**	0.1316*	0.0811*	**I(1)**
WSNR	-2.5241 [0.1204]	-2.9281 [0.1675]	-5.2663 [0.0002]***	-5.2306 [0.000]***	-2.2455 [0.1951]	-2.0824 [0.5356]	-7.2058 [0.0000]***	-8.0969 [0.0000]***	0.1281*	0.1274**	0.3777**	0.3012	**I(1)**
EXNR	-1.1512 [0.6828]	-2.3820 [0.3813]	-5.1562 [0.0002] ***	-5.0455 [0.0016] ***	-1.1209 [0.6952]	-2.4919 [0.3296]	-5.1480 [0.0002]***	-5.0008 [0.0017]***	0.6287*	0.1104*	0.0851*	0.0871*	**I(1)**
$DSNR_{t-1}$	-5.9749 [0.0000]***	-5.8800 [0.0002]***	-9.3461 [0.0000]***	-9.2281 [0.0000]***	-10.6956 [0.0000]***	-10.8599 [0.0000]***	-23.272 [0.0001]***	-29.102 [0.0000]***	0.3566**	0.3226	0.2293*	0.1983***	**I(1)**
RESTWSNR	-3.3516 [0.0206]**	-2.3078 [0.4169]	-5.6872 [0.0001]***	-4.0692 [0.0187]***	-2.7593 [0.0755]*	-2.4664 [0.3413]	-8.3439 [0.0000]***	-9.0248 [0.0000]***	0.1718*	0.1124**	0.2993*	0.2344	**I(1)**
POPULATIONMSIA	-6.1338 [0.0000]***	2.8717 [1.0000]	-0.8337 [0.7953]	-2.3370 [0.4031]	-3.6253 [0.0107]**	1.8378 [1.0000]	-0.7054 [0.8349]	-2.3184 [0.4123]	0.6623***	0.1815***	0.5477***	0.1467***	**I(0)**
HECTARE	-1.5036 [0.5190]	-2.1670 [0.4909]	-5.7996 [0.0000]***	-5.7334 [0.0003]***	-1.5099 [0.5158]	-2.1670 [0.4909]	-5.8066 [0.0000]***	-5.7518 [0.0003]***	0.4010	0.1296	0.1061	0.0757	

Mixed unit root test result required the bounds test by Pesaran *et al.* (1999) been used. The bounds test result is as follows:

TABLE 4
F-STATISTICS FOR TESTING THE EXISTENCE OF LONG-RUN RELATIONSHIPS

Variables	p	F-statistic
Natural Rubber:		
F(PRODNR/T,PRICEPO,HECTARE,GOV5)	3	2.9728[b]
F(IMNR/WNRP,PSBR,ER)	3	58.2439***[a]
F(LCNR/LMGDP,LPOPULATIONMSIA,LPSBR)	3	1.4292[a]
F(EXNR/IPIW,WNRP,T)	3	0.5587[b]
F(PRICENR/DSNR,WNRP)	1	2.4359[a]
F(WNRP/PSBR,ER,OILP)	3	29.4287***[a]

Note: *, **,* indicates the significance level at 1%, 5% and 10%. Critical values are cited from Narayan (2005). a=Table Case III: Unrestricted intercept and no trend and b=Table Case V: Unrestricted intercept and unrestricted trend.**

From the result in bounds test, exist long run relationship in IMNR and WNRP equation. While other equations aren't significance and doesn't cointegrated. However, this study can still proceed to 2SLS estimation based on Hsiao (1997a & 1997b). However, the study need to do order condition before proceed to 2SLS estimation. Table 5 is the result for order condition:

TABLE 5
ORDER CONDITION FOR NATURAL RUBBER EQUATION

Equation	k > m-1	Type of Order Condition
PRODNR	12 > 4-1	Overidentified
IMNR	13 > 3-1	Overidentified
CNR	14> 3-1	Overidentified
EXNR	14> 3-1	Overidentified
PRICENR	14> 2-1	Overidentified
WNRP	14> 3-1	Overidentified

Note: Based on Gujarati (2006), k = number of variables excluded in the equation been considered, m = number of endogenous variables in the equation

Based on order condition in Gujarati (2006), all the equation are overidentified and this fulfill the condition to proceed to 2SLS estimation.The results for 2SLS is in Table 6.

TABLE 6
2SLS ESTIMATION RESULTS FOR NATURAL RUBBER EQUATION

Natural Rubber Equation
$PRODNR_t$= 1392847.0 – 27373.95T_t – 0.5014$HECTARE_t$ + 0.8023$PRODNR_{t-1}$ – 44.3136GOV_{t-5} (2.0796)** (-1.9674)* (-2.2856)** (4.8437)*** (1.0651)
R^2 = 0.8618 F stat = 34.5859 LM = 0.2279
$IMNR_t$= -944389.7 + 144112.7$WNRP_t$ + 755.1997$PSBR_t$+ 354913.0ER_t (-6.44377)*** (2.4943)** (0.0313) (8.1933)***
R^2 = 0.8072 F stat = 33.6545 LM = 0.1597
$LCNR_t$= -2.7061 + 1.2835$LMGDP_t$ – 0.0517$LPSBR_t$ (1.9982)* (7.8908)*** (-0.5650)
R^2 = 0.9564 F stat = 131.8537 LM = 0.1254
$EXNR_t$ = 460532.4 + 10046.09$IPIW_t$ + 45802.64$WNRP_t$ – 47747.83T_t + 0.7341$EXNR_{t-1}$ (1.6174) (2.3107)** (1.3515) (-2.2984)** (4.4988)***
R^2 = 0.8876 F stat = 44.0044 LM = 0.1329
$PRICENR_t$ = 3.0377 – 1.5E-05$DSNR_t$ + 2.4084$WNRP_t$ + 0.1823$PRICENR_{t-1}$ (1.9940)* (-2.1674)** (5.7351)*** (1.1666)
R^2 = 0.9509 F stat = 154.2142 LM = 0.1443
$WNRP_t$ = 0.6478 + 0.0615$PSBR_t$ – 0.1979ER_t + 0.0045$OILP_t$ + 0.4282$WNRP_{t-1}$ (0.9342) (0.6801) (-1.0174) (1.7939)* (1.7333)*
R2 = 0.8435 F stat = 32.5123 LM=0.1347
Closing Identity Equation
$DSNR_t$=$DSNR_{t-1}$ + $IMNR_t$ + $PRODNR_t$ – CNR_t– $EXPNR_t$$WSNR_t$= $DSNR_t$+ $RESTWSNR_t$

Note: [ ] indicates the t-Statistic.*, **,* indicates the significance level at 1%, 5% and 10%.**

Based on the findings inR^2, F statistic and LM test, all the results are good.In the production equation, there are 3 variables that are significance. The variables are time trend, hectare natural rubber and production natural rubber with lagged 1 year. From the significant variables, production natural rubber with lagged 1 year is significant at positive coefficient while time trend and hectare natural rubber showed the negative relationship.

In import equation, only world synthetic rubber price isn't significant. World price showed a positive coefficient. Supposedly, increasing world price will decrease the import. Next, there is one variable that isn't significant in consumption equation. The variable is price synthetic rubber.

As compared to variables in export, world industrial production index and time trend are two coefficients that significance at 5 percent. While, export with lagged is the variables that significance at 1 percent. The result for world industrial production index and time trend is supported by Mohammed (1988).

Including constant, all variables are significant in domestic price equation except price with lagged 1 year. Lastly, variable crude oil price and world price with lagged are the important indicators in the world price equation compare to exchange rate and world price of synthetic rubber. Crude oil price and world price with lagged each will increase the world price to 0.0045 percent and 0.4282 percent respectively.

V. CONCLUSION AND RECOMMENDATION

Overall, it can be concluded that there are many factors that affected the natural rubber equation. The production depends on time trend, hectare natural rubber and production natural rubber with lagged 1 year. Therefore, it is important for the producers to working on idle land. It will increase the production rubber that can be tapped. Government incentive also should be provide as an effort to help smallholders.

World price and domestic stock are two variables that are significance in domestic price equation. When world price increase, the domestic price will follow to increase. This will benefit the smallholders. However, it is important to increase the natural rubber productivity as one of the support to ensure the competitiveness of natural rubber in the market. Lastly, world price with lagged and crude oil price are the important indicator in the world price equation.

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