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Exchange Rate Volatility and Leading Export Commodities of Plantations in Indonesia: The Gravity Model Approach

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Abstract
The plantation sector is a sector that has an important and strategic role in development. This is reflected in the role of the plantation sector as a provider of employment opportunities, meeting the domestic industry's needs for consumption and raw materials and achieving added value through increased competitiveness. This study aims to analyze the effect of the real exchange rate and volatility on Indonesia's leading plantation export commodities to trade partner countries from 1997 to 2016. The research method used is the estimated gravity model with fixed or random effects. The results showed that the exchange rate and volatility positively and negatively affected plantation exports. Thus, the Government must adopt policies to increase the competitiveness of domestic products and anticipate competition between domestic exporters. In addition, exchange rate stabilization policies are needed to control volatility to reduce uncertainty's impact on Indonesia's plantation exports.

Keywords: Exchange Rate, Leading Estate Crops, Export, Panel Data, Gravity Model

Volatilitas Nilai Tukar dan Komoditas Ekspor Unggulan Perkebunan Indonesia: Pendekatan Model Gravitasi

Abstrak
Sektor perkebunan merupakan salah satu sektor yang mempunyai peran penting dan strategis dalam pembangunan. Hal ini tercermin dari peran sektor perkebunan sebagai penyedia peluang bekerja, pemenuhan kebutuhan konsumsi dan bahan baku industri dalam negeri serta dalam pencapaian nilai tambah melalui peningkatan daya saing. Penelitian ini bertujuan untuk menganalisis pengaruh nilai tukar riil dan volatilitas terhadap komoditas unggulan ekspor perkebunan Indonesia ke negara mitra dagang perode tahun 1997 hingga 2016. Metode penelitian yang digunakan adalah model gravitasi yang diestimasi dengan dengan efek tetap atau acak. Hasil penelitian menunjukkan bahwa nilai tukar dan volatilitas berpengaruh positif dan negatif terhadap ekspor perkebunan. Dengan demikian, Pemerintah harus mengambil kebijakan untuk meningkatkan daya saing produk dalam negeri dan mengantisipasi persaingan antar eksportir dalam negeri. Selain itu, kebijakan stabilisasi nilai tukar diperlukan untuk mengendalikan volatilitas guna mengurangi dampak ketidakpastian terhadap ekspor perkebunan Indonesia.

Kata kunci: Nilai Tukar, Komoditas Perkebunan Unggulan, Ekspor, Data Panel, Model Gravitasi

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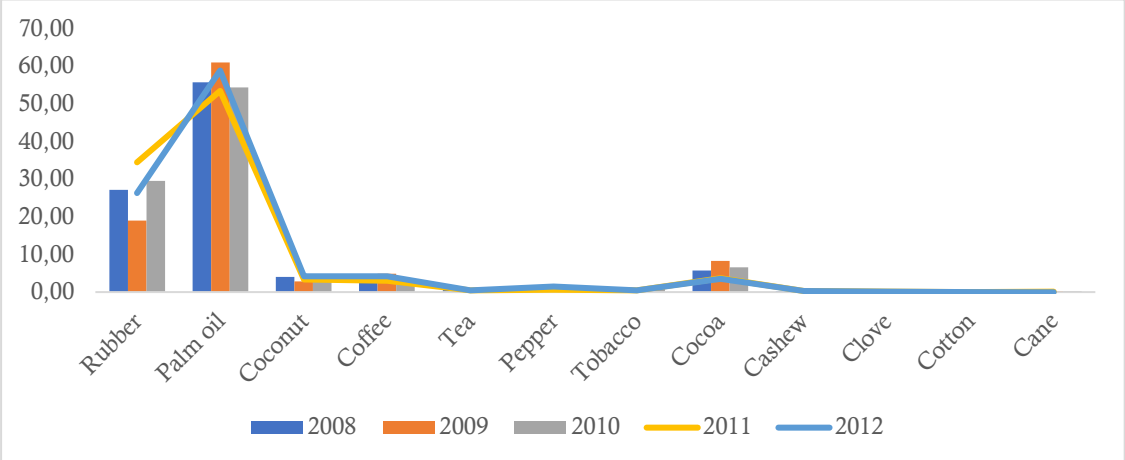
INTRODUCTION

Globalization has made countries dependent and reliant on one another; they cannot stand alone. Countries need each other, among others, to meet the needs of goods and services

from each of these countries. Every country has limited resources to meet all its needs; thus, it is crucial to have international trade.

Indonesia is one of the suppliers of oil and gas and non-oil and gas exports globally. At least 140 countries are Indonesia's export destinations. Non-oil and gas exports dominate Indonesia's export products. One of Indonesia's vital non-oil and gas sectors is the agricultural sector, as seen from its significant contribution to the Gross Domestic Product (GDP) of around 13.14% in 2017 or second only to the manufacturing sector (Central Bureau of Statistics, 2018).

The development of Indonesian exports from 2011 to 2017 shows that Indonesia's non-oil and gas exports' average reached 84.93%, while the oil and gas exports only reached 15.07%. This signals the Government to establish policies to increase non-oil and gas exports as it overgrows (Central Bureau of Statistics, 2017). One potential non-oil and gas sector is estate crops, a sub-sector of the agricultural sector. The GDP contribution of estate crops to GDP was around 3.47% in 2017, the biggest in the agricultural sector. This subsector provides employment, exports, and economic growth (Ditjenbun, 2019). The estate crops sub-sector has more than 100 commodities, and twelve are superior strategic commodities because they have high economic value and are essential in improving community welfare. The twelve commodities include rubber, palm oil, coconut, coffee, tea, pepper, tobacco, cocoa, cashews, cloves, cotton, and sugar cane.



Source: Directorate General of Estate Crops, processed data.

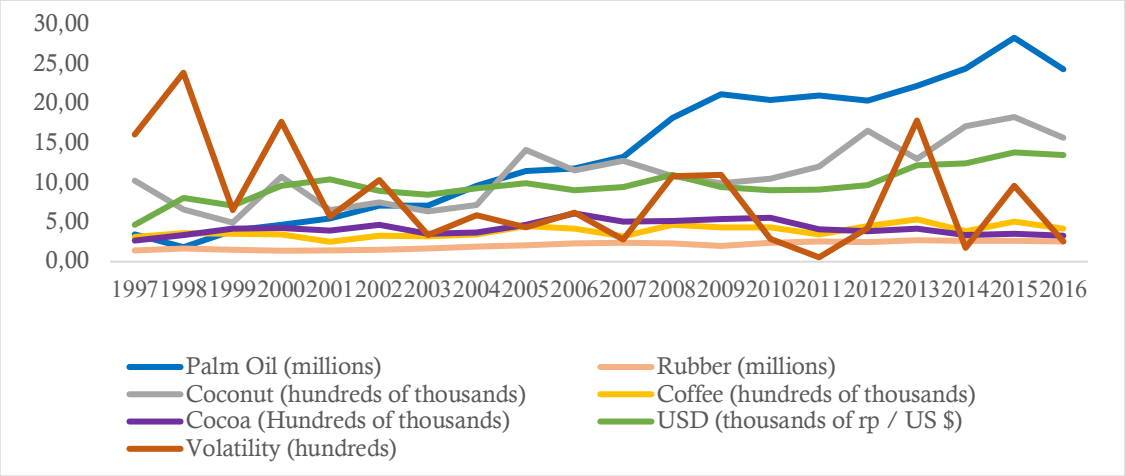
Figure 1. Percentage of Export Value of Indonesia's Leading Estate Crops against its Total in 2008-2012 (thousands of US)

Figure 1 above shows that palm oil, coconut, rubber, coffee, and cocoa have the most significant average export value of the twelve leading Indonesian estate crops from 2008 to 2012. In this case, palm oil has the highest average export value with US $ 14,214.8 thousand, a 56.74% average of the total leading Indonesian estate crops.

Since August 1997, Indonesia has adopted a free-floating exchange rate system to respond to the mid-1997 exchange rate crisis. Afterward, Indonesia faced volatility in foreign currency exchange rates as Rupiah's exchange rate against foreign currencies is

determined by market mechanisms (Goeltom & Zulverdi, 2003). *Exchange rate volatility* is an exchange rate uncertainty that can disrupt economic activity. In international trade, the price of a country's currency significantly determines export and import prices; its changes will result in economic prosperity (Sakitandi, Jiun, Tiong, & Robinson, 2003). This is in line with the research of Sercu & Uppal, (2003), where exchange rates substantially impact exchange rate certainty; thus, identifying the relationship between monetary policy on the exchange rate is needed to reduce trade variability in exports and imports.

Goeltom & Zulverdi (2003) states that the depreciation of a country's currency affects businesses' competitiveness in international competition. The depreciation may lead to an increase in demand for exported goods. To determine the relationship of exchange rate volatility in the free-floating exchange rate system on selected Indonesian estate crops, Figure 2 below plots 20 years of data from 1997-2016 to identify the data trends.



Source: Indonesian Statistics, 1997-2016. BPS (processed data)

Figure 2. Export Volume of Selected Commodities (Tons) and Exchange Rates and Volatility (USD) in 1997-2016

Figure 2 above plots the selected Indonesian estate crops with the Rupiah exchange rate against the US dollar and their volatility in different units for each unit. The volume of palm oil and rubber in millions of tonnes, and coconut, coffee, and cocoa in hundreds of thousands. Different volume units indicate different export volumes for estate crop commodities.

Volatility units in the unit of thousands indicate a fluctuating exchange rate. In 1998 there was a depreciation of the Rupiah exchange rate against the US dollar, but several estate crop exports had decreased demand, such as palm oil and coconut. The same thing happened in 2010; there was an exchange rate appreciation, but coconut, rubber, coffee, and cocoa had an increase in export demand. Demands will decrease when the price increases and the demands increase when the price decreases; in other words, the demand is negatively related to the price. This relationship between price and quantity is called the law of demand (Mankiw, 2009).

The GDP levels of exporting and importing countries also influence the demand for Indonesian export commodities. The bigger the GDP of the exporting country, the greater

the production capacity, allowing exports to increase. Meanwhile, the importing country's GDP measures the increased production capacity and the country's purchasing power. The greater the country's GDP, the greater the demand for palm oil export from Indonesia, and vice versa (Baniya, Rocha, & Ruta, 2020). Distance is a proxy for transportation costs, a barrier to international trade. This is because distance increases transportation costs and thus reduces trade opportunities. Thus, this study includes the distance between Indonesia and its five trading partners.

Previous studies suggest a relationship between exchange rates and their volatility with export demand. Utami & Dewi, (2018) states that the gravity model shows that Indonesia's real GDP and Indonesia's exchange rate against trading partners, and economic distance against trading partners significantly affect Indonesia's coffee beans export. Yanikkaya, Kaya, & Kocturk, (2013) analyzed the relationship of exchange rate volatility on Turkish agricultural commodities in 46 importing countries using the gravity model and showed that the exchange rate level significantly affected almost all export commodities. In the short and long term, exchange rate volatility significantly affects these export commodities. Purwanto, Erfit, & Mustika,(2021) states that the development of Indonesian coffee exports to Japan from 2000-2017 averaged -3.81%, coffee production at 0.99%, world coffee prices at 6.40%, and the rupiah exchange rate against the dollar 2.54%.

Moreover, during the 2000-2017 period, Indonesian coffee production and the exchange rate of the rupiah against the dollar significantly affected Indonesian coffee exports to Japan, while world coffee prices had no significant effect on Indonesian coffee exports to Japan. Chamunorwa & Choga (2015) showed that exchange rate volatility significantly negatively affected South African exports from 2000-2011. Volatility shows that it has a positive influence on exports in the research of Ishimwe & Ngalawa (2015) due to the consequences of an open economic system where exporting countries cannot store an excess supply of goods that arise due to increased exchange rate volatility to avoid reducing income arising from these risks, they export more. Zainal (2008) explains that the export sector cannot adapt to the existing economic conditions (exchange rate volatility).

This research provides critical empirical contributions by examining the relationship of exchange rate volatility against Indonesian export commodities' demand to Japan, China, The United States, Singapore, and Malaysia. Second, this study applies a gravity model to the equation; thus, other variables include the real GDP of trading partners, prices of the export commodities, and the distance between Indonesia and its trading partners. Third. This study conducted five regressions on each selected estate crop (palm oil, rubber, coconut, coffee, and cocoa).

METHOD

This research primarily focuses on analyzing exchange rates and volatility on demand for five Indonesian estate crop exports using the gravity model. Other variables on the gravity model are trading partners' real GDP, export commodity prices, and the economic distance between Japan, China, the United States, Singapore, and Malaysia as trading partners with Indonesia. The objects in this study are the variables of export volume (palm oil, coconut,

rubber, coffee, and cocoa), exchange rate, exchange rate volatility, real GDP of trading partners, export commodity prices, and the economic distance between Japan, China, The United States, Singapore, and Malaysia as Indonesia's largest trading partners in 1997 - 2016. This research covered 1997 to 2016, or 20 years to identify seasonal patterns of data and the effect of exchange rates when the exchange rate system was freely floating. This research uses descriptive and quantitative approaches. According to Husein (2011), descriptive design describes a phenomenon's nature or characteristics. This study's descriptive data provides a structured, factual, and accurate picture of the effect of exchange rate volatility on demand for selected Indonesian export commodities and other factors. The quantitative approach uses computable data to produce robust and relevant quantitative assessments. The quantitative technique used is the econometric technique. This study used a gravitational model approach based on Newton's law of gravity.

Meanwhile, determining the relationship between exchange rates and volatility on the export volume of five Indonesian estate crops used a quantitative analysis with an econometric model approach modified from the research of Li, Song, & Zhao, (2010). The study uses a fixed or random effect data regression panel method based on the Hausman test results and using the gravity equation model. Mauro, (2000) states that trade flow using the gravity equation is estimated better through the Fixed Effect panel data regression method because the equation follows the gravity model. To determine each variable's relationship, multiple linear regression analysis was used with the fixed or random effect panel data regression method to analyze the effect of export demand for selected estate crops commodities on the explanatory variable (independent variable). The research model specifications are as follows:

$$Q_t = f\left(Er_{jt}, Vol_{jt}, P_t, I_{jt}, ED_{jt}\right); \quad (1)$$

with

$$Vol_{jt} = \left[\left(\frac{1}{m}\right)\sum_{i=1}^{m}(Er_{jt}{}_{i-t-1} - Er_{jt}{}_{i+t-2})^2\ \right]^{1/2} \quad (2)$$

$$ED_{jt} = D_{jt}\ \frac{I_{jt}}{\sum I_{jt}} \quad (3)$$

Then

$$Q_t = f\left(Er_{jt}, \left[\left(\frac{1}{m}\right)\sum_{i=1}^{m}(Er_{jt}{}_{i-t-1} - Er_{jt}{}_{i+t-2})^2\ \right]^{1/2}, P_t, I_{jt}, D_{jt}\ \frac{I_{jt}}{\sum I_{jt}}\right) \quad (4)$$

where j are trading partners (Japan, China, The United States, Singapore, and Malaysia), t is annual data, m is the degree of moving average (moving average = 3), Q_t is the total export volume of selected Indonesian estate crops, Er_{jt} is the exchange rate, Vol_{jt} is the exchange rate volatility, P_t is the price of selected estate crops, I_{jt} is the real GDP of trading partners, ED_{jt} is the economic distance, D_{jt} is geographic distance dan $\mathcal{E}_{jt}$ is the error-term.

Equations (1) and (3) are the basic forms of the gravity and economic distance equations taken from the research of Li, Song, & Zhao, (2010), which modified independent variables, and equation (3.2) is taken from the research of Arize, Osang, & Slottje, (2000). Equation (4) is then converted into the gravity equation with the following form:

$$Q_t = \beta_0 \, Er_{jt}^{\beta_1} Vol_{jt}^{\beta_2} P_t^{\beta_3} \, I_{jt}^{\beta_4} \, ED_{jt}^{\beta_5} \qquad (5)$$

by carrying out logarithmic transformations and using the fixed or random effect panel data regression methods such as the research of Li, Song, & Zhao, (2010), the linear equation is obtained as follows:

$$logQ_t = \beta_0 + \beta_1 logEr_{jt} + \beta_2 \, logVol_{jt} + \beta_3 \, logP_t + \beta_4 \, logI_{jt} + \beta_5 \, logED_{jt} + \varepsilon_{jt} \qquad (6)$$

variable j is the id code of the trading partner, where j = 1 (Japan), j = 2 (China), j = 3 (The United States), j = 4 (Singapore) and j = 5 (Malaysia). Meanwhile, data and data sources for variables can be seen in Table 1 below.

Table 1. *Operationalization of Variables*

No	Variables	Symbol	Data Sources
1	Real exchange rate	Er_{jt}	World Bank
2	Exchange rate volatility	Vol_{jt}	World Bank
3	Real GDP of trading partner countries	I_{jt}	World Bank
4	Export prices	P_t	Statistik Indonesia, BPS
5	Economic distance	ED_{jt}	Cepii, research and expertise on the world economy
6	Export	Q_t	Statistik Indonesia, BPS

Based on the general hypothesis of the research, further, more detailed hypotheses can be made as follows:

- H1: The real exchange rate positively affects Indonesia's selected plantation commodity exports to destination countries.
- H2: Exchange rate volatility has a negative effect on exports of selected Indonesian plantation commodities to destination countries.
- H3: Export prices of selected plantation commodities have a negative effect on Indonesia's exports of selected plantation commodities to destination countries.
- H4: The real income of trading partner countries positively affects Indonesia's selected plantation commodity exports to destination countries.
- H5: Economic distance has a negative effect on exports of selected Indonesian plantation commodities to destination countries.

There are 3 (three) classical assumptions that must be tested to estimate the Ordinary Least Square and determine whether the estimation results are the best linear unbiased estimation (BLUE) or not. The three classical assumptions are: (1) no multicollinearity

between independent variables, (2) no heteroscedasticity, and (3) no serial correlation in residuals.

FINDING AND DISCUSSION

The Hausman test is carried out to choose the best model between the fixed or the random effect (Wooldridge, 2013). This test is based on the assumption that the two models are better than the common effect or OLS. The Hausman test follows the chi-square statistical distribution with the degree of freedom of k, where k is the number of independent variables. If the probability value is greater than 0.05 (α = 5%), then the selected model is a random effect, but otherwise, the fixed effect is chosen.

Table 2. *Hausman Test Results*

Equations	Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob
1	Cross-section random	110.42	5	0.0000
2	Cross-section random	0.34	5	0.9969
3	Cross-section random	4.32	5	0.5042
4	Cross-section random	0.16	5	0.9995
5	Cross-section random	5.69	5	0.3373

Based on Table 2, equation (2) of the total volume of rubber exports (Q_t2), equation (3) of the total volume of coconut exports (Q_t3), equation (4) of the total volume of coffee exports (Q_t4) and equation (5) of the total volume of cocoa exports (Q_t5) equals to the probability of cross-section Chi-Square is> = 5%; thus, Ho is rejected, resulting in the user panel data being random effect. Equation 1 has the total volume of palm oil exports (Q_t1) and the probability value of the cross-section of Chi-Square <= 5%; thus, Ho is not rejected, resulting in the user panel data being fixed effect.

Multicollinear Test

The correlation test is one way to test for the absence of multicollinearity problems. The correlation between one variable and another will be seen in this test. If the coefficient value is more than 0.80, the model has a multicollinearity problem, and if the coefficient value is not more than 0.80, the model has no multicollinearity problem (Oliver & Gujarati, 1993). The estimation result indicates a multicollinearity problem in the model of total palm oil export volume (Q_t1), total rubber export volume model (Q_t2), the coconut total export volume model (Q_t3), total export volume model of coffee (Q_t4). The total volume model of cocoa exports (Q_t5) (see appendix).

Heteroscedasticity and Autocorrelation Test

Heteroscedastic is a condition where a model does not have constant variance (Oliver & Gujarati, 1993). This condition will cause the regression coefficients to be inefficient. Meanwhile, autocorrelation symptoms arise because observations with time-series data are

interrelated. The results of the palm oil commodity heteroscedasticity test using the Wald test method show that the palm oil export volume model is free from heteroscedasticity problems with a significance level of 10%. In contrast, the export volume model for rubber, coconut, coffee, and cocoa is free from heteroscedasticity problems because it uses the Pooled EGLS model. Furthermore, using the Wooldridge test method, the palm oil commodity autocorrelation test results show that the export volume model is free from autocorrelation problems with a significance level of 1%. In contrast, the export volume model for rubber, coconut, coffee, and cocoa is free from autocorrelation problems because it uses the model (see appendix).

By using panel data using the fixed effect method or random effects through the Hausman test, the results show that the equation for oil palm export volume (Q_{t1}) uses the fixed effect method, the random effect on the rubber export volume equation (Q_{t2}), the random effect on the coconut export volume equation (Q_{t3}), random effect on the volume of coffee exports equation (Q_{t4}) and random effect on the equality of cocoa export volume (Q_{t5}). The estimation results of this study can be seen in Table 3 below.

Table 3. *Estimation Results of Plantation Export Demand Model*

	$LOG(Q_{t1})$ (Palm oil)	$LOG(Q_{t2})$ (Rubber)	$LOG(Q_{t3})$ (Coconut)	$LOG(Q_{t4})$ (Coffee)	$LOG(Q_{t5})$ (Cocoa)
C	-17.072***	1.326***	-14.727***	-2.488	0.756
	(2.729)	(0.499)	(2.093)	(2.658)	(3.898)
$LOG(Er_{jt})$	-0.813***	0.019	-0.107***	-0.089***	0.094**
	(0.105)	(0.011)	(0.038)	(0.034)	(0.039)
$LOG(Vol_{jt})$	-0.103***	-0.010*	0.055***	0.047***	-0.050**
	(0.017)	(0.006)	(0.0198)	(0.017)	(0.020)
$LOG(P_t)$	-0.510***	0.041***	-0.285***	-0.071*	-0.239***
	(0.119)	(0.002)	(0.064)	(0.039)	(0.047)
$LOG(I_{jt})$	1.784***	0.590***	1.311***	0.709***	0.563***
	(0.117)	(0.024)	(0.100)	(0.126)	(0.183)
$LOG(ED_{jt})$	-1.544***	-0.590***	-1.315***	-0.712***	-0.559***
	(0.139)	(0. .023)	(0.102)	(0.127)	(0.184)
R2	0.1451	0.8898	0.6576	0.5056	0.3640
F/χ	F(4, 90) = 4.68	χ(5)= 759.23	χ(5)= 180.53	χ(5)= 96.12	χ(5)= 53.81

* Significant at 10%, ** Significant at 5%, *** Significant at 10%
The values in parentheses are the standard error

Palm Oil Export Demand Model

The exchange rate variable (Er_{jt}) shows a negative coefficient direction of - 0.813 and is significant at the 1% level. This shows that a higher exchange rate (Er_{jt}) or depreciation of 1% will reduce the volume of palm oil exports (Q_t) by 0.813% per year, assuming ceteris paribus, which means that as value increases, the trading partners have a negative relationship towards the volume of palm oil exports. These findings do not follow the

hypothesis that the real exchange rate has a positive effect on exports of selected Indonesian plantation commodities to destination countries but follow previous research. The negative relationship of exchange rates during depreciation on export volume follows Yanikkaya, Kaya, & Kocturk (2013) assumption, which states that these commodities are insensitive to real exchange rates due to the market structure and monopolistic power of palm oil producers on international trade. According to Purnamasari, Hanani, & Huang (2014), the appreciation of the Rupiah's exchange rate against the trading partner's exchange rate will increase commodity exports. This is due to excess demand, which causes positive imports from trading partners.

The exchange rate volatility variable (Vol_{jt}) shows a negative coefficient direction of -0.103 and is significant at the 1% level, assuming ceteris paribus. These results are consistent with the hypothesis that exchange rate volatility has a negative effect on exports of selected Indonesian plantation commodities to destination countries. This negative relationship of exchange rate volatility on export volume follows Ketenci, (2017) research, where exchange rate volatility significantly reduces the average growth of export volume before liberalization in Turkey. Exchange rate volatility is an exchange rate uncertainty where its increase disrupts economic activity, including trade, and weakening exports. This study's results also align with Ekananda, (2005) and Mauro, (2000), stating that a volatile exchange rate indicates a high uncertainty. The higher exchange rate volatility causes an increase in production costs to overcome uncertainty and reduce international trade flows. Meanwhile, Antonius's research (2001) on the free-floating exchange rate explains that the uncertainty of the real effective exchange rate significantly impacts non-oil and gas real exports in the long run.

The palm oil export price variable (P_t) shows a negative coefficient of -0.510 and is significant at the 1% level. This shows that every 1% increase in the export price of palm oil (P_t) will reduce the volume of palm oil exports (Q_t) by 0.510% per year, assuming ceteris paribus. This means that the increasing export price of coconut palm oil has a negative relationship with the volume of palm oil exports. This finding follows the hypothesis that the export price of selected plantation commodities has a negative effect on exports of Indonesia's selected plantation commodities to destination countries. This negative relationship of export prices on export volume follows Hendria, Oktaviani, & Sartono (2018) demands will decrease when the price increases and demand increases when the price decreases; in other words, the export price has a significant effect in reducing the average growth of export volume.

The real GDP variable of trading partners (Japan, China, The United States, Singapore, and Malaysia) (I_{jt}) shows a positive coefficient direction of 1,784 and is significant at the 1% level, assuming ceteris paribus. These findings are consistent with the hypothesis that trading partner countries' real income is suspected to positively affect exports of selected Indonesian plantation commodities to destination countries. The positive relationship between the trading partner's real GDP on export volume follows the research of Yuniarti, (2007) and Ketenci, (2017), where they state that after Turkey's liberalization, the trading partner's real GDP has a significant effect on increasing the

average growth of export volume. The real GDP of trading partners reflects its purchasing power towards trade; thus, an increase in trading partners' real GDP will also increase economic activity, including trade, and increases exports.

The economic distance variable (ED_{jt}) shows a negative coefficient direction of - 1.544 and is significant at the 1% level, assuming ceteris paribus. These findings are consistent with the hypothesis that economic distance has a negative effect on exports of selected Indonesian plantation commodities to destination countries. This follows the research of Li, Song, & Zhao, (2010), where economic distance significantly reduces the average growth in export volume. Distance is an obstacle in international trade activities; if the distance between the two countries is far, the distribution costs will also be greater and vice versa (Krugman, Obsfeld, & Melitz, 2018).

Rubber Export Demand Model

The exchange rate variable shows a positive coefficient direction of 0.019, which is insignificant. This means that a trading partner's increasing exchange rate has a positive relationship with the volume of rubber exports. The positive relationship between the exchange rate during depreciation on export volume follows the research of Ginting (2013) and Ekananda (2005), which states that depreciation reduces the prices of domestic goods and increases the competitiveness of exported goods so that export demand increases.

The exchange rate volatility variable (Vol_{jt}) shows a negative coefficient direction of - 0.010 and is significant at the 10% level, assuming ceteris paribus. This negative relationship of exchange rate volatility on export volume follows the research of Ketenci, (2017), where exchange rate volatility significantly reduces the average growth of export volume before Turkey's liberalization. Exchange rate volatility is an exchange rate uncertainty where its increase may disrupt economic activity, including trade, and weaken exports. The results of this study also follow the research of Ekananda (2005) and Mauro (2000), which states that the highly volatile exchange rate indicates high uncertainty. The higher exchange rate volatility causes an increase in production costs to overcome uncertainty and reduce international trade flows. Meanwhile, Antonius (2001) on the free-floating exchange rate explains that the uncertainty of the real effective exchange rate significantly impacts non-oil and gas real exports in the long run.

The rubber export price variable (P_t) shows a positive coefficient of 0.041 and is significant at the 1% level, assuming ceteris paribus. This positive relationship of export prices on export volume does not fit the demand theory, which states that demand will decrease when the price increases and demand will increase when the price decreases. According to Purnamasari et al. (2014), the demand for Japanese natural rubber is independent of Indonesia. Natural rubber supplies from Thailand dominated Japanese natural rubber imports.

The real GDP variable of trading partners (Japan, China, The United States, Singapore, and Malaysia) (I_{jt}) shows a 0.590 positive coefficient direction and is significant at the 1% level, assuming ceteris paribus. The positive relationship of real GDP from trading partners on export volume follows the research of Purnamasari et al. (2014) and Ketenci

(2017) after Turkey's liberalization, where the real GDP of trading partners has a significant effect in increasing the average growth of export volume. The trading partner's real GDP reflects the country's purchasing power towards trade; thus, an increase in the real GDP of the trading partner increases economic activity, including trade, and increases exports.

The economic distance variable (ED_{jt}) shows a negative coefficient direction of 0.590 and is significant at the 1% level, assuming ceteris paribus. This negative relationship of economic distance on export volume follows the research of Li, Song, & Zhao, (2010), where economic distance significantly reduces the average growth in export volume. Distance is an obstacle in international trade activities; if the distance between the two countries is far, the distribution costs will also be greater and vice versa (Krugman et al., 2018).

Coconut Export Demand Model

The exchange rate variable (Er_{jt}) shows a negative coefficient direction of 0.107 and is significant at the 1% level, assuming ceteris paribus. The negative relationship of exchange rates during depreciation on export volume follows Yanikkaya, Kaya, & Kocturk (2013), which states that these commodities are insensitive to real exchange rates due to the market structure and the monopolistic power of producers coconut on international trade. According to Purnamasari et al.(2014), the appreciation of the Rupiah's real exchange rate against trading partners' exchange rate will increase commodity exports due to excess demand, which causes positive imports from Indonesian trading partners.

The exchange rate volatility variable (Vol_{jt}) shows a positive coefficient direction of 0.055 and is significant at the 1% level, assuming ceteris paribus. This positive relationship of exchange rate volatility on export volume follows the research of Yanikkaya, Kaya, & Kocturk, (2013), which states that, despite contradicting existing literature, the positive relationship on exports is because exporters easily cope with fluctuations in exchange rates through financial markets. According to Zainal, (2008), the export sector cannot adapt itself to economic conditions (exchange rate volatility). According to Chamunorwa & Choga, (2015) this positive relationship is due to the consequence of the open economic system of exporting countries. Thus, decreasing export profits from increased exchange rate uncertainty results in GDP reduction, this can be avoided by having exporting countries export more commodities in international trade.

The exchange rate volatility variable (Vol_{jt}) shows a negative coefficient direction of 0.285 and is significant at the 1% level, This negative relationship of export prices on export volume follows Hendria et al., (2018), which theoretically states that demands will increase when the price increases and demands increase when price decreases; in other words, the export price has a significant effect reducing the average growth of export volume.

The real GDP variable of trading partner (Japan, China, The United States, Singapore, and Malaysia) (I_{jt}) shows a positive coefficient direction of 1.311 and is significant at the 1% level, assuming ceteris paribus. The positive relationship of the trading partner's real GDP on export volume follows the research of Purnamasari et al., (2014) and

Ketenci, (2017) after Turkey's liberalization, where the trading partner's real GDP has a significant effect in increasing the average growth of export volume. The real GDP of trading partners reflects its purchasing power towards trade; thus, an increase in the trading partner's real GDP increases economic activity- including trade- and increases exports.

The economic distance variable (ED_{jt}) by 1,315 per year, assuming ceteris paribus. This means that the increasing economic distance has a negative relationship with coconut export volume. This negative relationship of economic distance on export volume follows the research of Li, Song, & Zhao, (2010), where economic distance has a significant effect in reducing the average growth in export volume. Distance is an obstacle in international trade activities; if the distance between the two countries is far, the distribution costs will also be greater and vice versa (Krugman et al., 2018).

Coffee Export Demand Model

The exchange rate variable (Er_{jt}) shows a negative coefficient direction of 0.089 and significant at the 1% level. This shows that a higher exchange rate (Er_{jt}) or depreciation of 1% will reduce the volume of coffee exports by 0.089% per year, assuming ceteris paribus. This negative relationship of exchange rates during depreciation on export volume follows the research of Yanikkaya, Kaya, & Kocturk, (2013), which states that these commodities are insensitive to real exchange rates due to the market structure and monopolistic power of coffee producers on international trade. According to Purnamasari et al., (2014), the appreciation of Rupiah's real exchange rate against the trading partner's exchange rate will increase commodity exports. This is due to excess demand, which causes imports to be positive from Indonesia's trading partners.

The exchange rate volatility variable (Vol_{jt}) shows a positive coefficient direction of 0.047 and is significant at the 1% level, assuming ceteris paribus. It follows the research of Yanikkaya (2013), which states that despite contradicting existing literature, the positive relationship of exchange rate volatility on exports is because exporters easily cope with fluctuations in exchange rates through financial markets. Furthermore, according to Zainal (2008), the export sector cannot adapt to economic conditions (exchange rate volatility). According to Chamunorwa & Choga (2015), this positive relationship results from the open economic system of exporting countries; thus, decreased export profits from increased exchange rate uncertainty results in GDP reduction; this can be avoided by having exporting countries export more commodities in international trade.

The coffee export price variable (P_t) shows a negative coefficient direction of 0.071 and is significant at the 10% level, assuming ceteris paribus. This negative relationship of export prices on export volume follows Hendria et al (2018); demand will decrease when the price increase and demand increases when the price decreases; thus, the export price significantly reduces the average growth of export volume.

The real GDP variable of trading partners (Japan, China, The United States, Singapore, and Malaysia) (I_{jt}) shows a positive coefficient direction of 0.709 and is significant at the 1% level, assuming ceteris paribus. The positive relationship of trading

partner' real GDP on export volume follows the research of Purnamasari et al. (2014) and Ketenci (2017) after Turkey's liberalization. The real GDP of trading partners has a significant effect on increasing the average growth of export volume. The trading partner's real GDP reflects its purchasing power towards trade; thus, its real GDP increases economic activity, including trade and exports.

The economic distance variable (ED_{jt}) shows a negative coefficient direction of 0.712 and is significant at the 1% level. This shows that every 1% increase in economic distance (ED_{jt}) will reduce the volume of coffee exports by 0.712% per year, assuming ceteris paribus. This negative relationship of economic distance on export volume follows the research of Li, Song, & Zhao, (2010), where economic distance significantly reduces the average growth in export volume. Distance is an obstacle in international trade activities; if the distance between the two countries is far, the distribution costs will also be greater and vice versa (Krugman et al., 2018).

Export Demand Model for Cocoa

The exchange rate variable (Er_{jt}) shows a positive coefficient direction of 0.094 and is significant at the 5% level, assuming ceteris paribus. The positive relationship of the exchange rate during depreciation on export volume follows the research of of Ginting, (2013) and Ekananda, (2005), which states that depreciation cheapens domestic goods and increases the competitiveness of exported goods so that export demand increases. This finding is in accordance with the hypothesis that the real exchange rate has a positive effect on Indonesia's selected plantation commodity exports to destination countries.

The exchange rate volatility variable (Vol_{jt}) shows a negative coefficient direction of 0.050 and is significant at the 5% level, assuming ceteris paribus. This negative relationship of exchange rate volatility on export volume follows the research of Ketenci (2014), where exchange rate volatility has a significant effect in reducing the average growth of export volume before Turkey's liberalization. Exchange rate volatility is an exchange rate uncertainty where its increase disrupts economic activity, including trade, thereby weakening exports. This study is also in line with the research of Ekananda, (2005) and Mauro, (2000) which states that highly volatile exchange rate indicates higher uncertainty. The higher exchange rate volatility causes an increase in production costs to overcome uncertainty and reduce international trade flows. Meanwhile, on the free-floating exchange rate explains that, in the long run, the uncertainty of the real effective exchange rate has a significant impact on non-oil and gas real exports.

The cocoa export price variable (P_t) shows a negative coefficient direction of 0.239 and is significant at the 1% level, assuming ceteris paribus. This negative relationship of export prices on export volume follows Hendria et al., (2018), that demand decreases when price increases and demands increase when price decreases; in other words, the export price has a significant effect in reducing the average growth of export volume.

The real GDP variable of trading partner (Japan, China, The United States, Singapore, and Malaysia) (I_{jt}) shows a positive coefficient direction of 0.563 and is

significant at the 1% level, assuming ceteris paribus. The positive relationship of real GDP from trading partner on export volume follows the research of Purnamasari et al., (2014) and Ketenci, (2017) after Turkey's liberalization, where trading partner's real GDP has a significant effect in increasing the average growth of export volume. The trading partner's real GDP reflects its purchasing power towards trade; thus, an increase in trading partner's real GDP increases economic activity- including trade- and increases exports.

The economic distance variable (ED_{jt}) shows a negative coefficient direction of 0.559 and is significant at the 1% level, assuming ceteris paribus. This negative relationship of economic distance on export volume follows the research of Li, Song, & Zhao, (2010), where economic distance has a significant effect in reducing the average growth in export volume. Krugman et al.,(2018) states that distance is an obstacle in international trade activities; if the distance between the two countries is far, the distribution costs will also be greater and vice versa.

CONCLUSION

The real exchange rate has a positive and significant effect on cocoa commodity exports but is not significant on rubber commodity exports. A high exchange rate or depreciation will cheapen domestic goods, thus increasing export demand. The exchange rate negatively and significantly affects palm oil, coconut, and coffee export. This indicates that the commodity is insensitive to real exchange rates due to market structure, monopoly power, and excess demand, which causes positive imports from Indonesia's trading partners. Exchange rate volatility negatively and significantly affects palm oil, rubber, and cocoa exports. Increasing exchange rate volatility will increase exchange rate uncertainty that disrupts international trading activities. Exchange rate volatility has a positive and significant effect on exports of coconut and coffee. Exporting countries export more coconut and coffee in international trade to overcome the decline in export profits from exchange rate uncertainty. Export prices negatively and significantly affect palm oil, coconut, coffee, and cocoa exports. This follows the demand theory; demands will decrease when the price increases and increase when the price decreases.

However, rubber's export price has a positive relationship with rubber's export. This is because Indonesia's rubber does not dominate rubber imports from a trading partner. The real GDP of trading partners has a positive and significant effect on palm oil, rubber, coconut, coffee, and cocoa exports. The real GDP of the trading partner reflects its purchasing power towards trade; thus, an increase in the real GDP of the trading partner increases economic activity- including trade- and increases exports. Economic distance negatively and significantly affects palm oil, rubber, coconut, coffee, and cocoa exports. Distance is an obstacle in international trade activities; if the distance between the two countries is far, the distribution costs will also be higher and vice versa.

The potential for developing Indonesia's export activities can continue to grow and improve because trading activities with trading partner countries are continuously increasing. This understanding is based on the real income of each country continuing to increase from year to year. This increase in income indicates the increasing purchasing

power of the people in a country to provide a reasonably good opportunity for traders in Indonesia to increase their international trade activities, especially export-oriented ones. Furthermore, the Government must strive to improve the competitiveness of domestic products against international products while anticipating competition between domestic exporters. In addition, stabilizing the exchange rate is necessary to keep volatility from being too high to reduce the negative impact on export trade.

Finally, the weakness of this study is that the research period has yet to consider the impact of the COVID-19 pandemic. Thus, further research should be carried out within a period that has considered the impact of Covid-19, especially during the Covid-19 pandemic. This matter needs to be done, considering the conditions before and after the Covid-19 pandemic will differ.

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APPENDIX

A. Multicollinierity

Table 4. *Multicollinearity Test Results of Oil Palm Total Export Volume Model*

	LogQ_t	LogEr_{jt}	LogVol_{jt}	LogP_t	LogI_{jt}	LogED_{jt}
$LogQ_t$	1.0000					
LogEr_{jt}	-0.0901	1.0000				
LogVol_{jt}	-0.4150	0.9129	1.0000			
LogP_t	0.6582	-0.0645	-0.2314	1.0000		
LogI_{jt}	0.2192	-0.2572	-0.2653	0.1888	1.0000	
LogED_{jt}	0.0679	-0.2511	-0.2097	0.0669	0.9869	1.0000

Table 5. *Multicollinearity Test Results of Rubber Export Total Volume Model*

	LogQ_t	LogEr_{jt}	LogVol_{jt}	LogP_t	LogI_{jt}	LogED_{jt}
$LogQ_t$	1.0000					
LogEr_{jt}	-0.0771	1.0000				
LogVol_{jt}	-0.3648	0.9129	1.0000			
LogP_t	0.7187	-0.0764	-0.2612	1.0000		
LogI_{jt}	0.2178	-0.2572	-0.2653	0.1676	1.0000	
LogED_{jt}	0.0688	-0.2511	-0.2097	0.0623	0.9869	1.0000

Table 6. *Multicollinearity Test Results of Coconut Total Export Volume Model*

	LogQ_t	LogEr_{jt}	LogVol_{jt}	LogP_t	LogI_{jt}	LogED_{jt}
$LogQ_t$	1.0000					
LogEr_{jt}	-0.0685	1.0000				
LogVol_{jt}	-0.2792	0.9129	1.0000			
LogP_t	0.6069	-0.0701	-0.2537	1.0000		
LogI_{jt}	0.1865	-0.2572	-0.2653	0.1938	1.0000	
LogED_{jt}	0.0590	-0.2511	-0.2097	0.0658	0.9869	1.0000

Table 7. *Multicollinearity Test Results of Coffee Total Export Volume Model*

	LogQ_t	LogEr_{jt}	LogVol_{jt}	LogP_t	LogI_{jt}	LogED_{jt}
$LogQ_t$	1.0000					
LogEr_{jt}	-0.0506	1.0000				
LogVol_{jt}	-0.2161	0.9129	1.0000			
LogP_t	0.5349	-0.0577	-0.2124	1.0000		

$LogI_{jt}$	0.1585	-0.2572	-0.2653	0.1949	1.0000	
$LogED_{jt}$	0.0494	-0.2511	-0.2097	0.0658	0.9869	1.0000

Table 8. *Multicollinearity Test Results of Cocoa Export Total Volume Model*

	$Log Q_t$	$LogEr_{jt}$	$LogVol_{jt}$	$LogP_t$	$LogI_{jt}$	$LogED_{jt}$
$LogQ_t$	1.0000					
$LogEr_{jt}$	-0.0302	1.0000				
$LogVol_{jt}$	-0.1715	0.9129	1.0000			
$LogP_t$	-0.1353	-0.0646	-0.2919	1.0000		
$LogI_{jt}$	0.0282	-0.2572	-0.2653	0.2114	1.0000	
$LogED_{jt}$	0.0118	-0.2511	-0.2097	0.0658	0.9869	1.0000

B. Heteroscedasticity

The results of the heteroscedasticity test for oil palm commodities using the Wald test method in Table 9 show that the oil palm export volume model is free from heteroscedasticity problems with a significance level of 10%, while the rubber, coconut, coffee and cocoa export volume models are free from heteroscedasticity problems because they have used Pooled EGLS (cross section random effect) model.

Tabel 9. *Heteroscedasticity Test Results of Total Oil Palm Export Volume Model*

Heteroskedasticity Test: Wald Test **H0: sigma(i)^2 = sigma^2 for all**			
Chi2(5)	10.36	Prob. Chi-Square(5)	0.0656

C. Autocorrelation

The results of the autocorrelation test for oil palm commodities using the wooldridge test method in Table 10 show that the oil palm export volume model is free from autocorrelation problems with a significance level of 1%, while the rubber, coconut, coffee and cocoa export volume models are free from autocorrelation problems because they have used Pooled EGLS (cross section random effect) model.

Table 10 *Autocorrelation Test Results of Total Oil Palm Export Volume Model*

Wooldridge test for autocorrelation in panel data **H0: no first-order autocorrelation**			
F(1, 4)	654.206	Prob. F	0.0000