



Examining between Exchange Rate Volatility and Natural Rubber Prices: Engle-Granger Causality Test

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ABSTRACT

There are two objectives of this study, first, it is to determine the impact of exchange rate volatility on Malaysian natural rubber (NR) prices of (SMR20 and RSS4); second, it is to forecast a short-term exchange rate (ERP) of Malaysian Ringgit (RM per USD) and NR prices strongly represented in the Malaysian NR market. The granger causality test is first analyzed using the vector error correction model (VECM) with the more efficient Engle-Granger causality procedure. Both short-term ERP and NR prices ex-ante forecasts are tested using Pindyck and Rubinfeld's procedures. The result shows the RSS4 NR price Granger-causes the SMR20 NR price and also ERP with unidirectional causality relationship. Both ERP and NR prices forecasts would be on a slightly increasing trend from January to June 2016. It was due to government and traders changing their behaviour by increasing domestic consumptions for the stabilization of the NR supply-demand balance.

Keywords: Exchange Rate Volatility, Forecasting, Malaysian Natural Rubber Price

JEL Classifications: C1, C2, D4, F31, F37

1. INTRODUCTION

Commodity markets are generally subjected to surprising changes towards demand and supply, the vagaries of environmental factors which influence the macroeconomic variables such as exchange rates, inflation, export and import or other strongly underlying growth factors based on the changes in government policies (Evenett and Jenny, 2012). These factors may disrupt production from key supplying countries. And yet, commodity prices do exhibit common characteristics: They may portray co-movement or co-integration due to high substitution elasticities, they display more variance than other market prices, and commodity prices can be characterized by long periods of stagnancy as interrupted by occasional price spikes (Evenett and Jenny, 2012). Budiman and Fortucci (2003) also explained the long-term rubber production needed to consider the technological innovation, economic

development, area planted, and prices. Therefore, the rubber production depended not only on the area planted but also on the age-composition of trees. For medium-term, the rubber economy was mainly related to the returning movement of the global economy. However, short-term factors were primarily weather, exchange rate volatility, futures markets interventions and unstable demand.

Goldberg and Charles (2005) explained that exchange rate (ERP) of a country's currency was considered as the value of one country's currency in terms of another currency. In Malaysia, 1 USD is equivalent to how much Malaysia Ringgit (RM), because most agricultural commodities are traded in USD. Agricultural commodity price and exchange rate volatilities attract global attention because of their potential effects on international trade and domestic food prices. The floating exchange rate

regime introduced in early 1970, had caused rapid fluctuation of currency based on foreign exchange market fundamental. The real exchange rate is a key economic variable that assesses the price competitiveness of a country and constitutes a crucial stake in economies wherein revenues are derived from exports' activity. From a macroeconomic point of view, exchange changes can have strong effects on the economy, as they may affect the structure of output and investment, lead to inefficient allocation of domestic absorption and external trade, influence labour market and prices, as well as alter external accounts. Exchange rate volatilities can affect rubber prices directly or indirectly (UNCTAD, 2011).

The increased commodity price volatility poised threat over the health of commodities export countries. The price volatility creates uncertainty over future price levels which complicates investment and hamper economic growth (Corden, 1983; Drabek and Brada, 1998; Dauvin, 2014). A negative volatility effect should be of particular importance for the large group of countries that include Malaysia, a country that relies on primary commodity exports as an essential source of income. According to UNCTAD (2011), more than two-third out of 216 countries had a share of primary commodities in total exports that had exceeded 30%. Osigwe and Uzonwanne (2015) found out also a wide range of different types of buyers and sellers in the foreign exchange market. If the values of either of the two component currencies had changed, a market-based exchange rate would be changed.

The objectives of the study first, it is to determine the impact of exchange rate volatility on Malaysian natural rubber (NR) prices of (SMR20 and RSS4); second, it is to forecast a short-term exchange rate (ERP) of Malaysian Ringgit (RM per USD) and NR prices strongly represented in the Malaysian NR market. The short-term ex-ante forecast will be explored from January to June 2016 based on the estimation period of the monthly data from January 1990 to December 2015. Therefore, exchange rates volatility could affect NR prices directly or indirectly as explained by (Burger et al., 2002 July 16) and (Budiman and Fortucci, 2003). The direct effect from the exchange rates would affect the export price in the rubber trading countries. The indirect effect from provisional demand could either be commodity tentative or foreign exchange tentative. However, in the short term, rubber prices could be changed based on movements of the foreign currencies of the exchange rate.

According to (Budiman and Fortucci, 2003), other impacts of exchange rate volatility were as follow:

1. Increase in domestic prices, rising consumer prices and falling real wages, which will affect real household income,
2. Increase of proportionate value of external debt exposure,
3. Low business confidence and credit crunch because of exchange rate uncertainties, and
4. If the exchange rates continue to remain unstable, the economic growth rate will continue to worsen.

In terms of primary commodities, NR prices had risen from USD2,000/tonne in September 2009 to USD5,500/tonne in February 2011 in Malaysia (Figure 1). Export volume had increased from 690 thousand tonnes to 960 thousand tonnes from 2009 to 2011. However, the NR prices had started to decrease

severely from USD2, 100 per tonne in January 2014 to USD1,100 per tonne in December 2015; the exchange rate was RM4.29 per USD during the period in Figure 1.

Figure 1 showed that the USD had depreciated against Malaysia's currency and Malaysia's real exchange rate had started to decline from 1997-1998. When the NR price had decreased but the exchange rate for Malaysia (RM/USD) had gone up, it meant that the exchange rate was still unstable, and it was creating that uncertainty over future price levels. It would complicate investment and discourage economic growth as the NR price was extremely low again as experienced during the estimating period in this study. Additionally, currency movements may show a discrepancy implication on competitiveness of the external trade, debt, and foreign direct investment (NERP, 2014).

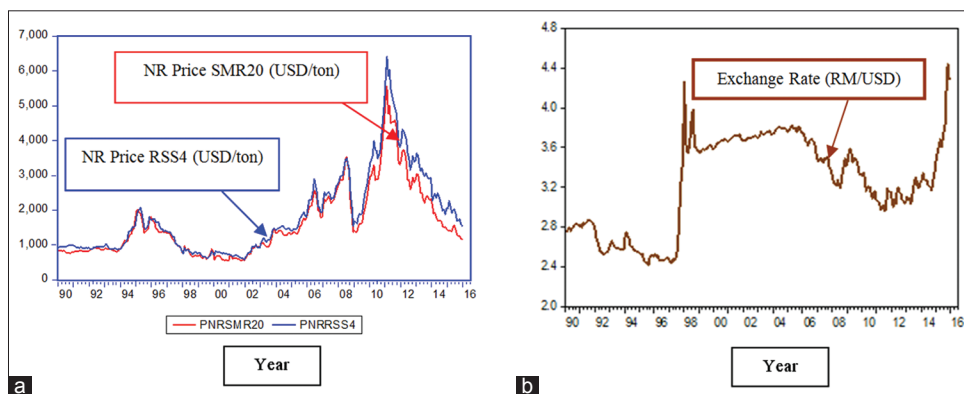
2. LITERATURE REVIEW

Osigwe and Uzonwanne (2015) suggested that there was a causality relationship between the foreign currency exchange rate and foreign direct investment (FDI). They used the unit root test for the stationary of the variables. They explained that all the variables became stationary at the first different level of the unit root test. Then, the variables were long-run relationship among the variables by Johansen co-integration test. The causality showed that unidirectional from foreign currency exchange rate and FDI at the lag section criteria mentioned the lag one to lag two selections. Moreover, there was bidirectional causality between foreign currency exchange rate and FDI at lag three selections. Therefore, it provided the knowledge and idea to establish this research methodology on the exchange rate volatility.

Jamil et al. (2012) investigated the exchange rate volatility on the industrial production of common currency in the European Monetary Union. They used the data from the monthly data collected from 1980 to 2009. The study used autoregressive EGARCH models for volatility analysis compared with nominal and real exchange rates. They found that all the industries were satisfied with the benefits after the introduction of common currency and even some industries also looked increasing in the exchange rate volatility. Thus, it could also provide that the currency changes had affected for every country that had joined the trading of their productivities.

Oskooee and Harvey (2014) studied the role of the exchange rate between the United States and Indonesia which traded agricultural commodities. Indonesia was the largest economy for trading the commodity in South East Asia. They estimated the currency depreciation on in-payments and out-payments in the trade. They disaggregated the trade flows between US and Indonesia. The sensitivity of in-payments was 108 United State export industries and out-payments were 32 United State import industries. They investigated that most industries responded to the exchange rate changes in the short-term but some were significantly affected in the long-term. This article endowed with the further study methodology about Asian countries exchange rate currency. Numerous old-fashioned theoretical studies as discussed by Ethier (1973) and Peree and Steinherr (1989) had indicated that

Figure 1: (a and b) Exchange rate volatility and natural rubber prices trends in 1990-2016



Source: MRB, 2015; ANRPC (2016) and (BNM, 2016)

an increase in exchange rate volatility exhibited adverse effects on international trade volume.

Whereas, Doroodian (1999) stated that this effect can only show in developing countries. This view was also shared by (Hooper and Kohlagen, 1978) who constructed a static model of demand and supply. Their results showed that the uncertainty of the exchange rate had negative effects on volume share; however, the volatility of the exchange rate had positive effects on trade price. flow shows that product prices became unstable if the volatility of the exchange rate had increased drastically under the floating exchange rate system. Therefore, firms with risk averse tendencies tended to decrease trade volume thus this affected real product prices. Simply put, the exchange rate volatility increased the exchange rate risk and thus reduced incentives of international trade. It was commonly acknowledged that increased exchange rate volatility restrained the growth of foreign trade. Negative effects of exchange rate uncertainty on trade flows supported the fact that exchange rate risk depressed trade flows (International Monetary Fund [IMF] (1984) and Clark et al. (2004). If movements in exchange rates became unpredictable, the profits made would be uncertain and, thus, depressed the benefits of international trade.

On the other hand, Thorbecke (2006) found that the exchange rate fluctuation would decrease Asian exports but export volume was not guaranteed to increase if the U.S. dollar depreciated. Therefore, the United States government should not expect the appreciation of Asian currencies to increase the export volume to the United States. Jarita (2008) tested the export and import price with the volatility of the exchange rate of the Malaysian ringgit from January 1999 to December 2006 via the vector error correction model (VECM). The results proved that the effects on export and import price from the volatility of the exchange rate were significant. On the contrary, a number of scholars think that exchange rate risk positively affected exports and imports with the explanation that exchange risk caused the substitution and income effect.

Giovannini (1998) discovered that when the exchange rate risk increased, most risk-neutral traders entered the market quickly and left the market slowly. The number of traders in the market would

increase, as will the trade volume. Bailey et al. (1986) assumed that traders could easily earn returns from the volatility of the exchange rate, coupled with knowledge of the trade. Franke (1991) proved that when the volatility of the exchange rate had increased, the cash flow from export increase was significantly greater than the entry and exit cost from the market for the trader who employed haphazard policies of entry and exit. De Grauwe (1988) & Broll and Eckwert (1999) proposed that the real options of export trade increased when the volatility of the exchange rate had increased.

The determinants of the NR price would affect the volatility of NR (latex) price in Malaysia (Sadali, 2013). Describing the high volatility in NR price, it was a relationship between the international trade (export and import), inflation and crude oil price. The data utilized the monthly data collected from 1998-2012. This paper tested the regression analysis and hypothesis testing between variables. The reason for the volatility of the NR price was clearly explained with the crude oil price, inflation, export, and import. Sadali (2013) mentioned that the NR import was a negative relationship between the prices. Also, it showed that crude oil price was a positive relationship with volatility of the price. Based on the findings, if the NR raw materials are imported from other countries, it would affect the decrease of the domestic NR price and consequently affect the world NR price as well. Thus, this article had also included the knowledge of the methodology on how to find the factors affecting the volatility of NR price.

On the aspect of factors affecting the NR price, Raju (2016) stated that synthetic rubber prices and crude oil prices affect NR prices whereby the decline in oil prices and the subsequent decline in the prices of synthetic rubber were some of the factors that have contributed to the volatility and instability in NR prices. He explained that if the NR exporting countries were affected by the economic slowdown especially with depreciation in the currencies and this was contributed to the decline in NR prices in these countries. This uncertainty will limit import capacity and thus result in lower investment and growth. The demand and supply volatility in both domestic and international markets could affect NR prices. In the case of NR, the domestic market is highly integrated with the international market. The instability in the prices in the international market has significantly affected the prices in the domestic market.

3. THEORETICAL FRAMEWORK AND METHODOLOGY

With previous literature reviews of commodity price analysis, this study focused on three issues in common: (i) The characteristics and determinants of commodity price volatility; (ii) its macroeconomic effects and; (iii) the optimal policy responses to such volatility (Cashin et al., 2002; Deaton, 1999; Khin et al., 2011 and 2013). Based on the literature, in Equation 1, the forecasts of NR price (SMR20) of the study particularly would be the function of the substitute natural rubber price of RSS4 and exchange rate price (RM/USD) (ERPM). A diagnosis checking for each variable is focused the data series for the stationary, using unit root test of the Augmented Dickey-Fuller (ADF) and Phillips-Peron's tests (PP) (Gujarati & Porter, 2009; Studenmund, 2014). The causal relationship is first analyzed along the VECM model with more efficient causality procedure (Engle and Granger, 1991). Both short-term forecasts of ERP and NR prices of (SMR20 and RSS4) will be tested by using (Pindyck and Rubinfeld, 1998). Originally, a short-term NR price VECM model mentioned as a function logs in below:

$$\Delta \text{PNRSMR20}_t = c_0 + a_1 \text{PNRRSS4}_{t-1} + a_2 \text{ERPM}_{t-1} + a_3 \text{PNRSMR20}_{t-1} + e_1 \quad (1)$$

Where:

PNRSMR20 = Price of natural rubber SMR20 in Malaysia (USD/tonne) deflated by the CPI

PNRRSS4 = Price of natural rubber RSS4 in India (USD/ton) deflated by the CPI

ERPM = Real exchange rate (Malaysia Ringgit (RM) per USD) (RM/USD)

T = Time trend monthly data from 1990 to 2015

e_i = Error terms

Moreover, we can write the other variables' VECM equations (2) and (3) as follows:

$$\Delta \text{PNRRSS4}_t = c_1 + a_4 \text{ERPM}_{t-1} + a_5 \text{PNRSMR20}_{t-1} + a_6 \text{PNRRSS4}_{t-1} + e_2 \quad (2)$$

$$\Delta \text{ERPM}_t = c_2 + a_7 \text{PNRSMR20}_{t-1} + a_8 \text{PNRRSS4}_{t-1} + a_9 \text{ERPM}_{t-1} + e_3 \quad (3)$$

c_s = Intercept; a_s = The coefficients of the related factors

Research hypotheses:

H_{01} : PNRSMR20 does not Granger cause PNRRSS4

H_{A1} : PNRSMR20 Granger cause PNRRSS4

H_{02} : PNRSMR20 does not Granger cause ERPM

H_{A2} : PNRSMR20 Granger cause ERPM

H_{03} : PNRRSS4 does not Granger cause PNRSMR20

H_{A3} : PNRRSS4 Granger cause PNRSMR20

H_{04} : PNRRSS4 does not Granger cause ERPM

H_{A4} : PNRRSS4 Granger cause ERPM

H_{05} : ERPM does not Granger cause PNRSMR20

H_{A5} : ERPM Granger cause PNRSMR20

H_{06} : ERPM does not Granger cause PNRRSS4

H_{A6} : ERPM Granger cause PNRRSS4

Moreover, this study used the Johansen co-integration test to estimate the long-run relationship between the variables and co-integrated. It is a statistical concept of the regression theory framework that described the long run equilibrium among the variables. Engle and Granger (1991) indicated that if a multiple linear regression of two or more non-stationary series was stationary, it was called the co-integrating equation and may be interpreted as a long-run equilibrium relationship among the variables. The Johansen co-integration equation for a short-term NR prices of (SMR20 and RSS4) and ERP is in Equation (4) as follows:

$$\text{Co-integration: } b_1 \text{PNRSMR20}_{t-1} + b_2 \text{PNRRSS4}_{t-2} + b_3 \text{ERPM}_{t-3} = 0 \quad (4)$$

b_s = The coefficients of the related factors

Engle and Granger (1991) found that the definition of causality was being used to determine the direction and causality between the two variables. Eigenvalue:

$$\begin{aligned} \text{PNRSMR20}_t = & \beta_1 \text{PNRSMR20}_{t-1} + \beta_2 \text{PNRSMR20}_{t-2} + \dots \\ & + \beta_p \text{PNRSMR20}_{t-p} \\ & + \alpha_1 \text{PNRRSS4}_{t-1} + \alpha_2 \text{PNRRSS4}_{t-2} + \dots \\ & + \alpha_p \text{PNRRSS4}_{t-p} + u_{2,t} \end{aligned} \quad (5)$$

$$\begin{aligned} \text{PNRSMR20}_t = & \beta_3 \text{PNRSMR20}_{t-1} + \beta_4 \text{PNRSMR20}_{t-2} + \dots \\ & + \beta_p \text{PNRSMR20}_{t-p} + \alpha_3 \text{ERPM}_{t-1} + \alpha_4 \text{ERPM}_{t-2} + \dots \\ & + \alpha_p \text{ERPM}_{t-p} + u_{2,t} \end{aligned} \quad (6)$$

$$\begin{aligned} \text{PNRRSS4}_t = & \beta_5 \text{PNRRSS4}_{t-1} + \beta_6 \text{PNRRSS4}_{t-2} + \dots + \beta_p \text{PNRRSS4}_{t-p} \\ & + \alpha_5 \text{PNRSMR20}_{t-1} + \alpha_6 \text{PNRSMR20}_{t-2} + \dots \\ & + \alpha_p \text{PNRSMR20}_{t-p} + u_{2,t} \end{aligned} \quad (7)$$

$$\begin{aligned} \text{PNRRSS4}_t = & \beta_7 \text{PNRRSS4}_{t-1} + \beta_8 \text{PNRRSS4}_{t-2} + \dots + \beta_p \text{PNRRSS4}_{t-p} \\ & + \alpha_7 \text{ERPM}_{t-1} + \alpha_8 \text{ERPM}_{t-2} + \dots + \alpha_p \text{ERPM}_{t-p} + u_{2,t} \end{aligned} \quad (8)$$

$$\begin{aligned} \text{ERPM}_t = & \beta_9 \text{ERPM}_{t-1} + \beta_{10} \text{ERPM}_{t-2} + \dots + \beta_p \text{ERPM}_{t-p} \\ & + \alpha_{10} \text{PNRRSS4}_{t-2} + \dots + \alpha_p \text{PNRRSS4}_{t-p} + u_{2,t} \end{aligned} \quad (9)$$

$$\begin{aligned} \text{ERPM}_t = & \beta_{11} \text{ERPM}_{t-1} + \beta_{12} \text{ERPM}_{t-2} + \dots + \beta_p \text{ERPM}_{t-p} \\ & + \alpha_{11} \text{PNRSMR20}_{t-1} + \alpha_{12} \text{PNRSMR20}_{t-2} + \dots \\ & + \alpha_p \text{PNRSMR20}_{t-p} + u_{2,t} \end{aligned} \quad (10)$$

α_s = The coefficients of the related factors; β_s = The coefficients of the related factors.

4. EMPIRICAL RESULTS

The results of the unit root test are presented in Table 1. The unit root test was previously defined by Gujarati and Porter (2009). If the data contained unit root, this data will be known as non-stationary, which may lead to spurious regression result. The hypotheses

Table 1: Unit-root tests for exchange rate and Malaysian NR prices

Variables	Unit root test				Stationary	
	Level		1 st difference		Level	1 st difference
	ADF	P-P	ADF	P-P		
PNRSMR20	-1.971	-1.792	-8.906***	-12.569***	Not Stationary	Stationary at I(1)
PNRRSS4	-1.771	-1.689	-8.992***	-12.756***	Not Stationary	Stationary at I(1)
ERPM	-1.136	-0.792	-15.138***	-15.083***	Not Stationary	Stationary at I(1)

St: Stationary; ***statistically significant at the 0.01 level. ADF: Augmented Dickey-Fuller, NR: Natural rubber

formed for testing the unit root; H_0 : The time series data has unit root (is non-stationary), and H_A : The time series data has no unit root (is stationary). The PNRSMR20 price, PNRRSS4 price, and ERPM were non-stationary at levels I(0) i.e., they had a unit root. Therefore, they were made by using unit root test at the first differencing I(1) level to become stationary. Thus, the time series were stationary at the first differences I(1) at the 0.01 level. The unit root (stationary) for this study has been tested by utilizing the Augmented Dickey-Fuller (ADF) and Phillip-Perron (P-P). First, it checked both ADF and P-P unit root test “t” statistic value. It was (-) negative and indicated the “t” statistic value was bigger than the “MacKinnon critical values” at all three levels of significance. Also, if each of ADF and P-P unit root test “t” statistic’s p-value was as like (0.0000) also less than at α 0.05 statistically significant, the time series data is no unit root (stationary).

Accordingly, the vector correction model (VECM) of the short-term NR price (SMR20) results was explained in Equation (11). In equation (11), the NR price (SMR20) forecasting model was explained by 65 percent of the variation using the RSS4 NR price and exchange rate parameters. There is a short-run relationship between independent variables of RSS4 NR price, exchange rate, the lag variable of SMR20 NR price (PNRSMR20_{t-1}) and dependent variable of SMR20 NR price (Δ PNRSMR20_t) at $\alpha=0.01$ and 0.05 level, respectively. Furthermore, the VECM model was included together with the short-run relationship between the variables and distributed lag variable. Therefore, (PNRSMR20_{t-1}) is a distributed lag variable of Δ PNRSMR20_t in this Equation (11). Moreover, the Breusch-Godfrey Serial Correlation LM test showed that residuals were significant at $\alpha=0.01$ level and it meant that the model had included the correct parameters. Residual diagnostics and parameter diagnostics contained the tools available for determining whether a selected model was valid.

$$\Delta\text{PNRSMR20}_t = 0.008 + 0.8694 \text{PNRRSS4}_{t-1} - 0.3073 \text{ERPM}_{t-1} - 0.4423 \text{PNRSMR20}_{t-1} + 0.0119 e_{1t} \quad (11)$$

t-statistics = [22.6708***] [-2.6483**]
[-3.8598**]

$R^2 = 0.6492$ Adjusted $R^2 = 0.6469$

Breusch-Godfrey serial correlation LM test

F-statistic = 1.5611 Prob. F(1,307) = 0.2125***

Obs*R² = 1.5734 Prob. Chi-Square(1) = 0.2097***

Note: t-statistics in [], ***statistically significant at the 0.01 level, **at the 0.05 level, and *at the 0.10 level.

Based on the results, in Equation (12), the NR price (RSS4) VECM forecasting model was explained by 57 percent of the variation using the SMR20 NR price and exchange rate parameters. There is also a short-run relationship between independent variables of SMR20 NR price (PNRSMR20_t), exchange rate and dependent variable of RSS4 NR price (Δ PNRRSS4_t) at α 0.05 level, however, the lag variable of RSS4 NR price (PNRRSS4_{t-1}) is not statistically significant.

$$\Delta\text{PNRRSS4}_t = 0.142 + 0.3863 \text{PNRSMR20}_{t-1} - 0.2190 \text{ERPM}_{t-1} - 0.0339 \text{PNRRSS4}_{t-1} + 0.0155 e_{2t} \quad (12)$$

t-statistics = [3.4817**] [-2.1724**]
[-0.3118ns]

$R^2 = 0.5707$ Adjusted $R^2 = 0.5611$

Based on the results, Equation (13) is the output of the exchange rate volatility (ERPM) VECM model. In Equation (13), the exchange rate (ERPM) forecasting model was explained by 54 percent of the variation using the SMR20 and RSS4 NR price parameters. There is also a short-run relationship between independent variables of SMR20 NR price (PNRSMR20_t), RSS4 NR price (PNRRSS4_{t-1}), the lag variable of exchange rate (ERPM_{t-1}) and dependent variable of exchange rate (Δ ERPM_t) at $\alpha = 0.05$ level, respectively.

$$\Delta\text{ERPM}_t = 0.013 - 0.0291 \text{PNRSMR20}_{t-1} - 0.0287 \text{PNRRSS4}_{t-1} + 0.2632 \text{ERPM}_{t-1} + 0.0051 e_{3t} \quad (13)$$

t-statistics = [-4.7035**] [-4.7501**]
[-4.2145**]

$R^2 = 0.5496$ Adjusted $R^2 = 0.5398$

After they were given the unit root test in I(1), they were tested for Johansen co-integration Equation (14) and test in Table 2. The Johansen co-integration equation for a short-term NR prices of (SMR20 and RSS4) and ERP is in Equation (14) as follows:

$$\text{Co-intEquation: } 0.2927 \text{PNRSMR20}_{t-1} - 0.5096 \text{PNRRSS4}_{t-1} + 0.1929 \text{ERPM}_{t-1} = 0 \quad (14)$$

t-statistics = [-2.4456**] [-4.8520**]
[-5.3604***]

Therefore, based on Equation (14), there is a long-term relationship between NR price (SMR20) (PNRSMR20_{t-1}), RSS4 (PNRRSS4_{t-1}) and exchange rate (ERPM_{t-1}) at α 0.05 and 0.01 level statistically significant and they are co-integrated each other in Table 2.

Table 2 shows Ho: There are no long-run and co-integration relationship between the variables. HA: There is long-run and co-integration relationship between the variables at the 5% and 1% level. It is based on P-values (5% and 1% level) of Eigenvalue and Trace Statistic. Eigenvalue and Trace statistics indicate 3 cointegrating equations significant long-run relationship at the 0.05 and 0.01 level. This means that there is a long-run relationship between NR prices of PNRSMR20 price, PNRRSS4 price, and ERPM exchange rate. Evidence of co-integration suggested the granger causality (Table 3) also showed Ho: PNRSMR20 does not Granger cause to PNRRSS4 and HA: PNRSMR20 Granger causes PNRRSS4 and so on. The results mentioned that one direction (unidirectional causality) from PNRRSS4 price to PNRSMR20 price; and from PNRRSS4 price to ERPM exchange rate at lag order 1, 2 and 3.

It indicated that if RSS4 price had high instability, it created volatility of SMR20 price as well as the exchange rate. Otherwise, the Malaysian NR price (SMR20) are related to increase or decrease based on the world NR prices such as India rubber price (RSS4), Shanghai rubber price, Japan rubber price (TOKOM), Singapore rubber price (SICOM) and so on (ANRPC, 2016). Also, currency exchange rate volatility can affect the NR price because most agricultural commodities are traded in USD. Osigwe and Uzonwanne (2015) analyzed also the Granger causality of foreign reserves, exchange rate and foreign direct investment (FDI). All of the variables were non-stationary at levels I(0) and became stationary after the first differences I(1). Moreover, the result proved that there was a long-run relationship among the variables and the Granger causality test which indicated unidirectional causality from exchange rate to other variables at lag order 1 and 2.

Cashin et al. (2004) explained that the real exchange rates of commodity-exporting countries and the real prices of their commodity exports had instability together over time. There was also a long-run relationship between real exchange rate and real commodity prices. They proved that the long-run real exchange rate and the prices of export commodities were not constant. Also, Dauvin (2014) used the cointegrating relationship between the real exchange rate and oil prices. He investigated the relationship between energy prices (oil prices) and the real effective exchange rate of commodity-exporting countries. He found that increased commodity price volatility caused the uncertainty the future exchange rate and it may affect the countries' economic growth. Figure 2 described both short-term NR prices (PNRSMR20 and PNRRSS4) and ERPM ex-ante forecasts would be slightly increasing trend from January to June 2016.

5. CONCLUSION

This study determined the impact of exchange rate volatility on both NR prices of (SMR20 and RSS4); and predicted the forecast of a short-term exchange rate (RM per USD) and both NR prices (SMR20 and RSS4) strongly represented in the Malaysian NR market. The results showed that between RSS4 price, SMR20 and ERP were a Granger-cause and unidirectional relationship. Both short-term NR prices and ERPM ex-ante forecasts would be a slightly increasing trend from January to June 2016. It may be due to the government and traders in changing their behaviour by increasing domestic consumptions for the stabilization of the NR supply-demand balance. Products like rubber tires, footwear, gloves, condoms and catheters of rubber products and latex products

Table 2: Johansen's co-integration test (intercept and no trend)

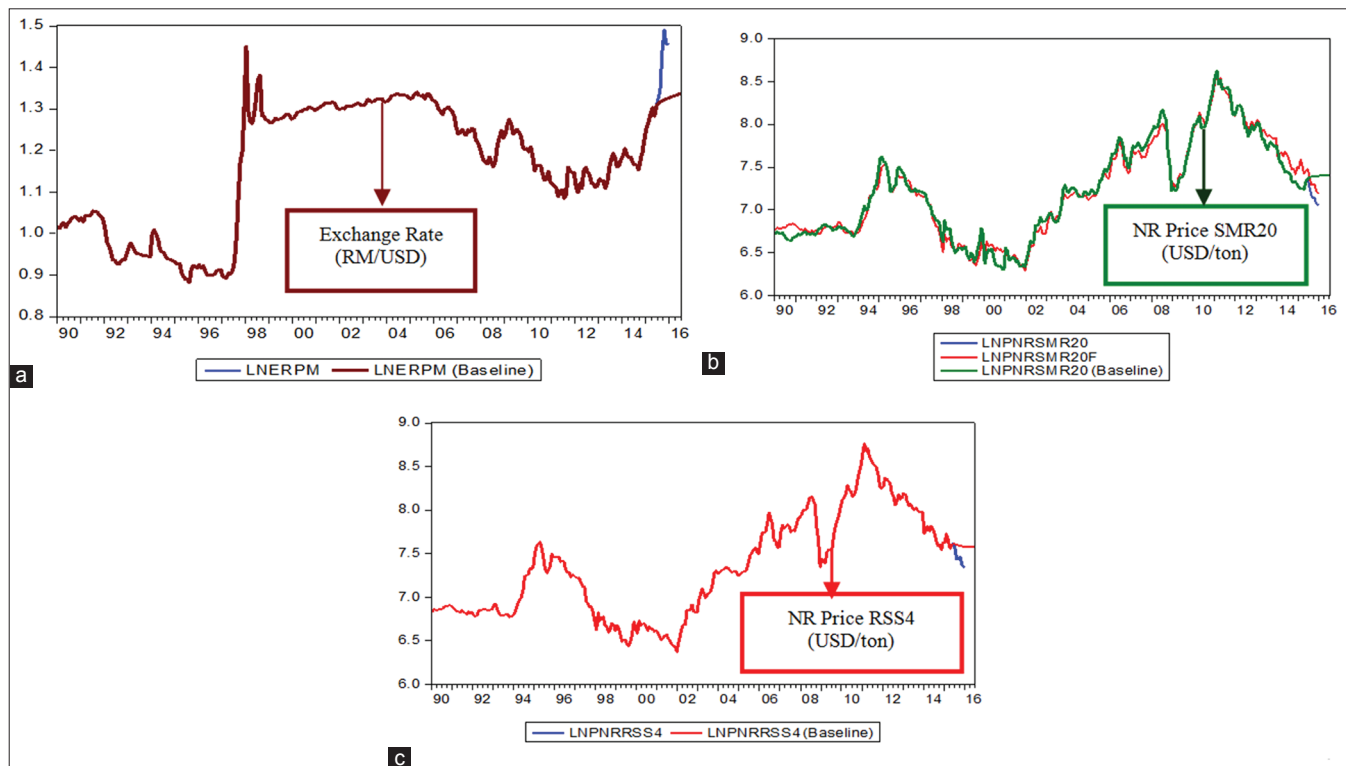
Hypothesized No. of CE (s)	Eigen value	Trace statistic	0.05 critical value	P-value	0.01 critical value	P-value
None*	0.3969	350.7542	29.7971	0.0001	35.4582	0.0001
At most 1*	0.3272	194.4782	15.4947	0.0001	19.9371	0.0001
At most 2*	0.2079	72.0246	3.8415	0.0000	6.6349	0.0000

Eigen and Trace statistics indicate 3 cointegrating eqn (s) at the 0.05 and 0.01 level. *denotes rejection of the hypothesis at the 0.05 and 0.01 level; **MacKinnon-Haug-Michelis (1999) P values

Table 3: Granger causality analysis and hypotheses testing decision

Null hypothesis	Lag order	F-statistic (P)	Hypothesis testing
PNRSMR20 → does not Granger cause PNRRSS4	1	0.172 (0.6780)	Not supported
PNRSMR20 → does not Granger cause ERPM		0.441 (0.5067)	Not supported
PNRRSS4 → does not Granger cause PNRSMR20		5.318**(0.0211)	Supported
PNRRSS4 → does not Granger cause ERPM		5.475**(0.0245)	Supported
ERPM → does not Granger cause PNRSMR20		0.0176 (0.8946)	Not supported
ERPM → does not Granger cause PNRRSS4		0.073 (0.7869)	Not supported
PNRSMR20 → does not Granger cause PNRRSS4	2	3.900 (0.1422)	Not supported
PNRSMR20 → does not Granger cause ERPM		1.151 (0.5625)	Not supported
PNRRSS4 → does not Granger cause PNRSMR20		16.957*** (0.0002)	Supported
PNRRSS4 → does not Granger cause ERPM		18.894** (0.0389)	Supported
ERPM → does not Granger cause PNRSMR20		1.740 (0.4190)	Not supported
ERPM → does not Granger cause PNRRSS4		2.491 (0.2888)	Not supported
PNRSMR20 → does not Granger cause PNRRSS4	3	3.325 (0.3441)	Not supported
PNRSMR20 → does not Granger cause ERPM		2.134 (0.5450)	Not supported
PNRRSS4 → does not Granger cause PNRSMR20		16.772*** (0.0008)	Supported
PNRRSS4 → does not Granger cause ERPM		19.432** (0.0384)	Supported
ERPM → does not Granger cause PNRSMR20		3.144 (0.3698)	Not supported
ERPM → does not Granger cause PNRRSS4		3.611 (0.3067)	Not supported

****Denotes rejection of the null hypothesis at the 0.01 and 0.05 level, respectively

Figure 2: (a-c) Short-term ex-ante forecasts of both natural rubber (NR) prices (log data) and exchange rate (log data) in the Malaysian NR market

selling industries and rubberwood products selling furniture industries, which use raw materials and export the rubber products in US dollars, would have benefited from this study's findings. Significantly, it is also encouraged that information be available for Malaysian rubber industries because they are still producing positive net trade flows, provide steady employment and consistent earnings for the government. For further studies, authors are willing to do the comparative forecasting accuracy by using univariate Autoregressive Integrated Moving Average (ARIMA), simultaneous system equation, and Autoregressive Conditional Heteroskedasticity (ARCH) type models with stationarity test. It would be directly considered in enhancing the validity of the current studies and providing new evidence on the impact of exchange rate volatility and comparative forecasting accuracy among the models. It will be based on the Root Mean Squared Error (RMSE), the Mean Absolute Error (MAE), the Root Mean Percent Error (RMPE) and Theil's inequality coefficients (U-Theil) criteria towards Malaysia's commodity trading with the other natural rubber producing countries.

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