DYNAMIC CAUSALITIES BETWEEN WORLD OIL PRICE AND INDONESIA'S COCOA MARKET: EVIDENCE FROM THE 2008 GLOBAL FINANCIAL CRISIS AND THE 2011 EUROPEAN DEBT CRISIS

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Abstract

This study examines and analyzes the short- and long-run dynamic causal relationship between the prices of Indonesian and world cocoa beans during the 2008 global financial crisis and the 2011 European debt crisis. Time series analysis consisting of cointegration, Vector Error Correction Model (VECM) and Granger causality are used to test long-run equilibrium, short- and long-run relationships, and dynamic causalities between the Indonesian cocoa and world cooa prices. The study found a long-run equilibrium between Indonesian cocoa price, world cocoa price, exchange rate, and world oil price. The Indonesian and world cocoa markets have a mutually influential relationship. However, an inefficient transmission of corrective adjustments in the Indonesian cocoa prices was documented over the study period. The exchange rate consistently affected Indonesian cocoa prices, while fluctuations in world oil prices were independent to domestic and world cocoa markets over the study period. Overall, the study documented a long-run equilibrium between Indonesian and global cocoa markets at the different level of speed of adjustment of the world cocoa price towards long-run equilibrium between the two economic crises. The Indonesian government needs to enhance international trade cooperation and pricing policy harmonization among cocoa producing- and importing-countries.

Keywords: Cocoa price, Exchange rate, Oil price, World cocoa market, Economic crisis
JEL classification: C01, C23, O13.

1. Introduction

The export of cocoa beans to the global cocoa market has been dominated by the developing countries (The United Nations Conference on Trade and Development - UNCTAD, 2015), including Indonesia. Meanwhile, the developed countries, in general, become importers of cocoa raw materials for fulfilling the needs of their manufacturing industry sector. As the third-largest cacao producing country after Ivory Coast and Ghana, Indonesia has contributed 15% (4.251 million tons) to the total world cocoa production (UNCTAD, 2017; Dewanta, 2019). The national production of cocoa in Indonesia has been contributed 87% by smallholder farmers, while the state plantation and larger private estates only contributed 8% and 5%, respectively (Yasa, 2005). In Indonesia, cacao plants are dominantly owned by farm households located in Sulawesi Island (Hoffmann et al., 2020). A total of 1.1 million households have involved in cocoa farming with a production area of 1.69 million hectares (Central Statistics Bureau of Indonesia - BPS, 2019).

Amid an increasing demand in the world cocoa market, the margin price received by the cocoa smallholder farmers as the primary cocoa producers in Indonesia has been relatively

lower compared to prices on the international market (Ministry of Agriculture of the Republic of Indonesia, 2016). Thus, the issue of the level of welfare of cocoa smallholder farmers has been a long-standing unresolved issue in Indonesia. The low quality of non-fermented cocoa beans exported to various destination countries has contributed to a cheaper of Indonesian cocoa prices (Witjaksono and Asmin, 2016). Fermentation of cocoa beans is one of the most critical ways in realizing an increase in cocoa value added (Figueroa-Hernández et al., 2019). Nevertheless, with an increasing trend of Indonesian cocoa production and world cocoa demand, the Indonesian cocoa agricultural sector could continuously capture the potential global market if it can maintain a long-run equilibrium between prices in the domestic and world cocoa markets.

Furthermore, with a large amount of potential land available for the development of cocoa farming business, Indonesia can play a role as a major raw material provider for the global cocoa processing industry sector endlessly despite the relatively low margin price enjoyed by the smallholder farmers. In Indonesia, cocoa is categorized as the primary commodity exports and is relied upon as an essential contributor to the national income and economic growth (Bank of Indonesia-BI, 2019). Indonesian cocoa has been very instrumental in ensuring world food security (UNCTAD, 2017). Thus, ensuring the steady growth of cocoa production and its price equilibrium become an important topic to be studied from an economic, ecological and social perspective. The government and stakeholders need to design proper agricultural-related economic policies for the highest smallholder farmers' benefits by making Indonesian cocoa more competitive in the global market (Mofya-Mukuka and Abdulai, 2013; Olimpia and Stela, 2017).

Global economic cycles often lead to volatility and persistence over national cocoa commodity prices. Changing trends in world food prices endanger food security worldwide, particularly in developing and underdeveloped countries. The dynamics of the global economy influence the behaviour patterns of export cocoa commodity markets (Ivanic and Will, 2014; Ying et al., 2014). The 2008 global financial crisis and the 2011 European debt crisis have triggered changes in the prices of food commodities and crude oil. Commodity price movements become more volatile after the 2008 global financial turmoil (Zhang et al., 2019). Coinciding with the onset of the economic crisis, worldwide cocoa and crude oil prices declined and fluctuated, which then impacted the world food price index (Cabrera and Schulz, 2016). Upon entering 2016, the world price of cocoa beans dropped dramatically (International Cocoa Organization-ICCO, 2016). Since 2004, the global factors have been becoming more significant in determining integration among commodity markets (Yin and Han, 2015). This shows that the market's ability to achieve price balances in both the short- and long-run has different effects and speed of adjustments across episodes of economic crisis due to differences in their nature, causes, intensities, and consequences.

With a large amount of potential land for the development of cocoa farming business, Indonesia can play a role as a major raw material provider for the global cocoa processing industry sector despite the relatively low margin price. In Indonesia, cocoa is included in the category of commodity exports and is relied upon as a contributor to the country's foreign exchange, boosting the pace of the national economy (Bank of Indonesia-BI, 2019), and is very instrumental in meeting world food needs (UNCTAD, 2017). Farm households mostly own cacao plants in Indonesia. A total of 1.1 million households are involved in cocoa farming with a production area of 1.69 million hectares (Badan Pusat Statistik Indonesia, 2019). This cocoa business is a type of small-scale smallholder plant whose production is central in Sulawesi Island (Hoffmann et al., 2020). Therefore, this sector is considered to be very strategic to be studied and developed from an economic, ecological and social perspective. The government and stakeholders need to design agricultural economic policies that are more competitive in the global market (Mofya-Mukuka and Abdulai, 2013; Olimpia and Stela, 2017).

Previous studies documented that the price cycle of domestic cocoa beans tends to become more sensitive to shocks in world prices and their quality (Fernández et al., 2017; Dewanta, 2019). The integration of commodity prices between international and domestic markets has been symmetrical (Arnade et al., 2017). This shows that a long-run equilibrium of the Indonesian cocoa market is closely related to the world cocoa price, which then creates horizontal market integration. However, an imbalance between the quantity of demand and

supply of cocoa leads to price volatility and readjustment (Ahrens et al., 2017). Cocoa price transmission can be viewed through interactions from the international to the domestic markets (Ceballos et al., 2017). Thus, the high volatility of world cocoa prices makes the lives of cocoa farmers vulnerable to poverty as in Africa (Tothmihaly, 2018). If the level of income received by cocoa farmers is still overshadowed by uncertainty due to price changes, then as much as possible it needs to be overcome through trade policies designed based on price forecasts and its long-run equilibrium.

In addition to pricing factors, exchange rate volatility also contributes to shocks to cocoa commodity prices (Cozmanca and Manea, 2010). Exchange rate volatility among countries has asymmetrical behaviour, and it affects export expansion, in addition to the emergence of strong positive effects due to exchange rate risk (Volkov and Yuhn, 2016; Buffie et al., 2018). The financial crisis is among the most significant factors in influencing exchange rates (Nedeljkovic and Urosevic, 2012). Besides, the global price of crude oil also plays a vital role in determining the prices of other commodities, including the price of cocoa beans on the domestic and international markets. Empirical evidence provides strong evidence of the impact of changes in world oil prices on agricultural commodity prices (Nazlioglu and Soytas, 2012; Fowowe, 2016). Where, the elasticity of real oil prices, in the long run, is expected to have a negative slope to demand, especially when it reaches peak production (Haugom et al., 2016).

Moreover, Wang et al. (2014) state that the price of crude oil and agricultural commodities experienced a sharp movement from 2006 to mid-2008. Economic pressures, restrictions on world oil production, and political turmoil caused crude oil prices to become increasingly sensitive (Shirinbakhsh and Bayat, 2011; Evgenidis, 2018). Therefore, there is a need for economic policy to minimize the adverse effects of global oil price movements on agricultural commodities' prices (Bastianin et al., 2016).

Many previous studies have investigated the effects of world oil price and the impact of exchange on the agricultural commodities market. For example, Wang et al. (2014) found the significant impact of oil prices on the prices of selected agricultural commodities in the US using the Structural Vector Autoregression (SVAR) approach. Meanwhile, Giordani et al. (2016) found a relationship among the prices of 32 food products in 77 countries in the world using the Two-Stage Least Square (2SLS) equation model. Using the Generalized Autoregressive Conditional Heteroscedasticity (GARCH) approach, Ceballos et al. (2017) found the transmission of grain prices from the international to the domestic markets of 41 food products in 27 developing countries.

Furthermore, Bahmani-oskooee and Aftab (2018) found the effect of changes in exchange rates on the Malaysia-China commodity trade using the Auto-Regressive Distributed Lag (ARDL) model. Nazlioglu and Soytas (2012) found links between oil prices, 24 agricultural commodity prices globally, and the exchange rate using panel cointegration and causality analyses. Volatility spillover was also found between the price of oil and the world price of wheat, corn, soybeans, and sugar using variance decompositions and impulse response functions techniques (Nazlioglu, Erdem, & Soytas, 2013). Finally, In the Indonesian context, Arsyad and Yusuf (2008) simulated that an increase in oil price causes cocoa exports to decline over 1983-2002.

The above reviewed previous studies generally examined the relationship of oil prices with prices of various agricultural commodities from various countries. They did not make specifications, both in terms of products and grouping data period based on the episodes of the economic crisis even though each economic crisis has different nature, causes, intensities, and consequences. In addition, although Indonesia is the third-largest cocoa producing country in the world, research on the effect of world oil prices on cocoa related-commodities in Indonesia is difficult to find published in international journals. Therefore, this research identifies agricultural commodities, specifically for Indonesian and world cocoa beans, to explore the behaviour of domestic cocoa prices and their short- and long-run relationships. This study also incorporates the exchange rate and West Texas Intermediate (WTI) oil variables into the time-series analyses using the Vector Error Correction Model (VECM), and multivariate Granger causalities approach. Besides, to offer detailed and accurate empirical findings of the impact of changes in oil prices on cocoa commodity prices across the

economic cycle periods, this study separates the analysis during the 2008 global economic crisis period and the 2011 European debt crisis.

The results of this study are expected to enrich the existing literature related to the interactions between world oil prices, exchange rates, and cocoa commodity prices from an Indonesian perspective. The results of this study will also be useful for policy-makers in designing cocoa commodity pricing strategies in Indonesia to improve the welfare of cocoa farmers. In addition, the results of this study also became an essential reference in formulating macroeconomic policy harmonization among global cocoa producers.

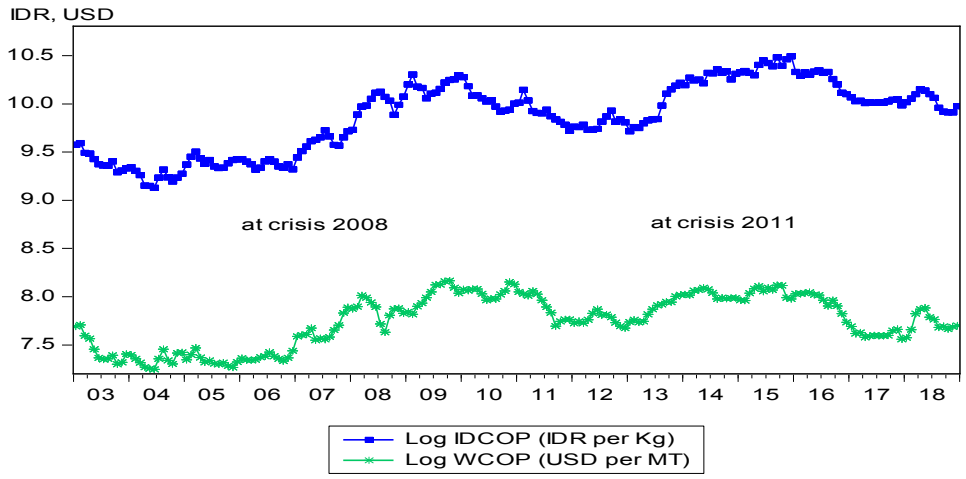
The rest of this study is structured in the following sequences. Section 2 presents the data and empirical research framework, followed by the findings, discussion, and implication of the study in Section 3. Finally, the conclusion is provided in Section 4.

2. Empirical Framework

2.1. Data

The main focus of this study is to highlight and measure the behaviour and short- and long-relationships between the price of Indonesian and world cocoa beans and their dynamic causalities during the 2003-2018 period. During the period of our study, the world cocoa bean market has been hit by two different economic crises, namely the 2008 global financial crisis and the 2011 European debt crisis. The extent of integration of the Indonesian and world cocoa prices, precisely the direction and pattern of price movements is illustrated in Figure 1.

Figure 1. Trends of Indonesian and world cocoa prices, 2003-2018



Sources: Central Bureau Statistics of Indonesia (BPS) and ICCO (2019).

To show changes in the growth of the cocoa beans prices, the data is transformed into the form of natural logarithms. As illustrated in Figure 1, the price movement of Indonesian cocoa beans (IDCOP) and the price of world cocoa beans (WCOP) show almost a similar pattern. This indicates that the international and domestic cocoa markets are symmetrically integrated (Arnade et al., 2017). The descriptive economic phenomenon which was passed by the economic crisis caused changes to prices quickly and had a profound impact. During the 2008 global financial crisis and the 2011 European debt crisis, the prices of cocoa beans in the Indonesian and global domestic markets show a declined trend.

Overall, IDCOP tends to move in parallel following the WCOP, especially when prices are experiencing an increase throughout 2003-2018 (ICCO, 2019). Meanwhile, the changes in the exchange rate of Indonesian Rupiah (IDR) to the US Dollar (USD) were still relatively stable before the 2008 global financial crisis. However, after passing through the 2008 economic crisis, the IDR depreciated sharply and fluctuated against the USD to the lowest level since 2003, amounting to IDR14,396.10 in September 2015, before returning to strengthen the following month (BI, 2019; IMF, 2019). Likewise, the world oil price of WTI type 2015 decreased to the lowest level in February 2016, amounting to USD30.35 per barrel (IMF,

2019). The phenomenon of volatile exchange rates and oil prices might have a negative influence on the cocoa market. Shah et al. (2019) stated that excessive economic uncertainty has a significant effect on economic activity and other macroeconomic variables.

This study utilizes monthly secondary time series data of Indonesian cocoa bean prices (IDCOP), world cocoa bean prices on the New York market (WCOP), the real exchange rate of IDR against USD (ER), and the world price of West Texas Intermediate (WOILP) crude oil over the period from January 2003 to December 2018. The data for IDCOP is gathered from the Central Bureau Statistics of Indonesia (BPS), while the WCOP is sourced from the International Cocoa Organization (ICCO). Furthermore, the ER is obtained from the Bank of Indonesia (BI) and the International Monetary Fund (IMF), and finally, the WOILP is collected from the International Monetary Fund (IMF).

Since the 2008 global financial crisis and the 2011 European debt crises have occurred during the study period, thus the analysis for each crisis period is performed to offer detailed empirical findings of the impact of changes in oil prices on cocoa commodity prices across the two economic crisis periods. The study then separates the data into three observational samples, namely:

i. Sub-sample 1: the 2008 global financial crisis period - covering January 2003 to December 2010 (89 observations);
ii. Sub-sample 2: the 2011 European crisis period - spanning from January 2011 to December 2018 (103 observations); and
iii. Full-sample: covering both Sub-sample 1 and Sub-sample 2 – spanning from January 2003 to December 2018 (192 observations).

2.2. Empirical model

The selection of variables used in the Vector Auto-Regressive (VAR) equation system is considered representative and relevant to answer the research objectives. Previous literature has explained the relationship between endogenous variables that influence each other (Nazlioglu and Soytas, 2012; Wang et al., 2014; Dewanta, 2019). First, what needs to be done in the identification and specification of the VAR model is the unit root test (Giuliodori and Rodriguez, 2015). The basic idea of the unit root test is represented in the following equations:

$$Y_t = \rho Y_{t-1} + \epsilon_t \quad \text{where, } -1 \leq \rho \leq 1 \tag{1}$$

$$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + \epsilon_t \tag{2}$$

$$Y_t - Y_{t-1} = (\rho - 1) Y_{t-1} + \epsilon_t \tag{3}$$

$$\Delta Y_t = \phi Y_{t-1} + \epsilon_t \tag{4}$$

when $\phi = (\rho - 1)$ has an absolute value of $\rho = 1$, thus $\phi = 0$, indicating the stochastic variable Y has a unit root or random walk, and the data is non-stationary. Δ in the Equation (4) is the first difference of the variable. To arrive at the stationary data, the differencing process, I(d) is taken so that the $\phi \neq 0$ or $\rho < 1$ (Gujarati and Porter, 2009).

This study adopts the Augmented Dickey-Fuller (ADF), and Philips-Perron (PP) approaches to test the data stationarity for all data sub-samples. If the absolute value of ADF and PP t-statistics is higher than the critical value of MacKinnon, or the p-value is smaller than the assigned significance level; thus, the observation data is said to be stationary. Given that the optimal lag length strongly influences the ADF and PP test results, therefore, the optimal lag-lengths included in the ADF test are determined based on the smallest values of Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwarz information criterion (SC), and Hannan–Quinn information criterion (HQ). Meanwhile, to determine the optimal lag-lengths included in the PP test, the study uses the truncation lag q from the Newey-West approach.

Furthermore, the type of time series data can be called cointegrated if at a certain differentiated level, I(d), the data is stationary. To test the presence of cointegration, the Johansen Cointegration test (Asteriou and Hall, 2011) is utilized in the study. Cointegration values can explain cointegrating relations if the balance error fluctuates around zero. This

shows that there is a long-term equilibrium relationship between endogenous variables at an optimal lag (p) in the VECM equation system. In other words, the error term (ϵ_t) must be a time-series data that is stationary and cointegrated viewed from the Trace statistic value that is greater than its critical value obtained from the following Equation (5):

$$Q_t = -T\sum_{i=r+1}^{k} \log(1-\lambda_i) \quad \text{where } r = 0, 1, ..., k-1 \tag{5}$$

Cointegration can also be identified from the Max-Eigen statistical value if it is greater than its critical value obtained from the following Equation:

$$Q_{max} = -T(1-\lambda_{i+1}) = Q_t - Q_{t+1} \tag{6}$$

If the test documented cointegration at a certain lag length, the short- and long-run relationships among variables could be properly estimated using the VECM technique. Following Wang et al. (2014) and Asteriou and Hall (2011), the general form of the VECM Equation could be written as follows:

$$\Delta Z_t = a_0 + a_{ij} + \Pi Z_{t-1} + \sum_{i=1}^{p} \Gamma_i \Delta Z_{t-i} + \epsilon_{ti} \tag{7}$$

where Z_t is an endogenous variable vector (i.e., IDCOP, WCOP, ER, and WOILP) with an order (n x m). Where, $\Pi = \alpha.\beta'$, matrix β' is a cointegration vector, and α is an error correction parameter vector. Meanwhile, Γ is the matrix of the coefficient modifier in the short- and long-run, and p is the optimal lag length.

Furthermore, the estimated regression of endogenous variables across the different crisis periods of the 2008 global financial crisis and the 2011 European debt crisis are estimated using the following VECM Equation:

$$\Delta IDCOP_t = a_1 + \beta_1 ECT(1)_{t-1} + \beta_{11}\sum_{i=1}^{P}\Delta IDCOP_{t-i} + \beta_{12}\sum_{i=1}^{P}\Delta WCOP_{t-i} + \beta_{13}\sum_{i=1}^{P}\Delta ER_{t-i} + \beta_{14}\sum_{i=1}^{P}\Delta WOILP_{t-i} + \epsilon_{t1} \tag{8}$$

$$\Delta WCOP_t = a_2 + \beta_2 ECT(2)_{t-1} + \beta_{21}\sum_{i=1}^{P}\Delta WCOP_{t-i} + \beta_{22}\sum_{i=1}^{P}\Delta IDCOP_{t-i} + \beta_{23}\sum_{i=1}^{P}\Delta ER_{t-i} + \beta_{24}\sum_{i=1}^{P}\Delta WOILP_{t-i} + \epsilon_{t2} \tag{9}$$

$$\Delta ER_t = a_3 + \beta_3 ECT(3)_{t-1} + \beta_{31}\sum_{i=1}^{P}\Delta ER_{t-i} + \beta_{32}\sum_{i=1}^{P}\Delta IDCOP_{t-i} + \beta_{33}\sum_{i=1}^{P}\Delta WCOP_{t-i} + \beta_{34}\sum_{i=1}^{P}\Delta WOILP_{t-i} + \epsilon_{t3} \tag{10}$$

$$\Delta WOILP_t = a_4 + \beta_4 ECT(4)_{t-1} + \beta_{41}\sum_{i=1}^{P}\Delta WOILP_{t-i} + \beta_{42}\sum_{i=1}^{P}\Delta IDCOP_{t-i} + \beta_{43}\sum_{i=1}^{P}\Delta WCOP_{t-i} + \beta_{44}\sum_{i=1}^{P}\Delta ER_{t-i} + \epsilon_{t4} \tag{11}$$

where *ECT* (Error Correction Term) is the adjustment correction of each equation in the VECM system. The negative and significant estimated coefficient of *ECT* indicates a gradual corrective in realizing a balance relationship from short- to long-term.

In the next step, the Granger causality test is conducted to measure the causal dynamic relationship among variables in the multivariate framework (Rahman and Kashem, 2017). The findings from the Granger causality test provide information related to causality and the direction of influence among variables (Asteriou and Hall, 2011). The existence of multivariate Granger causality could be identified from the probability value of the Wald test results. The multivariate Granger causality equation in the VECM system can be written as follows:

$$X(t) = \sum_{i=1}^{p} A_i X(t-i) + \epsilon(t) \tag{12}$$

where $X(t) \in R^{dx1}$ for t = 1,..., is a multivariate time series at optimal lag (p), and $\epsilon(t)$ is a Gaussian random vector, while A_i is a matrix for every i. If all estimates of the independent variable have a probability value of less than 0.05, then there is a causal relationship between the independent variables and the dependent variable within a multivariate framework.

3. Findings and Discussion

3.1. Statistic Descriptive

Descriptive statistics are useful to provide an overview of initial information about the investigated variables before conducting estimation regression. Table 1 illustrates that the mean prices of the Indonesian cocoa beans (IDCOP), world cocoa bean (WCOP) and WTI oil (WOILP) experienced a relatively significant increase over the period from June 2010 to December 2018. However, the highest values of world cocoa prices (WCOP) and WTI oil (WOILP) recorded in the Sub-sample 1 period (2003-2010). Meanwhile, the maximum value of the Indonesian cocoa price (IDCOP) and the IDR exchange rate existed in the Sub-sample 2 period (2010-2018). The changes in IDCOP and WCOP are relatively stable between the sub-sample periods.

Table 1. Statistic descriptive of the variables

Variable	IDCOP	WCOP	ER	WOILP
Full-sample: 2003-2018				
Mean	20581.36	2404.374	10599.03	68.469
Maximum	36065.00	3525.12	15010.00	133.93
Minimum	9235.00	1404.71	8235.80	28.09
Std. Deviation	6963.400	608.646	1946.639	24.160
Observations	192	192	192	192
Sub-sample 1: The 2008 global financial crisis (2003-2010)				
Mean	16305.17	2097.021	9363.748	62.217
Maximum	29885.00	3525.12	11866.30	133.93
Minimum	9235.00	1404.71	8235.80	28.09
Std. Deviation	6212.857	640.822	734.865	24.137
Observations	89	89	89	89
Sub-sample 2: The 2011 European debt crisis (2011-2018)				
Mean	24276.32	2669.950	11666.41	73.872
Maximum	36065.00	3472.27	15010.00	110.04
Minimum	16575.00	1917.68	8550.30	30.35
Std. Deviation	5268.250	430.987	2036.672	22.952
Observations	103	103	103	103

Furthermore, the ER volatility is higher and depreciates sharply in the Sub-sample 2. The ER has been very sensitive to external factors, especially when the world economy is facing the European debt crisis in 2011. An extreme point is identified during the period from May to June 2010. Based on the report of IMF (2019), the WTI crude oil was at a price level of USD73.74 per barrel in May 2010. In addition, WOILP has a higher standard deviation in the full sample period (2003-2018), while on average, the prices during the Sub-sample 2 is relatively higher, reaching USD73,872 per barrel. Geo-political and security tensions in the Middle East region in mid-2015 have caused volatility and fluctuations in world oil prices (Haugom et al., 2016).

3.2. Stationarity of Data

Unit root testing is an essential initial step when using time series data. In a time-series data analysis, all variables should be in the form of stationarity. This test has higher power when the time series exhibits nonlinear behaviour (Khraief et al., 2018). The findings of stationarity tests based on the ADF and PP tests are presented in Table 1.

Table 2. Results of unit root tests

Variable	Level		First Difference	
	ADF	PP	ADF	PP
Full-sample: 2003-2018				
IDCOP	0.7917	0.6860	0.0000***	0.0000***
WCOP	0.5145	0.8069	0.0000***	0.0000***
ER	0.7137	0.6126	0.0000***	0.0000***
WOILP	0.3076	0.3990	0.0000***	0.0000***
Sub-sample 1: The 2008 global financial crisis (2003-2010)				
IDCOP	0.1922	0.4915	0.0000***	0.0000***
WCOP	0.0290**	0.1274	0.0000***	0.0000***
ER	0.5977	0.4265	0.0000***	0.0000***
WOILP	0.0170**	0.2630	0.0000***	0.0000***
Sub-sample 2: The 2011 European debt crisis (2011-2018)				
IDCOP	0.9223	0.9140	0.0000***	0.0000***
WCOP	0.6274	0.7361	0.0000***	0.0000***
ER	0.6299	0.6415	0.0000***	0.0000***
WOILP	0.3504	0.5882	0.0000***	0.0000***

Note: ***, **, * Significant at the level 1%, 5%, 10%, the figures show p-values.

Table 2 presents the stationary test results of all variables, which can be identified from the p-value of the ADF and PP tests (Giuliodori and Rodriguez, 2015; Syahril et al., 2019). The acquisition of ADF and PP p-values at a higher level at a significance level of 1%, 5% and 10% shows non-stationary data, except only for data of WCOP and WOILP using the ADF approach for the sub-sample period of 2003 to 2010 with a significance level of 5%. Therefore, it is necessary to transform data so that all data becomes stationary. Through the differentiation process, $I(1)$ for each sub-sample, it is found that the ADF and PP p-values are smaller at 1% significance level, which means that the absolute value of the ADF and PP t-statistics is higher than the critical value. This shows that all data in all sub-samples have become stationary or contained no unit roots, where $\phi \neq 0$ (Equation 4). Agricultural commodities are very vulnerable to price volatility and market risk and changes in economic patterns and behaviour. Market prices are sensitive in times of crisis (El-Khatib and Hatemi-j, 2018) and speculation activities have a relatively large role in determining new prices equilibrium (Bohl et al., 2019).

After confirming that all variables are stationarity at the first difference, the cointegration is then tested. Since the cointegration test considers past values, thus the lag-lengths included in the estimation. To determining the optimum lag-length, the FPE, AIC, SC, and HQ criterion is used. The study identified that the proper optimum lag length for all sub-samples is equal to two based on all the above optimal lag-length criteria.

3.3. Johansen cointegration test

Cointegration test is conducted to explore the existence of a long-run relationship between variables that are non-stationary but have a linear combination (Giuliodori and Rodriguez, 2015). Table 3 presents the Johansen's cointegration test results based on each sub-sample with the two optimum lag-lengths.

As observed from Table 3, the values of Trace statistics and Max-Eigen statistics for all sub-periods are higher than their critical values at least at the 5% significance level. This means that there existed a cointegrating relationship between the variables of IDCOP, WCOP, ER, and WOILP. This further implies that there is a tendency of the variables to move together towards a long-run equilibrium (Wang et al., 2014; Cabrera and Schulz, 2016). Thus, to predict the long-run co-movement of a variable such as Indonesian cocoa beans price, it

can be predicted by relying on other variables such as world cocoa beans prices, oil prices, and exchange rate.

Table 3. The results of the Johansen cointegration tests

Null Hypothesis	Trace Test			Maximum Eigenvalue Test		
	Trace statistic	0.05 critical value	Prob.	Max-Eigen statistic	0.05 critical value	Prob.
Full-sample: 2003-2018						
r = 0	290.834	63.876***	0.0000	150.584***	32.118	0.0000
r ≤ 1	140.249	42.915***	0.0000	66.585***	25.823	0.0000
r ≤ 2	73.664	25.872***	0.0000	38.372***	19.387	0.0000
r ≤ 3	35.291	12.517***	0.0000	35.291***	12.517	0.0000
Sub-sample 1: The 2008 global financial crisis (2003-2010)						
r = 0	170.523	63.876***	0.0000	96.729***	32.118	0.0000
r ≤ 1	73.794	42.915***	0.0000	34.571***	25.823	0.0027
r ≤ 2	39.222	25.872***	0.0006	25.261***	19.387	0.0062
r ≤ 3	13.961	12.517**	0.0285	13.961**	12.517	0.0285
Sub-sample 2: The 2011 European debt crisis (2011-2018)						
r = 0	162.238	63.876***	0.0000	76.190***	32.118	0.0000
r ≤ 1	86.047	42.915***	0.0000	37.749***	25.823	0.0009
r ≤ 2	48.298	25.872***	0.0000	34.510***	19.387	0.0002
r ≤ 3	13.787	12.517**	0.0305	13.787**	12.517	0.0305

Note: *** and ** shows significance at the 1% and 5% levels.

Having a cointegration among the variables, thus study could properly use the VECM approach to measure the short- and long-run relationships among the investigated variables.

3.4. Long-run effects of world cocoa and oil prices, and exchange rate on the Indonesian cocoa price

Table 4 illustrates the findings of the long-run relationship between world cocoa price (WCOP), the exchange rate (ER), world oil prices (WOILP), and the Indonesian cocoa price (IDCOP) across three sub-samples of the study.

Table 4. Findings of the long-run relationship

Variable	IDCOP	WCOP	ER	WOILP
Full-sample: 2003-2018				
IDCOP	-	-0.113 [-11.011]***	-0.386 [-11.301]***	-0.141 [-11.045]***
WCOP	-8.840 [-10.849]***	-	3.415 [10.743]***	1.248 [10.803]***
ER	-2.588 [-5.214]***	0.292 [5.031]***	-	0.365 [5.808]***
WOILP	-7.083 [-0.383]	0.801 [0.380]	2.736 [0.436]	-
Sub-sample 1: The 2008 global financial crisis (2003-2010)				
IDCOP	-	-0.114 [-7.890]***	-0.394 [-8.085]***	-0.219 [-8.034]***
WCOP	-9.040 [-8.233]***	-	3.510 [8.255]***	1.983 [8.308]***
ER	-2.906 [-4.416]**	0.321 [4.321]**	-	0.637 [5.397]***
WOILP	-4.558 [-0.192]	0.504 [0.190]	1.568 [0.236]	-
Sub-sample 2: The 2011 European debt crisis (2011-2018)				
IDCOP	-	-0.110 [-8.766]***	-0.553 [-9.114]***	0.121 [8.509]***
WCOP	-9.095 [-9.036]***	-	5.033 [8.719]***	-1.104 [-8.782]***
ER	-1.807 [-2.714]**	0.199 [2.519]**	-	-0.219 [-2.653]**
WOILP	8.238 [0.322]	-0.906 [-0.323]	-4.559 [-0.337]	-

Note: ***, **, and * show significance at the levels of 1%, 5%, and 10%, and [.] is the t-statistics.

As observed in Table 4, the study found a different size and direction of the long-run relationship between the variables. The WCOP has a significant negative effect on IDCOP at the 1% level, and vice versa. In a long-run, an increase in WCOP has led the IDCOP to decline. Similarly, an increase in WCOP has caused the IDCOP to fall. This negative bidirectional causal relationship is due to the nature of the Indonesian cocoa commodities as the complement for other cocoa suppliers. Lower cocoa beans have caused some cocoa farmers to plant corn, rubber, and palm oil (Permani, 2013), which caused the production of cocoa beans in the long-run to decline and consequently led to an increase in domestic cocoa prices in Indonesia.

Additionally, the low quality of the Indonesian cocoa (Dewanta, 2019) that failed to meet the international standard. As the price of the Indonesian cocoa increases, the consumer would demand more world cocoa commodities due to its lower price and high quality. To maintain its high demand, the world cocoa price remained lower in the long-run. Similarly, as the price of the world cocoa increases, the consumer would demand more cocoa commodities from Indonesia due to its lower price. To maintain its high demand, the domestic cocoa price in Indonesia remained kept lower in the long-run mainly due to its low quality.

The study also found a significant negative effect of world oil price (WOILP) and the Indonesian exchange rate (ER) on the IDCOP at the 1% level, respectively. Almost 90% of cocoa production in Indonesia is marketed in the domestic market (Dewanta, 2019). Thus, the changes in the world oil price took a more prolonged effect on the Indonesia local market. An increase in world oil price caused a rise in the cost of production of processed cocoa such as cocoa liquor, powder and cocoa butter which lead to lower demand of the processed cocoa products in the Indonesian cocoa trading partners. Since Indonesia mainly exported the raw cocoa to Malaysia and Singapore that used as complementary inputs for their processed cocoa products (Dewanta, 2019), thus their demand for Indonesian cocoa would decline in the long-run. Lower demand for Indonesia cocoa has led to the price of Indonesian cocoa would also fall. The finding of negative effect exchange rate on Indonesian cocoa is in line with many previous studies (Olaiya, 2016; Verter, 2016). As the IDR appreciates, it has caused the domestic cocoa price in Indonesia to become more expensive and less competitive in the world cocoa market. Consequently, the demand for the price would decline, and their price would fall in the long-run.

On the other hand, the IDCOP has an insignificant effect in the WOILP, while IDCOP negatively affected ER. Only about 10% production of Indonesian cocoa beans has been mainly exported to the Asian market (92.46%), mostly to Malaysia (57.26%) and Singapore (31.88%). Meanwhile, the cocoa exports of Indonesia to other countries have been too small, namely to North America (4.95%) and Europe (2.54%) (International Trade Centre - IRC, 2001-2020). Overall, the Indonesian cocoa export value only amounted to USD112 Million in 2017. A small portion of Indonesian cocoa contribution to the world cocoa market is believed to have an insignificant effect on the world oil price. Finally, implementation of a cocoa bean export tax in the country through the Minister of Finance Regulation No. 67/PMK.011/2010, further caused lower export values of Indonesian cocoa beans to the world market (Permani, 2011).

A relatively higher domestic cocoa price caused Indonesian cocoa becomes less competitive worldwide in the short-run. Thus, to make it more attractive and competitive to the cocoa market, the exchange rate policy is implemented by depreciating Indonesian exchange which caused IDR to decline in the long-run. This could be the main reason for the adverse effect of IDCOP on the exchange rate in Indonesia.

Our study also documented a positive effect of world cocoa price on the exchange rate and vice versa. As the IDR appreciates, it has caused the domestic cocoa price in Indonesia to become more expensive and less competitive in the world cocoa market. To anticipate a lower demand for the Indonesian cocoa beans in the long-run due to its exorbitant prices, the price of the Indonesian cocoa beans would be lower and adjusted to the world cocoa market. Our finding is similar to Alori and Kutu (2019), who revealed that the shocks to the exchange rate affected the volatility of the value of cocoa exports in Nigeria positively. Thus, to enhance the cocoa exports, the government should stabilize the exchange rate through the managed exchange rate policy.

Finally, the WOILP positively affected both WCOP and ER, while WCOP and ER have a non-causal effect on WOILP. It has been well-documented that oil is the main caused on supply-side inflation. An increase in oil price contributes to the rise in the prices of many other products, including cocoa processed commodities. Additionally, real oil prices have been documented as the dominant source of real exchange rate movements. There has been a link between real oil prices and real exchange rates (Chen & Chen, 2007). Ghosh (2011) found positive oil price shocks on exchange rate volatility, and their effects were permanent on exchange rate volatility.

Overall, the nature of long-run relationships between IDCOP and other variables were similar across the sub-samples; the only differences are in term of the sizes. During the 2008 global financial crisis and the 2011 European financial crisis, the effects of exchange rate were more prominent due to higher exchange rate volatility during economic crises periods. For all sub-samples, the study found the bidirectional long-run effects between IDCOP and WCOP, IDCOP and ER, and WCOP and ER, while the unidirectional long-run effect is seen from the WOILP to IDCOP, WOILP to WCOP, and WOILP to ER. These findings show the critical role of world oil price in determining the worldwide economy. An increase in world oil price has led the world cocoa beans price to increase, the IDR to appreciate, and the IDCOP to decline.

The existence of a long-run relationship between IDCOP and WOC indicates the integration of the Indonesian and world cocoa market horizontally (Arnade et al., 2017). Due to weak competitiveness after being subjected to cocoa export duties, low quality of cocoa beans, and non-fermented cocoa exports lead to asymmetrical relationships between domestic cocoa in Indonesia and world cocoa market (Witjaksono and Asmin, 2016; Hasibuan and Sayekti, 2018). A sense of awareness to establish cooperation through regional trade agreements has reduced competition in the agricultural commodity market (Jambor et al., 2020). In general, our findings also show the sensitivity of IDR against USD exchange rate to net exports, the country's economic policies and market turmoil. The relationship between fiscal and monetary policy interactions can explain the implications of exchange rate conditions.

Finally, according to Volkov and Yuhn (2016) and Nakatani, 2018), an increase in inflation can damage the real exchange rate. WTI crude oil failed to reach equilibrium in short- to long-term. Haugom et al. (2016) stated that to make predictions about oil prices, it has a risk challenge. WTI oil prices fluctuated when the economy experienced a crisis in 2008 and 2011, the peak of which occurred in 2015. According to Evgenidis (2018), geo-political tensions, particularly in the Middle Eastern countries have caused high volatility in world oil prices and have an impact on macroeconomic fluctuations. The relationship of agricultural commodity prices is non-neutral with the world price of oil (Fowowe, 2016).

3.5. Multivariate dynamic causal relationships among prices of Indonesian cocoa, world cocoa, world oil, and exchange rate

Table 5 provides the findings of short- and long-run relationships and multivariate dynamic causal relationship among Indonesian cocoa price (IDCOP), world cocoa price (WCOP), world oil price (WOILP), and exchange rate (ER) across three sub-sample periods.

As illustrated in Table 5, the study found a long-run equilibrium between Indonesian cocoa price (IDCOP) and the variables of world cocoa price (WCOP), world oil price (WOILP), and exchange rate (ER). This is indicated by negative and significant Error Correction Terms (ECT) for all sub-samples. This means that a short-run disequilibrium in the Indonesia domestic cocoa price would be adjusted to a long-run equilibrium with the speed of adjustments of 0.931 during the 2003-2018 (full sample), -0.773 during the 2003-2010 period (the 2008 global financial crisis sub-sample), and -0.919 during the 2011-2018 period (the 2011 European debt crisis sub-sample). During the 2008 global financial crisis period, the speed of adjustment is slower as compared to the 2011 European debt crisis period, and the full sample period. It took a week for a short-run disequilibrium in the domestic cocoa price to be cleared and restored back to a long-run equilibrium during the 2008 global financial crisis.

Meanwhile, during the 2011 European debt crisis period and full sample period (2003-2018), to restore back the Indonesian cocoa market from the short-run disequilibrium to long-run equilibrium, it took 3 days and days, respectively. This further shows that the 2008 global financial crisis hit hardest the world economy, including the cocoa market. Thus, it took a more extended period for the cocoa market to restore back to its long-run equilibrium.

Table 5. Multivariate Dynamic causal relationships

Variable	IDCOP	WCOP	ER	WOILP	ECT
Full-sample: 2003-2018					
IDCOP	-	87.934*** (0.000)	58.622*** (0.000)	1.980 (0.371)	-0.931 [-11.270]***
WCOP	18.757*** (0.000)	-	9.562*** (0.008)	2.172 (0.337)	-0.474 [-5.331]***
ER	3.625 (0.163)	7.816** (0.020)	-	4.193 (0.123)	-0.089 [-1.582]
WOILP	1.800 (0.406)	2.359 (0.307)	4.833* (0.089)	-	0.003 [1.225]
Sub-sample 1: The 2008 global financial crisis (2003-2010)					
IDCOP	-	63.396*** (0.000)	33.011*** (0.000)	1.568 (0.456)	-0.773 [-8.960]***
WCOP	8.995*** (0.011)	-	1.961 (0.375)	0.244 (0.885)	-0.324 [-2.626]**
ER	2.330 (0.312)	12.769*** (0.002)	-	2.289 (0.318)	-0.145 [-1.832]*
WOILP	3.713 (0.156)	5.944** (0.051)	5.631* (0.060)	-	0.004 [1.695]
Sub-sample 2: The 2011 European debt crisis (2011-2018)					
IDCOP	-	29.049*** (0.000)	16.219*** (0.003)	0.053 (0.974)	-0.901 [-11.081]***
WCOP	13.314*** (0.001)	-	12.956*** (0.002)	3.819 (0.148)	-0.656 [-5.065]***
ER	0.226 (0.893)	0.260 (0.8780)	-	2.325 (0.313)	0.022 [0.363]
WOILP	1.573 (0.4552)	1.216 (0.5444)	1.384 (0.501)	-	-0.006 [-1.099]

Note: ***, **, and * show significance at the level 1%, 5%, and 10%, respectively. Figures in (.) and [.] show probability value and t-statistics.

The impact of the 2008 global financial crisis has caused shocks to the global cocoa market (Bahmani-oskooee and Aftab, 2018; Dias et al., 2019). This effect was evident in an increased level of fragility of the Indonesian cocoa market marked. Thus, when the economy faces a financial crisis, a hedging policy is a suitable strategy to manage the cocoa price sensitivity to the exchange rate fluctuations (El-Khatib and Hatemi, 2018). Besides, Indonesian cocoa beans traded in the global cocoa market were generally of low quality and non-fermented (Witjaksono and Asmin, 2016). This made the Indonesian cocoa beans used as supplementary raw material for the premium quality of Ghana cocoa beans (Quarmine et al., 2012) in the cocoa industry activities in Malaysia (Dewanta, 2019). Indonesian cocoa market has also faced an increasingly widespread of the 2011 European debt crisis.

In terms of short-run relationship and multivariate Granger causal relationship, the study recorded a bidirectional Granger causality between Indonesian cocoa price (IDCOP) and world cocoa price (WCOP) for all sub-samples. The Granger causal effects of WCOP on IDCOP were higher than the effects of IDCOP on WCOP for all sub-samples period. Although Indonesia is the third-largest cocoa producing country in the world, but more than 85% of its production is marketed in the domestic market. In comparison, only less than 15% of its production is exported to the world market (Dewanta, 2019). Countries in the African region dominate the determination of world cocoa bean prices (Wessel and Quist-wessel, 2015). This is believed to be the main reason for the more considerable influence of the world

cocoa market in the Indonesian domestic cocoa market. In other words, the world cocoa market dominated the changes in the Indonesian cocoa market. This finding shows that any pricing policy designed by the Indonesian government to regulate the domestic cocoa market should be strictly referred to the world cocoa market movements. Thus, pricing policy harmonization between the world cocoa suppliers, mainly through the ICCO, should be enhanced.

As the third-largest producer of cocoa beans in the world, Indonesia could ideally play a more significant role in determining the world cocoa market (Hoang and Meyers, 2015). But in fact, the behaviour of Indonesian cocoa prices follows the world price, because 70% of the world cocoa market share is controlled by countries in the West African region (Wessel and Quist-Wessel, 2015). Countries in the African region have a more exceptional competitive ability in the world cocoa market. Although the smallholder farmers have produced both cocoa farming in Africa and Indonesia (Wessel and Quist-Wessel, 2015; Hoffmann et al., 2020), but Indonesia has a minor role in the global cocoa market.

Table 5 also shows that there was a unidirectional relationship running from the ER to the IDCOP for all sub-samples. This indicates that the exchange rate volatility Granger caused changes in the price of cocoa beans in Indonesia. An appreciation (depreciation) of IDR caused the domestic cocoa product to become more expensive (cheaper) as compared to the cocoa prices in the world market. Similarly, the changes in the exchange rate have also a unidirectional Granger caused world oil price during the 2008 global financial crisis and the full sample period. However, during the 2010 European crisis period, the exchange rate has no causal relationship with the world oil price.

The exchange rate (ER) shows the asymmetrical effect in realizing the IDCOP balance in short- to long-run equilibrium. This is in line with the study by Volkov and Yuhn (2016), which documented that exchange rates have asymmetrical behaviour. Over the 2010-2018 period, IDR experienced a higher depreciation against USD. The financial crisis has triggered exchange rate fluctuations (Nedeljkovic and Urosevic, 2012). Commodity price movements have a higher level of significance after 2008 (Zhang et al., 2019). However, profits from trading activities cannot always be achieved when export duties imposed and faced high exchange rate risks. The Indonesian government has imposed a tax on Indonesian cocoa bean exports since April 2010. The implementation of the export tax policy hurts the competitiveness of cocoa beans (Hasibuan and Sayekti, 2018).

Furthermore, the study found that the WCOP and ER are found to have a bidirectional causal relationship during the full sample period. However, Effect of WCOP on ER is smaller as compared to the effect of ER on WCOP, indicating the more significant role of managing exchange rate in stabilizing the world cocoa market. During the 2008 global financial crisis, a unidirectional causality running WCOP to ER is found. On the other hand, during the 2011 European debt crisis, a unidirectional causality running from ER to WCOP is documented. Higher volatility of the exchange rate in the Eurozone during the debt crisis in 2011 adversely affected the world cocoa market. The movement of the exchange rate of IDR against USD was relatively stable over the 2003 to 2010 period, but experienced a substantial depreciation from over the period from 2011 to 2018, as was the case with world oil prices. In general, the exchange rate volatility has been very sensitive to net exports, the country's economic policies and market turmoil. The relationship between fiscal and monetary policy interactions can explain the implications of exchange rate conditions. Volkov and Yuhn (2016) and Nakatani (2018), an increase in inflation can damage the real exchange rate and consequently world oil price. Thus, predicting oil prices movement has a risk challenge as it caused by many other variables (Haugom et al., 2016).

Finally, the WOILP is found to be independent during all sub-sample periods, indicating non-unidirectional Granger causal effect running from WOILP to other variables. This evidence is also supported by the insignificance of all estimated coefficients of ECTs in the equation system. The price of WTI oil (WOILP) was insignificant in realizing the balance of IDCOP as a raw material product for the agricultural sector in all three sub-samples. Fluctuations in oil prices have an insignificant effect on the prices of cocoa beans in the domestic market. During the 2008 global financial crisis and 2011 European debt crisis, the price of WTI oil reached a maximum value of USD133.93 and USD110.04 per barrel; however, its volatility could be a source of fluctuations in economic variables (Dahl et al.,

2019) but in the Indonesian and global cocoa market. However, Ramli et al. (2019) found that the prices of rubber in Indonesia, Thailand, Malaysia and crude oil were symmetrical. Thus, it shows that the transmission of prices between commodities in international markets has been different, depending on their nature and use value (Arnade et al., 2017).

Overall, our findings show the integration between Indonesian and world cocoa markets during the study period, including the 2008 global financial crisis and the 2011 European debt crisis periods. A short-run disequilibrium in the Indonesian cocoa market due to shocks in other macroeconomic variables has been adjusted from time to time to its long-run equilibrium (Nazlioglu, 2014; Ahrens et al., 2017). The level of integration in cocoa commodity markets has been influenced by global factors (Yin and Han, 2015). However, their nature of dynamic causal relationships has been shaped by the nature, intensity, and consequences of economic crisis. Macroeconomic harmonization policy should be designed by cocoa-producing countries under the purview of ICCO to minimize the global economic shocks. Finally, the hedging policy is a better strategy to be implemented by the Indonesian government and other cocoa-producing countries to mitigate the exchange rate risk.

4. Conclusion

This study examined and analyzed the short- and long-run dynamic relationships between the prices of Indonesian cocoa beans and the world cocoa market during the 2003-2018 period, comprising the periods of 2008 global financial crisis and 2011 European debt crisis. Based on cointegration analysis, the study documented a long-run equilibrium between the Indonesian and the world cocoa market. Based on the VECM approach, the study found disequilibrium in the Indonesian cocoa markets due to shocks in the world cocoa market, exchange rate, and world oil prices were corrected in realizing long-run equilibrium conditions. The exchange rate affected Indonesian cocoa prices, while, fluctuations in world oil prices was independent to the cocoa markets, domestically and globally.

Efforts to explain the relationship and influence of global factors on the price of a commodity are the leading indicators that need to be managed to gain trade benefits (Ceballos et al., 2017). The relatively low price of Indonesian cocoa beans in the international market is a challenge and at the same time an opportunity if it can prepare fermented cocoa beans. Indonesian cocoa market has the potential to have horizontal integration with the global cocoa market. The prices of Indonesian and world cocoa beans influence each other in the short-term and long-term equilibrium relationships. Most of the Indonesian cocoa beans traded on the international market have been of low quality and generally non-fermented. The low quality of cocoa has an impact on weak market competition. Improving the quality of cocoa supplier enhance the market power of cocoa producers to determine the price of cocoa beans (Figueroa-Hernández et al., 2019).

The corrective ability of Indonesian and world cocoa beans prices to make adjustments towards different economic shocks was difference across the crisis periods. The speed of adjusting the price of Indonesian cocoa beans has been relatively slower compared to world prices. The Indonesian cocoa market tends to follow the direction of changes in world markets with a pattern of asymmetrical relations. The integration of international and domestic markets is symmetrical (Arnade et al., 2017). On the other hand, Andrade and Zachariadis (2016) stated that asymmetrical relationships occur between markets that have vertical integration. The exchange rate has a significant effect on Indonesian and world cocoa prices. The economic crisis contains uncertainty, making oil prices play a unique role in more considerable variations in agricultural commodity prices (Wang et al., 2014; Degiannakis and Filis, 2018).

The government and stakeholders need to encourage the success of Indonesian cocoa farming through agricultural and trade policies by taking into account the profitability of farmers. The government needs to increase international trade cooperation with export destination countries based on improving the quality standards of cocoa production to grasp full advantage of export opportunities at the time of exchange rate depreciation. The intensifying land for cocoa could promote Indonesian cocoa farming business to the world market.

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